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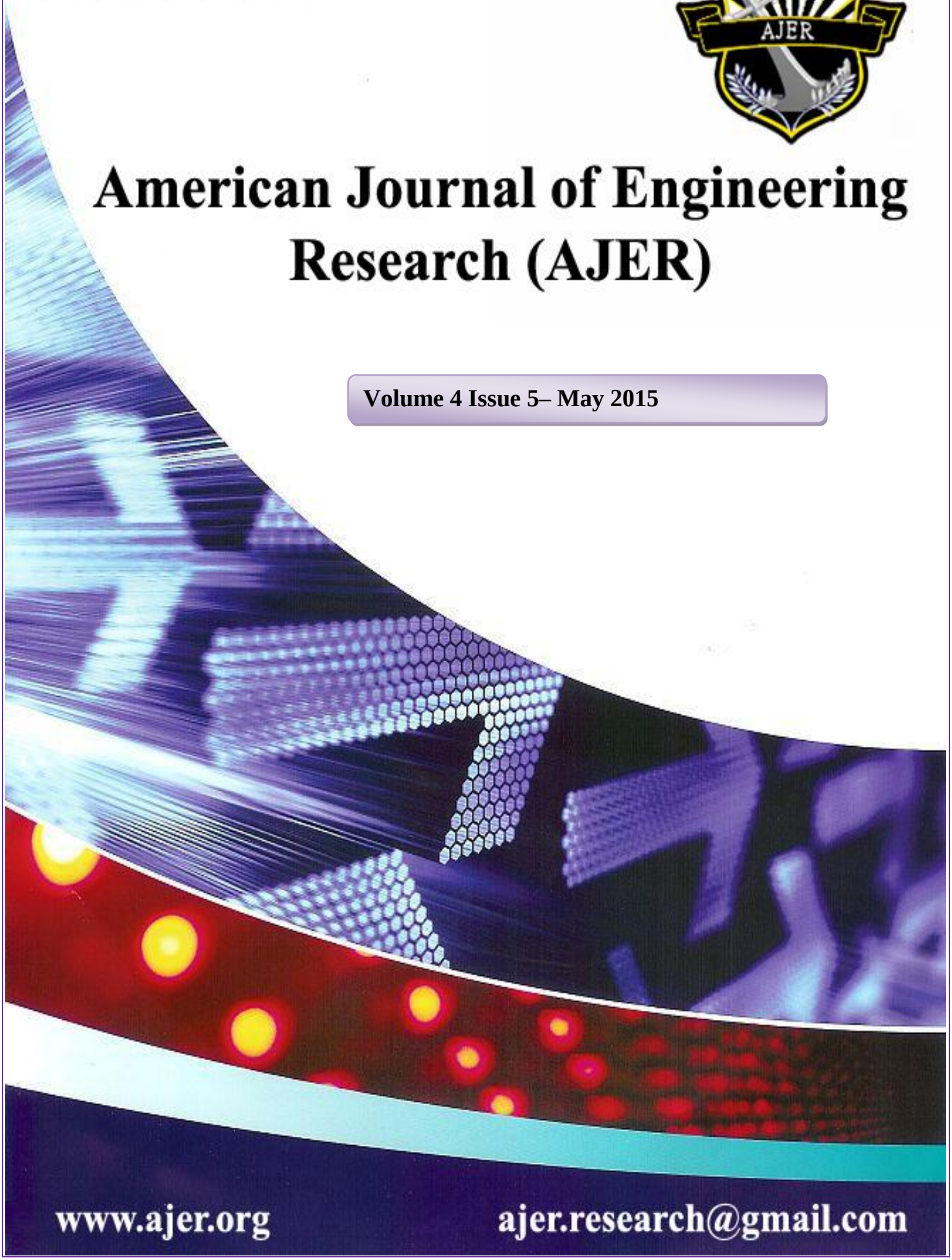

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Performance Evaluation of Insulating Firebricks Produced from Hydrometallurgically Purified Termite Hill Clay Reinforced with Alumina

[1,2]D.O. Folorunso, [1]S. Aribo, [1,3] O. Olaniran

[1] *Department of Metallurgical and Materials Engineering, Federal University of Technology, Akure, Nigeria*
[2] *Africa Materials Science And Engineering Networks: A Carnegie-IAS (RISE) Networks*
[3] *Department of Chemical and Metallurgical Engineering, Tshwane University of Technology, Pretoria West, Pretoria, South Africa.*

ABSTRACT : *The performance of insulating firebricks produced from hydrometallurgically purified termite hill clay admixed with varying percentages of alumina cement has been qualitatively evaluated. A large quantity of termite hill clay was mined from a location on the campus of The Federal University of Technology, Akure (FUTA), Nigeria. The bulk of clay was washed in water, the deleterious shafts decanted, the slurry dried in sun for three days and later in the oven at 90 °C for eight hours. The dried clay was then crushed and ground to a fine size of 100 µm, being the average particle size upon the sieve size analysis. Sieved clay was purified hydrometallurgically at a predetermined condition; 1.6 mol/dm^3 of oxalic acid at 90 °C for 150 min. and 200 rev/min agitation. Raw and purified clays were characterized using X-ray diffraction, Scanning Electron Microscopy and Transmission Electron Microscopy. Purified clay samples containing 5 – 20 % alumina were again fired at varying temperatures of 900 °C, 1100 °C, 1300 °C and 1500 °C and tested for some important refractory properties such as permanent linear change, modulus of rupture and permeability. Sample (purified clay + 10 % alumina fired at 1500 °C) that exhibited the best combination of these properties was examined under scanning electron microscope to see the effect of heat and analyzed chemically using the X-ray fluorescence machine to know the precise compositions.*

Keywords: *Insulating firebricks, Hydrometallurgy, Termite hill clay, Purification and Predetermined condition.*

I. INTRODUCTION

The insulating firebrick is a class of bricks which consists of adequately porous kaolin or fireclay. They are low in thermal conductivity, lightweight and sufficiently resistant to temperature which enables them to be used successfully on the hot side of the furnace wall. This therefore permits the use of thin walls of low thermal conductivity and low heat content. The low heat content is particularly valuable in saving fuel, time on heating up and allows rapid changes in temperature to be made, and also permits rapid cooling [1]. Even though substantial amount of research has been carried out in the area of production and development of good refractory materials for more than two centuries, the outcome of which has resulted in the varieties of refractory materials available in the world market today [2], most developing nations that are consumers of refractory materials still have to spend their hard-earned foreign reserves on the importation of these materials to meet their needs. In the light of this situation, there has been a continuous upsurge of interest in the imperative of looking inward, to develop good refractories using locally sourced materials. Consequently, a number of researches have been carried out on the thermophysical and thermochemical behaviour of some Nigerian refractory raw materials [3]. However, two major factors are still accentuating the development of good refractories using the local raw materials. The first one is the growing number of metallurgical industries that are in dire need of these refractories, while the other factor is the advent of foreign exchange market, a situation that has led to higher and unaffordable cost of procuring the refractory materials needed by these industries [2].

Despite the observation, that the behaviour of termite hill clay when subjected to refractory tests is in good comparison with the firebricks used for refractory applications [4], further improvement may still be obtained when an additive such as alumina cement is added in appropriate proportions or other forms of rectification are made. This notion has therefore informed the need for this research effort.

II. MATERIALS AND METHODS

The materials and equipment used were raw termite hill clay, oxalic acid (99.8% purity), alumina cement (Secar 71), atomic absorption spectrometer (AAS) machine (model Spectre AA 220 FS), X-ray fluorescence (XRF) machine (model ARL 8410), scanning electron microscope (SEM) model JEOL 840 and coupled with an EDS analyzer, X-ray diffraction (XRD) machine (model Philips PW 3710 with PW 1752 graphite monocromator), sieve size analyser (Microtrac FLEX 10.5.4), Labcon shaking incubator (models 3081U and 5082U), Carbolite furnace, Rawwley Sussex jaw crusher and grinder.

2.1 Preliminary Preparations for Analysis

A large quantity of termite hill clay was mined from FUTA campus in Nigeria. It was then washed in water in order to remove the deleterious particles by decantation. Water was then drained from the clay slurry using a plaster of Paris (P.O.P.) mould. The recovered clay was then dried in the sun for three days and again in the Carbolite furnace at 90 °C for 8 hours. The dried clay was finally jaw crushed and ground in a Rawwley Sussex grinder to 100 µm.

2.2 Sieve Analysis

Size analysis was carried out on the ground clay using Microtrac FLEX 10.5.4 Filter enabled analyzer. 20 g of the clay was fed into the machine, with a loading factor of 0.0173, transmission rate of 0.851 and allowed to run for 10 seconds. The average sieve size was found to be about 100 µm. The bulk of the clay was therefore sieved to 100 µm for subsequent analyses carried out on it, in order to ensure uniformity.

2.3 Clay Characterization

Analyses of the clay were carried out using XRD, TEM, SEM/EDS and XRF according to the standard procedure [5]. The results are presented in Figures 1, 2, 6 and Table 1 respectively.

2.4 Hydrometallurgical Processing of Termite Hill Clay

The clay was treated hydrometallurgically by putting a large quantity of clay and 500 % by volume of 1.6 mol/dm^3 of prepared oxalic acid solution in a flat-bottom glass container and kept inside the Labcon shaking incubator, models 3081U and 5082U for agitation at 200 rev/min at 90 °C for 150 min [6]. On the expiration of the set time, the container was removed and allowed to cool to room temperature. The filtrate was decanted and the residue washed several times with deionized water, until all the acid content was completely expelled. This was achieved by testing intermittently with a blue litmus paper, until no further change in colour was noticed. The clay residue was then dried in the Carbolite furnace at 90 °C, crushed, ground and sieved to 100µm for subsequent tests.

2.5 Preparation of Samples for Performance Evaluation

Measures (150g each) of the purified clay with varying quantities (5, 10, 15 and 20%) of high alumina cement were formed into cylindrical (50mm diameter x 50 mm high) specimens after mixing with about (10-15)% deionized water. The samples were dried in air for 24 hrs and later in the oven at 110 ºC for 48 hrs. Some selected samples, after drying at 110 ºC were again taken for firing in the furnace at 900 ºC, 1100 ºC, 1300 ºC and 1500 ºC. The fired samples were subsequently tested in accordance to the American Standard for Testing and Materials [7] for the following properties:

2.5.1 Permanent Linear Change (PLC)

Permanent linear change tests were carried out in accordance with the [7] standard. The heights of the firebrick test samples were measured with vernier callipers before firing at various temperatures. Three different linear measurements were taken in each case and the average value calculated. The test samples were then fired at temperatures of 900 ^{o}C, 1100 ^{o}C, 1300 ^{o}C and 1500 ^{o}C for 2 hours at the rate of 4 ^{o}C per min, after which they were slowly cooled to the room temperature. The heights of the fired test specimens were again measured in order to determine the changes in heights. The results are as presented in Figure 3.

2.5.2 Modulus of Rupture (MOR)

According to [7], modulus of rupture is defined as the maximum stress a rectangular test piece (150 mm x 25 mm x 25 mm) can withstand in a 3-point bending test until it breaks. In doing this, test specimens were prepared, dried at 110 ^{o}C, allowed to cool to the room temperature and fired to 1500 ^{o}C. Some of the samples were tested after cooling from 1500 ^{o}C to the room temperature (30 ^{o}C) and the others were tested while the samples were right inside the MOR furnace at 1500ºC. In each case, three samples were tested and the average values taken. The results are as presented in Figure 4.

2.5.3 Permeability

The permeability of the samples were measured to standard [7], using test specimens which had been dried in an oven at 110 °C to a constant weight within 0.1g accuracy and cooled to room temperature. The results are presented in Figure 5.

III. RESULTS AND DISCUSSION

3.1 X-ray Diffraction Analysis of Raw Termite Hill Clay

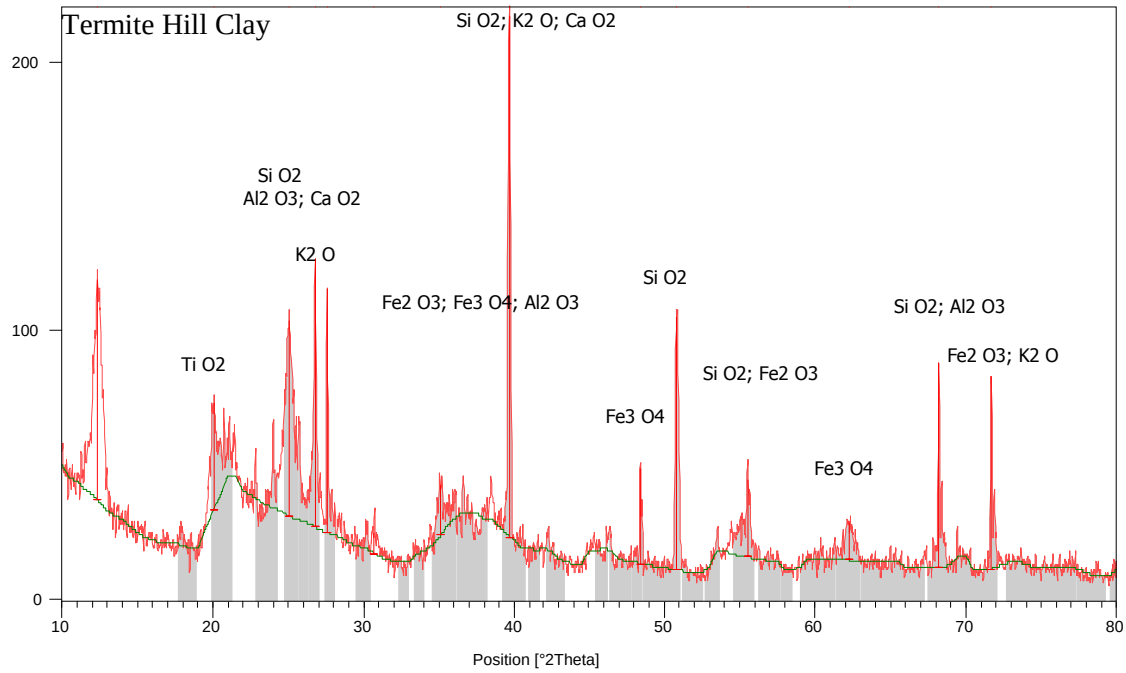
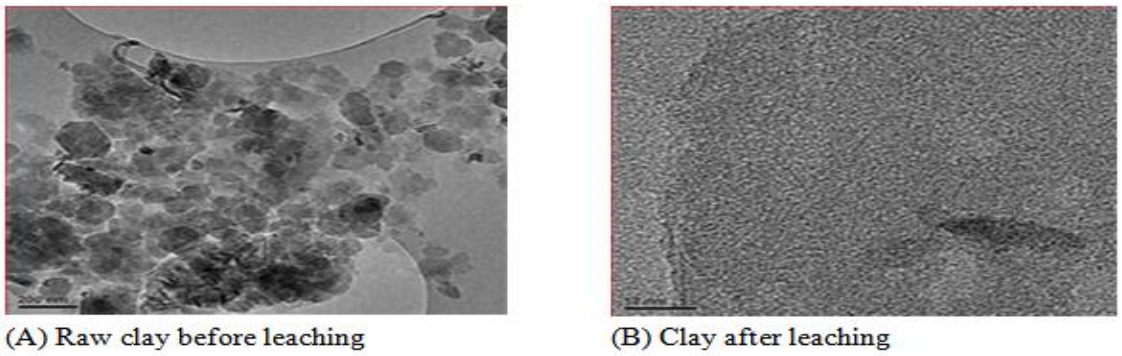


Figure 1: X-ray Diffraction Pattern for Termite Hill Clay

The pattern shows sharp high peaks for SiO_2, Al_2O_3, Fe_3O_4 and sharp but shorter peaks for K_2O, MgO, MnO, Na_2O and CaO. Some other oxides were also present but in very negligible proportions. The heights of the picks being directly proportional to the relative abundance of the various constituents of the clay.

3.2 Transmission Electron Micrograph (TEM)



(A) Raw clay before leaching (B) Clay after leaching

Figure 2: Transmission Electron Micrographs of Raw and Leached Termite Hill Clay

Plates A and B in Figure 2 are the transmission electron micrographs of the raw and leached termite hill clays respectively. They both show the distribution of the minerals present in them. The minerals occurred as agglomerates in the raw clays but after undergoing the purification process, they became finely and uniformly distributed in the bulk. The uniform dispersion of the minerals in the processed clays enabled the oxalic acid to make direct contacts with virtually all the grains in the clays and hence able to remove the iron present in them [5].

3.3 Permanent Linear Change (PLC)

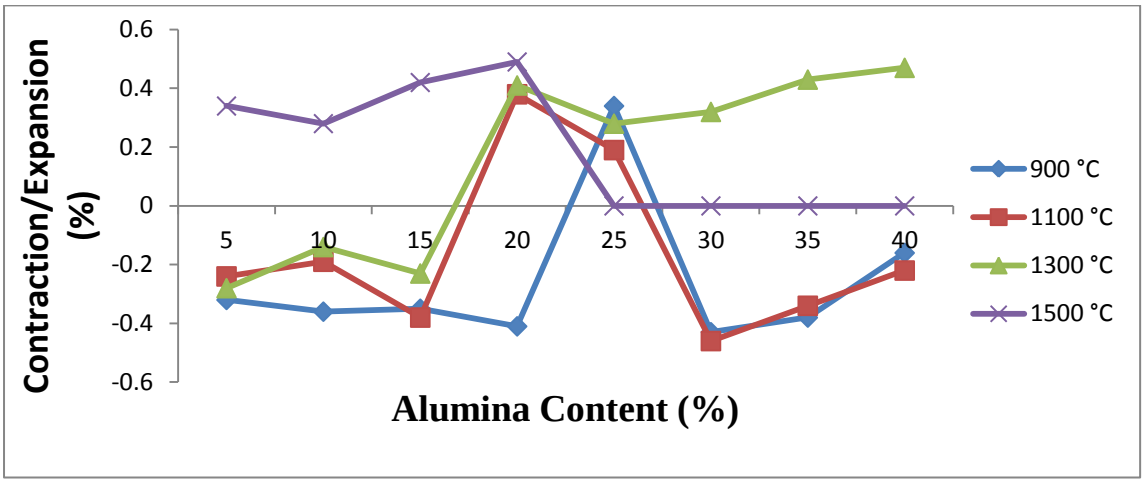


Figure 3: Permanent Linear Changes at Different Firing Temperatures

The results of the variation of permanent linear changes with alumina contents and firing temperatures are shown in Figure 3. It was observed that firebricks produced from the processed termite hill clay underwent linear contractions for firing temperatures of 900 ºC, 1100 ºC and 1300 ºC for low additions of alumina. For alumina contents between 20 and 30% the firebricks suffered permanent linear expansion after which the bricks suffered permanent linear contraction again. This is indicative of variations in the clay-alumina reactions at different alumina contents. Firing at 1500 ºC caused the firebricks to undergo a high permanent linear expansion and hence suffered dimensional instability.

When fired at 1500 ºC, the bricks suffered permanent linear expansion for alumina additions up to 20 %, beyond which the bricks became dimensionally unstable and crumbled under its own weight. This accounted for the reason samples with 25 % alumina and above had zero contraction/expansion on the graph (Figure 3)

3.4 Modulus of Rupture (MOR)

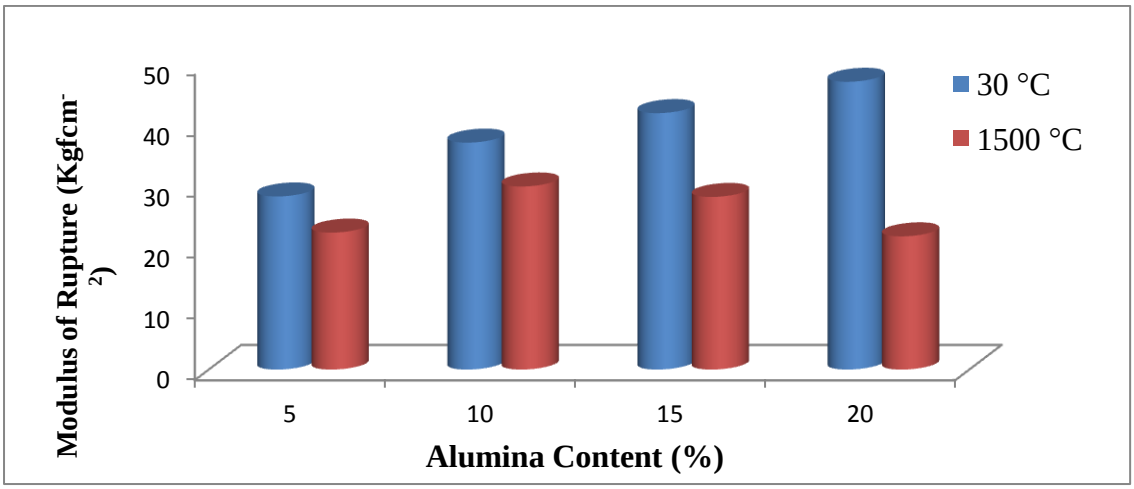


Figure 4: Modulus of Rupture at different alumina contents and temperatures

The modulus of rupture values at the room temperature (30 ^{o}C) and 1500 ^{o}C are shown in Figure 4. The values were very much lower when tested at 1500 ^{o}C than at 30^{o}C. The MOR increased progressively with the quantity of alumina in the cold state while it only increased to the maximum at 10 % alumina and dropped again when tested at 1500 ºC. The trend was due to the fact that the liquid so formed when the samples were first heated and allowed to cool had solidified to form glass which further strengthened the samples. On the other hand, when the samples were rupture tested at the elevated temperature of 1500 °C, the samples were still in the molten state and thus the strength was comparatively lower than when it had solidified to form glass.

However, the MOR attained the maximum value of 29.97 $Kgfcm^{-2}$ at 10 % alumina because the liquid phase formed when fired was adequately matched with the alumina present to form a solid mass and hence the relatively higher strength than at 15 % and 20 % alumina where the liquid phase was predominant.

3.5 Apparent Porosity

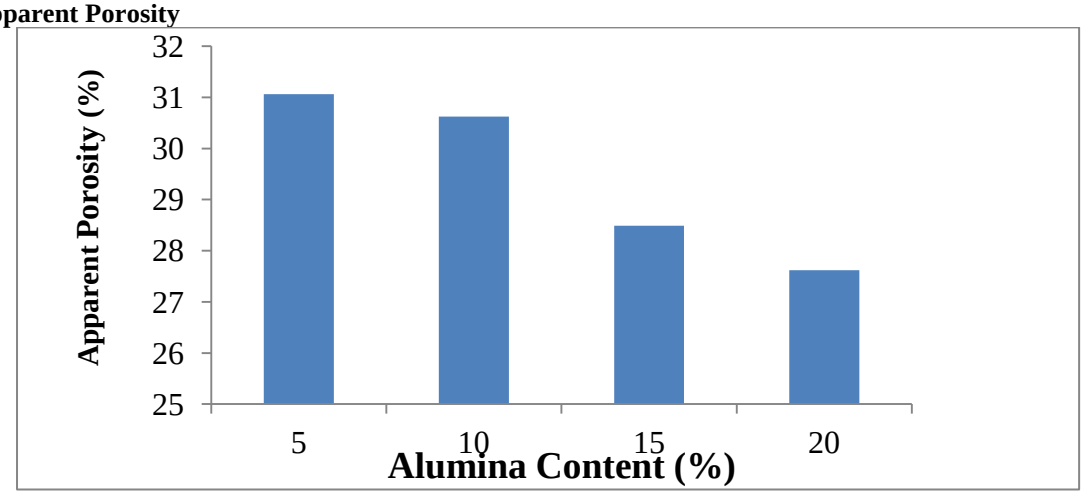


Figure 5: Apparent Porosities at different alumina contents

The permeability of the samples was measured as described in 2.5.4 above, for samples with 5 – 20 % alumina. The results are as presented in Figure 5. The permeability reduced with alumina contents because the pores were blocked as a result of the binding effect of alumina which reduces the interparticle distances between the grains. The maximum permeability obtained was 30.62 %, which was much lower than the 45 % required by standard [8] for insulating firebricks. It therefore becomes imperative for the introduction of a combustible material such as sawdust or rice husk which are expected to burn off at high temperature in order to further create pores for easy passage of the evolved gases.

3.6 Scanning Electron Microscopy (SEM)

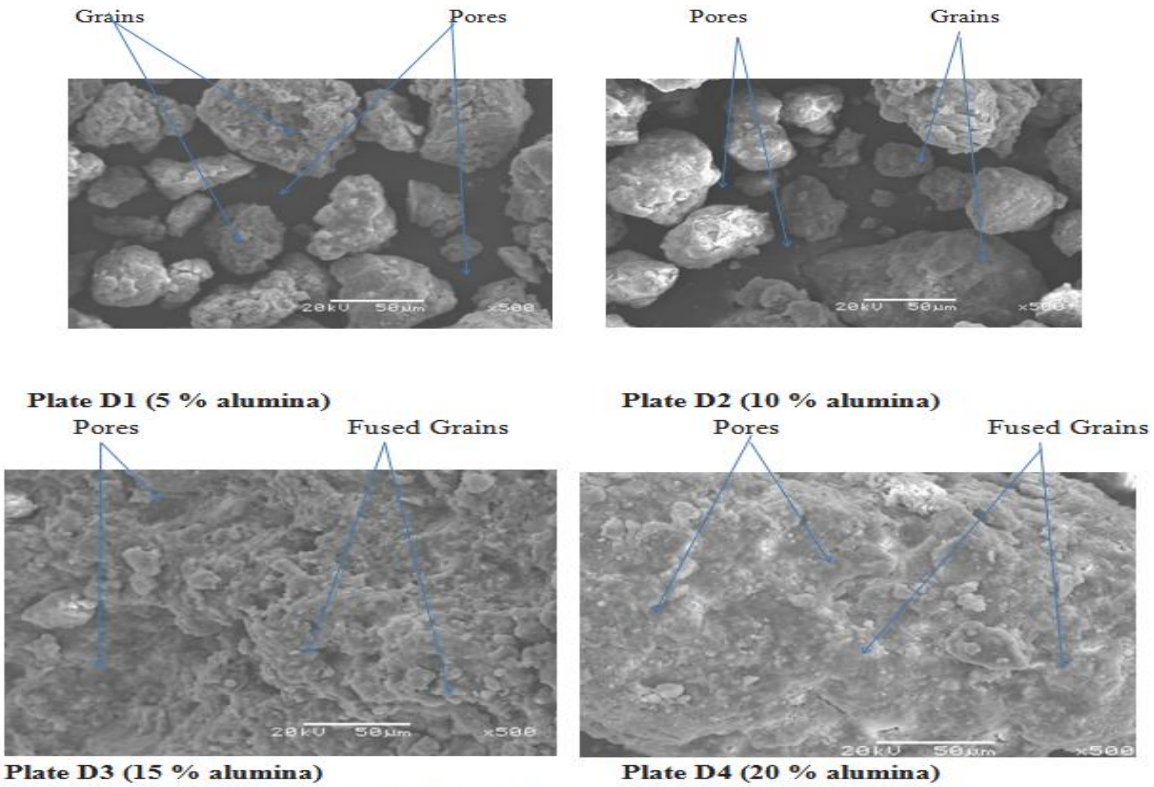


Figure 6: SEM micrographs (X500) of refractory bricks fired at 1500 °C

The Scanning Electron Microscopy of samples containing 5% – 20 % alumina was done in order to see the effect of high temperature firing on the samples. The results are as presented in Figure 6, Plates (D1 – D4). Plates D1 and D2 show the presence of large pores between individual clay particles loosely bonded together. Plates D3 and D4, on the other hand, show an evidence of melting and fusing together of the clay particles. This is even more pronounced in Plate D4. The fusing together of the clay particles in fired bricks containing 15% and 20% alumina resulted in pore closure which will ultimately lead to reduction in permeability. The firebrick therefore had comparatively high permeability when the alumina content was ≤ 10 %.
These observations account for the low permeability which the samples exhibited when the alumina contents were above 10 % and the moderate porosity when the alumina content was between 5 and 10 %. These observations further confirmed that the samples maintain phase stability when fired at temperature as high as 1500 ºC provided the alumina content is not more than 10 %.

3.7 XRF Analysis of the Constituents of chosen Brick

The brick that combined the desired properties of a good insulating firebrick (processed clay + 10 % alumina) was finally analyzed chemically in order to know the exact constituents. The results are presented in Table 1 below.

Table 1: XRF analysis of the components of the insulating firebrick produced

Compound	Processed clay	Pure alumina (Secar 71)	Brick produced
SiO_2	65.18	0.36	50.23
Al_2O_3	24.56	68.78	34.36
CaO	6.27	30.3	13.42
Fe_2O_3	1.28	0.07	0.74
MgO	0.7	0.22	0.13
K_2O	0.09	0.03	0.62
Na_2O	0.84	0.24	0.30
TiO_2	0.68	0.02	0.36
Cr_2O_3	0.03	0.04	0.04
P_2O_5	0.02	0.00	0.00
ZrO_2	0.1	0.00	0.00
Total	100.75	100.06	100.2

The brick that combined the desired properties of a good insulating firebrick (processed termite hill clay + 10 % alumina) was finally analyzed chemically in order to know the exact constituents. The results are presented in Table 1. The Table shows the chemical analysis of the various components that make up the insulating firebrick. The silica content of the brick produced was 50.23 %, the alumina content was 34.36 %, the calcium oxide content was 13.42 % , the iron oxide content was 0.74 % (less than 1 %) while the sum of MgO, K_2O and Na_2O contents was 1.05 % (less than 2 %).

However, the constituents of a good insulating firebrick are expected to be about 50 % silica, 30 % alumina and 15 % calcium oxide [9,10]. The brick produced with the processed termite hill clay and alumina can therefore operate satisfactorily as an insulating firebrick.

IV. CONCLUSION

The characterization by XRD affirmed that termite hill clay is mainly constituted by silica and alumina in major quantities and oxides of iron, calcium, magnesium and other elements in minor quantities. Hydrometallurgical purification of termite hill clay improves the efficiency of insulating firebricks by reducing the iron oxide content of the clay which is responsible for lowering the refractoriness. The addition of alumina cement accounts for improving the binding strength of the brick and also aid in raising the refractoriness.

Termite hill clay is therefore a promising material for the production of insulating firebricks at a very reduced cost without compromising quality, provided the appropriate quantity of alumina cement is added.

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The Purification and Adaptation of Termite Hill Clay for Furnace Lining by Graphite and Rice Husk Addition

D.O. Folorunso

Department of Metallurgical and Materials Engineering, Federal University of Technology, Akure, Nigeria
Africa Materials Science and Engineering Network (AMSEN): A Carnegie-IAS (RISE) Network.

ABSTRACT: *This work has studied the possibility of purifying termite hill clay hydrometallurgically and subsequently adapting it for furnace lining by the addition of graphite and rice husk granules. A large quantity of termite hill clay was mined from a location on the campus of The Federal University of Technology, Akure (FUTA), Nigeria. The slurry obtained from the clay after washing in water was sundried for three days and again dried in the furnace at 90 °C for 8 hours. Representative samples were characterized via the X-ray diffraction (XRD) and scanning electron microscopy (SEM) in order to ascertain the relative abundance of the constituents of the clay. Subsequently, a substantial quantity of the clay was purified by leaching at a predetermined condition of; 1.6 mol/dm^3 of oxalic acid at 90 °C for 150 min. and 200 rev/min agitations. Cylindrical samples (5cm diameter by 5cm high) containing 5 % - 30 % of graphite and 1% - 5 % rice husk granules were prepared, dried at 110 °C and subsequently fired at 900°C, 1100°C, 1300°C and 1500 °C, at the rate of 4 °C/min and soaked for 2 hrs. These samples were subjected to different refractory tests (bulk density, cold crushing strength, permanent linear change, thermal shock resistance, refractoriness under load and apparent porosity). Results obtained showed that purified termite hill clay admixed with 15 % graphite and 3 % rice husk exhibited the desired properties of a good refractory material suitable for lining a rotary furnace.*
Keywords: *Hydrometallurgy, Characterized, Constituents, Predetermined condition, Refractory tests*

I. INTRODUCTION

The refractory lining is a protective layer installed inside the kiln or furnace to insulate the furnace steel structure from high temperatures. It protects it from chemical attack, thermal shocks and abrasion wears. The lining may be monolithic refractories such as castable, gunning mixes or refractory bricks. The refractory selection depends upon the temperature inside the unit and the chemical nature of the material being processed. The thickness of the lining is generally in the range 80 to 300mm [1]. Furnace lining materials are chosen purposely for their ability to survive protracted exposure to extreme temperatures. Other desirable characteristics include resistance to abrasion, mechanical shock and chemical reactions within the molten metal. The most commonly used furnace lining materials are ceramic compounds and metal/ceramic combinations. Ceramic lining materials are made from a variety of raw materials each with its own particular strengths [2]. Common ceramic furnace lining materials include aluminum oxide, magnesite, silicon carbide, and dolomite. Refractories are chosen according to the conditions they will face [3,4]. Some applications require special refractory materials. Zirconia is used when the material must withstand extremely high temperatures. Silicon carbide and graphite are two other refractory materials used in some very severe temperature conditions, but they cannot be used in contact with oxygen, as they will oxidize and burn [3]. Nigeria has appreciable distribution of industries engaged in metal processing operations but lack adequate raw materials to support their growth [4]. In the light of this, there has been a continuous upsurge of interest in the area of the development of good refractories from vast deposits of clay spread across every region in Nigeria in the last two decades. However, some local clay deposits have been investigated with good results in Benue [5] and Ekiti States to meet local needs [6,7]. It is also on record that clays from chanchanga, Bida, Suleja and Zungeru all in Niger State, have better refractory and physical properties compared with imported ones [8]. Rice husk is an agricultural waste that accounts for 20% of the 649.7 million tons of rice produced each year worldwide [9]. The produced partially burnt husk from the milling plants when used as a fuel also contributes to pollution and efforts are being made to overcome this environmental challenge by applying the material as a supplementary cementing material [10]. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions [11].

The clay from the termite mound is capable of maintaining a permanent shape after moulding because of its plasticity. It is also less prone to crack when compared with ordinary clay. In addition, it has low thermal conductivity and expectedly reduced solar heat flow and temperature fluctuation within an enclosure [12]
However, most of these previous works did not venture into the use of termite hill clay and the removal of the constituent of the clay (iron oxides) that is responsible for lowering the refractoriness. It was on this background that this work was designed to first remove the iron oxide content by hydrometallurgical purification and again enhance the refractory properties of the purified clay by the addition of graphite and rice husk.

II. MATERIALS AND METHOD

The materials and equipment used were raw termite hill clay, oxalic acid (99.8% purity), graphite powder, pulverized rice husk, atomic absorption spectrometer (AAS) machine (model Spectre AA 220 FS), X-ray fluorescence (XRF) machine (model ARL 8410), scanning electron microscope (SEM) model JEOL 840 and coupled with an EDS analyzer, X-ray diffraction (XRD) machine (model Philips PW 3710 with PW 1752 graphite monocromator), sieve size analyser (Microtrac FLEX 10.5.4), plaster of Paris (P.O.P.) mould, Rawwley Sussex jaw crusher and grinder, Labcon shaking incubator (models 3081U and 5082U), Carbolite furnace and compression testing machine (model Pat 2001)

2.1 Raw clay preparations for analysis

A large quantity of termite hill clay was mined from FUTA campus in Nigeria. It was then washed in water in order to remove the deleterious particles by decantation. Water was then drained from the clay slurry using a P.O.P. mould. The recovered clay was then dried in the sun for three days and again in the Carbolite furnace at 90 °C for 8 hours. The dried clay was finally jaw crushed, ground in a Rawwley Sussex grinder and sieved to 100 µm, being the average sieve size upon the size analysis.

2.2 Clay Characterization

Analyses of the clay were carried out using SEM/EDS, XRD, and XRF according to the standard procedure [13]. The results are presented in Fig. 1, 2 and Table 1 respectively.

2.3 Hydrometallurgical Purification of Termite Hill Clay

The clay was treated hydrometallurgically by putting a large quantity of clay and 500 % by volume of 1.6 mol/dm^3 of prepared oxalic acid solution in a flat-bottom glass container and kept inside the Labcon shaking incubator, models 3081U and 5082U for agitation at 200 rev/min at 90 °C for 150 min [14]. On the expiration of the set time, the container was removed and allowed to cool to room temperature. The filtrate was decanted and the residue washed several times with deionized water, until all the acid content was completely expelled. This was achieved by testing intermittently with a blue litmus paper, until no further change in colour was noticed. The clay residue was then dried in the Carbolite furnace at 90 °C, crushed, ground and sieved to 100µm for subsequent tests.

2.4 Preparation of Samples for Performance Evaluation

Measures (150g each) of the purified clay with varying quantities (5 - 30%) of graphite were formed into cylindrical (50mm diameter x 50 mm high) specimens after mixing with about (10-15)% deionized water. The samples were dried in air for 24 hrs and later in the oven at 110 ºC for 48 hrs. Some selected samples, after drying at 110 ºC were again taken for firing in the furnace at 900 ºC, 1100 ºC, 1300 ºC and 1500 ºC. Samples for porosity test were admixed with rice husk in the varying quantities of 1 – 5%. The fired samples were subsequently tested in accordance to the American Standard for Testing and Materials [15] for the following properties:

2.4.1 Bulk Densities and Cold crushing strengths

Test specimens fired at varying temperatures of 900 ºC, 1100 ºC, 1300 ºC and 1500 ºC were produced. The masses, heights and diameters of the specimens were measured. The bulk densities of these specimens were computed and results are presented in Fig. 3. To determine the cold crushing strength, the specimens were subjected to compressive load until fracture, using an Auto Compression Testing Machine model Pat 2001. The results are presented in Fig. 4.

2.4.2 Permanent Linear Change (PLC)

Permanent linear change tests were carried out in accordance with the [15] standard. The heights of the firebrick test samples were measured with vernier callipers before firing at various temperatures. Three different linear measurements were taken in each case and the average value calculated. The test samples were then fired at temperatures of 900 ^{o}C, 1100 ^{o}C, 1300 ^{o}C and 1500 ^{o}C for 2 hours at the rate of 4 ^{o}C per min, after which they were slowly cooled to the room temperature. The heights of the fired test specimens were again measured in order to determine the changes in heights. The results are as presented in Fig. 5.

2.4.3 Thermal Shock Resistance (TSR)

Thermal shock resistance tests were performed in accordance to the [15] standard. Cylindrical test specimens were heated in a furnace maintained at 1100°C for 30 minutes and then removed to cool in air for 10 minutes. After this, the test specimen was examined for formation of cracks on the surface. The specimens were then returned into the furnace, heated for 10mins, air-cooled again for 10minutes and surface examined for cracks. This cycle of heating and cooling was repeated until surface cracks were observed. The number of cycles required to produce cracks is regarded as the thermal shock resistance. The results are presented in Fig. 6.

2.4.4 Refractoriness Under Load (RUL)

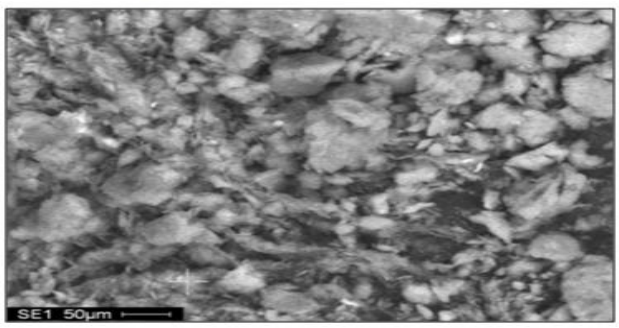
Refractoriness under load test was carried out in accordance to the International Standard Organization and American Standard for Materials and Testing specifications [15]. Samples with dimension 50 mm high by 50 mm diameter were prepared and dried at 110 ºC for 48 hours. They were drilled co-axially with holes of 12.5 mm diameter after cooling to the room temperature. The drilled samples were then set in the RUL furnace one after the other, where the specimens were each subjected to a constant load of 0.2 Nmm^{-2} at increasing temperatures. The heights of the samples were noted at temperature intervals of 100 °C. The change in height was plotted against temperature and the temperature at which the height of each of the samples changed by 0.5 % was taken as the refractoriness of the samples under load. The results are as presented in Fig. 7.

2.4.5 Apparent Porosity

The apparent porosities of the samples were measured using test specimens which had been dried in an oven at 110 °C to a constant weight within 0.1g accuracy and cooled to room temperature. The apparent porosity values were measured in accordance to [15] and the results presented in Fig. 8.

III. RESULTS AND DISCUSSION

3.1 Scanning Electron Microscopy (SEM)



Element	Wt%	At%
C	08.62	14.44
O	44.54	56.00
Mg	01.10	00.91
Al	12.26	09.14
Si	25.00	14.32
K	02.18	01.12
Fe	06.30	04.07
Matrix	Correction	ZAF

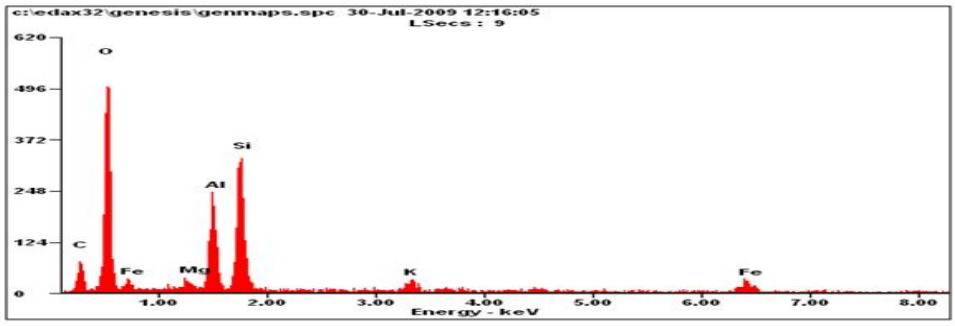


Figure 1: SEM Micrograph (X500) of termite hill clay particle sizes, the EDS pattern and the chemical composition.

The SEM/EDS analysis shows the SEM micrographs of the relative sizes of the clay particles at X 500 magnification and the spectra depicting the peaks of the elements present. The EDS shows the actual percentages of the various elements contained in the clay. The clay contained some quantity of iron, principally in the iron oxide mineral. This and other minerals contained in the clay were quantified in the XRF analysis in Table 1. There is however, a close correlation in the quantities of Fe_2O_3 revealed by both SEM/EDS and the XRF analysis, 6.30 % and 5.97 % respectively.

3.2 X-Ray Diffraction (XRD)

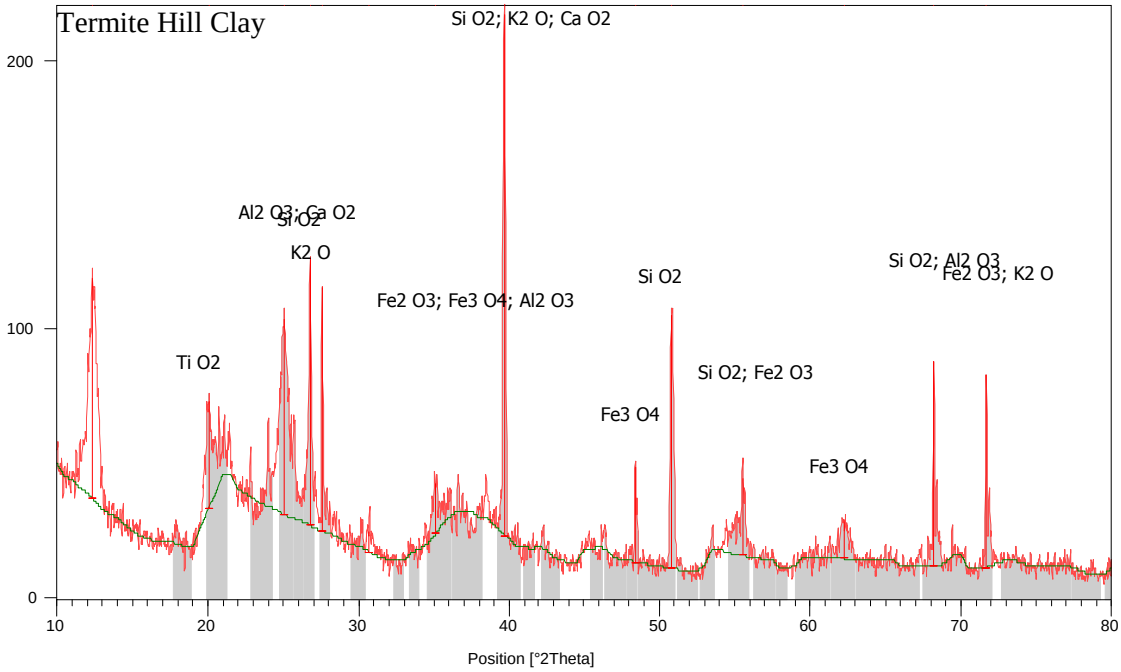


Figure 2: X-ray Diffraction Pattern for Termite Hill Clay

The qualitative analysis of the clay as depicted by the XRD pattern shows sharp high peaks for SiO_2, Al_2O_3, Fe_3O_4 and sharp but shorter peaks for K_2O, MgO, MnO, Na_2O and CaO. Some other oxides were also present but in very negligible proportions.

3.3 XRF of the Raw and Leached Clay Samples

Table 1: XRF of the Raw and purified termite hill clays

Oxides	Raw (Wt. %)	Leached (Wt. %)	Oxides	Raw (Wt. %)	Leached (Wt. %)
Al_2O_3	19.76	24.89	TiO_2	1.11	1.12
SiO_2	62.34	51.84	MnO	0.03	0.03
Fe_2O_3	5.97	2.54	Cr_2O_3	0.02	0.03
CaO	0.63	9.33	P_2O_5	0.03	0.04
K_2O	2.87	1.27	V_2O_5	0.02	0.03
MgO	0.63	0.42	NiO	0.01	0.02
Na_2O	0.85	0.24	ZrO_2	0.05	0.06
LOI(Raw)	6.24		LOI(Leached)		8.13
Total			Total	100.00	99.99

The results of the chemical analyses by X-ray Fluorescence are presented in Table1. The Table shows semi-quantitative analysis of the clay, revealing the percentages of the principal minerals and elements present.
The Major minerals contained in the clay are SiO_2 and Al_2O_3, which constituted more than 80%. The other mineral present in some appreciable quantity was Fe_2O_3 (5.97 %). Present in very small quantities were K_2O, MgO, CaO, Na_2O and MnO minerals. The remaining minerals exist in negligible quantities of less than 1%. Their presence has been found not to constitute any threats to the expected performance of the refractory lining at high temperatures [13,14,1].

It is expected that most of the major minerals will enhance the desirable properties. However, the presence of iron oxide (Fe_2O_3) is detrimental and must be reduced to an appreciable level [13,14]. Therefore, for the clay to perform satisfactorily as a lining material, the iron oxide level was reduced by hydrometallurgical purification from 5.97 % to 2.54 %. Purification was further necessitated by the need to justify the following facts as established by [17].

(a) Percentage sum total of K_2O, Na_2O and MgO was more than the required standard of 2 % [17]. Purification now reduced it from 4.35 to 1.93 %,

(b) CaO content was less than 15 % required for good refractory performance [17]. Purification now increased it from 0.63 to 9.33 %.

(c) Silica (SiO_2) content was higher than about 50 % as required [17]. It has now reduced from 62.34 to 51.84% after purification.

(d) Alumina (Al_2O_3) content was lower than about 30 % required of good lining bricks [17]. It has now increased from 19.76 to 24.89.

a. Bulk Density

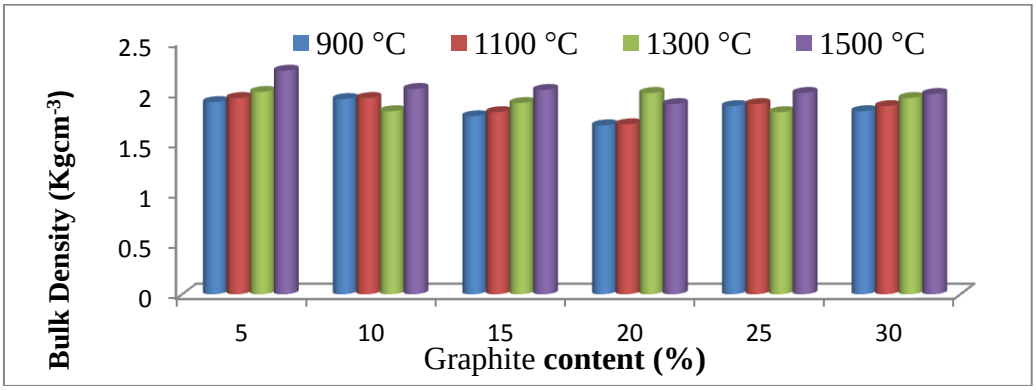


Figure 3: Bulk Densities of Termite hill clay at various graphite contents and firing temperatures

The results of the bulk densities of processed termite hill clay with the addition of different proportions of graphite powder, when fired at different temperatures are contained in Fig. 3. As expected of any good refractory lining material, the bulk density should range between 1.8 and 2.2 gdm^{-3} [17]. This range of values is clearly exhibited by the clay at almost all the percentage graphite addition. Furthermore, the variation in the bulk densities was due to voids formation resulting from the burning off of organic matters from the bricks during firing. These organic matters are usually not uniformly distributed and hence the variation. However, firing at higher temperature could cause voids closure as a result of softening or liquid phase formation which could also cause bulk density variation.

3.5 Cold Crushing Strength

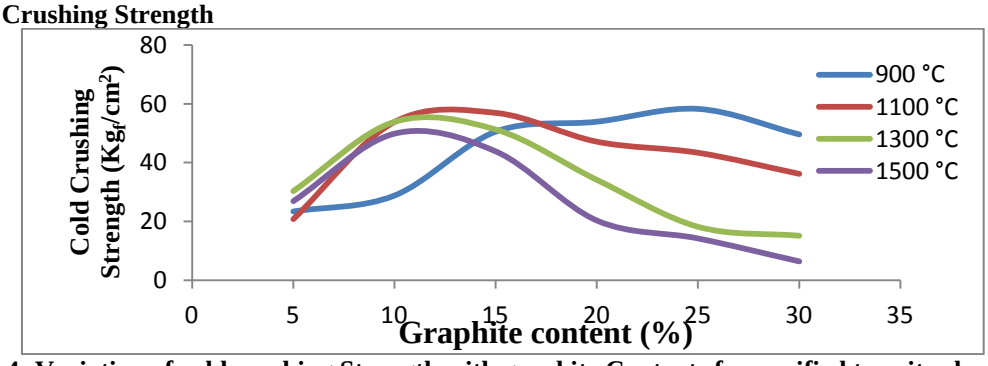


Figure 4: Variation of cold crushing Strength with graphite Contents for purified termite clay fired at different temperatures.

Fig. 4 shows the variation of cold crushing strengths of firebricks containing 5% to 30% graphite and fired at temperatures between 900 °C and 1500 °C. It was observed that at all the firing temperatures, the strengths increased to the maximum at about 10-15 % graphite and then decreased at higher graphite contents. Also, the lower the quantity of graphite, the higher the firing temperature at which the maximum strength was obtained. This trend can be attributed to the fact that the low melting compounds burn off completely at higher firing temperatures thereby reducing the cohesiveness of the clay grains and consequently the adhesion of the grains to graphite as well. The reduction in the cohesive and adhesive forces leads to the reduction in the crushing strength.

The trend was more evident at 1500 ºC and graphite content above 15 % when the crushing strength dropped drastically. Even though the sample fired at 900 ºC exhibited a reasonably high crushing strength, the fact still remains that melting in the furnace is usually at higher firing temperatures. Therefore it is more desirable to consider the behaviour of the samples at higher temperatures and, above all, the graphite content at which the high strength occurred (25 %) was grossly uneconomical for industrial production. It therefore becomes imperative to choose 15 % graphite as the optimum, which is in agreement with [17,18]

3.6 Permanent Linear Change

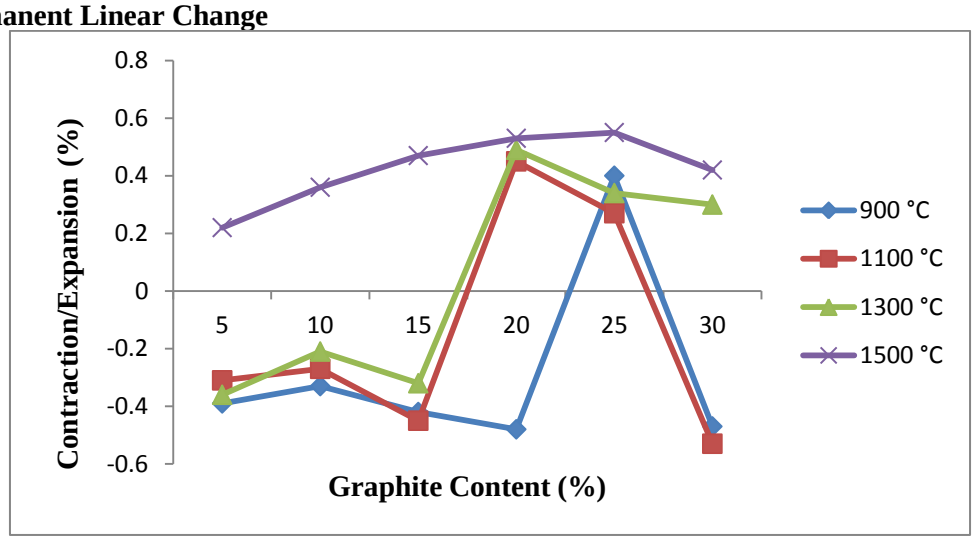


Figure 5: Permanent Linear Changes at different firing Temperatures

The results of the variation of permanent linear changes with graphite contents and firing temperatures are shown in and Fig. 5. It was observed that firebricks produced from the processed termite hill clay underwent linear contractions for firing temperatures of 900 ºC, 1100 ºC and 1300 ºC for low additions of graphite. For graphite contents between 20% and 30% the firebricks suffered linear expansion after which they showed linear contraction again. This is indicative of variations in the clay-graphite reactions at different graphite contents. Firing at 1500 ºC caused the firebricks to undergo linear expansion at all levels of graphite addition without suffering dimensional instability. This therefore, confirms that the bricks so produced will function satisfactorily at a temperature as high as 1500 ºC.

3.7 Thermal Shock Resistance

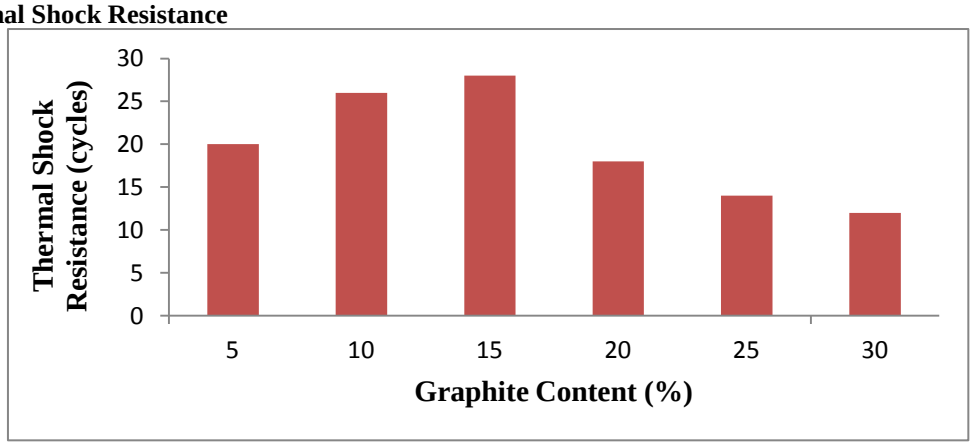


Figure 6: Thermal shock resistance at various graphite contents

Figure 6 shows the thermal shock resistance of the firebricks produced from the processed termite hill clay at different graphite contents. The results represent the outcome of the tests carried out as described in section 2.4.3 above. They revealed that thermal shock resistance increased from 20 cycles at 5% graphite addition to 28 cycles at 15% addition. Thereafter, further graphite additions caused sharp reductions in the thermal shock resistance.

[19] in his previous work adopted the principle below in determining thermal shock resistance: TSR above 30 cycles were classified as "excellent", those in the range 25-30 cycles as "good", 20-25 cycles as "fair", 15-20 cycles as "acceptable", 10-15 cycles as "poor", while less than 10 cycles were classified as "very poor". It is therefore concluded that the addition of; between 10 % and 15 % graphite will produce good lining material for refractory works, 5 % graphite is quite fair while 20 % graphite is acceptable but 25 -30 % graphite is poor for the purpose.

3.8 Refractoriness Under Load

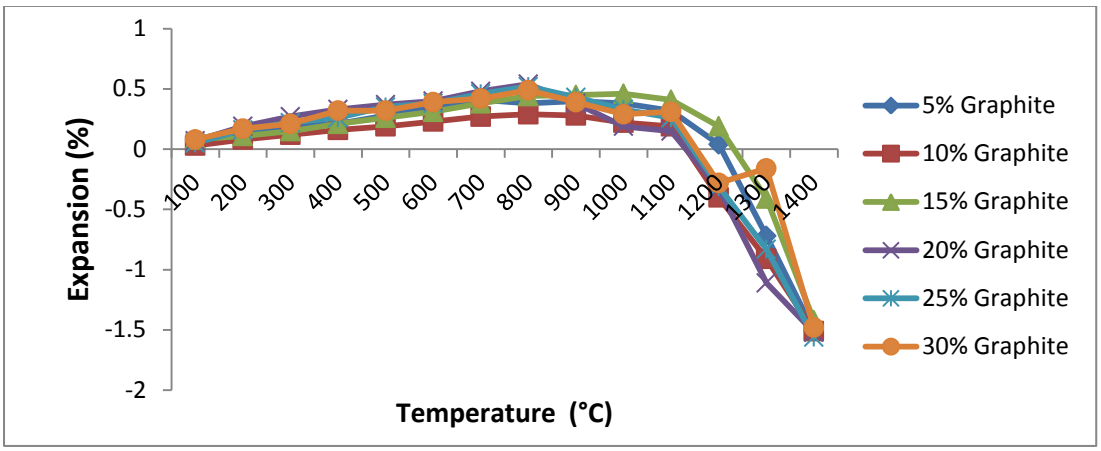


Figure 7: Refractoriness Under Load (RUL) at different graphite contents

Fig. 7 shows the results for the refractoriness under load tests for specimens with 5% – 30 % graphite contents under a constant load of 0.2 N mm^{-2} and increasing temperature up to 1300 ºC, in accordance to [15] standard. The RUL value of about 1190 ºC, which was the temperature at which the height of the sample reduced by 0.5 % under the 0.2 N mm^{-2} load, was obtained for graphite content of 15%, which is the highest and therefore the recommended value for the production of refractory lining firebricks from termite hill clay.

3.9 Apparent Porosity

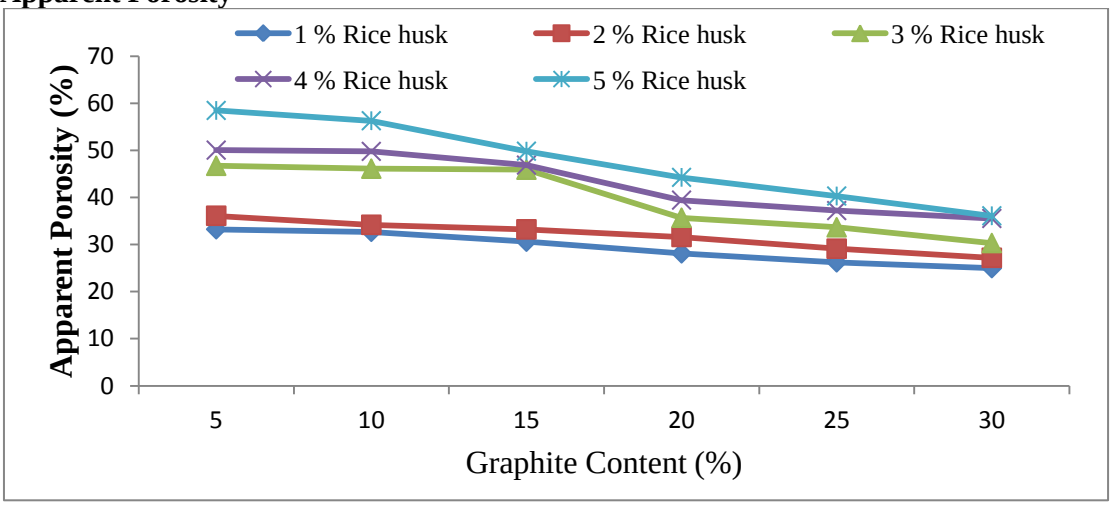


Figure 8: Variation of apparent porosities with graphite and rice husk content

The apparent porosities were enhanced by the addition of rice husk in the range of 1% - 5 %. The results are as presented in Fig. 8. The apparent porosity increased as the percentage rice husk increased at all levels of graphite content because the rice husk burnt off at the elevated temperature of 1500 ºC. The more the rice husk added, the more the pores created. Despite this trend, the porosity still reduced with graphite at each rice husk content. The reduction is attributable to the increased binding effect of graphite in the samples, which binds the grains together, thereby reducing the interparticle distances and hence the reduction in the porosity.

The results obtained show that 3 % rice husk exhibited the desired expectations; ≥ 45 % porosity [20]. Strength, however, is inversely proportional to porosity because the larger and more numerous the pores, the thinner the enclosing wall of solid material and the lower the strength [17,18]. Sample with 15 % graphite and 3 % rice husk was therefore chosen as the most promising of the samples because it possesses apparent porosity of 45.91 %.

IV. CONCLUSION

The research has shown that termite hill clay will serve as a good material for furnace lining if purified hydrometallurgically in order to remove one of its constituents (Fe_2O_3) that is responsible for lowering the refractoriness. The addition of graphite has greatly improved the refractory performance of the termite hill clay, especially when added in the appropriate quantity of 15 %. The porosity of refractory lining material increases with the addition of rice husk. However, the optimum value of porosity is obtained when the proportion of rice husk in the mix is 3 %. The refractory mix, therefore, that contains 82 % of hydrometallurgically purified termite hill clay, 3 % rice husk and 15 % graphite will perform satisfactorily as a good material for lining a rotary furnace.

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The impact of human capital on the productivity of the company: case of Congo Brazzaville

Mouele Mboungou Patrick Joe Stivell[1], Jinlin Zhang[2]

Zhongnan University of economics and Law, Wuhan, 430073.P.R.China

Abstract: *Today the most precious capital of an organization is not anymore establish as material assets, but rather as human assets and the combination of skills. It is to say that, henceforth human being is in the center of any development in a company. Thus, it is necessary to train and value the human potential in order to reach goals assign by any company. This work has for main objective to show the importance which dresses the human capital and the rational usage of agents in the development process of companies in Congo, by using investigation data within the company Breweries of Congo in 2007-2008.*

Keywords: *human resources, productivity, efficiency of the company, the breweries of Congo (Brazzaville)*

I. INTRODUCTION

Nowadays companies grant a considerable or important place to training due to the acceleration of the technological innovation from the beginning 1960s, which creates difficulties of adaptation in organizations. This acceleration changes the state of the balance of power, because workers see their skills decreasing. Indeed, the heavy industry concentrates its efforts on the development of material factors of production (capital, and work). However, it is in this same period that the importance of the human factor is highlighted in particular with the human resources theory, a theory elaborated and developed by two big authors Theodore W.Schultz and Gary Becker and many others such as J.Mincer, E.Denison,

According to L.Sekiou (1995), for companies, train employees turn out to be the unique way of facing technological changes. Thus these years represent a of reflection time for all the economic agents from industrialized countries in any area. Therefore, it appears important to value the human potential of companies. The fundamental hypothesis of the human resources theory is that the training, general or specific has the aim to increase the productivity of those receiving this training; so this one positively impacts on economic growth. In both factors of production from the neo-classic theory, (the technical capital and the less qualified capital) is added as supported by the upholders of human resources theory as abovementioned, a new factor the human capital according to A. Capped (1960)

Concept of the human resources and the productivity: a magazine (review) of literature

1.1. Definition of the human resources

As regards the literature review, many authors focused their attention on the link between company performance and training. Peter Drucker (1999) is one of these authors. He affirms that "human being is the source, the rarest and the more precious capital of any industrial company". For any modern company, the staff represents the condition of success, a success that will depend on human resources occupying key positions.

According to Becker (1964) the human capital defines itself as all productive capacities that somebody acquires by accumulation of general or specific knowledge, savoir faire. The notion of capital expresses the idea that it is an immaterial stock imputed to someone (i.e. Idiosyncratic) which could be accumulated and employed. It is an individual choice and a personal investment.

The human capital is all the capacities, the talents, the qualifications, the experiences accumulated by someone and which partially determine his or her capacity to work or to produce for himself or for others (Jacques Generaux, 1969).

So Henri Mintzberg (1998) underlines that on the theory of organizations, "company is such as a set of people undertaking a collective action in pursuit of the realization of a concerted action". Thus, the profit of the company depends on the performance, the efficiency and the skill of the staff.

For HPP (Haitian Priority Project, 2009), the human capital has five components: the parental education, the schooling, the professional / university education, formation of the adults and education in the workplace. The human resources theory distinguishes two possible forms of training: the general training and the specific training.

The general formation: Acquired in a high education system, its transferability and its attachment to the worker explain the fact that it is financed by the latter, because he can use it on the whole working market. From its side, the firm or the company is by no means encouraged to bear the training costs of someone, susceptible to take advantage of these skills in another company that would be ready to pay him a better salary. In order to avoid such an inconvenient situation, the financing of the activity will take the shape of a lower remuneration (compared to his marginal productivity). The agreement between the employee and the company thus consists, on one hand in the purchase by the company of the "working strength", and in the purchase of training by the worker on the other hand.

The specific training: Acquired within a production unit of the good or the service, raised the productivity of the worker within the company but not or few except this one. In this case, the financing is assured at the same time by the firm and the worker. During the period of training, the salary received by the worker is lower than the one that it would have perceived outside, of the company. This differences measure his contribution to the specific training, but it remains upper to his productivity in value, clear of the economic cost of the training. This difference expresses the contribution of the firm to the financing of this training. The firm accepts such a contract only if she estimates to have a chance to make profitable her investment: the salary that she will pay at the end of the training period will be upper to the spare salary of the employee for jobs outside the company in order to incite the employee to stay in, but this salary will be inferior to his productivity in value, the difference with the salary paid representing the remuneration for the specific equity investment of the company.

So in the endogenous growth models, the human capital assimilates itself to a stock of recoverable knowledge economically and incorporated into people…ex-post measured by the salary paid .The knowledge is measured only by its monetary contribution and not by what it can bring to a process of knowledge accumulation.

The measure of the human capital: About the measure of human capital, several economic studies take into account education or training, so the level of the human capital is often measure by the training level of the adult population. Indeed, it gives a measure of the competence of the population and the workforce insofar as access to education allows people to acquire knowledge the savoir faire essential to an active participation to an economic life. Furthermore, there is a strong positive correlation between education and health, then between education and nutrition. So, as measure of human capital, one shall retain the educational level and the specific training.

1.2. The human capital theory

The human capital theory was developed in 1964 by Gary Becker. The human capital defines itself as all productive capacities which someone acquires by accumulating general or specific knowledge, know-how and experience. The notion of capital expresses the idea that it is an immaterial stock imputes to a person a stock that can be accumulated and consumed.

It is an individual choice, a personal investment. As any investment, it is estimated by the difference between the initial expenses, the cost of educational expenses and the concerned spending (purchase of books etc.), the opportunity cost, which correspond to the salary he would receive if he ever was in active life and his future income updated. Thus, the employee makes a choice between working and gets training courses which will allow him to perceive higher incomes; the preservation of its physical capital (health, food) is also taken into account. He optimizes his capacities by avoiding these one to depreciate too much because of the depreciation of its general and specific knowledge or the degradation of its physical and moral health. He invests to increase his future productivity and his income. As all the investments, the individual has to deal with the law of diminishing returns and the irreversible character of his expenses.

The arbitral models: people getting same capacities do not choose the same studies. This difference is directly connected to their social origin. Before starting a school program, the theory supposes here that people proceed to a advantages calculation - costs balance by the probability of success. The theory poses) then as hypothesis which the students from disadvantage areas will take more important risk than the others.

The competition models: This model rejects the strong hypothesis of the theory of the human capital: the productivity is not any more brought by the worker but considered as being a part of the workstation. Two characteristics matter within the company: the capacity of adaptation of the worker has the firm' structure and its efficiency at its workstation.

II. PRODUCTIVITY

The productivity is defined as a capacity to produce, of bringing back more or less the relationship between the quantity of the product and the necessary factors for the production. The productivity is only a measure of the efficiency of the production, but the productivity is the one obtained by dividing the price of an article by the hourly or middle salary. An average productivity of a factor is the relation of the quantity produced and the quantity used by its factors. The marginal productivity of a factor indicates the increase of the production resulting from the use of the additional unit of this factor. The property of diminution of the marginal productivity of a factor means that if one successively adds additional units of a variable factor the quantities of the other factors remaining unchanged, the increases of production which result from it decrease from certain point. The average productivity is increasing when the marginal productivity is superior to the average productivity.

PM => PM> Pm. PM => PM> Pm

The average productivity is maximal when it is equal to the marginal productivity

PM MAX => PM=Pm.

therefore, the work productivity reports the whole honorable stage of transformation not only from the last

leading to the delivery of the product, to the consumption. In its economic approach, the productivity is considered as a measure or an ratio obtained by dividing the production by one of the production factors. We can also calculate the productivity of work, capital or of raw materials investments etc. When the word productivity is alone it refers to "the productivity of work". There is also a notion of global productivity of factors (GPF) which aims at synthesizing the productivity of the whole process of production, this variation measures approximately the technical progress. The productivity can also be measured by the quantity of energy used or the productivity of a unit or a production line.

2.1. Contribution to the formation on productivity

In its most general acceptance, the productivity is a report where, to the numerator there is the production (in quantity or in quality) and, to the denominator, such or such reserved factor: number of necessary working hours, invested capital etc. the word "productivity" must not be assimilated to "efficiency": in the concept of productivity, human aspects are irreparable from economic aspects. One considers that, within a company "the satisfied worker is an effective and productive worker ". So, it can be concluded that the employer who want to improve the productivity of his staff will have to ensure the satisfaction of each employee at his workstation.

The "productivity" is one of indication often retained and its study is the beginning of E Mayo's researches about the morale. If the productivity is a state of mind (Ardant) then its assimilation in the morale is natural, as far as the "morale" indicates the state of mind which incites the worker to produce (Roethlisberger).

However, the productivity is an indication of participation; but the participation does not involve satisfaction. Today, all agents approve the idea that formation is become essential for the survival of the majority of companies confronted with technological, scientific and social evolutions. This is to say that training has an impact on production in particular on the mass production which remains based on a simple principle of the improvement of the productivity which essentially resulted from the acceleration of the rhythm at the post of work. This productivity can be difference for every company.

III. COMPANY

Any company is created not to disappear but rather to exist and survive by making good combinations of its factors of production such as work, capital and the nature in order to maximize the cost and the profit.

Company is so defined as being an organization in which an entrepreneur allocates against an income some factors of production to the production of goods and services intended for the exchange for the purpose of realizing a profit.

So, it can be said that the company is an economic structure comprising one or several people working in an organized way to supply goods and services to customers in a competitive environment (the market) and not competitive (the monopoly). The sole proprietorship or the proper name company, which is run by a single natural person, does have neither a personality nor a different patrimony to that natural person running this company. And according to Thoma Suavet, the company is an organization constituting an economic unity destined to the production, to the exchange or to the circulation of goods and services. Company differs from the simple organization project intended to dissolve in its term, it is rather designed over time and for the driving of several similar projects and it implies a sustainability of resources (ex: machines, human resources, shareholders). So, three big types of companies exist in any country:

- private profit-seeking companies (small and medium-sized industry and large companies;
- Private non lucrative companies (under the voluntary sector).

3.1. Contribution of the training on the company efficiency

The vocational training is an essential or determining tool, for agents or employees eager to satisfy company or organization expectations and guarantee its efficiency. It allows employees to assure diverse functions entrusted to them, employees have to increase constantly their human capital; this increase is made possible only with the in-service training. The efficiency of the company highlights two aspects on one hand the formation for the benefit of the company and on the other hand formation in the profit of the employee.

IV. PROBLEMATIC

Based on to the requirement of any scientific work, the first stage of the investigation is the existence of a problem that the researcher wishes to solve, or a question that he wishes to answer. In a general way, the problem is defined as a structure of information which the connection engenders at the researcher's a gap being translated by an effect of surprise or stimulating questioning to motivate him making a research. It is also defined by, L.Althusser as "a definition of the fields of theoretical knowledge in which the problem of the exact place of its position of concepts is raised. So, the problem sends back to a fundamental question: can a link be established between the company performance and human capital? Then two secondary questions are raised:

in what extent human capital constitutes the key factor of success within the company?

How can be estimated the contribution of human capital to the company efficiency?

Two hypotheses are retained:

The application of modern management techniques such as the vocational training is one of the most important elements in economic developments of any company.

There is a correlation between human capital and company efficiency.

4.1. Data Description

within the framework of this work, the survey realized within the breweries will be used. The Company Breweries of Congo arose from the fusion in 1994 of the Breweries of Brazzaville (said Primus) subsidiary of Heineken group and the Congolese company of Breweries Kronenbourg (SCBK) from CFAO Paris group. Both merged companies had begun their activities in Congo: for the Breweries Brazzaville in 1952 in Brazzaville and in 1962 for SCBK in Pointe-Noire. Each of both Shareholders detains 50 % of the new company. In 1996, the Breweries of Congo absorbed the Pontenegrine Company of Drinks (PCD). The Breweries of Congo is a limited company with Board of directors with 7 637 895 000 XAF of share capital.The head office is situated in Brazzaville, Edith Lucie Bongo Ondimba Avenue, Mpila-BP 105.Avec a secondary Establishment located in Pointe-Noire, Bitékila Dombi Avenue, PB: 1147. Registered to the trade Register and the Movable credit under the number BZV-CGO-RCCM-02-B-095.Its Taxpayer number (NIU): M2005110000055116

Breweries of Congo Staff

in 2009 the company had 711 employees, 337 on Brazzaville site and 374 in Pointe-Noire.Without forgetting thousands of indirect jobs generated by some extra activities (Distributors, carriers, retailers, and related staff).

Index form of the Company

Today, The Breweries of Congo has three (3) production factories plants among which two in Pointe-Noire (a brewery and a lemonade laughs) and one in Brazzaville, producing beers and carbonated drinks (5 brands of beer and 5 brands of Carbonated drinks with diverse flavors, a malted drink and 22 size of an alcoholized drink.)

4.2. Training policy within the breweries of Congo

The direction has the heavy task to manage the personal total staff of the company, throughout the training service, the organization of the staff in-service training of the company. Moreover, it also takes care of the pay as well as employees health at the breweries level. The in-service training of employees is conducted by the training department. This department is hierarchically connected to human resources department. The training department has for main missions and attributions: the identification and the analysis of needs, training cost, the elaboration of the training plan. For a good organization of staff training, the training service has to insure on the administrative plan the information of employees about the training, the realization of the actions, the management of staff in training, the expenses accounting.

4.3. Organization of the training

In the continuation of the approach that leads to the training implementation, the real follow-up answers two requirements for the breweries of Congo. On one hand, she proceeds to the systematic evaluation of training initiatives at three levels: The educational objectives, which have to take into, account the reality of the learning
Training objectives, in order to facilitate the appreciation of the training results
Progressive Objectives of the company; they measure his effects on the ground.
On the other hand, the brewery by its training service analyzes at people level.
The initial training of agents
The professional experiences such as the know-how
The trainings followed in court of career, including those followed at the employee initiative.

4.4. Identification and needs analyzes

Companies generally have different needs: financial, material or staff training… the training needs of staff occupies a special place for the Brewery of Congo and present varied sources of identification. It can become identified further to a death, a redundancy, a retirement, a resignation and finally with the skill gaps. The analysis of training needs of the brewery rely essentially on the comparison between employees skills and those needed in the current of intended activities. It uses two approaches to analyze its needs in training.
There is a yearly meeting of every person in charge with his collaborators. The training service takes advantage of this meeting insofar as training problems is a special concern of the meeting report.
Finally, the brewery uses a reference table of skills for every employment; it can highlight the skills to be developed for every employee.

a-evaluation of the training cost

The sum spent on staff training; represent the budget or the cost of training. For breweries, this spending is proportional in training initiatives planned by her and take into account other elements such as:
Staff to train;
Educational spending
The remuneration for trainees;
The training duration
However, the training cost does not remain constant, because it is function of the number and the nature of the current needs.

Picture 1: formation budget of the Breweries of Congo 2007-2008(in XAF)

Years / Management	2007	2008	écarts
General	20.271.686	43.365.448	23.084.762
Industrial	76.493 168	43.071.952	36.475.216
Marketing and trade	25.435.829	18.246.944	-7.188.885
Financial	18.504.265	28.324.080	9.819.815
Human Resources	19.947.119	20.178.080	230.961
General Management	23.316.921	46.876.864	2.355.943
Total	186.968.988	200.146.366	13.031.380

Source : Training Department

Data presented in the picture above, are the projected budgets from the Breweries of Congo for years 2007 and 2008. One notices gaps or imbalance in every direction. Between the 2007's and 2008's budget, these gaps justify themselves by the fact that needs are not always the same in every period or year, so the staff training cost does not remain constant for every year.

b.Elaboration of the training plan

The clarification plan of the Congo's Breweries, translated the will of the company to define the training policy choices, in term of training initiative beyond the constraints of the activity, this plan is established for a short period of one year. The training plan plans and organizes training initiatives of the company according to reserved objectives. Among these objectives the one insuring the adaptation of employees to the evolution of their jobs is a legal obligation. Adapting employee's skills to the orientations strategic of the company in order to offer to all the possibilities of progress are frequent objectives, Breweries grant a particular attention to the definition of objectives of every training initiative, because the training becomes for the company a favor instrument of skills blooming. This plan includes:

- Objectives, Priorities, Contents, Pedagogy, Duration, calendar Budget et Categories of beneficiaries

Types of training

In the breweries of Congo it is taken into account two types of training: the on-the-job training which is informal because realized in the structures of breweries and the vocational training given to agents outside the structures of the company and which this one acknowledges diplomas.

V. METHODOLOGY OF THE EVALUATION OF HUMAN CAPITAL IMPACT ON COMPANY'S PRODUCTIVITY.

The objective here is to show the contribution of the vocational training to the efficiency of the company. For that purpose, Raymond Barre stipulates that " when a firm gets itself a factor of production, it registers a cost, but it expects that its productivity increases and in the fact that the total incomes increase as a result of an increase of its productivity ". In a general way, the efficiency (of a company) is evaluated through elements such as: production, profitability, the net income…Also it is necessary to add the immaterial production in particular the punctuality, diligence, the seriousness, the professionalism, skills and the know-how. The situation of the company will be presented before and after the training of its staff (situation in terms of production and products sale), to be able to show the impact of this training on the production and to the sale capacity.

Situation of the company before the training

Within the framework of our study, the situation of the company is going to limit itself simply on the production and to the sale of drinks (gaseous and alcoholized). This production and drinks sale will be presented in boards below.

Picture 2: percentage of production by trimester.

Period / Production	1st trimester	2nd trimester	3rd trimester	4th trimester
Soft drinks	62%	64%	70%	73%
Alcoholized drinks	75%	80%	82%	85%

Source : Commercial department and marketing

This board, as it can be noticed gives information about the percentages of production of drinks by quarter. As regards carbonated drinks, the production evolves in a following way: 62 % of realized in the first quarter, it increases of 2% and 6% by reaching respectively 64 % and 70 % in the second and third quarter. This production finally reaches 73 % for the fourth quarter, or an increase of 3 %.concerning, alcoholized drinks, for the first quarter the production was 75 % and crosses respectively of 80 % and 82 % for second and third quarter, a respective increase of 5 % and 2 %. This production reaches 85 % to the fourth quarter with a 3 % increase.

Picture 3: percentage of sales by trimester

Period / production	1st trimester	2nd trimestre	3rd trimester	4 th trimester
Soft drinks	60%	50%	58%	58%
Alcoholized drinks	90%	93%	87%	85%

Source : Commercial department and marketing

The present data in the picture above refer to the trimestral sales of drinks. It can be noticed a decreasing evolution of sales for the first and the second quarter represented by the following respective percentages: 60 % of sales realized in the first quarter 50 % at the second one, that corresponds a 10 % decrease. Finally, one notes 58 % of sales for the third and fourth quarter. So, an increasing evolution of 8% is noticed between the second and the third quarter. Then, there is a steadiness of sales for the last two quarters; concerning carbonated drinks. As regards the sales of alcoholic drinks, they present a good tendency between the first one and the second quarter, expressed by the following percentages: 90 % in the first quarter and 93 % in the second one; it is a positive evolution of 3 %. However, from the second to the fourth quarter, sales knew a negative evolution, which is translated by the following percentages: 87 % and 85 %, a progressive reduction of 6 % in the third quarter and in 2 % in the last one.

Although these results are significant, they do not reach the maximal profit that the company expected. It is in such moments that the persons in charge of the company and in particular those from the sales and marketing department are worry to set up strategies to reach the fixed commercial objectives because some weaknesses were on the base of these bad results such as the delays in delivery, the prerequisites to become an authorized dealer who do not facilitate the entry on the market of new dealers. This is can explain the interest to undertake some training initiatives in order to mitigate these difficulties.

Situation of the company after the training

The percentage of the production and sales after the staff training appears as follows:

Picture 4: percentage of drinks production per trimester

Period / Production	1st trimester	2nd trimester	3rd trimester	4 th trimester
Soft drinks	69%	79%	87%	93%
Alcoholized drinks	85%	90%	94,5%	98%

Source: Communication department of production

One notices that after training, a variation of the production level of the various drinks. For soft drinks, the production of the first quarter is 69 % and passes to 79 % in the second quarter corresponding to an increase of 10 %, then it passes respectively in 87 % and 93 % in the third and fourth quarter, or a 8 % increase in the third quarter and 6 % in fourth quarter. For alcoholized drinks, one notes 85 % and 90 % of production respectively for the first one and second quarter with an increase of 5 %. For the third and the fourth quarter, the production passes respectively from 94, 5 % to 98 % corresponding to a 4, 5 % decrease in the third quarter and 3,5 % in the fourth one compared to the second trimester.

As a matter of fact, both situations, previously presented allow noticing a gap from the level of the expressed production. This is why there is an interest to present boards representing the difference of the production level of drinks before and after the staff training.

Picture 5: difference of production level

Period / Production	1st trimester	2nd trimester	3rd trimester	4 th trimester
Soft drinks	07%	15%	17%	20%
Alcoholized drinks	10%	10%	12,5%	13%

Source: Production Department

This board presents the comparative results of the production in the situation of before and after staff training. These variations express well the impact of the training on the production. Thus it is important to note that there was a considerable improvement of the production, in particular from the first to the last quarter. The increase of the soft drinks production goes from 07 % for the first quarter to 20 % for the fourth quarter, passing through 15 % and 17 % respectively in the second and third quarter. One notices then stead increase of the alcoholized drinks production compared to soft drinks; there is 10% for the first and the second quarter and 12,5 % and 13 % respectively for the third and fourth quarter. At the end of the analysis of these data, some observation must be specified concerning the increase of the noticed production.

At first, this improvement of drinks production is due to the increase of skills of agents (which is possible only by the acquisition of the knowledge what means the staff training) evolving in these competent departments justified on one hand by the polyvalence or the flexibility of agents working on the production line, then by the good behavior of these last one highlighted by their punctuality, their professionalism to insure the production line with efficiency and without forgetting also the motivation of employees.

However, efforts still need to be made in the staff training area in order to always provide to the company skilled employees capable to reach company's objectives.

The picture below will present the situation of sales after the training

Picture 6: percentage of sales after formation

Period / Production	1st trimester	2nd trimester	3rd trimester	4 th trimester
Soft drinks	80%	82%	84%	86%
Alcoholized drinks	90%	94%	96%	98,5%

Source: Communication from Sale Department

From the picture above, one notices the increase of the percentage of sale drinks for after formation in Breweries. First, let's take a look of the situation of soft drinks sale. The sale realized in the first quarter reached 80 %, it is 82 % in the second quarter and it remains constant in the third and fourth quarter. It is important to indicate that there was a 2 % increase successively between the second and the third quarter then it is noted a steadiness in the fourth quarter.

Concerning the sale of alcoholized drinks, it is noticed an interesting increase of 4 % compared with the sale of soft drinks. This increase is expressed by the following percentages: 90 %, in the first quarter and 94 % in the second quarter. In the third quarter there is equality of 2 % with soft drinks but it is in the fourth quarter where this percentage soars just a little of 0, 5 % compared with the third quarter.

It emerges from this observation that there are variations of the level of sales between the situation before and after the training. This leads to present a board representing the variations of sales.

Picture7 : variations of sales

Period / Production	1st trimester	2nd trimester	3rd trimester	4 th trimester
Soft drinks	20%	32%	26%	28%
Alcoholized drinks	0%	1%	9%	13,5%

Source: Communication from Sale Department

This board presents the comparative result of drinks sales before and after staff training. These various gaps show partially the contribution of the training on the sale capacity. This improvement of the level of sales is translated by following percentages: 20 %, 32 %, 26 % and 28 % for soft drinks, following respective percentages of the first to the fourth quarter.

The improvement of the alcoholized drinks sales is less important than soft drinks. It appears as follows: 0 % for the first quarter, 1 % for the second quarter, 9% for the third and 13.5% for the fourth quarter.

At the end of this analysis, some observations can be made. In the first place, it is important to point out that the contribution of the training on the improvement of sales is due to the increase of employees skills from sales department, skills expressed in terms of marketing strategies oriented to the realities of the market. Secondly there is good reason to underline the contribution of the equipment's distributions (vehicles) which facilitate the fast deliveries. Indeed, in commercial area, it is not enough to train how to sell at the most because there is always the reaction of the market (competition) making sales variation inconstant and cannot remain increasing. It can be explain by the reduction in the sales of soft drinks recorded by Breweries between the second and the third quarter corresponding to 6 %. Then this percentage goes up slightly from 2 % in the fourth quarter. On the other hand, one notices a very light evolution of sales of 1 % for alcoholized drinks between the first one and the second quarter. To sum up, it is highlighted that the vocational training is not the exclusive factor which improves the production and the sale of goods and services of any company.

VI. CONCLUSION AND RECOMMENDATION

At the end of this study related to the analysis of the human capital impact on the productivity of the company, it can be admitted, with regard to what precedes that the vocational training is an outcome leading towards progress. Continuing in the direction of these main lines would mark a serious step towards an effective management. For that purpose, the human capital turns out to be the most important aspect for an effective management of the company insofar as it has in its program of activities a training plan to improve the quantity and/or the quality of its work and to end, reach the improvement of the productivity and by the same way the improvement of its efficiency.

The personal and professional fulfillment, the notion of retention program, applied to the customer relationship management, can be defined as "all the actions including the preliminary reflection, to make customers more active (in terms of consumption) and perpetuate the preferential relation between these customers and the company ". Transcribed in terms of marketing HR, this notion applies to the collaborators of the company and includes all the actions of motivation through various forms of participation in particular, but also more and more training and personal fulfillment.

Why? At first for a very simple reason: besides the fact that this training is essential to the improvement of people potential for the sake of the company, for the most dynamic elements, this formation is a requirement in the sustainable investment of stakeholders within this company. Because each one understood that, to make a successful career in an economic and social environment in perpetual change, it is essential not only to refine permanently its skills but also to acquire some new.

New fact: this evolution, which before could take decades are extremely fast today, in particular in leading-edge sectors and new technologies. That is why also the company is invested by its employees of the responsibility of training them permanently, otherwise they would not be ready to dedicate it their work, knowing that tomorrow it will not have value on the market anymore.

The coherence.

The second reason why the company has to set up program of personal and professional development is that its performance on its market depends more and more on its capacity to create the coherence in the functioning of its teams, while their organization has to non-stop adapt itself to the new needs of this market. This permanent re-creation passes through the learning of techniques management throughout project for example. But this also require to develop at every collaborator's a number of relational and behavioral qualities that they do not often possess.

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- A simple method of analysis and synthesis;

- An objective approach of skills management.

It gives to every company the possibility of developing a tool accessible to the largest number.

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Development of an Electric induction furnace for heat treatment of ferrous and non-ferrous alloys

Ufuoma Peter Anaidhuno[1]; Chinedum Ogonna Mgbemena[2]
[1,2]*Department of Mechanical Engineering, Federal University of Petroleum Resources, Effurun, Nigeria*

ABSTRACT : *A 3kg capacity Electric induction furnace with a power rating of 2500W for heat treatment of ferrous and non-ferrous alloys was developed. The furnace which is made from mild steel sheet was monolithically lined with fire clay refractories and designed to attain a temperature of 1200^{0}C on the automatic control panel. This project was primarily undertaken to build local capacity in foundry practice in Nigeria and to encourage the demonstration of fundamental foundry practice for undergraduates of a Nigerian University.*

KEYWORDS *-Furnace, Temperature, induction, Foundry, Ferrous, Non-ferrous*

I. INTRODUCTION

1.1 Background of the Study

Electric Induction heating is a non-contact heating process which is used to bond, harden or soften metals or other conductive materials [1, 2]. In advanced manufacturing processes, induction heating provides an appealing assemblage of speed, consistency and control. Induction heating has a good heating efficiency, high production rate and clean working environments. The fundamentals of induction heating have been apprehended and utilized in manufacturing since the 19th century [1, 3, 4]. Historically, the early development of Induction furnaces started from the discovery of the principle of electromagnetic induction by Michael Faraday. However, De Ferranti in the late 1870s started experimenting with induction furnaces in Europe. Edward Allen Colby patented an induction furnace for melting metals in the year 1890 and produced the first steel the United States in 1907 [5].

During World War II, the technology grew rapidly to satisfy pressing wartime demands for a quick and authentic method of hardening metal engine parts. Lately, the concentration on lean manufacturing techniques and emphasis on improved quality control have led to a rediscovery of induction technology, along with the development of precisely controlled solid state induction power supplies [1]. In a majority of the heating methods, a torch or open flame is instantly applied to the metal part, but with induction heating, heat is actually "induced" within the part itself by circulating electrical currents [1]. On account of heat being transferred to the product through electromagnetic waves of which the part never comes into direct contact with any flame, there is no product contamination and when duly set up, the process can be replicated and controlled. This dissertation deals on the construction of an electric heat treatment furnace with easier and better control system and timing unit.

Typical applications of induction heating are melting of metals, heating of metals, brazing and welding and all sorts of surface treatments. However, by using electric conductive recipients (e.g. graphite) also other materials like glass can be heated. Surface hardening techniques are suitable for steel with a carbon percentage of at least 0.3 %, where the work piece is heated up to approximately 900°C and after that it is chilled [4]. This technique is used for the hardening of gear wheels, crankshafts, valve stems, saw blades, spades, rails, and many other things. The inductive process has the advantage that the treatment can be localized very accurately.

II. MATERIALS AND METHODOLOGY

This chapter introduces the materials and methods employed in the design and development of the electric induction heat treatment furnace.

2.1 Materials

The materials utilized for the design and development of the Electric heat-treatment furnace are: 1.5 mm thick steel sheets, kaolin clay, hard wood saw dust, temperature controller, switch, light indicators, wire, heating element-copper coil. Tables 1-2 show the detailed materials used in the development of the electric heat treatment furnace and their cost implications. The total costs for a unit is $862 (Eight hundred and sixty two dollars).

2.2 Furnace casing

The steel sheet selected is a mild steel of composition: 0.15% C, 0.45% Mn, 0.18% Si, 0.031% S, 0.001% P, 0.0005% Al, 0.0008% Ni and 0.1867% Fe. It was selected for the fabrication of the furnace casing because of its light weight, good strength, excellent formability, weldability, availability, and low cost of purchase. The furnace casing houses all the components of the furnace including: the refractory bricks and lining, the electro-technical devices (temperature controller, light indicator etc.), the coils. The design was made taking into consideration that the control box should be attached to the casing, and the control box must have holes for easy wiring. The casing was made from a 1.5mm thick flat sheet of mild steel. The sheet was cut to size of 500mm and then folded into box shape. The folding joint was seam welded for strength and rigidity.

2.3 Design/Model Drawings

The design/model drawings of the furnace were achieved using AUTOCAD. Figures 1-11 show the various views and sections of the electric heat treatment furnace developed.

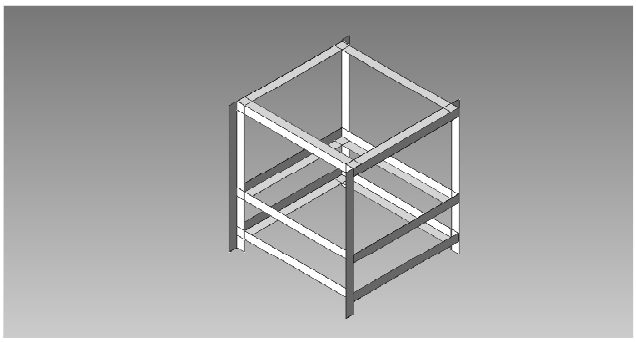

Figure 1 Skeletal Frame Work of the Furnace.

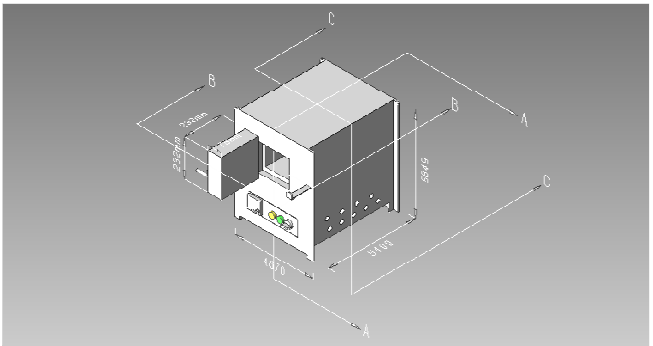

Figure 2 Furnace Pictorial view with Detailed Dimensions

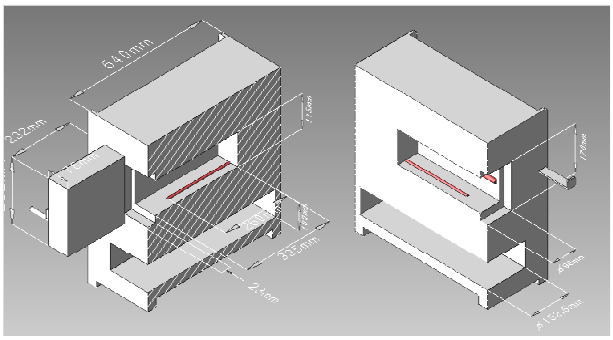

Figure 3 Section A-A of the Furnace

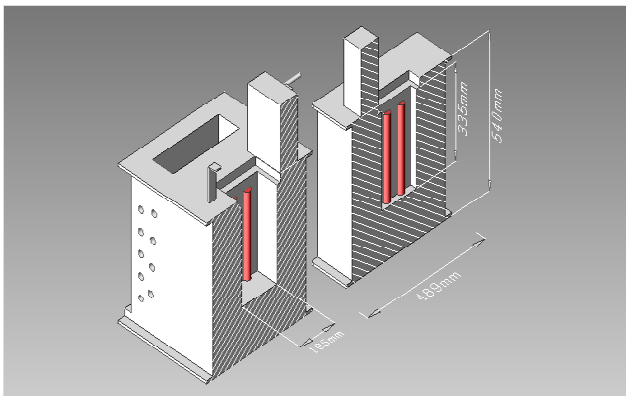

Figure 4 Section B-B of the Furnace

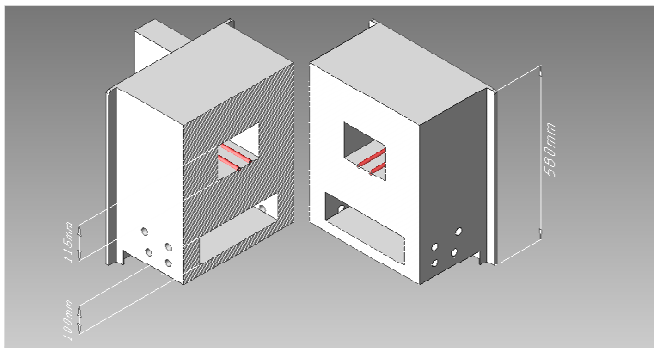

Figure 5 Section C-C of the Furnace

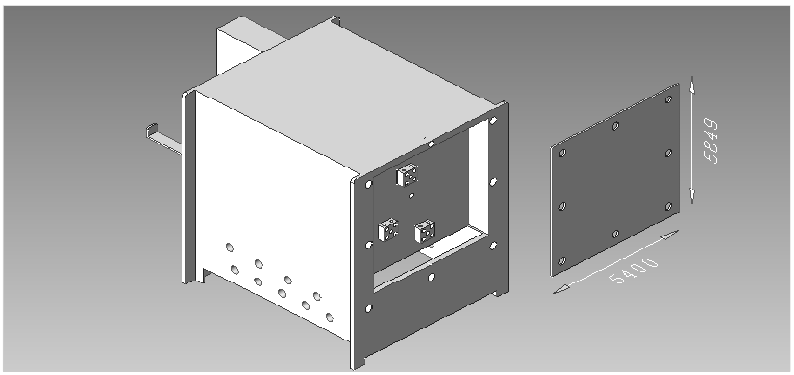

Figure 6 Back View of the Furnace.

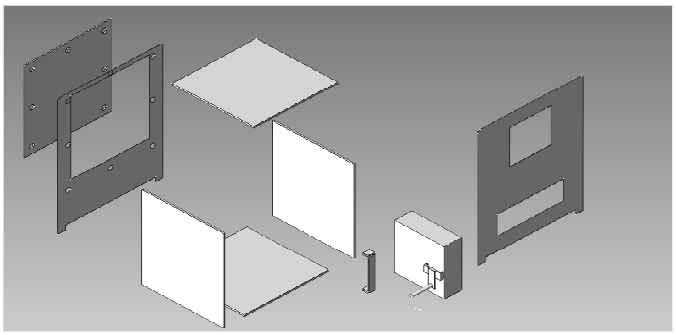

Figure 7 Parts of the Furnace

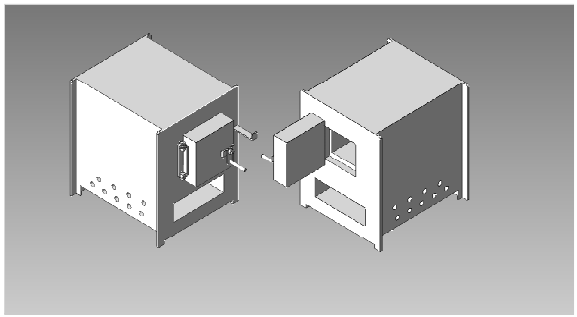

Figure 8 Furnace with the Door Opened and Closed

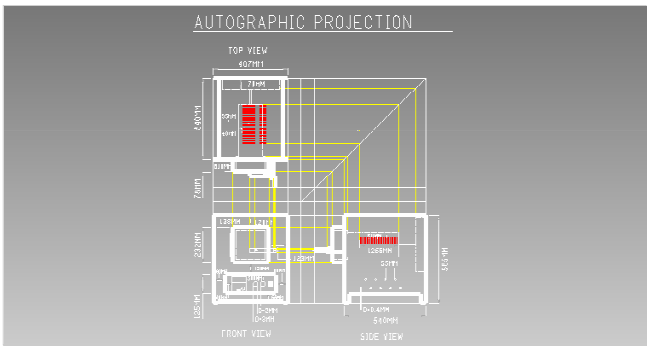

Figure 9 Autographic Projection of the Furnace

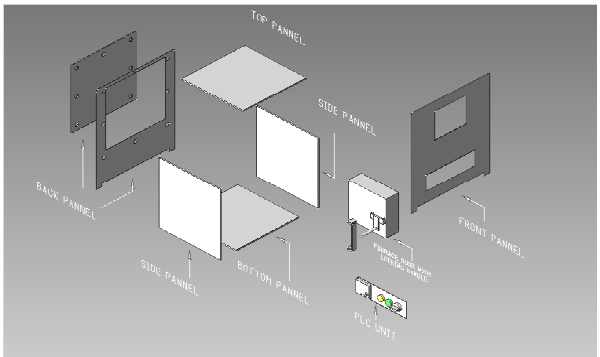

Figure 10 Labeled Furnace Parts

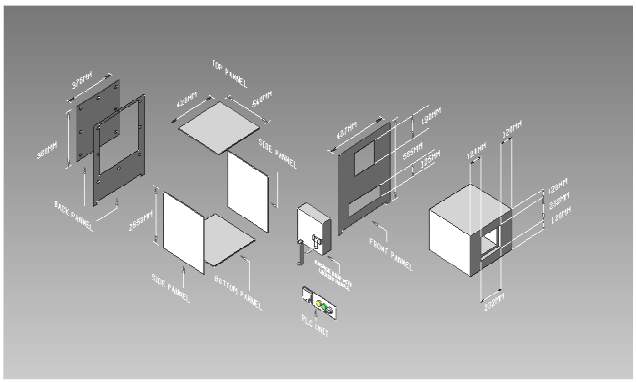

Figure 11 Dis-Assembling Drawing

Table 1 List of Materials, Their Source and Function

S/N	MATERIAL	SOURCE	FUNCTIONS
1	Metal sheet	Diamond Metraco International Ltd, 1387 Bridge Head Market, Onitsha	Metal sheet was used to build the casing or panel of the furnace. It is capable to withstand high temperature It hardly gets burnt It has the tendency to withstand sagg
2	Angle iron	Zonal Steel company, A377 Bridge Head Market, Onitsha	It acts as a reinforcement to the casing and through which the legs are provided
3	Asbestos sheet	Naze Timber shop, Owerri	This contributes to retain the heat in the furnace i.e. it prevents heat loss. It prevents damage to the metal casing by preventing excess heat that mat burn the metal body or cause corrosion
4	Fire clay	Nwanneji & Sons (Nig) Itape	This was used for casting. It has the tendency to withstand crack and breakage when heated. It has the ability to retain heat
5	Beads	Bridge Head Market Onitsha	They act as insolators to prevent current from escaping the induction coils. The prevent shock
6	Induction coils	Rusana Electrical store, No. 65 Old Aba Road PH	It produces heat for heat treatment
7	Temperature relay	Rusana Electrical store, No. 65 Old Aba Road PH	It displays the temperature of the furnace. It displays working principles
8	Circuit breaker	Rusana Electrical store, No. 65 Old Aba Road PH	It controls the working principles of the electrical parts
9	Switch	Rusana Electrical store, No. 65 Old Aba Road PH	It acts as the powering section of the furnace
10	Indicators	Rusana Electrical store, No. 65 Old Aba Road PH	One indicates power ON and OFF, the other indicates danger
11	Electrodes	Elinus and son Enterprises, Steel Market, Owerri	It was used for the joining and welding together of components
12	Water	School borehole	It was used to make the solution of fire clay and silica
13	Cable	Onitsha	For the connection and wiring of the electrical and power systems
14	Fuse	Rusana Electrical store, No. 65 Old Aba Road PH	For the transfer and grip of current
15	Filler	Shop 35 A, New market, Owerri	It was used for filling up of opened regions on the panel
16	Paint	Shop 35A New market, Owerri	It was used for the nice looking and finishing of the project
17	Template	University workshop	It was used for the excavation of the opening for heat treatment portion

Table 2 Bill for Engineering Measurement and Evaluation

S/N	MATERIAL	QUANTITY	UNIT COST ($)	TOTAL COST ($)
1	Metal sheet (1.5mm)	1	36	36
2	Angle iron 2X2	1	31	31
3	Template	-	16	16
4	Asbestos	¼ roll	13	13
5	Fire clay	3 bags	47	141
6	Purslin Beads	200	0.5	100
7	Heating Element	5	9	45
8	Temperature relay	1	128	128
9	Circuit breaker	1	31	31
10	Switch	1	5	5
11	Indicators	2	2.6	5.2
12	Electrodes	1	10.25	10.25
13	Cable/wire	15Meters	1.30	19.5
14	Fuse	1	5	5
15	Filler	-	-	8
16	Paint	1	13	13
17	Transportation/Logistics			105
18	Labour costs			150
	Total			$861.95

III. FURNACE PERFORMANCE AND EVALUATION

The Electric heat treatment furnace was evaluated to ascertain its performance by heat treating mild steel with the following dimension: length 150mm and diameter 50mm at the range of temperature 35°-1200° over a period of 2000 seconds. The results obtained were tabulated as indicated in Table 3 and graphically in Figure 12. It was observed that the temperature of the furnace was maintained at 1200 degrees over a period exceeding 2000seconds and this shows that the furnace was designed to attain a maximum temperature of 1200°.

Table 3 Performance Analysis of Heat treatment of mild steel conducted on the furnace

Time (Seconds)	Temperature (Degree)
0	35
30	200
120	400
260	600
580	800
1000	1000
1500	1200
2000	1200

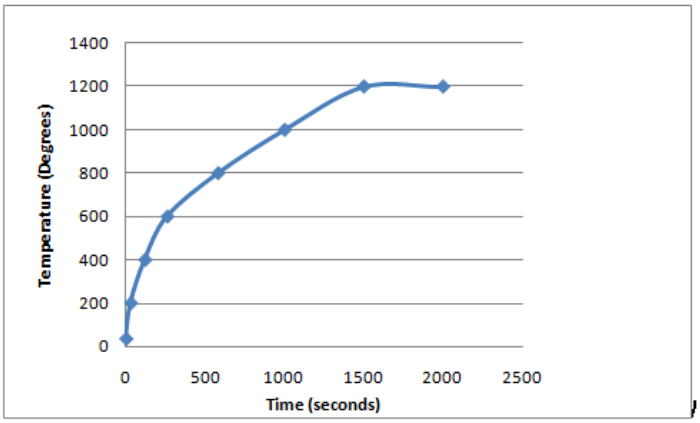

Figure 12 Graphical representation of the performance of the furnace during heat treatment of mild steel.

IV. CONCLUSION

This project was undertaken to design and develop an electric induction heat treatment furnace for undergraduate students' demonstrations on heat treatment processes such as annealing, normalizing, case hardening, tempering, spheroidizing etc. in the Mechanical Engineering Foundry Shop. The furnace was constructed putting into consideration; its temperature attainment, capacity of metals it can hold, the depth/surface area to be heat treated, operators safety, space to be occupied in the workshop floor, cost restrictions, availability of the materials used, its maintainability and portability **.**

Finally, the actualization and realization of this project is a boost to the development of local manpower capacity in Nigeria and also to advance the reliability of engineering materials in service.

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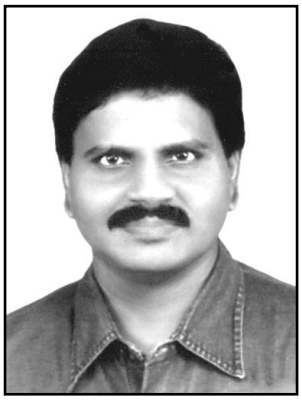
THALI CULTURE OF ANGELS?...

("Mangala Sutra")



M. Arulmani, B.E.
(Engineer)

V.R.Hema Latha, M.A., M.Sc., M.Phil.
(Biologist)

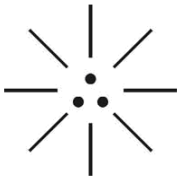
'**Marriage**' is the ceremony when Bride and Bridegroom are united legally for regeneration of their **heirs**. Presently it is the global level culture that '**THALI**' is tied on the bride's neck putting '**three knots**'. There are so many theories about three knots.

i) Marriage is essential for creation?...
ii) Wife is essential for creation?...
iii) Thali is essential for Bondage?...

No... No... No... Yes... Yes... Yes...

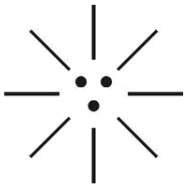
This scientific research focus that '**WIFE**' shall be considered as the **'IMAGE' of 'MOTHER'**. In other words '**WIFE**' shall be considered as the **'Transformed soul' of 'Mother Nature'**. The philosophy of motherly bondage, wife bondage shall be indicated as below.

(i)



MOTHER
(Soul)
(Pal-e)

(ii)

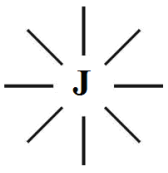


WIFE
(Matter)
(Thali-e)

This scientific research focus that the creator of universe considered created everything through "**MOTHER NATURE**" rather than "**WIFE**". The mother nature shall be considered '**J-RADIATION**' (Zero hour radiation of universe) also called as '**SOULS**' and source of energy.

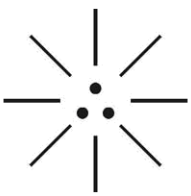
It is focused that **Human ancestors** shall be considered as lived in '**MARS PLANET**' in the early universe. The mother nature shall be considered as "**integral part of creator**" and source of Natural White Energy for creation of entire universe. It is focused that the creator of universe shall be considered as **Supernatural person (or) Supreme God** called by author as '**RAMANUJAM**' and the mother nature as "**JANAKI**". The mother nature considered composed of Billions of Souls and each soul shall be considered as having inbuilt "**Triphthong Mantra**" called by author as "**JAYAM**" (J-AUM) as described below.

(i)



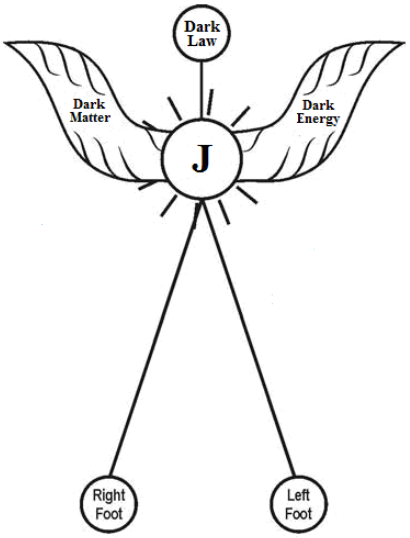
JANAKI
(Mother Nature)

(ii)



JAYAM
(Tripthong Mantra)

(iii)



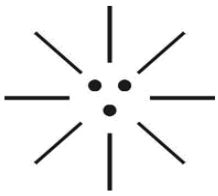
RAMANUJAM
(THEN MALAIYAN)
(Atheist)

Case study shows that "Thali" in marriage ceremony is considered as sacred weapon. Thali when tied to bride's neck that promotes 'wifehood' and when removed from the neck to 'widowhood'. In Sanskrit thali is called as mangala sutra. Mangal means holy; sutra means 'thread'.

Case study shows that the thali culture in marriage was not mentioned in Sangam literature and probably might be evolved during 10th – 12th century. Eminent poet Seikizhar of Periapuranam sang in detail of custom of typing thali in brides neck. Kamban also in his epic Kambar Ramayanam devoted several verses to glorify thali. Further Parisam vaippu is the most ancient Hindu devotional ritual. In Tamil parisam means dowry. The ritual parisam is performed on the way of Shiva Ratri. It is a tradition that parisam is given to bride upon her marriage. Normally Rs.1000 to Rs.10,000 is given as parisam and lakhs of rupees taken back by bridegroom as dowry.

Scholors also believe that the three knots, symbolize Brahma, Vishnu, Rudhrha considered as three protections, for the bride. In Indian culture Bengal, Oriya, Assamese do not have the custom of mangala sutra. Further the followers of shiva have three horizontal lines and followers of Vishnu have three vertical lines in thali and in caste system each caste have their own design of thali. What does mean Thali?...

It is focused that Thali shall mean binding of two souls integrated with Mother Nature. The three-in-one cultural identity shall also be called as AMULET. Amulet shall mean authorized metal piece for wearing on the necks of both bride and bridegroom as a token of betrothal.



பரிசம்
(Amulet)

i) Right dot is like Bridegroom soul

ii) Left dot is like Bride soul

iii) Centre dot is like mother nature

It is further focused that Devas population (Angel race) do not have any culture of Thali as Angels shall be considered as "virgin population" (messengers of God) do not have any marriage system and have strong "ethical binding" with creator. Further in Devas population "Male Angel" shall be considered as responsible for "PREGNANCY". It is evident from biblical study that "She shall be called Woman because she was taken out of Man (genesis 2; 23)"

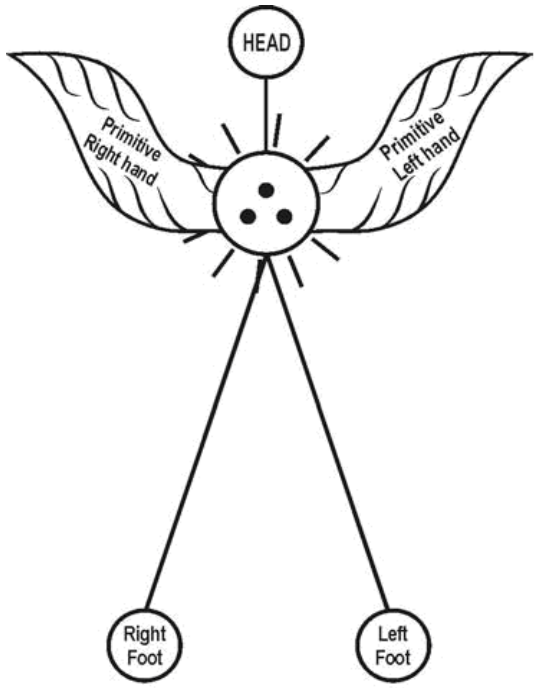
Male Pregnancy?...
(No thali cuture)

Thali shall be considered as Ancient Tamil culture on Earth planet and Thali shall be considered tied to both 'Bride and Bridegroom' to have marital identity. It is evident from Tamil cinema where mega star "MGR" also have worn thali (Thaiethu) during "duet song" with partner. During the course of time the thali culture restricted to only bribe due to 'male chavunism'.

- Author

This research further focus that during dark age of universe the Devas population (Angels) shall be considered as descended to "**Earth planet**" due to varied environmental condition. It is speculated by the author that **ST.RAMA, ST. SITA** shall be considered as transformed population from **MARS PLANET** probably during **APRIL 14** in Ancient time (say 3,00,000 years ago).

(i)



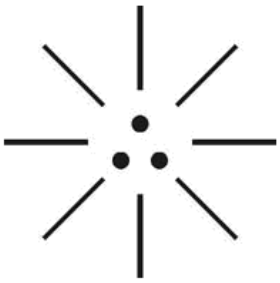
ST. RAMA
(Father of Thiri Renkam)
(April 14)

(ii)

ST. SITA
(Mother of Thiri Renkam)
(April 14)

ST. RAMA, ST. SITA had Thali?...

It is hypothesized that '**RAMA SETHU**' shall mean **SOUL BRIDGE** strongly connecting **both the hearts**. The binding bridge shall also be called as "**RAMA AMULET**" (Bridging the Heart).



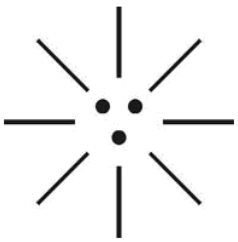
RAM AMULET
(Bridging the Heart)

i) Right dot '**Rama soul**'

ii) Left dot '**Sita soul**'

iii) Center dot '**Janaki**' (mother nature)

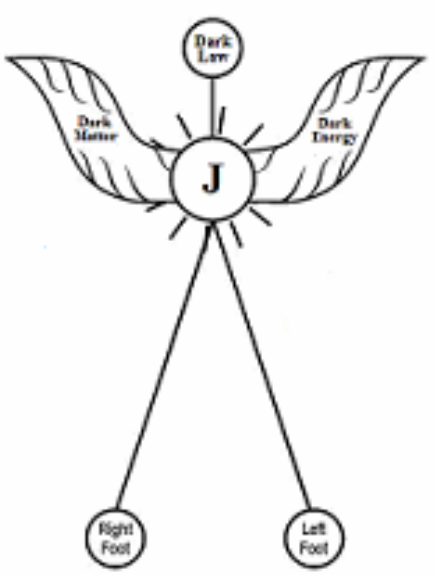
This research further focus that the etymology of word "**MARRIAGE**" (MARRI + AGE) the period when Devas populations lived in **MARS PLANET**. Thali shall be considered as "**Law of marriage**". In proto Indo Europe root word marriage shall mean "**KALYANAM**" (KALAI + ANNAM)



தாலி
(Law of Marriage)

i) Right dot – Kalai (Bridegroom)
ii) Left dot – Annam (Bride),
iii) Center dot – Ancestor (Mother nature)

இராமானுஜம் மந்திரம்!...



தந்தை பெரியார்
(RAMASAMY)
(Atheist)

நான் யார் தெரியுமா?...
நான் ஒரு படைப்பாளி?...
விண்ணுலகம், மண்ணுலகம் எனது படைப்பு!...
எனது உர் தென்திருப்பதி... தென் மதுரை!...
தென்னவன் என்றால் படைப்பாளி... ஈழத்து முத்து...

ஜெயம் எனது முன்னெழுத்து மந்திரம்...
ஜெயம் எனது படைப்பின் சக்தி (Souls)...
ஜெயம் இல்லையேல் உலகம் இல்லை...
ஜெயமே ஜெயம்... இராமஜெயம்...
ஜெயமே எனது தாயார்... அழுதசுரபி...

நீயா?... நானா?...
மாமியாரா?... மருமகளா?...
தாயா?... தாரமா?...
இது தீராத பிரச்சனை... உலகளாவிய பிரச்சனை...
தாயே எனக்கு முதன்மையானவள்...

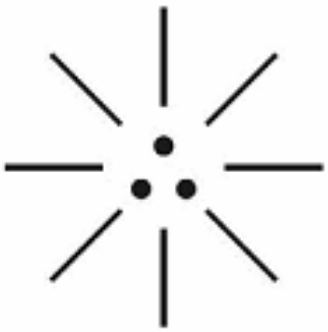
பிரச்சனை வேண்டாம்... தகராறு வேண்டாம்...
எனவே தாயைமட்டும் தெரிந்துகொண்டேன்...
தாயே எனது ஆன்மா... தாயே எனது மூச்சு...
தாயே எனது படைப்பின் இரகசியம்
தாயில்லாமல் நானில்லை... நான் தாயின் பிள்ளை...

அரங்கநாதன், அரங்கநாயகி எனது முதல் பிள்ளைகள்
படைப்பின் திருநாள் எனது திருமண நாள்...
ஜெயமே எனது திருமண மந்திரம்...
ஜெயமே எனது திருமண அடையாளம்...
ஜெயம் என்றால் ஆன்மாவின் ஒருங்கிணைப்பு...

இராமன், சீதா எனது "பூலோக தூதர்கள்"...
இராமன், சீதா எனது "பூலோக தேவதைகள்" (Dark Angels)
இராமன், சீதா பூலோகத்தின் "முதல் தம்பதிகள்"...
இராமன், சீதா என்றால் "மாதிரி தம்பதிகள்"
"இராமசேது" என்றால் பாலமல்ல இதயங்களின் சங்கமம்

மீனாச்சி, சுந்தரேஸ்வரர் எனது "பேரப்பிள்ளைகள்"...
மீனாச்சியோ ஒரு "வைணவம்"..
சுந்தரேஸ்வரரோ ஒரு "சிவசமயம்"...
தாலி கட்டிக்கொள்ள ஆசைப்படுகிறார்கள்!...
பரவாயில்லை!!! கட்டிக்கொள்ளட்டுமே!!!

தாலி என்றால், "ஆன்மாக்களின் சங்கமம்"...
தாலி என்றால் "இதயங்களின் ஒருங்கிணைப்பு"...
தாலி என்றால் "இருவரும் கட்டிக்கொள்வது"...
தாலி என்றால் "இருவருக்கும் சொந்தமானது"...
மணமகள் இறந்தால் "மணமகனும் தாலி அறுக்க வேண்டும்"
மறுமணம் செய்து கொண்டால் மீண்டும் கட்டிக்கொள்ளட்டும்...



ஜெயம்
(Soul of Ramanujam)
(Mantra)

M.அருள்மணி
தமிழ்பேசும் இந்தியன்,
மதுரைவாசி, கிராமத்தான்.

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Rehydration characteristics and modeling of cassava chips

Ajala, A.S.,[1] Ajala, F.A.[2] and Oyedele, J.O.[1]
[1]*Department of Food Science and Engineering, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria*
[1]*Department of Computer Science and Engineering, Ladoke Akintola University of Technology, P.M.B. 4000, Ogbomoso, Nigeria*

ABTRACT: *Cassava chips with dimension 4x2x0.2cm were re-hydrated in distilled water at 20^0C, 30^0C and 40^0C in a laboratory water bath. Kinetics of re-hydration was investigated using three different re-hydration models namely Peleg, exponential and Weibull. The pattern of water absorption was observed to be faster at the initial period of soaking. Higher temperature induces faster moisture absorption in the chips. Non linear regression analysis was used to fit in the experimental data and the coefficient of determination was found to be greater than 0.72 for all the models. The values of R^2, RMSE, MBE and reduced chi square showed that Weibull model best described the re-hydrating behaviour of the cassava chips.*

KEY WORD: *rehydration, modeling, temperature, cassava chips*

I. INTRODUCTION

Cassava chips are the most common form in which dried cassava root are marketed. It is a rich source of cassava pellet, alcohol, industrial starches and cassava beer (Wheatly *et al*, 1995, CBN, 2012). Processing cassava chips involves peeling and slicing into flat shapes before drying either in sun or mechanical dryers (Tewe 1994). The methods of preservation include storing in baskets, silos, bags and cribs. The major challenge facing the shelf life of cassava chips is moisture gain during storage due to hygroscopic nature and tends to absorb moisture which promotes the formation of moulds and thus early deterioration of the chips. Having this information makes it therefore utmost important to consider effective storage system for cassava chips. The shelf life of cassava chips is expected to be between 6-12 months if properly stored. The duration of storage is influence by other factors such as insect infestation but since dried cassava chips are hard for insect to penetrates, moisture absorption by the chips make it soft and helps insects to penetrate into these chips and cause deterioration. Therefore, the key factor to monitor is how to prevent moisture from gaining entrance into the storage system where the chips are kept. Consequently, to design effective storage for the chips, knowledge of water absorption properties is required which necessitated modeling of water transfer in chips slab. This is the objective of the study.

Empirical models have been applied to study absorbing characteristics of foods; for instant Peleg model (Gowen et al., 2007), Weibull distribution model (Garcia-Pascual *et al.*, 2006; Machado, *et al.*, 1999; Marabi, et al., 2003) and exponential model (Gowen *et al.*, 2007; Kashaninejad, *et al.*, 2007). So, these three models would be used to study the re-hydrating behaviour of the chips.

II. MATERIALS AND METHODS

(a) Re-hydration kinetics of dehydrated cassava chips experiment

The re-hydration behaviour of the chips was studied using three temperatures namely 20, 30 and 40^{o}C. The chips were placed inside a beaker containing water. The ratio of the dried chips to water was 1: 30 as recommended by Johnson, et al., 1998; Bhuvaneswari et al., 1999**.** The beaker was then placed in a water bath at a pre-set temperature. The chips were removed at interval of time from the water and placed on absorbent cloth to remove the free water on the surface the chips and the change in weight of the chips was recorded. The samples were subsequently returned to water via wire mesh, and the process was repeated until the chips moisture content attained saturation moisture content. Experiments were triplicated and the average results were used for modeling process. The moisture ratio (MR) is computed in equation 1 as follows:

$$MR = \frac{W_r}{W_d} \quad (1)$$

(b) Mathematical model

Three equations were used for re-hydration modelling process. The experimental data were fitted into these three different models as presented in Table 1. These models described the relationship between moisture gain and soaking time with various coefficients attached to each model

Table I: **Mathematical drying models**

Models	Equation	References
Peleg	$M_t - M_0 = \frac{t}{k_1 + k_2 t}$	Bahadur *et al.*, 2007
Weibull	$MR = \exp(-(\frac{t}{\beta})^{\alpha}$	Khazaei, 2008
Exponential	$MR = \exp(-kt)$	Khazaei, 2008

(c) Statistical Analysis

The constant of each model was determined using a non-linear regression analysis performed using programming protocol of Statistical Package for Social Scientist (SPSS 15.0 versions) software to determine the goodness of fit of experimental data into mathematical equation. According to Maydeu-Olivares and CGarcı´a-Forero (2010), the goodness of fit (GOF) of a statistical model describes how well it fits into a set of observations. GOF indices summarize the discrepancy between the observed values and the values expected under a statistical model. GOF statistics are GOF indices with known sampling distributions, usually obtained using asymptotic methods that are used in statistical hypothesis testing. In this study, statistical criteria such as coefficient of determination (R^2), reduced chi-square (χ^2), root mean square error (RMSE) and mean bias error (MBE) were used to test the reliability of the models. The equation for each statistical criterion is as shown in equations 2-4

$$\chi^2 = \frac{\sum_{i-1}^{n} (MR_{(\exp,\ i)} - MR_{(pred\ ,i)})^2}{N - z} \quad (2)$$

$$\text{MBE} = \frac{1}{N}\sum_{i=1}^{n} (MR_{(pred\ ,i)} - MR_{(\exp,\ i)}) \quad (3)$$

$$\text{RMSE} = \left[\frac{1}{N}\sum_{i=1}^{n} (MR_{(pred\ ,i)} - MR_{(\exp,\ i)})^2\right]^{1/2} \quad (4)$$

III. RESULTS AND DISCUSSION

(a) Water absorption pattern of the Chips

Figure 1 shows the water absorption characteristics of the chips at 20, 30 and 40^{o}C. The chips exhibited almost the same pattern in the first 15 minutes but the graph shows wide gap among each other thereafter. The graph shows an increase rate of water absorption followed by slower absorption as soaking time increased. Previous works by other researchers show identical curves (Abu-Ghannam and McKenna, 1997; Bello et al., 2004; Sopade et al., 1992, Mahir *et al.*, 2002, Maharaj and Sankat, 2000).

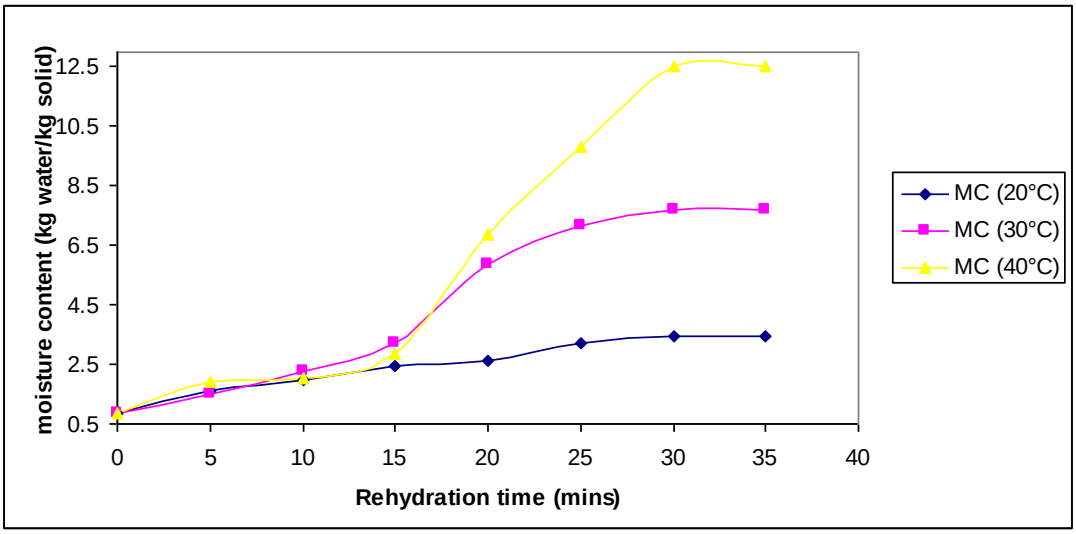

Figure 1: Moisture content against time

Temperature shows a significant influence on the re-hydrating profile of the chips. At the end of 30 minutes, the chips had gained moisture of 3.35 kg water/kg solid, 7.12 kg water/kg solid and 12.35kg water/kg solid at 20, 30 and 40^{o}C respectively. From these values, higher temperature aids the absorption because water molecules are exited to penetrate into the granular cell of the chips. The same observation has been reported by Smiles (2005) and Ajala *et al* 2012.

Figure 2 shows the change in rate of re-hydration of the samples at 20, 30 and 40^{o}C. The change in rate of re-hydration implies the amount of change in moisture the sample absorbed within an interval of time. From the graph, sample re-hydrated at 40^{o}C has an initial value of 48.5g/hr followed by 32.0g/hr at 30^{o}C and 9.02g/hr at20^{o}C. As soaking time increased, the graph declined down the slope and flattened off showing that the change in water absorption continue to decline as the sample tends to saturation point when moisture are no longer absorbed. This saturation stage was branded relaxation stage by Khazaei 2008.Similar curve has been reported by Bahadur *et al.*, (2007).

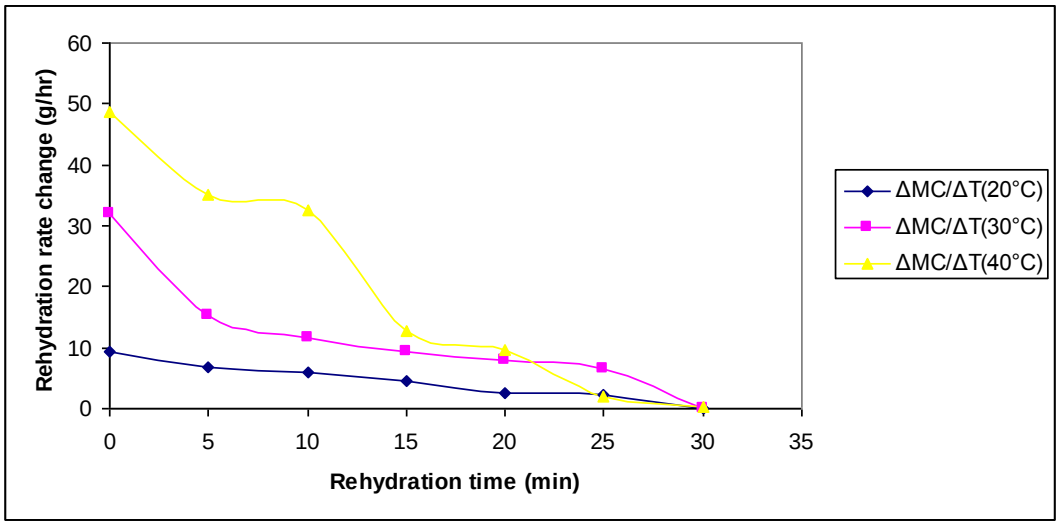

Figure 2: Re-hydration change rate against time

Table 2 shows the values of statistical criteria used in evaluating the three models used. The lowest value of chi square is found to be 0.019396 (exponential model) while the highest is 0.79384 (Weibull model). The lowest value of MBE is -0.0296 (exponential model) while the highest is 0.714286 (Weibull model). Furthermore, t he lowest value of RMSE is found to be 0.128939 (exponential model) while the highest is 0.890977 (Weibull model).The values of R^2 of Peleg model is as follows: 0.955, 0.966 and 0.827; Weibull:

0.926, 0.967 and 0.920; exponential: 0.733, 0.677 and 0.775 for 20, 30 and 40°C respectively. On the average, the value of R^2 for Peleg, Weibull and exponential are 0.916, 0.937 and 0.728. From these values, the highest value of R^2 is found to be 0.937 which correspond to Weibull model while the lowest value of R^2 is 0.728 correspond to exponential model. Therefore, in this study, Weibull model is considered the best model to represent re-hydrating characteristics of cassava chips because it has best fit with experimental data. A good fit occurred when R^2 is high and other statistical criteria such as reduced chi square, MBE and RMSE are low (Ahmet *et al.*, 2007).

Table 3 shows the value of re-hydrating constant of the samples. In Peleg model, the lowest value for k_1 is 8.429 minutes while the highest value is 60.563 minutes. Lowest value for k_2 is -1.046 while highest is 0.708. The re-hydrating constant in Weibull model is stated thus: α lowest value is 0.095 while α highest value is 0.405. β lowest value is 29.445 minutes while the highest is 12.465 minutes . The lowest value of *k* in exponential model is 3.525 min^{-1} while the highest value is 11.566 min^{-1}. The value of K_1 in Peleg model and *k* in exponential model are inversely related to moisture absorption. This implies that as k_1 and *k* increase, water absorption decreases. This is the same observation reported by Mahir *et al* (2002). Contrariwise, β values increases as water absorption increases

Table II: Models Evaluation using statistical criteria

Model	Temp (°C)	R^2	χ^2	MBE	RMSE
Peleg	20	0.956	0.54802	0.518571	0.740284
	30	0.966	0.40016	0.411429	0.632582
	40	0.827	0.78878	0.672857	0.888133
Weibull	20	0.926	0.54048	0.54	0.735173
	30	0.967	0.39752	0.425714	0.630492
	40	0.920	0.79384	0.714286	0.890977
Exponential	20	0.733	0.027985	-0.03879	0.154879
	30	0.677	0.034653	-0.0296	0.172345
	40	0.775	0.019396	-0.05695	0.128939

Table III: Values for model constants

Model	Temp (°C)	*k* (min^{-1})	k_1(min)	k_2 (-)	α (-)	β (min)
Peleg	20		60.563	0.708		
	30		30.495	-0.066		
	40		8.429	-1.046		
Weibull	20				0.188	-29.445
	30				0.095	-16.911
	40				0.405	-12.465
Exponential	20	11.566				
	30	7.851				
	40	3.525				

CONCLUSION

Temperature affects water absorption behaviour of the samples in such a way that as temperature increase, water absorption is faster. Weibull model had best fit and represent well the re-hydration characteristics of the dehydrated cassava chips.

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Effective of Earthquake load on Behavior of Rectangular Shear Wall in RC Frame Building

Mahdi Hosseini[1], Dr.Hadi Hosseini[2], Prof.Tabassum Naqvi[3], Seyed Amin Ahmadi Olounabadi[4]

[1,] *Ph.D. Scholar student in Structural Engineering, Dept. of Civil Engineering, Aligarh Muslim University (AMU), Aligarh, Uttar Pradesh , India*
[2,] *Ph.D. in Aerospace Engineering , working in International Earthquake Research Center of America (IERCA)*
[3,] *Professor in Structural Engineering, Dept. of Civil Engineering, Aligarh Muslim University (AMU), Aligarh, Uttar Pradesh , India*
[4,] *Ph.D. Scholar student in Computer Science and Engineering, Dept. of Computer Science and Engineering, Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, Telengana , India*

ABSTRACT: *Structural walls, or shear walls, are elements used to resist lateral loads, such as those generated by wind and earthquakes. Structural walls are considerably deeper than typical beams or columns. This attribute gives structural walls considerable in-plane stiffness which makes structural walls a natural choice for resisting lateral loads. In addition to considerable strength, structural walls can dissipate a great deal of energy if detailed properly. Walls are an invaluable structural element when protecting buildings from seismic events. Buildings often rely on structural walls as the main lateral force resisting system. Shear walls are required to perform in multiple ways. Shear walls can then be designed to limit building damage to the specified degree. The load-deformation response of the structural walls must be accurately predicted and related to structural damage in order to achieve these performance goals under loading events of various magnitudes. The applied load is generally transferred to the wall by a diaphragm or collector or drag member. The performance of the framed buildings depends on the structural system adopted for the structure The term structural system or structural frame in structural engineering refers to load-resisting sub-system of a structure. The structural system transfers loads through interconnected structural components or members. These structural systems need to be chosen based on its height and loads and need to be carried out, etc. The selection of appropriate structural systems for building must satisfy both strength and stiffness requirements. The structural system must be adequate to resist lateral and gravity loads that cause horizontal shear deformation and overturning deformation. The efficiency of a structural system is measured in terms of their ability to resist lateral load, which increases with the height of the frame. A building can be considered as tall when the effect of lateral loads is reflected in the design. Lateral deflections of framed buildings should be limited to prevent damage to both structural and nonstructural elements. In the present study, the structural performance of the framed building with shear wall will be analysis. In this paper, the structural performance of the RC framed building with Rectangularshear wall in will be analysis. The importance of the shear wall in resist the wind and earthquake load are study, the effect of the shear walls on the conventional frame system. The best location of shear wall are near center of mass and center of gravity .The im*provement in the structural performance of the building with frame system by using shear wall is study.

KEY WORDS**:** *Rectangular shear wall,Structural walls,Shear walls,frame structure,Seismic Load,frame system*

I. INTRODUCTION

EarthquakeLoad

The seismic weight of building is the sum of seismic weight of all the floors. The seismic weight of each floor is its full dead load plus appropriate amount of imposed load, the latter being that part of the imposed loads that may reasonably be expected to be attached to the structure at the time of earthquake shaking. It includes the weight of permanent and movable partitions, permanent equipment, a part of the live load, etc. While computing the seismic weight of columns and walls in any storey shall be equally distributed to the floors above and below the storey.

Earthquake forces experienced by a building result from ground motions (accelerations) which are also fluctuating or dynamic in nature, in fact they reverse direction some what chaotically. The magnitude of an earthquake force depends on the magnitude of an earthquake, distance from the earthquake source(epicenter), local ground conditions that may amplify ground shaking (or dampen it), the weight(or mass) of the structure, and the type of structural system and its ability to with stand abusive cyclic loading. In theory and practice, the lateral force that a building experiences from an earthquake increases in direct proportion with the acceleration of ground motion at the building site and the mass of the building (i.e., a doubling in ground motion acceleration or building mass will double the load).This theory rests on the simplicity and validity of Newton's law of physics: F = m x a, where 'F' represents force, 'm' represents mass or weight, and 'a' represents acceleration. For example, as a car accelerates forward, a force is imparted to the driver through the seat to push him forward with the car(this force is equivalent to the weight of the driver multiplied by the acceleration or rate of change in speed of the car). As the brake is applied, the car is decelerated and a force is imparted to the driver by the seat-belt to push him back toward the seat. Similarly, as the ground accelerates back and forth during an earthquake it imparts back-and-forth(cyclic) forces to a building through its foundation which is forced to move with the ground. One can imagine a very light structure such as fabric tent that will be undamaged in almost any earthquake but it will not survive high wind. The reason is the low mass (weight) of the tent. Therefore, residential buildings generally perform reasonably well in earthquakes but are more vulnerable in high-wind load prone areas. Regardless, the proper amount of bracing is required in both cases.

Why Are Buildings With Shear Walls Preferred In Seismic Zones?

Reinforced concrete (RC) buildings often have vertical plate-like RC walls called Shear Walls in addition to slabs, beams and columns. These walls generally start at foundation level and are continuous throughout the building height. Their thickness can be as low as 150mm, or as high as 400mm in high rise buildings. Shear walls are usually provided along both length and width of buildings. Shear walls are like vertically-oriented wide beams that carry earthquake loads downwards to the foundation.

"We cannot afford to build concrete buildings meant to resist severe earthquakes without shear walls." Mark Fintel, a noted consulting engineer in USA Shear walls in high seismic regions requires special detailing. However, in past earthquakes, even buildings with sufficient amount of walls that were not specially detailed for seismic performance (but had enough well-distributed reinforcement) were saved from collapse. Shear wall buildings are a popular choice in many earthquake prone countries, like Chile, New Zealand and USA. Shear walls are easy to construct, because reinforcement detailing of walls is relatively straight-forward and therefore easily implemented at site. Shear walls are efficient; both in terms of construction cost properly designed and detailed buildings with Shear walls have shown very good performance in past earthquakes. The overwhelming success of buildings with shear walls in resisting strong earthquakes is summarized in the quote: And effectiveness in minimizing earthquake damage in structural and non- Structural elements (like glass windows and building contents).

When a building is subjected to wind or earthquake load, various types of failure must be prevented:

• slipping off the foundation (sliding)

• overturning and uplift (anchorage failure)

• shear distortion (drift or racking deflection)

• collapse (excessive racking deflection)

The first three types of failure are schematically shown in the Figure 1 Clearly, the entire system must be tied together to prevent building collapse or significant deformation.

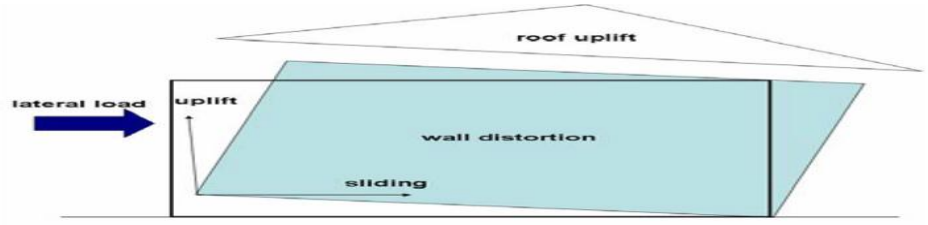
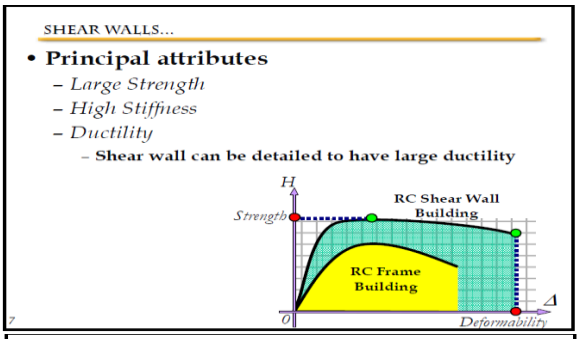
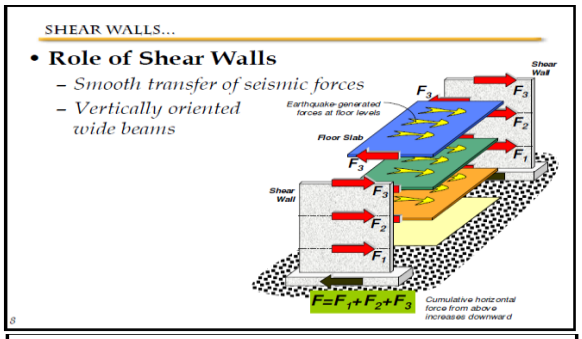
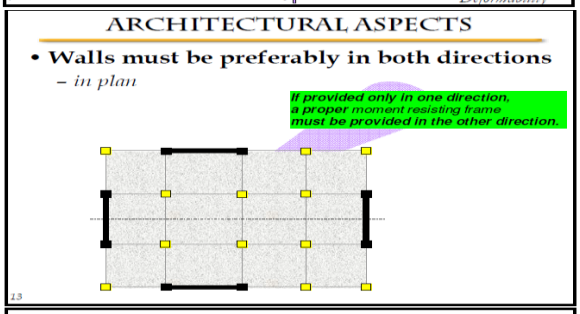


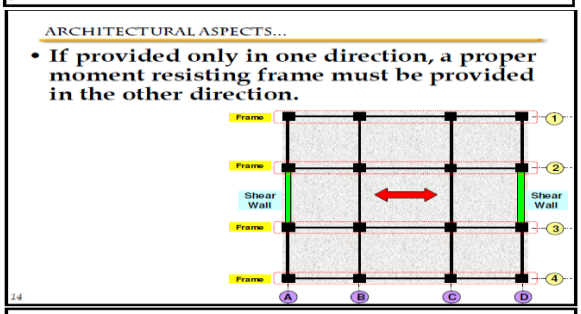
Figure 1:Schematic of the deformations of the structure due to the lateral loads

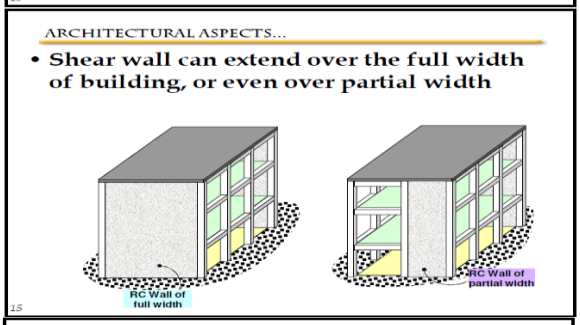
Most RC buildings with shear walls also have columns; these columns primarily carry gravity loads (i.e., those due to self-weight and contents of building). Shear walls provide large strength and stiffness to buildings in the direction of their orientation, which significantly reduces lateral sway of the building and thereby reduces damage to structure and its contents. Since shear walls carry large horizontal earthquake forces, the overturning effects on them are large. Thus, design of their foundations requires special Attention. Shear walls should be provided along preferably both length and width. However, if they are provided along only one direction, a proper grid of beams and columns in the vertical plane (called a moment-resistant frame) must be provided along the other direction to resist strong earthquake effects.

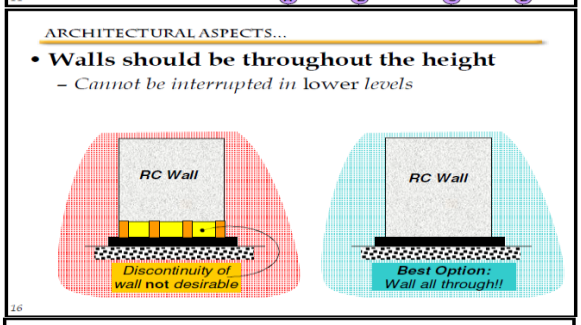


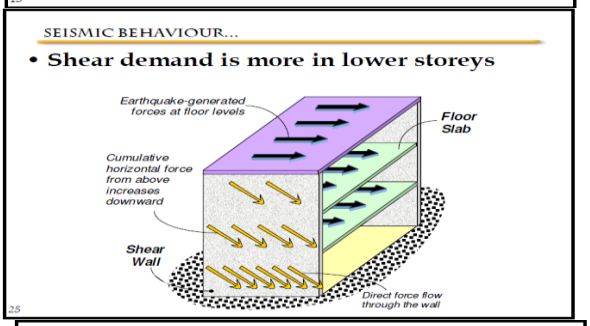


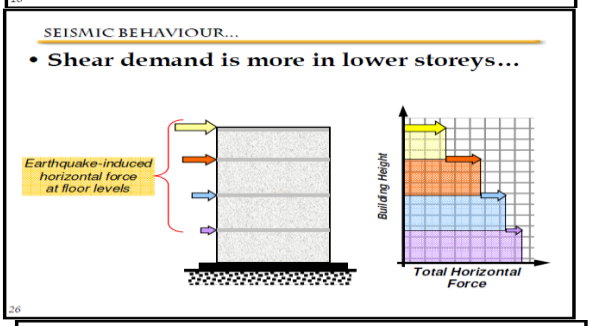


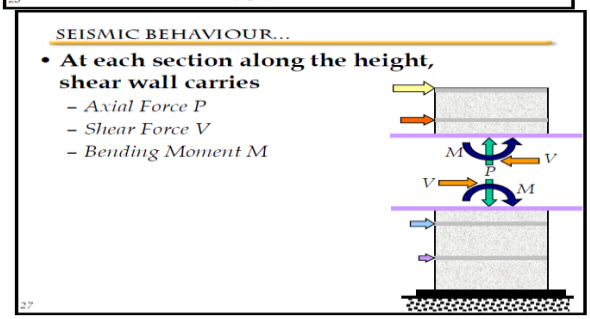


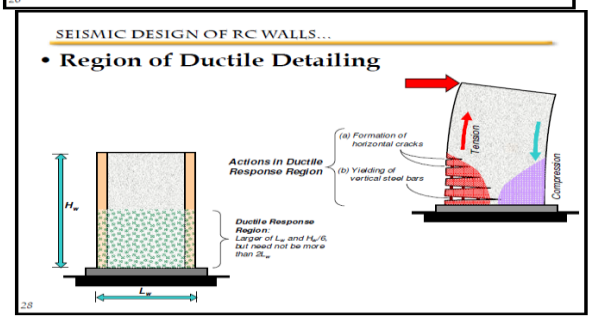












III. METHODOLOGY

When a structure vibrating. An earthquake can be resolved in any vibrating. An earthquake can be resolved in any three mutually perpendicular directions-the two horizontal directions (longitudinal and transverse displacement) and the vertical direction (rotation).This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are designed for the combined effects of gravity loads and seismic loads to verify that adequate vertical and lateral strength and stiffness are achieved to satisfy the structural performance and acceptable deformation levels prescribed in the governing building code. Because of the inherent factor of safety used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans, those in which stability for design, or for overall stability analysis of structures.

In general, most earthquake code provisions implicitly require that structures be able to resist:

1. Minor earthquakes without any damage.
2. Moderate earthquakes with negligible structural damage and some non-structural damage.
3. Major earthquakes with some structural and non-structural damage but without collapse.

The structure is expected to undergo fairly large deformations by yielding in some structural members.

To avoid collapse during a major earthquake, members must be ductile enough to absorb and dissipate energy by post-elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements, when the element or system forces yields to fails, the lateral forces can be redistributed to a secondary system to prevent progressive primary failure.

Earthquake motion causes vibration of the structure leading to inertia forces. Thus a structure must be able to safely transmit the horizontal and the vertical inertia forces generated in the super structure through the foundation to the ground. Hence, for most of the ordinary structures, earthquake-resistant design requires ensuring that the structure has adequate lateral load carrying capacity. Seismic codes will guide a designer to safely design the structure for its intended purpose.Seismic codes are unique to a particular region or country. In India, IS 1893(Part1) : 2002is the main code that provides outline for calculating seismic design force. This force depends on the mass and seismic coefficient of the structure and the latter in turn depends on properties like seismic zone in which structure lies, importance of the structure, its stiffness, the soil on which it rests, and its ductility. IS 1893 (Part 1) : 2002deals with assessment of seismic loads on various structures and buildings. Whole the code centers on the calculation of base shear and its distribution over height. The analysis can be performed on the basis of the external action, the behavior of the structure or structural materials, and the type of structural model selected. Depending on the height of the structure and zone to which it belongs, type of analysis is performed. In all the methods of analyzing multi- storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels, which include half that of columns and walls above and below the floor. In addition, appropriate amount of live load at this floor is also lumped with it.

Quite a few methods are available for the earthquake analysis of buildings; two of them are presented here:

1- Equivalent Static Lateral Force Method (pseudo static method).
2- Dynamic analysis.
I. Response spectrum method.
II. Time history method.

Equivalent lateral Force (Seismic Coefficient) Method

This method of finding lateral forces is also known as the static method or the equivalent static method or the seismic coefficient method. The static method is the simplest one and it requires less computational effort and is based on formulae given in the code of practice. In all the methods of analyzing a multi storey buildings recommended in the code, the structure is treated as discrete system having concentrated masses at floor levels which include the weight of columns and walls in any storey should be equally distributed to the floors above and below the storey. In addition, the appropriate amount of imposed load at this floor is also lumped with it. It is also assumed that the structure flexible and will deflect with respect to the position of foundation the lumped mass system reduces to the solution of a system of second order differential equations. These equations are formed by distribution, of mass and stiffness in a structure, together with its damping characteristics of the ground motion.

Lateral Distribution of Base Shear

The computed base shear is now distributed along the height of the building, the shear force , at any level depends on the mass at that level and deforms shape of the structure . Earth quake forces deflect a structure into number of shapes known as the natural mode shapes. Number of natural mode shapes depends up on the degree of freedom of the system. Generally a structure has continuous system with infinite degree of freedom the magnitude of the lateral force at a particular floor (node) depends on the mass of the node , the distribution of stiffness over the height of the structure , and the nodal displacement in the given mode. The actual distribution of base share over the height of the building is obtained as the superposition of all the mode of vibration of the multi - degree of freedom system .

Dynamic Analysis

Dynamic analysis shall be performed to obtain the design seismic force, and its distribution in different levels along the height of the building, and in the various lateral load resisting element, for the following buildings:

***Regular buildings*:** Those greater than 40m in height in zones IV and V, those greater than 90m in height in zone II and III.

***Irregular buildings*:** All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.

The analysis of model for dynamic analysis of buildings with unusual configuration should be such that it adequately models the types of irregularities present in the building configuration. Buildings with plan irregularities, as defined in Table 4 of IS code: 1893-2002 cannot be modeled for dynamic analysis.

Dynamic analysis may be performed either by the TIME HISTORY METHOD or by the RESPONSE SPECTRUM METHOD

Time History Method

The usage of this method shall be on an appropriate ground motion and shall be performed using accepted principles of dynamics. In this method, the mathematical model of the building is subjected to accelerations from earthquake records that represent the expected earthquake at the base of the structure.

Response Spectrum Method

The word spectrum in engineering conveys the idea that the response of buildings having a broad range of periods is summarized in a single graph. This method shall be performed using the design spectrum specified in code or by a site-specific design spectrum for a structure prepared at a project site. The values of damping for building may be taken as 2 and 5 percent of the critical, for the purposes of dynamic of steel and reinforce concrete buildings, respectively. For most buildings, inelastic response can be expected to occur during a major earthquake, implying that an inelastic analysis is more proper for design. However, in spite of the availability of nonlinear inelastic programs, they are not used in typical design practice because:

1- Their proper use requires knowledge of their inner workings and theories. design criteria, and
2- Result produced are difficult to interpret and apply to traditional design criteria , and
3- The necessary computations are expensive.

Therefore, analysis in practice typically use linear elastic procedures based on the response spectrum method. The response spectrum analysis is the preferred method because it is easier to use.

IV. NUMERICAL ANALYSES

STRUCTURE

G+19 earthquake resistant structure with shear walls

Problems In The Building Due To Earthquake

Main problems that would be arising due to earthquake in the structure are story drift and deflection of the building due to its large height and also torsion and others, so if the structure is proved to be safe in all the above mentioned problems than the structure would be safe in all cases in respect earthquake.

Geometrical Properties

1.No.of stories of the Building model=20
2.Column size=500 mm x 500 mm
3.Beam size= 700 mm x 500 mm
4.Slab thickness=200mm

Loads

1.Live Load=3KN/m2
2.Wall Load=12.4KN/m
3.Floor Finishing =1KN/m2
4. Wind load
Wind coefficients
(i) Wind Speed=50m/s
(ii)Terrain Category =2
(iii) Structure Class=B
(iv) Risk Coefficient(k1)=1
(v)Topography(k3)=1
Seismic loading
(i) Seismic zone factor(Z)=0.36
(ii) Soil Type= Medium(II)
(iii) Response Reduction factor(R) =5%
(iv) Story Range=Base to 20
(v) Important factor(I)=1

Material Properties

Table I : The materials used in structure and their general properties are

Material Text	Unit weight KN/m3	Elastic Modulus KN/m2	Shear Modulus KN/m2	Poisson Ratio Unit less	Thermal expansion coefficient 1/C
Concrete	23.563	24855578.28	10356490.95	0.2	0.0000099
Rebar steel	76.973	199947978.8	76903068.77	0.3	0.0000117
Bar steel	76.9730	199947978.8	769030068.77	0.3	0.0000117

Load Combinations

Load combination is the foremost important criteria for designing any structure and more important is the distribution of those loads on to various components of the structure like beams, columns, slabs and in our case shears walls and concrete core wall too. There are many kinds of loads existing depending on the location of the where the structure is to be constructed for example in a place where wind is frequent there we have to consider the wind loads and places where rains are heavy rain loads are included and same way all the other loads such as snow loads, earthquake load and etc. are included however DEAD LOADS, LIVE LOADS AND IMPOSEDLOADS are always included. Dead loads are all common depending on the structural components and specific gravity of the structure, to get the self weight of the structural component volume or area of the component is multiplied by the specific gravity of the component. Live loads depend on the purpose we are constructing the building. Imposed loads depend on the seismic loads, dead loads and according to are 1893 part 1 percentage of those values is finally considered.

The following Load Combinations have been considered for the design

1. 1.5(DL+ LL)
2. 1.5(DL ± EQXTP)
3. 1.5(DL ± EQYTP)
4. 1.5(DL ± EQXTN)
5. 1.5(DL ± EQYTN)
6. 1.2(DL + LL ± EQXTP)
7. 1.2(DL + LL ± EQYTP)
8. 1.2(DL + LL ± EQXTN)
9. 1.2(DL + LL ± EQYTN)
10. 1.5(DL ± WLX)
11. 1.5(DL ± WLY)
12. 1.2(DL + LL ± WLX)
13. 1.2(DL + LL ± WLY)

DL – Dead Load
LL – Live Load
EQTP–Earthquake load With torsion positive
EQTN–Earthquake load With torsion negative
WL- Wind load

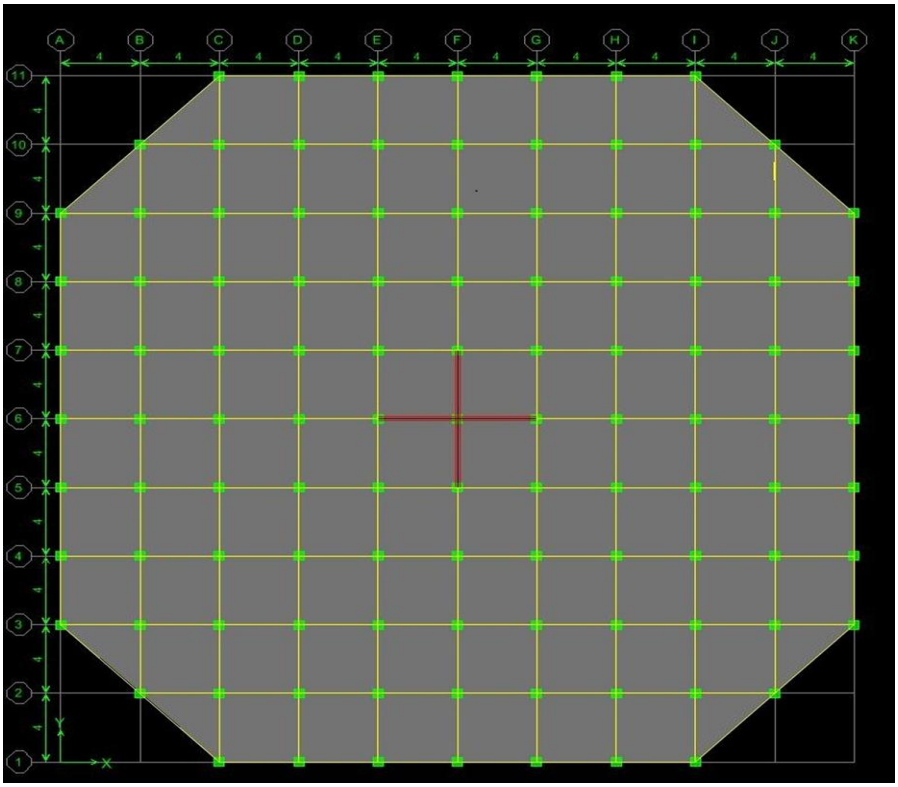
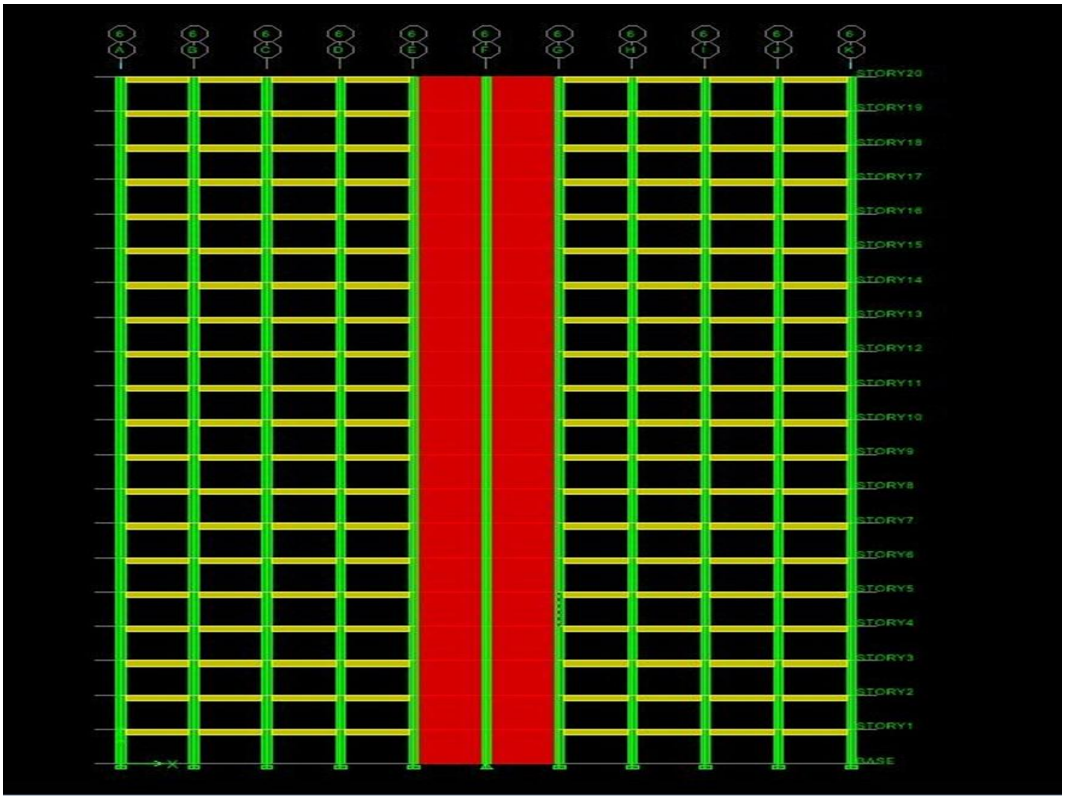


Figure 2: Basic Plan of The Building



Figur3: Elevation of the building

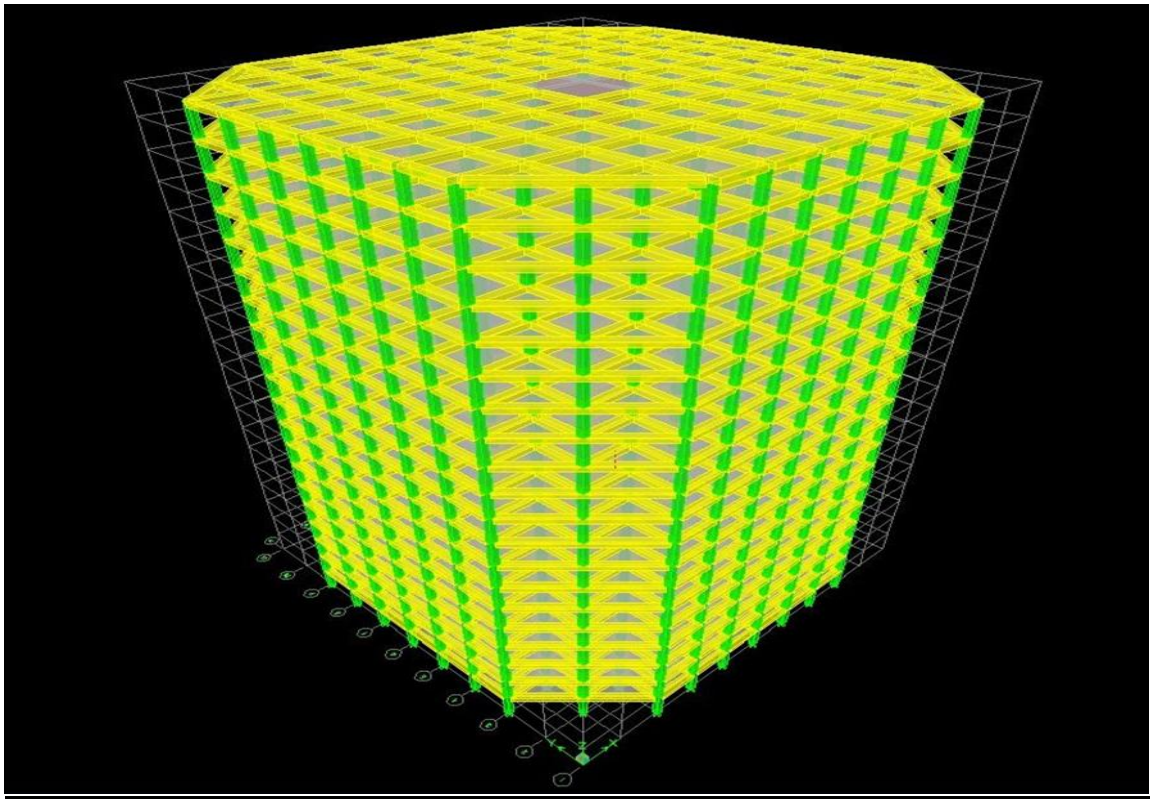
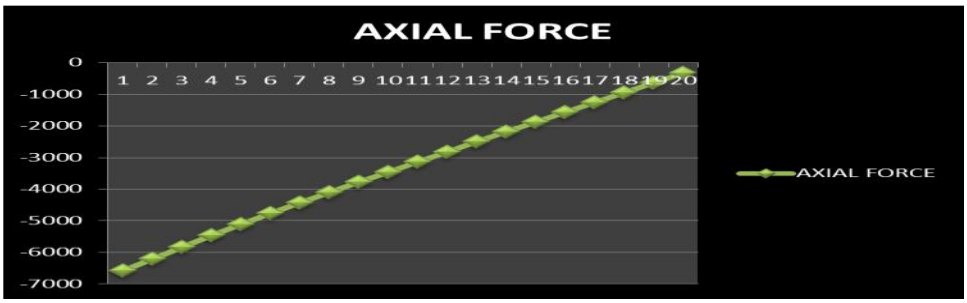
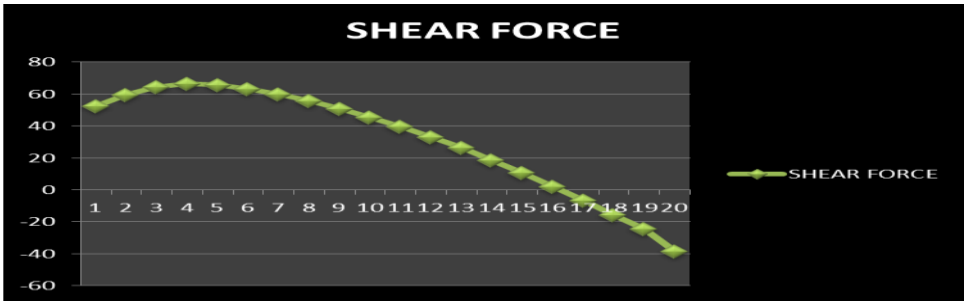


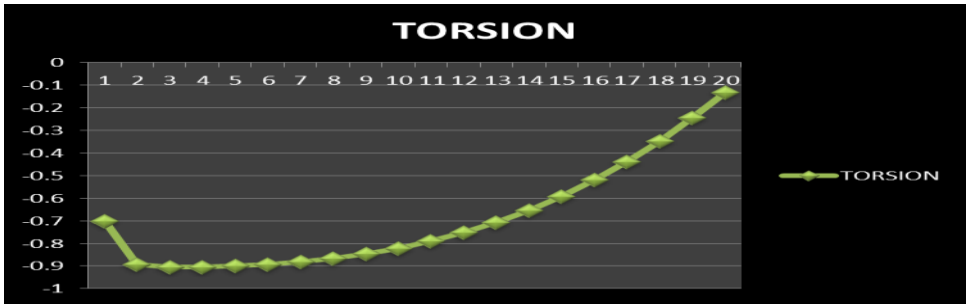
Figure 4:3-D modeling

Table II: Axial force, Shear Force, Torsion and Moment for columnC3

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQX	1.25	-6586.71	52.61	-0.701	6.334
STORY2	C3	1.2DLLLEQX	1.25	-6200.93	59.27	-0.894	3.966
STORY3	C3	1.2DLLLEQX	1.25	-5829.32	64.44	-0.905	3.776
STORY4	C3	1.2DLLLEQX	1.25	-5468.27	66.37	-0.904	3.712
STORY5	C3	1.2DLLLEQX	1.25	-5116.59	65.62	-0.9	3.652
STORY6	C3	1.2DLLLEQX	1.25	-4772.84	63.28	-0.893	3.584
STORY7	C3	1.2DLLLEQX	1.25	-4435.75	59.85	-0.882	3.507
STORY8	C3	1.2DLLLEQX	1.25	-4104.19	55.63	-0.867	3.419
STORY9	C3	1.2DLLLEQX	1.25	-3777.15	50.81	-0.847	3.317
STORY10	C3	1.2DLLLEQX	1.25	-3453.8	45.45	-0.822	3.197
STORY11	C3	1.2DLLLEQX	1.25	-3133.41	39.58	-0.791	3.057
STORY12	C3	1.2DLLLEQX	1.25	-2815.39	33.18	-0.752	2.891
STORY13	C3	1.2DLLLEQX	1.25	-2499.25	26.24	-0.707	2.697
STORY14	C3	1.2DLLLEQX	1.25	-2184.64	18.75	-0.653	2.47
STORY15	C3	1.2DLLLEQX	1.25	-1871.28	10.69	-0.591	2.206
STORY16	C3	1.2DLLLEQX	1.25	-1559.02	2.14	-0.519	1.9
STORY17	C3	1.2DLLLEQX	1.25	-1247.79	-6.8	-0.438	1.549
STORY18	C3	1.2DLLLEQX	1.25	-937.67	-15.87	-0.346	1.15
STORY19	C3	1.2DLLLEQX	1.25	-628.25	-24.28	-0.243	0.701
STORY20	C3	1.2DLLLEQX	1.25	-323.52	-38.57	-0.132	0.177







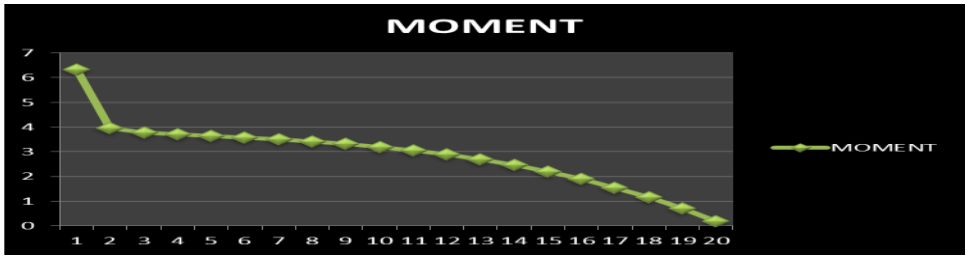


Figure 5: Axial force, Shear Force, Torsion and Moment for columnC3

Table III: Axial force, Shear Force, Torsion and Moment for columnC8

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQX	1.25	-6483.38	70.63	-0.701	6.098
STORY2	C8	1.2DLLLEQX	1.25	-6102.03	76.82	-0.894	3.919
STORY3	C8	1.2DLLLEQX	1.25	-5738.56	81.5	-0.905	4.626
STORY4	C8	1.2DLLLEQX	1.25	-5386.9	83.06	-0.904	5.194
STORY5	C8	1.2DLLLEQX	1.25	-5045.42	82.04	-0.9	5.693
STORY6	C8	1.2DLLLEQX	1.25	-4712.14	79.47	-0.893	6.085
STORY7	C8	1.2DLLLEQX	1.25	-4385.38	75.81	-0.882	6.378
STORY8	C8	1.2DLLLEQX	1.25	-4063.7	71.36	-0.867	6.577
STORY9	C8	1.2DLLLEQX	1.25	-3745.86	66.25	-0.847	6.686
STORY10	C8	1.2DLLLEQX	1.25	-3430.85	60.54	-0.822	6.711
STORY11	C8	1.2DLLLEQX	1.25	-3117.82	54.24	-0.791	6.656
STORY12	C8	1.2DLLLEQX	1.25	-2806.06	47.31	-0.752	6.525
STORY13	C8	1.2DLLLEQX	1.25	-2495.05	39.72	-0.707	6.322
STORY14	C8	1.2DLLLEQX	1.25	-2184.39	31.43	-0.653	6.052
STORY15	C8	1.2DLLLEQX	1.25	-1873.8	22.44	-0.591	5.718
STORY16	C8	1.2DLLLEQX	1.25	-1563.2	12.76	-0.519	5.326
STORY17	C8	1.2DLLLEQX	1.25	-1252.59	2.5	-0.438	4.88
STORY18	C8	1.2DLLLEQX	1.25	-942.27	-8.14	-0.346	4.393
STORY19	C8	1.2DLLLEQX	1.25	-632.04	-18.38	-0.243	3.859
STORY20	C8	1.2DLLLEQX	1.25	-326.92	-34.34	-0.132	2.942

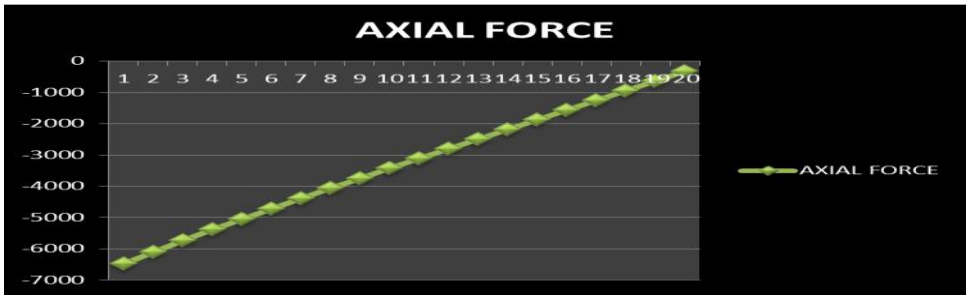
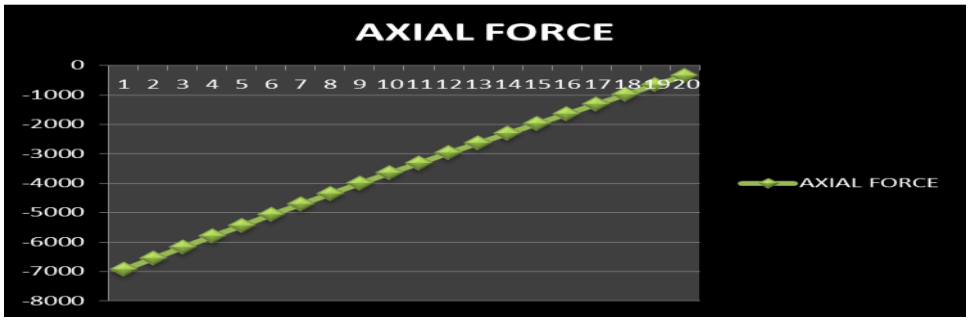
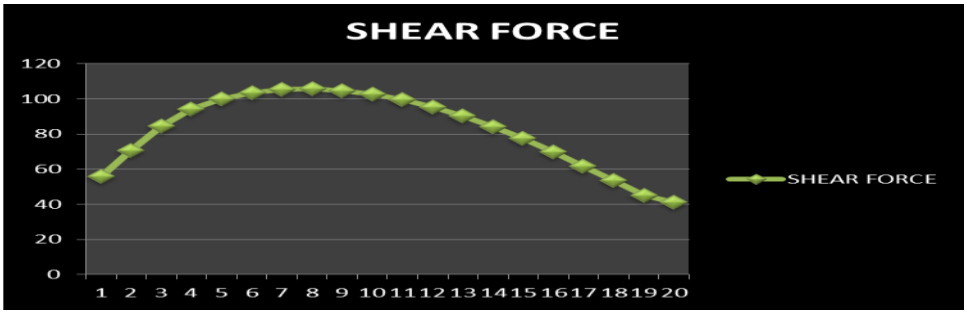


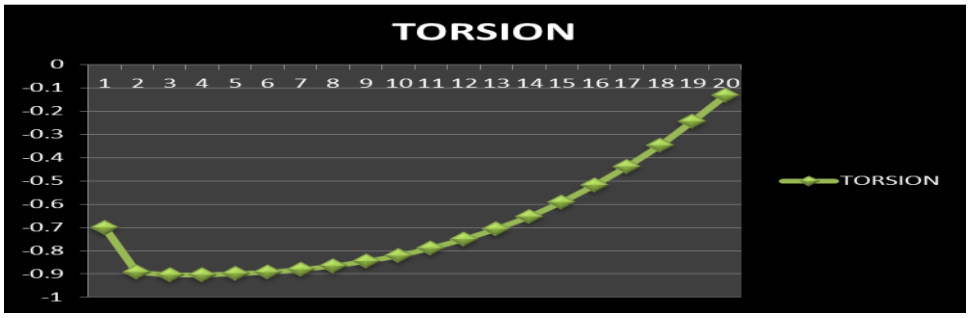
Figure 6: Axial force,Shear Force, Torsion and Moment for columnC8

Table IV: Axial force, Shear Force, Torsion and Moment for columnC11

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQX	1.25	-6934.71	55.69	-0.701	4.552
STORY2	C11	1.2DLLLEQX	1.25	-6553.17	70.43	-0.894	3.132
STORY3	C11	1.2DLLLEQX	1.25	-6175.2	84.53	-0.905	3.318
STORY4	C11	1.2DLLLEQX	1.25	-5801.64	93.99	-0.904	3.609
STORY5	C11	1.2DLLLEQX	1.25	-5432.62	100.01	-0.9	3.89
STORY6	C11	1.2DLLLEQX	1.25	-5068.25	103.61	-0.893	4.153
STORY7	C11	1.2DLLLEQX	1.25	-4708.5	105.35	-0.882	4.393
STORY8	C11	1.2DLLLEQX	1.25	-4353.24	105.61	-0.867	4.606
STORY9	C11	1.2DLLLEQX	1.25	-4002.28	104.62	-0.847	4.788
STORY10	C11	1.2DLLLEQX	1.25	-3655.37	102.52	-0.822	4.935
STORY11	C11	1.2DLLLEQX	1.25	-3312.23	99.38	-0.791	5.045
STORY12	C11	1.2DLLLEQX	1.25	-2972.55	95.27	-0.752	5.114
STORY13	C11	1.2DLLLEQX	1.25	-2636.01	90.21	-0.707	5.14
STORY14	C11	1.2DLLLEQX	1.25	-2302.29	84.25	-0.653	5.12
STORY15	C11	1.2DLLLEQX	1.25	-1971.05	77.46	-0.591	5.052
STORY16	C11	1.2DLLLEQX	1.25	-1641.95	69.92	-0.519	4.934
STORY17	C11	1.2DLLLEQX	1.25	-1314.64	61.83	-0.438	4.764
STORY18	C11	1.2DLLLEQX	1.25	-988.78	53.48	-0.346	4.534
STORY19	C11	1.2DLLLEQX	1.25	-663.86	45.12	-0.243	4.324
STORY20	C11	1.2DLLLEQX	1.25	-341.55	41.25	-0.132	3.098







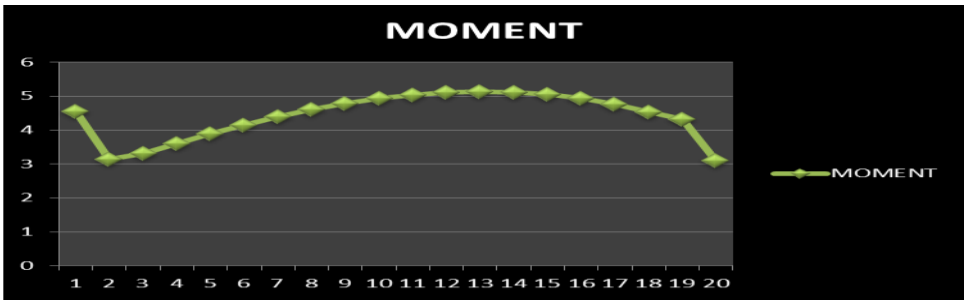


Figure 7:Axial force, Shear Force, Torsion and Moment for columnC11

Table V: Axial force, Shear Force, Torsion and Moment for columnC14

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQX	1.25	-6783.79	68.36	-0.701	5.024
STORY2	C14	1.2DLLLEQX	1.25	-6402.91	86.42	-0.894	2.786
STORY3	C14	1.2DLLLEQX	1.25	-6026.73	103.62	-0.905	2.16
STORY4	C14	1.2DLLLEQX	1.25	-5656.24	116.05	-0.904	1.645
STORY5	C14	1.2DLLLEQX	1.25	-5291.65	124.87	-0.9	1.14
STORY6	C14	1.2DLLLEQX	1.25	-4932.95	131.05	-0.893	0.644
STORY7	C14	1.2DLLLEQX	1.25	-4579.98	135.11	-0.882	0.16
STORY8	C14	1.2DLLLEQX	1.25	-4232.4	137.42	-0.867	-0.311
STORY9	C14	1.2DLLLEQX	1.25	-3889.84	138.19	-0.847	-0.769
STORY10	C14	1.2DLLLEQX	1.25	-3551.85	137.55	-0.822	-1.214
STORY11	C14	1.2DLLLEQX	1.25	-3217.98	135.59	-0.791	-1.647
STORY12	C14	1.2DLLLEQX	1.25	-2887.78	132.36	-0.752	-2.069
STORY13	C14	1.2DLLLEQX	1.25	-2560.83	127.9	-0.707	-2.484
STORY14	C14	1.2DLLLEQX	1.25	-2236.72	122.26	-0.653	-2.894
STORY15	C14	1.2DLLLEQX	1.25	-1915.07	115.51	-0.591	-3.302
STORY16	C14	1.2DLLLEQX	1.25	-1595.53	107.77	-0.519	-3.712
STORY17	C14	1.2DLLLEQX	1.25	-1277.79	99.22	-0.438	-4.128
STORY18	C14	1.2DLLLEQX	1.25	-961.52	90.17	-0.346	-4.537
STORY19	C14	1.2DLLLEQX	1.25	-646.26	80.65	-0.243	-5.113
STORY20	C14	1.2DLLLEQX	1.25	-333.95	79.49	-0.132	-3.98

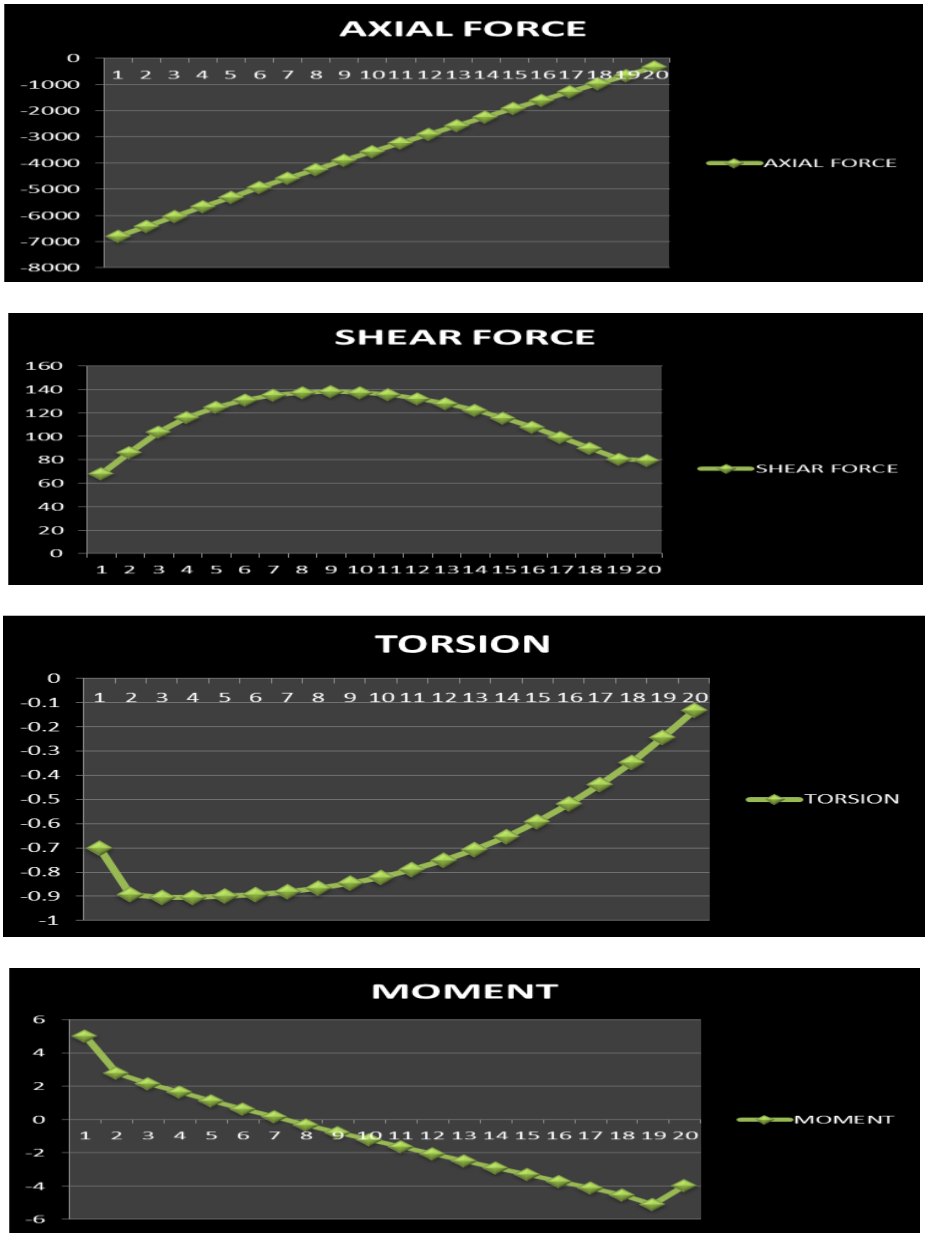


Figure 8: Axial force, Shear Force, Torsion and Moment for columnC14

Table VI: Axial force, Shear Force, Torsion and Moment for columnC3

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C3	1.2DLLLEQY	1.25	-6800.3	4.62	0.699	22.041
STORY2	C3	1.2DLLLEQY	1.25	-6418.46	-1.51	0.888	18.985
STORY3	C3	1.2DLLLEQY	1.25	-6047	-7.82	0.899	21.631
STORY4	C3	1.2DLLLEQY	1.25	-5683.41	-13.23	0.898	23.242
STORY5	C3	1.2DLLLEQY	1.25	-5326.54	-18.08	0.894	24.182
STORY6	C3	1.2DLLLEQY	1.25	-4975.29	-22.37	0.887	24.671
STORY7	C3	1.2DLLLEQY	1.25	-4628.75	-26.18	0.876	24.792
STORY8	C3	1.2DLLLEQY	1.25	-4286.17	-29.55	0.861	24.613
STORY9	C3	1.2DLLLEQY	1.25	-3946.92	-32.55	0.841	24.169
STORY10	C3	1.2DLLLEQY	1.25	-3610.48	-35.22	0.816	23.484
STORY11	C3	1.2DLLLEQY	1.25	-3276.39	-37.61	0.784	22.572
STORY12	C3	1.2DLLLEQY	1.25	-2944.31	-39.76	0.746	21.443
STORY13	C3	1.2DLLLEQY	1.25	-2613.93	-41.71	0.7	20.104
STORY14	C3	1.2DLLLEQY	1.25	-2284.99	-43.49	0.646	18.571
STORY15	C3	1.2DLLLEQY	1.25	-1957.31	-45.15	0.584	16.865
STORY16	C3	1.2DLLLEQY	1.25	-1630.72	-46.71	0.512	15.021
STORY17	C3	1.2DLLLEQY	1.25	-1305.11	-48.21	0.431	13.102
STORY18	C3	1.2DLLLEQY	1.25	-980.44	-49.65	0.339	11.198
STORY19	C3	1.2DLLLEQY	1.25	-656.24	-50.72	0.236	9.531
STORY20	C3	1.2DLLLEQY	1.25	-335.79	-59.21	0.125	6.297

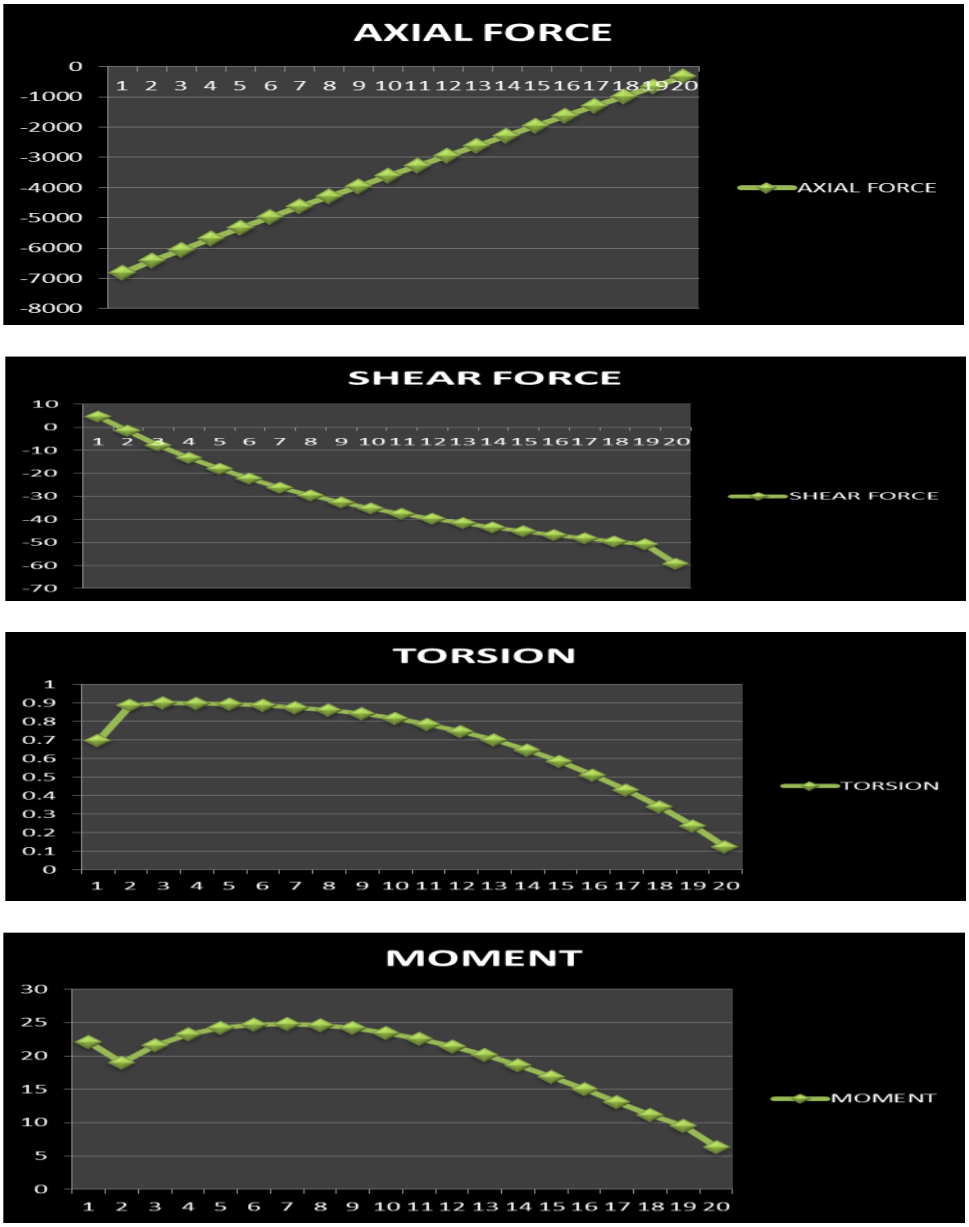


Figure 9:Axial force, Shear Force, Torsion and Moment for columnC3

TableVII:Axial force, Shear Force, Torsion and Moment for columnC8

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C8	1.2DLLLEQY	1.25	-7206.65	-12.14	0.699	22.482
STORY2	C8	1.2DLLLEQY	1.25	-6830.45	-15.16	0.888	18.521
STORY3	C8	1.2DLLLEQY	1.25	-6457.85	-18.41	0.899	20.64
STORY4	C8	1.2DLLLEQY	1.25	-6087.2	-21.12	0.898	21.731
STORY5	C8	1.2DLLLEQY	1.25	-5718.21	-23.56	0.894	22.221
STORY6	C8	1.2DLLLEQY	1.25	-5350.65	-25.72	0.887	22.322
STORY7	C8	1.2DLLLEQY	1.25	-4984.45	-27.66	0.876	22.115
STORY8	C8	1.2DLLLEQY	1.25	-4619.6	-29.38	0.861	21.665
STORY9	C8	1.2DLLLEQY	1.25	-4256.11	-30.9	0.841	21.004
STORY10	C8	1.2DLLLEQY	1.25	-3894.04	-32.25	0.816	20.152
STORY11	C8	1.2DLLLEQY	1.25	-3533.42	-33.41	0.784	19.118
STORY12	C8	1.2DLLLEQY	1.25	-3174.31	-34.4	0.746	17.909
STORY13	C8	1.2DLLLEQY	1.25	-2816.75	-35.21	0.7	16.53
STORY14	C8	1.2DLLLEQY	1.25	-2460.74	-35.84	0.646	14.991
STORY15	C8	1.2DLLLEQY	1.25	-2106.3	-36.26	0.584	13.309
STORY16	C8	1.2DLLLEQY	1.25	-1753.39	-36.47	0.512	11.516
STORY17	C8	1.2DLLLEQY	1.25	-1401.92	-36.44	0.431	9.663
STORY18	C8	1.2DLLLEQY	1.25	-1051.81	-36.13	0.339	7.851
STORY19	C8	1.2DLLLEQY	1.25	-702.51	-35.39	0.236	6.167
STORY20	C8	1.2DLLLEQY	1.25	-356.75	-38.38	0.125	3.988

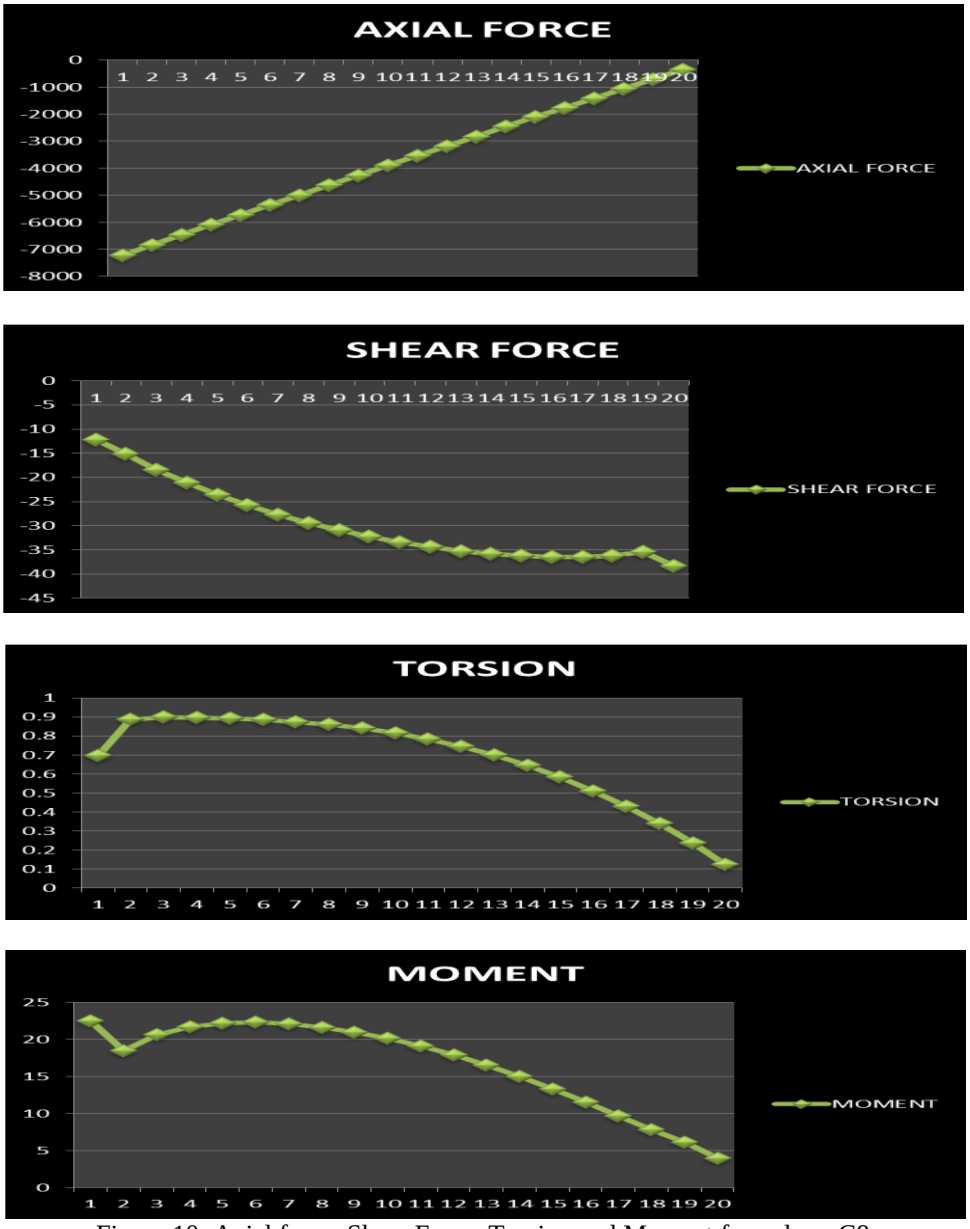
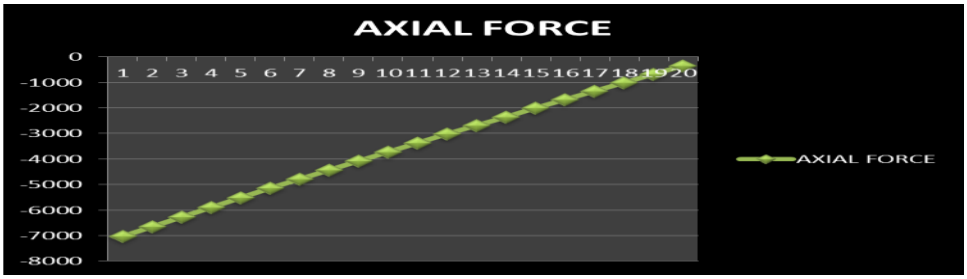
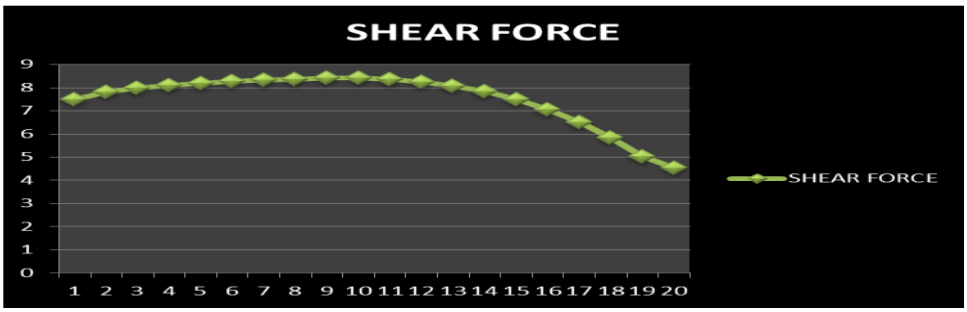


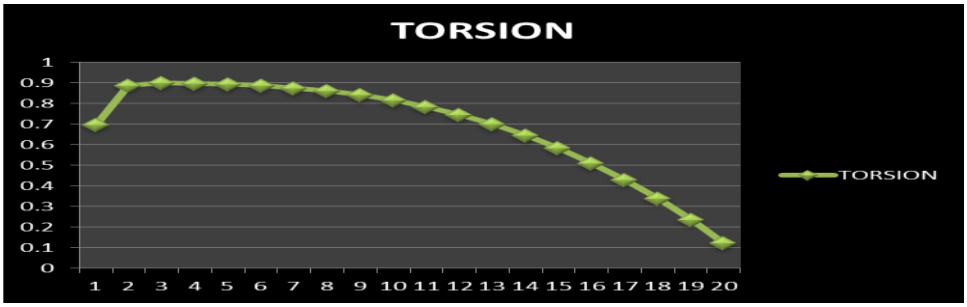
Figure 10: Axial force, Shear Force, Torsion and Moment for columnC8

TableVIII:Axial force, Shear Force, Torsion and Moment for columnC11

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C11	1.2DLLLEQY	1.25	-7019.18	7.49	0.699	23.415
STORY2	C11	1.2DLLLEQY	1.25	-6636.78	7.82	0.888	20.128
STORY3	C11	1.2DLLLEQY	1.25	-6257.96	8	0.899	23.039
STORY4	C11	1.2DLLLEQY	1.25	-5883.17	8.11	0.898	24.968
STORY5	C11	1.2DLLLEQY	1.25	-5512.48	8.2	0.894	26.213
STORY6	C11	1.2DLLLEQY	1.25	-5145.94	8.27	0.887	26.992
STORY7	C11	1.2DLLLEQY	1.25	-4783.48	8.33	0.876	27.383
STORY8	C11	1.2DLLLEQY	1.25	-4425	8.38	0.861	27.449
STORY9	C11	1.2DLLLEQY	1.25	-4070.31	8.41	0.841	27.224
STORY10	C11	1.2DLLLEQY	1.25	-3719.21	8.41	0.816	26.731
STORY11	C11	1.2DLLLEQY	1.25	-3371.44	8.36	0.784	25.981
STORY12	C11	1.2DLLLEQY	1.25	-3026.76	8.26	0.746	24.985
STORY13	C11	1.2DLLLEQY	1.25	-2684.87	8.09	0.7	23.751
STORY14	C11	1.2DLLLEQY	1.25	-2345.49	7.85	0.646	22.292
STORY15	C11	1.2DLLLEQY	1.25	-2008.31	7.51	0.584	20.632
STORY16	C11	1.2DLLLEQY	1.25	-1673.02	7.07	0.512	18.807
STORY17	C11	1.2DLLLEQY	1.25	-1339.31	6.52	0.431	16.878
STORY18	C11	1.2DLLLEQY	1.25	-1006.85	5.84	0.339	14.932
STORY19	C11	1.2DLLLEQY	1.25	-675.19	5.03	0.236	13.272
STORY20	C11	1.2DLLLEQY	1.25	-345.76	4.54	0.125	9.105







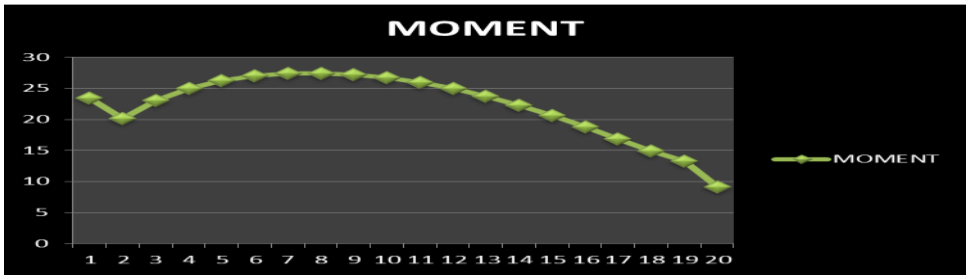


Figure 11: Axial force, Shear Force, Torsion and Moment for columnC11

Table IX:Axial force Shear Force, Torsion and Moment for columnC14

Story	Column	Load	Loc	AXIAL FORCE	SHEAR FORCE	TORSION	MOMENT
STORY1	C14	1.2DLLLEQY	1.25	-7070.16	-2.85	0.699	23.743
STORY2	C14	1.2DLLLEQY	1.25	-6687.15	-1.09	0.888	19.879
STORY3	C14	1.2DLLLEQY	1.25	-6307.79	0.76	0.899	22.248
STORY4	C14	1.2DLLLEQY	1.25	-5932.5	2.54	0.898	23.621
STORY5	C14	1.2DLLLEQY	1.25	-5561.29	4.27	0.894	24.322
STORY6	C14	1.2DLLLEQY	1.25	-5194.1	5.95	0.887	24.57
STORY7	C14	1.2DLLLEQY	1.25	-4830.76	7.59	0.876	24.446
STORY8	C14	1.2DLLLEQY	1.25	-4471.07	9.18	0.861	24.018
STORY9	C14	1.2DLLLEQY	1.25	-4114.8	10.72	0.841	23.322
STORY10	C14	1.2DLLLEQY	1.25	-3761.7	12.22	0.816	22.383
STORY11	C14	1.2DLLLEQY	1.25	-3411.5	13.65	0.784	21.215
STORY12	C14	1.2DLLLEQY	1.25	-3063.94	15.03	0.746	19.831
STORY13	C14	1.2DLLLEQY	1.25	-2718.74	16.33	0.7	18.241
STORY14	C14	1.2DLLLEQY	1.25	-2375.63	17.56	0.646	16.46
STORY15	C14	1.2DLLLEQY	1.25	-2034.36	18.71	0.584	14.513
STORY16	C14	1.2DLLLEQY	1.25	-1694.65	19.78	0.512	12.436
STORY17	C14	1.2DLLLEQY	1.25	-1356.25	20.77	0.431	10.293
STORY18	C14	1.2DLLLEQY	1.25	-1018.89	21.67	0.339	8.186
STORY19	C14	1.2DLLLEQY	1.25	-682.23	22.35	0.236	6.223
STORY20	C14	1.2DLLLEQY	1.25	-347.61	25.91	0.125	3.862

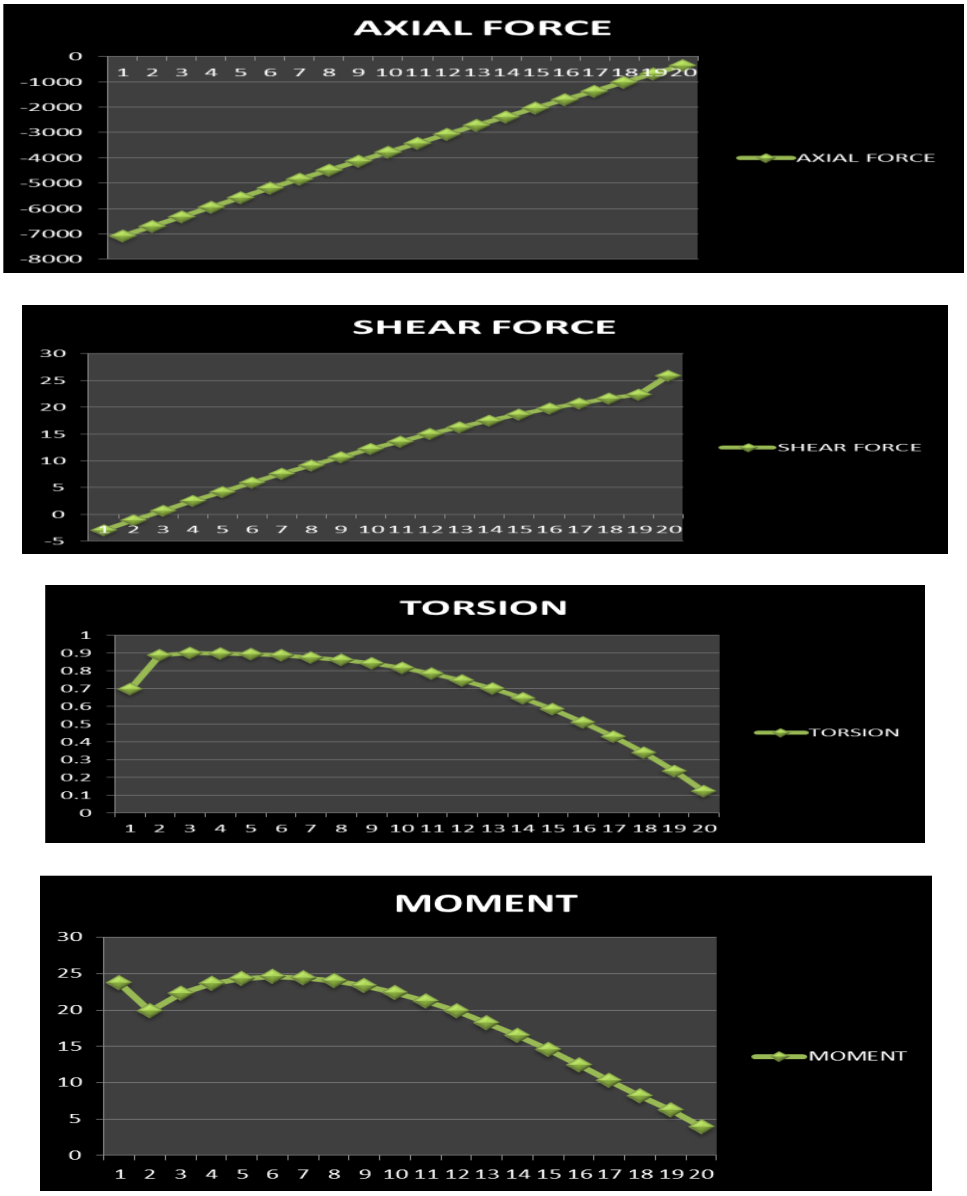
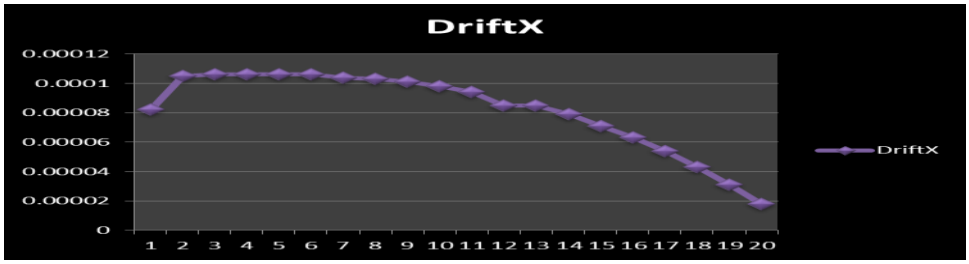


Figure 12: Axial force, Shear Force, Torsion and Moment for columnC14

Table X: Story Drift in X and Y Direction

Story	Load	DriftX	DriftY
STORY20	DLLLLEQY	0.000018	
STORY20	DLLLLEQY		0.000292
STORY19	DLLLLEQY	0.000031	
STORY19	DLLLLEQY		0.000355
STORY18	DLLLLEQY	0.000043	
STORY18	DLLLLEQY		0.000416
STORY17	DLLLLEQY	0.000054	
STORY17	DLLLLEQY		0.000476
STORY16	DLLLLEQY	0.000063	
STORY16	DLLLLEQY		0.000532
STORY15	DLLLLEQY	0.000071	
STORY15	DLLLLEQY		0.000584
STORY14	DLLLLEQY	0.000079	
STORY14	DLLLLEQY		0.00063
STORY13	DLLLLEQY	0.000085	
STORY13	DLLLLEQY		0.000669
STORY12	DLLLLEQY	0.000085	
STORY12	DLLLLEQY		0.000702
STORY11	DLLLLEQY	0.000094	
STORY11	DLLLLEQY		0.000728
STORY10	DLLLLEQY	0.000098	
STORY10	DLLLLEQY		0.000747
STORY9	DLLLLEQY	0.000101	
STORY9	DLLLLEQY		0.000759
STORY8	DLLLLEQY	0.000103	
STORY8	DLLLLEQY		0.000763
STORY7	DLLLLEQY	0.000104	
STORY7	DLLLLEQY		0.00076
STORY6	DLLLLEQY	0.000106	
STORY6	DLLLLEQY		0.000747
STORY5	DLLLLEQY	0.000106	
STORY5	DLLLLEQY		0.000723
STORY4	DLLLLEQY	0.000106	
STORY4	DLLLLEQY		0.000684
STORY3	DLLLLEQY	0.000106	
STORY3	DLLLLEQY		0.000626
STORY2	DLLLLEQY	0.000105	
STORY2	DLLLLEQY		0.000541
STORY1	DLLLLEQY	0.000082	
STORY1	DLLLLEQY		0.000371



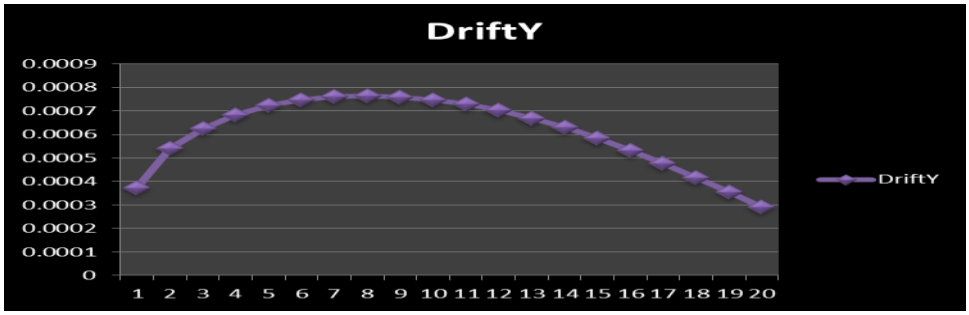


Figure13: Story Drift in X& Y Direction

II. DISCUSSION ON RESULTS

When a structure is subjected to earthquake, it responds by vibrating. An example force can be resolved into three mutually perpendicular directions- two horizontal directions (X and Y directions) and the vertical direction (Z). This motion causes the structure to vibrate or shake in all three directions; the predominant direction of shaking is horizontal. All the structures are primarily designed for gravity loads-force

equal to mass time's gravity in the vertical direction. Because of the inherent factor used in the design specifications, most structures tend to be adequately protected against vertical shaking. Vertical acceleration should also be considered in structures with large spans those in which stability for design, or for overall stability analysis of structures. The basic intent of design theory for earthquake resistant structures is that buildings should be able to resist minor earthquakes without damage, resist moderate earthquakes without structural damage but with some non-structural damage. To avoid collapse during a major earthquake, Members must be ductile enough to absorb and dissipate energy by post elastic deformation. Redundancy in the structural system permits redistribution of internal forces in the event of the failure of key elements. When the primary element or system yields or fails, the lateral force can be redistributed to a secondary system to prevent progressive failure.

IS 1893 (part- 1) Code recommends that detailed dynamic analysis, or pseudo static analysis should be carries out depending on the importance of the problems.

IS 1893 (part- 1) Recommends use of model analysis using response spectrum method and equivalent lateral force method for building of height less than 40m in all seismic zones as safe., but practically there may be the building which are more than 40m in height. So there exist so many problems due to the increase in height of the structure.

The earthquake resistant structures are constructed using IS 1893 part-1 and there are some assumptions to be made in the design according to the codal provisions and these assumptions account to one of the uncertainties that occur in the design starting from mix design to workmanship and many other

The following assumptions shall be made in the earthquake resistant design of structures:

Earthquake causes impulsive ground motions, which are complex and irregular in character, changing in period and amplitude each lasting for a small duration. Therefore, resonance of the type as visualized under steady-state sinusoidal excitations will not occur as it would need time to buildup such amplitudes. The structural prototype is prepared and lots of data is been collected from the prototype. All the aspects such as safety of structure in shear, moment and in story drift have been collected. So now to check whether to know whether the structure is safe with established shear walls and all construction of core wall in the center we need to compare the graphical values of structure with the shear wall and a simple rigid frame structure.

Story Drift

The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories. The council of Tall Buildings and Urban Habitat considers building having 9 or more stories as high-rise structures. But, from a structural engineer's point of view the tall structure or multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. So lateral forces due to wind or seismic loading must be considered for tall building design along with gravity forces vertical loads. Tall and slender buildings are strongly wind sensitive and wind forces are applied to the exposed surfaces of the building, whereas seismic forces are inertial (body forces), which result from the distortion of the ground and the inertial resistance of the building. These forces cause horizontal deflection is the predicted movement of a structure under lateral loads and story drift is defined as the difference in lateral deflection between two adjacent stories. Lateral deflection and drift have three effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures.

When the initial sizes of the frame members have been selected, an approximate check on the horizontal drift of the structures can be made. The drift in the non-slender rigid frame is mainly caused by racking. This racking may be considered as comprising two components: the first is due to rotation of the joints, as allowed by the double bending of the girders, while the second is caused by double bending of the columns. If the rigid frame is slender, a contribution to drift caused by the overall bending of the frame, resulting from axial deformations of the columns, may be significant. If the frame has height width ratio less than 4:1, the contribution of overall bending to the total drift at the top of the structure is usually less than 10% of that due to racking. [2]. The following method of calculation for drift allows the separate determination of the components attributable to beam bending, and overall cantilever action.

Drift problem as the horizontal displacement of all tall buildings is one of the most serious issues in tall

building design, relating to the dynamic characteristics of the building during earthquakes and strong winds. Drift shall be caused by the accumulated deformations of each member, such as a beam, column and shear wall. In this study analysis is done with changing structural parameters to observe the effect on the drift (lateral deflection) of the tall building due to both wind and earthquake loading. There are three major types of structures were identified in this study, such as rigid frame, coupled shear wall and wall frame structures.

Is 1893 Part 1 CodalProvoisions for Storey Drift Limitations

The storey drift in any storey due to the minimum specified design lateral force, with partial load factor of 1.0, shall not exceed 0.004 times the storey height For the purposes of displacement requirements only, it is permissible to use seismic force obtained from the computed fundamental period (T) of the building without the lower bound limit on design seismic force specified in dynamic analysis.The tallness of a structure is relative and cannot be defined in absolute terms either in relation to height or the number of stories. The council of Tall Buildings and Urban Habitat considers building having 9 or more stories as high-rise structures. But, from a structural engineer's point of view the tall structure or multi-storied building can be defined as one that, by virtue of its height, is affected by lateral forces due to wind or earthquake or both to an extent. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces. So lateral forces due to wind or seismic loading must be considered for tall building design along with gravity forces vertical loads. Tall and slender buildings are strongly wind sensitive and wind forces are applied to the exposed surfaces of the building, whereas seismic forces are inertial (body forces), which result from the distortion of the ground and the inertial resistance of the building. These forces cause horizontal deflection is the predicted movement of a structure under lateral loads . Lateral deflection and drift have three effects on a structure; the movement can affect the structural elements (such as beams and columns); the movements can affect non-structural elements (such as the windows and cladding); and the movements can affect adjacent structures. Without proper consideration during the design process, large deflections and drifts can have adverse effects on structural elements, nonstructural elements, and adjacent structures. When the initial sizes of the frame members have been selected, an approximate check on the horizontal drift of the structures can be made. In this study analysis is done with changing structural parameters to observe the effect on the lateral deflection of the tall building due to earthquake loading. There are three major types of structures were identified in this study, such as rigid frame, coupled shear wall and wall frame structures.

III. CONCLUSION

I. It is evident from the observing result that the shear wall are making value of torsion very low.

II. It is evident from the observing result that for combination loads 1.2 DLLLEQX&1.2DLLLEQY ,maximum value of moment at story one and minimum value of shear force also at story one . The Moment is maximum when the shear force is minimum or changes sign.

III. The story drift for the combination loadDL+LL+EQy in X&Y direction shown different performance and less value for story drift in all combinations at story 20.The value of story drift is very low because of adding shear walls to the building

IV. Based on the analysis and discussion ,shear wall are very much suitable for resisting earthquake induced lateral forces in multistoried structural systems when compared to multistoried structural systems whit out shear walls. They can be made to behave in a ductile manner by adopting proper detailing techniques.

V. Shear walls must provide the necessary lateral strength to resist horizontal earthquake forces.

VI. When shear walls are strong enough, they will transfer these horizontal forces to the next element in the load path below them, such as other shear walls, floors, foundation walls, slabs or footings.

IV. For the columns located away from the shear wall the Bending Moment is high and shear force is less when compared with the columns connected to the shear wall.

VIII. Shear walls also provide lateral stiffness to prevent the roof or floor above from excessive side-sway.

IX. When shear walls are stiff enough, they will prevent floor and roof framing members from moving off their supports.

X. Also, buildings that are sufficiently stiff will usually suffer less nonstructural damage.

XI. The vertical reinforcement that is uniformly distributed in the shear wall shall not be less than the horizontal reinforcement .This provision is particularly for squat walls (i.e. Height-to-width ratio is about 1.0).However ,for walls whit height-to-width ratio less than 1.0, a major part of the shear force is resisted by the vertical reinforcement. Hence ,adequate vertical reinforcement should be provided for such walls.

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Author's Profile:

I. Mahdi Hosseini , Ph.D. scholar student in Structural Engineering, Dept. of Civil Engineering, Aligarh Muslim University (AMU), Aligarh, Uttar Pradesh , India

Research interest: Structural Engineering ,Structural Dynamics ,Structural Optimization, structural design, Reinforced Concrete Structures, ,Earthquake Engineering

Email: civil.mahdi.hosseini@gmail.com

II. Dr. Hadi Hosseini ,Ph.D. in Aerospace Engineering , working in International Earthquake Research Center of America (IERCA)

Email: hadi.invention@gmail.com

III. Prof. Tabassum Naqvi, Professor in Structural Engineering, Dept. of Civil Engineering, Aligarh Muslim University (AMU), Aligarh, Uttar Pradesh , India
Research interest: Structural Dynamics , Earthquake Engineering

Email: haidertabassum@gmail.com

IV. Seyed Amin Ahmadi Olounabadi Ph.D. scholar student in Computer Science and Engineering, Dept. of Computer Science and Engineering, Jawaharlal Nehru Technological University Hyderabad (JNTUH), Hyderabad, Telengana , India
Research interest: Network and Network Security, IT, Network Management

Email: aminorange2006@gmail.com

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A Digital Mitigation: Application of Service Oriented Architecture by Microfinance Institutions

AjalaFunmilola[1].A. PhD &Akanbi James O.[2]
[1]*Senior Lecturer, Ladoke Akintola University of Technology, Ogbomoso, Nigeria*
[2]*Research Assistant, Institute of Archeology and Museum Studies, Nigeria.*

ABSTRACT. *Information Communication Technology (ICT) is considered to be the back bone of interprocess communication of the records of the Microfinance Institutions who are the key players of distribution of the funds to the poor and to the people who are not eligible for standard financial services. In spite of the latest techniques used, MFIs face challenges in implementing the technology in respect to the high operational cost, unregulatory framework or lack of integration among the diversified technology platforms. This paper highlights the regulation of processes in Microfinance using a potential technology called Service oriented Architecture which would help to monitor any activity of Microfinance Institutions and gives MFIs greater sustainability and interoperability. SOA implementation in MFI's helps in optimizing business performance amidst change, competition, and increase in regulatory reporting. Binding the loosely coupled functionalities is one of the important features of SOA which directly helps MFIs, whose functions work under silo organization. An architectural model using SOA for a particular module of MFI (Loan Officer and MFI) and the various transactions between them has been proposed through this paper.*

KEYWORDS: Microfinance, Challenges of Technology, Service Oriented Architecture.

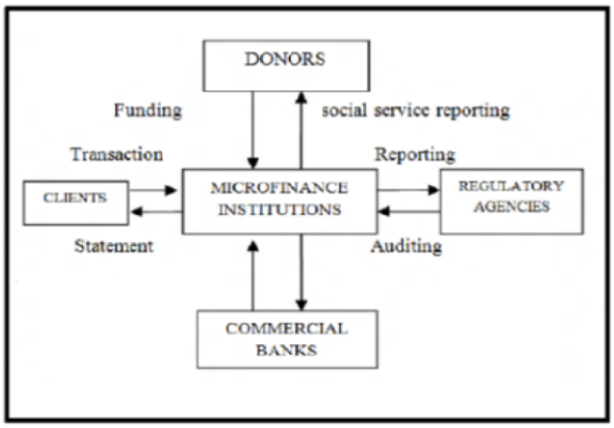
I. INTRODUCTION

Microfinance is generally understood as the provision of basic financial services, including savings, credit, money– transfer and even insurance, to the poor. Microfinance began during the years 1960s and 1970s as a humanitarian activity directed at the poor. At the very beginning Microfinance was associated with providing poor families with very small loans called microcredit, to help them engage in productive activities or to enable them to grow their tiny businesses and to shape them as micro entrepreneurs. These small credits are offered to the poor by special Financial Institutions called Micro Finance Institutions. MFIs basically concentrate on social welfare of the poor with slight inclination of profit. Microfinance Institutions involve more people than any other traditional banking Organizations. Information Communication Technology (ICT) has emerged has a powerful solution to address the outreach such as sustainability and maintainability of MFI's. But how far is the technology implemented, if implemented can there be an enhancement with the latest technology like Service Oriented Architecture is the orientation of this paper.

II. OBSERVATIONS AND FACTS

As it was discussed previously Microfinance (MF) initiatives involve more people than traditional banking and thus have to gather, store and analyse more data. It is not possible for a single loan officer to manage this alone. There is a real need to support at least some of the operations with technology. The primary aspect in this regard is that the solutions provided to MFIs by Technology

- Should be affordable as it is necessary to have operating costs as low as possible.
- Should improve the customer's convenience.
- Reach greater areas and generate more revenues.
- Technology implementation by MFI's also need to reduce the fraud.
- Should help them to control and improve quality of financial information.



2.1 Information Communication Technology (ICT) in Microfinance Institutions:

A host of ICT applications are already in use by few well established MFI's, while some are in the pilot stage. The application ranges from basic MIS solution to the Mobile phones, Personal Digital Assistants (PDA's), Point-of-Sale (POS) technologies and Automatic Teller Machines (ATM's), Internet, Database Management Systems.

Table 2 shows the usage of innovative ICT techniques used by few MFI's around the world. (Source: Microfinance –Exploring the Role of Technology, S.Rajagopalan)

2.2 Challenges facing by Microfinance Institutions in Technology Mitigations :

Despite the numerous developments, microfinance institutions still face numerous challenges in various forms like:

- ✓ High Operations Cost.
- ✓ Un-regulatory Framework
- ✓ Weak Management
- ✓ No trained Staff
- ✓ MIS not efficient to collaborate the data and analyse the data.
- ✓ The group based business methodology that works behind MF concepts is one of the main reason it achieves high repayment rates and this should be preserved by the technology where some ICT tools like ATM's or Credit Cards does not allow clients to work in groups.
- ✓ MFIs may find it difficult to do business with those who haven't embraced any electronic technology at all.

From the above points it is clear that Challenges for MFI's in adopting Technology would be from two perspectives.

1. Managerial Capacities
2. Technology implementation according to the change in the business processes, which MFI's will be required to adapt.

An encouraging sign from MFI's point of view is the growing interest among donor agencies, technology developers and academia to collaborate in the effort to develop appropriate and affordable technology solutions to serve the poor MFIs presently are working as silos. There is no way to integrate the various activities of MFI's. There are web portals like:

- ✓ Mix Market portal - which provides key information of MFI"s worldwide.
- ✓ E-promoting - sharing information across all interested parties,

But all these resources lack certain aspects like:-

- Reporting based Architecture •Dynamic and Interactive form that would facilitate faster interactions between stakeholders and catalyze partnership.
- Technology framework for Multiple Services Delivery.
- Microfinance Client Database with in-built statistical features to analyze and present records in an easy accessible manner.[6]

Therefore, there is a need to provide robust, sustainable business model mechanism to capture information at every level .This model should ensure standardized records tracking system reduce the cost of data capture from distributed areas and should help for quick information transfer- integrating the silos.

This paper focus on solutions built on potential technology model like Service Oriented Architecture (SOA) that can help MFIs work effectively, while minimizing costs and improving profitability. The paper portrays the architecture of SOA-MFI for one section of MFI's processes, among the various sections available in the value chain of MFI .This Model can help MFI's to evaluate their information systems to get a faster accurate and better solution and can resolve some of the issues like dynamic and Interactive form for faster interactions, Multiple Services Delivery, Microfinance Client Database with in-built statistical features etc.

III. PROPOSAL

3.1 Microfinance Operations Implementing SOA : A service-oriented architecture is essentially a collection of services. These services communicate with each other. The communication can involve either simple data passing or it could involve two or more services coordinating some activity.

Hence, Service oriented architecture (SOA) is an architecture where independent systems and applications communicate with each other by exposing and using services. Services are defined using open standards, making inter-communication much easier to implement, and less dependent on proprietary communication protocols. [1]

Web Services (WSDL, UDDI, SOAP, and XML) refers to the technologies that allow for making these connections. Services are what we connect together using Web Services. The combination of services internal and external to an organization - make up a service-oriented architecture.

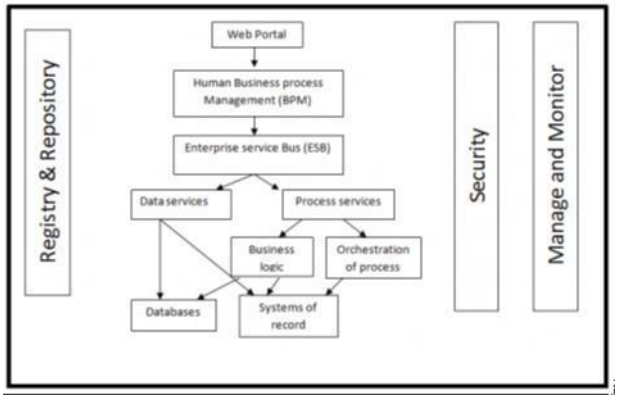


Fig. 1.1: A Map of SOA Component

3.2 Implementing SOA to One Process Module of MFI between MFI and Loan Officer:

The Microfinance Institutions are expanding their operations by doing high volume of transaction in poor rural locations. Loan Officers, employees of MFI's need to travel to different rural areas to interact with the clients and update the day's or week's transactions in the MIS. He also needs to prepare the weekly, monthly report of the transactions. The outreach work of MFI is conducted by Loan Officers. The business model is highly distributed with many points of presence across geographies. The efficiency and profitability of each transaction is in the hands of Loan Officer and therefore his productivity is the key factor in the sustainability or profitability of any MFI. The Facilitating Technologies needed for him are stated in the Table-2

Sl. No	TECHNLOGY TOOL	DESCRIPTION
1.	MIS	Efficient MIS to give updated reports
2.	DATABASE	Database to maintain the records of all the clients in that rural area
3.	BUSSINESS PROCESS MODELLING TOOLS	BPM tools which accurately describes each process of the transactions between the Loan Officer and the Clients
4.	PDAs/MOBILE PHONES	To fasten the transactions ,reduce the paper records and time saving from data entry at the branch offices.
5.	WEB PORTALS USING WEB SERVICES	Web portals of the MFI to register the transactions
6.	NETWORK TECHNOLOGIES -INTERNET	To update the information on institution wide Intranet.

- Integrating all these facilities stated in the table -3 and orchestration of different processes could be done using SOA because SOA enables efficient messaging and business processes management from the front end channels. The below figure 1.2 shows an example of Service Oriented Architecture between MFIs and LOAN OFFICERS.

The Figure 1.2 shows a clear integration of Different Business Process activities of Loan Officer with Clients or with MFI. The SOA paves way for a smooth working of different activities of Loan Officer with his single hand set PDA/Mobile. Web Services with its different techniques takes the challenge of integrating the processes and updating the records which reduces the burden of

- Updating the Records in the MIS at MFI Office only.
- Reduces Fault Record tracking because Business Processes are aligned through BPM under SOA.
- Integration of several MFI areas

Databases .This can be at low cost since SOA supports interoperability of loosely coupled Distributed Environment.

- Makes Multiple Service Delivery.
- Movement of Loan Officer to each area can be reduced.
- The MFIs can track their territory transactions easily within their office using Web Services of SOA.

IV. CONCLUSION

"The day we can marry the power of the Microprocessor with the power of Microfinance, we will have developed a terrific solution to provide microfinance transactions to poor people in a low-cost, user-friendly way" (Vijay Mahajan Chairman, BASIX)

Many such Microfinance Practitioners too believe that Technology as a potential driver for the growth of the Microfinance Sector. Microfinance organizations in recent years have gained international recognition and they are now recognized as a strategy to fight poverty. This paper highlights to briefly picture the concept of microfinance and confront it with the predominant technology like SOA.

SOA implementation in MFI's helps in optimizing business performance amidst change, competition, and increase in regulatory reporting.

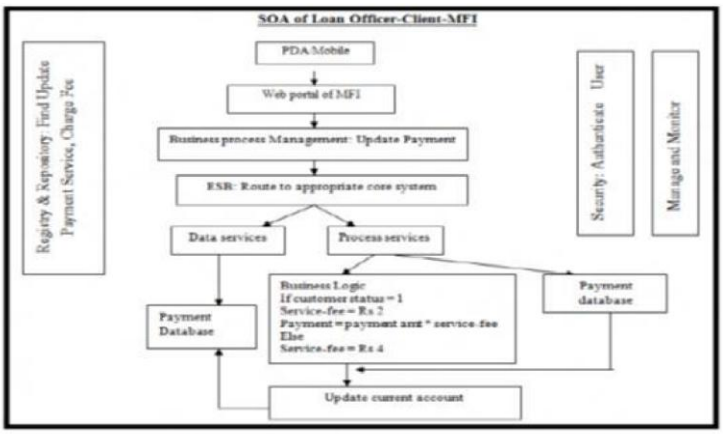


Fig. 1.2: Shows the Map of the various SOA components of MFI-Loan Officer

Binding the loosely coupled functionalities is one of the important features of SOA which directly helps MFIs because MFIs functions work under silos. SOA works effectively with Business Process Management Implementation which is the priority for any MFI s as they need to have a formal and efficient structure to record complex transactions and take intelligent business decisions. SOA helps to meet the growing demand of MFIs to provide timely and quality information at the place of operation to the customers, to their Stake Holders and its employees on field, while minimizing operational costs – The Primary criteria of Micro Finance Institutions.

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Investigation of Ground water Potential using Mathematical Model: A Case Study in Part of Northwest Region of Bangladesh

Md. Tarikul Islam[1], Md. Monirul Islam[2], Md. Iquebal Hossain[3].
[1] *Senior Specialist, Institute of Water Modelling, Dhaka, Bangladesh;*
[2] *Associate Specialist, Institute of Water Modelling, Dhaka, Bangladesh;*
[3] *Executive Engineer, Barind Multipurpose Development Authority, Rajshahi, Bangladesh;*

ABSTRACT: *Groundwater is the most essential and valuable resources for agriculture, domestic and industrial purposes. Unplanned withdrawal of groundwater is risky for the system due to limited replenishment and increasing water demand with continuously growing population, especially for the arid and semi-arid catchments. Scarcity of rainfall in time and reducing of upstream flow in the internal rivers have increased dependency on groundwater irrigation. Estimation of groundwater potential for a region is essential not only for sustainability of irrigation project but also for a sustainable water resources management at the regional level, which means in general at the basin scale. Due to the competition of all water users of a river basin, especially in water scarce regions, a comprehensive approach is needed regarding agricultural, domestic, industrial, and ecological aspects. In this paper, a case study was carried out for Pabna, Sirajgonj, Bogra, Gaibandha, Rangpur, Kurigram, Nilphamari and Lalamonirhat Districts which is situated in the north-west part of Bangladesh using physically distributed hydrological modelling. To bring about 3,000 km^2 potential land under irrigation through sustainable water resources management, an integrated Groundwater-Surface Water model was developed using mathematical modelling tools which was calibrated for the period 2006-2010 and validated for the period 2011-2013. Using model result, groundwater water resources, requirement for present and future demand for various purposes and possible expansion of irrigation coverage for the study area were assessed. As a result irrigation coverage as well as agricultural production would be increased considerably if the project is implemented following the study findings and suggestions. So the study output has positive impact and for sustainable water resources management it is essential to use the state-of -the art technology.*

Keywords: *Mathematical Modelling, Irrigation, Groundwater, Surface water, Zoning. Potential resources, Sustainable water resources management.*

I. INTRODUCTION

Currently, one-third of the world's population is living in countries and regions of water resources limitation (Bates, et al., 2008). Because of limited water availability imposing strong restrictions on natural and human systems, the management of water resources has become an increasingly pressing issue in semiarid and arid regions. Generally, when the demand of water has reached the limits that the natural system can provide, water shortage can become a major obstacle to social and economic development for one region (Bronster et al., 2000; Li et al., 2006). Therefore, these issues have forced planners to contemplate and propose ever more comprehensive, complex, and ambitious plans for water resources systems in the semiarid and arid regions (Li et al.,2008).

Different studies have documented that groundwater level declined substantially during the last decade causing threat to the sustainability of water use for irrigation in this region and impacting upon other sectors too (Jahan et al. 2010). Due to lack of proper knowledge, indiscriminate installation of pumps and non-availability of modern technologies, farmers inappropriately lift water without caring ground sources. These impacts upon interlinked sources of water table which is declining alarmingly in many areas of Bangladesh. Although the groundwater dominates the total irrigated area, its sustainability is at risk in terms of quantity in the northwest region (Simonovic 1997; Shahid 2011). Frequent shortage of water in the region has had impacts that can be ranged as economical, social and environmental (Takara and Ikebuchi, 1997; Sajjan et al. 2002; Dey et al. 2011).

A recent study shows that groundwater level in some areas falls between 5-10 m in dry season and most of the tubewells fail to lift sufficient water (Dey and Ali 2010). Researchers and policymakers are advocating sustainable development as the best approach to today's and future water problems (Loucks2000; Cai X et al. 2001). With groundwater development, fluctuations will amplify; but as long as rainfall is managed to recharge aquifers, and proactive water saving strategies are put in place, a steady and sustainable state can be achieved (IWMI 2010). In mainstream irrigation thinking, groundwater recharge is considered as a by-product of flow irrigation, but in today's world, groundwater recharge needs to be understood on its first emergency for making groundwater sustainable integrating all possible options (IWMI 2010).

Hydrologic model was a useful tool for water resources management (Sahoo et al., 2006). Previously, many lumped hydrologic models were developed to investigate watershed hydrology. With a low data requirement, these lumped catchment models could reflect runoff dynamics and water balance in water resource management systems. However, the lumped models assumed the study watershed as a spatially homogeneous region, and the spatial heterogeneity of the climate variable and land surface was not considered (Bronster et al., 2000).

Consequently, several distributed and semidistributed hydrological models were developed in response to the aforementioned challenges (Apul et al., 2005). For example, Refsgaard (1997) integrated MIKE SHE, MIKE 11, MIKE 21, and DAISY to study the environmental assessment in connection with the Gabcikovo hydropower scheme. Sahoo et al. (2006) used the physically distributed hydrological modeling system (MIKE SHE) to study the watershed response to storm events within the Manoa-Palolo stream system on the island of Oahu, Hawaii. IWM (2005, 2006, 2009 and 2014) used the physically distributed hydrological modeling system (MIKE SHE & MIKE 11) for the assessment of potential groundwater and surface water resources. The primary advantage of the distributed hydrological models was enabled to reflect the spatial variations for characteristics of watershed (e.g., rainfall, topography, soil type, and land use) (Refsgaard, 1997). However, higher data requirement became a main obstacle on extensively applying these models to practical problems.

Both the Poverty Reduction Strategy (PRS) and Millennium Development Goal (MDG) of the Government of Bangladesh attached priority to increase agricultural production. In this backdrop, Barind Multipurpose Development Authority (BMDA) undertook a programme entitled "Groundwater Resource Study and Interaction Information System (IIS) Development of Pabna, Sirajgonj, Bogra, Gaibandha, Rangpur, Kurigram, Nilphamari and Lalmonirhat Districts through Mathematical Model Study" having gross area of 17,455 km2 and cultivable area of 12,765 km^2. The study was carried out by IWM (2014) to bring about additional 3,084 km^2 cultivable land under irrigation for maximizing crop production

The study area is shown in Fig. 1 where yearly rainfall varies from 1800 mm to 2600 mm, relative humidity is from 46% to 83% and land leve varies from 4 to 68 mPWD. The objective of this paper is to review the state of art for investigation of potential groundwater resources for irrigation and ultimately growing food production by bringing more area under irrigation coverage without allowing environmental degradation.

II. APPROACH AND METHODOLOGY

Estimation of groundwater potential for a region is essential not only for sustainability of irrigation project but also for a sustainable water resources management at the regional level, which means in general at the basin scale. Due to the competition of all water users of a river basin, especially in water scarce regions, a comprehensive approach is needed regarding agricultural, domestic, industrial, and ecological aspects.In order to achieve the study objectives, IWM (2014) developed an integrated GW-SW model for the study area. The models developed under this study based on MIKE-11 (DHI, 1999) and MIKE-SHE (DHI, 1999). All the major river systems and updated topographic features were included in surface water (sw) model setup while hydro-geological setting, aquifer properties, DEM, land use pattern, abstractions were incorporated in groundwater (gw) model. Both the models were coupled through MIKE SHE. The coupled model was calibrated for the period of 2006 to 2010 and validated for the period of 2011-2013. The validated model was used to simulate various options and to assess the resources.Groundwater resources were assessed considering yield criteria of 7m depth from ground surface, so that STW & HTW remain active and potential recharge was assessed upto the depth which recharge fully during monsoon due to rain. Usable recharge was considered as 75% of the potential recharge (IWM, 2006) to account for various uncertainties inherent in different assumptions and natural loss. Irrigation zones were demarcated on the basis of water availability, groundwater level fluctuation, functionality of suction mode pumps, safe yield, extent of irrigation coverage, extent of drainage congestion etc. Environmental impacts, social acceptance and economic viability of the project were also assessed. The approach of the study is shown in a schematic plan illustrated in Fig. 2.

Figure 1: Location Map of the Study Area

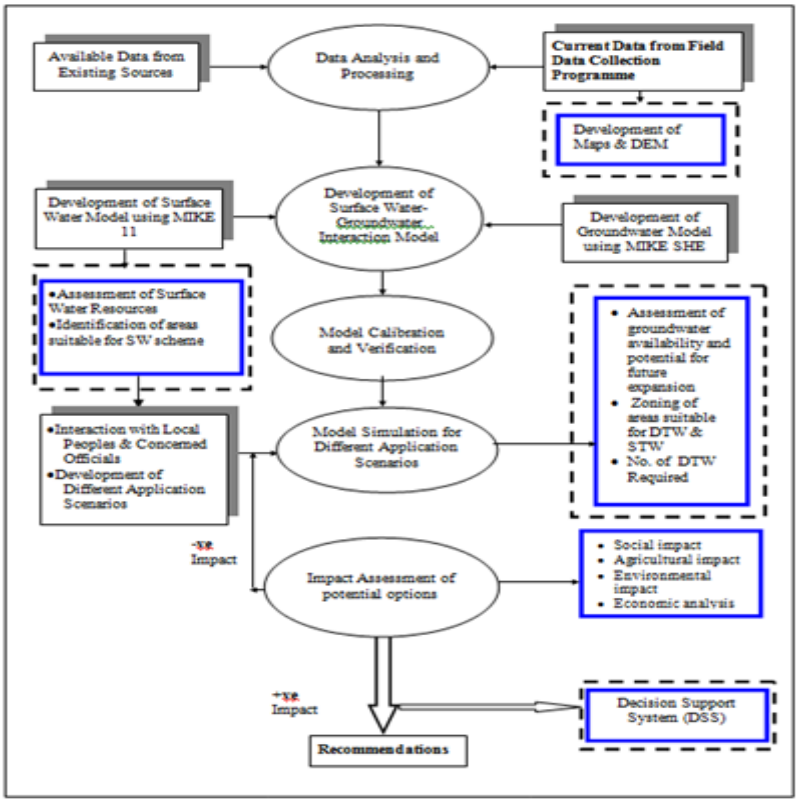

Figure 2: Schematic Diagrams of the Study

III. RESULTS AND DISCUSSIONS

1.1 Assessment of Groundwater Resources

Upazila-wise groundwater resource for average hydrological year was assessed based on recharge characteristics, potential recharge and safe yield criteria. The end of April is the end of irrigation period when the lowest water table generally occurs, after that water table starts rising due to recharge from rainfall. Recharge is the net storage in saturated and unsaturated zone. The components that influence the groundwater storage after April are mainly rainfall, runoff, overland flow, overland storage, drain to river, evapo-transpiration, boundary inflow and outflow. All the factors were considered during estimation of potential recharge through water balance for each Upazila. The water balance (MIKE SHE output) for Rangpur Sadar is shown in Fig. 3; Potential Recharge = 1795mm (precipitation) – 3mm (overland flow) – 715mm (Evapo-transpiration) – 56mm (outflow) + 216mm (inflow) – 15mm (overland storage) – 201mm (drain SZ/Boundary) = 1021mm. The total yearly demand for irrigation, drinking and industrial purposes were also estimated. Upazilawise potential resources and total yearly demand in the study area are given in Table 1.

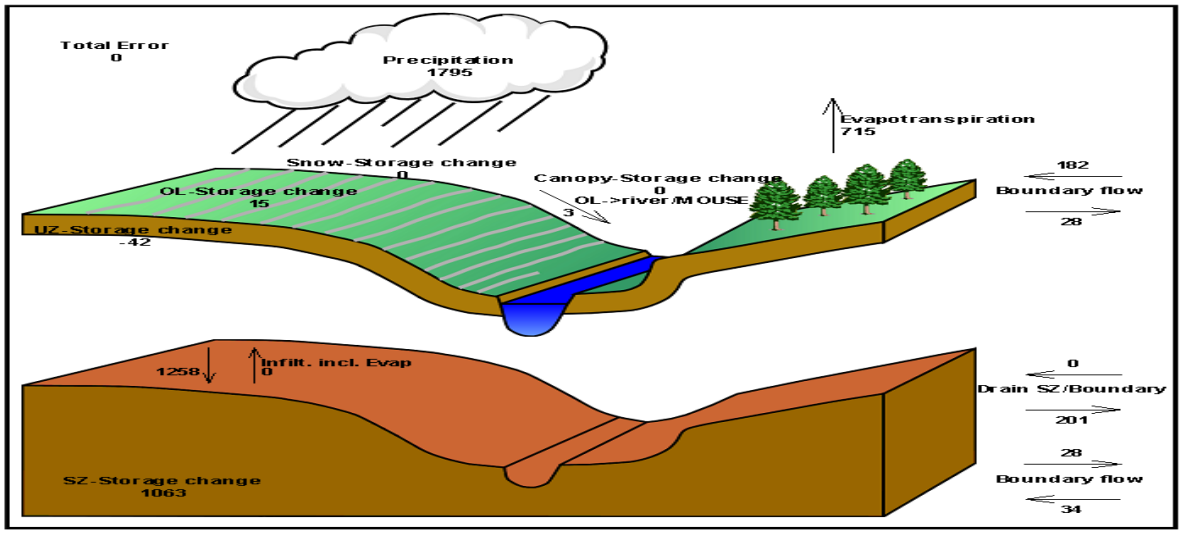

Figure 3: Water Balance Components of Rangpur Sadar

District	Upazila	Potential Recharge (mm)	Total Demand (mm)	Upazila	Potential Recharge (mm)	Total Demand (mm)
Pabna	Atgharia	585	365	Ishwardi	495	245
	Bera	526	289	P. Sadar	852	318
	Bhangura	754	414	Santhia	513	262
	Chatmohar	629	318	Sujanagar	671	283
	Faridpur	669	397			
Sirajganj	Belkuchi	878	353	Shahjadpur	680	400
	Chauhali	686	159	S. Sadar	869	319
	Kamarkhanda	875	314	Tarash	734	475
	Kazipur	1168	334	Ullahpara	990	447
	Royganj	1095	427			

District	Upazila	Potential Recharge (mm)	Total Demand (mm)	Upazila	Potential Recharge (mm)	Total Demand (mm)
Bogra	Adamdighi	935	498	Nandigram	916	614
	B. Sadar	972	595	Sariakandi	1054	345
	Dhunat	813	506	Shajahanpur	982	524
	Dhupchanchia	901	406	Sherpur	855	530
	Gabtali	916	544	Shibganj	823	490
	Kahaloo	969	497	Sonatola	896	572
Gaibandha	Fulchhari	987	339	Sadullapur	797	436
	G.Sadar	961	447	Saghatta	720	519
	Gobindaganj	781	570	Sundarganj	1026	404
	Palashbari	737	491			
Rangpur	Badarganj	842	492	Pirgachha	1023	341
	Gangachara	904	508	Pirganj	1026	399
	Kaunia	1083	423	R.Sadar	1021	474
	Mitha Pukur	946	417	Taraganj	874	519
Kurigram	Bhurungamari	1318	396	Phulbari	961	384
	Char Rajibpur	895	182	Rajarhat	1059	374
	Chilmari	1172	241	Raumari	977	372
	K. Sadar	1132	340	Ulipur	974	360
	Nageshwari	1076	383			
Nilphamari	Dimla	1054	353	Kishoreganj	900	378
	Domar	1010	448	N. Sadar	759	432
	Jaldhaka	1080	463	Saidpur	847	487
Lalmonirhat	Aditmari	894	418	L.Sadar	923	431
	Hatibandha	934	370	Patgram	751	341
	Kaliganj	962	415			

1.2 Development of Future Scenarios:

The developed model was simulated for a number of future scenarios, out of those three are described here;

Option 0: Base Condition i.e. Existing Situation with 80% dependable rainfall

- Hydrological condition for the design year 2008 (80% dependable).

- All existing features i.e. existing crop coverage, irrigation demands etc.

Option 1: Future Option with design year

- Hydrological condition for the design year 2008 (80% dependable).
- Crop coverage for future condition

Option 2: Future Option with extreme dry year

- Hydrological condition for the year 1994 (extreme dry condition).
- Crop coverage for future condition

From the analysis of different options, it was revealed that, there is scope for irrigation expansion in some Upazilas under average hydrological condition.

Spatial distribution maps of maximum and minimum depth to groundwater tables were prepared (Fig. 4) to see the effect of pumping during irrigation season and also to see whether groundwater table regains to its original positions or not. It was observed that maximum depth to groundwater table remains within 2.0 m to 8.0 m in most of the areas on 1st May. The groundwater table goes beyond the suction limit of shallow tube well (STW) or hand tube well (HTW) in some part of the area but groundwater table regains to its original position during monsoon due to recharge from rainfall and remains below 2 m in most of the areas.

The model was also simulated for base and future condition to see the impact on groundwater for expansion of irrigation in future where command area has been increased upto 80% of cultivable area and also for extreme dry year condition. The comparison of the groundwater level hydrograph is shown in Fig. 5. It is observed that groundwater level goes further below due to additional abstraction but it regains to its original level due to recharge from rainfall. It is also observed that in dry year condition, having less rainfall, further depletion of groundwater table occurs than that in option 1.

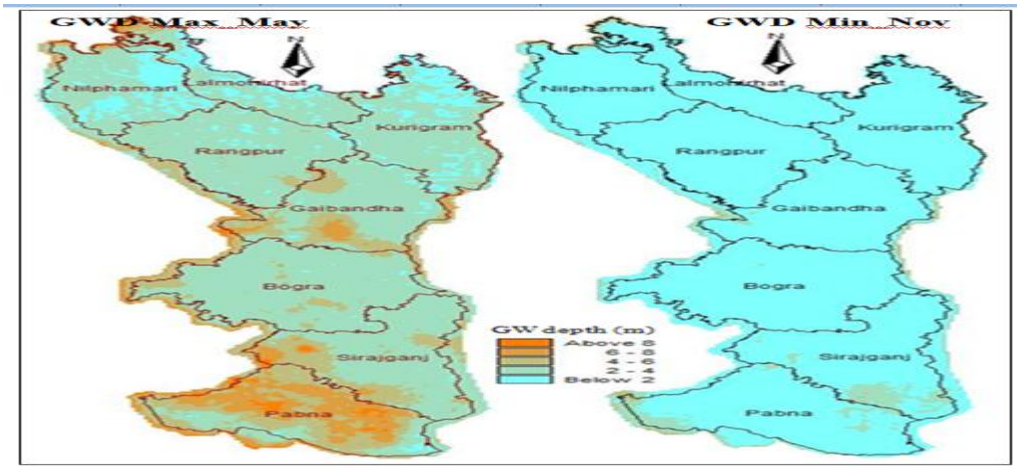

Figure 4: Depth to Groundwater Table for Base Condition

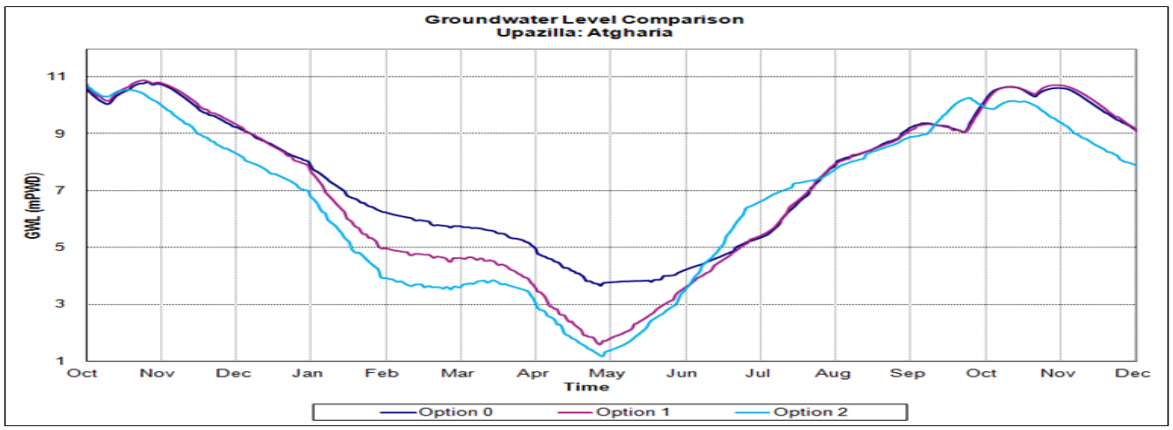

Figure 5: Comparison of Groundwater Level between Base and Future Condition

IV. CONCLUSIONS

The study was conducted to assess the potentiality of groundwater resources and to find out the scope for expansion of irrigation command area allowing no declining trend of groundwater table . The set of conclusions based on different components of the study are as follows:

- It reveals from the study that most of the area has high potentiality for groundwater development having higher rainfall & easily recharge of groundwater due to higher seepage & percolation rate in compare with Barind area and presence of water bodies and beels. There are no shortages of groundwater to meet the present demand. There is a sufficient surplus resource which may be used for further development bringing more potential area under irrigation in future.
- Model simulation reveals that for present condition during dry season, groundwater table goes below 10m to 12m from the ground surface in some part of Bogra and Pabna District but it regains to its original position during monsoon. Also at Iswardi, the groundwater level goes beyond suction limit (7m) of STW or HTW mainly due to low water level in Ganges during dry season though there is no considerable abstraction but groundwater table fully regains to its original level during monsoon.
- Having higher abstraction of groundwater for future condition, depletion of groundwater table may be about 1-2m during dry season but it is replenished in monsoon.
- Model simulation reveals that during dry year condition, depletion of groundwater level may occur in some upazilas of Bogra, so the monitoring is necessary.

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Inventory Model (Q, R) With Period of Grace, Quadratic Backorder Cost and Continuous Lead Time

Dr. Martin Osawaru Omorodion
Joseph Ayo Babalola University, Ikeji-Arakeji, Nigeria.

ABSTRACT: *The paper considers the simple economic order model where the period of grace is operating, the lead time is continuous and the backorder cost is quadratic. The lead time follows a gamma distribution. The expected backorder cost per cycle is derived and averaged over all the states of the lead time L. Next we obtain the expected on hand inventory. The Lead time is taken as a Normal variate. The expected backorder costs are, derived after which the expected on hand inventory is derived. The cost inventory costs for constant lead times is then averaged over the states of the lead times which is taken as a normal distribution.*

***KEY WORDS**: Continuous Lead Times, Gamma Distribution, Normal Distribution, Period of Grace, Bessel Functions, Inventory on hand, Expected Backorder Costs and Chi-Squared Distribution.*

Demand

The cost of a backorder $C_\beta(t)$ for backorder of length t = $C_\beta(L-z-p)$ = $b_1+b_2(L-z-p)+b_3(L-z-p)^2$ where p is the grace period, where the system is out of stock in the time interval z to z tdz. After the re-order point is reached the R+Y was demanded in the time z and a demand occurred in time dz. The longer the period of grace the greater the reduction in inventory costs.

SIMPLE INVENTORY MODEL WITH PERIOD OF GRACE, QUADRATIC BACKORDER COST AND CONTINUOUS LEAD TIME

I. INTRODUCTION

In this inventory model there is a period of grace before backorder costs are incurred. In Hadley (1972), the general model was stated. This paper derives the backorder costs when the backorder cost is a quadratic cost depending upon the length of time of backorder after the grace period. The various costs such as expected backorder costs and expected on hand inventory are derived, to arrive at the total costs of holding inventory. Demand over the lead time is normally distributed and lead time is a gamma variate.

II. LITERATURE REVIEW

Saidey (2001), in his paper Inventory Model with composed shortage considered grace period (perishable delay in payment) before setting the account with the supplier or producer.
Schemes (2012) also considered credit terms which may include an interest free grace period as much as 30 days in his paper 'Inventory models with shelf Age an Delay Dependent Inventory costs'.
Hadley and Whitin gave a simple general model for period of grace.
Zipkin (2006), treats both fixed and random lead times and examines both stationary and limiting distributions under different assumptions.

III. DERIVATION

Let the period of grace be p, where the period of grade is the period for which a backorder bears no cost. Let H(L) be the probability density function of the lead time L.

$C_\beta(t)$ is the cost of a backorder of length t.

H(L) = $\frac{\alpha^k L^{k-1} esp(-\alpha L)}{\overline{(k)}}$ $\alpha > 0$…….. (1)

In the analysis k would take on integer values only.
The p.d.f. of demand over the lead time L.

$$g\left(\frac{x-DL}{\sqrt{\sigma 2L}}\right)=\frac{esp\left[-\frac{1}{2}\left(\frac{x-DL}{\sqrt{\sigma^2 L}}\right)^2\right]}{\sqrt{2\pi\sigma^2 L}} \quad -\infty > x < \infty \ldots\ldots\ldots\ldots\ldots (2)$$

Let R + Y, 0 <Y<Q be the inventory position at time O, then if the system is out of stock in the time internal z to z + dz after the re-order point is reached then R +Y was demanded in the time Z and a demand occurred in time dz.

Length of time of backorder = L-z length of time of backorder which bears a cost
= L – z – p.
Cost of a backorder = C_β (L – z – p)

Where the C_β (t) is the cost of a backorder = $b_1 + b_2$ (L – z – p) + b_3 (L – z – p)^2. (3)

Expected backorder cost per cycle G_1 (Q, R).

$$= D\int_0^\infty \int_0^Q \int_0^{L-P} \frac{C_\beta(L-z-p)}{\sqrt{\sigma^2 L}}.H(L).g\left(\frac{R+Y-Dz}{\sqrt{\sigma^2 L}}\right).dzdydL \ldots\ldots\ldots\ldots\ldots (4)$$

Let v = z + p

$$G_1(Q,R) = D\int_0^\infty \int_0^Q \int_0^L \frac{C_\beta(L-v)}{\sqrt{\sigma^2 L}} H(L)g\left(\frac{R+Y+Dp-Dv}{\sqrt{\sigma^2 L}}\right) dvdYdL \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Making use of equation (2)

$$G_1(Q,R) = D\int_0^\infty \int_0^Q \int_0^L \frac{C_\beta(L-v)}{\sqrt{2\pi\sigma^2 L}}.H(L)esp\frac{1}{2}\left(\frac{R+Y-Dp-Dv}{\sqrt{\sigma^2 L}}\right)dvdYdL \ldots. (6)$$

Substituting for C_β (L-v) from 3

$$G_1(Q,R) = D\int_0^\alpha \int_0^Q \int_0^L (b_1+b_2(L-v) + b_3 (L-v)^2 + H(L) \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

esp -1/2 $\left(\frac{R+Y+DP-DV)}{\sqrt{\sigma^2 L}}\right.$ dvdYdL

Noting that

$$D\int_0^L \frac{(b_1+b_2(L-v)+b_3(L-v)^2}{\sqrt{\sigma^s L}} esp-1/2\left(\frac{R+Y-Dp-Dv}{\sqrt{\sigma^2 L}}\right)^2 dv \ldots\ldots\ldots\ldots\ldots (8)$$

=

$$\left(\frac{b_1+b_3\sigma^2L}{D^2}+\frac{b_3\sigma^2L}{D^2}\left(\frac{R+Y+Dp-DL}{\sqrt{\sigma^2L}}\right)^2-\frac{\sqrt{\sigma^2L}b_2}{D}\left(\frac{R+Y+Dp-DL}{\sqrt{\sigma^2L}}\right)F\left(\frac{R+Y+Dp-DL}{\sqrt{\sigma^2L}}\right)\right.$$

$$\left.-\left(\frac{\sqrt{\sigma^2}Lb_2}{D}-\frac{b_3\sigma^2L}{D^2}\left(\frac{R+Y+Dp-DL}{\sqrt{\sigma^2}L}\right)\right)g\left(\frac{R+Y+Dp-DL}{\sqrt{\sigma^2}L}\right)\right) \quad \text{..... (9)}$$

Substituting into $G_1(Q,R)$ of (7) and changing the range of Y

$$=\int_0^{\infty}H(L)\int_{R+Dp}^{R+Q+Dp}\left(\frac{b_1+b_3\sigma^2L}{D^2}+\frac{b_3\sigma^2L}{D^2}\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)^2-\frac{b_2\sqrt{\sigma^2L}}{D}\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)\right)F\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dxdL\right)$$

$$=-\int_0^{\infty}H(L)\int_{R+Dp}^{R+Q+Dp}\left(\sqrt{\sigma^2Lb_2}+b_3\frac{\sqrt{\sigma^2L}}{D^2}\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)\right)g\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dxdL \quad \text{..... (10)}$$

Let $G_1(Q,R) = \int_{R+Dp}^{R+Q+Dp}G_2(x)dx$ ..... (11)

Hence from equation (10)

$$G_2(x) = -\int_0^{\infty}H(L)\left(\frac{b_1+b_3\sigma^2L}{D^2}+b_3\frac{\sigma^2L}{D^2}\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)\frac{b_2}{D}(x-DL)F\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)\right)dL$$

$$-\frac{b_2}{D}(x-DL)F\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dL$$

$$-\int_0^{\infty}H(L)\left(\frac{b_0\sigma L^{1/2}}{D}-b_3\frac{\sigma^2L}{D^2}\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)\right)g\left(\frac{x-DL}{\sqrt{\sigma^2}L}\right)dL \quad \text{..... (12)}$$

Substituting for H (L) from 1 and simplifying

$$G_2(x) = \frac{\alpha^k}{\Gamma(K)}\int_0^{\infty}\left(b_1L^{K-1}+b_3\frac{\sigma^2L^k}{D^2}+\frac{b_3x^2L^{k-1}}{D^2}\right.$$

$$\left.-2\frac{b_3xL^K}{D}+\frac{b_3L^{k+1}}{D^2}-\frac{b_2xL^{k-1}}{D}+b_2L^k\right)\text{esp}(-\alpha L)\,F\left(\frac{x-DL}{\sqrt{\sigma^2}L}\right)dL$$

$$-\frac{\alpha^k}{\Gamma k}\int_0^{\infty}\left(\frac{\alpha L^{k-1/2}b_2}{D}-b_3\frac{\sigma L^{k-1/2}}{D^2}x+b_3\frac{\sigma L^{k+1/2}}{D}\right)\text{esp}(\alpha L)g\left(\frac{x-DL}{\sqrt{\sigma^2}L}\right)dL \quad \text{..... (13)}$$

Re-arranging terms

$$G_2(x) = \frac{\alpha^k}{\sqrt{k}}\left[L^{k-1}\left(b_1+\frac{b_3x^2}{D^2}-\frac{b_2x}{D}\right)\right.$$

$$\left. -L^k\left(\frac{b_3\sigma^2-}{D^2}-2\frac{b_3x}{D}+b_2\right)+\frac{b_3L^{k-1}}{D^2}\right) esp(-\alpha L)$$

$$F\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dL-\frac{\alpha^k\sigma}{\sqrt{k}}\left[L^{k-1/2}\left(\frac{b_2}{D}-\frac{b_3x}{D^2}\right)\right]$$

$$+\frac{b_3L^{k+1/2}}{D}\left]esp(-\alpha L)g\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dL\right. \quad \text{..... (14)}$$

Integrating

$$\int_0^\infty \frac{1}{\sqrt{\sigma^2L}}H(L)g\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dL=\int_0^\infty esp\,\frac{(-\alpha L)L^{k-1}\alpha^k}{\sqrt{\sigma^2L}.\sqrt{k}}g\left(\frac{x-DL}{\sqrt{\sigma^2L}}\right)dL$$

$$=\frac{\alpha^k}{\sqrt{2\pi}\sqrt{k}}\int_0^\infty L^{k-3/2}esp\left(\frac{Dx}{\sigma^2}\right)esp\left(\frac{-x^2}{2\sigma^2L}-L\left(\frac{2\alpha\sigma^2+D^2}{2\sigma^2}\right)\right)$$

$$=\frac{\alpha^k}{\sigma\sqrt{2\pi}}esp\frac{\left(\frac{Dx}{\sigma^2}\right)}{\sqrt{k}}\left[2\left(\frac{x^2}{2\alpha\sigma^2+D^2}\right)^{1/2(K-1/2)}K_{k-1/2}\left[\frac{x}{\sigma^2}\left(2\alpha\sigma^2+D^2\right)^{1/2}\right]\right]$$

If k is an integer then

$$K_{k-1/2}(z)=k_{1/2}(z)\sum_{j=0}^{k-1}\frac{(k+j-1)}{j!(k-j-1)!}(2z)^{-j}$$

Where $K_{1/2}(z)=\frac{\sqrt{\pi}}{\sqrt{2}}(z)^{-1/2}esp(-z)$

Hence $K_{k-1/2}(z)=\sqrt{\pi}\sum_{j=0}^{k-1}\frac{(k+j-1)}{j!(k-j-1)!}(2z)^{-j-1/2}esp(-Z)$

And Letting

$$\vartheta^2 = 2\alpha\ \sigma^2+D^2$$

$$G_2(x) = esp\left(\frac{Dx}{\sigma^2}\right)\frac{\alpha^k}{\sqrt{(k)}\sqrt{2\pi}}\left[b_1+\frac{b_3x^2}{D^2}-\frac{b_2x}{D}\right]$$

$$\sum_{z=1}^{k}\frac{(k-1)}{\alpha^2(k-z)!}\left(2D\left(\frac{x}{\theta}\right)^{k-Z+1/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right)+2x\left(\frac{x}{\theta}\right)^{k-z-1/2}K_{k-z-1/2}\left(\frac{x\sigma^2}{\sigma^2}\right)\right)$$

$$+\left(\frac{b_3\sigma^2}{D^2}-\frac{2b_3x}{D}+b_2\right)\sum_{z=1}^{k+1}\frac{k!}{\alpha^z(k-z+1)!}\left(2D\left(\frac{x}{\theta}\right)^{k-z+3/2}\right.$$

$$\left.K_{k-Z+3/2}\left(\frac{x\theta}{\sigma}\right)+2x\left(\frac{x}{\theta}\right)^{k-z+1/2}K_{k-Z+1/2}\left(\frac{x\sigma}{\sigma^2}\right)\right)$$

$$+\frac{b_3}{D^2}\sum_{z=1}^{k+2}\frac{(k+1)!}{\alpha^z(k-z+2)!}\left(2D\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z-21/2}\left(\frac{x\theta}{\sigma^2}\right)+2x\left(\frac{x}{\theta}\right)^{k-z+11/2}K_{k-z-11/2}\left(\frac{x\theta}{\sigma^2}\right)\right)$$

$$-\frac{\alpha^k esp\left(\frac{Dx}{\sigma^2}\right)}{\sqrt{(k)}\sqrt{2\pi}}\left[2\left(\frac{b_2}{D}-\frac{b_3x}{D^2}\right)\left(\frac{x}{\theta}\right)^{k+1/2}K_{k+1/2}\left(\frac{x\theta}{\sigma^2}\right)+\frac{2b_3}{D}\left(\frac{x}{\theta}\right)^{k+11/2}K_{k+11/2}\left(\frac{x\theta}{\sigma^2}\right)\right]$$

Re-arranging terms

$$G_2(x)=\frac{\alpha^k esp\left(\frac{Dx}{\sigma^2}\right)}{2\sigma}\frac{b_1}{\sqrt{(k)}}\left[\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^2(k-z)!}\left(2D\left(\frac{x}{\theta}\right)^{k-z+1/2}\right)\right]$$

$$K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right)+2x\left(\frac{x}{\theta}\right)^{k-z-1/2}K_{k-z-1/2}\left(\frac{x\vartheta}{\sigma^2}\right)$$

$$+\frac{\alpha^k esp\left(\frac{Dx}{\sigma^2}\right)}{2\sigma\sqrt{2\pi\sqrt{(k)}}}\frac{b_2}{D}\left[-\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^z(k-z)!}\right]\left(2.D\theta\left(\frac{x}{\theta}\right)^{k-z+11/2}+K_{k-z-1/2}\left(\frac{x\theta}{\sigma}\right)\right.$$

$$\left.+2\theta\left(\frac{x}{\vartheta}\right)^{k-z+11/2}+K_{k-z-1/2}\left(\frac{x\theta}{\sigma^2}\right)\right)$$

$$+\sum_{z=1}^{k+1}\frac{k!}{\alpha^z(k-z+1)!}(2D^2\left(\frac{x}{\theta}\right)^{k-z+11/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right)$$

$$+2\theta D\left(\frac{x}{\theta}\right)^{k-z+11/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^2}\right)$$

$$-2\sigma^2\left(2\left(\frac{x}{\theta}\right)^{k-11/2}K_{k-11/2}\left(\frac{x\theta}{\sigma^2}\right)\right)$$

$$+\alpha^k\frac{esp\left(\frac{Dx}{\sigma^2}\right)b_3}{2\sigma\sqrt{2\pi\sqrt{(k)}}}\left[\sum_{z=0}^{k}\frac{(k-1)!}{\alpha^z(k-z)!}\left(\frac{2\theta^2}{D}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-2+1/2}\left(\frac{x\theta}{\sigma^2}\right)+\frac{2}{D^2}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma_2}\right)\right)\right]$$

$$+\sum_{z=1}^{k-11}\frac{k!}{\alpha^{z}(k-z+1)!}\left(\frac{2\sigma^{2}}{D}\left(\frac{x}{\sigma}\right)^{k-z+11/2}K_{k-2+11/2}\left(\frac{x\theta}{\sigma^{2}}\right)\right)$$

$$+\frac{2\theta\sigma^{2}}{D^{2}}\left(\frac{x}{\theta}\right)^{k-z-11/2}K_{k-Z+1/2}\left(\frac{x\theta}{\sigma^{2}}\right)$$

$$-\sum_{z=1}^{k+1}\frac{k!}{\alpha^{z}(k-z+1)!}\left(\frac{4}{D^{2}}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^{2}}\right)\right.$$

$$+\frac{4\theta^{2}}{D}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z+1/2}\left(\frac{x\theta}{\sigma^{2}}\right)$$

$$+\sum_{z=1}^{k+2}\frac{(k+1)!}{\alpha^{z}(k-z+2)!}\left(\frac{2}{D}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z+21/2}\left(\frac{x\theta}{\sigma^{2}}\right)+\frac{2\theta}{D^{2}}\left(\frac{x}{\theta}\right)^{k-z+21/2}K_{k-z+11/2}\left(\frac{x\theta}{\sigma^{2}}\right)\right)$$

$$+\frac{2\alpha^{k}esp\left(\frac{Dx}{\sigma^{2}}\right)}{\sqrt{(k)}}\left[\frac{\sigma\theta}{D^{2}\sqrt{2\pi}}\left(\frac{x}{\theta}\right)^{k+11/2}K_{k+1/2}\left(\frac{x\theta}{\sigma_{2}}\right)-\frac{\sigma}{\sqrt{2\pi D^{2}}}\left(\frac{x}{\theta}\right)^{k+11/2}K_{k-11/2}\left(\frac{x\theta}{\sigma^{2}}\right)\right] \quad (16)$$

From equation 11

$$G_{1}(Q_{1}R)=\int_{R+Dp}^{R+Q+Dp}G_{2}(x)dx$$

Where $G_1(Q,R)$ is the expected backorder cost per cycle

Expanding

$$G_{1}(Q,R)=\int_{R+Dp}^{R+Q+Dp}G_{2}(x)dx-\int_{R+Q+Dp}^{\infty}G_{2}(x)dx \quad \text{.....(17)}$$

Integrating $G_2(x)$ with respect to x from z to ∞ and applying

$$\int H(L)g\left(\frac{x-DL}{\sqrt{\sigma^{2}L}}\right)dL$$

$$=\int_{0}^{\infty}\frac{1}{\sqrt{2\pi\sigma^{2}L}}esp-1/2\left(\frac{x-DL}{\sqrt{\sigma^{2}L}}\right)^{2}\frac{\alpha^{k}L^{k-1}esp(-\alpha L)}{\sqrt{(k)}}dL \quad \text{..... (18)}$$

$$\int_{Q}^{\infty}G_{2}(x)dx \text{ and letting } \lambda=\left(\frac{\theta-D}{\sigma^{2}}\right)$$

$$=\frac{2\alpha^{k}b_{1}}{4\sqrt{(k)}}\left[\sum_{z=1}^{k}\frac{(k-1)}{\alpha^{z}(k-z)!}\left[2D\sum_{j=0}^{k-z}\frac{(k-z+j)!}{j(k-z-j)!}\right.\right.$$

$$\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j} \cdot\chi^2\left(\frac{2\lambda Q}{2(k-z-j+1)}\right)\frac{1}{(\theta\lambda)^{k-z+1}}(k-z-j)!$$

$$+\theta\sum_{j=0}^{k-z-1}\frac{(k-z-1-j)!}{j(k-z-1-j)!}\frac{1}{(\theta\lambda)^{k-z+1}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z-j+1}\right)$$

$$+\frac{2\alpha^k b_2}{4D\sqrt{(k)}}\left[-\sum_{z=1}^{k}\frac{(k-1)!}{\alpha^z(k-z)!}\left[D\theta\sum_{j=0}^{k-z}\frac{(k-z+j)!}{j(k-z-j)!}\right.\right.$$

$$\frac{1}{(\theta\lambda)^{k-z+2}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z-j+1)}\right)$$

$$\left.\left.+\theta\sum_{j=0}^{k-z-1}\frac{(k-z-1+j)!}{j!(k-z-1-j)!}\frac{(k-z-j)!}{(\theta\lambda)^{k-z+2}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z-j+1)}\right)\right]\right]$$

$$+\sum_{z=1}^{k+1}\frac{k!}{\alpha^z(k-z+1)!}\left[D^2\sum_{j=0}^{k-z+1}\frac{(k-z+1-j)!}{j!(k-z+1-j)!}\frac{(k-z+1-j)!}{(\theta\lambda)^{k-z+2}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\right]$$

$$\chi^2\left(\frac{2\lambda Q}{2(k-z+2-j}\right)+2\theta D\sum_{j=0}^{k-z}\frac{(k-z+j)!}{j!(k-z-j)!}\frac{(k-z+1-j)!}{(\theta\lambda)^{k-z+2}}$$

$$\left.\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z+2-j)}\right)\right]$$

$$-2\sigma^2\sum_{j=0}^{k}\frac{(k+j)!}{j!(k-j)!}\frac{(k-j)!}{(\theta\lambda)^{k+1}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k+1-j)}\right)\Bigg]$$

$$+\frac{\alpha^k b_3}{2\sqrt{(k)}}\left[\sum_{z=0}^{k}\frac{(k-1)!}{\alpha^z(k-z)!}\left[\frac{2\theta^2}{D}\sum_{j=0}^{k-z}\frac{(k-z+j)!}{j!(k-z-j)!}\right.\right.$$

$$\frac{(k-z+2-j)!}{(\theta\lambda)^{k-z+3}}\left(\frac{2\vartheta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z+3-j)}\right)$$

$$\left.\left.+\frac{2\theta^3}{D^2}\sum_{j=0}^{k-z-1}\frac{(k-z+1+j)}{j!(k-z-1-j)!}\frac{(k-z+2-j)!}{(\theta\lambda)^{k+z+3}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z+3-j)}\right)\right]\right]$$

$$+\sum_{z=1}^{k+1}\frac{k!}{\alpha^2(k-z+1)!}\left[\frac{2\sigma^2}{D}\sum_{j=0}^{k-z+1}\frac{(k-z+1+j)!}{j!(k+1-z-j)!}(k-z+1-j)!\left(\frac{1}{\theta\lambda}\right)^{k-z+2}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\right.$$

$$\left.\chi^2\left(\frac{2\lambda Q}{2(k-z+2-j)}\right)\right]$$

$$+\frac{2\theta\sigma^2}{D^2}\sum_{j=0}^{k-z}\frac{(k-z+j)!}{j!(k-z-j)!}(k-z+1-j)!\frac{1}{(\theta\lambda)^{k-z+2}}$$

$$\chi^2\left(\frac{2\lambda Q}{2(k-z+2-j)}\right)\Bigg]-\sum_{z=1}^{k-1}\frac{k!}{\alpha^z(k-z+1)!}\Bigg[\frac{4}{D^2}\sum_{j=0}^{k-z+2}$$

$$\frac{(k-z+2+j)!}{j!(k-z+2-j)!}\frac{(k-z+2-j)!}{(\theta\lambda)^{k-z+3}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}$$

$$\chi^2\left(\frac{2\lambda Q}{2(k-z-j+3)}\right)\Bigg]+\frac{4\theta^2}{D}\sum_{j=0}^{k-z+1}\frac{(k-z+1+j)!}{j!(k-z+1-j)!}$$

$$(k-z+2-j)!\left(\frac{1}{\theta\lambda}\right)^{k-z+3}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k-z-j+3)}\right)\Bigg]$$

$$+\sum_{z=1}^{k+2}\frac{(k+1)!}{\alpha^z(k-z+2)!}\left(\frac{2}{D}\sum_{j=0}^{k-z+2}\frac{(k-z+2+j)!}{j!(k-z+2-j)!}\right)(k-z+2-j)!$$

$$\left(\frac{1}{\theta\lambda}\right)^{k-z+3}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2Q}{2(k-z+3-j)}\right)$$

$$+\frac{2\theta}{D^2}\sum_{j=0}^{k-z+1}\frac{(k-z+2-j)!}{j!(k-z+1-j)!}\left(\frac{1}{\vartheta\lambda}\right)^{k-z+3}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2Q}{2(k-z+3-j)}\right)$$

$$-\frac{2\sigma^2}{D}\sum_{j=0}^{k+1}\frac{(k+1+j)!}{j!(k+1-j)!}\frac{(k+1-j)!}{(\vartheta\lambda)^{k+2}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k+2-j)}\right)$$

$$+\frac{2\sigma^2\theta}{D}\sum_{j=0}^{k}\frac{(k+j)!}{j!(k-j)!}\frac{(k+1-j)!}{(\theta\lambda)^{k+2}}\left(\frac{2\theta}{\lambda\sigma^2}\right)^{-j}\chi^2\left(\frac{2\lambda Q}{2(k+2-j)}\right)\quad\text{.....(19)}$$

Let $G_3(z)$ equal the b_1 factor of (19) .....(20)
Let $G_4(z)$ equal the b_2 factor of (19) .....(21)
Let $G_5(z)$ equal the b_3 factor of (19) .....(22)

Hence from (17)
The expected backorder cost per cycle
$= b_1 (G_3(R + Dp) - G_3 (R + Q + Dp) + b_2 (G_4 (R + Dp)$
$- G_4 (R + Q + Dp) + b_3 (G_5 (R + Dp) - G_5 (R + Q + Dp))$ .....(23)
Hence the expected cost per year

$$= \frac{b_1}{Q}\left(G_3(R+Dp)-G_3(R+Q+Dp)\right)+\frac{b_2}{Q}(G_4(R+Dp)$$
$$-G_4(R+Q+Dp))+\frac{b_3}{Q}\left(G_5(R+Dp)-G_5(R+Q+Dp)\right) \quad \text{..... (24)}$$

Next we obtain the expected on hand inventory at any time.

Let (D, R) be the expected on hand inventory at any time
Let G_6 (x) be the probability density function of the quantity on hand x at anytime t. x control be less or above the re-order level R. 0<x<R

$$D(Q,R)=\int_0^R xG_6(x)dx+\int_R^{R+Q} xG_6(x)dx$$

If x lies above R

Where $G_6(x)=\frac{1}{Q}\int_R^{R+Q} esp-1/2\left(\frac{v-x-DL}{\sqrt{\sigma^2 L}}\right)^2 dx$

If x lies above R

$$G_6(x)=\frac{1}{Q}\int_0^{R+R} esp\left(-\frac{1}{2}\left(\frac{v-x-DL}{\sqrt{\sigma^2 t}}\right)\right)dv$$

Given that the system was in state v and v-x was demanded.

Which gives, expressing in k standard deviations of stock

$$G_1(x)=\frac{1}{Q}\left(F(k-\frac{x}{\sqrt{\sigma^2 L}}\right)-F\left(k+\frac{(Q-x)}{\sqrt{\sigma^2 L}}\right) \qquad 0<x<R$$

$$G_1(x)=\frac{1}{Q}\left(1-F\left(k+\frac{(Q-x)}{\sqrt{\sigma^2 L}}\right)\right) \qquad R<x<R+Q$$

Hence D(Q, R)= $\frac{1}{Q}\int_0^R\left(xF\left(\frac{R-x-DL}{\sqrt{\sigma^2 L}}\right)-xF\left(\frac{R+Q-x-DL}{\sqrt{\sigma^2 L}}\right)\right)dx$

$$+\frac{1}{Q}\int_R^{R+Q}\left(x-xF\left(\frac{R+Q-x-DL}{\sqrt{\sigma^2 L}}\right)\right)dx$$

Simplifying

$$D(Q,\ R)=\frac{1}{Q}\int_0^R xF\left(\frac{R-x-DL}{\sqrt{\sigma^2 L}}\right)dx-\frac{1}{Q}\int_0^{R+Q} xF\left(\frac{R+Q-x-DL}{\sqrt{\sigma^2 L}}\right)dx$$

$$+\frac{1}{Q}\int_R^{R+Q} xdx$$

Let V= $\frac{R-x-DL}{\sqrt{\sigma^2 L}}$ and $\frac{R+Q-x-DL}{\sqrt{\sigma^2 L}}$ In each integral

Then $D(Q_1R)=\frac{\sqrt{\sigma^2 L}}{Q}\int_{R\frac{R-DL}{\sqrt{\sigma^2 L}}}^{\frac{-DL}{\sqrt{\sigma^2 L}}}\sqrt{\sigma^2 L}V-R+DL)F(V)dV$

$$+\frac{\sqrt{\sigma^2 L}}{Q}\int_{\frac{R+Q-DL}{\sqrt{\sigma^2 L}}}^{\frac{-DL}{\sqrt{\sigma^2 L}}}(\sigma^2 LV-R-Q+DL)dV+\frac{(R+Q)^2-R^2}{2Q}$$

Remembering that $k = \frac{R - DL}{\sqrt{\sigma^2 L}}$

Then expressing R in terms of standard deviations of stock

$$D(Q,K) = -\frac{\sigma^2 L}{Q}\int_k^{\frac{-DL}{\sqrt{\sigma^2 L}}}(V-k)F(V)dV + \frac{(\sigma^2 L)}{Q}\int_{\frac{k+Q}{\sqrt{\sigma^2 L}}}^{\frac{-DL}{\sqrt{\sigma^2 L}}}$$

$$(V-(k+\frac{Q}{\sqrt{\sigma^2 L}})F(V)dV + \frac{Q}{2} + K\sqrt{\sigma^2 L}$$

Simplifying

$$D(Q,K) = -\frac{\sigma^2 L}{Q}\int_k^{\frac{-DL}{\sqrt{\sigma^2 L}}} VF(V)dV + \frac{(\sigma^2 L)}{Q}\int_k^{\frac{-DL}{\sqrt{\sigma^2 L}}} kF(V)dV$$

$$+\frac{\sigma^2 L}{Q}\int_{\frac{k+Q}{\sqrt{\sigma^2 L}}}^{\frac{-DL}{\sqrt{\sigma^2 L}}} vF(V)dv + \frac{(\sigma^2 L)}{Q}\int_{\frac{k+Q}{\sqrt{\sigma^2 L}}}^{\frac{-DL}{\sqrt{\sigma^2 L}}}(k+\frac{Q}{\sqrt{\sigma^2 L}})F(V)dV$$

$$+\frac{Q}{2} + k\sqrt{\sigma^2 L}$$

Hence D(Q, k), noting that $F\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right) = 1$

and $\int_k^{\infty} F(v)dv = -kF(k) + g(k)$

and $\int_k^{\alpha} vF(v)dv = 1/2(1-k^2)F(k) + kg(k)$

Hence D(Q, k)

$$= -\frac{\sigma^2 L}{Q}\left(k(F(k)-g(k) - \left(\frac{-DL}{\sqrt{\sigma^2 L}}\right)F\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right) + g\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right)\right) - \frac{\sigma^2 L}{2Q}\left((1-k^2)F(k) + kg(k)\right)\right.$$

$$-\left(1-\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right)^2 F\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right) - g\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right)\right) + \frac{\sigma^2 L}{Q}\left(\left(k+\frac{Q}{\sqrt{\sigma^2 L}}\right)F\left(K+\frac{Q}{\sqrt{\sigma^2 L}}\right)\right)$$

$$+\left(k+\frac{Q}{\sqrt{2\sigma^2 L}}\right)g\left(k+\frac{Q}{\sqrt{\sigma^2 L}}\right) - \left(1-\frac{DL}{\sqrt{\sigma^2 L}}\right)^2 F\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right) - g\left(\frac{-DL}{\sqrt{\sigma^2 L}}\right)\Bigg) + \frac{Q}{2} + k\sqrt{\sigma^2 L}$$

Which gives

$$D(Q,k) = k\sqrt{\sigma^2 L} + \frac{Q}{2} + \frac{\sigma^2 L}{2}\left((1+k^2)\overline{(k)} - kg(k)\right)$$

$$-\frac{\sigma^2 L}{2}\left(1+\frac{(k+Q)^2}{\sigma^2 L}\right)F\left(\frac{k+Q}{\sqrt{\sigma^2 L}}\right)$$

$$-\left(k+\frac{Q}{\sqrt{\sigma^2 L}}\right)g\left(\frac{k+Q}{\sqrt{\sigma^2 L}}\right)\Bigg) \quad \text{.....(25)}$$

Remembering that k = $\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)$ then

Substituting for k then

$$D(Q,R,L)=\frac{Q}{2}+R-DL+\frac{\sigma^2 L}{2}\left(1+\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)^2\right)$$

$$F\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)-\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)g\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)-\frac{\sigma^2 L}{2}\left(1+\frac{R+Q-DL}{\sqrt{\sigma^2 L}}\right)^2$$

$$F\left(\frac{R+Q-DL}{\sqrt{\sigma^2 L}}\right)+\left(\frac{R+Q-DL}{\sqrt{\sigma^2 L}}\right)g\left(\frac{R+Q-DL}{\sqrt{\sigma^2 L}}\right)$$

But $\frac{\sigma^2 L}{2}\left(1+\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)^2\right)F\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)-\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)g\left(\frac{R-DL}{\sqrt{\sigma^2 L}}\right)$ .....(26)

$$=\int_R^{\infty}\left(\sqrt{\sigma^2 L}\,g\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)\right)-(V-DL)F\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)\Bigg)dV \quad \text{.....(27)}$$

Hence

$$D(Q,R,L)=\frac{Q}{2}+R-DL+\int_R^{R+Q}\sqrt{\sigma^2 L}\,g\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)$$

$$-(V-DL)F\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)dV$$

Where D(Q,R,L) is the inventory on hand for a given lead time L.
Hence expected on hand inventory

$$=\int_0^{\infty}H(L)D(Q,R,L)DL \quad \text{.....(28)}$$

$$\int_0^{\infty}\left(\frac{Q}{2}+R\right)H(L)DL-D\int_0^{\infty}LH(L)dL+\frac{1}{Q}\int_0^{\infty}\int_R^{R+Q}H(L)\sqrt{\sigma^2 L}$$

$$\left(g\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)-(V-DL)F\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)dVdL\right) \quad \text{.....(29)}$$

Noting that

$\int_0^{\alpha}\int_R^{R+Q} H(L)\sqrt{\sigma^2 L}\left(g\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)-(V-DL)F\left(\frac{V-DL}{\sqrt{\sigma^2 L}}\right)\right)dVdL$ is the coefficient of b_2 in (iv)

Then integrating (29)
We have

$$D(Q,R)=\frac{Q}{2}+R-\frac{Dk}{\alpha}+\frac{1}{Q}\left(G_4(R)-G_4(R+Q)\right)$$

Cost of ordering = $\left(\frac{DS}{Q}\right)$

Inventory costs for mode (Q_1R)

$$C=\frac{DS}{Q}+hcD(Q_1R)+\frac{b_1}{Q}\left(G_4\left(R+Dp+\frac{1}{Q}(G_4(R)-G_4(R+Q)\right)\right)$$

Cost of ordering = $\frac{DS}{Q}$ ……(30)

Inventory costs for mode (Q_1R)

$$C=\frac{DS}{Q}+hcD(Q_1R)+\frac{b_1}{Q}\left(G_3(R+Dp)-G_3(R+Q+Dp)\right)$$

$$+\frac{b_2}{Q}\left(G_4(R+Dp)-G_4(R+Q+Dp)+b_3(G_5(R+Dp)-G_5(R+Q+Dp)\right)\text{.....(31)}$$

Substituting for $D(Q_1R)$ from (30)

$$C=\frac{DS}{Q}+\frac{Qhc}{2}+hc(R-\frac{Dk}{\alpha})+b_1\left(G_3(R+Dp)-G_3(R+Q+Dp)\right)$$

$$+\frac{b_2}{Q}\left(G_4(R+Dp)-G_4(R+Q+Dp)\right)+b_3(G_5(R+Dp)-G_5(R+Q+Dp))$$

$$+\frac{hc}{Q}(G_4(R)-G_4(R+Q)\text{.....(34)}$$

The corresponding cost when no period of grace p is operating is

$$C=\frac{DS}{Q}+\frac{Qhc}{2}+hc(R-\frac{Dk}{\alpha})+b_1\left(G_3(R)-G_3(R+Q)\right)$$

$$+\frac{(hc+b_2)}{Q}\left(G_4(R)-G_4(R+Q)\right)+\frac{b_3}{Q}(G_5(R)-G_5(R+Q))$$

IV. IMPACT OF THE STUDY

The study will enable industries or organizations having thousands of items in their warehouses located in various locations of the world and items supplied by different manufacturers with accurately use realistic lead times in arriving at their inventory cost.
In many of such cases lead times are not constant.
Expressing lead time as continuous gives a more realistic estimate of inventory costs.

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A Troubleshooting Approach towards the Generation of White Patches on Silk Fabric

Prof. S. K. Ghosh[1*], Mr. Abir Baran Das[2a], Rajib Bhattacharyya[3b]
[1]*Professor, Department of Jute and Fibre Technology, University of Calcutta,35, Ballygunge Circular Road, Kolkata- 700019, West Bengal, India*
[2]*Quality Assurance Manager, J. J. Spectrum Silk, West Bengal, India*
[3]*Senior Research Fellow, Department of Jute and Fibre Technology, University of Calcutta,35, Ballygunge Circular Road, Kolkata- 700019, West Bengal, India*

ABSTRACT: *The phenomenon of occurrence of white patches on dyed silk fabric stored for few months, after production, is an intricate matter. There may be many reasons behind this occurrence. The possible sources may be deposition of fatty acid salts or growth of certain fungus or micro-organisms. This study focuses a detailed observation and analysis of white patches occurring in dyed silk fabric that has been stored for some months. An attempt has been made in this study to identify the possible reason behind the occurrence of these patches on the fabric and analyze the surface morphology of the affected areas of the fabric by adopting Scanning Electron Microscope (SEM) study, Fourier Transform Infrared Spectroscopy (FT-IR) and fungal growth study. The studies have identified the presence of some chemical compounds in this white deposition. Furthermore, the article also discusses the mechanism of deposition of these chemical compounds.*

Keywords *-silk, fungus, SEM, FTIR, microbiological testing, fatty acid, salt deposition*

I. INTRODUCTION

Silk is a naturally occurring protein fibre produced by the worms and has been potentially used as a textile material for over five thousand years. Natural raw silk is composed mainly of sericin about (22-25 %), fibroin about (62.5-67.0 %) and the rest is of water and mineral salts [1]. Fibroin is a single protein which is insoluble in hot water. On the other hand, sericin is primarily amorphous and acts as a gum binder to maintain the structural integrity of the cocoon, which makes it more water-soluble than fibroin [2]. This delicate filamentous fibre is well known for its sheen texture, water absorbency, dyeing affinity, thermal tolerances along with insulation properties [3]. Silk is basically a strong fibre having strength 3.6-4.0 cN/tex which can be attributed for its linear and beta configuration and considerable crystalline polymer system [4]. Amongst the different species of moths producing raw silk the best known variety is the Lepidopter Bombyx mori. Customarily, prior to weaving, raw silk is degummed for removal of sericin to obtain its soft and lustrous feel. Chemical substances like lubricants, antistatic agents, natural-based auxiliaries which are added during degumming of the silk fibres provide food source for microorganisms. Synthetic fibres are not totally immune to micro-organisms but it has been found that certain synthetic fibres like polyurethane fibres can get damaged due to the growth of micro-organisms. On the other hand, natural fibres because of evolution are more easily attacked by micro-organisms as for example wool is more susceptible to bacterial attack while cotton is more likely attacked by fungi [5]. Once a fabric is invaded by fungal growth, various cleaning methods may not return the garment to its previous condition. Natural fabrics (i.e. wool, cotton and silk) appear to support more fungal growth than manmade fabrics (polyester) [6].

Heald, Commoner and Ballard have described in the article entitled 'A Study of deposits on glass in direct contact with mounted textiles' their observation about different appearances according to the material stored under glass using a whole range of analysis methods to identify the substances. These were generally identified as saturated fatty acids and a decomposition product of unsaturated fatty acids.

Migrated soaps present in exhibition fabrics and textile objects due to earlier processing and washing procedures were interpreted as the origin of these fatty acids [7]. In a silk processing unit it has been observed that the occurrence of white patches in the finished fabric cause a serious problem. Those industries which export expensive silk fabrics, suffer heavy loss due to such severe problems. These obstinate white patches are found to be visible all over the fabric in local colonies and may appear in any fabric lot. Sometimes there are some large spots observed near the selvedge ends of the fabrics. They visually appear like fungi. The fabric samples have been subjected to Scanning Electron Microscope (SEM) study, Fourier Transform Infrared Spectroscopy (FT-IR) and fungal growth study to identify the possible reason behind the occurrence of these patches on the fabric surface and analyze the surface morphology of the affected areas of the fabric. The studies have identified the presence of some chemical compounds in this white deposition.

II. MATERIAL AND METHODS

The fabric sample had been made from 100% filature and duppion silk yarn having the specifications as furnished in Table 1. The parameters of the produced fabric have been defined in Table 2. The conditions adopted and the chemicals applied here during the degumming followed by dyeing of the silk yarn have been provided in Table 3.

Table 1 Yarn specifications

Sl. No.	Yarn Particulars	Warp Yarn	Weft Yarn
1.	Variety	Mulberry filament filature silk	Duppion silk
2.	Count before degumming	2 ply 42 denier	2 ply 220 denier
3.	Count after degumming	2 ply 34 denier	2 ply 175 denier
4.	Twist per metre	700	180
5.	Twist direction	s-twist	z-twist

Table 2 Fabric Specifications

Sl. No.	Fabric property parameters	Values
1	Weave construction	Plain weave
2	Thread density (ends/cm × picks /cm)	48 × 33
3	Areal density (gsm)	91.00

Table: 3 Yarn dyeing process and recipe

	Recipe	Quantity in g/lit. (weft)	Quantity in g/lit. (warp)
Degumming Material: Liquor=1:20 30 min at 90° C, Ph 10.5-11	(1) Wetting & stain removal agent	2	2
	(2) Lubricating agent	2	2
	(3) Wetting agent	1	1
	(4) Enzyme, degumming agent	3.5	-------
	(5) Soap	------	5gpl
Bleaching Material: Liquor=1:20 30 min at 90° C, Ph 8-9	Hot wash and cold wash	10 min each	10min each
	(1) Hydrogen peroxide	3	3
	(2) Stabilizer AWNI	1	1
Dyeing Material: Liquor=1:20 30 min at 86°C	(1) Leveling agent (2) Acetic acid (for Ph 3-4) (3) Metal complex dye Navy blue (shade)	2 2 As per shade depth	2 2 As per shade depth
	Hot wash and cold wash	10 min each	10 min each
Dye fixation at 50° C for 10 min	Dye fixing agent (Optifix)	4	4
Scrooping at 25^0C	(1) Acetic acid (2) Anti-fungal agent (3) lubricating agent (4) Antistatic agent	2 4 2 ------	2 4 2 3

The defective silk fabric sample had been examined visually. The defect appeared like fungal growth as shown in Fig.1 below.

Fig.1 occurrence of white patches on the surface of the dyed silk fabric

III. MICROBIOLOGICAL TEST

The microbiological testing of the dyed silk fabric samples had been carried out as per Parallel Streak Method of AATCC Test Method 147-2004 which is useful for evaluating bacterial growth on treated textile materials. The dyed silk fabric samples had been placed in intimate contact with nutrient agar which had been previously streaked with an inoculum of a test bacterium. A standard strain of bacteria is used which is specific to the requirements of the material under test. Staphylococcus aureus was used as a representative gram positive organism. No bacterial growth had been found to be occurring on the surface of the textile material.

IV. SCANNING ELECTRON MICROSCOPE (SEM) STUDY

The scanning electron microscope (SEM) is one of the most versatile instruments available for the examination and analysis of the micro structure surface morphology and chemical composition characterizations. The electron microscope produces images of the dyed fabric samples by scanning it with a focused beam of electrons. The electrons interacted with atoms in the sample, producing various signals that can be detected and that contain information about the sample's surface topography and composition. This study had been conducted at several national and international research organizations. The defective places of the dyed fabric had been observed under SEM at magnification level of 500 X, 1.00 K X, 10.00 K X where the defects were seen as extraneous fine flakes and agglomeration of deposits as supported by the SEM photographs provided below [Figs. 2 (a), 2 (b) and 2 (c) respectively]. The SEM analysis and observations of the other national and international research organizations have been provided in Figs. 3, 4 respectively.

Fig. 2(a) SEM at Mag 500 X

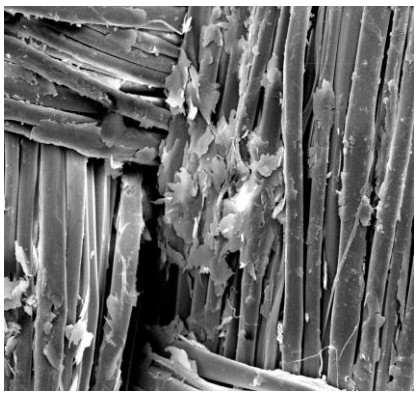

Fig. 2(b) SEM at Mag1.00 K X

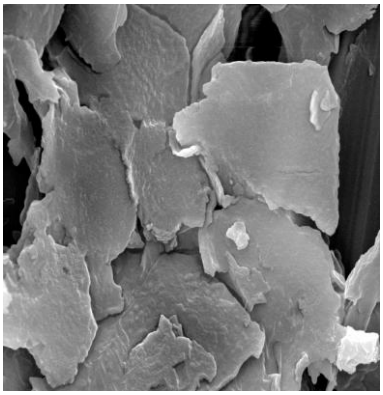

Fig.2(c) SEM at Mag 10.00 K X

Courtesy: *Razabazar Science College, University of Calcutta, India*

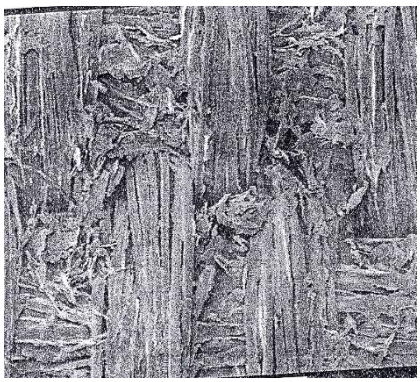
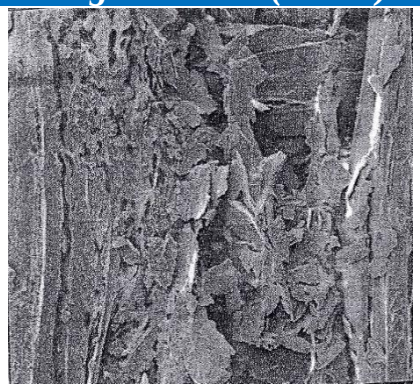
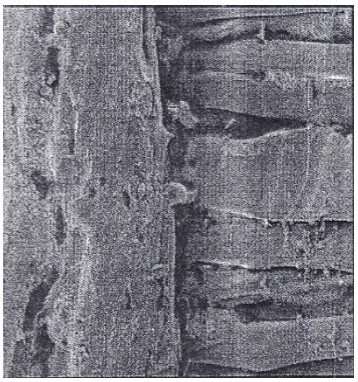

Fig. 3(a) SEM at Mag 200 X **Fig. 3(b) SEM at Mag 500 X** **Fig. 3(c) SEM at Mag 700 X**

Courtesy: *Bombay Textile Research Association, India*

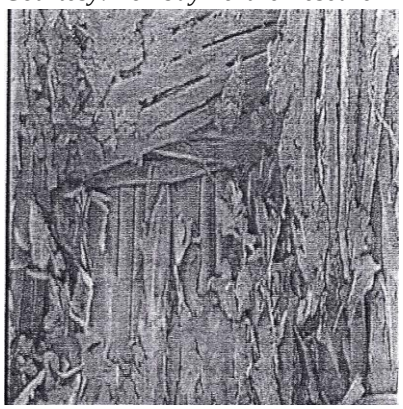
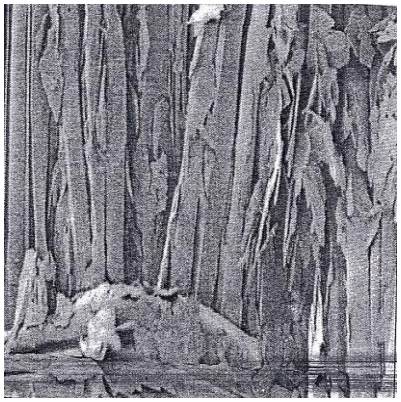
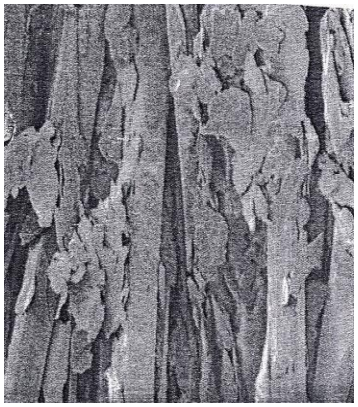

Fig. 4(a) SEM at Mag 350 X **Fig. 4(b) SEM at Mag 500 X** **Fig. 4(c) SEM at Mag 1.00 KX**

Courtesy: *Intertek Testing Services India Pvt. Ltd., Mumbai, India*

V. FTIR SPECTROSCOPY ANALYSIS

Fourier Transform Infrared spectroscopy (FT-IR) has wide applicability in structure elucidation analyzing both qualitatively and quantitatively, of materials which are either synthesized chemically or of natural origin [7].

In this method the dyed silk fabric samples had been placed on the FTIR spectrometer and the infrared radiation had been allowed to pass through the fabric samples. Some of the infrared radiation have been absorbed by the sample while the rest amount gets transmitted. The resulting spectrum represents the molecular absorption and transmission, creating a molecular fingerprint of the sample. It had been observed that no two unique molecular structures produce the same infrared spectrum. The FTIR spectroscopy analysis of the dyed silk fabric samples both in the affected and unaffected areas have been carried out in National Institute of Research on Jute and Allied Fibre Technology, India and the results of the spectral analysis have been shown in Fig. 6 below.

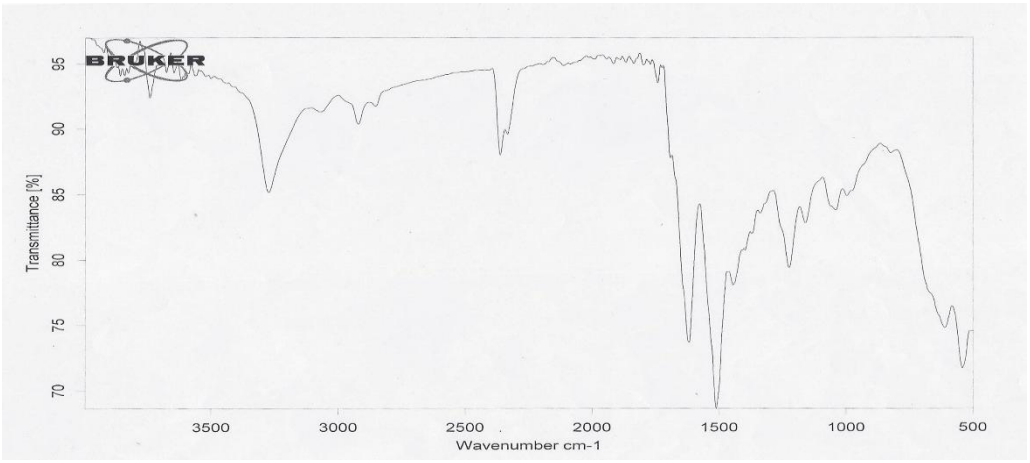

Fig. 6(a) FTIR spectroscopy analysis of the of the dyed silk fabric sample (without affected area)

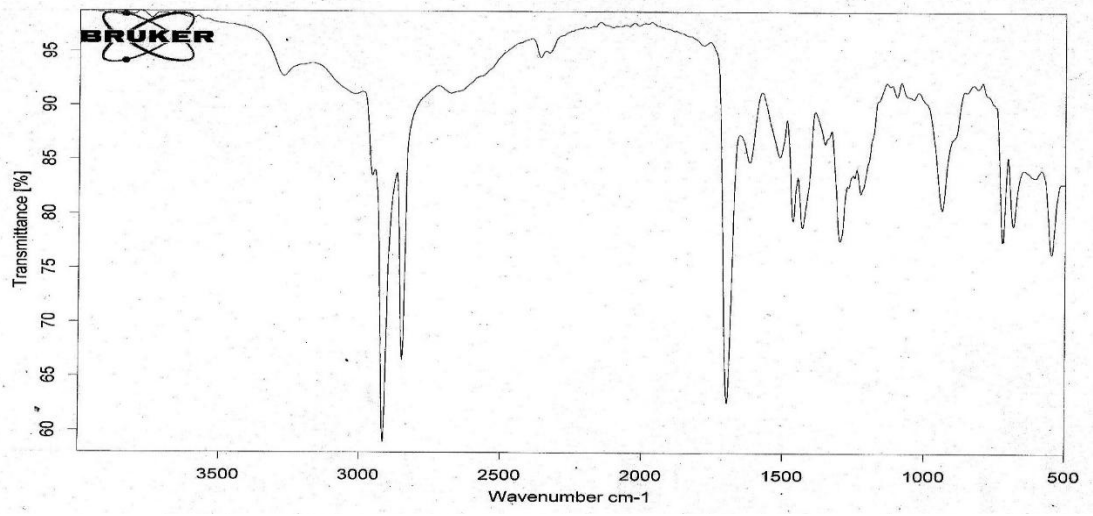

Fig. 6(b) FTIR spectroscopy analysis of the affected area (white patches) of the dyed silk fabric sample

Courtesy: *National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT), India*

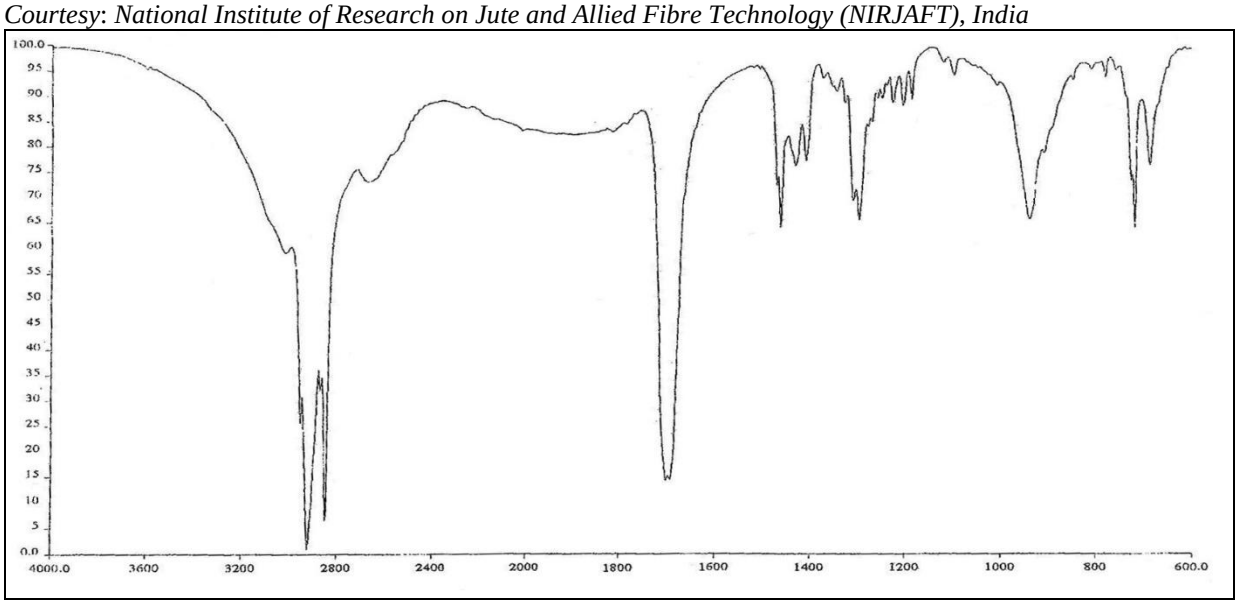

Fig. 7 FTIR spectroscopy analysis of the affected area (white patches) of the dyed silk fabric sample

Courtesy: *Stazione Sperimentale Seta, Italy*

VI. RESULTS AND DISCUSSIONS

The different testing methods carried out at the different national and international research organizations, their test reports and analysis indicate the presence of non-fibrous deposits on the fabric surface at the defective areas which is not seen in the normal areas of the fabric. All the national and international research organizations after performing the method of microbiological testing of the dyed silk fabric samples have unanimously confirmed that there was no microbial or fungal growth on the surface of the dyed silk fabric. The international research organization Stazione Sperimentale Seta, Italy have given hints about the agglomeration of fatty acid deposits which have appeared as white flakes under high magnification. Again, Davis and Mauer have achieved in their work the specific identification of fatty acid compounds from spectral analysis by focusing on specific absorbance regions [9] and their FTIR spectral findings show that the wavenumber of the fatty acid compounds belong in the spectral region of 2955 cm^{-1} to 2850 cm^{-1} which fairly correlates with the FTIR spectral analysis of the affected area (white patches) of this dyed silk fabric sample, Fig.7. According to Heald, Commoner, Ballard and Mary, a probable source of fatty acid deposits is the residual soap left in the textile from wet processing of textiles. Wulfert stated that fatty acids and fatty acid soaps diffusion had noticed in non-textile objects like panel paintings too, but these kinds of residues might have enhanced mobility due to the use of detergents in washing treatments but would not be rinsed off completely.

VII. CONCLUSION

The results obtained in the present study indicate that white patches on silk fabric are not due to the growth of fungus or microorganisms but indicates the deposition of some chemicals which have accumulated during the process. This observation and its reason behind occurrence is being proliferated by FT-IR study conducted by the several research organizations. According to the FT-IR report, deposition of fatty acid or its residual salts have originated due to use of soap applied as a degumming agent and insufficient rinsing may not have removed this completely. The authors are of the opinion that as the fabric production is a lengthy process and is handled by different workers during different stages of production like chemical measurement, machine running, checking of parameters, dyeing, weaving and storing therefore there may not be sufficient supervision and follow-up of the standard machine and process parameters. Moreover, proper washing maintaining the adequate time and rate of flow of water after each stage of process is very important in mitigating these type of defects.

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FREE CONVECTION AND MASS TRANSFER FLOW THROUGH A POROUS MEDIUM WITH VARIABLE TEMPERATURE

[1]R.K.Mondal, [2]Md.A.Hossain,[3]R.Ahmed ,[4]S.F.Ahmmed
[1,2,3,4,]*Mathematics Discipline Khulna University, Khulna*

ABSTRACT: *Aim of the paper is to investigate the hydro magnetic effects of a uniform transverse magnetic field on the free convection and mass transfer flow of an electrically conducting fluid past an exponentially accelerated infinite vertical plate through a porous medium with variable temperature. The problem is governed by coupled nonlinear partial differential equations. The dimensionless equations of the problem have been solved by the explicit finite difference method. Here the plate temperature is increasing linearly with time and the concentration level near the plate is increased. Among the effects of various parameters in going into the problem, the velocity and skin friction is broadly discussed with the help of graph.*

KEYWORDS*: Vertical plate, Unsteady, Explicit finite difference method, Porous medium andelectrically conducting fluid.*

I. INTRODUCTION

Magneto hydrodynamic (MHD) is the branch of continuum mechanics which deals with the flow of electrically conducting fluids in electric and magnetic fields. Many natural phenomena and engineering problems are important being subjected to an (MHD) analysis. Moreover, Magneto hydrodynamic (MHD) has drawn the attention of a broad number of scholars due to its variant applications. In engineering it finds its application in (MHD) pumps, (MHD) bearings etc. Freeconvection flows are of a great attention in a number of industrial applications like as fiber and granular insulation, geothermal systems etc. Convection in porous media has application on geothermal energy recovery, oil extraction, thermal energy storage and flow through filtering devices. The occurrences of mass transfer are also very general in theory of stellar structure and remarkable effects are detectable, at least on the solar surface. The study of influences of magnetic field on free convection flow is important in liquid metal, electrolytes and ionized gases. Also the study of flows through porous media became of great attention due to its wide application in many scientific and engineering problems.

Gupta et al. [9] (Gupta et al. 1979) studied free convection on flow past a linearly accelerated vertical plate in the arrival of viscous dissipative heat using perturbation method. Free convection flow past an accelerated infinite plate discussed by Pop, I. and. Soundalgekar [1](Pop, I. and. Soundalgekar 1980). Kafousias and Raptis [4] (Kafousias and Raptis 1981) expanded the problem of Gupta et al. to involve mass transfer effects subjected to variable suction and injection. Sing and Naveen Kumar [3] (Sing and Naveen Kumar 1984) was studied free convection effects on flow past an exponentially accelerated vertical plate. Hossain and Shayo [7] (Hossain and Shayo 1986) discussed skin friction for accelerated vertical plate analytically. BasantkumarJha [2] (BasantkumarJha 1991) studied MHD free convection and mass transform flow through a porous medium. LatterlyCombined heat and mass transfer effects on MHD free convection flow past an oscillating plate embedded in porous medium have analyzed by R.C. Chaudhary and Arpita Jain [5] (R.C.Chaudhary et al. 2007). Recently Muthukumaraswamy et al. [6](Muthukumaraswamy et al. 2008) discussed mass transfer effects on exponentially accelerated isothermal vertical plate.

In current years, the problems of free convective and heat and mass transfer flows through porous medium under the effects of magnetic field have drawn the attention of a large number of researchers due to their applications in many branches of science and technology such as transportation cooling of re-entry vehicles and rocket boosters and film vaporization in combustion chambers. On the other hand in case of power generation MHD is receiving considerable attention due to the possibilities it offers for much higher thermal efficiencies in power plants. In view of these applications, the aim of the paper is to study on the transverse magnetic field on the free convection and mass transfer flow past an exponentially accelerated vertical plate with variable temperature through a porous medium. Dimensionless governing equations are solved by using the explicit finite difference method.

In our present work, we have studied about free convection and mass transfer flow through a porous medium with variable temperature. The governing equations for the unsteady case are also studied. Then these governing equations are transformed into dimensionless momentum, energy and concentration equations are solved numerically by using explicit finite difference technique with the help of a computer programming language Compaq visual FORTRAN 6.6. The obtained results of this problem have been discussed for the different values of well-known parameters with different time steps. The tecplot 9.0 is used to draw graph of the flow.

II. MATHEMATICAL FORMULATION

$$\frac{\partial \bar{u}}{\partial \bar{t}} = g\beta(\bar{T}-\bar{T}_\infty)+g\beta'(\bar{C}-\bar{C}_\infty)+\nu\frac{\partial^2\bar{u}}{\partial\bar{y}^2}-\frac{\sigma B_0^2}{\rho}(\bar{u}-u_0e^{\bar{a}\bar{t}})-\frac{\nu\bar{u}}{\bar{K}} \tag{1}$$

$$\rho C_p\frac{\partial\bar{T}}{\partial\bar{t}} = \kappa\frac{\partial^2\bar{T}}{\partial\bar{y}^2} \tag{2}$$

$$\frac{\partial\bar{C}}{\partial\bar{t}} = D\frac{\partial^2\bar{C}}{\partial\bar{y}^2} \tag{3}$$

The boundary conditions related with the problem are,

$$\begin{aligned}
&\bar{t}\le 0:\bar{u}=0, \quad \bar{T}=\bar{T}_\infty,\ \bar{C}=\bar{C}_\infty \quad \text{for all } \bar{y}\\
&\bar{t}>0:\bar{u}=u_0e^{\bar{a}\bar{t}},\ \bar{T}=\bar{T}_\infty+(\bar{T}_w-\bar{T}_\infty)A\bar{t},\ \bar{C}=\bar{C}_w \text{ for all } \bar{y}=0\\
&\bar{u}=0,\ \bar{T}\to\bar{T}_\infty, \quad \bar{C}=\bar{C}_\infty, \quad \text{as } \bar{y}\to\infty
\end{aligned} \tag{4}$$

where $\bar{u}$ is the velocity of the fluid in $\bar{x}$ direction, $\bar{T}$ is the temperature and $\bar{C}$ is the concentration component of the fluid respectively, g is the acceleration due to gravity, $\bar{C}_\infty$ is the concentration in the fluid far away from the plate, $\bar{C}_w$ is the concentration of the plate, $\bar{y}$ is coordinate axis normal the plate, B_0 is the external magnetic field, C_p is specific heat at constant pressure, $\bar{T}_\infty$ is the temperature of the fluid far away from the plate, $\bar{T}_w$ is the temperature of the plate, a is the acceleration parameter, u_0 is the velocity of the plate, D is the chemical molecular diffusivity, K is the permeability parameter, ρ is the density, ν is kinematic viscosity and $\bar{t}$ is the corresponding time, β is the volumetric coefficient of thermal expansion and β' is the volumetric coefficient of expansion with concentration respectively.

Here, $A=\dfrac{u_0^{\,2}}{\nu}$,

Since the solutions of the governing equations under the boundary conditions will be based on the finite difference method so it is necessary to make the equation dimensionless. For this reason now we introduce the following dimensionless quantities,

$$\begin{aligned}
&u=\frac{\bar{u}}{u_0},\ y=\frac{\bar{y}u_0}{\nu},\ t=\frac{\bar{t}u_0^{\,2}}{\nu},\ \theta=\frac{\bar{T}-\bar{T}_\infty}{\bar{T}_w-\bar{T}_\infty},\ G_r=\frac{g\beta\nu(\bar{T}_w-\bar{T}_\infty)}{u_0^{\,3}},\ a=\frac{\bar{a}\,\nu}{u_0^{\,2}},\\
&G_m=\frac{g\beta'\nu(\bar{C}_w-\bar{C}_\infty)}{u_0^{\,3}},\ P_r=\frac{\mu C_p}{\kappa},\ S_c=\frac{\nu}{D},\ M=\frac{\sigma B_0^{\,2}\nu}{\rho u_0^{\,2}},\ K=\frac{u_0^{\,2}\bar{K}}{\nu^2}
\end{aligned} \tag{5}$$

Then equation (1)-(3) and boundary conditions (4) leads to,

$$\frac{\partial u}{\partial t} = G_r\theta + G_m C + \frac{\partial^2 u}{\partial y^2} - M(u - e^{at}) - \frac{u}{K} \tag{6}$$

$$\frac{\partial \theta}{\partial t} = \frac{1}{P_r}\frac{\partial^2 \theta}{\partial y^2} \tag{7}$$

$$\frac{\partial C}{\partial t} = \frac{1}{S_c}\frac{\partial^2 C}{\partial y^2} \tag{8}$$

With the initial and boundary conditions;

$$\begin{aligned} &t \le 0: \quad u = 0, \quad \theta = 0, \quad C = 0, && \text{for all} \quad y \\ &t > 0: \quad u = e^{at}, \theta = t, C = 1 && \text{for all} \quad y = 0 \end{aligned} \tag{9}$$

Skin friction and Nusselt number

From the velocity field, the effects of different parameters on the Skin friction and Nusselt number have been studied. Skin friction is defined as, $\tau = \frac{1}{2\sqrt{2}} Gr^{-\frac{3}{4}} \left(\frac{\partial u}{\partial y}\right)_{y=0}$ and Nusselt number is defined as,

$$Nu = \frac{1}{\sqrt{2}} Gr^{-\frac{3}{4}} \left(\frac{\partial T}{\partial y}\right)_{y=0}.$$

III. NUMERICAL SOLUTION

Many physical phenomena in applied science and engineering when formulated into mathematical models fall into a category of systems known as non-linear coupled partial differential equations. Most of these problems can be formulated as second order partial differential equations. A system of non-linear coupled partial differential equations with the boundary conditions is very difficult to solve analytically. For obtaining the solution of such problems we adopt advanced numerical methods. The governing equations of our problem contain a system of partial differential equations which are transformed by usual transformations into a non-dimensional system of non-linear coupled partial differential equations with initial and boundary conditions. Hence the solution of the problem would be based on advanced numerical methods. The finite difference Method will be used for solving our obtained non-similar coupled partial differential equations.

From the concept of the above discussion, for simplicity the explicit finite difference method has been used to solve from equations (6) to (8) subject to the conditions given by (9).To obtain the difference equations the region of the flow is divided into a grid or mesh of lines parallel to *X* and *Y* axis is taken along the plate and *Y*-axis is normal to the plate.

Here the plate of height $X_{\max}(=20)$ i.e. X varies from 0 to 20 and regard $Y_{\max}(=50)$ as corresponding to $Y \to \infty$ i.e. *Y* varies from 0 to 50. There are *m*=100 and *n*=200 grid spacing in the *X* and *Y* directions respectively.

It is assumed that ΔX and ΔY are constant mesh sizes along *X* and *Y* directions respectively and taken as follows,

$$\Delta X = 0.20\left(0 \le x \le 20\right)$$

$$\Delta Y = 0.25\left(0 \le x \le 50\right)$$

with the smaller time-step, Δt=0.005.

Using the explicit finite difference approximation, the following appropriate set of finite differenceequations are obtained as;

$$\frac{U_j' - U_j}{\Delta\tau} = G_r\theta_j + G_m C_j + \frac{U_{j+1} - 2U_j + U_{j-1}}{(\Delta y)^2} - M(U_j - exp(a.j.\Delta t)) - \frac{U_j}{K} \tag{10}$$

$$\frac{\theta_j' - \theta_j}{\Delta\tau} = \frac{1}{P_r}\left(\frac{\theta_{j+1} - 2\theta_j + \theta_{j-1}}{(\Delta y)^2}\right) \tag{11}$$

$$\frac{C_j' - C_j}{\Delta\tau} = \frac{1}{S_c}\left(\frac{C_{j+1} - 2C_j + C_{j-1}}{(\Delta y)^2}\right) \tag{12}$$

Initial and boundary condition takes the following forms,

When $t \le 0$ then $U_j^0 = 0,\ \theta_j^0 = 0,\ C_j^0 = 0,$ for all y

When $t > 0$ then $U_j^0 = \exp(a.j.\Delta t),\ \theta_j^0 = t,\ C_j^0 = 1,$ for all $y = 0.$ (13)

$U_j^n = 0,\ \theta_j^n = 0,\ C_j^n = 0,$ as $y \to \infty$

IV. RESULTS AND DISCUSSION

It is very difficult to study the influence of all governing parameters involved in the present problem " Free convection and mass transform flow through a porous medium with variable temperature".Therefore,this study is noticed on the effects of governing parameters on the transient velocity,temperature as well as on the concentration profiles.To have a physical feel of the problem we exhibit results to how the material parameters of the problem affect the velocity and skin friction.The velocity profiles for various parameters are presented in the figure (1) to (12) for the cases of heating and cooling of the plate.

The effects of Magnetic parameter (M), Permeability parameter (K), Schmidt number (S_c), Thermal grashof number (G_r), Mass grashof number (G_m) and accelerated parameter (a) on the velocity profiles and skin frictions are discussed below:

Figure (1) and (2) discuss about the effects of M (Magnetic parameter) in case of cooling and heating of the plate at t=0.2 and t=0.4. It is found that the velocity decreases with increasing magnetic parameter (M) for the case of cooling of the plate. It is because that the presence of transverse magnetic field produces a resistive force similar to drag force which results to resist the fluid flow and that is the reason for reducing its velocity.The alternative effects is noticed in the case of heating of the plate.Figure (3) and (4) reveal the velocity variations with K (Permeability parameter) in case of cooling and heating of the plate at t=0.2 and t=0.4 respectively. It is found that the velocity increases with increasing permeability parameter (K) for the case of cooling of the plate.Because of the fact that the presence of porous medium increases the resistive flow. The reverse effects is noticed in the case of heating of the plate.

Figure (5) and (6) express the velocity variations with S_c (Schmidt number) in case of cooling and heating of the plate at t=0.2 and t=0.4 respectively. It is noticed that the velocity decreases with increasing Schmidt number (S_c) for the case of cooling of the plate.But the reverse effects is found in the case of heating of the plate.It is also found that for the case of heating of the plate the velocity profiles increases near the surface of the plate and become maximum and decreases far away from the surface.But the reverse effects is noticed in the case of cooling of the plate.

Figure (7) and (8) discussed the effects of G_r (Thermal grashof number) and G_m (Mass grashof number) in case of cooling and heating of the plate at t=0.2 and t=0.4.It is found that for the increasing of G_r (Thermal grashof number) and G_m (Mass grashof number) obtained the increases of velocity for the both cooling and heating of the plate.Figure (9) and (10) reveal the velocity variations with a (accelerated parameter) in case of cooling and heating of the plate at t=0.2 and t=0.4. It is observed that the velocity increases with increasing accelerated parameter (a) for the case of cooling and heating of the plate.

The skin friction is displayed in the figure (11) and (12). From the figure (11) it is clear that for the increasing of M (Magnetic parameter) skin friction decreases but for the incresing of K (Permeability parameter) skin friction increases. From the figure (12) it is observed that the increasing of a (accelerated parameter) resulting the decreases of skin friction.

In our present paper we have solved our problem by using explicit finite difference method as the solution tool whereas Rajesh V,[8] used Laplace transform method as the solution tool. We see that there is almost same agreement between our numerically calculated results and the pervious results of Rajesh, V [8].

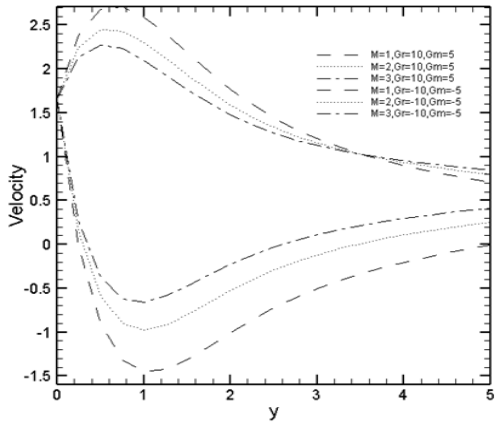

Figure 1: Velocity profiles for different values of M against y when, K=0.5, a=0.5, S_c=0.60, P_r=7.0 and t=0.2.

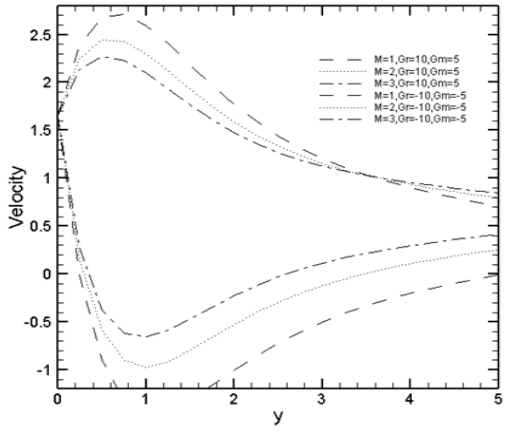

Figure 2: Velocity profiles for different values of M against y when, K=0.5, a=0.5, S_c=0.60, P_r=7.0 and t=0.4.

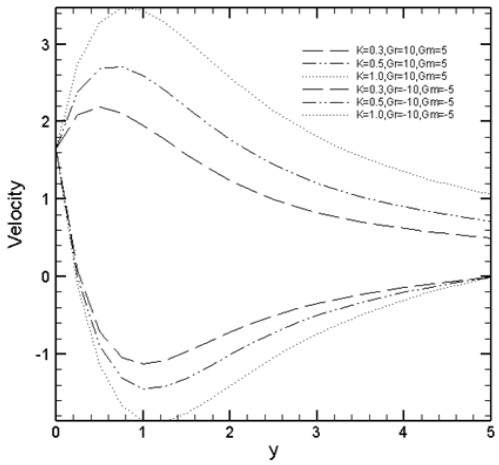

Figure 3: Velocity profiles for different values of K against y when, M=1.0, a=0.5, S_c=0.60, P_r=7.0 and t=0.2.

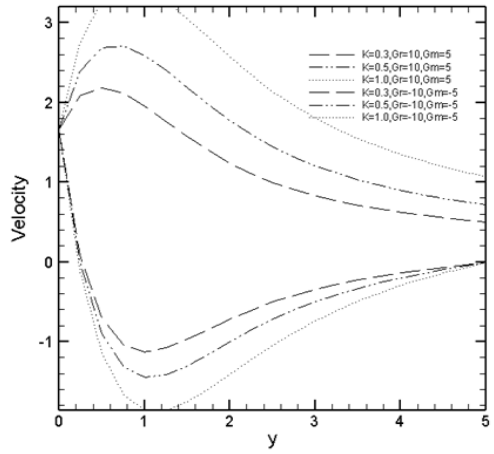

Figure 4: Velocity profiles for different values of K against y when, M=1.0, a=0.5, S_c=0.60, P_r=7.0 and t=0.4.

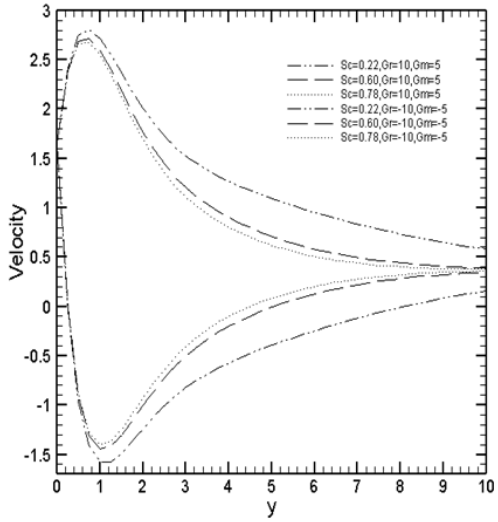

Figure 5: Velocity profiles for different values of S_c against y when, M=1.0, K=0.5, a=0.5, P_r=7.0 and t=0.2.

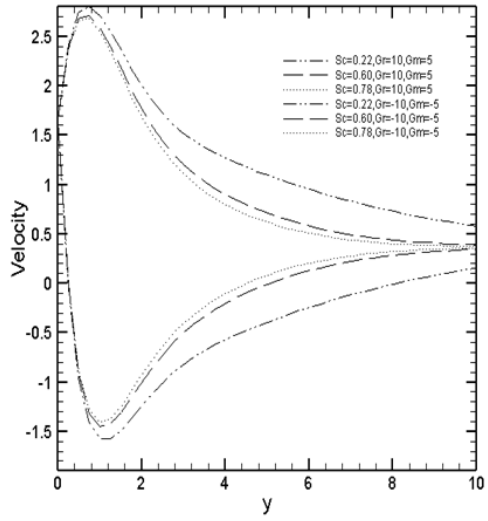

Figure 6: Velocity profiles for different values of S_c against y when, M=1.0, K=0.5, a=0.5, P_r=7.0 and t=0.4.

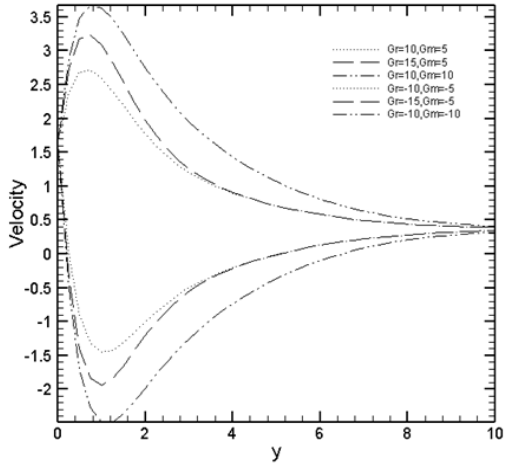

Figure 7: Velocity profiles for different values of G_r when, M=1.0, K=0.5, a=0.5, S_c=0.60, P_r=7.0 and t=0.2.

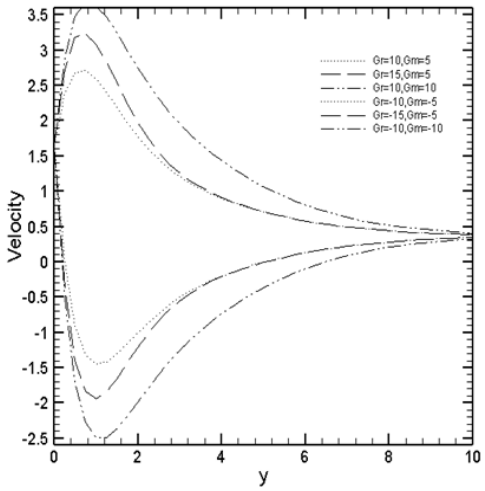

Figure 8: Velocity profiles for different values of G_r against y when, M=1.0, K=0.5, a=0.5, S_c=0.60, P_r=7.0 and t=0.4.

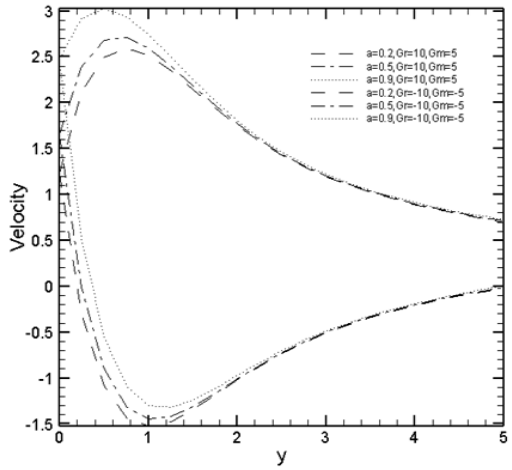

Figure 9: Velocity profiles for different values of a against y when, M=1.0, K=0.5, S_c=0.60, P_r=7.0 and t=0.2.

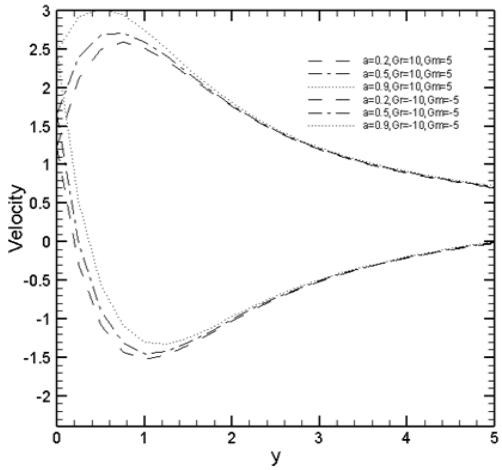

Figure 10: Velocity profiles for different values of a against y when, M=1.0, K=0.5, S_c=0.60, P_r=7.0 and t=0.4.

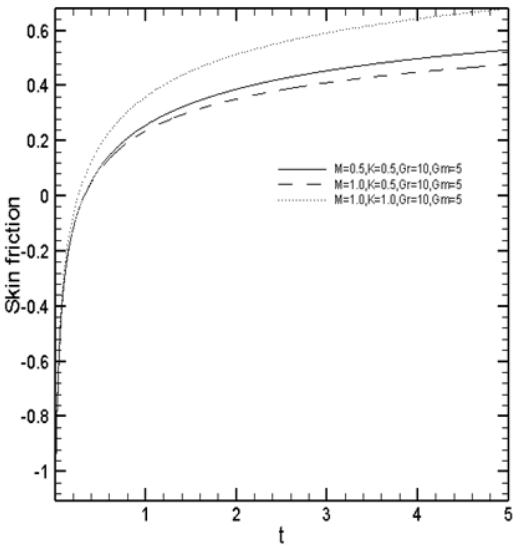

Figure 11: Skin friction for different values of M and K against t when, a=0.5, S_c=0.60 and P_r=7.0.

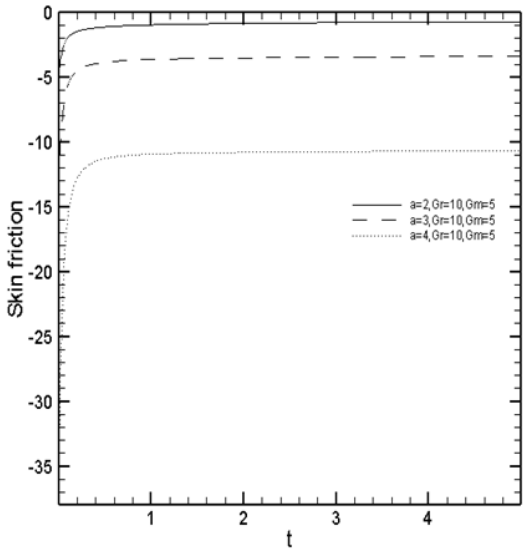

Figure 12: Skin friction for different values of a against t when, M=1, K=0.5, S_c=0.60 and P_r=7.0.

V. CONCLUSION

In this paper we have been studied the free convection and mass transform flow through a porous medium with variable temperature. Here we discussed the various effects of the physical parameter on the velocity. We are restricted in case of temperature and concentration. Because there is no effects of temperature and concentration on the fluid. Here we also discussed the effects of skin friction for different parameters.

- The velocity decreases with increasing Magnetic parameter (M) and Scmidth number (Sc) whereas the velocity profiles increases with increasing thePermeability parameter (K),Thermal grashof number (G_r), Mass grashof number (G_m) and accelerated parameter (a) in case of cooling of the plate.The reverse effect occurs in case of heating plate.
- The skin friction decreases with increasing of Magnetic parameter (M) and accelerated parameter (a)whereasskin friction increases with the increasing value of Permeability parameter (K).

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"JANGLISH" IS CHEMMOZHI?...("RAMANUJAM LANGUAGE")

M.Arulmani, B.E.
(Engineer)

V.R.Hema Latha, M.A., M.Sc., M.Phil.
(Biologist)

Presently there are thousands of languages exist across the world. **"ENGLISH"** is considered as dominant language of International business and global communication through influence of global media. If so who is the **"linguistics Ancestor"** of **"ENGLISH?"**...

> *TAMIL + ENGLISH = TANGLISH?...*
> *NO... NO... NO...*
> *ANGLISH + TANGLISH = ENGLISH?...*
> *YES... YES... YES...*
>
> *- Author*

This scientific research focus that "**ANGLISH**" (universal language) shall be considered as the **Divine and universal language** originated from **single origin. ANGLISH** shall also be considered as Ethical language of **"Devas populations"** (Angel race) who lived in **MARS PLANET** (also called by author as EZHEM) in the early universe say 5,00,000 years ago. Janglish shall be considered as the **SOUL** (**mother nature**) of **ANGLISH**.

JANGLISH
(Language Logo)

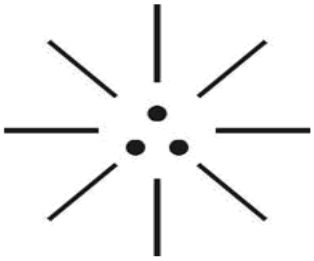
During the **expanding universe** the Devas populations considered transformed to **"EARTH PLANET"** during dark age of universe (plasma age) and the new populations when lived on the Earth planet shall be considered as spoken **'TANGLISH"** say around 3,00,000 years ago. The suffix "**ISH**" considered derived from Proto Indo Europe root word **"EZHEM".**

JANGLISH means (JAYAM + EZHEM)
ANGLISH means (ANJALI + EZHEM)
TANGLISH means (TAMIL + EZHEM)
ANGLISH means language of 'ANGEL'

- Author

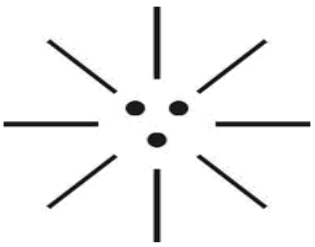
The philosophy of **ANGLISH, TANGLISH** in language evolution shall be hypothetically narrated as below:

(i)



ANGLISH
(Universal Grammer)

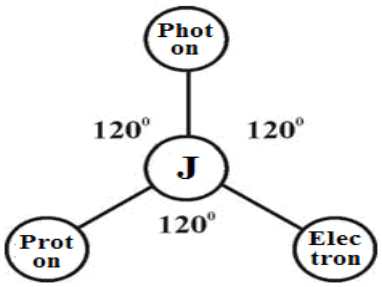
(ii)



TANGLISH
(Law of Language)

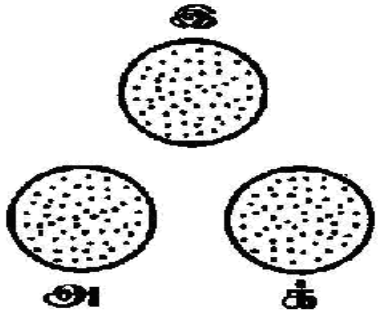
i) Right dot is like VOWEL (**MOON**)
ii) Left dot is like CONSONANT (**EARTH**)
iii) Centre dot is like RHYTHM (**SUN**)

It is focused that the three dot ellipse (…) in English usage shall be considered derived from three-in one **Angelic Alphabet (**Anglish)**.** Further the **'EN-Series"** of English like **CHINGLISH, DENGLISH, FINGLISH, FRANGLAIS, GLOBISH, HINGLISH, HUNGLISH, KONGLISH, SPANGLISH, TENGLISH, TINGLISH** pronounced by various global **"TONGUES"** shall be considered derived from the philosophy of "**ANGLISH**" (Angel language)



JANGLISH
(Mother of Tongues)

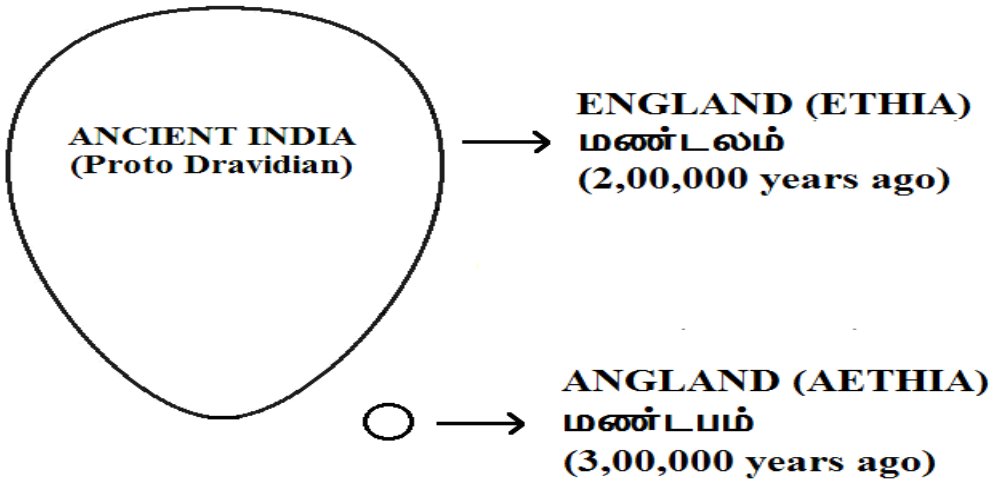
i) Right dot is like "TONGUE" (**Proton**)
ii) Left dot is like "LIPS" (**Electron**)
iii) Centre dot is like 'HEART" (**Photon**)



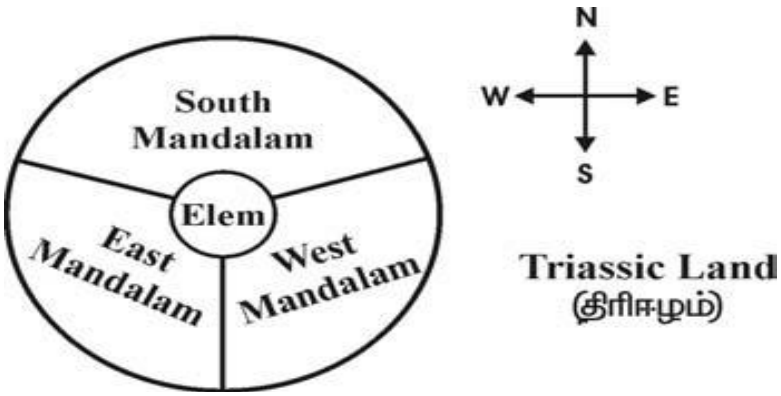
3G ENGLISH
(Language Evolution)

It is further focused that **ENGLAND** shall mean **ancient single large continent** called by author as ETHIA who have spoken single language **TANGLISH** (3,00,000 years ago). In Triassic period the single large continent undergone three major land divisions which might have lead to three regions of world nations. The Philosophy of **ETHIA, AETHIA, TRIASSIC** shall be described as below. The major three land division shall be called as **ANTHRAITE** (South), **KARNADAITE** (East), **KERALAITE** (West).

(i)



(ii)



i) **ANTHRAITE** is like "**LION**" (**Vainavaism**)
ii) **KARNADAITE** is like "**TIGER**" (**Sankaraism**)
iii) **KERALAITE** is like "**ELEPHANT**" (**Acharyaism**)

It is further focused that the ancient four Vedas shall be considered written in different language in different phase of time as described below. The Philosophy of Sivaism, Ariyaism shall be considered evolved at later period from ancient Philosophy of Vainavaism.

(i) Creation Mantra (Ramanujam) – **JANGLISH** (5,00,000 years ago)
(ii) RIG Veda (Brahmaism) – **ANGLISH** (4,00,000 years ago)
(iii) Yajur Veda (Ramaism) – **TANGLISH** (3,00,000 years ago)
(iv) Sama Veda (Krishnaism) – **ENGLISH** (2,00,000 years ago)
(v) Epics (Sivaism) – **SANSKRIT** (1,00,000 years ago)

Case Study

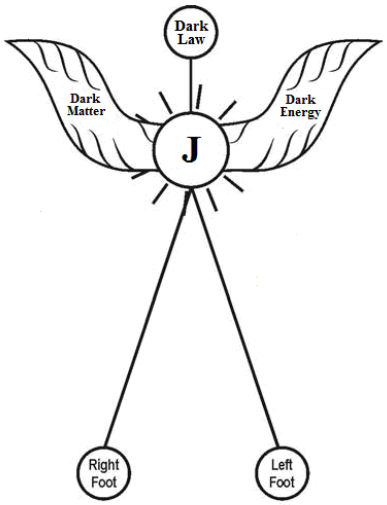
In language evolution case study shows that various Four Ancient Vedas Rigveda, Samaveda, Yajurveda, Atharvaveda considered as collection of Hymns in support of Ancient languages collected during 1500 & 1000 BCE. It includes elements like mythology, epics, palm script poem, stone culvet etc. The earliest imprints of human activities in India go back to the "Paleolithic age" roughly between 4,00,000 and 2,00,000 BCE. Stone implements and cave paintings from this period have been discovered in many parts of "South Asia".

Further Biblical study shows that ArchAngel and other Angels made communication to Adam, Mother Mary in High level language say Telepathy, Spirit Radiant language. 'Tower of Babel' stipulates that creation of numerous languages from the single origin of "Admic language". Bible study also focus that multiple languages created by act of God from tribes origin.

It is hypothesized that the creator of universe 'MEGA STAR' (called by author as RAMANUJAM) who consider created everything through three-in-one Mantra 'JANGLISH" (Jayam). Further the philosophy of Hindu Trinity gods BRAHMA, VISHNU, SHIVA might have spoken

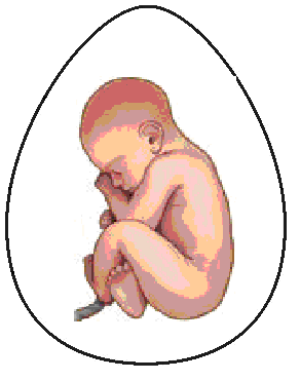
various mantra languages in different Vedic periods as described below.

(i)



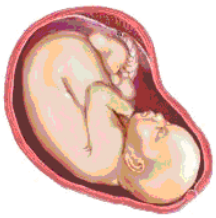
RAMANUJAM
(Supreme God)
(JANGLISH)

(ii)



BRAHMA
(ANGLISH)

(iii)



RAMA
(TANGLISH)

(iv)

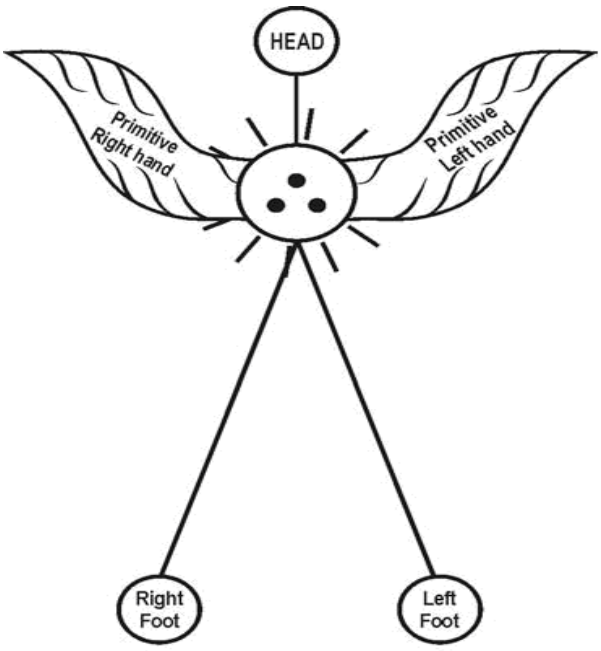
KRISHNA
(ENGLISH)

i. 'E' is like JANGLISH
ii. 'EZHEM' is like ANGLISH
iii. 'ELANKAM' is like TANGLISH
iv. 'ENGLAND' is like ENGLISH
(Language Evolution)

- Author

It is focused that **ST. RAMA, ST. SITA** considered descended from **MARS PLANET to EARTH PLANET** probably during "**APRIL 14**" and spoken "**TANGLISH**" when dwelled in the island of Ancient **ANGLAND** (Kachcha theevu).

(i)

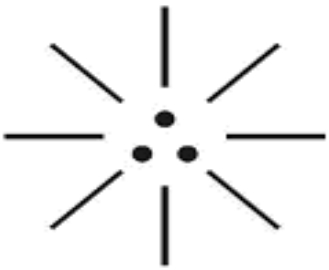


ST. RAMA
(Tanglish)

(ii)

ST. SITA
(Tanglish)

புதுக்கவிதை?...



AMMUTHAM
(Anglish)

மொழிக்கு மூலம் தாயா?... தந்தையா?...
"ஜெயமே ஜெயம்" இது மொழியல்ல...
படைப்பின் மந்திரம் (Creative Poem)!...
தந்தை இராமனுஜம் மந்திரம் "ஜெயம்" (Janglish)

தேவ தேவதைகள் பேசிய மொழி அமுதமோ! (Anglish)
தேவமொழி என்பது முன்தொழுந்து வள்ளுவம் (Ethics)!...
வள்ளுவர் இராமனுஜம் அவதாரமோ (Lord Brahma)?...
வள்ளுவருக்கு ஆதிப்பெயர் "திருவல்லுவர்"!...

இராமாயணமொழி பரட்சிமொழியோ!...
இராம் சீதா பேசிய மொழி தங்கிலீஷ் (Tanglish)!...
'தங்கிலீஷ்" பூமியின் முதல்தாய் மொழி (Mother tongue)!!...
தங்கிலீஷ் என்றால் இழுத்து இழுத்து பேசுவது!!!...

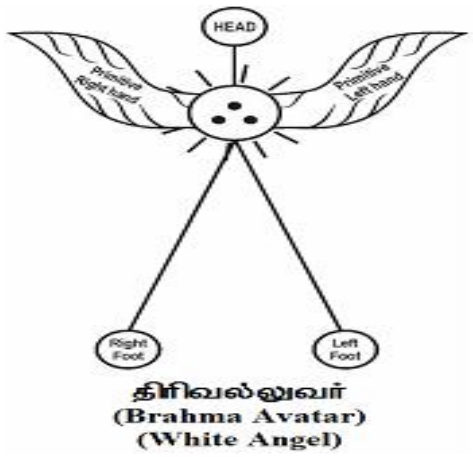
"முத்தமிழ்" என்றால் இராமனுஜம் மந்திரம் (Janglish)
"கன்னித்தமிழ்" என்றால் அமுதமொழி (Anglish)
"கொடுந்தமிழ்" என்றால் சீதாமொழி (Tanglish)
"செந்தமிழ்" என்றால் உலகமொழி (English)

"முத்தமிழ்" ஒரு "கீதம்" (Rig Veda)
"கன்னித்தமிழ்" ஒரு "அமுதம்" (Yajur Veda)
"கொடுந்தமிழ்" ஒரு "இசைகீதம்" (Sama Veda)
"செந்தமிழ்" ஒரு "சக்தம்" (Atharva Veda)

செவ்வாய் தோஷம் என்றால்?
செவ்வாய் கிரக முதாதையர் வள்ளுவம்
தேவ தேவதை ஆசி
பிரம்மாவின் தெய்வீக ஆசி (Ordinance)

இராமனுஜம் ஒரு சமத்துவ நேசரோ!...
ஆண் பெண் இருவரும் அவருக்கு சமம்...
வலது கரம் "ஆதாமுனுஜ்" (Adam)
இடது கரம் "ஆதாமுனாஜ்" (Eve)

பிரம்மாவுக்கு பூமியில் கோயில் இல்லையா?...
யார் சொன்னது?...
தெருவுக்கு தெரு அவருக்கு கோயில்!
ஆம்!... பிரம்மா எனும் ஆதியன் "திருவள்ளுவர்"...

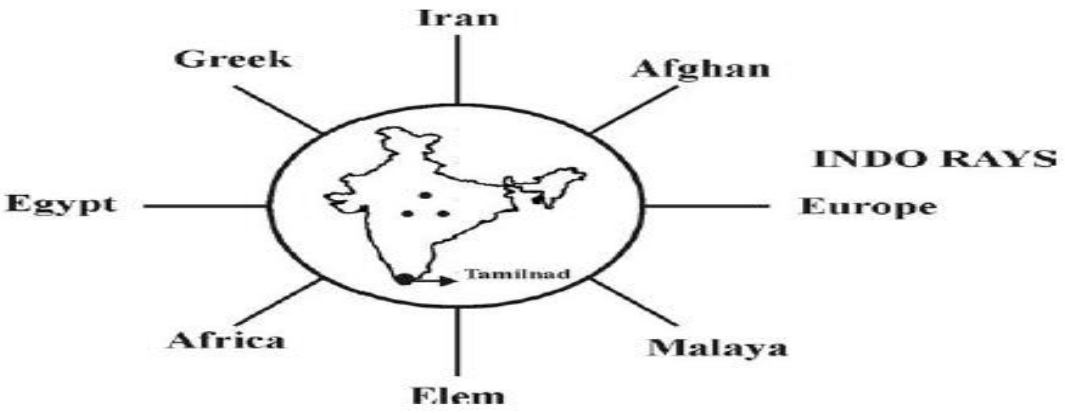


- M. Arulmani,
Tamil Based Indian

Conclusion

It is concluded that **TANGLISH** shall be considered as the source of **HINGLISH and ENGLISH** which might have been evolved from three fundamental ethnic groups of ancient single continent **ENGLAND** (also called by anthropologist as **INDO**). During the course of time **SANSKRIT,** GREEK, LATIN might be evolved from HINGLISH, ENGLISH around 1,00,000 years ago. It is further focused that **ANGLAND** shall be considered as the virgin island formed on the Earth planet even before origin of single large continental mass **ENGLAND.** The Philosophy of ancient tribes angles, Saxons, Jutes might have been evolved from three fundamental ethnic groups of single continent during **TRIASSIC PERIOD.**

சமர்ப்பணம்



“ இந்தியநாடு என் தாய்;
தமிழ்நாடு என்தாயின் பாதஅடி.
என் தாயின் பாத அடியில் இப்புத்தக அஞ்சலி ”

Previous Publications:

[1]. YUGADI WISHES (IARA, March 2015)
[2]. TAMIL PUTHANDU!... (AJER, April 2015)
[3]. THEN MADURAI?... (IJERD, April 2015)
[4]. TAMIL NEW YEAR COOL DRINK?... (AJER, April 2015)
[5]. SCIENTIFIC RAMANUJAM?... (IJERD, April 2015)
[6]. ARENKA NAYAKI IS MOTHER OF RAMA?... (AJER, April 2015)
[7]. TRIVIDAITE?... (IJERD, April 2015)
[8]. THALI CULTURE OF ANGELS?... (AJER, April 2015)
[9]. UNIVERSAL POET?... (IJERD, April 2015)

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CAN LORD JUDGE GOD?...("BARRISTER RAMANUJAM")

M.Arulmani, B.E.
(Engineer)

V.R.Hema Latha, M.A., M.Sc., M.Phil.
(Biologist)

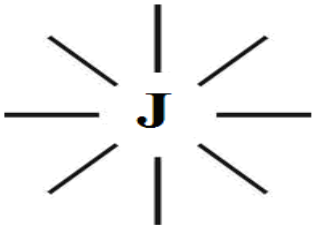
In global level Legal system, political, cultural system the words **SIN, WIN, BAD, GOOD, NEGATIVE, POSITIVE** are commonly used. Similarly the words **LORD, GOD** are also used coLOmmonly in various religions. In court language also the person who delivers judgement is addressed as **OH... MY LORD... HEAR MY PRAYER...** If so…

i) What does mean "GOD"?...
ii) What does mean LORD?...
iii) What does mean GOOD?...
iv) What does mean BAD?...
v) What does mean SIN?...
vi) What does mean WIN?...
vii) Can LORD JUDGE GOD?...

... Author

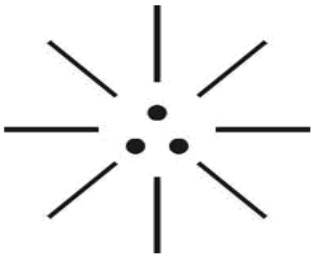
The scientific research focus that the "**Supernatural person**" who created the entire universe and human shall be called as "**GOD**" (**BARRISTER**). The creator of universe shall also be called by name by author as "**RAMANUJAM**" who considered created everything through his mother called by name as '**JANAKI**'. **JANAKI** shall mean '**CREATIVE SOUL**' (or) '**JUSTICE**'. In other words the whole universe was considered created by Ramanujam (Barrister) through "**LAW OF JUSTICE**". The philosophy of Ramanujam, justice, law of justice shall be described as below:

(i)



நீதி
(JUSTICE)
(Law of Life)

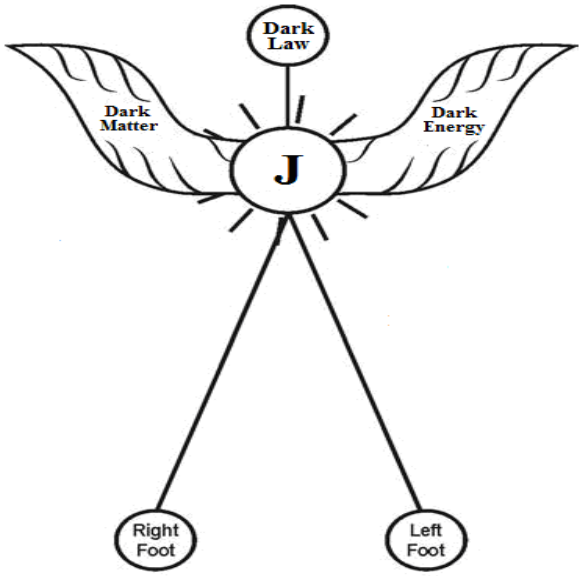
(ii)



தீர்த்தம்
(AMMUTHAM)
(Law of Redemption)

i) Right dot is like **DHARMAM** (Character)
ii) Left dot is like **KARMAM** (Conduct)
iii) Centre dot is like **BRAHMAM** (Integrity)

The Philosophy of Ramanujam who shall be considered as the **SUPREME GOD** and King of Universal Parliament is indicated as below.

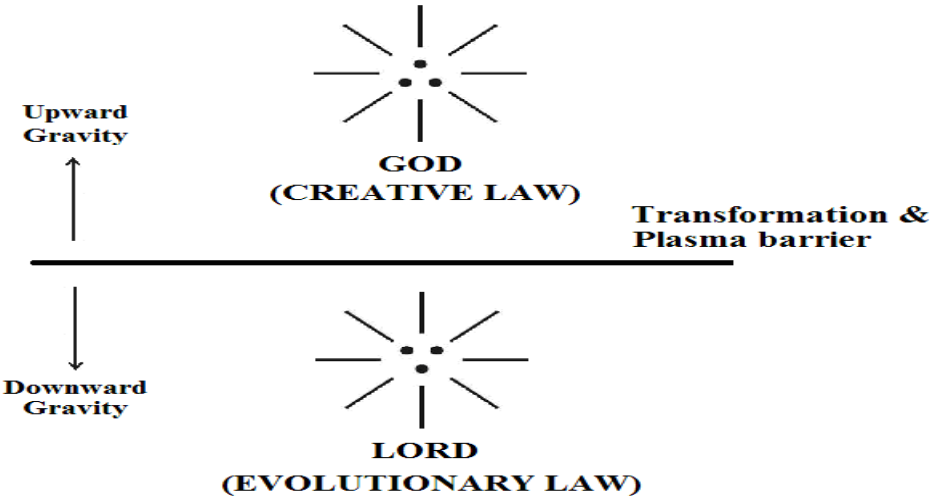


RAMANUJAM
(BARRISTER)
(King of Universal Parliament)

a) LORD Differs from GOD?...

It is hypothesized that **LORD, GOD** shall mean legally distinguished word have opposite in meaning.

i) LORD shall mean DOWNWARD GRAVITY
ii) GOD shall mean UPWARD GRAVITY
iii) SIN shall mean DOWNWARD GRAVITY
iv) WIN shall mean UPWARD GRAVITY
v) BAD shall mean DOWNWARD GRAVITY
vi) GOOD shall mean UPWARD GRAVITY
vii) NEGATIVE shall mean DOWNWARD GRAVITY
viii) POSITIVE shall mean UPWARD GRAVITY



b) Can LORD JUDGE GOD?...

Tt is hypothesized that in the early universe **HUMAN ANCESTORS** considered lived in **MARS PLANET** (5,00,000 Years ago). The human ancestors considered as **NATURAL POPULATIONS** created by **SOULS**. The natural population shall also be called by author as **BRAHMAS (or) DEVAS** who are genetically varied population belong to **ANGEL RACE** compared to modern Human who live in **EARTH PLANET**.

It is further focused that **BRAHMAS, DEVAS** shall be considered as **VIRGIN POPULATIONS** who do not require purification process (Religious rituals) with "**THEERTHEM**" (**HOLY WATER**).

> *Devas population shall be considered as drink THEERTHEM (Holy Drink) rather than WATER. THEERTHEM shall mean THREE AMMUTHAM which shall be considered as the fundamental law of three-in-one process of ritual purification medicine for sins. ARENKANATHAN, ARENKANAYAKI shall be considered as DEVAS (Godly populations) belongs to ANGEL RACE.*
>
> *...Author*

The philosophy of 'DEVAS (Gods) shall be described as below.

(i)

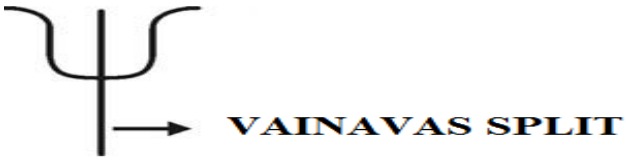
ARENKANAYAKI
(DEVAS)

(ii)

c) Why Theerthem required?...

It is hypothesized that during the expanding universe the **DEVAS** considered transformed to **EARTH PLANET** due to growth of **DOWNWARD GRAVITY** called by name by author as **VAINAVAS**. **VAINAVAS** shall first human ancestors lived on Earth Planet (say 3,00,000 years ago). The first human ancestors shall be called as **LORD RENKANATHAN, LORD RENKANAYAKI**. Further the ancient ancestors considered lived in **AETHIA** (Also called as **KACHCHA THEEVU**). **AETHIANS** shall mean single large **CASTELESS SOCIETY**.

During the course of time the '**VAINAVAS**' shall be considered divided into **THREE ETHNIC GROUPS** (**THREE GHOSTY**). The three ghosty probably originates at **THIRUKOSHTYUR** (Presently at Sivaganga district in Tamil Nadu)



i) ACHARYAN GHOSTY (LIKE ADI SANKARA)
ii) NATHAN GHOSTY (LIKE ACHARYAS)
iii) DASAN GHOSTY (LIKE SANKARAS)

The ancient **ethinic split** among vainavas might have earned **CURSE** and acquired **SIN** which necessitated purification process with **THEERTHEM**. The Philosophy of evolution from Devas, Vainavas, Krishnas shall be described below.

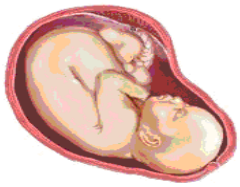
(i)

JANAKI
(Justice)
(Soul)

(ii)

BRAHMA
(Barrister)
(God)

(iii)



RAMA
(Colonel)
(Vainavas)

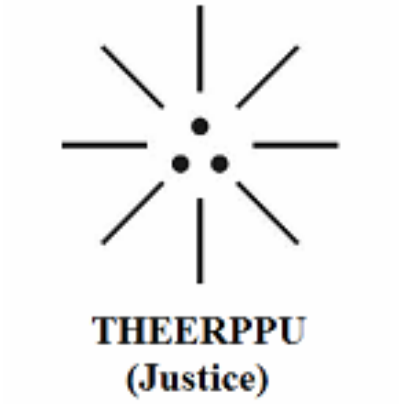
(iv)

KRISHNA
(Acharyas)
(Lord)

LORD shall be considered as God of Earthly population. They shall be considered as having no competence to 'JUDGE' the DEVAS (Gods) for purity of their "SOULS". If the 'LORD' judge 'GOD' means the fundamental philosophy of BRAHMAS shall be defeated. No lord on the earth can judge the CHARACTER, CONDUCT, INTEGRITY of mother supreme JANAKI.

...M. Arulmani,
Tamil based Indian

புதுக்கவிதை



அரெங்கதாதன், அரெங்கதாயகி...
இராமாஜனும் படைப்பு ! (DEVAS)...
ஜானகியோ இராமாஜனும் தாய் !!
நீதிதேவதை !!! (Supreme Justice)

அரெங்கதாயகி அரெங்கதாதன்
நீதியின் விதி... (Law of Justice)
நீதிவழங்கும் முதல் தாய் தந்தை...
யார் உங்களுக்கு தீர்ப்பு கூறமுடியும்?...

புவிஈர்ப்பு விசையால் (Earth gravity)
பூமிக்கு வந்தார்கள்...
ரெங்கதாதன், ரெங்கதாயகி
எனும் பெயரில்...

ரெங்கதாதன் குடும்பம் (God son) என்றால்...
கூட்டுக்குடும்பம்... (Single joint family)
ஜாதியில்லா குடும்பம் (Casteless family)
அயோத்தியா நாட்டுக்கு சொந்தமானவர்கள் (Aethia)

காலத்தின் கட்டாயத்தால் (Gravity force)
ரெங்கதாதன் குடும்பம் மூன்றாக திரிந்தது (Ethnic)
"ஆச்சாரியன்", "நாதன்", "தாசன்" (Trinity)
எனும் குடும்பமாக...

திரிந்து போன குடும்பத்துக்கு (Ethnic family)
திரித்தம் தேவைப்பட்டது (Holy water)
பாவம் போக்கும் "பரிகாரம் மருந்து" (Repentance tonic)
இது யார் செய்த பாவம்?... (Sin mark)

Can Lord Judge GOD?...
Can Lord Judge DEVAS?...
Can Lord Judge ANGELS?...
Can Lord Judge JANAKI?...

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A Numerical Study of Natural Convection in a Square Enclosure with Non-Uniformly Heated Bottom Wall and Square Shape Heated Block

M. Jahirul Haque Munshi[1,*], A. H. Bhuiyan[2], M. A. Alim[2]
[1]*Department of Mathematics, Faculty of Science, Engineering & Technology, Hamdard University Bangladesh, New Town, Sonargaon, Narayanganj-1440.*
[2]*Department of Mathematics, Bangladesh University of Engineering and Technology (BUET), Dhaka- 1000, Bangladesh*

Abstract : *The present work is aimed to study has been carried out of natural convection in a square enclosure with non-uniformly heated bottom wall and square shape heated block with different Prandtl numbers of 0.71, 1.0 and 1.5 has been investigated numerically. The horizontal bottom wall of the square cavity was non-uniformly heated and inner square shape heated block kept at T_h while the side walls of the cavity were maintained at a cold temperature T_c with $T_h > T_c$ and upper wall is adiabatic. Finite element method was employed to solve the dimensionless governing equations of continuity, momentum and energy of the problem. Using the developed code, a parametric study was performed, and the effects of the Rayleigh number and the different Prandtl number on the fluid flow and heat transfer inside the square enclosure were investigated. The obtained results showed that temperature distribution and flow pattern inside the square enclosure depended on both strength of the magnetic field and Rayleigh number. For all cases two counter rotating eddies were formed inside the square enclosure. The magnetic field is decreased with the intensity of natural convection and flow velocity. Also it was found that for higher Rayleigh numbers a relatively stronger field was needed to decrease the heat transfer through natural convection.*

Keywords: *Natural convection, square enclosure, magnetic field, square shape heated block.*

Nomenclatures:

B_0	Strength of the magnetic field	Greek symbols	
g	gravitational acceleration	α	thermal diffusivity
L	length of the cavity	β	Volumetric coefficient of thermal expansion
Nu	Nusselt number	ν	kinematic viscosity of the fluid
P	dimensional pressure	θ	non-dimensional temperature
p	pressure	ρ	density of the fluid
Pr	Prandtl number	ψ	non-dimensional stream function
Ra	Rayleigh number		
T	dimensional temperature		
u, v	velocity components	Subscripts	
U, V	non-dimensional velocity components	c	cold wall
x, y	Cartesian coordinates	h	hot wall
X, Y	non-dimensional Cartesian coordinates		

I. Introduction

Natural convection have industrial applications in which the heat and mass transfer occur concurrently as a result of combined buoyancy effects of thermal and species diffusion. Now a day, natural convection is a subject of central importance in the present technology development and all kinds of engineering applications. Historically, some of the major discoveries in natural convection have helped shape the course of development and important fields for the application of the cooling of power electronics, solar collectors, solar stills, attic spaces, etc.

A number of studies have been conducted to investigate the flow and heat transfer characteristics in closed cavities in the past. Kuhen et al. [1] an experimental and theoretical study of natural convection in the annulus between horizontal concentric cylinders. S. V. Patankar [2] numerical methods for heat transfer and fluid flow, New York, Hemisphere. Acharya [3] studied natural convection in an inclined enclosure containing internal energy sources and cooled from below. Chadwick et al. [4] presented natural convection in a discretely heated enclose for single and multiple heater configurations experimentally and analytically. Aydin et al. [5] investigated natural convection of air in a two-dimensional rectangular enclosure with localized heating from below and symmetrical cooling from the side walls. Fusegi et al. [6] performed a numerical study on natural convection in a square cavity by using a high-resolution finite difference method. The authors considered differentially heated vertical walls and uniform internal heat generation in the cavity. Ganzarolli et al. [7] investigated the natural convection in rectangular enclosures heated from below and cooled from the sides. Natural convection heat transfer in rectangular cavities heated from the bottom had been investigated by Hasaaoui et al. [8]. Turkoglu et al. [9] made a numerical study using control volume approach for the effect of heater and cooler locations on natural convection on cavities. The authors indicated that for a given cooler position, average Nusselt number increases as the heater is moved closer to the bottom horizontal wall. Aydin et al. [10] numerically investigated natural convection of air in a two-dimensional rectangular enclosure with localized heating from below and symmetrical cooling from the side walls. Asan et al.[11] studied the steady-state, laminar, two-dimensional natural convection in an annulus between two isothermal concentric square ducts. Roy chowdhury et al. [12] analyzed natural convective flow and heat transfer features for a heated cylinder kept in a square enclosure with different thermal boundary conditions. Dong et al. [13] studied the conjugate of natural convection and conduction in a complicated enclosure. Their investigations showed the influences of material character, geometrical shape and Rayleigh number (Ra) on the heat transfer in the overall concerned region and concluded that the flow and heat transfer increase with the increase of thermal conductivity in the solid region; the overall flow and heat transfer were greatly affected by both geometric shape and Rayleigh number. Braga et al. [14] numerically studied steady laminar natural convection within a square cavity filled with a fixed amount of conducting solid material consisting of either circular or square obstacles. It was found that the average Nusselt number for cylindrical rods was slightly lower than those for square rods. De et al. [15] performed a simulation of natural convection around a tilted heated square cylinder kept in an enclosure within the range of $10^3 \leq Ra \leq 10^6$. They reported detailed flow and heat transfer features for two different thermal boundary conditions and obtained that the uniform wall temperature heating was quantitatively different form the uniform wall heat flux heating. Varol et al. [16] solved the problem of two-dimensional natural convection in a porous media filled triangular enclosure with a square body. Kahveci et al. [17] studied natural convection in a partitioned vertical enclosure heated with a uniform heat flux. Basak et al. [18] studied and solved the finite element analysis of natural convection flow in a isosceles triangular enclosure due to uniform and non-uniform heating at the side walls. Varol et al. [19] numerically investigated natural convection in right-angle porous trapezoidal enclosure with partially cooled from inclined wall. Kent, EF. [20] presented numerical analysis of laminar natural convection in isosceles triangular enclosures for cold base and hot inclined walls. Yui et al. [21] made a work on unsteady natural convection heat transfer from a heated horizontal circular cylinder to it air-filled coaxial triangular enclosure. Rahman et al. [22] offered a numerical model for the simulation of double-diffusive natural convection in a right-angled triangular solar collector. Mahmoodi et al. [23] studied numerically magneto hydrodynamic free convection heat transfer in a square enclosure heated from side and cooled from the ceiling. Jani et al. [24] numerically investigated magneto hydrodynamic free convection in a square cavity heated from below and cooled from other walls. Bhuiyan et al. [25] offered a numerical method for the simulation magnetohydrodynamic Free Convection in a square cavity with semicircular heated block. Nader et al. [26] investigate natural convection of Water-Based Nanofluids in a Square Enclosure with non-uniform heating of the bottom wall. Pirmohammadi et al. [27] shows that the effect of a magnetic field on buoyancy-driven convection in differentially heated square cavity.

On the basis of the literature review, it appears that no work was reported on the natural convection flow in a square enclosure with non-uniformly heated bottom wall and square shape heated block with internal heat generation. The obtained numerical results are presented graphically in terms of streamlines, isotherms, local Nusselt number and average Nusselt number and Rayleigh numbers.

II. Physical Configuration

The physical model considered in the present study of natural convection in a square enclosure with non-uniformly heated bottom wall and square shape heated block is shown in Fig.1 The height and the width of the cavity are denoted by L. Inside the square cavity at a constant high temperature T_h, while, the two vertical walls are maintained at cold temperature T_c and the upper wall is adiabatic. The bottom wall is non- uniformly heated wall. The magnetic field of strength B_0 is applied parallel to x- axis. The square cavity is filled with an electric conductive fluid with Pr = 0.71, 1.0 and Pr =1.5 that is considered Newtonian and incompressible.

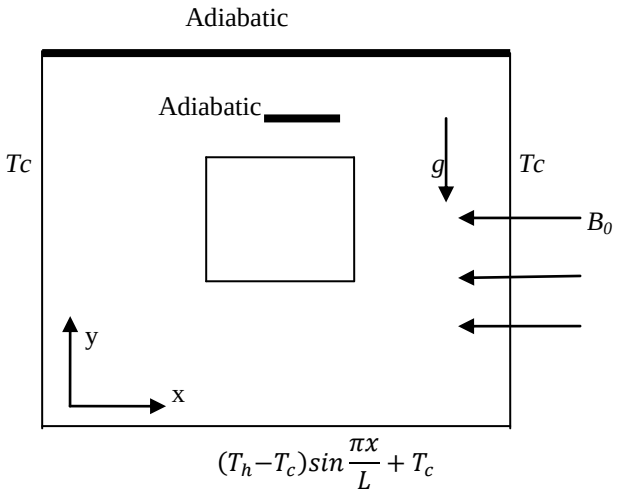


Fig.1 Schematic view of the cavity with boundary conditions considered in the present study

III. Mathematical Formulation

The assumption uncouples the Navier-Stokes equations from Maxwell's equations. No electric field is present and the Hall effect is neglected. The thermo-physical properties of the fluid are assumed to be constant. Except the density variation in the buoyancy term which is treated according to Boussinesq approximations while viscous dissipation effects are considered negligible. In general, the cavity fluid is assumed to be Newtonian and incompressible, steady, laminar, natural convection flow.

With above mentioned assumptions, the governing equations for conservations of mass, momentum and energy can be written as

Mass conservation equation:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} = 0 \tag{1}$$

Momentum conservation equations:

$$\rho\left(\frac{\partial u}{\partial x} + \frac{\partial u}{\partial y}\right) = -\frac{\partial p}{\partial x} + \mu\left(\frac{\partial^2 u}{\partial x^2} + \frac{\partial^2 u}{\partial y^2}\right) \tag{2}$$

$$\rho\left(\frac{\partial v}{\partial x} + \frac{\partial v}{\partial y}\right) = -\frac{\partial p}{\partial y} + \mu\left(\frac{\partial^2 v}{\partial x^2} + \frac{\partial^2 v}{\partial y^2}\right) + \rho g \beta (T - T_c) - \sigma B_0^2 v \tag{3}$$

Energy conservation equations:

$$u\frac{\partial T}{\partial x} + v\frac{\partial T}{\partial y} = \alpha\left(\frac{\partial^2 T}{\partial x^2} + \frac{\partial^2 T}{\partial y^2}\right) \tag{4}$$

where x and y are the distances measured along the horizontal and vertical directions respectively; u and v are the velocity components in the x and y directions respectively; T denotes the fluid temperature, p is the pressure, ρ is the fluid density, g is the gravitational acceleration, β is the volumetric coefficient of thermal expansion, B_0 is the magnitude of magnetic field, α is the thermal diffusivity.

The above equations are non-dimensionalzed by using the following dimensionless quantities

$$X = \frac{x}{L}, Y = \frac{y}{L}, \quad U = \frac{uL}{\alpha}, V = \frac{vL}{\alpha}, P = \frac{pL^2}{\rho\alpha^2}, \theta = \frac{(T - T_c)}{(T_h - T_c)} \tag{5}$$

where $\upsilon = \frac{\mu}{\rho}$ is the reference kinematic viscosity and θ is the non-dimensional temperature. After substitution of dimensionless variable we get the non- dimensional governing equations are:

$$\frac{\partial U}{\partial X} + \frac{\partial V}{\partial Y} = 0 \tag{6}$$

$$U\frac{\partial U}{\partial X} + V\frac{\partial U}{\partial Y} = -\frac{\partial P}{\partial X} + \Pr\left(\frac{\partial^2 U}{\partial X^2} + \frac{\partial^2 U}{\partial Y^2}\right) \tag{7}$$

$$U\frac{\partial V}{\partial X} + V\frac{\partial V}{\partial Y} = -\frac{\partial P}{\partial Y} + \Pr\left(\frac{\partial^2 V}{\partial X^2} + \frac{\partial^2 V}{\partial Y^2}\right) + Ra\ \Pr\theta - Ha^2\ \Pr V \tag{8}$$

$$U\frac{\partial \theta}{\partial X} + V\frac{\partial \theta}{\partial Y} = \left(\frac{\partial^2 \theta}{\partial X^2} + \frac{\partial^2 \theta}{\partial Y^2}\right) \tag{9}$$

where *Ra*, *Pr* and *Ha* are the Rayleigh, Prandtl and Hartman numbers and are defined as:

$$Ra = \frac{\beta(T_h - T_c)L^3}{\alpha\nu}, \Pr = \frac{\nu}{\alpha}, Ha = B_0 L\sqrt{\frac{\sigma}{\rho\nu}} \tag{10}$$

The effect of magnetic field into the momentum equation is introduced through the Lorentz force term, $\vec{J} \times \vec{B}$ that is reduced to a systematically damping factor $-\sigma B_0 v^2$.

To computation of the rate of heat transfer, Nusselt number along the hot wall of the enclosure is used that is as follows:

$$Nu_{local} = -\frac{\partial\theta}{\partial Y}\Big|_{Y=0} \quad Nu_{local} = -\frac{\partial\theta}{\partial X}\Big|_{X=0} \tag{11}$$

The average Nusselt number of the hot bottom wall of the square cavity is obtained as follows:

$$Nu = \int_0^1 Nu_{local} dX \tag{12}$$

The non- dimensional boundary conditions for solving the governing (6- 9) are:

On the bottom wall of the square cavity: U= 0, V= 0, θ = sin(πX)
On the square shape heated block walls: U= 0, V= 0, θ = 1
On the cold walls: U= 0, V= 0, θ = 0

The non-dimensional stream function is defined as $U = \frac{\partial\psi}{\partial Y}, V = -\frac{\partial\psi}{\partial X}$ (13)

IV. Numerical Technique

The nonlinear governing partial differential equations, i.e., mass, momentum and energy equations are transferred into a system of integral equations by using the Galerkin weighted residual finite-element method. The integration involved in each term of these equations is performed with the aid Gauss quadrature method. The nonlinear algebraic equations so obtained are modified by imposition of boundary conditions. These modified nonlinear equations are transferred into linear algebraic equations with the aid of Newton's method. Lastly, Triangular factorization method is applied for solving those linear equations.

4.1. Program Validation and Comparison with Previous Work

In order to check on the accuracy of the numerical technique employed for the solution of the problem considered in the present study, the code is validated with Pirmohammadi et al. [27] shows that the effect of a magnetic field on buoyancy-driven convection in differentially heated square cavity, the two vertical walls are maintained at cold temperature T_c and the upper wall is adiabatic. Streamlines and isotherms are plotted in Fig. 2. Showing good agreement.

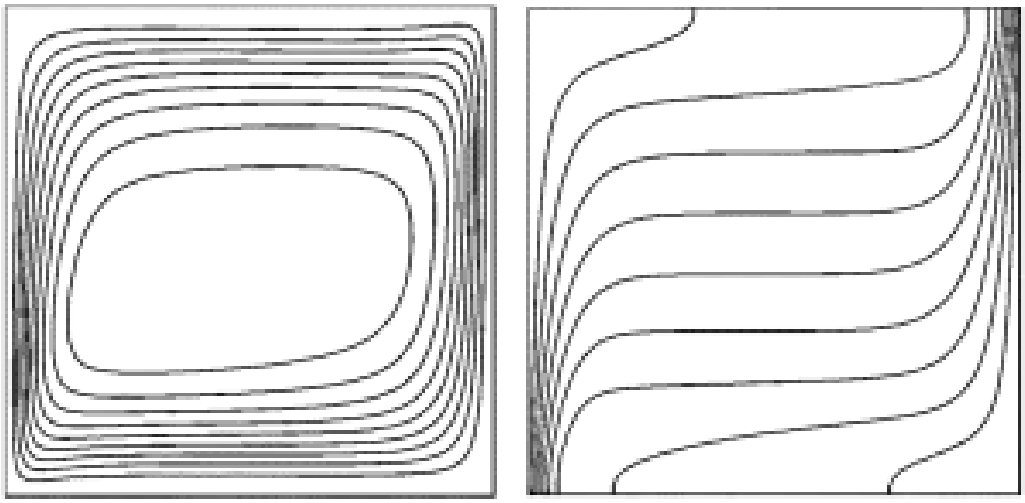


Fig. 2(a). Pirmohammadi et al.[27] Obtained streamlines and Isotherms for Ra = 10^6, Pr = 0.7 33 and Ha=50.

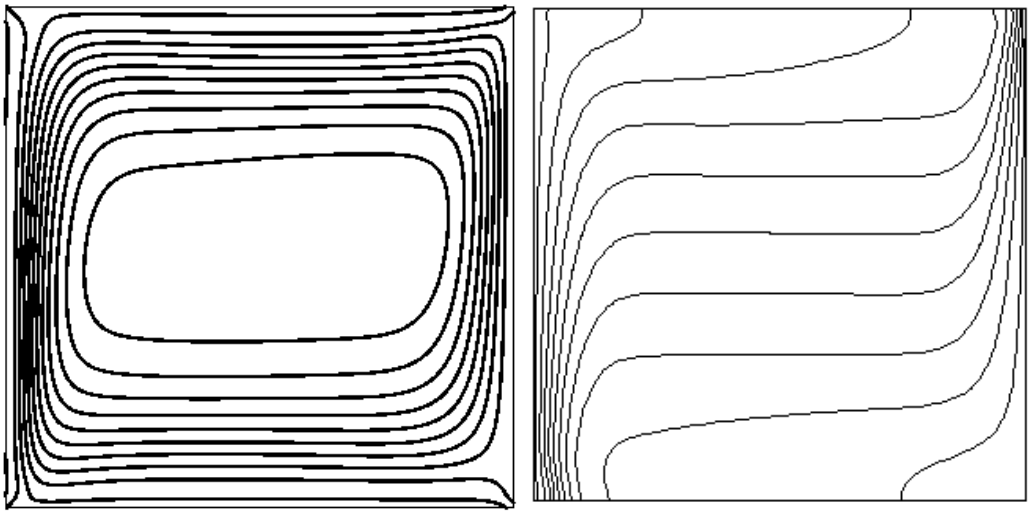


Fig. 2(b). Present: Obtained streamlines and Isotherms for Ra = 10^6, Pr = 0.71 and Ha = 50

V. Result and Discussion

A numerical work was performed by using finite element method to natural convection in a square enclosure with non-uniformly heated bottom wall and square shape heated block. The non- dimensional significant parameter different Prandtl numbers of 0.71, 1.0 and 1.5 has been investigated numerically. The results have been obtained for the Rayleigh number ranging from 10^3 to 10^6, Hartmann number of 50. The results are presented in terms of streamlines, isotherms inside the square cavity, and the vertical velocity component along the bottom wall of the square cavity, the local Nusselt number along bottom wall and left wall of the square cavity and the average Nusselt number along the bottom wall of the square cavity. Variations of streamlines and isotherms inside the square cavity with Rayleigh number are presented in Fig. 3.1, 3.2, 3.3 and 4.1, 4.2, 4.3 respectively. We observed from the figures with existence centerline of the cavity, the flow and temperature fields are symmetrical about this line. As can be seen from the streamlines in the Fig. 3.1, 3.2, 3.3 a pair of counter-rotating eddies are formed in the left and right half of the cavity for all Rayleigh numbers considered. Each cell ascend through the symmetry axis, then faces the upper wall and moves horizontally and finally descends along the corresponding cold side wall.

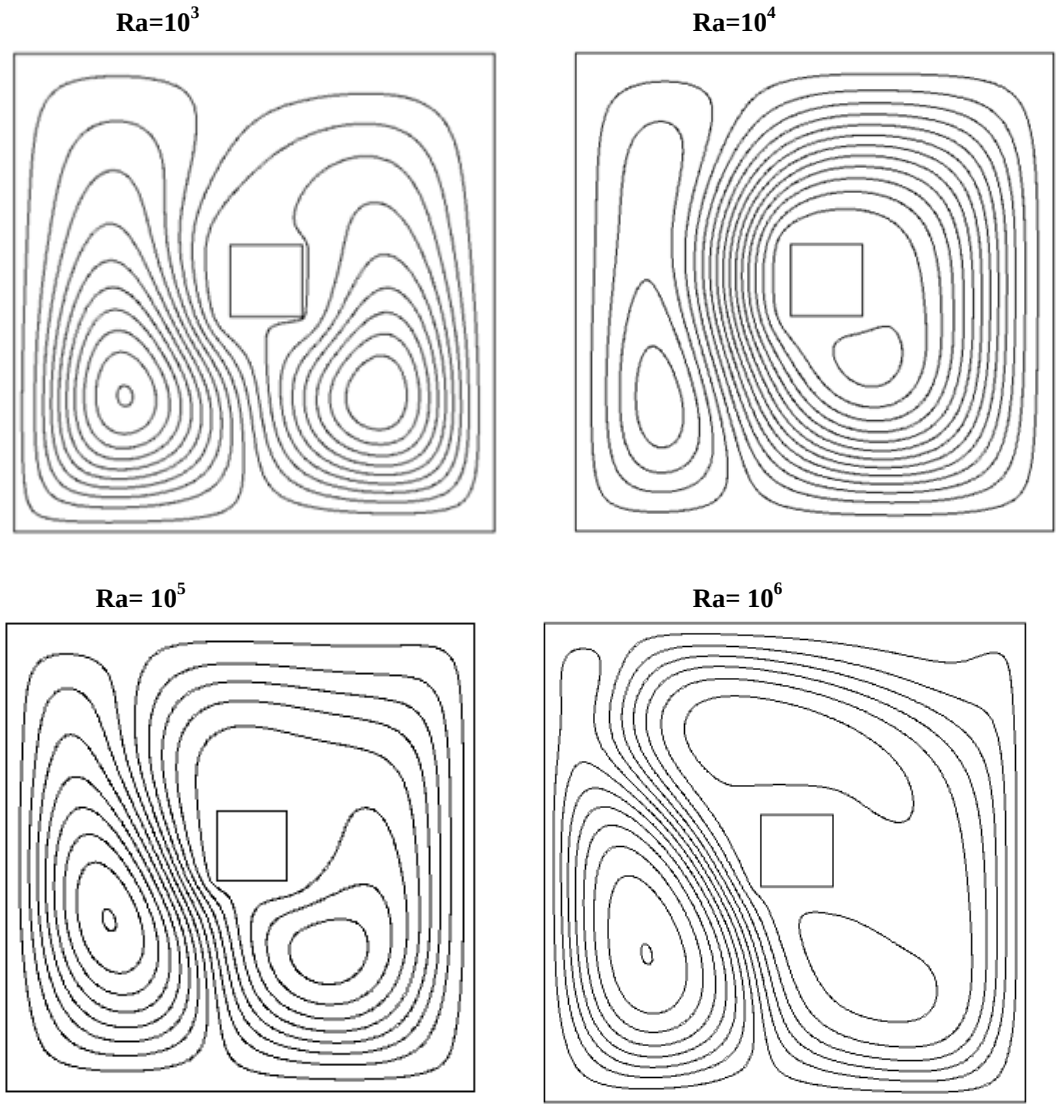
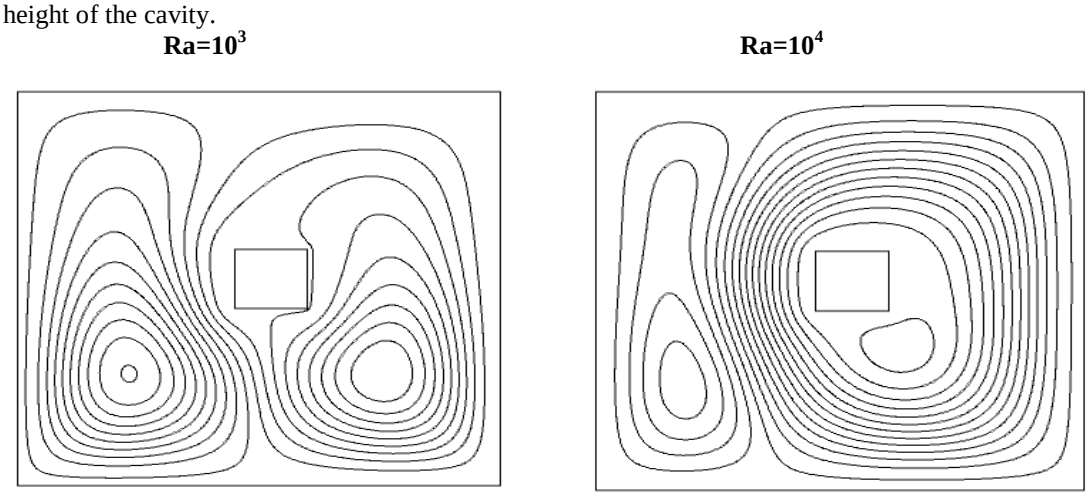


Fig. 3.1 Streamlines at different Rayleigh numbers, Prandtl number of 0.71

At Ra= 10^3 and in the absence of the magnetic field, the maximum absolute value of the stream function increases; there is a circulating flow in the cavity with central streamline into an elliptic shape of eddies are in the lower and upper half of the cavity. For different Prandtl number and Ra increasing, so flow strength increasing. With increase in Rayleigh number and buoyancy force, the elliptic shape of the eddies move upward insofar as at Ra= 10^6, locate in the upper half of the cavity. At Ra= 10^6 the elliptic shape are elongated along the height of the cavity.



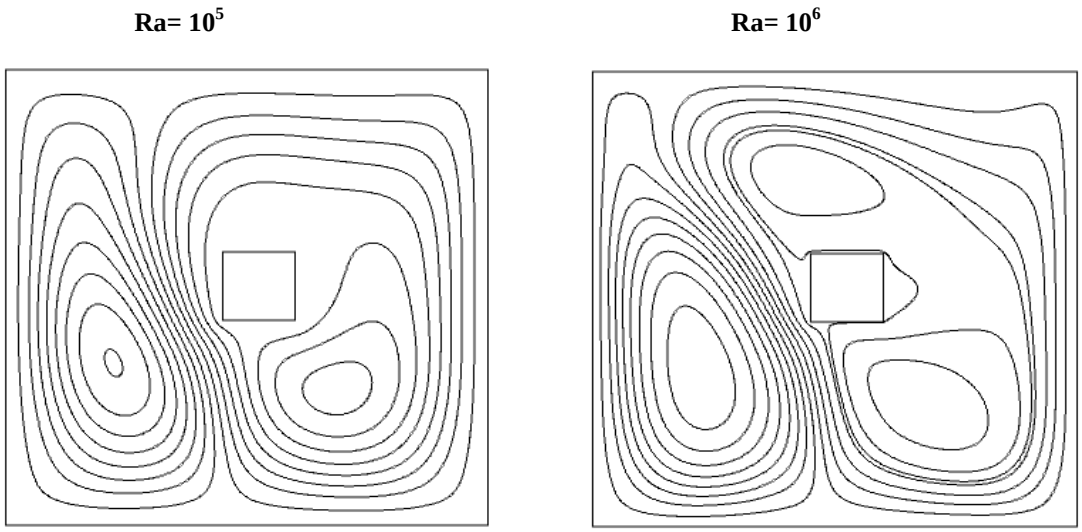


Fig. 3.2 Streamlines at different Rayleigh numbers, Prandtl number of 1.0

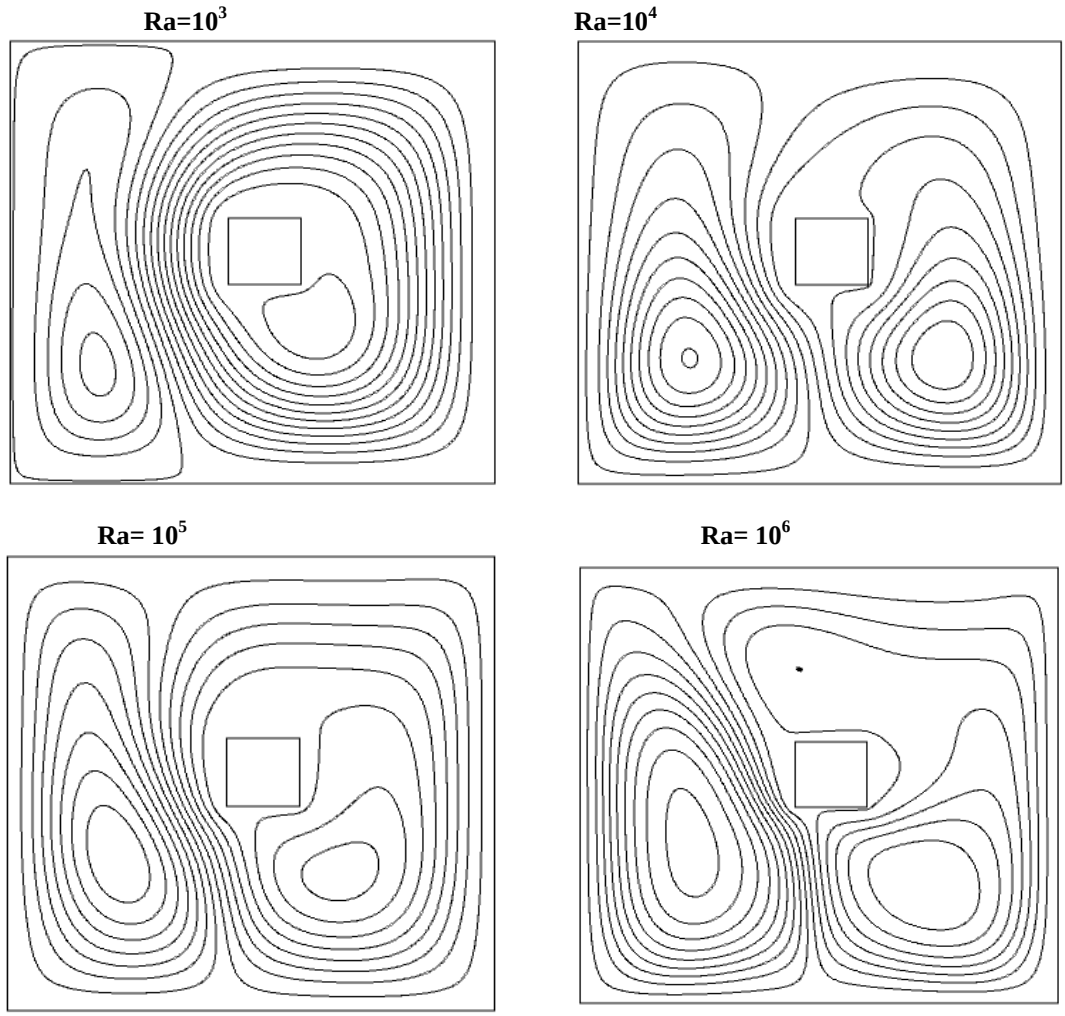


Fig. 3.3 Streamlines at different Rayleigh numbers, Prandtl number of 1.5

Conduction dominant heat transfer is observed form the isotherms in Fig. 4 at Ra= 10^3 to 10^6. With increase in Rayleigh number, the isotherms are condensed next to the side wall which means increasing heat transfer through convection. Formation of thermal boundary layers can be found from the isotherms at Ra= 10^3 and 10^6. The cavity was heated at the left and right wall are cooled while the rest of the boundaries were insulated. Moreover, the inner body is kept isothermal.

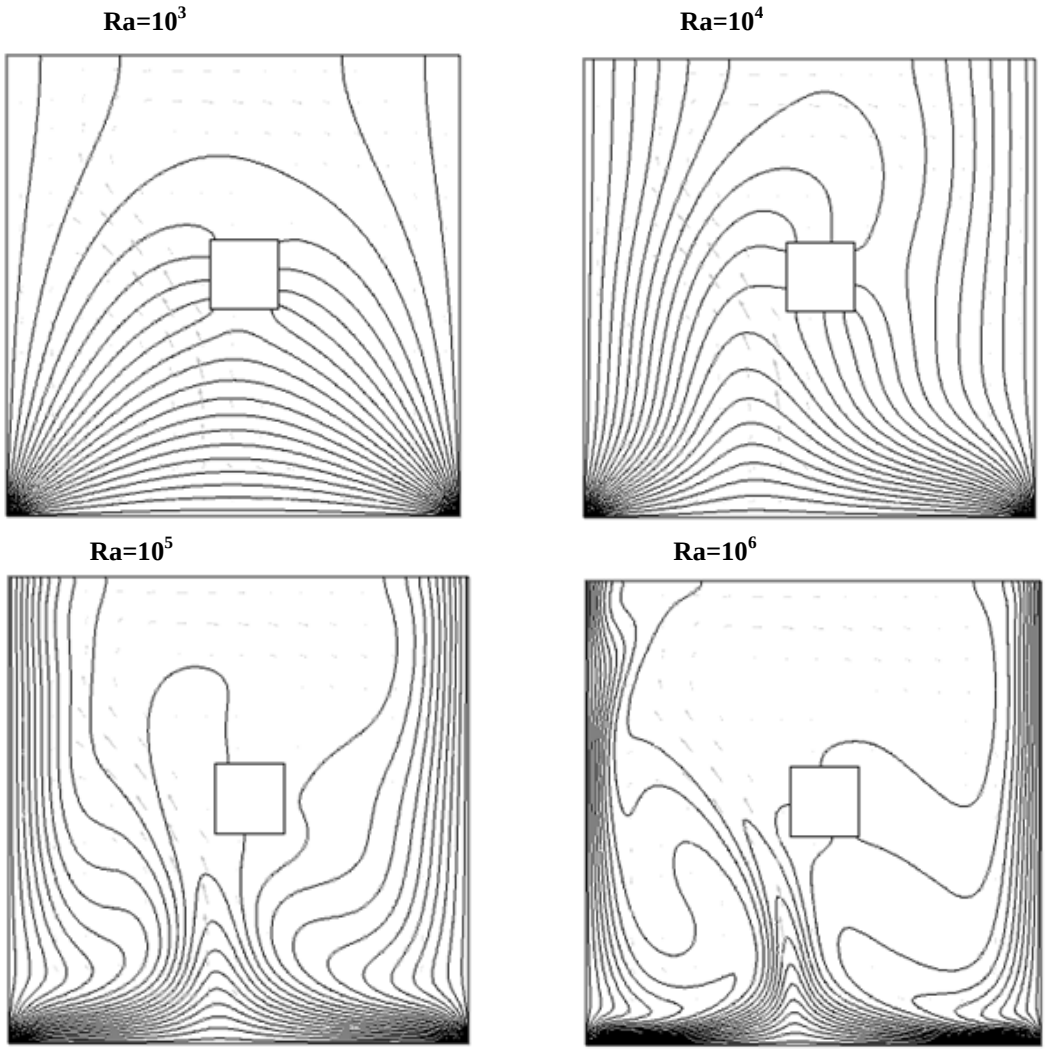
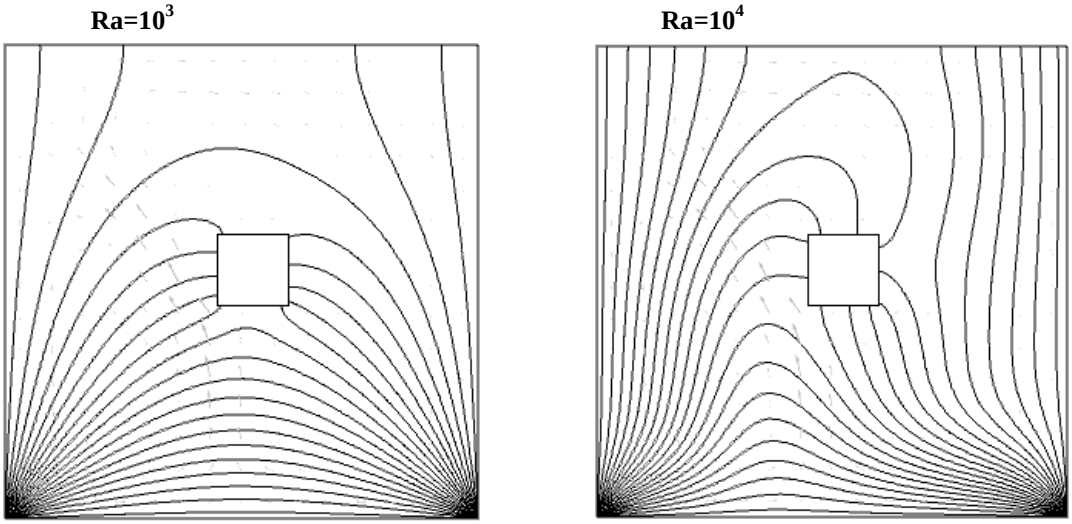


Fig. 4.1 Isotherms at different Rayleigh numbers, Prandtl number of 0.71



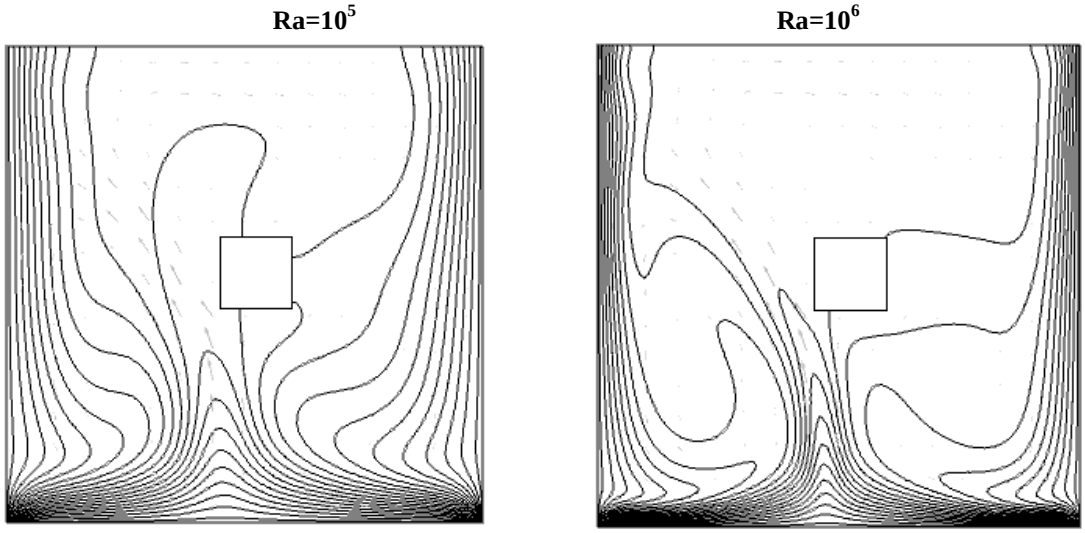


Fig. 4.2 Isotherms at different Rayleigh numbers, Prandtl number of 1.0

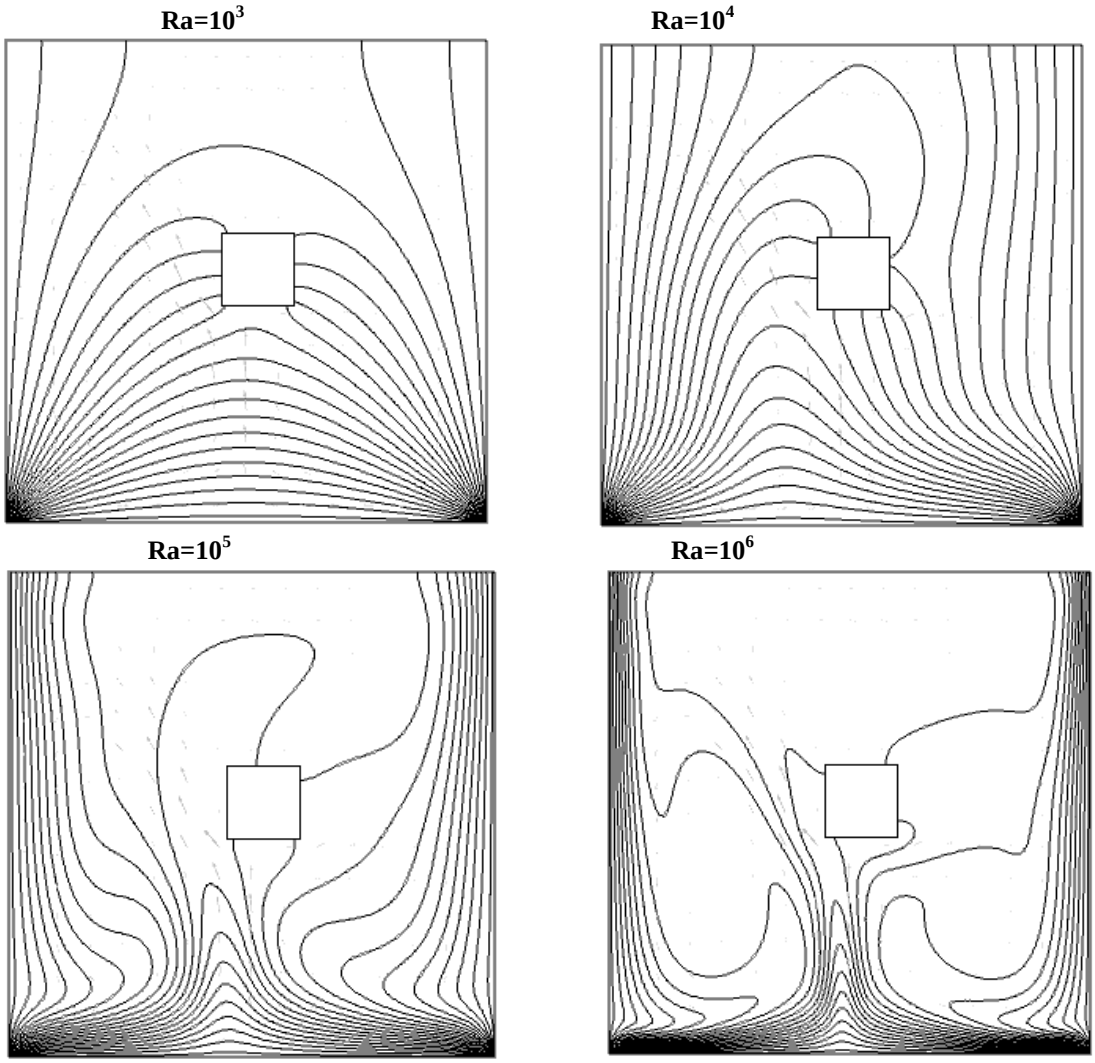


Fig. 4.3 Isotherms at different Rayleigh numbers, Prandtl number of 1.5

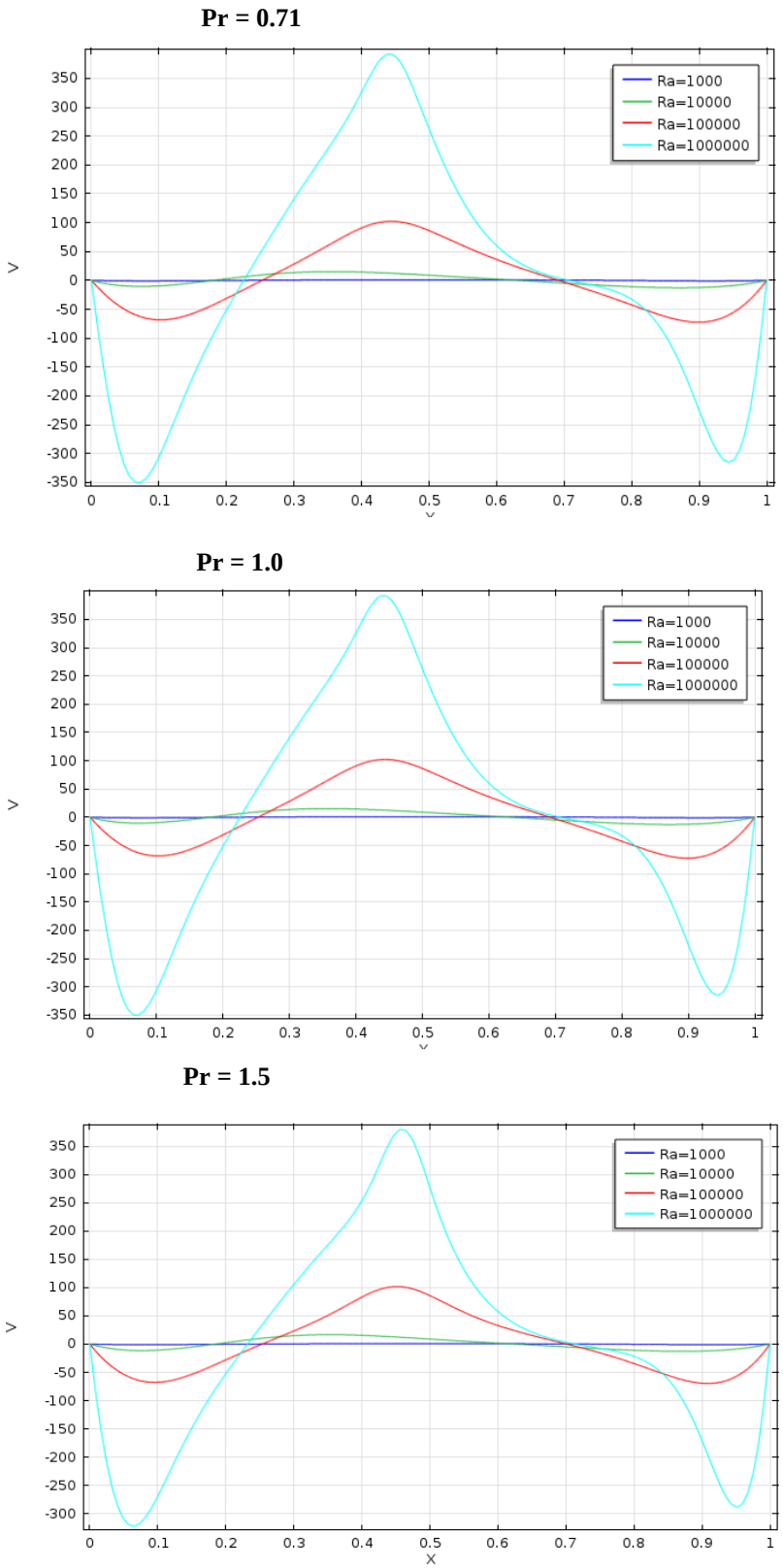


Fig. 5. Variation of the vertical velocity component along the bottom wall of the square cavity with Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5

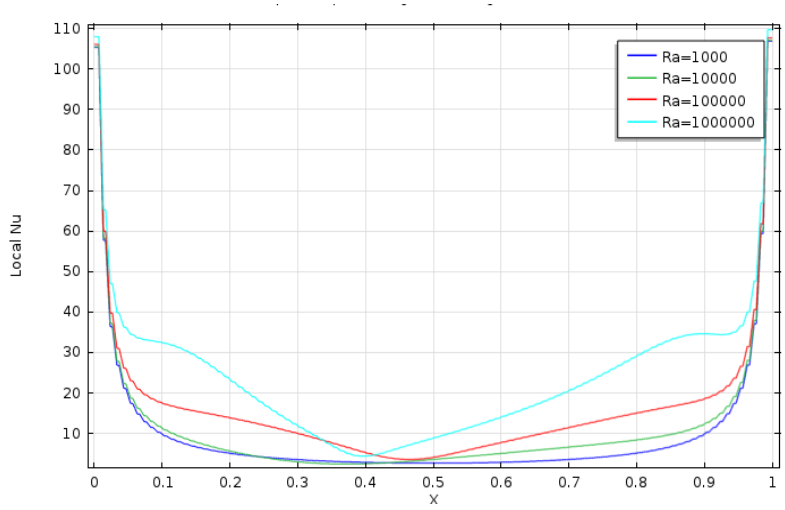
For increasing the Prandtl number (increasing the strength of the magnetic field) we found stream lines the elliptic shape of eddies move upward and close to the upper corners of the cavity. This phenomenon means decrease in the flow velocity with increasing Prandtl number. From the isotherms it is observed that with increase in Prandtl number, free convection is suppressed and heat transfer occurs mainly through convection.

At Pr = 0.71and for Ra= 10^3 and 10^5, the isotherms illustrate a pure conduction heat transfer, while at Ra= 10^6 a combination of conduction and weak free convection observed from the corresponded isotherms. As a result it can be said that with increase in the buoyancy force via increase in Rayleigh number, to decrease free convection, a stronger magnetic field is needed compared to the lower Rayleigh numbers.

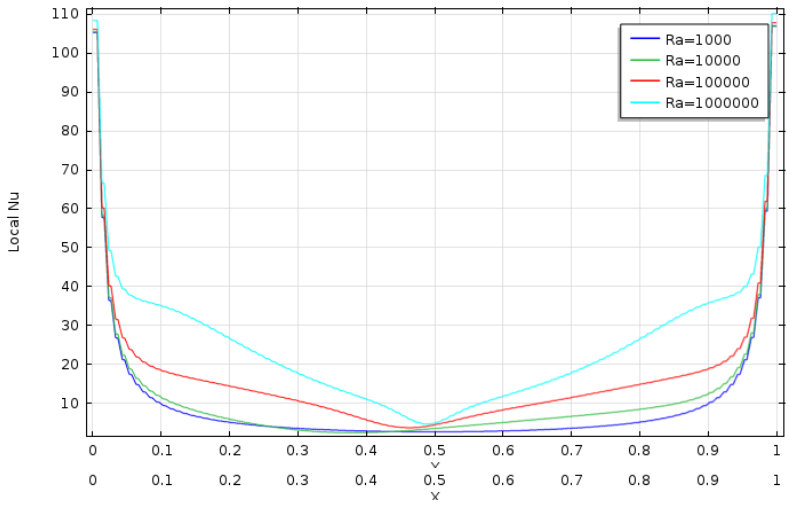
Effects of the magnetic field on the flow and temperature fields at Ra= 10^6 are completely different from the previous results at lower Rayleigh numbers. At Pr= 1.0 the thickness of the thermal boundary layers decreases. At Pr = 1.5 the isotherms are parallel with the horizontal walls in the vicinity of these walls, while in the major portion of the cavity the isotherms are parallel with the side walls. From the streamlines it is observed that at Pr = 0.71, the centrally located elliptic shape of the eddies move downward and their shape converts from ellipse to a right triangle. At Pr = 1.0 and Pr = 1.5 the shape of the core of eddies converts to isosceles triangle and locates close to the hot bottom wall.

Variations of the vertical velocity component along the bottom wall of the square cavity with the Rayleigh number and for Pr = 0.71, Pr = 1.0 and Pr = 1.5 are shown in Fig. 5. It can be seen from the figure that the absolute value of maximum and minimum value of velocity increases with increasing the Rayleigh number (increasing the buoyant force).

Pr = 0.71



Pr = 1.0



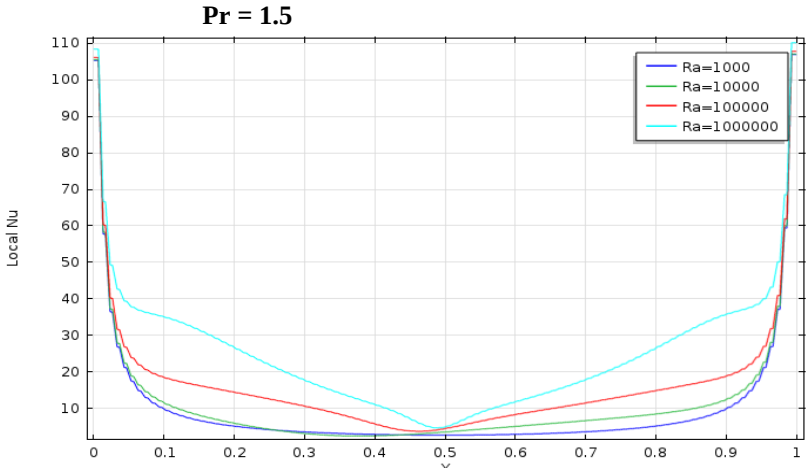
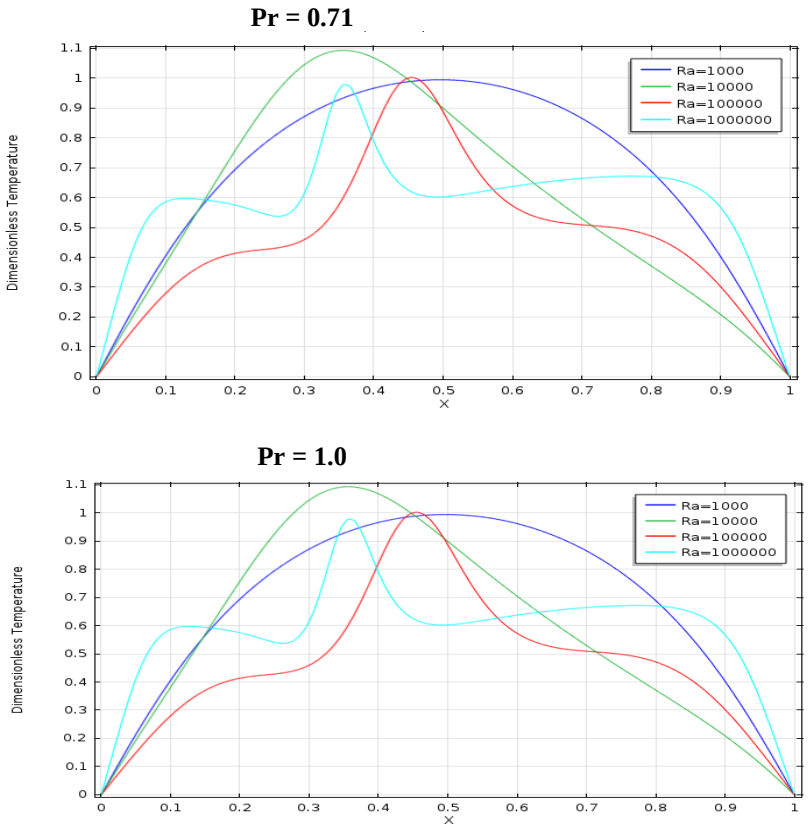


Fig. 6. Variation of the local Nusselt number along the bottom wall of the square cavity with Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5.

Variations of the local Nusselt number along the bottom wall of the square cavity with the Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5are shown in Fig. 6. Owing to the symmetry in thermal boundary conditions, the local Nusselt number is symmetrical with respect to the vertical midline of the cavity. It can be seen from the figure that the local Nusselt number increases with the Rayleigh number in major portion of the hot wall. In the middle of the bottom wall the local Nusselt number equals to zero and does not change significantly with increase in the Rayleigh number.

Variations of the local Nusselt number along the left wall of the square cavity with the Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5 are shown in Fig. 6. Owing to the symmetry in thermal boundary conditions, the local Nusselt number is symmetrical with respect to the left wall of the cavity. It can be seen from the figure that the local Nusselt number increases with the Rayleigh number in major portion of the hot wall. In the middle of the left wall the local Nusselt number equals to zero and does not change significantly with increase in the Rayleigh number.



Pr = 1.5

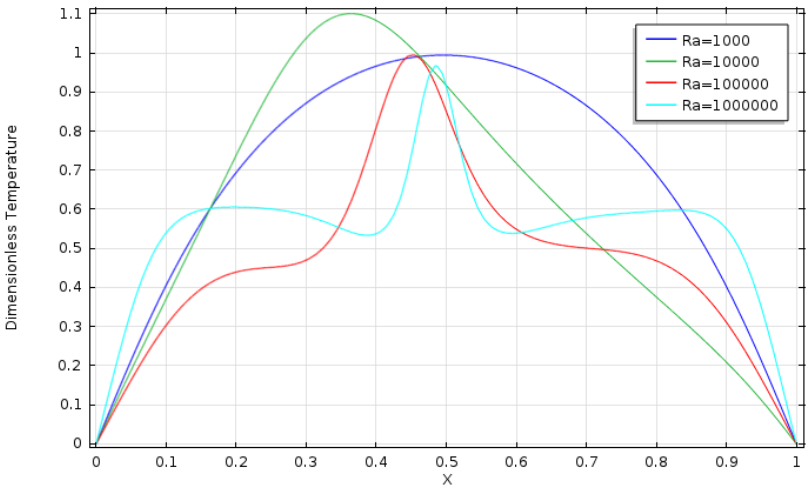


Fig. 7. Variation of the dimensionless temperature along the bottom wall of the square cavity with Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5

Variation of the dimensionless temperature along the bottom wall of the square cavity with Rayleigh number at different Prandtl number of 0.71, 1.0 and 1.5 are shown in Fig. 7. For moderate and high Rayleigh number (Ra= 10^3, 10^4 ,10^5 and 10^6) and for a weak magnetic field strength there is a temperature of the absolute value of maximum and minimum value of temperature increases with increasing the Rayleigh number (increasing the buoyant force). This is because at high Ra and low Pa, convection is dominant heat transfer mechanism. Heat transfer by convection alters the temperature distribution to such an extent that temperature gradients in the centre are close to zero. From the stream line pattern we see that there is a strong upward flow near the cold wall and downward flow at the hot wall.

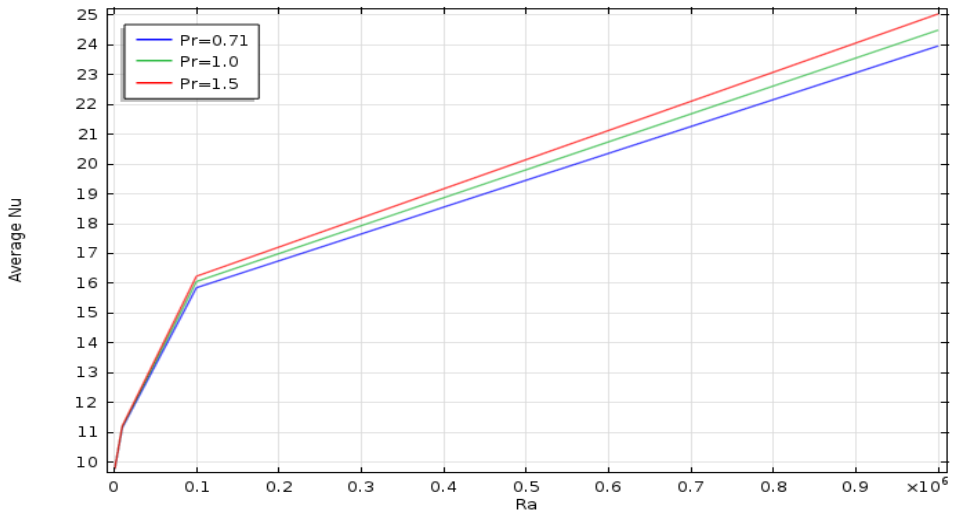


Fig. 8. Variation of the average Nusselt number along the bottom wall of the square cavity with Rayleigh numbers at different Prandtl number of 0.71, 1.0 and 1.5.

Plot of the average Nusselt number of the nonuniformly heated bottom wall as a function of Rayleigh number at different Prandtl numbers is shown in Fig. 8. For a fixed Rayleigh number, with increase in the Prandtl number the flow velocity decreases, the free convection is suppressed and finally the rate of heat transfer decreases. At Pr = 0.71, 1.0 and 1.5 the average Nusselt number is equal for Ra = 10^3, 10^4 , 10^5 and 10^6 a higher heat transfer rate occurs. At a constant Prandtl number, with increase in Rayleigh number the buoyancy force increases and the heat transfer is enhanced. Therefore at high Rayleigh numbers, a relatively stronger magnetic field is needed to decrease the rate of heat transfer.

IV. Conclusion

A numerical work has been done to simulate natural convection in a square enclosure with non-uniformly heated bottom wall and triangular shape heated block, cooled from other walls filled with an electric conductive fluid with different Prandtl number of 0.71, 1,0, 1.5 was studied numerically. Finite element method was to solve governing equations for a heat generation parameters, Rayleigh numbers and Prandtl numbers. Very good agreements were observed between Rayleigh numbers at different Prandtl numbers. Subsequently, a parametric study was performed and the effects of the Rayleigh number and the Prandtl number on the fluid flow and heat transfer were investigated. For all cases considered, two counter rotating eddies were formed inside the cavity regardless the Rayleigh and the Prandtl number. The obtained results showed that the heat transfer mechanisms, temperature distribution and the flow characteristics inside the cavity depended strongly upon both the strength of the magnetic field and the Rayleigh number. Moreover it was observed that, for low Rayleigh numbers, by increase in the Prandtl number, natural convection is suppressed and heat transfer occurs through conduction mainly.

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Gaseous Air Pollutants and its Environmental Effect-Emittedfrom the Tanning Industry at Hazaribagh, Bangladesh

Md. Abul Hashem, Md. Samsul Arefin and Abu Jor
Department of Leather Engineering, Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh.

ABSTRACT :*This article has focused on gaseous air pollutants and its environmental effect-emitted from tanning industry during leather processing, especially in unhairing & liming, deliming, pickling and finishing operations in which hydrogen sulphide (H_2S), ammonia (NH_3), chlorine (Cl_2) and volatile organic compounds (VOCs) are emitted respectively at Hazaribagh, Dhaka, Bangladesh. The toxic hydrogen sulphide (H_2S) gas has negative effect at atmosphere by the process of photochemical reaction; it increases the greenhouse methane gas. In atmosphere, gaseous form of ammonia (NH_3) reacts with available acids and form their corresponding salts cause cloudiness and finally they return to earth surface by wet or dry deposition which effects on aquatic life. Workers in tanning industries are directly inhaled toxic chlorine gas suffers withvarious health complexities. Emission of VOCs isthe mostly formaldehyde and it is captured in photochemical oxidation by ozone as well as UV radiation. It's an important precursor of smog formation where it reacts with oxides of nitrogen (NOx) including peroxyacetyl nitrate (PAN); smog decreases the visibility in the urban area.*

Keywords: *Tanning industry, Emission, Air pollutants, Hydrogen Sulphide, Ammonia, Chlorine, VOCs*

I. INTRODUCTION

Worldwide raw hide or skin is the basic raw materials for the tanning industry.Raw hide/skin contains two types of proteins i) structural and ii) non-structural protein. The fibrous protein is known as collagen that is converted to leather by the process of tanning. Tanning involves the conversion of putrescible raw hide or skin to make finish leather where a series of chemical operations are required to hold several types of attributes. The non-fibrous proteins like albumins, globulins etc. have to remove by a series of chemical treatment and mechanical operations. Each and every chemical unit treatment as well as mechanical operation produces different types of solid waste, liquid waste and gaseous air pollutants and most of the tanningindustries discharge as green (without treating/filtering) to the environment.

Worldwide tanning industries are known as obnoxious for being producing high pollutants and environmental degradation. In Bangladesh tanning industry is one of the fast growing industry. There are about 220 leather industries in Bangladesh, 85% of them are located in the western part of capital city Dhaka[1] and others are scattered all over the country [2]. Since the last decades of industrialization, Bangladesh is facing the environmental degradation of river, Buriganga and other linked rivers due to receiving the discharged green solid and liquid wastes from the tanning industries [3]. The solid and liquid effluent comprised of decaying flesh, soluble proteins, fat, toxic chemicals, dissolved lime, suspended and dissolved solids, organic matters, dyestuffs and coloring pigments, heavy metals like chromium etc. [4]. Gaseous air pollutants hydrogen sulphide (H_2S), ammonia (NH_3), sulphur dioxide (SO_2), carbon dioxide (CO_2), fume of formic acid, chlorine (Cl_2), volatile organic compounds (VOCs) etc. are produced in different stages of leather processing which are directly merged to atmosphere [5]. Gaseous air pollutants are returned to the earth surface as acid rain or fog or mist which effect on aquatic life, vegetation as well as on human health.

Due to generation of high pollutants as well as causing environmental degradation tanning industries of Bangladesh has gained a negative image at the good-tempered society therefore facing a severe challenge to survive. However, it is one of the export earning sectors to strengthen the national economy of the country. The Export Promotion Bureau reported that in the fiscal year of 2013-14 Bangladesh earnedUS$1.29million from the leather sector. Besides, gradually demands of finished leather and fashionable leather products growing all over the world due to its comfortable and distinct properties.

Unfortunately, excluding one tannery (Apex Unit-2) none of the tanneries has an effluent treatment plant (ETP) in Bangladesh. In Bangladesh, per day hideor skins are estimated to be processed for leather production 240MT in which generating 8.47 million liters wastewater and 98MT solid wastes [6]. It is estimated that in Bangladesh during deliming operation yearly 3.5×10^6–12.8×10^6 m^3 ammonia is produced where 2.2×10^6–8.1×10^6 m^3 is directly merged to atmosphere and 1.3×10^6–4.7×10^6 m^3 is mixed at pH 8.5–9.0 in wastewater [7]. In atmosphere ammonia reacts with available acids *i.e.* sulphuric acid, nitric acid and hydrochloric acid to form their corresponding salts causing cloudiness [8]. Ammonia once is discharged to atmosphere, it returns to the earth surface either as gaseous form or as an ammonium ion [9].

The objectives of this article are to symbolize the status of selective emitted air pollutants H_2S, NH_3, Cl_2 and VOCs from tanning industries, especially in unhairing & liming, deliming, pickling and finishing operations and their change in the atmosphere as well as effect on the environment.

II. STUDY AREA

The area is located at Hazaribagh, in the western part of capital city Dhaka where most of the tanning industries situated and covering an area of 25 ha [2]. Every day leather processing starts normally at 6:00 am and continue until 10:00 pm. In some cases the operations continuously run whole night. During this long time, various chemical and mechanical operations are employed and each chemical unit operations are generating toxic gaseous pollutants which directly merge to atmosphere without any filtering. All these primary pollutants are changed by the atmospheric reaction produce secondary pollutants and finally causes harmful to the environment as well as effect on human health. The conventional leather processing flow chart of Bangladesh is shown in **Fig. 1** with emitted gaseous air pollutants.

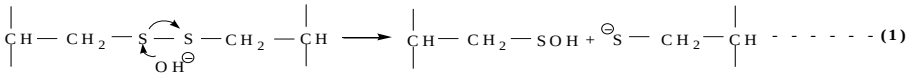
III. MATERIALS AND METHODS

3.1 Data Collection

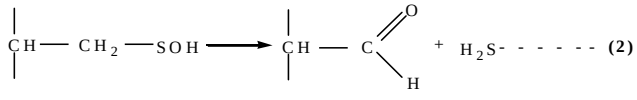
Conventional leather processing chemical unit operational steps was monitored to know the generation of gaseous air pollutants. Most of the tanning industries are used almost same chemicals for the same operations. Gaseous hydrogen sulphide (H_2S), ammonia (NH_3), chlorine (Cl_2) and volatile organic compounds (VOCs) are generated in unhairing & liming, deliming, pickling and finishing operations, respectively.

3.2 Unhairing &Liming

In unhairing & liming, sodium sulphide (Na_2S) and calcium oxide (CaO) are used to remove keratinous and non-fibrous proteins. In some cases sodium hydrosulphide (NaSH) is also used instead of sodium sulphide. During liming operation gaseous hydrogen sulphide (H_2S) is produced which directly merges to atmosphere. At first the cystine is hydrolyzed in the presence of NaOH as reaction (1).



In the presence of sulphides competitive reaction hydrogen sulphide (H_2S) is produced as reaction (2).



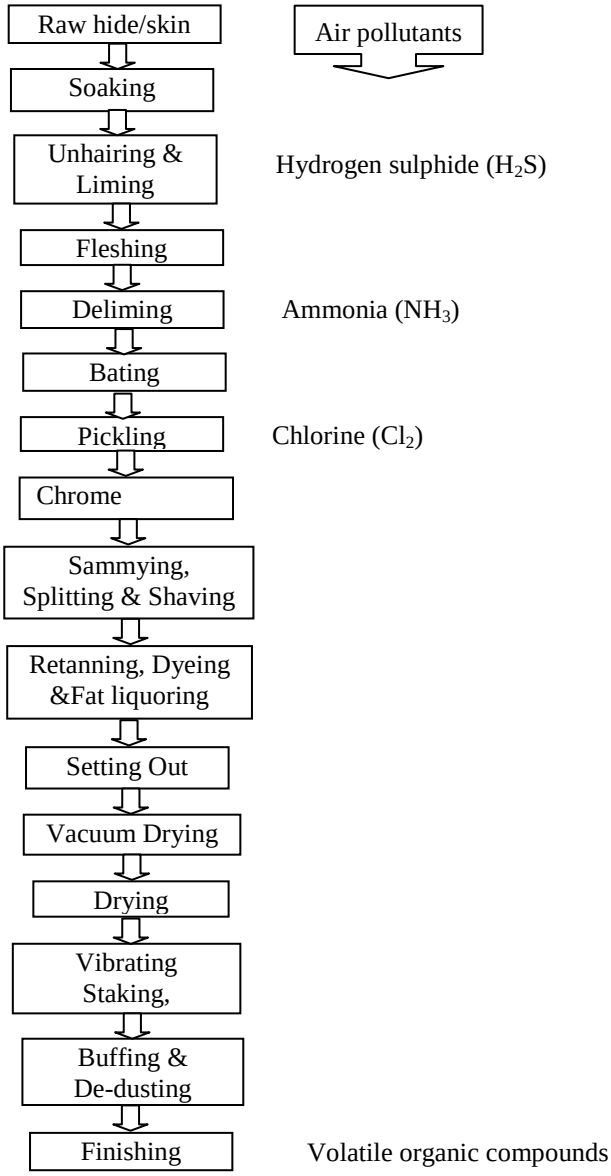


Figure 1. Flow chart of leather processing

3.3 Deliming

After fleshing, subsequently limed pelt is passed through an operation to remove lime from the inside of pelt is known as deliming. During unhairing & liming operation different percentage of lime is used based on the hide/skin substances. The solubility of lime is 1.65 g/L at 20°C and with increasing temperature the solubility is decreased [10] that's why unhairing & liming operation is continued for long time 18-20 hrs. After unhairing & liming, pelt contains lime as per weight basis from 0.5–2.0% [11]; this lime has to be removed fully or partially before starting the next operation like bating. Normally lime is removed by neutralizing either acids, acid-salts, ammonium salts or other substances with an acid reaction. In Bangladesh only limited number of deliming agents are used like ammonium sulphate ($(NH_4)_2SO_4$) and ammonium chloride (NH_4Cl).

$$Ca(OH)_2 + NH_4Cl = CaCl_2 + 2NH_3 + 2H_2O \text{ - - - - - - - - } (3)$$

$$Ca(OH)_2 + (NH_4)_2SO_4 = CaSO_4 + 2NH_3 + 2H_2O \text{ - - - - - } (4)$$

It is clear from the equations (1) and (2) that ammonia is produced from the both deliming agents. The percentage of deliming agents ammonium sulphate and ammonium chloride are used depending on the lime

content in pelt. In the conventional deliming process sodium met-bisulphate ($Na_2S_2O_5$) is used to get the bleaching effect on pelt surface. The percentages of conventional deliming agents are used in tanning industries are shown in the **Table 1.**

Table 1. Deliming agents are used at selected tanning industry

Tanning industry	% of Deliming agents	
(ID)	NH_4Cl	$(NH_4)_2SO_4$
T1	0.25–0.5	2.0–3.0
T2	0.30–0.5	1.5–3.0
T3	0.25–0.4	2.0–3.0

3.4 Pickling

Immediately after deliming and bating, pelt is pickled (acidify) with strong acid usually sulphuric acid (H_2SO_4) together with organic acid (formic acid) to adjust pH 2.5–3.0 to facilitate the next operation such as chrome tanning. In pickling, sodium chloride (NaCl) and sodium chlorite ($NaClO_2$) is used. Sodium chloride (NaCl) is used to prevent the acid swelling and sodium chlorite ($NaClO_2$) is usedan oxidizing unhairing agent to split up the disulphide (−S−S−) bond. Sodium chlorite ($NaClO_2$) dissolves inaqueous formed chlorine dioxide (ClO_2^-) which reacts with keratin (cystine) formed keratinsulfonic acid and free chlorine [12]. This reaction is occurred in acidic condition and takes about 24 hrs. That's why after using oxidative unhairing agent drum usually keep stopped for overnight to complete the reaction [13] as well as pelt can easily uptake the acid into cross section level. During this long reaction time, produced chlorine gas is come out from inside the drum by hollow axle and directly merges to atmosphere.

$$\mathbf{ClO^- + H^+ \rightarrow 2ClO_2 + ClO_3^- + Cl^- + H_2O} \text{ - - - - - - - - - - - - (5)}$$

$$\mathbf{4R–S\text{-}S\text{-}R + 10ClO_2 + H_2O \rightarrow 8R{-}SO_3^- + H^+ + Cl_2} \text{ - - - - - (6)}$$

In the next morning sodium thiosulphate ($Na_2S_2O_3$) is introduced to decompose the excess ClO_2, in order to prevent oxidation of subsequently used as trivalent chromium (basic chromium sulphate)to hexavalent chromium.

3.5 Finishing Operations

The last chemical operation of leather processing on dried leather surface to change its surface effect, both the aesthetic and functional aim is known as finishing. Different type of binders, mixture of pigments, dye solutions, waxes, fillers, and auxiliaries are applied on leather surface to make it attractive. After giving a final top layer on leather surface various fixing agents are used including formaldehyde, polyurethane, nitrocellulose etc. All these volatile reagents, spray dusts are emitted to atmosphere during finishing operation.

IV. RESULTS AND DISCUSSIONS

4.1 Hydrogen Sulphide (H_2S) in Unhairing & Liming

In tannery, normally unhairing & liming takes for about 18–20 hours; during long time chemical reaction as well as mechanical agitation produce H_2S gas. The H_2S gas comes out from the hollow axle of drum/from open paddle which is directly mixed with air inside the tanning industry. It is a colorless gas, and is slightly heavier than air. It has a strong odor of rotten eggs. In tannery, operators are used to work without nose mask and frequently inhale gaseous H_2S and are suffering in difficulties. High concentration of H_2S (> 900ppm) for one minute causes instant coma and death [14]. H_2S is not only produced in liming but also produced when spent lime liquor is mixed with the acidic ranges spent tanning liquor like spent chrome tanning or spent pickle liquor. It is the conventional practice to discharge spent lime and chrome tanning liquor simultaneously at the same stream continuously H_2S gas is produced. People in the tannery areas are inhaled the poisonous H_2S gas. In 2010, three workers died of inhaling toxic H_2S gas; it was produced by wrong dosing of chemicals mixing of basic chromium sulphate (BCS) in the liming drum at night. In next morning when workers opened the door of drum inhaled huge amount of H_2S gas and cause death [15]. The fluxes of H_2S led to toxic levels of H_2S at atmosphere by the atmospheric photochemical reaction. Besides, ozone shield destroy and increase the greenhouse methane gas [16].

4.2 Ammonia (NH_3) in Deliming

As of (1) and (2) equations, one part of calcium oxide (CaO) can be neutralized by 2.4 parts of ammonium sulpahte or 1.9 part of ammonium chloride. In both cases equivalent amount of gaseous ammonia is produced. As estimated, per day 220MT hides and skins are processed at Hazaribagh; after unhairing & liming pelt contains lime 1.2–4.4MT. To remove this large amount of lime by so called deliming operation, yearly 3.5×10^6–12.8×10^6 m^3 ammonia is produced from the tanneries at Hazaribagh, Bangladesh. Usually, pH of deliming is kept 8.5–9.0 to aid the next operation known as bating. In this pH, solubility of ammonia in water at 25°C is 15.3%–36.6% [17]. Assuming that produced 1.3×10^6 – 4.7×10^6 m^3 of ammoniais directly discharged into wastewater at pH 8.5–9.0 and finally mixes to river, Buriganga; remaining 2.2×10^6 – 8.1×10^6 m^3 is merged directly to atmosphere.

Ammonia is a highly hydrophilic base and it has irritating properties. It affects on human being due to its alkaline corrosiveness; either it's gaseous or liquid form can be irritate to the eyes, respiratory tract and skin [18]. Ammonia and its hydroxide are corrosive, can rapidly penetrate to eye and may cause permanent injury.

In tanneries, operators are frequently handled the delimed pelt or leather and waste liquor with bare hands and foot as well as without nose mask. Besides, persons who are engaged other works are exposed to inhale gaseous form of ammonia from inside the tannery. Resulting, person who are directly or indirectly involved in the tanneries are getting contact with ammonia or its hydroxide are suffering from many difficulties.

Ammonia is lighter than air, as a result after emitting from any sources- it is directly merged to atmosphere. It has a short atmospheric lifetime of about 24 hrs. [19]. Once ammonia is emitted to atmosphere it could undergo conversion to NH_4^+ aerosol due to its highly reactive nature and quickly deposited near to the sources of emission [20]. The conversion of ammonia (NH_3) to ammonium ion (NH_4^+) in aerosol is dependence on the concentration of acids in atmosphere. Formed ammonium salts at atmosphere are the main components of smog aerosols; it effects on cloudiness of the atmosphere as well as earth radiation budget [8].

$$NH_3 + H_2SO_4 \rightarrow NH_4HSO_4 + NH_3 \rightarrow (NH_4)_2SO_4 \text{ - - - - (7)}$$

$$NH_3 + HCl \rightarrow NH_4NO_3 \text{ - - - - - (8)}$$

$$NH_3 + HCl \rightarrow NH_4Cl \text{ - - - - - - (9)}$$

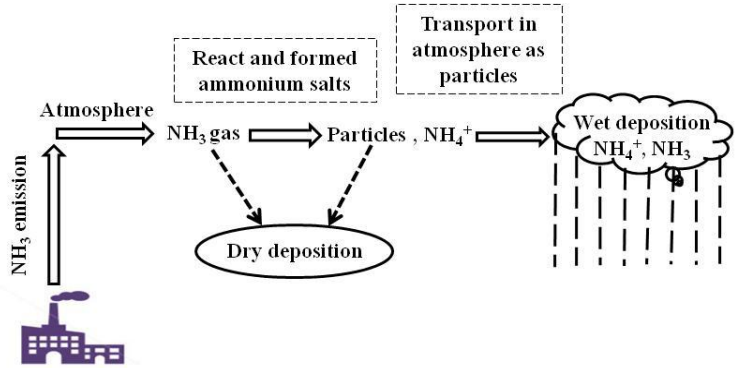


Figure 3. Emission of ammonia and its change at atmosphere

Gaseous ammonia or particulate matters can be removed from the atmosphere by wet and dry deposition and may occur: (i) as gaseous form (ii) in the aqueous form as ammonium ion (NH_4^+) and (iii) as an aerosol in submicron atmospheric water droplets. In the **Fig. 3** shows the emission of gaseous ammonia in the atmosphere and its changes. The ammonium ion associated with nitrate, sulphate or some other anion is incorporated into an aerosol or as part of the ionic mix is found in cloud and raindrops.

4.3 Chlorine (Cl_2) in pickling

Gaseous chlorine (Cl_2) is produced in pickling which is responsible for atmospheric pollution. It is a toxic gas that irritates the respiratory system. It is 2.5 times heavier than air that's why produced gaseous chlorine in pickling remains inside the drum; workers are frequently inhaled toxic chlorine gas when they open the door of the drum. Person could loss of consciousness and possibility death if he/she trapped in high concentration of chlorine [21].

4.4 VOCs in finishing operations

Volatile organic compounds (VOCs) are emitted in finishing operation including formaldehyde, acetone, butyl acetate, isopropyl alcohol etc. In tanneries operators are frequently handled organic solvents with bare hand and without nose mask; they are suffering in various difficulties like abdominal pain, diarrhoea, convulsion and respiratory problem. Although most of the developed countries have reduced the using of formaldehyde (H-CHO) as well set a permissible level in leather [22]. Tanneries of Bangladesh are also used formaldehyde and others organic solvents. Due to their high vapor pressure a good fraction is emitted to atmosphere during finishing operation; as formaldehyde is the precursor of many chemical compounds.

The VOCs are the atmospheric air pollutants. They are involved in photochemical oxidation by ozone as well as UV radiation [23]. The H-CHO emitted from the tanneries, it has short-lived and typical life-time is a few hours in day time [24]. The primary reaction of emitted formaldehyde in the air is direct photolysis and photo chemically produced hydroxyl radicals ($OH^{\cdot}$). *Atkinson* [25] reported that photolysis of formaldehyde occurs according to the following reactions:

$$H\text{-}CHO + h\nu \longrightarrow H_2 + CO_2$$

$$\longrightarrow H^{\cdot} + \dot{H}CO \quad ---(10)$$

Where, $h\nu$ represents energy. Formaldehyde reacts with hydroxyl radical and produce water and HCHO radical [25].

$$H\text{-}CHO + OH^{\cdot} \longrightarrow H^{\cdot} + \dot{H}CO \quad ---(11)$$

The above reaction and subsequently react with HCO radical may lead to the production of water, carbon monoxide, formic acid, and per hydroxyl radical or formaldehyde adducts [26]. Due to its high solubility transfer into rain and returns to earth surface water as wet deposition which may be important sinks [27]. In the urban atmosphere, formaldehyde is an important precursor in smog formation where it reacts with oxides of nitrogen (NOx) and other compounds like peroxyacetyl nitrate (PAN) [28] and smog decreases the visibility.

V. CONCLUSION

In tanneries, various air pollutants H_2S, NH_3, Cl_2 and VOCs are produced; depending on their solubility a good fraction are directly merged to the atmosphere. Emission of H_2S led to toxic levels of H_2S at atmosphere by photochemical reaction resulting destroying ozone shield and increases the greenhouse methane gas. In the atmosphere gaseous form of ammonia reacts with available acids as well as form their corresponding salts cause cloudiness. Chlorine gas is harmful for workers. Emissions of VOCs have negative impact to environment; after emission it returns to earth surface as wet or dry deposition causes smog in urban area reduces the visibility. It has become a foremost responsibility of the concern authorities including owner of tanneries as well as the environmental authorities to control the emission of air pollutants to atmosphere for cleaner leather production.

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DEEMED UNIVERSITY?... ("RAMANUJAM UNIVERSITY")

M.Arulmani, B.E.
(Engineer)

V.R.Hema Latha, M.A., M.Sc., M.Phil.
(Biologist)

Case study shows that the philosophy of "**Deemed University**" is considered as the **Autonomous body** having **High tech Infra structure**, **High tech education** offered by **High tech professors** of university exclusively for High tech students say **High income group (HIG)** capable of paying crores of rupees for getting admission which can never dream by poor students of **low income group (LIG)** (or) **No income group (NIG)** having merit.

i. What does mean University?...
ii. What does mean Student?...
iii. What does mean Teacher?...
iv. What does mean Professor?...
v. University differs from demand university?...

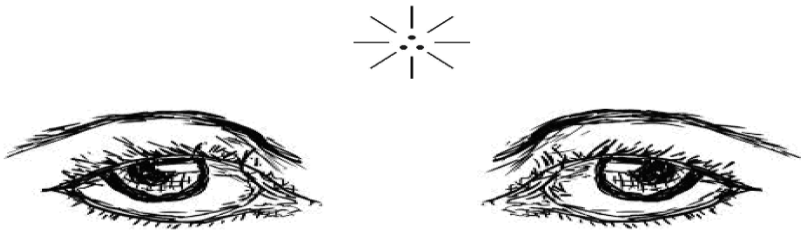
...Author

This scientific research focus that the creator of Universe shall be considered as the **super natural person** called by name by author as '**RAMANUJAM**' who considered created entire universe and matters through his **MOTHER JANAKI** (**Souls**).

> *i) RAMANUJAM shall mean 'Father of University*
> *ii) JANAKI shall mean Universal Knowledge*
> *iii) UNIVERSE shall mean Source of knowledge*
> *iv) KNOWLEDGE shall mean FREE EDUCATION offered by GOD*
>
> *...Author*

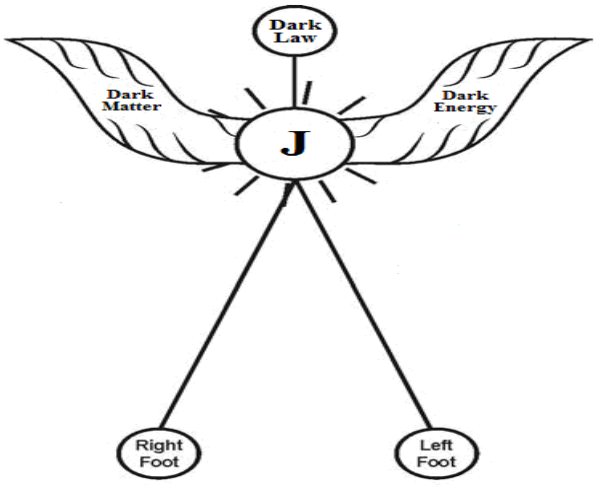
The philosophy of RAMANUJAM (University) JANAKI (Knowledge) shall be described as below:

(i)



கலைமகள்
(Universal Knowledge)

(ii)



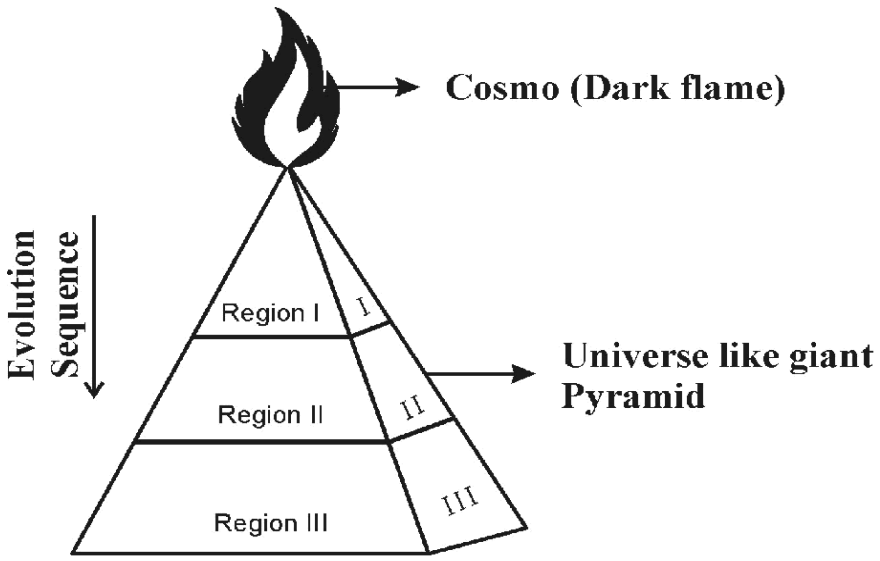
கல்வி தந்தை
(Father of University)

This research further focus that various scientific theories, philosophies, technological concepts considered given to the children of world as '**Natural gift**' offered by Ramanujam, Janaki based on that Eminent Scientists, Technologist could discover various techniques, medicines, comforts for sustainability of Human in the **expanding universe**.

a) Philosophy of Ramanujam University?...

It is focused that the philosophy of **UNIVERSITY** shall be considered derived from the philosophy of '**UNIVERSE**'. No universe shall mean no existence of universities, deemed universities; no '**soul**' (knowledge) means no discoveries, no innovations. The philosophy of **RAMANUJAM UNIVERSITY** and foundation of University shall be described as below:

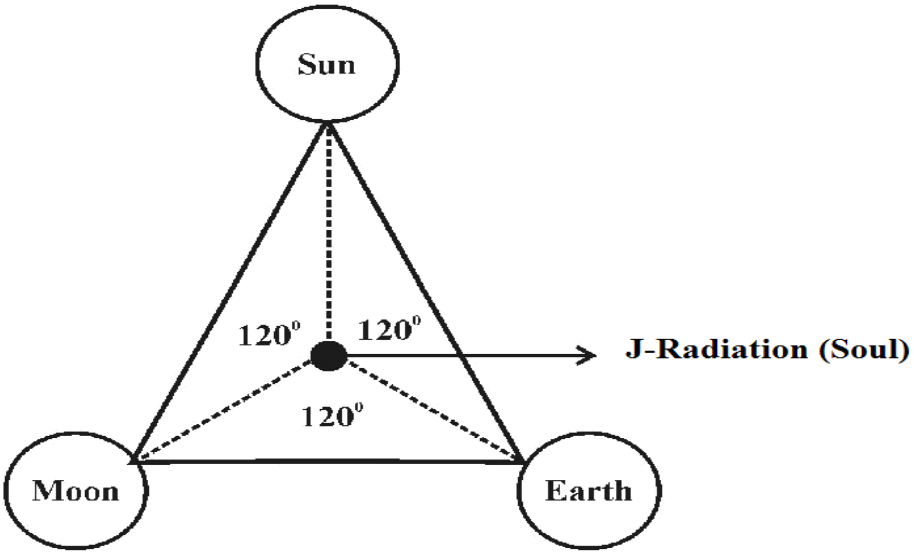
(i)



கலைக்கூடம்
RAMANUJAM UNIVERSITY
(Three tier Universe)

Region I - Antineutrinos radiation region (Black radiation)
Region II - Neutrinos radiation region (Stardust radiation)
Region III - EMR and Matter region (Einstein region)

(ii)



கல்வி
(UNIVERSAL KNOWLEDGE)
(Three-in-one Foundation)

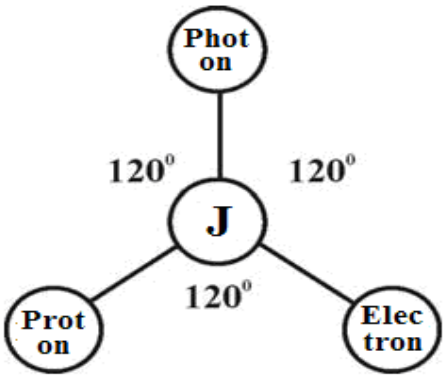
i) **SUN** is like source of **PHILOSOPHY** (Brahman)

ii) **EARTH** is like source of **SCIENCE** (Karmam)

iii) **MOON** is like source of **TECHNOLOGY** (Dharmam)

iv) **J.RADIATION** is like source of **WHITE LOGIC** (soul)

The **J-RADIATION** shall also be considered as the source of **Universal Principle**.



கலைச்செல்வம்
(Universal Principle)

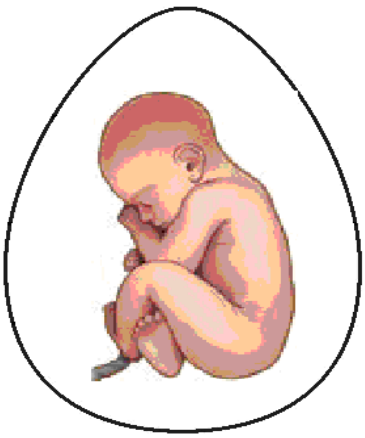
b) "SCHOOL" differs from "DEEMED UNIVERSITY"?...

It is hypothesized that **ARENKANATHAN, ARENKANAYAKI** shall be considered as the **Human Ancestors** (Brahmas) who considered lived in **MARS PLANET** (5,00,000 years ago). They shall be considered as "**SUPER SCIENTISTS**" (Wisdom) whom the wisdom knowledge imparted to them '**FREE OF COST**'. **MARS ANCESTORS** shall be considered expert in **Astrophysics, Astronomy** who effectively considered the relative position of **various planets** in the early universe for effective maintenance of **BALANCED CLIMATIC CONDITION** hence they lived for thousands of years. **STUDENT** differs from **PROFESSOR?...** The philosophy of **STUDENT, TEACHER, PROFESSOR** shall be distinguished as below:

(i)

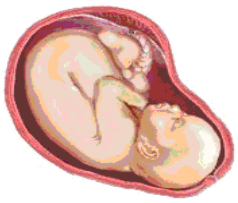
JANAKI
(UGC)

(ii)



BRAHMA
(Student)
(SCHOOL)

(iii)



RAMA
(Teacher)
(COLLEGE)

(iv)

KRISHNA
(Professor)
(DEEMED UNIVERSITY)

i) **RAMANUJAM** shall mean **THEORY**

ii) **JANAKI** shall mean **WHITE LOGIC**

iii) **BRAHMA** shall mean **PHILOSOPHY**

iv) **RAMA** shall mean **DARK LOGIC**

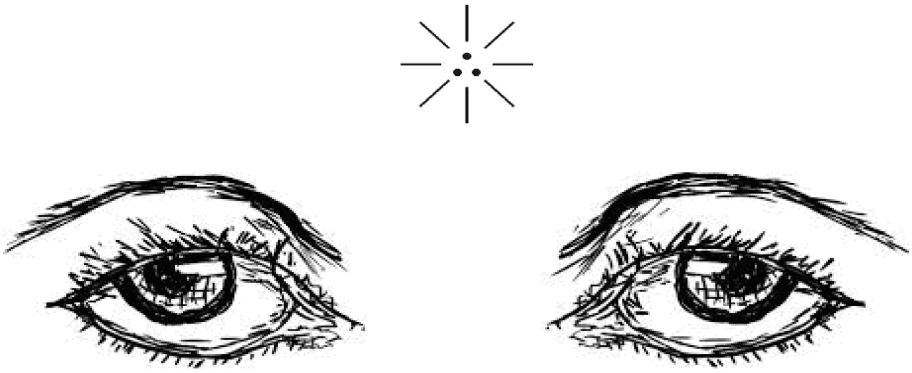
v) **KRISHNA** shall mean **SCIENCE**

vi) **SHIVA** shall mean **TECHNOLOGY**

c) Philosophy of Chancellor?...

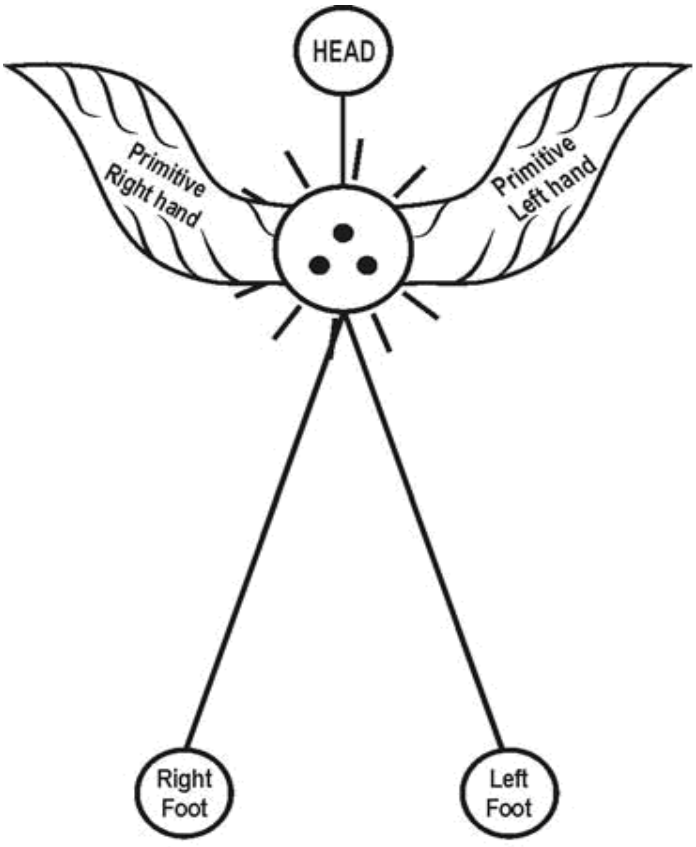
It is focused that during "**PLASMA AGE**" of expanding universe the human ancestors who lived in **MARS PLANET** (Brahma Angels) considered transformed to **EARTH PLANET** (3,00,000 years ago) and earthly human ancestors considered generated thereafter. The first human Ancestors on the earth planet shall also be called as **DARK POPULATIONS** (**proto Indos**) who probably reached Earth planet on '**APRIL 14**'.

(i)



ST. SITA
(Vice Chancellor)

(ii)



ST. RAMA
(Chancellor)

CASE STUDY

Case Study shows that during 17th & 18th Centuries, the old education system involving no expenditure on education. In India, especially, before independence, say during British Period, Mogul Period, the education was offered FREE OF COST for everyone. One cited example is that grandmothers & grandfathers used to tell proudly that their 7th Std is equivalent to present day post-graduation. Further after independence the cost of education has become very high and only high income group can do for higher education just like medicine, engineering, etc. In the present day education system, for admission in LKG Std, there is an approximate annual expenditure of Rs.1 Lakh and parents have to write examination and attend the interview for admission.

Gandhian thought of education focused three areas that is spiritual, intellectual & physical development of children. Further the real system of education is one whether the children of RICH and POOR, of king on the subject, receive education through crafts and also Gandhian thought of education also focus that all education in a country has got to be demonstrably in promotion of the progress of country. Various global nations offering total FREE EDUCATION to the citizens irrespective of age.

Conclusion:

This scientific research recommends to **UNO** and **GLOBAL NATIONS** for imparting balanced free education to every one irrespective of income group, caste, creed, religion. The Government may have full control over **Deemed Universities**. The Management of Deemed Universities may consider at least 30% "**FREE SEATS ALLOCATIONS**" to Government sponsored candidates through competitive examination. In private Industries also 30% **EMPLOYEES POST** shall be allotted to Govt. sponsored candidate through Employment Exchange.

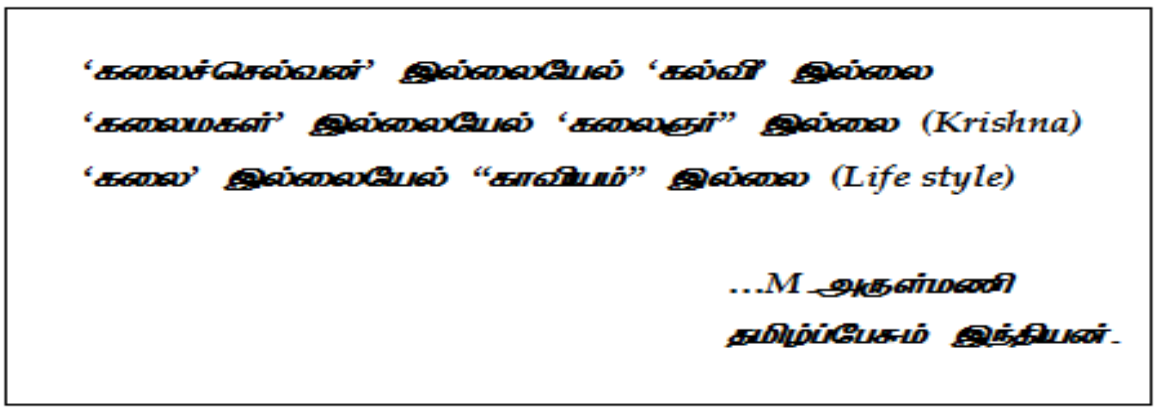

புதுக்கவிதை

✳

கலைமகள்
(UGC)

கல்வி (Knowledge) இறைவன் தந்த பரிசு (Gift)
அனைவர்க்கும் கிடைக்கட்டும் (For all)
ஜாதி, மத, வருமான வரம்பு இல்லாமல் (No Bias)

கலைச்செல்வன் நம் 'கல்வித்தந்தை' (Ramanujam)
கலைமகள் நம் 'கல்வித்தாய்' (Janaki)
கலைக்கூடம் நம் "கோவில்" (Universe)


'கலைச்செல்வன்' இல்லையேல் 'கல்வி' இல்லை
'கலைமகள்' இல்லையேல் 'கலைஞர்" இல்லை (Krishna)
'கலை' இல்லையேல் "காவியம்" இல்லை (Life style)

...M.அருள்மணி
தமிழ்ப்பேசும் இந்தியன்.

Previous Publications:

[1]. YUGADI WISHES (IARA, March 2015)
[2]. TAMIL PUTHANDU!... (AJER, April 2015)
[3]. THEN MADURAI?... (IJERD, April 2015)
[4]. TAMIL NEW YEAR COOL DRINK?... (AJER, April 2015)
[5]. SCIENTIFIC RAMANUJAM?... (IJERD, April 2015)
[6]. ARENKA NAYAKI IS MOTHER OF RAMA?... (AJER, April 2015)
[7]. TRIVIDAITE?... (IJERD, April 2015)
[8]. THALI CULTURE OF ANGELS?... (AJER, April 2015)
[9]. UNIVERSAL POET?... (IJERD, April 2015)
[10]. "JANGLISH" IS CHEMMOZHI?... (AJER, April 2015)
[11]. RAMANUJAM PARLIAMENT?... (IJERD, May 2015)
[12]. CAN LORD JUDGE GOD?... (AJER, May 2015)
[13]. MAY DAY?... (IJERD, May 2015)

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Assessment of Human Exposure to Magnetic Field from Overhead High Voltage Transmission Lines in a City in South Western Nigeria

Ponnle Akinlolu, Adedeji Kazeem
Department of Electrical and Electronics Engineering, Federal University of Technology, Akure, Nigeria.

ABSTRACT: *The increase in electricity consumption, population, and land use has now forced high voltage transmission lines (HVTLs) either to pass or be installed around or through urban cities. This increases the level of human exposure to electromagnetic field radiation as this field produced around the HVTLs extends outwards covering some distance. This may cause a number of health hazards. It is even dangerous to a human who touch any metallic object in proximity of the HVTL, as it may have an appreciable voltage induced on it due to inductive, capacitive or resistive interference from the line. This paper evaluates the magnetic field produced at mid-span by a 132kV, and a 330kV, 50Hz adjacent HVTLs with horizontal and vertical configuration in Akure, a city in South Western Nigeria using analytical method from electromagnetic field theory. This is then compared to the recommended standard limit of public exposure to magnetic field. The results of the computation showed that currently, the general public exposure to the magnetic field along the HVTLs is safe. However, right of way (ROW) along the power lines is being violated as buildings and work places exist within the ROW.*

Keywords - *health hazard, high voltage transmission lines, limit of public exposure, magnetic flux density, right of way.*

I. INTRODUCTION

Power and Energy systems have enjoyed tremendous growth in many countries for the past few years. For continuous power supply to both rural and urban areas, electric energy has to be transported over a long distance (several kilometers) by a transmission line. The voltage carried by this line has to be high enough to reduce losses along the line of transmission. Due to increase in population and expansion of human activities all over the world, it has been realized that for high voltage transmission lines (HVTLs) that were initially installed far away from cities, human occupation and activities have encroached into the areas occupied by these lines. Even in some cases, houses, work places and other structures now share with these lines.

The current flowing through an energized conductor of a transmission line produces a magnetic field at right angle to the direction of the current according to Fleming's Right Hand rule, which extends into space as shown in Fig. 1. Since the currents flowing in the phase conductors of the transmission lines are alternating at 120^0 to one another, then for a transmission line operating at a frequency of 50Hz, the magnetic field changes direction at a frequency of 50 cycles per second. The intensity of the magnetic field radiated by the HVTL also depends on strength (magnitude) of the current in the phase conductors of the transmission line [1-4].

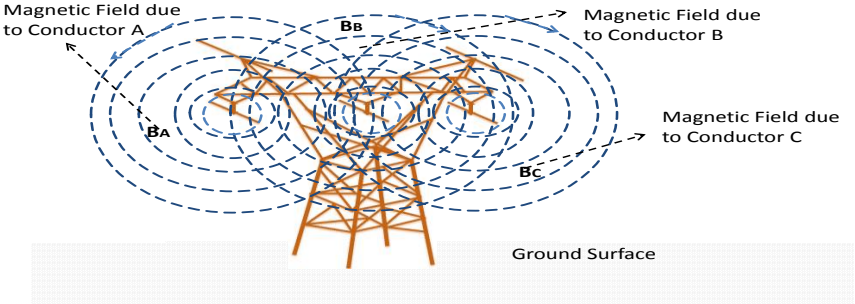

Figure 1: Magnetic field produced by a three-phase transmission line (not to scale).

The magnetic fields produced by HVTLs are in the extremely low frequency (ELF) range of the electromagnetic spectrum, and are therefore treated as quasi static fields [5]. The energy produced by these fields though very small, can cause serious health effects if concentrated on the human body for a long period of time [6-12]. The extremely low frequency (50-60Hz) electromagnetic field which comes under non-ionizing radiation can still cause health effects [13, 14]. Long-time exposure to this magnetic field has some biological effect on humans if it exceeds the threshold value stipulated by the European standard 2004/40/EC (EU Directive 2004/40/EC) [15]. More also, because this field induces voltage on any metallic object parallel or at an angle to the transmission line in its right of way, it can also cause shock hazard to humans touching this metallic object especially in the case of ground fault [16, 17]. Possible adverse effects of electromagnetic fields originating from high-voltage power lines have given rise to discussions in both scientific and public communities for years [7, 18]. The research work in [19] reported that extremely low electromagnetic fields are possibly carcinogenic, based on epidemiological results for childhood leukemia.

Technical specification and guidelines have been issued by organizations over the years in determining the permissible exposure limit of people to magnetic field [20-29]. The International Commission on Non-Ionizing Radiation Protection (ICNIRP) [22, 29], and the Council for European Union [15] recommended permissible limit to exposure of electric and magnetic field. This limit is shown in Table 1.

Table1: ICNIRP (1998, 2010) and Council for European Union (2004) exposure guideline

Power line operating frequency	50Hz	
	Electric Field (V/m)	Magnetic Field (μT)
Public exposure limits	5000	100
Occupational exposure limits	10000	500

More also, the National Health and Medical Research Council (1989) issued a guideline on the occupational and general public exposure limit to electromagnetic field at 50/60 Hz frequency [20]. This was done under the following headings:

(i) Occupational Exposure Limit: Continuous exposure to general public during the working day should be limited to magnetic flux density not greater than 0.5mT (rms). Short-term occupational whole body exposure for up to two hours per workday should not exceed a magnetic flux density of 5mT [20].

(ii) General Public Limit: Members of the general public should not be exposed on a continuous basis to unperturbed magnetic flux density exceeding 0.1mT (rms). This restriction applies to areas in which members of the general public might reasonably be expected to spend a substantial part of the day. Exposures to magnetic flux densities between 0.1 and 1.0mT (rms) should be limited to a few hours per day. When necessary, exposures to magnetic flux density in excess of 1mT should be limited to a few minutes per day [20].

Different research works in [6, 12, 13, 18-20, 22, 29, 30-33] have been carried out to evaluate the effect of electromagnetic field radiation from nearby high voltage transmission lines and other sources of magnetic fields on humans. Similarly, a number of well-established effects of exposure to low-frequency EMFs on the nervous system in [22, 29] include the direct stimulation of nerve and muscle tissue, and the induction of retinal phosphenes. It was reported in [31, 32] that exposure to electromagnetic field at power frequency (50/60Hz) may increase the risk of many diseases, due to the current induced in the human tissue. Also, research works in [7-9] pointed out that magneto-hydrodynamic effect from magnetic field forces on moving charged particles at very high static field levels can alter cardiac function and blood flow, and can cause vertigo. More also, nerve and muscle excitation can be induced by magnetic fields as well as through contact currents. Furthermore, the International Agency for Research on Cancers (IARC) (2002) pointed out that 50Hz or 60Hz magnetic fields have been classified in the list of possible carcinogenic agents [25].

The government of most countries ensures safety of her citizens and people residing in the country by dealing with the situations relating to electromagnetic field radiations from HVTL systems. They have limited the level of electromagnetic field intensity in various environments by enforcing laws and regulations to guarantee safety for people [30]. In Nigeria, structures are being erected under distribution lines and the health effect of this also needs to be considered. Different laws and land use regulations have been issued out to limit the public exposure to magnetic field produced by transmission lines. The Transmission Company of Nigeria (TCN) has a regulation that any building constructed along the HVTLs must give a ROW of 15m and 25m for 132kV and 330kV lines respectively [34]. Initially, these HVTLs are deployed far away from where there are concentrated human activities, but with increasing population growth, rural-urban migration, coupled with lack of proper enforcement of rules and regulations, towns and cities have now encroached into these transmission grid lines. Some people even still live and set up their work place in the right of way of these transmission lines.

This is because either the land is cheap or free for usage most especially mechanic shops and saw mills. A typical example of this is shown in Fig. 2, where HVTLs pass over residential houses and work places in an area in Akure city, Nigeria.

(a) (b)

Figure 2: Residents and various work places directly (a) under an HVTL and (b) under/in proximity of 132kV and 330kV HVTLs in Akure, Nigeria.

This situation is getting out of hand as more and more houses and workshops are being continuously built close to and share corridor with transmission lines which raise the fear of increasing public exposure to the magnetic field produced by the line current of these transmission lines. Aliyu *et al* (2012) performed measurement of magnetic flux densities below Jos - Gombe 330kV and 132kV lines in Central/Eastern Nigeria. They found that even though the field values were all below the standard limit values, many people did not obey the regulation of TCN, as many houses have been built to share corridor with the transmission lines [35].

In this work, we focused and evaluated the magnetic field produced by a 132kV, and a 330kV, 50Hz adjacent HVTLs with horizontal and vertical configuration in Akure, a city in South Western Nigeria, using analytical method from electromagnetic field theory and compared values obtained with the ICNIRP standard limit of public exposure to magnetic field. The two HVTLs run from Oshogbo transmission station (TS). The 132kV line terminates at Akure 132/33kV TS, while the 330kV line terminates at Benin 330/132kV TS [36-40]. The 330kV line is for the main transmission which constitutes the national grid, while the 132kV line is for sub-transmission, and are both maintained by Transmission Company of Nigeria (TCN). The field at mid-span between two towers for minimum ground clearance was evaluated.

II. MATERIALS AND METHODS

The computation of the mid-span magnetic field distribution in the vertical plane with minimum ground clearance was performed for the region where the two power lines are close to each other in the city.

2.1 Power Line Configuration

Fig. 3 shows the geometrical configurations of the power lines. The phase conductors are labeled A, B, and C. a_h is the separation between the phase conductors of the horizontal geometry while the vertical separation between the phase conductors of the vertical geometry is a_v. H_t is the distance of the lowest conductor from the ground at the tower. This is different from the ground clearance at mid-span between two towers. Though the towers of the two lines are staggered (not co-located) in order to reduce the combined magnetic field strength underneath the lines, but for this work, we assumed their mid-span are in the same region for worst case scenario.

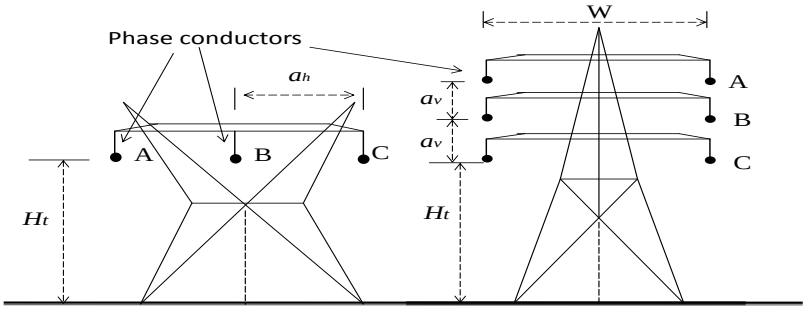

Figure 3: Schematic of the configuration of the power lines.

2.2 Model for Computation

The calculation of the magnetic field is reduced into a simple plane problem because the situation is exactly the same on every section of the lines. Two-dimensional analysis is sufficiently accurate using Biot-Savart Law, image method and superposition principle [4, 5, 41-46]. For the computations, some assumptions and simplifications were made. All conductors constituting the lines are assumed to be straight, horizontal, and parallel to one another. The medium is assumed to be linear. The ground is assumed to be flat, free of irregularities, conductive but magnetically transparent. Typical values of relative permeability of various soils and rocks ranges from 1.00001 to 1.136 except rocks in iron-mining areas [47]. The presence of towers, utility poles, buildings, vegetation and any other object in the area is neglected. Since the power line frequency is 50Hz, the magnetic field is treated as a quasi-static field [5, 41-43].

Considering a phase conductor belonging to one of the power lines carrying current I_A which passes through point (x_A, y_A) on the $z = 0$ plane with ground clearance H_g as shown in Fig. 4, there is an image conductor at a depth H_m below the ground passing through point (x_{Am}, y_{Am}) on the $z = 0$ plane. The vertical plane is chosen to lie on $(x, y, 0)$ i.e. $z = 0$ plane on which the point of observation lies. Height is represented with y-axis.

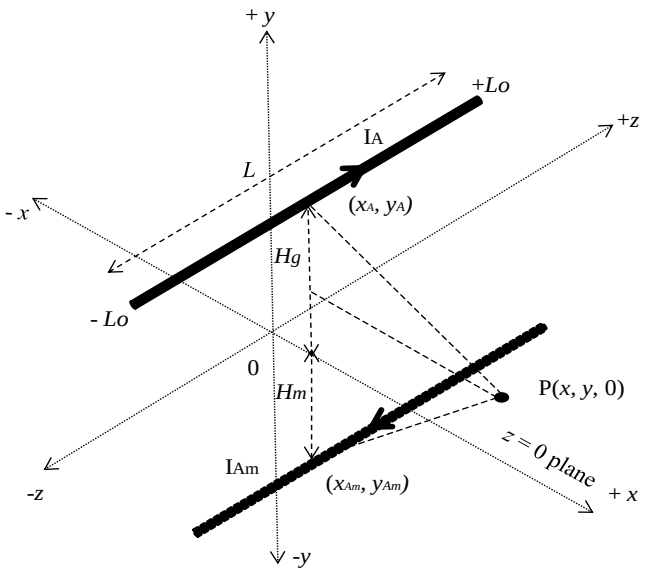

Figure 4: A current-carrying phase conductor above the earth plane.

If L is the length of the conductor, and L_o is half the conductor length, then at a point of observation $P(x, y)$ on the $z = 0$ plane, the horizontal component of the magnetic flux density due to the phase conductor with current I_A is:

$$B_{Ax} = -B_{gA}\left(\frac{y_A - y}{d_A}\right) - B_{mA}\left(\frac{y - y_{Am}}{d_{Am}}\right), \tag{1}$$

and the vertical component of the magnetic flux density due to the phase conductor is:

$$B_{Ay} = -B_{gA}\left(\frac{x - x_A}{d_A}\right) + B_{mA}\left(\frac{x - x_{Am}}{d_{Am}}\right), \tag{2}$$

where

$$B_{gA} = \frac{\mu_o I_A L_o}{2\pi d_A \sqrt{L_o^2 + d_A^2}}, \tag{3}$$

$$B_{mA} = \frac{\mu_o I_A L_o}{2\pi d_{Am} \sqrt{L_o^2 + d_{Am}^2}}, \tag{4}$$

$$d_A = \sqrt{(y_A - y)^2 + (x - x_A)^2}, \tag{5}$$

and

$$d_{Am} = \sqrt{(y - y_{Am})^2 + (x - x_{Am})^2} \tag{6}$$

In Fig. 4, $y_A = H_g$, $x_A = x_{Am}$, and $y_{Am} = -(H_g + \delta)$ where δ is the earth's skin depth (depth of penetration), and is expressed as:

$$\delta = \sqrt{\frac{\rho}{\mu_o \pi f}} \tag{7}$$

ρ is the resistivity of the earth and f is the frequency of the source current. Typical values of earth resistivity ranges from 10 to 1000 Ωm, therefore the skin depth is in hundred of meters below the ground.

Similar expressions can be derived for all the other phase conductors in the two circuits taking into consideration the distances between the conductors and the point of observation. Assuming the steady state current in the three conductors of a line varies as sinωt, with a phase angle φ to one another, then at point P on the plane, the total horizontal and total vertical component of the magnetic flux density B_{Rx} and B_{Ry} respectively are expressed as:

$$\begin{aligned} B_{Rx} &= k_1 \sin \omega t + k_2 \cos \omega t \\ B_{Ry} &= k_3 \sin \omega t + k_4 \cos \omega t \end{aligned} \tag{8}$$

where for phase arrangement $A_1B_1C_1$ - $A_2B_2C_2$,

$$\begin{aligned} k_1 &= B_{B1x} + B_{B2x} + \cos \varphi \left(B_{A1x} + B_{A2x} + B_{C1x} + B_{C2x}\right) \\ k_2 &= \sin \varphi \left[\left(B_{A1x} + B_{A2x}\right) - \left(B_{C1x} + B_{C2x}\right)\right] \\ k_3 &= B_{B1y} + B_{B2y} + \cos \varphi \left(B_{A1y} + B_{A2y} + B_{C1y} + B_{C2y}\right) \\ k_4 &= \sin \varphi \left[\left(B_{A1y} + B_{A2y}\right) - \left(B_{C1y} + B_{C2y}\right)\right] \end{aligned} \tag{9}$$

The magnitudes of the resultant horizontal and vertical components respectively are:

$$\begin{aligned} \left|B_{Rx}\right| &= \sqrt{k_1^{\,2} + k_2^{\,2}} \\ \left|B_{Ry}\right| &= \sqrt{k_3^{\,2} + k_4^{\,2}} \end{aligned} \tag{10}$$

The magnitude of the resultant flux density, B_R is:

$$\left|B_R\right| = \sqrt{\left|B_{Rx}\right|^2 + \left|B_{Ry}\right|^2} \tag{11}$$

In the computation, the resultant magnetic flux density distribution in the vertical plane below the power lines was obtained for a balanced system in which the current in the conductors are at a phase angle φ of 120^o to one another. We considered the installed capacity at Akure TS for the 132kV line [36, 40], and power flow from Oshogbo TS to Benin TS for the 330kV line [38]. While the two lines carry different amount of current, the phase conductors in each line are assumed to carry the same amount of current. The mid-span ground clearance H_g of 8m was used to allow for maximum sag and expansion at 75^0C. Earth's resistivity of 100 Ωm was used. At each point, horizontal component, vertical component, and resultant magnetic flux density were computed. MATLAB software was used for the computation and result presentation.

III. RESULTS AND DISCUSSION

3.1 Field at Ground Level

Fig. 5 shows the lateral profiles of the computed unperturbed magnetic flux densities at ground level below the power lines for the vertical component, horizontal component, and the resultant flux density. It can be observed that the flux densities are higher below the 132kV line than the 330kV line. This is expected since the 330kV lines which make up the national grid, transmits power at higher voltage and lesser current. The 132kV line services Akure, Ekiti and Owo load regions, with its injection TS at Oshogbo, Nigeria. In the figure, the vertical component has higher values than the horizontal component for some regions below the lines.

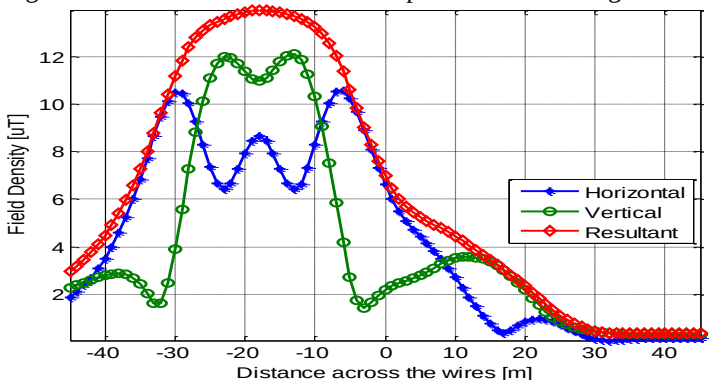

Figure 5: Lateral profiles of the computed magnetic flux densities at ground level below the power lines.

3.2 Field Horizontal Component

Fig. 6 shows the lateral flux density profile of the horizontal component of the magnetic field below the power lines at heights of 1m and 4m above the ground.

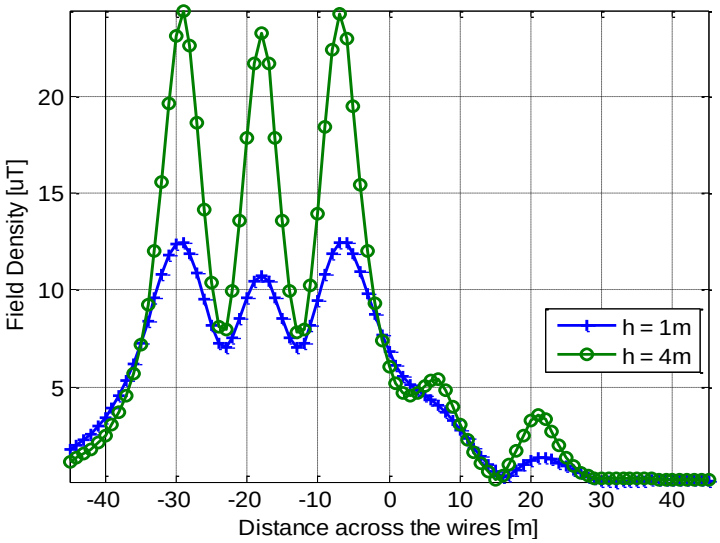

Figure 6: Lateral flux density profile of the horizontal component of the magnetic field below the power lines at two different heights from the ground.

The height of 1m is the recommended standard height of measurement of magnetic fields from AC power lines [48], in which most human activities lie within. The height of 4m is also chosen to correspond to the level of human activities that are up to one-storey building from the ground. As expected, the maximum values of the flux density at height of 4m are higher than the values at height of 1m, and the values occur directly below the conductors. Nevertheless, from the figure, the maximum value at height of 4m does not exceed 25μT. This is below the standard limit of public exposure.

3.3 Field Vertical Component

Fig. 7 shows the lateral flux density profile of the vertical component of the magnetic field below the power lines at heights of 1m and 4m above the ground.

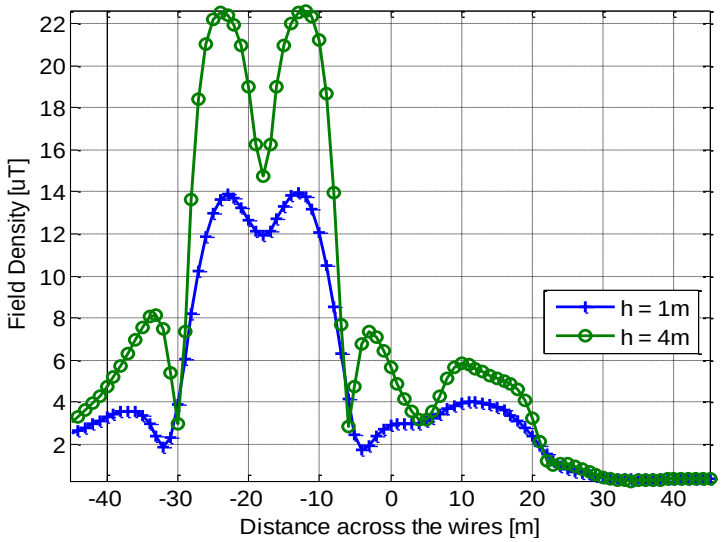

Figure 7: Lateral flux density profile of the vertical component of the magnetic field below the power lines at two different heights from the ground.

In this figure also, the maximum values of the flux density at height of 4m are higher than the values at height of 1m. The maximum value at height of 4m does not exceed 23μT which is below the standard limit of public exposure. A careful observation of Fig. 6 and Fig. 7 reveals that for some regions below the lines, at a height of 1m above the ground, the maximum values of the vertical component are higher than the maximum values of the horizontal component; while at a height of 4m above the ground, the maximum values of the vertical component are less than the maximum values of the horizontal component.

3.4 Resultant Field

Fig. 8 shows the lateral resultant flux density profile of the magnetic field below the power lines at heights of 1m and 4m above the ground.

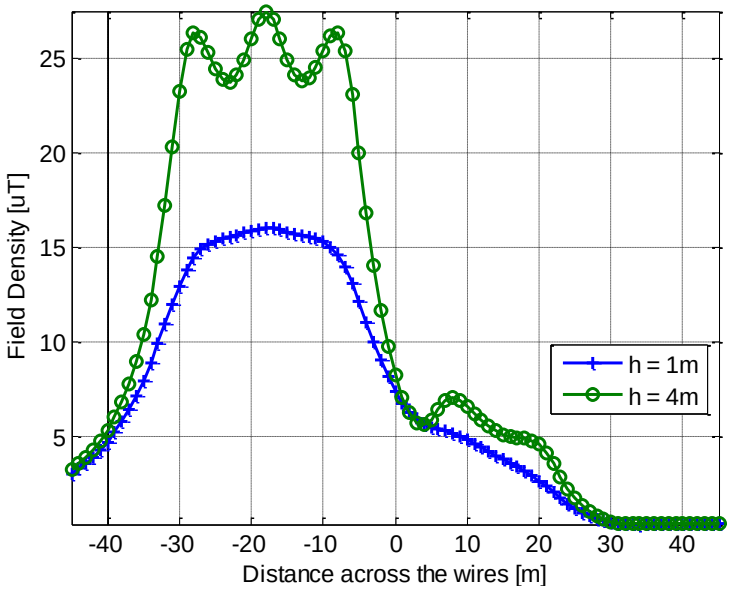

Figure 8: Lateral resultant flux density profile of the magnetic field below the power lines at two different heights above the ground.

Maximum value obtained at a height of 1m is 16μT, and the maximum value obtained at a height of 4m is 27.5μT. These values are below the ICNIRP standard limit of general public exposure of 100μT. The maximum value at height of 1m corresponds to about 16% of the standard limit of exposure, and the maximum value at height of 4m corresponds to about 28% of the standard limit of exposure. This shows that currently, there is no risk for the general public. Aliyu *et al* (2012) also arrived at the same conclusion from their measurement of Jos - Gombe lines [35].

However, physical inspection in this region where the magnetic fields due to the HVTLs was computed revealed that the regulation of TCN ROW for HVTLs has been violated, as there are people having their work places, directly below the power lines as well as erecting residential buildings that encroached into the ROW of the power lines.

IV. CONCLUSION

The magnitude of the magnetic flux densities below 132kV and 330kV power lines in Akure, Nigeria have been computed and analysed for general public exposure using the ICNIRP (1998 & 2010) reference levels for general public exposure limit. The results of the computations showed that currently, the general public exposure to the magnetic field along the HVTLs is safe. The maximum computed value at a height of 1m and 4m is about 16% and 28% of the ICNIRP reference level respectively.

However, right of ways (ROWs) along the power lines are being violated as buildings exist less than 15m and 25m away from the 132kV and 330kV lines respectively; and work places for various occupations and makeshift structures exist directly below the power lines. There is need by regulatory/law enforcement agents to ensure that the ROWs along the power lines are observed by the general public because *athermal* effects of long term electromagnetic pollution may lead to serious health hazards.

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Implementation SVC and TCSC to Improvement the Efficacy of Diyala Electric Network (132 kV).

Ghassan Abdullah Salman [1]
[1](*Electrical Power and Machines Engineering, Collage of Engineering /Diyala University, Diyala, Iraq)*

ABSTRACT: *In modern power system, the quality and efficiency of the power system have become the rudiments control centers with no change or add new lines, through improving the performance of systems using the SVC and TCSC. In this paper, has been studying and analyzing the Diyala electricity network (132kV) and then improve the performance of the network using SVC and TCSC where improved set of goals within the network, which are: to reduce the real power losses and reactive power losses, reducing the power flow of transmission lines loaded with more than the allowable limit and improve voltages for buses network to maintain at acceptable values. The appropriate values and placement for SVC and TCSC are found using Newton Raphson method based on the above objectives. In this paper, using PowerWorld software and MATLAB based on power system analysis toolbox (PSAT) software to get the results. The simulation results demonstrate the effectiveness and robustness of the proposed SVC and TCSC on a set of goals as above to improvement of Diyala electric network (132kV).*

Keywords: *SVC, TCSC, Newton Raphson, PowerWorld, PSAT.*

I. INTRODUCTION

Modern power systems are prone to diffused failures. Operation and planning of large interconnected power system are becoming more and more complex when the power demand is increase, so power system will become less secure. Operating environment, conventional planning and operating methods can leave power system exposed to instabilities [1, 2]. The planning and daily operation of modern power systems call for numerous power flow studies. The main objective of a power flow study is to determine the steady state operation condition of the electrical power network. The steady state may be determined by finding out the flow of active and reactive power throughout the network and the voltage magnitude and phase angles at all nodes of the network [3, 4] The power electronics technology development gives good opportunities to design new power system equipment for power system stability. FACTS technology has become a very effective means to improve the performance of power system without the necessity of adding new transmission lines. These devices can regulate the active and reactive power and control the power flow by reducing the power flow in overloaded lines, the system security margin improved, voltage profile maintain at acceptable levels and reduce active and reactive line losses [2,5,6 and 7].The combination of TCSC and SVC were considered in the power system and the best location of these devices can be very effective to improved power system network and incorporating the SVC and TCSC will regulates the voltage and power flows even under network contingencies [8, 9]

This paper focuses on the rating and best location of SVC and TCSC models and their implementation in Diyala Electric Network (132 kV) based on Newton Raphson load flow algorithm, to control voltage of the buses, reducing the power flow in overloaded transmission lines and reducing the overall system losses.

II. PROBLEM FORMULATION

The objective function of this paper is to find the optimal sizing and location of TCSC and SVC devices. This paper investigation three objective function combination which maintain bus voltage at desired level, minimizes the power flow in overloaded lines and minimizes the real and reactive power loss. Better results can be obtained by investigate all the objective function.

1.1. Voltage Level [6]

Bus voltage magnitude should be maintained within the allowable range to ensure quality service. Voltage profile (Voltage level) is an important problem to power system. This objective function takes voltage levels into account. For voltage levels between 0.95 to 1.1 p.u.

1.2. Overloaded Lines [6, 10]

This objective is to minimize the power flow in overloaded transmission lines; this objective is calculated for every line of the system. The lines loading must be less than 100%. The active power and reactive power flow on lines can be applied as follows:

$$P_{Gi} - P_{Di} = V_i \sum_{k=1}^{N_B} V_j \left[G_k \cos(\delta_i - \delta_j) + B_k \sin(\delta_i - \delta_j)\right] \quad \dots (1)$$

$$Q_{Gi} - Q_{Di} = V_i \sum_{k=1}^{N_B} V_j \left[G_k \sin(\delta_i - \delta_j) + B_k \cos(\delta_i - \delta_j)\right] \quad \dots (2)$$

Where P_{Gi} is the real power generation at bus **i**; P_{Di} is the real power demand at bus **i**; Q_{Gi} is the reactive power generation at bus **i**; P_{Di} is the reactive power demand at bus **i**; N_B is the total number of buses in the system; V_i is the voltage magnitude at bus **i**; V_j is the voltage magnitude at bus **j**; G_k is the conductance of the kth line; B_k is the susceptance of the kth line; δ_i is the voltage angle at bus **i**; and δ_j is the voltage angle at bus **j**.

1.3. Active and Reactive Power Loss [11]

The objective is to minimize the total active and reactive power losses in the transmission lines can be expressed as follows:

$$P_L = \sum_{k=1}^{N_L} G_k \left(V_i^2 + V_j^2 - 2V_iV_j \cos(\delta_i - \delta_j)\right) \quad \dots (3)$$

$$Q_L = \sum_{k=1}^{N_L} B_k \left(V_i^2 + V_j^2 - 2V_iV_j \sin(\delta_i - \delta_j)\right) \quad \dots (4)$$

Where N_L is the total number of lines in the system; G_k is the conductance of the kth line; B_k is the susceptance of the kth line; V_i is the voltage magnitude at bus **i**; V_j is the voltage magnitude at bus **j**; δ_i is the voltage angle at bus **i**; and δ_j is the voltage angle at bus **j**.

III. MODELING OF FACTS CONTROLLER

In this paper, two different FACTS devices have been selected to place in suitable location and suitable size to improve the performance of Diyala Electric Network (132 kV). These are: SVC (Static VAR Compensator) shown in Fig. 1, TCSC (Thyristor Controlled Series Compensator) shown in Fig. 2. SVC can be used to control reactive power in network and TCSC can change line reactance.

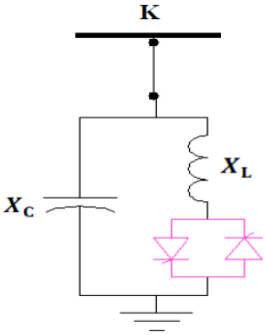

Figure (1): Model of SVC

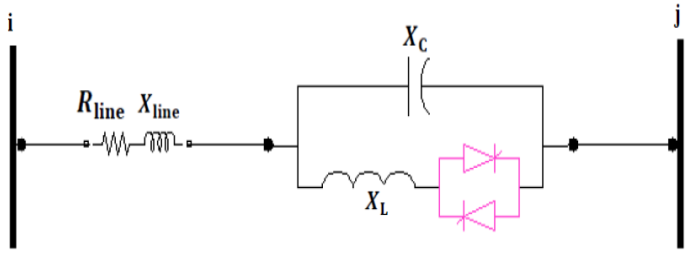

Figure (2): Model of TCSC

2.1. Static VAR Compensator (SVC) Model [12, 13]

Static VAR Compensator (SVC) is a shunt connected FACTS controller whose main objective is to regulate the voltage at a given bus by controlling its equivalent reactance. SVC firing angle model it consists of a fixed capacitor (FC) with a thyristor controlled reactor (TCR) and the thyristor switched capacitor (TSC) with TCR as shown in Fig. 1. The equivalent reactance X_{SVC}, which is function of a changing firing angle α (range of 90° to 180°), is made up of the parallel combination of a thyristor controlled reactor (TCR) equivalent admittance and a fixed capacitive reactance. SVC firing angle model is implemented in this paper as follows:

$$X_{TCR} = \frac{\pi X_L}{\sigma - \sin\sigma} \quad \dots (5)$$

Where $\sigma = 2(\pi - \alpha)$; σ is the conduction angle and α is the firing angle.

$$X_{TCR} = \frac{\pi X_L}{2(\pi-\alpha)-\sin(2\alpha)} \quad \dots (6)$$

$$X_{SVC} = \frac{\pi X_C X_L}{X_C[2(\pi-\alpha)+\sin(2\alpha)]-\pi X_L} \quad \dots (7)$$

$$B_{SVC} = -\frac{1}{X_{SVC}} \quad \dots (8)$$

2.2. Thyristor Controlled Series Compensator (TCSC) Model [7, 14]

Thyristor Controlled Series Compensator (TCSC) is a series connected FACTS controller whose main objective is to regulate the power flow on a transmission line by controlling its equivalent transmission line reactance.

Fig.2 is a representation of TCSC model which consists of a series capacitor in parallel with a Thyristor Controlled Reactor (TCR). The equivalent reactance X_{TCSC} of the combination of fixed capacitor and thyristor controlled reactor is a function of the firing angle α (range of 90° to 180°). In this paper TCSC model can be represented by the following equation:

$$X_{TCSC} = X_C - \frac{X_C^2}{(X_C-X_L)}\frac{(\sigma+\sin(\sigma))}{\pi} + \frac{4X_C^2}{(X_C-X_L)}\frac{\cos^2(\sigma/2)}{(k^2-1)}\frac{(k\tan(k\sigma/2)-\tan(\sigma/2))}{\pi} \quad \dots (9)$$

Where $\sigma = 2(\pi-\alpha)$; $k = \sqrt{\frac{X_C}{X_L}}$; σ is the conduction angle and α is the firing angle.

IV. SIMULATION RESULTS

The implementation of SVC and TCSC are performed on Diyala (132kV) electrical network system. The system consists of 3 generators, 10 buses, 7 loads and 15 lines (3 double lines and 9 single lines). The configuration of Diyala electrical network (132kV) shown in figure (3) and the line data is given in table (1).

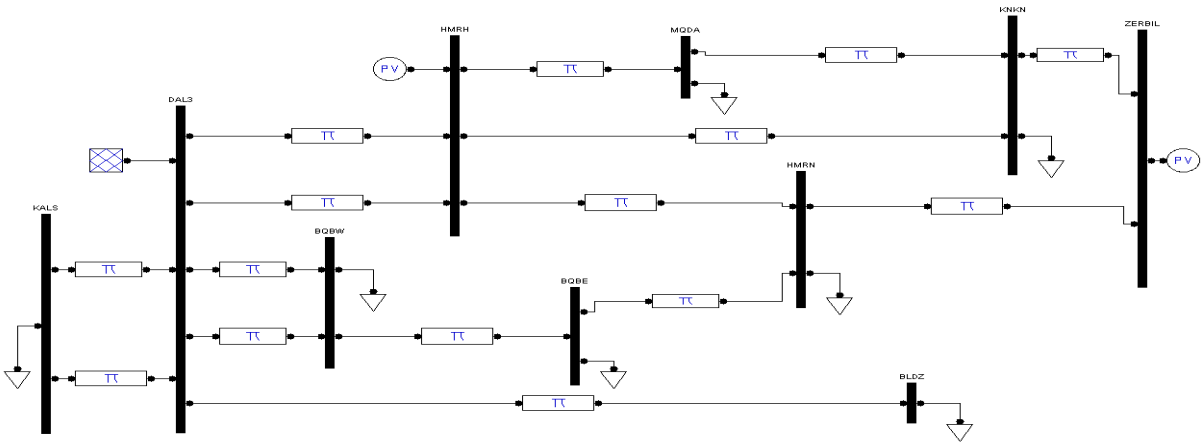

Figure (3): Diyala electrical network (132kV)

Table (1): Line data for Diyala electrical network (132kV)

Line	R (p.u)	X (p.u)	B (p.u)	Rating (MVA)
KALS - DAL3	0.0027	0.0156	0.0073	236
KALS - DAL3	0.0027	0.0156	0.0073	123
DAL3 - HMRH	0.0333	0.1332	0.031	123
DAL3 - HMRH	0.0333	0.1332	0.031	123
DAL3 - BQBW	0.0044	0.019	0.0041	123
DAL3 - BQBW	0.0044	0.019	0.0041	123
HMRH - MQDA	0.0222	0.0953	0.0191	123
HMRH - KNKN	0.0528	0.2263	0.0454	123
HMRH - HMRN	0.0205	0.0881	0.0177	123
BQBW - BQBE	0.0146	0.0366	0.0067	74
DAL3 - BLDZ	0.0372	0.1596	0.032	123
BQBE - HMRN	0.0879	0.1782	0.0313	74
MQDA - KNKN	0.0267	0.1143	0.0229	123
KNKN - ZERBIL	0.0356	0.1525	0.0306	123
HMRN - ZERBIL	0.0773	0.3312	0.0665	123

The simulation results are presented as follows:

The optimal size and placement of FACTS device based on maintain bus voltage at desired level, reducing the power flow in overloaded lines and reduce losses. These objectives investigated when SVC connected at buses BQBE and MQDA shown in figure (4), the parameter setting of SVC is given in table (2) and TCSC connected in series with lines (HMRH – HMRN) and (DAL3 – BLDZ) shown in figures (5&6) respectively, the parameter setting of TCSC is given in table (2).

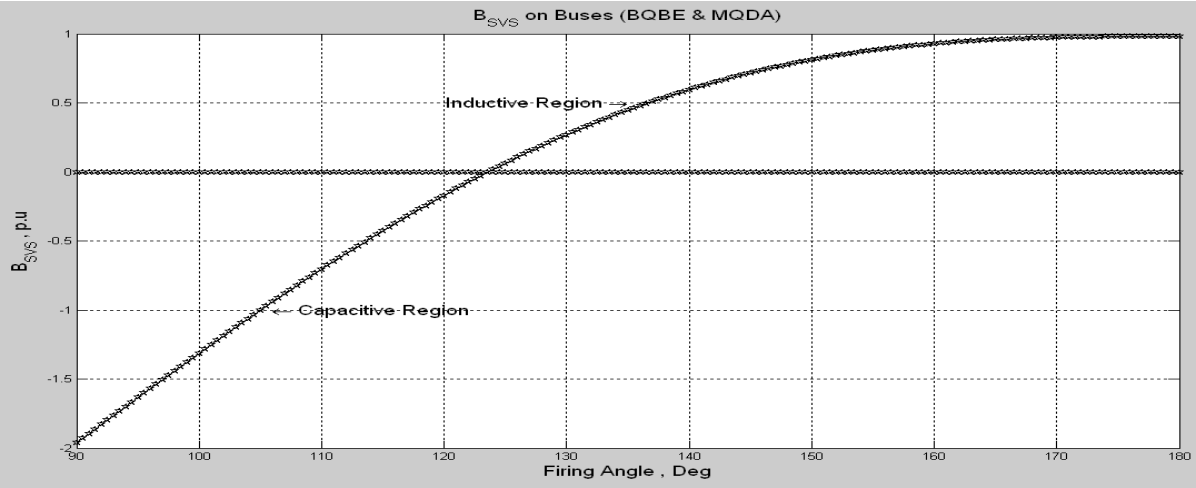

Figure (4): SVC on buses BQBE and MQDA

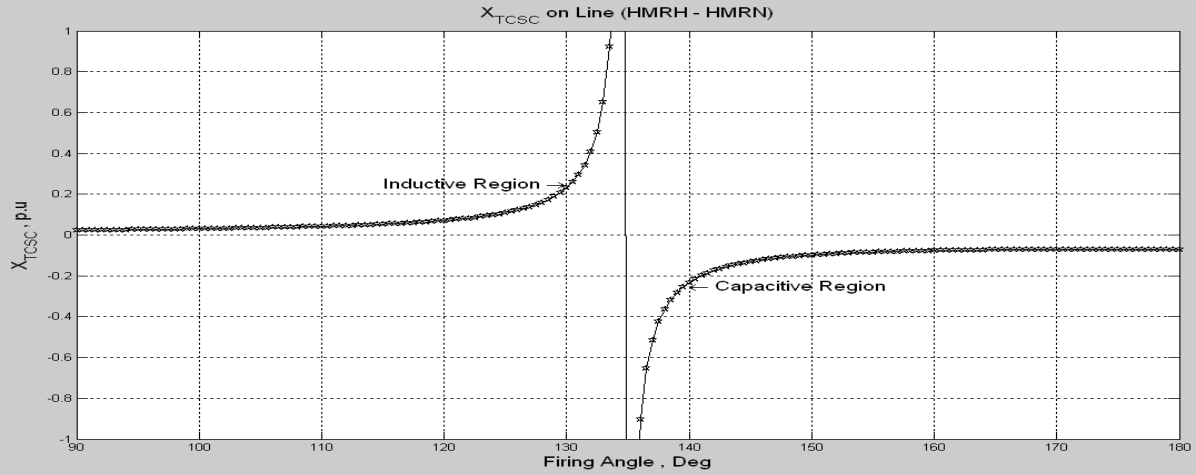

Figure (5): TCSC on line (HMRH – HMRN)

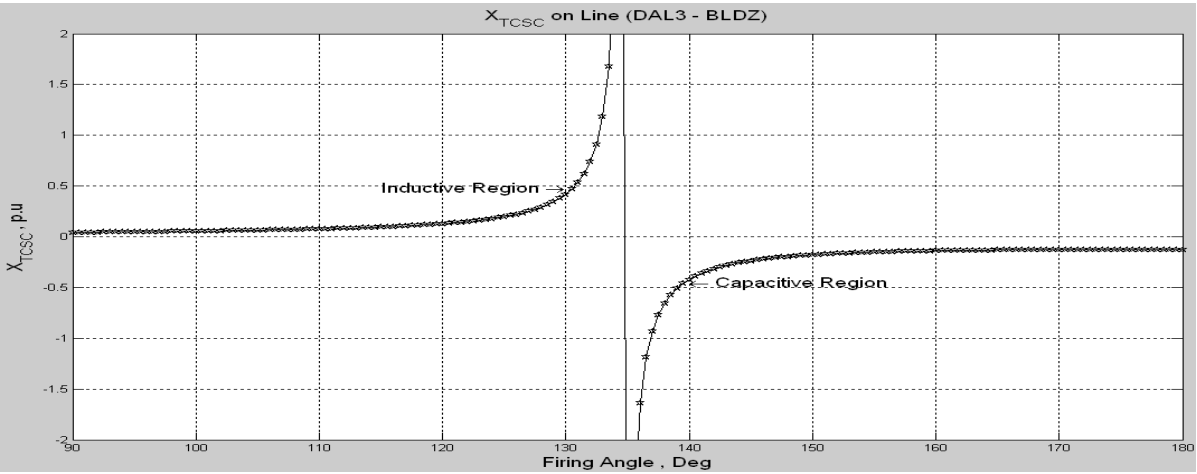

Figure (6): TCSC on line (DAL3 – BLDZ)

Table (2): Parameter setting of SVC and TCSC

	Bus BQBE	Firing Angle	Bus MQDA	Firing Angle
B_{SVC} (p.u)	- 0.736	109.5	- 0.568	112.4
	Line (DAL3 – BLDZ)	Firing Angle	Line (HMRH – HMRN)	Firing Angle
X_{TCSC} (p.u)	- 0.1273	169.8	- 0.0702	170.2

The results carried out using PowerWorld and MATLAB based on power system analysis toolbox (PSAT). In figures (7&8) without using SVC and TCSC shows the lines (BQBW – BQBE) and (KNKN – ZERBIL) are loaded over than maximum rating, active power losses (19 MW by PowerWorld, 18.122 MW by MATLAB) and reactive power losses (33 MVAR by PowerWorld, 28.915 MVAR by MATLAB). The bus voltages at buses (KNKN, MQDA, BQBE and BLDZ) are lower than of desired value.

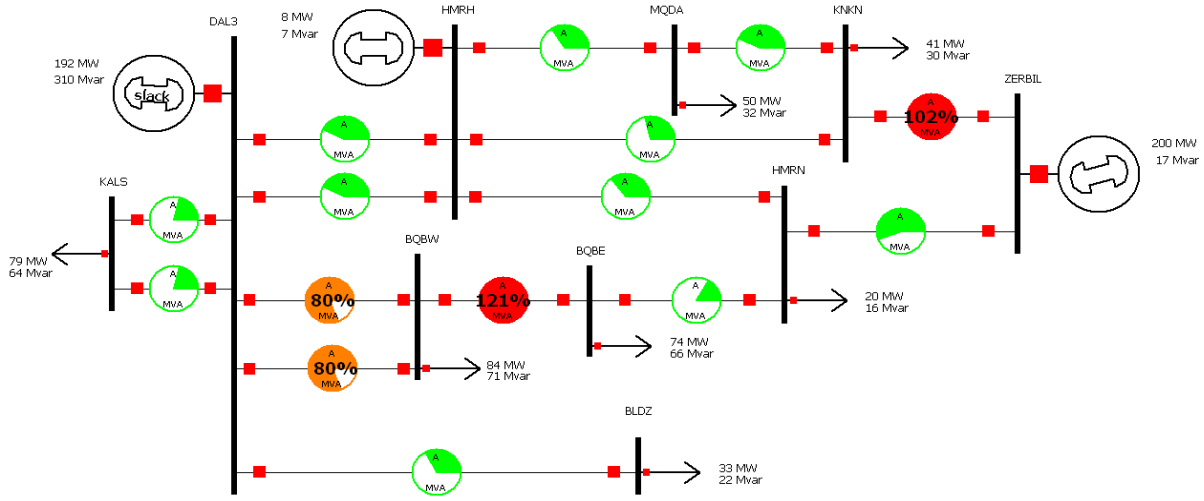

Figure (7): Diyala electrical network (132kV) using PowerWorld without (SVC&TCSC)

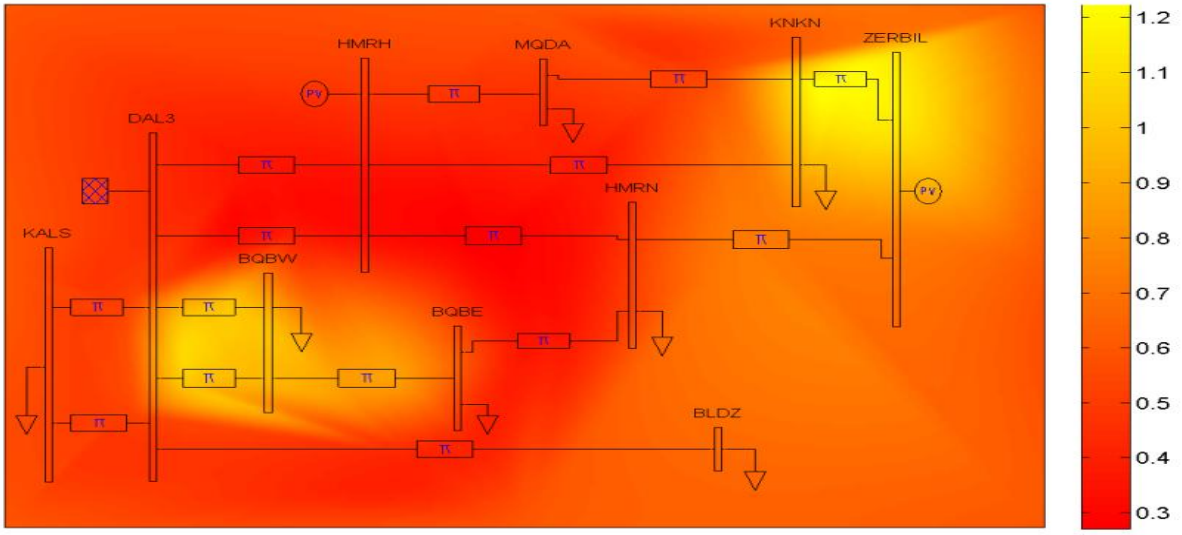

Figure (8): Diyala electrical network (132kV) using MATLAB without (SVC&TCSC)

In figures (9&10) with using SVC and TCSC shows the lines (BQBW – BQBE) and (KNKN – ZERBIL) are loaded lower than maximum rating, active power losses (17 MW by PowerWorld, 16.041 MW by MATLAB) and reactive power losses (24.5 MVAR by PowerWorld, 20.343 MVAR by MATLAB). The bus voltages at buses (KNKN, MQDA, BQBE and BLDZ) are within desired value.

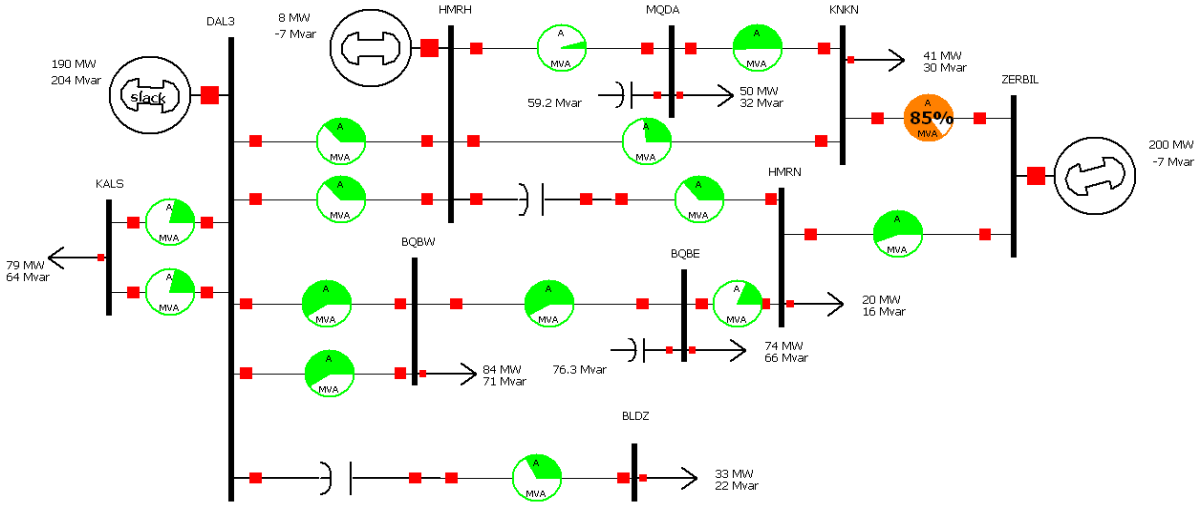

Figure (9): Diyala electrical network (132kV) using PowerWorld with (SVC&TCSC)

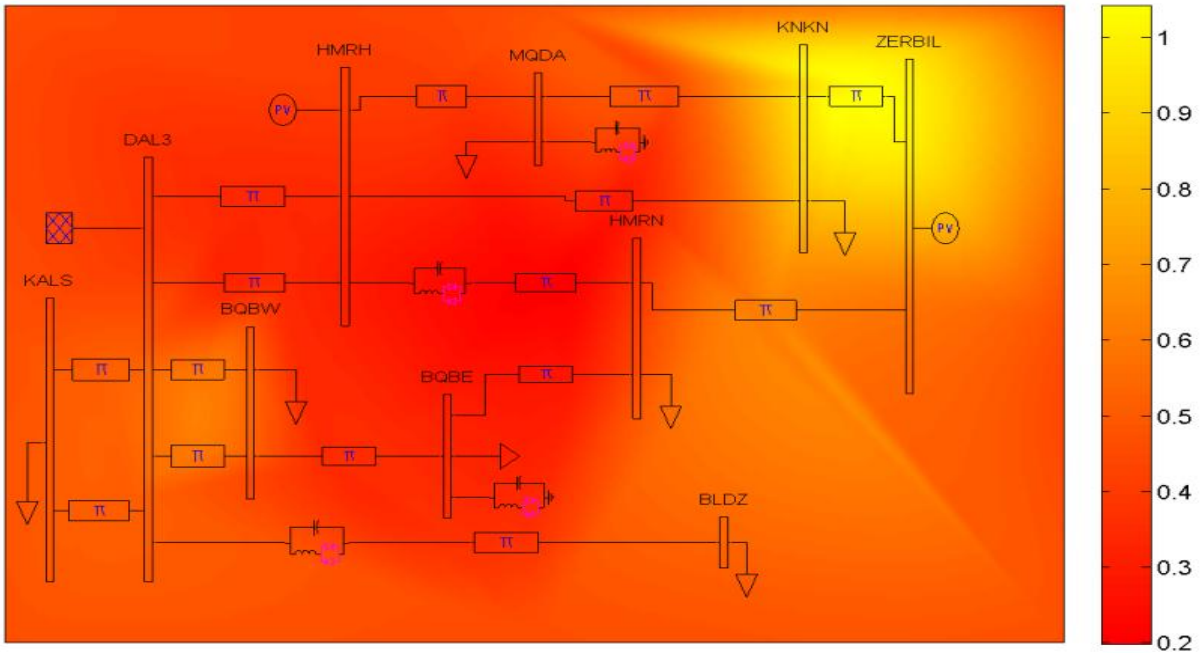

Figure (10): Diyala electrical network (132kV) using MATLAB with (SVC&TCSC)

The bus voltage before and after placing SVC and TCSC shows in table (3), while active and reactive power generation, active and reactive power losses before and after placing SVC and TCSC shows in table (4) and power flow in overloaded lines before and after placing SVC and TCSC shows in table (5).

Table (3): The bus voltage before and after placing SVC and TCSC

Voltage at Bus (p.u)	PowerWorld		MATLAB	
	Without SVC&TCSC	With SVC&TCSC	Without SVC&TCSC	With SVC&TCSC
KNKN	0.907	1.0	0.928	1.001
MQDA	0.916	1.021	0.924	1.022
BQBE	0.908	1.018	0.915	1.02
BLDZ	0.919	1.01	0.926	1.016

Table (4): Total active, reactive power generation and losses before and after placing SVC and TCSC

	PowerWorld		MATLAB	
	Without SVC&TCSC	With SVC&TCSC	Without SVC&TCSC	With SVC&TCSC
Total Active Power Generation (MW)	400	398	398.122	396.041
Total Reactive Power Generation (MVAR)	334	325.5	329.915	321.343
Total Active Power Losses (MW)	19	17	17.122	15.041
Total Reactive Power Losses (MVAR)	33	24.5	28.915	20.343

Table (5): Line flow before and after placing SVC and TCSC

	PowerWorld		MATLAB	
Line Flows Between Bus (MVA)	Without SVC&TCSC	With SVC&TCSC	Without SVC&TCSC	With SVC&TCSC
BQBW – BQBE	89.54	44.4	88.131	43.707
KNKN – ZERBIL	125.46	104.55	124.985	104.431
DAL3 – BQBW	98.4	73.8	96.862	73.002

V. CONCLUSIONS

This paper combination of SVC and TCSC has been considered to improvement the voltage profile (maintain at acceptable limits), reduction active and reactive losses of power system and reduction power flow in overloaded lines for Diyala electrical network (132kV). The optimal location and sizing of SVC and TCSC are calculated for objectives as above by Newton Raphson technique based on MATLAB m-file, the bus bars BQBE and MQDA represent optimal locations to placement SVC while; the lines (DAL3 – BLDZ) and (HMRH – HMRN) represent optimal locations to placement TCSC. In this paper, a power flow analysis was carried out using PowerWorld and MATLAB and the lines with over loaded were indentified also, the buses with low voltages were indentified. The effect of the application of SVC and TCSC for enhancing the performance of Diyala electric network (132kV) was demonstrated. PowerWorld and MATLAB (with and without SVC & TCSC) provided approximately the same effect on the voltage profile and same effect on over loaded lines. MATLAB gives a higher minimization in active and reactive power losses compared to PowerWorld. Finally, the results are very much promising.

VI. Acknowledgements

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Smokeless Cook stove an Advancement of the Combustion Technology and Innovative Approach towards Eco-Efficiency and Low Emissions in Rural Areas

Manoj Kumar Sharma, R.N. Shrivastava, Nikita Sharma
M.Tech. Scholar, Truba Institute of Engineering & Information Technology, Bhopal (M.P.) India
Oriental Institute of Science & Technology, Bhopal (M.P.) India.
B.Sc. (Hons), Student, Govt. P.G. College, BHEL, Bhopal (M.P.) India

Abstract: *In rural India many women spending several hours a day cooking over an indoor open stove is a normal practice. What these women fail to realize is that there is an invisible killer in their kitchen of burning biomass fuels causes almost 500,000 deaths every year in India alone. A design initiative can use its design expertise to help these women continue with their traditional culture, while empowering them to select a way of cooking that does not endanger their lives. It describes the brief and the open-innovation process used in creating the 'Chulha' (Stove) – a low-smoke stove that prevents sickness and death from indoor air pollution due to cooking activities with biomass fuels in rural low-income communities. Evaluation included a certification of stove's thermal performance, fuel consumption and carbon monoxide emissions. Stoves under testing used bio-organic waste. The firewood used as fuel was free from any potential pollutants. The design brief challenged team has to come up with a low-smoke solution for healthy and safe cooking able to fit the local socio-cultural and infrastructural conditions of rural and semi-urban areas. More specifically, objectives were to design, develop and test a solution, which able to reduce indoor pollution and therefore health-related diseases with respect to local culinary habits and cooking behaviors. With the advancement of the combustion technology and innovative approach towards applying the known principle of cook stove designing. The cook stove technology has gain the boost and now fourfold improvement in the overall thermal efficiency as compare to the traditional tri-stone cook stove. Apart from the type and quality of the fuel used, design of the cook stove chamber is the deciding factor for the associated emission causing by the fuel combustion. . TIDE has put up an effort to train more entrepreneurs. But finding the right candidate for training is a limiting factor to overcome.*
Key Words: *Smokeless Stove, Eco-Efficiency, thermal performance, Low Emissions, Biomass Fuel.*

I. Introduction

The Stove is not only benefits the users but also various stake holders, who are active in the value chain smokeless stoves. The production and distribution of the Chulha stimulates the creation of local entrepreneurial skills and provides low cost, affordable solutions that those who really need them. It became clear from the results of the research that the local design requirements called for a cooking solution able to fulfill the following physical and socio-cultural conditions i.e. adaptability to different biomass fuels from wood to cow dung. A technical assessment of the Chulha (Stove) has been conducted in laboratory to define its eco-efficiency and low emission. Use of different, non-standard cooking vessels and various logistic constraints, results world deaths from indoor air pollution due to burning solid fuels are estimated at 1,917,000 each year. India alone accounts for 25% of such deaths almost 800,000 of the victims are women and children. (Source: WHO 2015)

II. NPIC Program to Improve Cook Stoves

Since the energy crisis of the 1970s, improvement in biomass burning cook stoves to save fuel was considered as an urgent need. Various organizations in the world over started working towards the same. In India, the Department of Non-conventional Energy Sources (DNES), which was created in 1982 initiated demonstration of improved cook-stoves soon after its inception followed by launching of a demonstration project on Improved

Chulha in 1983. The programme objectives were to identify (i) fuel wood conservation; (ii) removal/reduction of smoke from kitchens; (iii) Reduction of deforestation and environmental degradation (iv) Reduction in the drudgery of tasks performed by women and girl-children and their consequent exposure to health hazards; and (v) employment generation in rural areas. In 1992, the DNES was upgraded to Ministry of Non-conventional Energy Sources (MNES) and continued to manage this programme. Later on in 2009 it was renamed as Ministry for New and Renewable Resources (MNRE)).

The **National Programme on Improved Cook stoves** (NPIC) was implemented through involvement of various State Nodal Departments/ Agencies in almost all the States and Union Territories. The technical training support programme was provided by 22 **Technical Back-up Support Units** (TBSUs), set up under the NPIC at different universities, IITs and other institutions of the country. More than 60 fixed and portable models of improved Chulha, with and without chimney, single-pot and multi-pot, suitable for different fuels, cooking habits and local requirements and using different materials of construction were developed and taken up for installation under NPIC.

Fig.1 Traditional Cook-Stove

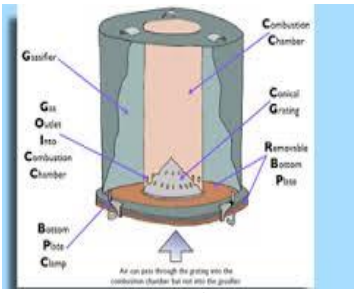

Fig.2 Inner View of Stoves

Fig.3 Traditional way of Cooking

III. Technical Testing

Test conducted upon a few comparative values of Traditional Stoves:–

(a) Time required for boiling 1 liter water-
11.5 minutes, 14 minutes, 22 minutes –

(b) Fuel required for boiling 1 liter water-
225gm, 315gm, 415gm

(c) Heating efficiency
Highest, lower, lowest

(d) Rate of cooling
Lowest, lower, highest

(e) Soot retention-
100mg, 80mg, 20mg

IV. Employment Opportunity

TIDE provides employment to 24 full time staff and some of the staff is engaged in developing the stove enterprises. Further, it has created employment opportunity by training 14 entrepreneurs, who has business employ about 40 skilled and 90 semi-skilled workers for making the stoves. These entrepreneurs also have the opportunity to develop new types of stoves, or improve the existing ones. Benefiting the women workforce, the project helped women self – help groups in increasing income generation in the areas of fish – drying, cashew nut processing and drying of coconuts.

V. Methodology

Based on international standards of emission and combustion, a standard testing protocol and procedure is under development. An international conference, organized by USAID in 1982, has resulted three distinct testing/evaluation techniques under the 1985 VITA protocol. Before launching the cook stove in to the market, cook stove need to go through three distinct test procedures, includes both lab and field test. These are:

The Water Boiling Test (WBT) – This is a laboratory test that simply simulates the cooking process. Here water in the cooking pot is heated to evaluate the thermal efficiency and associated emission generation during the combustion. Other than above, WBT test helps to provide an initial assessment of stove performance, design evaluation during the development, compare the effectiveness as compared to the different designs for performing the same task and ensures to meet the design specifications.

The Controlled Cooking Test (CCT) – This is a field test that analyzes how the new stove performs compared to common or traditional cooking methods. The test helps to compare the amount of fuel used by different stoves to cook a common food.

The Kitchen Performance Test (KPT) – This is a community field test that measures fuel use in homes.

All these tests helps to validate the stove from initial optimization of the technical design in the laboratory under the controlled artificial atmosphere to the final field testing with lot of actual field variables, affecting the cook stove performance. Those who want to secure the carbon credit; they need to go through one more test is called Gold Standard Cook Stove Methodology.

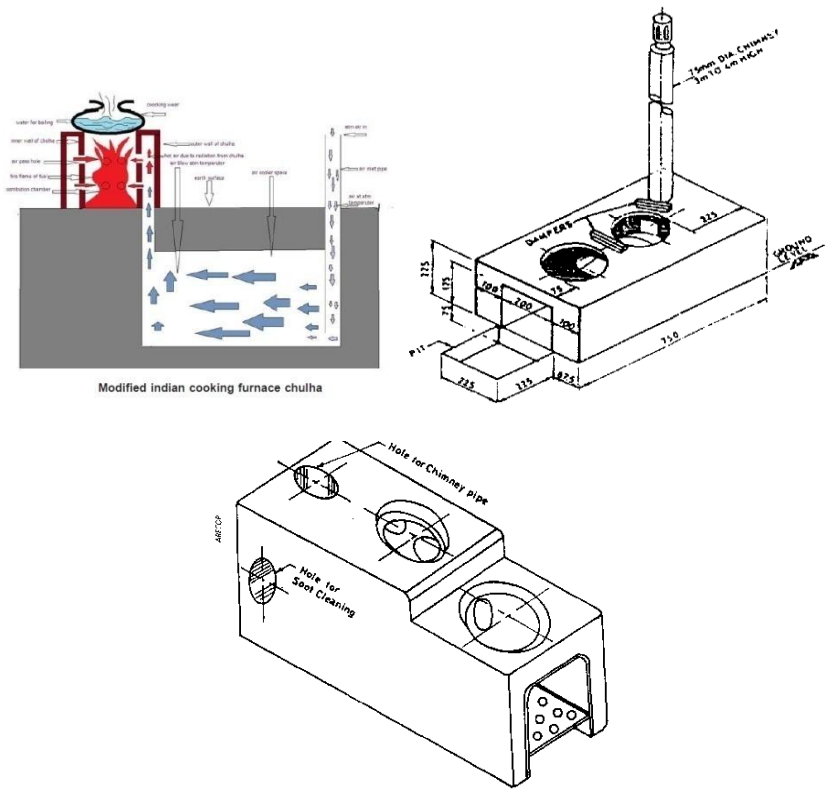

Fig. 4 Modified Design Cook stoves

There are four centers, which have been recognized by the MNRE for the testing and certification of the cook stoves:

1. East zone – IMMT, Bhubaneswar
2. West zone – MPUAT, Udaipur
3. North zone - IIT Delhi
4. South zone - IISc Bangalore

MNRE has been continuously engaged in various new 'improved cook stoves' initiative that aims to facilitate the development on the next-generation of biomass stoves for household cooking and their widespread deployment. Activities undertaken by MNRE under "New Indian Cook-stove Initiative" are given below:

- Organization of Brain-storming consultation on improved cook-stoves.
- Setting up of Core-Group comprising of experts from Institutions, industries, NGOs and other organizations active in the area of improved cook-stoves.

- Project taken up on "A new initiative for improved cook-stoves – preparatory activities for launch" through IIT Delhi and TERI.
- Launch of National Improved Cook-stove Initiative.
- Pilot field testing and evaluation of community size biomass cook-stoves for mid-day meals, hostels and eating joints/ Dhabas.
- Organized meeting of sub-group on revision of modified BIS standards and test protocols.
- Setting up of Steering Committee under the Chairmanship of Member, Planning Commission on National Biomass Cook-stoves Initiative.
- Steering Committee of Planning recommended for Innovative on cook-stoves competition through 'X' Prize Foundation.
- Formulation of Section 25 Company for providing institutional structure to introduce policy interventions.
- Organization of joint national workshop.
- Testing improved cook-stoves at IMMT, Bhubaneswar and MPUAT Udaipur.
- Stoves passed BIS Standard: Vikram cook-stove, Harsha Multi-fuel cook-stove, Oorja Cook-stove, Phillips Cook-stove.
- Excise duty exemption for improved cook-stoves.
- Improved cook-stoves included in Indira Awas Yojana of the Government.
- Supporting up gradation of 3 nos. of improved cook-stoves test centers at IIT Delhi, IIMT Bhubaneswar and MPUAT Udaipur and the fourth is already in operation at IISc, Bangalore.
- Pilot Implementation of various 'Delivery Models' for implementation of family type improved cook-stoves including production and supply of processed fuel are being contemplated.

VI. Testing and User Feedback

Aryan Industries **(www.aaryanindustries.in, Bhopal)** is producing smokeless cook stoves and has tested its cook stoves in rural and semi-urban homes, involving technical experts and stove users. Feedback regarding improvements suggested a few modifications to the initial versions of the stove. Design interventions included technical changes related to the manufacturing process to optimize heat flow within the stoves and improve their thermal efficiency, an easier way of assembling components such as self locking pieces. The introduction of a soot collector and fixing chimneys to the wall then, modified versions were installed in 12 homes for further trial and to evaluate their technical performance.

Fig. 5 Aaryan smokeless Cook-stoves

Fig. 6 MNER approved Chulha

Fig. 7 Cow dung Cakes for Fuel

According to the BIS Standards, 2013. The test results of Aaryan Smokeless Cook-stove have been communicated to MNRE. The average values for the different parameters studied were found as follows:
Power Output: 1.61 kW
Efficiency: 25.61 %
PM: 237.80 mg/ MJd,
CO: 5.21 g/MJd
Body Temperature: 69.33 ºC
Handle Temperature: 42.83 ºC

Since, the CO Emission parameter and body temperature parameters are much higher than the acceptable limits set by BIS for natural draft biomass Cook-stoves, therefore it need some modification in design.

The Aaryan Smokeless Cook-stoves were presented in several places for demonstration and received immense appreciation in-

- Vigyan Mela 2012 Indore,
- Bhopal Vigyan Mela, 2013
- Bhopal Vigyan Mela, 2014 (Best pavilion award by Ministry of Energy Govt. of M.P.
- Savishkar iFAST 2015, MANIT Bhopal MP India.
- Search and Research Youth Conclave-2015, Growing India International Conference on
- Indian Research Scenario, April 11th & 12th, 2015 TTTI Bhopal M.P.
- Tapti Vigyan Mela, 2015 Burhanpur M.P. India.
- Mandla Vigyan Mela, 2015 Mandla M.P. India.

VIII. Initiatives Taken

TIDE established in 1993 is a non-profit organization that aims at applying appropriate technology to rural situations. It does not innovate, but adapts products developed by research institutions to fit the user requirements and local conditions. The organization based in Bangalore, and works through a network at grass root entrepreneurs. These entrepreneurs and university graduates are trained by TIDE.
In southern India, an estimated eight million people work in small and tiny businesses. This includes food processing and preparation, textiles, Ayurvedic medicines and brick-making to name a few. These businesses run with small turnovers and for achieving a healthy bottom-line overheads are kept at a minimum. So when it comes to choosing a heat source for various manufacturing process, it is the low cost wood and other forms of biomass. Fuel efficiency is not given much consideration. However, there is an adverse impact on the environment. To mitigate these environmental concerns, **Technology Informatics Design Endeavour** (TIDE) developed a range of energy efficient stoves for the grass – root businesses to improve their operations using less wood. An improved stove works more efficiently by better heat transfer and combustion of the fuel. The manufacturing site for the stoves is always close to the location where it would be used and as far as possible they use locally available material. TIDE works with small town fabricators for different components of the stove. Quality control is an area where TIDE lays a lot of emphasis. To sustain the popularity of any product is an area that cannot be neglected. Towards this, they collaborate with leading institutes. The Central Power Research Institute tests the efficiency of the product, while The Centre for Sustainable Technologies at the Indian Institute of Sciences collaborates in the development process, carrying out field tests and in data collection. According to an assessment carried by TIDE in 2006 the stoves has saved 39 million per year in fuel costs. The TIDE fuel efficient stove also benefits the environment enormously by saving on biomass. For assessing the biomass savings, TIDE has developed an accounting methodology. This is based on test done by the Central Power Research Institute.

IX. Requirement of Cook-stoves At Targeted Market Are in Four Segments

Mid Day Meal Manufacturer: Stove that can cook more than 40,000 meals per day in a centralized kitchen. This stove is provided with a briquette fuelled steam boiler and stem-kettles that save up to 70% of fuel bills when replaced with LPG.
Micro Entrepreneurs: Stove for making fried snacks is an automated powdered biomass stove (Surya stove) having temperature controlling facility. As a result fuel feed can be controlled on the basis of the heat requirement of the food being cooked (or fried). This stove saves up to 50% of fuel when replaced with diesel fired stove.
Company and College Hostel Canteen: Stove for cooking meals for 1000 people. For such institutions Aryan Industries suggested steam boiler as well as biomass briquette fired Earth stoves (model ES10) and leaves it to the client to decide on the option depending on their financial ability. These options, when replaced with LPG help save up to 70% in fuel bills.
Restaurants and Road Side Dhabas: Vikram Stoves come in two models-ES2 and ES3 and save up to 70% of fuel when replaced with LPG. These models come with briquette fired with DC powered blower.

X. Cost Analysis of Running One Community Cook Stove

In fact, whatever cook stove model is used, each has the potential to save almost 50% of fuel cost. The numbers of LPG cylinders is almost to the tune of 750 LPG cylinders a year. The new models of Cook stoves have a strong body to withstand heavy work load of community kitchens.

Table- 1

Cost Analysis for 500 People		
Average consumption of Briquettes in Smokeless Cook Stoves	150	Kg/day
Total Expenditure on Briquette per month (considering Briquette cost @Rs. 8 per kg)	36000	Rs/month
LPG consumption (for same heat value)	112	No./month
Total Expenditure on LPG Cylinder per month (considering LPG cost @Rs. 450 per cylinder	50400	Rs./month
Net Savings	**14400**	**Rs./month**

VII. Future Scope of Work

The stoves should be equipped with well designed combustion chamber volume resulting in high combustion and heat transfer efficiencies. The stoves should be designed to burn the fuel totally with high temperature with optimized air-to-fuel ratio. The area of contact between the hot gases and the heated vessel volume should be maximized in order to increase the heat transfer process. An efficient insulation minimizes the heat loss and reduces the risk of burning from direct contact. An optimally designed chimney to vent the flue gases is designed to reduce heat losses to the atmosphere. The chimneys take smoke away from the users.

Bypass duct for efficient draft - It ensures equal heat distribution and right turbulence under the first and second pot, resulting in faster cooking and boiling. - It helps bring down the boiling time by 3 minutes, reaching boiling time in 10-11 minutes: standard stoves boils around 22 minutes while our previous Chulha version (without bypass) between 13-14 minutes.

Soot collector for cleaner air – The soot collector reduces the amount of soot that reaches the chimney and therefore both the risk of pipe obstruction and the time required for chimney maintenance. - Soot can be collected by passing the gases through a zigzag path in the chimney chamber at the stove level. Like any entrepreneurial venture, this also has it challenges. Currently, TIDE and its entrepreneurs are installing 1,300 stoves per year. For taking this project forward.

XI. Results and Discussions

It is expected that these Green Entrepreneurs in the long run will be able to establish the stoves free of charge in the client's premises and establish briquette supply chain for these customers, similar to the existing LPG delivery system prevalent in the country. To make the business more viable for the Green Entrepreneurs, 60% of the carbon offset money is used. In the long run, the firm hopes to create thousands of such entrepreneurs operating self sustaining, It is estimated that with a mere investment of 5 lakh, such an enterprise can be created that can generate an income of 15,000-20,000 per year. A firm near Chandigarh is manufacturing of stoves and delivering more than 3500 Stoves in many parts of the country including Punjab, Haryana, Rajasthan, Bihar, Tamil Nadu, Andhra Pradesh and Maharashtra for diverse clients, including clients making 40,000 meals per day, to small road-side restaurants. There is enormous potential to scale up this technology and use it for a variety of small-scale industries. Literally starting from scratch, the firm lacks the much needed catalyst of capital investment to strengthen its manufacturing infrastructure. Improved stoves also brought hygiene in the kitchen area by reducing smoke and soot in the air. Concentration of carbon monoxide was brought down to 480µg/m³ from 4260 µg/m³ in indoor air. Room temperature of the kitchen was also brought down by at least 8º C. Improved cook stoves also led to employment generation. They provided employment to 80 masons and 12 fabricators, and many people may get employment as the popularity of improved cook stoves increases. The technology is very easy to replicate and costs involved are very low. Due to these factors improved cook stoves have huge potential for replication not only in Andhra Pradesh, where there are about 4000 way side hotels but also all over India, wherever conventional stoves are used for cooking food in way side hotels, Dhabas and individual households.

XII. Conclusions

First of all, we have realized that an understanding of the local physical infrastructural, economic and socio-cultural conditions is imperative before making any technological choices. The challenge is coming up with an accessible, affordable and sustainable solution for local needs to evaluate the best technological solution at a given moment in time, rather than opt for the best available technology. With our Chulha for instance, insights from the targeted users and local stakeholders helped us to understand current barriers to cultural acceptance, as well as constraints on product dissemination. Based on these insights the most feasible and appropriate technological answer is to achieve our objectives. Last but not least, it should be noted that the co-design approach resulted not only in a way of delivering a solution that better fit the context of application, but also enhanced the potential benefits of the stakeholders involved, democratizing the value creation process, and therefore increasing the chance of implementing valuable solutions for all. Indeed, with this approach, users and stakeholders worked together in a participatory process where they all put their own interests on the table. Key, in this regard, was to go beyond listening intensively to local communities to acquiring their true engagement, where users were even empowered in the decision making process. From the very start of the experience, adopting a process in which designers and researchers operate in a multidisciplinary team, where an open dialogue with NGOs and various local stakeholders bringing knowledge from the field, is essential in envisioning an effective human-centered solution. The value co-creation process undertaken during this journey of understanding and learning has resulted in a stove that makes indoor cooking healthier, cleaner and faster when compared with traditional indoor open cooking fires. The Chulha also claims to be, simple to use and easy to maintain.

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Mechanical Strength Modeling and Optimization of Lateritic Solid Block with 4% Mound Soil Inclusion

Onuamah, P.N.[1], Ezeokpube G.C. [2]
[1](Department of Civil Engineering Enugu State Univetrsity of Science and Technology, Enugu, Nigeria
[2](Department of Civil Engineerin, Michael Okpara University of Agriculture, Umudike, Abia State, Nigeria)

ABSTRACT :*The work is an investigation for the model development and optimization of the compressive strength of solid sandcrete block with mound soil inclusion. The study applies the Scheffe's optimization approach to obtain a mathematical model of the form* $f(x_{i1},x_{i2},x_{i3},x_{i4})$*, where* x_i *are proportions of the concrete components, viz: cement, mound soil, laterite, and water. Scheffe's experimental design techniques are followed to mould various solid block samples measuring 450mm x 225mm x 150mm and tested for 28 days strength. The task involved experimentation and design, applying the second order polynomial characterization process of the simplex lattice method. The model adequacy is checked using the control factors. Finally a software is prepared to handle the design computation process to take the desired property of the mix, and generate the optimal mix ratios.*

Keywords: *Sandcrete, Pseudo-component, Simplex-lattice, optimization, Experimental matrix*

I. INTRODUCTION

The construction of structures is a regular operation which heavily involves sandcrete blocks for load bearing or non-load bearing walls. The cost/stability of this material has been a major issue in the world of construction where cost is a major index. This means that the locality and the usability of the available materials directly impact on the achievable development of any area as well as the attainable level of technology in the area.As it is, concrete is the main material of construction, and the ease or cost of its production accounts for the level of success in the area of environmental upgrading involving the construction of new roads, buildings, dams, water structures and the renovation of such structures. To produce the concrete several primary components such as cement, sand, gravel and some admixtures are to be present in varying quantities and qualities. Unfortunately, the occurrence and availability of these components vary very randomly with location and hence the attendant problems of either excessive or scarce quantities of the different materials occurring in different areas. Where the scarcity of one component prevails exceedingly, the cost of the concrete production increases geometrically. Such problems obviate the need to seek alternative materials for partial or full replacement of the scarce component when it is possible to do so without losing the quality of the concrete.

1.1 Optimization Concept

The target of planning is the maximization of the desired outcome of the venture. In order to maximize gains or outputs it is often necessary to keep inputs or investments at a minimum at the production level. The process involved in this planning activity of minimization and maximization is referred to as optimization [1]. In the science of optimization, the desired property or quantity to be optimized is referred to as the objective function. The raw materials or quantities 4hose amount of combinations will produce this objective function are referred to as variables. The variations of these variables produce different combinations and have different outputs. Often the space of variability of the variables is not universal as some conditions limit them. These conditions are called constraints. For example, money is a factor of production and is known to be limited in supply. The constraint at any time is the amount of money available to the entrepreneur at the time of investment. Hence or otherwise, an optimization process is one that seeks for the maximum or minimum value and at the same time satisfying a number of other imposed requirements [2]. The function is called the objective function and the specified requirements are known as the constraints of the problem.

Everybody can make concrete but not everybody can make structural concrete. Structural concrete are made with specified materials for specified strength. Concrete is heterogeneous as it comprises sub-materials. Concrete is made up of fine aggregates, coarse aggregates, cement, water, and sometimes admixtures. [3] report that modern research in concrete seeks to provide greater understanding of its constituent materials and possibilities of improving its qualities. For instance, Portland cement has been partially replaced with ground granulated blast furnace slag (GGBS), a by–product of the steel industry that has valuable cementatious properties [4].

1.2 Concrete Mix Optimization

The task of concrete mix optimization implies selecting the most suitable concrete aggregates from the data base. Several methods have been applied. Examples are by [10], [17]. [11] proposed an approach which adopts the equilibrium mineral assemblage concept of geochemical thermodynamics as a basis for establishing mix proportions. [8] reports that optimization of mix designs require detailed knowledge of concrete properties. Low water-cement ratios lead to increased strength but will negatively lead to an accelerated and higher shrinkage. Apart from the larger deformations, the acceleration of dehydration and strength gain will cause cracking at early ages.

1.3 Modeling

Modeling involves setting up mathematical formulations of physical or other systems. Many factors of different effects occur in nature in the world simultaneously dependently or independently. When they interplay they could inter-affect one another differently at equal, direct, combined or partially combined rates variationally, to generate varied natural constants in the form of coefficients and/or exponents. The challenging problem is to understand and asses these distinctive constants by which the interplaying factors underscore some unique natural phenomenon towards which their natures tend, in a single, double or multi phase system.

For such assessment a model could be constructed for a proper observation of response from the interaction of the factors through controlled experimentation followed by schematic design where such simplex lattice approach of the type of [9] optimization theory could be employed. Also entirely different physical systems may correspond to the same mathematical model so that they can be solved by the same methods. This is an impressive demonstration of the unifying power of mathematics [10].

II. LITERATURE REVIEW

In the past ardent researchers have done works in the behavior of concrete under the influence of its components. With given proportions of aggregates the compressive strength of concrete depends primarily upon age, cement content, and the cement-water ratio [11]. Of all the desirable properties of hardened concrete such as the tensile, compressive, flexural, bond, shear strengths, etc., the compressive strength is the most convenient to measure and is used as the criterion for the overall quality of the hardened concrete [2]. Optimization of mix designs require detailed knowledge of concrete properties. The task of concrete mix optimization implies selecting the most suitable concrete aggregates from a data base. Mathematical models have been used to optimize some mechanical properties of concrete made from Rice Husk Ash (RHA), - a pozolanic waste [9],and [12]. Macrofaunal activities in soil are known to affect the nutrient and organic matter dynamics and structure of the soil. Such changes in soil properties have profound influences on the productivity of the ecosystem. Termites are the dominant macrofaunal group found in the tropical soils. Termites process considerable quantities of soil materials in their mound building activities. Such activities might have potential effects on carbon sequestration, nutrient cycling, and soil texture [13].

The result of a study on some characteristics of laterite- cement mix containing termite mound soil (50% by weight of laterite) as replacement of laterite are presented by [14]. The study showed that laterite-mound soil mix stabilized with 6% cement could serve as a base course for roads for agricultural trafficking in rural areas where mound soils are abundant. The inclusion of mound soil in mortar matrix resulted in a compressive strength value of up to 40.08N/mm2, and the addition of 5% of mound soil to a concrete mix of 1:2:4:0.56 (cement: sand: coarse aggregate: water) resulted in an increase of up to 20.35% in compressive strength [15]. Simplex is a structural representation (shape) of lines or planes joining assumed positions or points of the constituent materials (atoms) of a mixture, and they are equidistant from each other [16]. When studying the properties of a q-component mixture, which are dependent on the component ratio only the factor space is a regular (q-1)–simplex [17]. Simplex lattice designs are saturated, that is, the proportions used for each factor have m + 1 equally spaced levels from 0 to 1 (x_i = 0, 1/m, 2/m, … 1), and all possible combinations are derived from such values of the component concentrations, that is, all possible mixtures, with these proportions are used [17].

Sandcrete blocks are masonry units used in all types of masonry constructions such as interior and exterior load bearing walls, fire walls party walls, curtain walls, panel walls, partition, backings for other masonry, facing materials, fire proofing over structured steel members, piers, pilasters columns, retaining walls, chimneys, fireplaces, concrete floors, patio paving units, curbs and fences [18]. The block is defined by ASIM as hollow block when the cavity area exceeds 25% of the gross cross-sectional area, otherwise it belongs to the solid category [18]. [19] stated that methods of compaction during moulding has a marked effect on the strength of sandcrete blocks. Hence, it was found that blocks from factories achieving compaction by using wooden rammers had higher strength than those compacted by mechanical vibration, except when the vibration is carried out with additional surcharge.

III. BACKGROUND THEORY

This is a theory where a polynomial expression of any degrees, is used to characterize a simplex lattice mixture components. In the theory only a single phase mixture is covered. The theory lends path to a unifying equation model capable of taking varying mix component variables to fix equal mixture properties. The optimization that follows selects the optimal ratio from the component ratios list that is automatedly generated. This theory is the adaptation to this work of formulation of response function for compressive strength of sandcrete block.

3.1 Simplex Lattice

Simplex is a structural representation (shape) of lines or planes joining assumed positions or points of the constituent materials (atoms) of a mixture [16], and they are quidistant from each other. Mathematically, a simplex lattice is a space of constituent variables of X_1, X_2, X_3,……, and X_i which obey these laws:

$$\left.\begin{array}{l} X \neq \text{negative} \\ 0 \leq x_i \leq 1 \\ \sum_{i=1} x_i = 1 \end{array}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

That is, a lattice is an abstract space.

To achieve the desired strength of concrete, one of the essential factors lies on the adequate proportioning of ingredients needed to make the concrete. [9] developed a model whereby if the compressive strength desired is specified, possible combinations of needed ingredients to achieve the compressive strength can easily be predicted by the aid of computer, and if proportions are specified the compressive strength can easily be predicted.

3.2 Simplex Lattice Method

In designing experiment to attack mixture problems involving component property diagrams the property studied is assumed to be a continuous function of certain arguments and with a sufficient accuracy it can be approximated with a polynomial [17]. When investigating multi-components systems the use of experimental design methodologies substantially reduces the volume of an experimental effort. Further, this obviates the need for a spatial representation of complex surface, as the wanted properties can be derived from equations while the possibility to graphically interpret the result is retained.

As a rule the response surfaces in multi-component systems are very intricate. To describe such surfaces adequately, high degree polynomials are required, and hence a great many experimental trials. A polynomial of degree n in q variable has C^n_{q+n} coefficients. If a mixture has a total of q components and x_1 be the proportion of the i^{th} component in the mixture such that,

$$x_i >= 0 \ (i=1,2, \ldots.q), \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

then the sum of the component proportion is a whole unity i.e.

$$X_1 + x_2 + x_3 + x_4 = 1 \text{ or } \sum x_i - 1 = 0 \ \ldots. \quad .. \quad .. \quad .. \quad (3)$$

where i = 1, 2, …., q… Thus the factor space is a regular (q-1) dimensional simplex. In (q-1) dimensional simplex if q = 2, we have 2 points of connectivity. This gives a straight line simplex lattice. If q=3, we have a triangular simplex lattice and for q = 4, it is a tetrahedron simplex lattice, etc. Taking a whole factor space in the design we have a (q,m) simplex lattice whose properties are defined as follows:

i. The factor space has uniformly distributed points,

ii. Simplex lattice designs are saturated [17]. That is, the proportions used for each factor have m + 1 equally spaced levels from 0 to 1 (x_i = 0, 1/m, 2/m, … 1), and all possible combinations are derived from such values of the component concentrations, that is, all possible mixtures, with these proportions are used.

Hence, for the quadratic lattice (q,2), approximating the response surface with the second degree polynomials (m=2), the following levels of every factor must be used 0, ½ and 1; for the fourth order (m=4) polynomials, the levels are 0, 1/4, 2/4, 3/4 and 1, etc; [9] showed that the number of points in a (q,m) lattice is given by

$$C_{q+m-1} = q(q+1) \ldots (q+m-1)/m! \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

3.2.1 The (4,2) Lattice Model

The properties studied in the assumed polynomial are real-valued functions on the simplex and are termed responses. The mixture properties were described using polynomials assuming a polynomial function of degree m in the q-variable x_1, x_2 ……, x_q, subject to equation 3.1, and will be called a (q,m) polynomial having a general form:

$$\hat{Y} = b_0 + \sum_{i\le l\le q} b_i X_i + \sum_{i\le l<j\le q} b_{ij} X_i X_j + \ldots + \sum_{i\le l<j<k\le q} b_{ijk} + \sum b_{i1i2\ldots in} X_{i1} X_{i2} \ldots X_{in} \quad \ldots\ldots \quad (5)$$

$$\hat{Y} = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_{12}X_1X_2 + b_{13}X_1X_3 + b_{14}X_1X_4 + b_{24}X_2X_4 + b_{23}X_2X_3 + b_{34}X_3X_4$$

$$b_{11}X^2_1 + b_{22}X^2_2 + b_{33}X^2_3 + b_{44}X^2_4 \quad \ldots \quad \ldots \quad (6)$$

where b is a constant coefficient.

The relationship obtainable from Eqn (6) is subjected to the normalization condition of Eqn. (3) for a sum of independent variables. For a ternary mixture, the reduced second degree polynomial can be obtained as follows:

From Eqn. (3)

$$X_1 + X_2 + X_3 + X_4 = 1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (7)$$

i.e

$$b_0 X_2 + b_0X_2 + b_0 X_3 + b_0X_4 = b_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

Multiplying Eqn. (3.7) by X_1, X_2, x_3, x_4, in succession gives

$$\begin{aligned} X_1^2 &= X_1 - X_1X_2 - X_1X_3 - X_1X_4 \\ X_2^2 &= X_2 - X_1X_2 - X_2X_3 - X_2X_4 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (9) \\ X_3^2 &= X_3 - X_1X_3 - X_2X_3 - X_3X_4 \\ X_4^2 &= X_4 - X_1X_4 - X_2X_4 - X_3X_4 \end{aligned}$$

Substituting Eqn. (8) into Eqn. (9), we obtain after necessary transformation that

$$\begin{aligned} \hat{Y} = {} & (b_0 + b_1 + b_{11})X_1 + (b_0 + b_2 + b_{22})X_2 + (b_0 + b_3 + b_{33})X_3 + (b_0 + b_4 + b_{44})X_4 + \\ & (b_{12} - b_{11} - b_{22})X_1X_2 + (b_{13} - b_{11} - b_{33})X_1X_3 + (b_{14} - b_{11} - b_{44})X_1X_4 + (b_{23} - b_{22} - \\ & b_{33})X_2X_3 + (b_{24} - b_{22} - b_{44})X_2X_4 + (b_{34} - b_{33} - b_{44})X_3X_4 \quad \ldots \ldots \ldots (10) \end{aligned}$$

If we denote

$$\beta_i = b_0 + b_i + b_{ii}$$

and $$\beta_{ij} = b_{ij} - b_{ii} - b_{jj},$$

then we arrive at the reduced second degree polynomial in 6 variables:

$$\hat{Y} = \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_{12}X_1X_2 + \beta_{13}X_1X_3 + \beta_{14}X_1X_4 + \beta_{23}X_2X_{23} + \beta_{24}X_2X_4 + \beta_{34}X_3X_4 \quad (11)$$

Thus, the number of coefficients has reduced from 15 in Eqn 6 to 10 in Eqn 11. That is, the reduced second degree polynomial in q variables is

$$\hat{Y} = \sum \beta_i X_i + \sum \beta_{ij} X_i \quad \ldots\ldots\ldots\ldots\ldots \quad (12)$$

3.2.2 Construction of Experimental/Design Matrix

From the coordinates of points in the simplex lattice, we can obtain the design matrix. We recall that the principal coordinates of the lattice, only a component is 1 (Table 1) zero.

Table 1 Design matrix for (4,2) Lattice

N	X_1	X_2	X_3	X_4	Y_{exp}
1	1	0	0	0	Y_1
2	0	1	0	0	Y_2
3	0	0	1	0	Y_3
4	0	0	0	1	Y_4
5	½	1/2	0	0	Y_{12}
6	½	0	1/2	0	Y_{13}
7	1//2	0	0	1/2	Y_{14}
8	0	1/2	1/2	0	Y_{23}
9	0	1/2	0	1/2	Y_{24}
10	0	0	1/2	1/2	Y_{34}

Hence if we substitute in Eqn. (11), the coordinates of the first point (X_1=1, X_2=0, X_3=0,and X_4=0, Fig (3.1), we get that $Y_1 = \beta_1$.

And doing so in succession for the other three points in the tetrahedron, we obtain

$$Y_2 = \beta_2,\ Y_3 = \beta_3,\ Y_4 = \beta_4 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (13)$$

The substitution of the coordinates of the fifth point yields

$$Y_{12} = ½\ X_1 + ½X_2 + ½X_1.{}^1/_2X_2$$
$$= ½\ \beta_1 + ½\ \beta_2 + {}^1/_4\ \beta_{12}$$

But as $\beta_i = Y_i$ then

$$Y_{12} = ½\ \beta_1 - ½\ \beta_2 - {}^1/_4\ \beta_{12}$$

Thus

$$\beta_{12} = 4\ Y_{12} - 2Y_1 - 2Y_2 \quad . \quad . \quad . \quad . \quad . \qquad (14)$$

And similarly,

$$\beta_{13} = 4\ Y_{13} - 2Y_1 - 2Y_2$$
$$\beta_{23} = 4\ Y_{23} - 2Y_2 - 2Y_3$$

etc.

Or generalizing,

$$\beta_i = Y_i \text{ and } \beta_{ij} = 4\ Y_{ij} - 2Y_i - 2Y_j \quad . \quad . \quad . \quad . \quad . \quad . \qquad .(15)$$

which are the coefficients of the reduced second degree polynomial for a q-component mixture, since the four points defining the coefficients β_{ij} lie on the edge. The subscripts of the mixture property symbols indicate the relative content of each component X_i alone and the property of the mixture is denoted by Y_i.

3.2.3 Actual and Pseudo Components

The requirements of the simplex that

$$\sum_{X=1} Xi = 1$$

makes it impossible to use the normal mix ratios such as 1:3, 1:5, etc, at a given water/cement ratio. Hence a transformation of the actual components (ingredient proportions) to meet the above criterion is unavoidable. Such transformed ratios say $X_1^{(i)}$, $X_2^{(i)}$, and $X_3^{(i)}$ and $X_4^{(i)}$ for the i^{th} experimental points are called pseudo components. Since X_1, X_2 and X_3 are subject to $\sum Xi = 1$, the transformation of cement:mound soil:laterite:water at say 0.30 water/cement ratio cannot easily be computed because X_1, X_2,X_3 and X_4 are in pseudo expressions $X_1^{(i)}$, $X_2^{(i)}$, and $X_3^{(i)}$.For the i^{th} experimental point, the transformation computations are to be done.

The arbitrary vertices chosen on the triangle are A_1(1:5.6:2.4:0.3), A_2(1:5:3:0.32) A_3(1:4.8:3.2:0.33), and A_4(1:5.8:2.2:0.28), based on experience and earlier research reports.

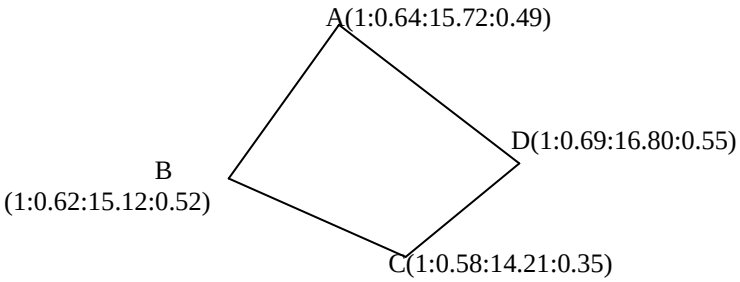

Fig. 1 Tetrahedral Simplex

3.2.4 Transformation Matrix

If Z denotes the actual matrix of the i^{th} experimental points, observing from Table 2 (points 1 to 3),

$BZ = X = 1$ . . . . . .(16)

where B is the transformed matrix.

Therefore, $B = I.Z^{-1}$

Or $B = Z^{-1}$ . . . . . (17)

For instance, for the chosen ratios A_1, A_2 A_3 and A_4 (fig. 1),

$$Z = \begin{pmatrix} 1 & 0.64 & 15.72 & 0.49 \\ 1 & 0.62 & 15.12 & 0.52 \\ 1 & 0.58 & 14.21 & 0.35 \\ 1 & 0.69 & 16.80 & 0.55 \end{pmatrix} \quad . \quad . \quad . \quad . \quad . \quad . \quad (18)$$

From Eqn 17,

$B = Z^{-1}$

$$Z^{-1} = \begin{pmatrix} -3.01 & 8.20 & 2.42 & -6.61 \\ -224.80 & 52.74 & 59.53 & 112.53 \\ 9.31 & -2.96 & 2.35 & -4.00 \\ 3.05 & 9.31 & -7.31 & -5.05 \end{pmatrix}$$

Hence,

$B Z^{-1} = Z. Z^{-1}$

$$= \begin{pmatrix} 1 & 0.64 & 15.72 & 0.49 \\ 1 & 0.62 & 15.12 & 0.52 \\ 1 & 0.58 & 14.21 & 0.35 \\ 1 & 0.69 & 16.80 & 0.55 \end{pmatrix} \begin{pmatrix} -3.01 & 8.20 & 2.42 & -6.61 \\ -224.80 & 52.74 & 59.53 & 112.53 \\ 9.31 & -2.96 & 2.35 & -4.00 \\ 3.05 & 9.31 & -7.31 & -5.05 \end{pmatrix}$$

$$= \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}$$

Thus, for actual component Z, the pseudo component X is given by

$$X \begin{pmatrix} X_1^{(i)} \\ X_2^{(i)} \\ X_3^{(i)} \\ X_4^{(i)} \end{pmatrix} = B \begin{pmatrix} -3.01 & 8.20 & 2.42 & -6.61 \\ -224.80 & 52.74 & 59.53 & 112.53 \\ 9.31 & -2.96 & 2.35 & -4.00 \\ 3.05 & 9.31 & -7.31 & -5.05 \end{pmatrix} Z \begin{pmatrix} Z_1^{(i)} \\ Z_2^{(i)} \\ Z_3^{(i)} \\ Z_4^{(i)} \end{pmatrix}$$

which gives the X_i(i=1,2,3) values in Table 2.

The inverse transformation from pseudo component to actual component is expressed as

$$AX = Z \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (19)$$

where A = inverse matrix

$$A = Z X^{-1}.$$

From Eqn 16, X = BZ, therefore,

$$A = Z.(BZ)^{-1}$$
$$A = Z.Z^{-1}B^{-1}$$
$$A = IB^{-1}$$
$$= B^{-1} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (20)$$

This implies that for any pseudo component X, the actual component is given by

$$Z = \begin{pmatrix} 1 & 0.64 & 15.72 & 0.49 \\ 1 & 0.62 & 15.12 & 0.52 \\ 1 & 0.58 & 14.21 & 0.35 \\ 1 & 0.69 & 16.80 & 0.55 \end{pmatrix}$$

$$Z \begin{pmatrix} Z_1^{(i)} \\ Z_2^{(i)} \\ Z_3^{(i)} \\ Z_4^{(i)} \end{pmatrix} = B \begin{pmatrix} 1 & 0.64 & 15.72 & 0.49 \\ 1 & 0.62 & 15.12 & 0.52 \\ 1 & 0.58 & 14.21 & 0.35 \\ 1 & 0.69 & 16.80 & 0.55 \end{pmatrix} X \begin{pmatrix} X_1^{(i)} \\ X_2^{(i)} \\ X_3^{(i)} \\ X_4^{(i)} \end{pmatrix} \quad . \quad . \quad . \quad . \quad . \quad (21)$$

Eqn 21 is used to determine the actual components from points 5 to 10 , and the control values from points 11 to 13 (Table 2).

Table 2 Values for Experiment

N	X_1	X_2	X_3	X_4	RESPONSE	Z_1	Z_2	Z_3	Z_4
1	1	0	0	0	Y_1	1.00	0.64	15.72	0.49
2	0	1	0	0	Y_2	1.00	0.62	15.12	0.52
3	0	0	1	0	Y_3	1.00	0.58	14.21	0.35
4	0	0	0	1	Y_4	1.00	0.69	16.80	0.55
5	½	1/2	0	0	Y_{12}	1.00	0.63	15.42	0.51
6	½	0	1/2	0	Y_{13}	1.00	0.32	14.97	0.42
7	1//2	0	0	1/2	Y_{14}	1.00	0.67	16.26	0.52
8	0	1/2	1/2	0	Y_{23}	1.00	0.31	14.67	0.44
9	0	1/2	0	1/2	Y_{24}	1.00	0.66	15.96	0.54
10	0	0	1/2	1/2	Y_{34}	1.00	0.35	15.51	0.45
Control points									
11	0.25	0.25	0.25	0.25	Y_{1234}	1.00	0.49	15.46	0.48
12	0.5	0.25	0.25	0	Y_{1123}	1.00	0.48	15.19	0.46
13	0.25	0.5	0	0.25	Y_{1224}	1.00	0.64	15.69	0.52

3.2.5 Use of Values in Experiment

During the laboratory experiment, the actual components were used to measure out the appropriate proportions of the ingredients: cement, mound soil, laterite and water for casting the samples. The values obtained are presented in Tables in section 5.

3.3 Adequacy of Tests

This is carried out by testing the fit of a second degree polynomial [17]. After the coefficients of the regression equation has been derived, the statistical analysis is considered necessary, that is, the equation should be tested for goodness of fit, and the equation and surface values bound into the confidence intervals. In experimentation following simplex-lattice designs there are no degrees of freedom to test the equation for adequacy, so, the experiments are run at additional so-called control points.

The number of control points and their coordinates are conditioned by the problem formulation and experiment nature. Besides, the control points are sought so as to improve the model in case of inadequacy. The accuracy of response prediction is dissimilar at different points of the simplex. The variance of the predicted response, S_Y^2, is obtained from the error accumulation law. To illustrate this by the second degree polynomial for a quaternary mixture, the following points are assumed:

X_i can be observed without errors [17].

The replication variance, S_Y^2, is similar at all design points, and

Response values are the average of n_i and n_{ij} replicate observations at appropriate points of the simplex

Then the variance $S_{\hat{Y}i}$ and $S_{\hat{Y}ij}$ will be

$$(S_{\hat{Y}}^2)_i = S_Y^2/n_i \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (22)$$

$$S_{\hat{Y}}^2)_{ij} = S_Y^2/n_{ij}. \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (23)$$

In the reduced polynomial,

$$\hat{Y} = \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_{12}X_1X_2 + \beta_{13}X_1X_3 + \beta_{14}X_1X_4 + \beta_{23}X_2X_{23} + \beta_{24}X_2X_4 + \beta_{34}X_3X_4 \quad . \quad . \quad . \quad .(24)$$

If we replace coefficients by their expressions in terms of responses,

$\beta_i = Y_i$ and $\beta_{ij} = 4Y_{ij} - 2Y_i - 2Y_j$

$$\hat{Y} = Y_1X_1 + Y_2X_2 + Y_3X_3 + Y_4X_4 + (4Y_{12} - 2Y_1 - 2Y_2)X_1X_2 + (4Y_{13} - 2Y_1 - 2Y_3)X_1X_3 + (4Y_{14} - 2Y_1 - 2Y_4)X_1X_4 + (4Y_{23} - 2Y_2 - 2Y_3)X_2X_3 + (4Y_{24} - 2Y_2 - 2Y_4)X_2X_4 + (4Y_{34} - 2Y_3 - 2Y_4)X_3X_4$$

$$= Y_1(X_1 - 2X_1X_2 - 2X_1X_3 - 2X_1X_4) + Y_2(X_2 - 2X_1X_2 - 2X_2X_3 - 2X_2X_4) + Y_3(X_3 - 2X_1X_3 + 2X_2X_3 + 2X_3X_4) + Y_4(X_4 - 2X_1X_4 + 2X_2X_4 + 2X_3X_4) + 4Y_{12}X_1X_2 + 4Y_{13}X_1X_3 + 4Y_{14}X_1X_4 + 4Y_{23}X_2X_3 + 4Y_{24}X_2X_4 + 4Y_{34}X_3X_4 \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (25)$$

Using the condition $X_1 + X_2 + X_3 + X_4 = 1$, we transform the coefficients at Y_i

$$X_1 - 2X_1X_2 - 2X_1X_3 - 2X_1X_4 = X_1 - 2X_1(X_2 + X_3 + X_4)$$

$$= X_1 - 2X_1(1 - X_1) = X_1(2X_1 - 1) \text{ and so on.} \quad . \quad (26)$$

Thus

$$\hat{Y} = X_1(2X_1 - 1)Y_1 + X_2(2X_2 - 1)Y_2 + X_3(2X_3 - 1)Y_3 + X_4(2X_4 - 1)Y_4 + 4Y_{12}X_1X_2 + 4Y_{13}X_1X_3 + 4Y_{14}X_1X_4 + 4Y_{23}X_2X_3 + 4Y_{24}X_2X_4 + 4Y_{34}X_3X_4 \quad . \quad . \quad . \quad . \quad . \quad (27)$$

Introducing the designation

$$a_i = X_i(2X_1 - 1) \text{ and } a_{ij} = 4X_iX_j \quad . \quad . \quad . \quad . \quad . \quad (27a)$$

and using Eqns (3.22) and (3.230) give the expression for the variance S_Y^2.

$$S_{\hat{Y}}^2 = S_Y^2 \left(\sum_{1\le i\le q} a_{ii}/n_i + \sum_{1\le i<j\le q} a_{jj}/n_{ij}\right) \quad . \quad . \quad . \quad . \quad .. \quad (28)$$

If the number of replicate observations at all the points of the design are equal, i.e. $n_i=n_{ij}=$ n, then all the relations for $S_{\hat{Y}}^2$ will take the form

$$S_{\hat{Y}}^2 = S_Y^2\xi/n \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (29)$$

where, for the second degree polynomial,

$$\xi = \sum a_i^2 + \sum_{1\le i\le q} a_{ij}^2 \quad 1\le i<j\le q \quad . \quad . \quad (30)$$

As in Eqn (30), ξ is only dependent on the mixture composition. Given the replication variance and the number of parallel observations n, the error for the predicted values of the response is readily calculated at any point of the composition-property diagram using an appropriate value of ξ taken from the curve.

Adequacy is tested at each control point, for which purpose the statistic is built:

$$t = \Delta_Y/(S_{\hat{Y}}^2 + S_Y^2) = \Delta_Y n^{1/2} /(S_Y(1 + \xi)^{1/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad (31)$$

where $\Delta_Y = Y_{exp} - Y_{theory}$ . . . . . (32)

and n = number of parallel observations at every point.

The t-statistic has the student distribution, and it is compared with the tabulated value of $t_{\alpha/L}(V)$ at a level of significance α, where L = the number of control points, and V = the number for the degrees of freedom for the replication variance.

The null hypothesis is that the equation is adequate is accepted if $t_{cal} < t_{Table}$ for all the control points.

The confidence interval for the response value is

$$\hat{Y} - \Delta \le Y \le \hat{Y} + \Delta \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (3.33)$$

$$\Delta = t_{\alpha/L,k}\, S_{\hat{Y}} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (34)$$

where k is the number of polynomial coefficients determined.

Using Eqn (29) in Eqn (34)

$$\Delta = t_{\alpha/L,k}\, S_Y(\xi/n)^{1/2} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (35)$$

IV. METHODOLOGY

To be a good structural material, the material should be homogeneous and isotropic. The Portland cement, sandcrete or concrete are none of these, nevertheless they are popular construction materials [20].The necessary materials required in the manufacture of the sandcrete in the study are cement, mound soil, laterite and water.

4.1 Materials

The Laterite materiasl were collected at Emene area of Enugu State and conformed to BS 882 and belongs to zone 1 of the ASHTO classification. The mound soil were collected from bushes in the same area. The water for use is pure drinking water which is free from any contamination i.e. nil Chloride content, pH =6.9, and Dissolved Solids < 2000ppm. Ordinary Portland cement is the hydraulic binder used in this project and sourced from the Dangote Cement Factory, and assumed to comply with the Standard Institute of Nigeria (NIS) 1974, and kept in an air-tight bag.

4.2 Preparation of Samples

The sourced materials for the experiment were transferred to the laboratory. The pseudo components of the mixes were designed following the background theory from where the actual variables proportions were developed. The component materials were mixed at ambient temperature according to the specified proportions of the actual components generated in Table 2. In all, two solid blocks of 450mm x225 x150mm for each of ten experimental points and three control points were cast for the compressive strength test, cured for 28 days after setting and hardening.

4.3 Strength Test

After 28 day of curing, the blocks were crushed to determine the sandcrete block strength, using the compressive testing machine to the requirements of BS 1881:Part 115 of 1986.

V. RESULT AND ANALYSIS

5.1 Determination of Replication Error And Variance of Response

To raise the experimental design equation models by the lattice theory approach, two replicate experimental observations were conducted for each of the ten design points. Below is the table which which contain the results of two repetitions each of the 10 design points plus three Control Points of the (4,2) simplex lattice, and show the mean and variance values per test of the observed response, using the following mean and variance equations below:

$$\ddot{Y} = \sum_{i}(Y_r)/r \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (36)$$

where $\hat{Y}$ is the mean of the response values and

r =1,2.

$$S_Y^2 = \sum^{p}[(Y_i - \ddot{Y}_i)^2]/(n-1) \quad . \quad . \quad . \quad . \quad . \quad . \quad (37)$$

where n = 13.

Table 3 Result of the Replication Variance of the Compressive Strength Response for 450x225x150 mm Block

Experiment No (n)	Repetition	Response Y (N/mm$^{2)}$	Response Symbol	$\sum Y_r$	$\ddot{Y}_r$	$\sum(Y_r - \ddot{Y}_r)^2$	S_i^2
1	1A 1B	2.94 2.06	Y_1	5.00	2.50	0.30	0.03
2	2A 2B	2.41 1.98	Y_2	4.39	2.20	0.09	0.01
3	3A 3B	2.24 1.96	Y_3	4.20	2.10	0.00	0.00
4	4A 4B	2.30 2.08	Y_4	4.38	2.19	0.02	0.00
5	5A 5B	2.43 1.99	Y_{12}	4.42	2.21	0.01	0.00
6	6A 6B	2.31 2.30	Y_{13}	4.61	2.31	0.00	0.00
7	7A 7B	2.69 1.95	Y_{14}	4.64	2.31	0.27	0.02
8	8A 8B	2.54 2.67	Y_{23}	5.21	2.61	0.01	0.00

9	9A 9B	1.97 2.36	Y_{24}	4.33	2.17	0.08	0.01
10	10A 10B	2.23 2.07	Y_{34}	4.30	2.15	0.01	0.00
Control Points							
11	11A 11B	2.41 2.27	C_1	4.68	3.24	0.01	0.00
12	11A 11B	2.17 2.21	C_2	4.38	2.19	0.00	0.00
13	13A 13B	2.61 2.12	C_3	4.73	2.37	0.12	0.01

$\sum 0.10$

Replication Variance

$S_{Yc}^2 = (\sum S_i^2)/(n-1) = 0.10$

Replication Error

$S_{Yc} = (S_{Yc}^2)^{1/2} = 0.10^{1/2} = 0.31$

5.1.1 Determination of Regression Equation for the Compressive Strength

From Eqn 15 and Table 3 the coefficients of the reduced second degree polynomial is determined as follows:

$\beta_1 = 2.50$
$\beta_2 = 2.20$
$\beta_3 = 2.10$
$\beta_4 = 2.19$
$\beta_{12} = 4(2.21) - 2(2.50) - 2(2.20) = -0.55$
$\beta_{13} = 4(2.31) - 2(2.50) - 2(2.10) = 0.02$
$\beta_{14} = 4(2.31) - 2(2.50) - 2(2.19) = -0.10$
$\beta_{23} = 4(2.61) - 2(2.20) - 2(2.20) = 1.83$
$\beta_{24} = 4(2.17) - 2(2.20) - 2(2.19) = -0.11$
$\beta_{34} = 4(2.15) - 2(2.10) - 2(2.19) = 0.02$

Thus, from Eqn (11),

$$\hat{Y} = 2.50X_1 + 2.20X_2 + 2.10X_3 + 2.19X_4 - 0.55X_1X_2 + 0.02X_1X_3 - 0.10X_1X_4 + 1.83X_2X_3 - 0.11X_2X_4 + 0.02X_3X_4 \quad (38)$$

Eqn (38) is the mathematical model of the compressive strength of the solid sandcrete block based on the 28-day strength.

5.1.2 Test of Adequacy of the Compressive strength Model

Eqn 38, the equation model, will be tested for adequacy against the controlled experimental results.

We recall our statistical hypothesis as follows:

1. Null Hypothesis (H_0): There is no significant difference between the experimental values and the theoretical expected results of the compressive strength.
2. Alternative Hypothesis (H_1): There is a significant difference between the experimental values and the theoretical expected results of the compressive strength.

5.1.3 t-Test for the Compressive strength Model

If we substitute for X_i in Eqn (38) from Table 3, the theoretical predictions of the response ($\hat{Y}$) can be obtained. These values can be compared with the experimental results (Table 3). For the t-test (Table 4), a, ξ, t and Δ_y are evaluated using Eqns 27, 30, 31 and 32 respectively.

Table 4 t-Test for the Test Control Points

N	CN	I	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ξ	Ÿ	$\hat{Y}_a$	Δ_y	t
1	C_1	1	2	-0.125	0.250	0.016	0.063		2.34	2.32	0.02	0.09
		1	3	-0.125	0.250	0.016	0.063					
		1	4	-0.125	0.250	0.016	0.063					
		2	3	-0.125	0.250	0.016	0.063					
		2	4	-0.125	0.250	0.016	0.063					
		3	4	-0.125	0.250	0.016	0.063					
						0.094	0.375	0.469				
2	C_2	1	2	0.000	0.500	0.000	0.250		2.19	2.37	0.18	-0.67
		1	3	0.000	0.500	0.000	0.250					
		1	4	0.000	0.000	0.000	0.000					
		2	3	0.000	0.250	0.000	0.063					
		2	4	0.000	0.000	0.000	0.000					
		3	4	0.000	0.000	0.000	0.000					
						0.000	0.563	0.563				
3	C_3	1	2	-0.125	0.500	0.016	0.250		2.37	2.18	0.18.	0.65
		1	3	-0.125	0.000	0.016	0.000					
		1	4	-0.125	0.250	0.016	0.063					
		2	3	-0.125	0.000	0.016	0.000					
		2	4	-0.125	0.500	0.016	0.250					
		3	4	-0.125	0.000	0.016	0.000					
						0.094	0.563	0.656				

Significance level $\alpha = 0.05$,
i.e. $t_{\alpha/L}(V_c) = t_{0.05/3}(13)$, where L=number of control point.

From Appendix A, the tabulated value of $t_{0.05/3}(13)$ is found to be 3.01 which is greater than any of the calculated t-values in Table 4. Hence we can accept the Null Hypothesis.

From Eqn (35), with k= 3 and $t_{\alpha/k,v} = t_{0.05/k}(13) = 3.01$,
Δ = 1.13 for C_{1234}, 1.16 for $C_{1124=0.26}$, and 1.208 for C_{1224},
which satisfies the confidence interval equation of
Eqn (33) when viewed against the response values in Table 4.

5.2 Computer Program

The computer program is developed for the model (Appendix 1). In the program any desired Compressive Strength can be specified as an input and the computer processes and prints out possible combinations of mixes that match the property, to the following tolerance:

Compressive Strength - 0.00005 N/mm^2,

Interestingly, should there be no matching combination, the computer informs the user of this. It also checks the maximum value obtainable with the model.

5.2.1 Choosing a Combination

It can be observed that the strength of 2.435 N/sq mm yielded 4 combinations. To accept any particular proportions depends on the factors such as workability, cost and honeycombing of the resultant lateritic concrete.

IV. Conclusion and Recommendation

6.1 Conclusion

Simplex design was applied successfully to prove that the modulus of lateritic concrete is a function of the proportion of the ingredients (cement, mound soil, laterite and water), but not the quantities of the materials [16]. The maximum compressive strength obtainable with the compressive strength model is 2.61 N/sq mm. See the computer run outs which show all the possible lateritic concrete mix options for the desired modulus property, and the choice of any of the mixes is the user's. One can also draw the conclusion that the maximum values achievable, within the limits of experimental errors, is quite below that obtainable using sand as aggregate. This is due to the predominantly high silt content of laterite. It can be observed that the task of selecting a particular mix proportion out of many options is not easy, if workability and other demands of the resulting lateritic concrete have to be satisfied. This is an important area for further research work. The project work is a great advancement in the search for the applicability of laterite and mound soil in concrete mortar production in regions where sand is extremely scarce with the ubiquity of laterite. The paper provides an optimized design perspective of the use of admixtures instead of undersigned percentage addition which is currently prevalent in the concrete industry of the world.

6.2 Recommendations

From the foregoing study, the following could be recommended:

i) The model can be used for the optimization of the strength of concrete made from cement, mound soil, laterite and water.

ii) Laterite aggregates cannot adequately substitute sharp sand aggregates for heavy construction.

iii) More research work need to be done in order to match the computer recommended mixes with the workability of the resulting concrete.

iii) The accuracy of the model can be improved by taking higher order polynomials of the simplex.

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APPENDIX 1

```
'QBASIC BASIC PROGRAM THAT OPTIMIZES THE PROPORTIONS OF SANDCRETE MIXES
 'USING THE SCHEFFE'S MODEL FOR CONCRETE COMPRESSIVE STRENGTH
 CLS
 C1$ = "(ONUAMAH.HP) RESULT OUTPUT ": C2$ = "A COMPUTER PROGRAM "
 C3$ = "ON THE OPTIMIZATION OF A 4-COMPONENT SANDCRETE MIX"
 PRINT C2$ + C1$ + C3$
 PRINT
 'VARIABLES USED ARE
 'X1, X2, X3,X4, Z1, Z2, Z3,Z4, Z$,YT, YTMAX, DS

 INPUT "ARE MIX RATIOS KNOWN AND THE ATTAINABLE STRENGTH NEEDED?,CHOOSE Y=
YES OR N=NO"; OPTION$
 IF OPTION$ = "Y" THEN
  INPUT "X1="; X1
  INPUT "X2="; X2
  INPUT "X3="; X3
  INPUT "X4="; X4
  X = X1 + X2 + X3 + X4
  X1 = X1 / X: X2 = X2 / X: X3 = X3 / X: X4 = X4 / X
  GOTO 25
 ELSE
  GOTO 20
 END IF

 'INITIALISE I AND YTMAX

20 I = 0: YTMAX = 0


  FOR MX1 = 0 TO 1 STEP .01
   FOR MX2 = 0 TO 1 - MX1 STEP .01
    FOR MX3 = 0 TO 1 - MX1 - MX2 STEP .01
     MX4 = 1 - MX1 - MX2 - MX3
     YTM = 2.5 * MX1 + 2.2 * MX2 + 2.1 * MX3 + 2.19 * MX4 - .55 * MX1 * MX2 + .02 * MX1 * MX3 -
.1 * MX1 * MX4 + 1.83 * MX2 * MX3 - .11 * MX2 * MX4 + .02 * MX3 * MX4
     IF YTM >= YTMAX THEN YTMAX = YTM
    NEXT MX3
   NEXT MX2
  NEXT MX1
 INPUT "ENTER DESIRED STRENGTH, DS = "; DS

 'PRINT OUTPUT HEADING
 PRINT
25  PRINT TAB(1); "No"; TAB(10); "X1"; TAB(18); "X2"; TAB(26); "X3"; TAB(34); "X4"; TAB(40);
"YTHEORY"; TAB(50); "Z1"; TAB(58); "Z2"; TAB(66); "Z3"; TAB(74); "Z4"
 IF OPTION$ = "Y" THEN 30
 PRINT
```

```
    'COMPUTE THEORETICAL STRENGTH, YT
     FOR X1 = 0 TO 1 STEP .01
       FOR X2 = 0 TO 1 - X1 STEP .01
         FOR X3 = 0 TO 1 - X1 - X2 STEP .01
           X4 = 1 - X1 - X2 - X3
30         YT = 2.50 * X1 + 2.20 * X2 + 2.10 * X3 + 2.19 * X4 - .55 * X1 * X2 + .02 * X1 * X3 - .10 * X1 * X4
+ 1.83 * X2 * X3 + .11 * X2 * X4 - .02 * X3 * X4

           IF OPTION$ = "Y" THEN 40
           IF ABS(YT - DS) <= .00005 THEN
           'PRINT MIX PROPORTION RESULTS
           Z1 = X1 + X2 + X3 + X4: Z2 = .64 * X1 + .62 * X2 + .58 * X3 + .69 * X4: Z3 = 15.74 * X1 + 15.12 *
X2 + 14.21 * X3 + 16.8 * X4: Z4 = .49 * X1 + .52 * X2 + .35 * X3 + .55 * X4
40          I = I + 1
           PRINT TAB(1); I; USING "##.###"; TAB(7); X1; TAB(15); X2; TAB(23); X3; TAB(32); X4;
TAB(40); YT; TAB(48); Z1; TAB(56); Z2; TAB(64); Z3; TAB(72); Z4
           PRINT
           PRINT
           IF OPTION$ = "Y" THEN 540
           IF (X1 = 1) THEN 550
         ELSE
           IF (X1 < 1) THEN GOTO 150
         END IF


150       NEXT X3
       NEXT X2
     NEXT X1
   IF I > 0 THEN 550
   PRINT
   PRINT "SORRY, THE DESIRED STRENGTH IS OUT OF RANGE OF MODEL"
   GOTO 600
540 PRINT TAB(5); "THE ATTAINABLE STRENGTH IS "; YT; "N/mm2"
   GOTO 600
550 PRINT TAB(5); "THE MAXIMUM VALUE PREDICTABLE BY THE MODEL IS "; YTMAX; "N / Sq
mm "
600 END
```

```
 A COMPUTER PROGRAM (ONUAMAH.HP) RESULT OUTPUT ON THE OPTIMIZATION OF A 4-
 COMPONE
 NT SANDCRETE MIX

 ENTER DESIRED STRENGTH, DS = ? 2.435

 No     X1     X2     X3     X4    YTHEORY  Z1     Z2     Z3     Z4

  1    0.020  0.570  0.380  0.030  2.435  1.000  0.607  14.837  0.456


  2    0.030  0.500  0.420  0.050  2.435  1.000  0.607  14.840  0.449


  3    0.120  0.400  0.460  0.020  2.435  1.000  0.605  14.809  0.439


  4    0.160  0.350  0.490  0.000  2.435  1.000  0.604  14.773  0.432


    THE MAXIMUM VALUE PREDICTABLE BY THE MODEL IS  2.608853 N / Sq mm


 Press any key to continue
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Innovative Control of Noise and Vibration of Industrial Equipments and Machines

[1]Owhor, Sampson Chisa, [2]Abdul Alim Ibrahim Gambo , [3]Ojo, Victor Kayode , [4]Dan´Azumi Daniel

[1]Mechanical Engineering, Faculty of Engineering/ Federal University Wukari, P.M.B 1020 Wukari, Taraba State, Nigeria.
[2]Department of Chemical and Biomedical Engineering, Federal University Wukari,Taraba State, Nigeria.
[3]Works & maintenance Department/ Federal University Wukari, Taraba State.
[4]Works & maintenance Department/ Federal University Wukari, Taraba State.

Abstract *: Noise and Vibration of industrial equipment is the grave factor influencing its production state, working conditions of staff and job safety. In course of technology development the more potent machines are used, it is quite often accompanied by an increase of vibration and noise level. This is experienced by equipment as it is transmitted to building structures, environment and through staffs. The system of equation advocated in this research work has been permitted to evaluate reduction of machine vibrations caused by unbalance movement of its members, thereby transmitting it onto the floor and the environment. A noise problem generally consists of three inter-related elements- the source, the receiver and the transmission path. This transmission path is usually the atmosphere through which the sound is propagated, but can include structural materials of any building containing the receiver. The development of innovative noise control treatments provides opportunities for applying basic physics and engineering procedures.*

Keywords: *Environment, Industrial equipment, Insulation, Noise, Resonance, Vibration.*

I. Introduction

The more potent machine becomes, the more its vibration and noise disturbs people. Vibration and noise is not only harmful to human being but also hinders fulfillment of working operations, both psychologically and physically. A vibration with frequencies between 25-40 and 60-90 Hz is degraded as visual perception. When frequency of vibration is close to the natural frequency of oscillations of the human body, equal about 5 Hz, operating of vibration becomes especially ideal. In different parts of body the natural frequencies make: in pelvic area 4-6 Hz, in abdominal area 4-8 Hz, and the head 30 Hz (Woodson and Conover 1966). The sources of vibrations of industrial equipment are: impulse applied technological forces, impacts, unbalance of rotated parts, inertia forces of parts with periodic motion. Therefore, the problem of reducing harmful vibrations remains actually permanent; one solution to the problem is the improvement of the kinematics, balancing of inertia forces, developing of shock free technological processes. However these actions are not always possible. That is why the other way to reduce harmful effect of vibration is vibration insulation of the equipment, installed on building structures. Vibration insulation is the reduction of the transmission of vibrations which is reached by the installation of pliable members of small stiffness between vibratory units and adjacent structures (Ya, 1974). Millions of workers around the world are exposed to sound levels that are likely to cause permanent hearing loss, even though many of them wear hearing-protection devices. Many people do not realize that these devices and hearing-protection programs are not the preferred way of protecting hearing. The preferred way, often called “engineering controls,” is to reduce the noise of machinery or introduce a noise control element between machinery and workers (Rao, 1995). Engineering controls are preferred for many reasons, including permanence, effectiveness with or without worker/supervisor compliance, less absenteeism, easier communication, lower worker compensation costs, and reduced legal costs. In fact, engineering controls are the protection method of choice according to the Occupational Safety and Health Administration. Many of these controls could be integrated into machinery by original equipment manufacturers, nonetheless, for non-engineering reasons; they have been eliminated from machinery design. Since the late 1940s, scientists and engineers have been working on ways to control noise from machinery (Jensen et al 1978). In the 1970s, the emphasis was on engineering controls in the workplace, but since then the focus has shifted because OSHA has

not enforced the requirement for engineering controls and because industry leaders have failed to take into account the risk to hearing when purchasing equipment.

II. Occupational Noise-Exposure Regulation

When the daily noise exposure is composed of two or more periods of noise exposure of different levels, their combined effect should be considered, rather than the individual effect of each. If the sum of the fractions: presented in equation (1) exceeds unity, then the mixed exposure should be considered to exceed the limit value.

$$C(1)/T(1) + C(2)/T(2) + \ldots + C(n)/T(n) \quad (1)$$

Where:

T (n) indicates the total time of exposure permitted at that level.

Exposure to impulsive or impact noise should not exceed 140 dB peak sound pressure level. Note that the regulation calls for engineering controls to be used first to reduce sound levels to within the limits specified in Table (1), and only if the controls do not succeed in bringing the sound levels down, the hearing-protection devices are to be used in addition. The requirement is that "feasible administrative or engineering controls" be tried. Simply explained, "administrative control" means removing workers from noise exposure by rotating them from noisy to quieter areas. "Feasible" means—that it can be done. However, sometimes the cost of a noise control treatment is cited as a reason why it is "not feasible" for a particular company to install it (Franken, 1974).

A number of very simple engineering controls can often be implemented with great success:

- proper maintenance (e.g., fixing steam leaks)
- modified operating procedures (e.g., relocating an operator and equipment controls to a quieter position)
- relocation of noisy vents away from workers
- replacement of equipment (e.g., buying a quieter version of the product)
- modified room treatment (e.g., introducing sound absorption in the space between equipment and worker to reduce noise in the distant reverberant field)
- relocation of equipment (e.g., putting noisy equipment in areas that are often unoccupied)
- proper operating speed (e.g., running equipment at lower speed to reduce noise)

Despite the effectiveness and ease of taking these simple actions, they are often ignored.

When employees are subjected to sound exceeding those listed in Table -1, feasible administrative or engineering controls shall be utilized. If such controls fail to reduce sound levels within the levels of Table -1, personal protective equipment shall be provided and used to reduce sound levels to within the levels of the table.

TABLE 1 Permissible Noise Exposures

Duration per day, hours	Sound level dBA slow response
8	90
6	92
4	95
3	97
2	100
1-1/2	102
1	105
1/2	110
1/4 or less	115

2.2 SOME COMMON SOURCES OF NOISE

2.2.1 Noise Sources Involving Fluid Flow: Noise sources that involve fluid flow include fans, compressors, engines, pumps and valves. The most frequent problem is sound from the discharge, but engineering solutions (e.g., lined ducts; dissipative and reactive silencers; and special-purpose silencers) are available for both intake and discharge noise. Ducts can be lined with sound-absorbing material, such as fiber glass or mineral wool. Typical thicknesses are 1 to 4 inches. Thicker materials are used for low-frequency noise. Dissipative silencers involve using sound-absorbing materials, such as mineral wool or fiber glass, to attenuate noise. A simple dissipative silencer would be a series of parallel baffles running lengthwise from a noise source that requires airflow. The absorptive material would likely be covered with glass-fiber cloth to reduce erosion caused by airflow, and perforated or expanded metal might be added to protect it against contact damage. The silencer could be improved by using longer baffles and decreasing the space between them. Reactive silencers operate on the basis of mismatching acoustic impedance. Whenever a sound wave meets a

change in the acoustic impedance, some of its energy is reflected back to the source or back and forth within the silencer(Randall et al 2002),. An example of a reactive muffler is shown in Figure 1.

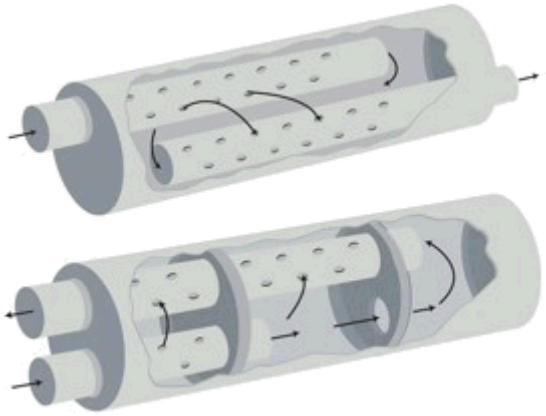


FIGURE 1 Diagram of reactive mufflers showing expansion chambers.

Recently, a special-purpose silencer was developed based on the principles of a Helmholtz resonator (a small neck and a larger cavity, such as a bottle). As sound waves pass over the opening of the neck, a small portion of gas at the neck of the bottle begins to oscillate back and forth. The frequency at which this "slug" of gas oscillates is a function of mass-spring resonance—the slug in the neck acts as the mass, and the volume of gas in the cavity acts as the spring. This resonance is a function of the diameter of the neck, the density of the gas, the length of the neck, the volume of the cavity, and the speed of sound in thegas(Liu,2003). The resonance frequency in Hz of a simple Helmholtz resonator can be calculated from equation (2).

$F = {}^{1}/_{2\prod(MC)^{0.5}}$ (2)

Where:

M =ρl/A (ρ = the gas density (kg/m^3)

l = the "effective" length of the neck (m), and

A = the cross-sectional area of the neck (m^2).

$C = V/c^2$ (3)

Where:

V = the volume of the cavity (m^3), = the density (kg/m^3), and

c = the speed of sound (m/s) in the gas).

The ends of the tube influence the resonance frequency by increasing the effective length (l) of the neck. Note that the resonance frequency is independent of density. The resonance frequency of a typical 500 ml water bottle, about 200 Hz, can be excited by blowing across the top of the bottle.

One special-purpose silencer, invented by (Bruce, 2004) uses the Helmholtz concept to reduce centrifugal compressor noise, which often includes a strong tonal component at the blade-passing frequency of the compressor. The resonators for the Dresser-Rand Duct Resonator Array (DRA) are shown in Figure 2.

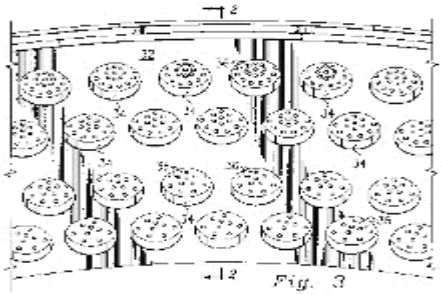


FIGURE 2 Dresser-Rand Duct Resonator Array .

The numerous holes in the resonators, acting as masses in parallel, raise the resonance frequency. The cavity behind these holes acts as the volume for the resonator. The DRA, which consists of numerous resonators positioned at the diffuser of the compressor, can also be located in a pipe spool in discharge piping. The DRA

reduces the A-weighted sound level by at least 10 dB—which is similar to "halving" the loudness of the sound. Significant noise radiating from piping in refineries and from forced-draft and induced-draft fan ducts can be reduced simply with layers of treatment around the piping (Figure 3). Typically,

The first layer is 2 to 4 inches of 6 to 8 lbs/ft^3 glass fiber or mineral wool wrapped around the pipe. Next a mass-loaded vinyl or lead sheeting weighing 1 to 2 lbs/ft^2 is wrapped around the glass fiber or mineral wool. Finally, a weatherproof covering is added. This type of treatment can provide 10 to 20 dBA of noise reduction, depending on the details of the installation.

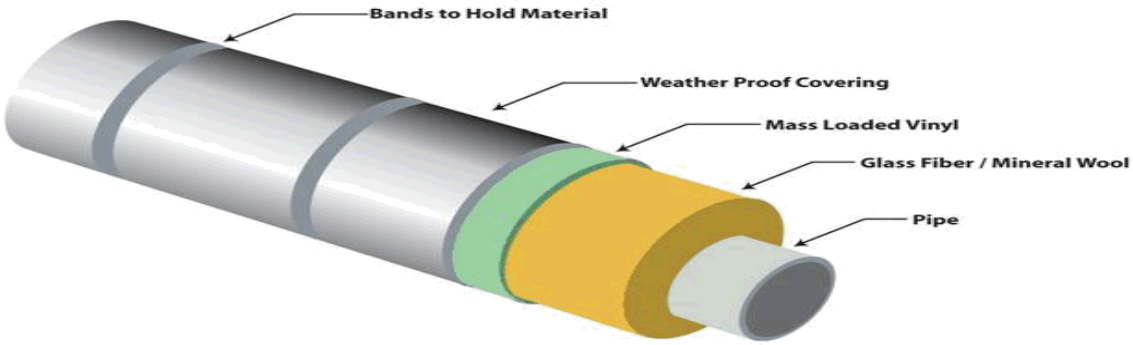


FIGURE 3 Pipe Logging.

2.2.2 Radiated Noise from Machinery Housings: Airborne noise can radiate from any surface. In a piano, for example, the keys strike the hammers, which hit the strings. Although the strings do not produce much sound by themselves, they are attached to the soundboard, which is very large compared to the strings and radiates the sound. In general, the larger the vibrating panel, the more sound is radiated from the surface. Another example is a metal parts bin into which metal parts are dropped. If the bin is made of perforated, rather than solid metal, the radiating area, and thus the radiated sound, is reduced. Of course, materials with high internal damping radiate less noise. If the bin were made of rubber (with high internal damping) rather than metal (with low internal damping), the radiated sound would be reduced accordingly. Sometimes machinery is housed inside an enclosure provided by the original equipment manufacturer. If there is any possibility that the resonance frequencies of the enclosure panels will be excited, it is desirable that the housing be treated with a damping material. If the machine inside the enclosure causes significant vibration of the enclosure housing and structure, then the panels should be "vibration-isolated" from the structure. In addition, it may be useful for the machinery enclosure to be mounted on vibration isolators to minimize the amount of vibration transmitted to the floor.

2.3 Machinery Shields: An acoustical shield may be inserted between the worker and a noisy section of a machine. An acoustical shield, often mounted on the machine, can provide 8 to 10 dB of noise reduction under the following circumstances: the worker is near the noisy operation; the smallest dimension of the shield is at least three times the wavelength of the dominant noise; and the ceiling above the machine is covered with sound-absorptive material (Stewart,2007).Shields can be manufactured from safety glass, quarter-inch thick clear plastic, metal, or wood. Criteria for selecting materials include durability, cost, the need for visual observation of the operation, and the need for physical access to the operation. If possible, oil-resistant, cleanable, sound-absorptive materials should be incorporated into the machine side of the shield. Handles and casters can be provided to facilitate moving of the shield, and hinged sections can be incorporated into the design to provide physical access to the machine. Neoprene can be used to minimize acoustical leaks through joints or hinges. When shields are used to replace less acoustically efficient machine guards, the shield should be fitted carefully to cover all noise leaks and then vibration-isolated to keep the shield from vibrating with the

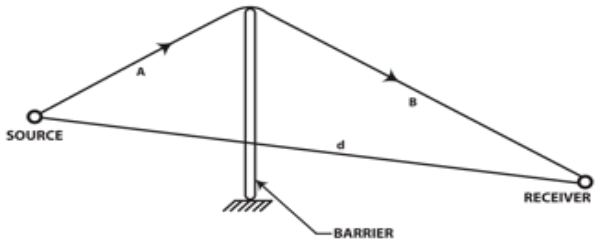


FIGURE 4 Geometry for determining sound attenuation by a noise barrier (d is the straight line distance from source to receiver and A+B is the shortest path length of wave travel over the wall between source and receiver).

2.4 Barriers: Any solid wall that blocks the line of sight between a noise source and an observer will reduce the noise level at the location of the observer. The noise reduction depends on the frequency of the noise, the distance between the source and the wall, the distance between the receptor and the wall, and the height of the wall. Low-frequency sound, which has wavelengths comparable to the size of the wall, diffracts around the ends and over the top. Thus, low-frequency sounds are less attenuated than high-frequency sounds. Typically, low-frequency sounds are attenuated by less than 5 dB, whereas high-frequency sounds can be attenuated by as much as 20 dB. The highest practical value for barrier attenuation is 24 dB. If the noise source is inside a room, then the barrier effect may be reduced, depending on the room absorption and the location of the receivers relative to the barrier wall. Most formulas for calculating the attenuation provided by a barrier assume that the wall is infinitely long. One typical calculation procedure uses the difference between a direct path from the source to the receiver and the path over the barrier (Figure 4). This difference is called the "path length difference."Attenuation = 10 log (3 + 0.12 f d).–P), where f = the frequency in Hz, and P is the path difference in meters (A+B).

Partial Enclosures: A partial enclosure is a series of walls around a machine with the top left open. This treatment can be effective inside a plant for positions near a wall. However, some of the noise radiates out the open top and contributes to the reverberant sound in the room. Reflections from the ceiling increase the sound level at greater distances from the barrier (Figure5).

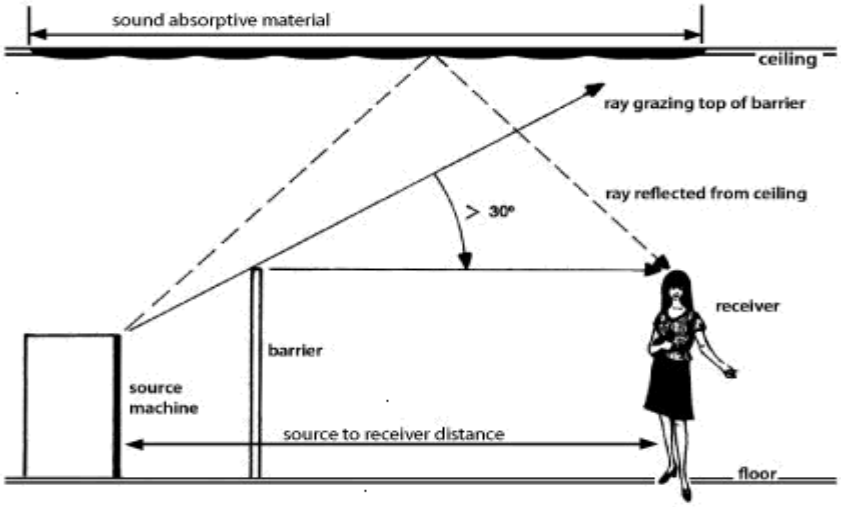


FIGURE 5 Source-barrier-reciever geometry for an indoor noise source.

For a 10 dB reduction, the angle shown in the figure must be greater than 30, and the ceiling must either be sound absorptive or 1.5 times the distance from the source to the receiver. A sound-absorptive ceiling can reduce reflected sounds, thereby increasing the effectiveness of the barrier. For maximum effectiveness, the sound-absorptive ceiling should extend out to the location of the receivers, and the inside of the barrier walls should be sound absorptive.

Total Enclosures: A total enclosure with a closed top will provide better noise reduction than a partial enclosure. However, enclosures usually need openings to provide access for personnel (e.g., visual, maintenance, operator usage); access to materials (e.g., raw materials, product, scrap removal and ventilation. Leaks around doors, windows, and hatches greatly reduce the acoustical effectiveness of enclosures. Closed-cell elastomeric weather-stripping with a pressure-sensitive adhesive can be used to prevent sound leakage from around doors, windows, and hatches. Special acoustical gaskets are available, as well as magnetic-strip gaskets similar to those used on refrigerator doors. If workers need to be able to see inside an enclosure, lighting may be required. If workers evaluate the performance of the machinery by its sound, it may be necessary to retrain them or to place a rugged microphone inside the enclosure that sends a signal to a small adjustable loudspeaker at the worker position. Occasionally, it is possible to develop processors that incorporate workers' knowledge to automatically adjust the machinery for optimal performance. Openings for raw materials, products, and scrap-flow can be tunnels lined with sound-absorptive material. The noise reduction will depend on the length and cross-section of the tunnel, as well as the thickness of the sound-absorptive material.

Ventilation is required for all total enclosures and for some partial enclosures. The amount of air required for cooling is a function of the heat generated within the enclosure, as shown in equation:4

$Q=1.76W/\Delta T$ 4

Q = the flow of cooling air in cubic feet per meter at sea level,

W = the watts of heat generated, and

ΔT = the temperature rise permitted above the ambient temperature (F). Ventilation openings can be acoustically lined ducts, elbows, or mufflers, depending on the severity of the problem. Machinery with special heat-sensitive equipment may require special cooling. Neither the enclosure panels nor the enclosure structure should be in contact with any part of the machinery. If the enclosure is mounted on the machinery, it should be vibration-isolated from the machinery. All holes in the enclosure for electricity, oil, water, steam, air, or hydraulic power must open into a junction box packed and sealed with at least 3 inches of glass fiber. A convenient design can be built on an angle-iron frame to which the enclosure panels can be attached with quarter-turn captive screws. The enclosure should be as small as possible without touching the machinery. Noise reductions of 20 dB can be obtained with careful attention to design and construction.

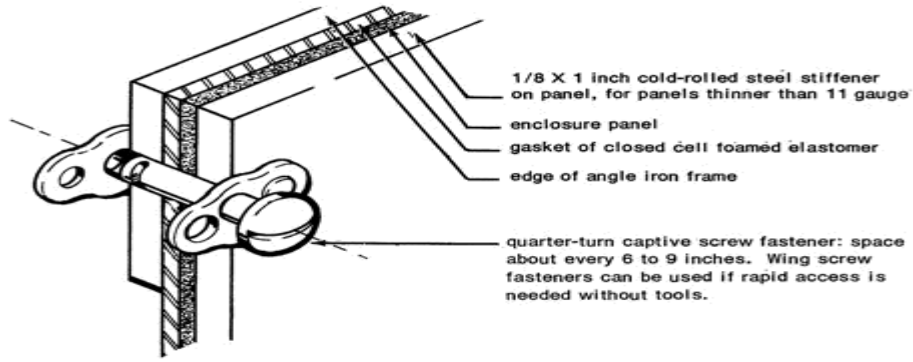


FIGURE 6 Enclosure panels secured to frame by quarter-turn fasteners.

Figure 6 shows the connection of the panels to the angle iron frame. Damping and sound-absorption material are attached to the interior of the panel. The enclosure should also be vibration-isolated from the floor (Figure 7). If the machine vibrates, it may also be important to isolate it using steel springs or elastomers, depending on the circumstances.

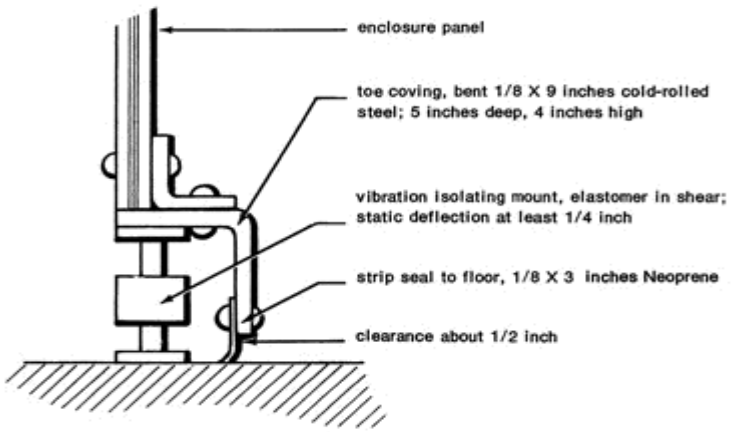


FIGURE-7 Vibration isolation and toe covering.

If the enclosure panels are metal, their resonances can be distributed uniformly in frequency if the panel is reinforced by bolted-on angle irons (bolting and damping). These stiffeners should be placed to divide the panel into smaller areas, no two of which are the same size and shape. Frames for doors, windows, and hatches can also be used as stiffeners. Windows are an acoustical weak link in enclosures. Generally, if the A-weighted sound level must be reduced by more than 20 dB, double-glazing will be necessary. The inside layer, which must withstand rough handling and cleaning to remove oil, grease, and dirt, should be safety glass. All panes should be set into soft elastomeric gaskets. Room-temperature-setting silicone rubbers are useful. The

window(s) should be placed carefully to provide the necessary information to the operator. In extreme cases, closed-circuit video monitoring can be used. If the dimensions of the enclosure result in resonance, the enclosure can be driven to high levels of vibration and become a new radiator of these sound components. When the enclosure is driven to high levels of vibration, the sound-pressure level outside the enclosure can be higher than it was before the enclosure was installed. If the noise source occupies a sufficient fraction of the room volume, this effect can be significantly reduced by using absorbent lining on the interior surfaces of the enclosure and by stiffening the panels and lining them with damping materials (Inovich, 1990).

2.5 **Some common noise and their Control in Industry**

Many plants are unnecessarily noisy because the most basic elements of noise control are not applied. The table-2 gives a brief summary of some common noise sources and applicable noise control techniques, materials or devices. Although these measures may reduce noise from the sources treated, remember, to obtain an overall measurable noise reduction requires the noise source to be the dominant source in the area. All new equipment should be purchased to be quiet. In general, encourage buyers to specify that sound levels should meet 80 dBA at 1m. It is unlikely that purchasing equipment meeting 85 dBA at 1m will give plant sound levels under 85 dBA when multiple items are installed.

Noise Source	**Approach**	**Principle**
Air Exhaust	Air Exhaust Muffler	Spreads air exhaust over many small holes to reduce velocity.
Air Jet	Air Thrust Nozzle (for cooling, cleaning, drying or moving)	Entrains air to primary jet to increase airflow at a slower speed, i.e. quieter but with increased thrust.
Fan	Inlet or Outlet Silencer	Absorbs sound in baffles lined with fiberglass or mineral wool. Specification requires some expertise.
New Electric Motor (most often required for 3600 rpm and higher)	Quiet Line Motor	Available in most sizes and speeds. Usually higher efficiency than conventional noisy motor. Much better option than quieting after purchase.
Existing electric motor	Motor silencer/motor mute	Silences motor cooling fan, usually the major noise source. Must be sized not to overheat motor. Better to buy a quiet motor in the first place.
Noise Source	**Approach**	**Principle**
"Singing" motor	Filter electric power supply	Power supplies producing DC or current for variable speed motors often produce audible harmonics in the regular plant power system.
New flow valves	Buy to meet noise specification.	Most valve selection programs will help select quiet valves. These are premium price, but often worth the extra cost.
Existing loud valves (usually high pressure drop)	Quiet trim valve	Quiet trim can be retrofit in existing valves in some situations to make them considerably quieter.
Existing loud valves (usually high pressure drop)	Orifice plate	Introduce an orifice plate across the pipe to reduce pressure drop across the noisy valve.
Flow noise in pipes	Repair leaks and insulate pipes	Acoustical insulation can reduce noise from piping, but in some cases must extend a considerable distance from a noisy valve.

Flow noise in pipes	Wrap acoustical lagging around pipes	Wrap pipes in a composite of mineral wool blanket covered with metal jacket or loaded vinyl
Pump rooms and other similar small equipment rooms	Line with sound absorbing material.	Small industrial rooms can be highly reverberant, increasing sound levels inside.
Separate different circuits	Allows shut down circuit to be worked on under quiet conditions while other circuit continues to operate.	
Isolated, noisy, automatic equipment	Noise enclosure with heavy (steel) outer shell and sound absorbing lining (fiberglass)	Must be designed to provide inspection, light, access, maintenance and adequate cooling.
Hydraulic equipment	Isolate from drip trays and tanks, insulate hoses and enclose pump if necessary	Can often be specified quiet
Ventilation openings	Acoustical louvres	Provide about 10 dB attenuation with 50% free area

Table -2A

Control Feature	**Approach**	**Principle**
Operator Booth	Acoustical leaks developed	Check for poor door & window seals, holed or cracked panels, interior absorbent walls & ceiling treatment damaged or removed, booth in mechanical contact with mill.
Machine enclosure	Acoustical leaks developed	Check for poor door & window seals, holed or cracked panels, interior absorbent walls & ceiling treatment damaged or removed infeed/outfeed tunnels without cover flaps, machine in mechanical contact with enclosure wall.
Noisy mobile equipment	Acoustical leaks developed	Muffler missing, damaged, rusted or incorrectly sized

Table -2B

Buying quiet equipment is always better than quieting noisy equipment that is already installed. Applying the above should help this to happen.

3.O **Model of a machine installed on elastic vibration absorbers**

The analysis of vibrations of production equipment carried out by many researchers (Ya, 1974) and (Hansan et al 2003). The outcomes of analysis of vibration system is shown on Fig.2 This system corresponds to production machine installed on elastic members. It was considered that the machine consists of fixed and moving part. The last ones are the masses m_1,m_2……m_m, the motion of which is determined by the machine structure which is considered less than the mass M_o of fixed parts. The model is placed in the systems rectangular coordinates. One of them XYZ is connected to mass M_O, origin of the system O is combined with the center of mass G_O. Otherξ_O, η_O,ξ_O ,with the origin in the same point O, is independent, fixed in space. The axes of the system XYZ coincide with principal axes of inertia of the mass M_O. In the balanced state both of these systems coincide. The connection of systems at the arbitrary moment is determined, the coordinates ξ_O ,η_O,ξ_O, the point $G_O$and angles φ,Ψ,Θ, which are selected to be small for small oscillations of the mass M_O. The mass of the i^{th} traveling part is M_i, coordinates of its center of gravity are X_i, Y_i, Z_i. The sum of parts m, is equal m, its coordinates are X, Y, Z.

1. From the expressions for a kinetic energy after transformations one get the left parts of the Lagrange equations of the second kind:

$$\left|\begin{array}{lll} (M_o+m)\ddot{\xi}_o & + & m\ \ddot{X} \\ (M_O+m)\ddot{\eta}_o & + & m\ \ddot{y} \\ (M_o+m)\ddot{\xi}_o & + & m\ \ddot{z} \\ (A+a)\ddot{\varphi} & + & \sum m_i\ \left(\ddot{y_{\iota x_\iota}} - \ddot{x_\iota} y_i\right) \\ (B+b)\ddot{\Psi} & + & \sum m_i\ (\ddot{x_{\iota z_\iota}} - z_\iota x_i) \\ (C+c)\ddot{\theta} & + & \sum m_i\ (z_{\iota y_\iota} - \ddot{y_\iota} z_\iota) \end{array}\right| \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

Lagrange equations of the second order

In which; m$\ddot{X}$, m$\ddot{Y}$ and m$\ddot{Z}$ are Inertia forces of the linearly moving parts,

$\sum m_i(\ddot{y}_\iota x_i - \ddot{x}_\iota y_i)$, $\sum m_i(\ddot{x}_\iota z_i - \ddot{z}_\iota x_i)$ and $\sum m_i(\ddot{z}_\iota y_i + \ddot{y}_\iota z_i)$ are distributing moments

A, B, C – principal moments of inertia of the mass M_o concerning fixed axes,

a, b, c – total moments of traveling masses concerning axes XYZ, and they will be expressed as shown in equation (6)

$$\left.\begin{array}{l} a = I_{1z} + I_{2z} + \cdots + I_{iz} \\ b = I_{1y} + I_{2y} + \cdots + I_{iy} \\ c = I_{1x} + I_{2x} + \cdots + I_{ix} \end{array}\right\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where I_{ix},I_{iy}, I_{iz} and- moments of inertia of i^{th} mass concerning axes X, Y, Z.

The right hand members of Lagrange differential equations are composed by means of the expressions for the potential energy of the system. The potential energy for n elastic members is given by the expression indicated in equation (7)

$$P = \frac{1}{2}\left(\sum_{i=1}^{n} c_{\xi i} u_i^2 + \sum_{i=1}^{n} c_{ni} v_i^2 + \sum_{i=1}^{n} c_{\xi i} w_i^2 + \sum_{i=1}^{n} k_{\xi i}\varphi^2 + \sum_{i=1}^{n} k_{ni}\Psi^2 + \sum_{i=1}^{n} k_{\xi i}\theta^2\right) \ldots (7)$$

Where:

U, v, and w – Deformation of the elastic members,

C – Linear stiffness of elastic members,

K – Torsion stiffness of elastic members.

The deformation of the elastic members can be expressed as presented in equation 8:

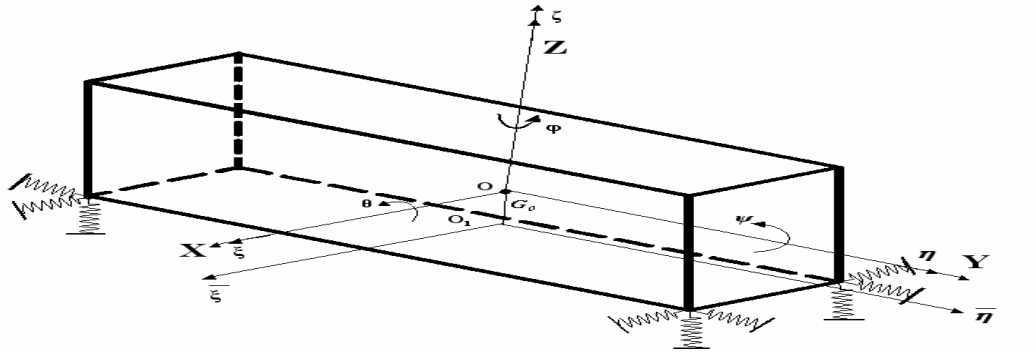
$$\left.\begin{array}{l} u_i = \xi_o + \eta_i\phi - \xi_i\Psi \\ v_i = \eta_o + \xi_i\theta - \xi_i u \\ w_i = \xi_o + \xi_i\Psi - \eta_i\,\theta \end{array}\right\} \ldots\ldots\ldots\ldots\ldots (8)$$

Substitute equation (8) in equation (37we get:

$$P = \frac{1}{2}\left(\sum_{i=1}^{n} c_{\xi i}(\xi_o + \eta_i\varphi - \xi_i\Psi)^2 + \sum_{i=1}^{n} c_{ni}(\eta_o + \xi_i\theta - \xi_i\varphi)^2 + \sum_{i=1}^{n} c_{\xi i}(\xi_o + \xi_i\Psi - \eta_i\theta)^2 + \sum_{i=1}^{n} k_{\xi i}\theta^2 + \sum_{i=1}^{n} k_{\eta i}\Psi\theta^2 + \sum_{i=1}^{n} k_{\xi i}\varphi^2\right) \ldots\ldots\ldots (9)$$

Finding of partial derivatives from potential energy on generalized coordinates gives right hand members of the system of differential equations depicting oscillations of the model of the machine installed on the elastic shock- absorbers (Fig.2) as shown in equation 10:

$$\left.\begin{array}{l} (M_o+m)\xi_o + \left(\xi_o C_\xi + \varphi u_\eta - u_\xi\Psi\right) = -m\ddot{X} \\ (M_o+m)\ddot{\eta}_o + \left(\eta_o C_\eta + \theta V_\xi - V_\xi\varphi\right) = -m\ddot{y} \\ (M_o+m)\ddot{\xi}_o + \left(\xi_o C_\xi + \Psi\omega_\xi - \omega_\eta\theta\right) = -m\ddot{z} \\ (A+a)\ddot{\varphi} + \left(\varphi C_{\xi\xi} + \xi_o u_\eta - \eta_o V_\xi - \Psi C_{\eta\xi} - \theta C_{\xi\xi}\right) = -\sum m_i(\ddot{y}_\iota x_i - \ddot{x}_\iota y_i) \\ (B+b)\Psi + \left(\ddot{\Psi} C_{\eta\eta} - \xi_o u_\xi + \xi_o\omega_\xi - \theta C_{\xi\eta} - \varphi C_{\xi\eta}\right) = -\sum m_i(\ddot{x}_\iota z_i - \ddot{z}_\iota x_i) \\ (C+c)\theta\left(\theta C_{\xi\xi} + \eta_o V_\xi - \ddot{\xi_o}\omega_\eta\right) = -\sum m_\iota(\ddot{z}_\iota y_\iota - \ddot{y}_\iota z_i) \end{array}\right\} \ldots\ldots\ldots (10)$$



Fig, 8. Model of the production machine installed on elastic members

In these equations: the linear stiffness's are as indicated in equation 11:

$$\left.\begin{aligned} C_\xi &= \sum_{i=1}^{n} C_{\xi i} \\ C_\eta &= \sum_{i=1}^{n} C_{\eta i} \\ C_\zeta &= \sum_{i=1}^{n} C_{\zeta i} \end{aligned}\right\} \text{..... (11)}$$

☞ Linear – rotary stiffness's are shown in equation 12:

$$\left.\begin{aligned} u_\eta &= \sum_{i=1}^{n} C_{\xi i}\eta_i \qquad & u_\zeta &= \sum_{i=1}^{n} C_\zeta \xi_i \\ v_\xi &= \sum_{i=1}^{n} C_{\eta i}\xi_i & v_\zeta &= \sum_{i=1}^{n} C_{\eta i}\zeta_i \\ w_\xi &= \sum_{i=1}^{n} C_{\zeta i}\xi_i & w_n &= \sum_{i=1}^{n} C_{\zeta i}\eta_i \end{aligned}\right\} \text{..... (12)}$$

*The torsion stiffness's are presented in equation 13:

$$\left.\begin{aligned} C_{\xi\xi} &= \sum_{i=1}^{n}(k_{\zeta i} + C_{\eta i}\xi_i^2 + C_{\zeta i}\eta_i^2) \\ C_{\eta u} &= \sum_{i=1}^{n}(k_{\eta i} + C_{\zeta i}\xi_i^2 + C_{\xi i}\zeta_i^2 \\ C_{\zeta\zeta} &= \sum_{i=1}^{n}(k_{\zeta i} + C_{\xi i}\eta_i^2 + C_{\eta i}\xi_i^2 \end{aligned}\right\} \text{..... (13)}$$

* Gyroscopic stiff nesses are given by equation 14:

$$\left.\begin{aligned} C_{\xi\eta} &= C_{\eta\xi} = \sum_{i=1}^{n} C_{\zeta i}\xi_i\eta_i \\ C_{\eta\zeta} &= C_{\zeta\eta} = \sum_{i=1}^{n} \xi_i\,\eta_i\zeta_i \\ C_{\zeta\xi} &= C_{\xi\zeta} = \sum_{i=1}^{n} C_{\eta i}\,\xi_i\zeta_i \end{aligned}\right\} \text{..... (14)}$$

The given system includes in its right hand members the disturbing forces caused by the unbalanced moving masses. Equations (10) can be used at the designing of vibration dampers (absorber) in order to avoid loads transmitted by the machine onto the floor. In many cases not all the motions of the machine are interdependent, and then the system (10) is simplified. If two principal central axes of stiffness are only principal axes of inertia, but not the central ones ,the principal central axis of inertia will be the third principal central axis of stiffness then all gyroscopic (14) and four of six linear – rotary (12) stiff nesses are equal zero. In this case the system (10) is essentially simplified and becomes as denoted by equation 15.

$$\left.\begin{aligned} (M_o + m)\ddot{\xi}_o + \xi_o C_\xi &= -m\ddot{X} \\ (M_o + m)\ddot{\eta}_o + \eta_o C_\eta &= -m\ddot{y} \\ (M_o + m)\ddot{\zeta}_o + \zeta_o C_\zeta &= -m\ddot{z} \\ (A + a)\ddot{\varphi} + \varphi C_{\zeta\zeta} &= -\sum m_i(\ddot{y}_\iota x_i - \ddot{x}_\iota y_i) \\ (B + b)\ddot{\Psi} + \Psi C_{\eta\eta} &= -\sum m_i\,(\ddot{x}_\iota z_i - \ddot{z}_\iota x_i) \\ (C + c)\ddot{\theta} + \theta C_{\zeta\zeta} &= -\sum m_i\,(\ddot{z}_\iota y_i - \ddot{y}_\iota z_i) \end{aligned}\right\} \text{..... (15)}$$

3.0 **Developing of model of machine installed on elastic–dissipative vibration dampers**

The systems (10) and (15) are not taking into account dissipation of energy of oscillations in the vibration dampers. To take into consideration this dissipation one should add a damping to the vibration dampers and simplify the scheme a little, having shown only vertical components of each of four hearings Ilnawafleh, (2001). In this case the machine is presented by the model shown at Fig.3. The origin of the coordinated system is placed in the point of the static equilibrium of the center of masses of the machine, as the axes of coordinates the central axes of inertia of the machine are considered. The model has six degrees of freedom by the way of linear displacement along axes and angular displacements around the last .As a result of a unbalance of mobile masses there is a disturbing force Ilnawafleh, et al (2005) and Shilin, et al (2008) which can be accepted equal $Q = sin\omega t$, as well as in the already reviewed model. The restoring force of each vibration damper is proportional to its deformation. The force of a viscous strength of vibration damper absent in the model at Fig.2 is proportional to the speed of deformation.

The vibrations of the model (Fig, 3) are described by equations 16.

$$\left.\begin{aligned}
m\ddot{x} &= \sum_{i=1}^{4} F_{xi} + Qsin\omega t \\
m\ddot{y} &= \sum_{i=1}^{4} F_{yi} \\
m\ddot{z} &= \sum_{i=1}^{4} F_{zi} - P \\
I_x\ddot{\Psi} &= -F_{zi}l_{y1} + F_{z2}l_{y2} - F_{z3}l_{y1} + F_{z4}l_{y2} + \sum_{i=1}^{4} F_{yi}z_b \\
I_y\ddot{\varphi} &= F_{z1}l_{x2} + F_{z2}l_{x2} - F_{z3}l_{x1} - F_{z4}l_{x1} + \sum_{i=1}^{4} F_{xi}\, z_b - Qsin\omega t z_Q \\
I_z\ddot{\theta} &= F_{x1}l_{y1} - F_{x2}l_{y2} + F_{x3}l_{y1} - F_{x4}l_{y2} + F_{y2}l_{x2} - F_{y3}l_{x1} - F_{y4}l_{x1}
\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots (16)$$

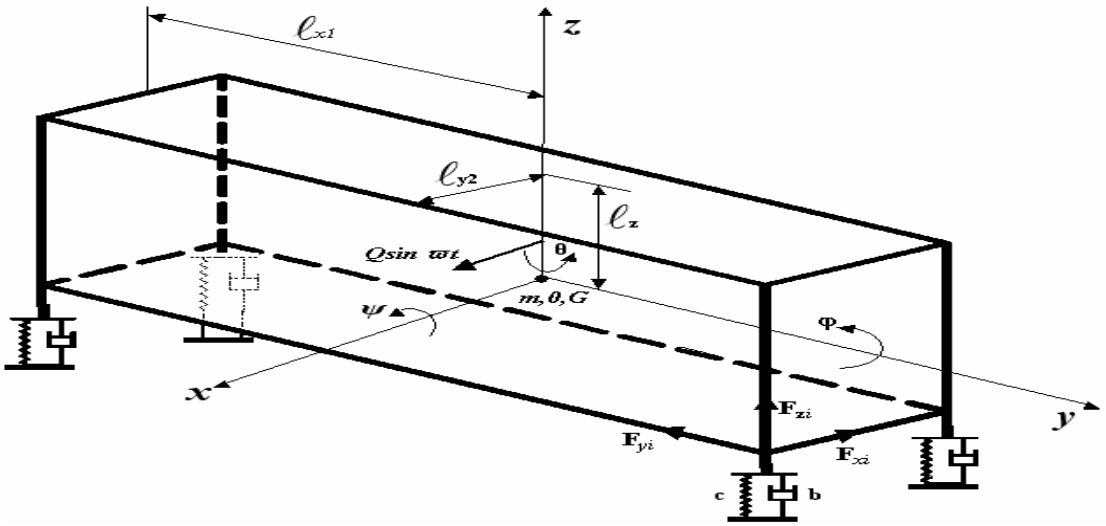


Fig 8. Model of the production machine installed on elastic-damping supports

Where

$$\left.\begin{aligned}
F_{x1} = F_{x3} &= -C_x\left(x + z_b + l_{y1}\theta\right) - b_x\left(\dot{x} + z_b\dot{\varphi} + l_{y1}\dot{\theta}\right) \\
F_{x2} = F_{x4} &= -C_x\left(x + z_b\varphi + l_{y2}\theta\right) - b_x\left(\dot{x} + z_b\dot{\varphi} + l_{y2}\dot{\theta}\right) \\
F_{y1} = F_{y2} &= -C_y(y + z_b\Psi + l_{x2}\theta) - b_y(\dot{y} + z_b\dot{\Psi} + l_{x2}\dot{\theta}) \\
F_{y3} = F_{y4} &= -C_y(y + z_b\Psi + l_{x1}\theta) - b_y(\dot{y} + z_b\dot{\Psi} + l_{x1}\dot{\theta}) \\
F_{z1} &= -C_z\left(z + l_{x2}\varphi + l_{y1}\Psi\right) - b_z\left(\dot{z} + l_{x2}\dot{\varphi} - l_{y1}\dot{\Psi}\right) \\
F_{z2} &= -C_z\left(z + l_{x2}\varphi + l_{y2}\Psi\right) - b_z\left(\dot{z} + l_{x2}\dot{\varphi} - l_{x2}\dot{\Psi}\right) \\
F_{z3} &= -C_z\left(z + l_{x1}\varphi + l_{y1}\Psi\right) - b_z\left(\dot{z} - l_{x1}\dot{\varphi} - l_{y1}\dot{\Psi}\right) \\
F_{z4} &= -C_z\left(z + l_{x1}\varphi + l_{y2}\Psi\right) - b_z\left(\dot{z} - l_{x1}\dot{\varphi} + l_{y2}\dot{\Psi}\right)
\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots (17)$$

Substituting (17) in (16) the transformations would lead to the system of linear differential equations of the second order shown in equation 18.

$$\left.\begin{aligned}
&M\ddot{x} + b_{11}\dot{x} + b_{15}\dot{\varphi} + b_{16}\dot{\theta} + C_{11}x + C_{15}\varphi + C_{16}\theta = Q\sin\omega t\\
&M\ddot{y} + b_{22}\dot{y} + b_{24}\dot{y} + b_{26}\dot{\theta} + C_{22}y + C_{24}\Psi + C_{26}\theta = 0\\
&M\ddot{z} + b_{33}\dot{z} + b_{34}\dot{\Psi} + b_{35}\dot{\varphi} + C_{33}z + C_{34}\Psi + C_{35}\varphi = -P\\
&I_x\ddot{\Psi} + b_{42}\dot{z} + b_{43}\dot{z} + b_{44}\dot{\Psi} + b_{45}\dot{\varphi} + b_{46}\dot{\theta} + C_{42}y + C_{43}z + C_{44}\Psi + C_{45}\varphi + C_{46}\theta = 0\\
&I_y\ddot{\varphi} + b_{51}\dot{x} + b_{53}\dot{z} + b_{54}\dot{\Psi} + b_{55}\dot{\varphi} + b_{56}\dot{\theta} + C_{51}x + C_{55}\varphi + C_{56}\theta = -Qz_b\sin\omega t\\
&I_z\ddot{\theta} + b_{61}\dot{x} + b_{62}\dot{y} + b_{64}\dot{\Psi} + b_{65}\dot{\varphi} + b_{66}\dot{\theta} + C_{61}x + C_{62}y + C_{64}\Psi + C_{65}\varphi + C_{66}\theta = 0
\end{aligned}\right\} \quad \ldots\ldots\ldots (18)$$

in which stiffnesses *C* are described by the relations presented in equation 19.

$$\left.\begin{aligned}
&C_{11} = 4C_x;\ C_{15} = C_{51} = 4C_xZ_b;\ C_{16} = C_{61} = 2C_x\,(l_{y1} - l_{y2})\\
&C_{22} = 4C_y;\ C_{24} = C_{42} = 4C_yZ_b;\ C_{26} = C_{62} = 2C_y(l_{x2} - l_{x1})\\
&C_{33} = 4C_z;\ C_{34} = C_{43} = 4C_z(l_{y2} - l_{y1});\ C_{35} = C_{53} = 2C_z(l_{x2} - l_{x1})\\
&C_{44} = 2C_z(l_{y2}^2 + l_{y1}^2) + 4C_yZ_b^2\\
&C_{45} = C_{54} = C_z(l_{x2}l_{y2} + l_{x1}l_{y1} - l_{x1}l_{y2} - l_{x2}l_{y1})\\
&C_{46} = C_{64} = 2C_yZ_b(l_{x2} - l_{x1})\\
&C_{55} = 2C_z(l_{x1}^2 + l_{x2}^2) + 4C_xZ_b^2;\ C_{56} = C_{65} = 2C_xZ_b(l_{y1} - l_{y2})\\
&C_{66} = 2C_x(l_{y1}^2 + l_{y2}^2) + 2C_y(l_{x1}^2 + l_{x2}^2)\\
&C_{12} = C_{13} = C_{14} = 0;\ c_{23} = C_{25} = 0;\ C_{36} = 0
\end{aligned}\right\} \quad \ldots\ldots\ldots (19)$$

The coefficients of strength are described quite similarly.

IV. SOLUTION OF THE COMPOSED SET OF EQUATIONS

The natural frequencies are found by means of the determinant of the equation system (17) under the condition that for the zero instant at the linear and angular displacements and the speeds at all coordinates are considered equal zero and that the right side members of the equation system (17) also equal zero as shown in equation 20.

$$\begin{vmatrix}
C_{11} - M_w^2 & 0 & 0 & 0 & C_{15} & C_{16}\\
0 & C_{22} - M_w^2 & 0 & C_{24} & 0 & C_{26}\\
0 & 0 & C_{33} - M_w^2 & C_{34} & C_{35} & 0\\
0 & C_{42} & C_{43} & C_{44} - I_xW^2 & C_{56} & 0\\
C_{51} & 0 & C_{53} & C_{54} & C_{55} - I_yW^2 & 0\\
C_{61} & C_{62} & 0 & C_{64} & C_{65} & C_{66} - I_zW^2
\end{vmatrix} = 0$$

As an example consider the production machine of the mass m=1500 kg. Moments of inertia concerning principal axes are I_x=300 Nms^2,I_z =630 Nms^2. Frequency of rotation speed of the main shaft n=230 rpm, frequency of the disturbing force ω= 24s^{-1}, its amplitude Q=5

$$C_x = C_y = 1011Nms^{-1}, C_z = 3 * 10^6Nms^{-1}$$

Damping factors:

$$b_x = b_y = 2.5 * 10^6Nms^{-1}, b_z = 4.3 * 10^3\ Nms^{-1}$$

Coordinates of supports:

$$z_b = 0.5m\ ;\ l_{x1} = 1.0m\ ;\ l_{x2} = 0.54m\ ; l_{y1} = 1.8m\ ; l_{y2} = 0.83m$$

The solution of the set of equations for the case of natural vibrations of the machine in a vertical direction found by means of MATLAB, shows that this natural frequency makes 71 s^{-1}, whereas the disturbing frequency, as was mentioned, equal 24 s^{-1}. Hence the machine runs in under resonance mode, in which natural frequency is far enough from a resonance.

The calculation, also by means of MATLAB, of the enforced vertical vibrations has shown, that their amplitude X_0 =1.2*10^{-4} m. Then the dimensionless dynamic factor is $K_d = {}^{cx_0}/_{Q} = 0.2$

Comparing its value with a unit, we are convinced, that the first one is much less, and one come to the conclusion, that the vibration insulation of the given machine meets the lead requirements.

V. Conclusion

1. The model offered herein of the production machine is installed on the vibration dampers and developed with the account of elastic and dissipative properties of the vibration dampers. The system of equation is permitted to evaluate the reduction of the machine vibrations caused by the unbalance movements of its members and thereby transmitting it onto the floor.
2. By means of the developed system of equations, it is proven that, taken as an example the production machine that runs far from a resonance and its vibration dampers effectively meet the requirements of the working environment.
3. Like any other engineering problem, noise control requires detailed work—first to identify the source, then to determine the most effective noise control technique, and then to determine the most cost-effective solution. However, like any other purchase, quality costs are required.
4. The development of innovative noise control treatments provides opportunities for applying basic physics and engineering procedures.

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5G- FUTURE GENERATION TECHNOLOGIES OF WIRELESS COMMUNICATION "REVOLUTION 2020"

Manjurul H. Khan[1], P.C. Barman[2]

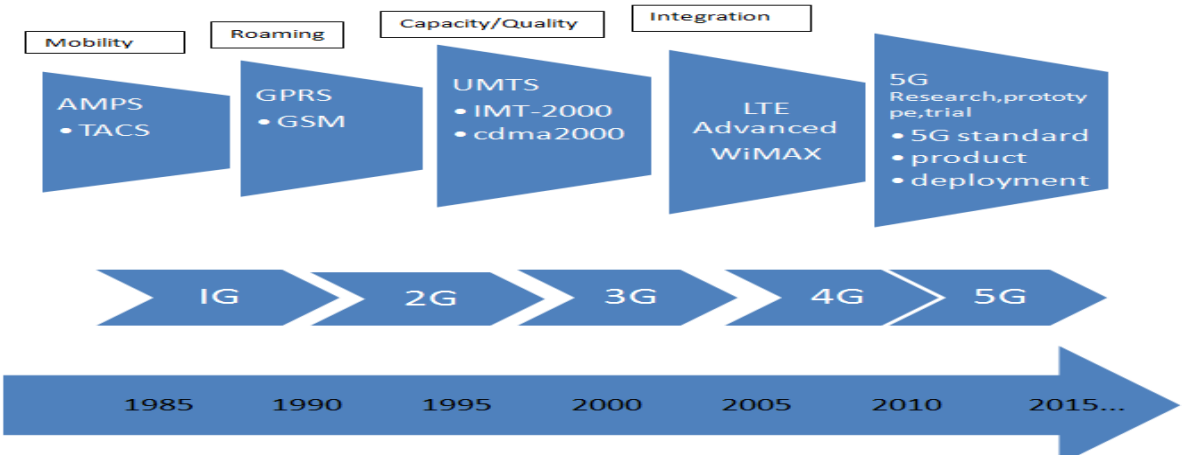
[1] *Information Technology Department (System), Janata Bank Limited, Head Office, Dhaka, Bangladesh.*
[2] *Department of Information & Communication Engineering, Islamic University, Kushtia, Bangladesh.*

ABSTRACT: *This paper is focused on the specification of future generations of wireless mobile communication networks. The paper throws light on the evolution and development of various generations of mobile wireless technology along with their significance and advantages of one over the other. 5G technologies will change the way most high-bandwidth users access their phones. With 5G people will experience a level of call volume and data transmission never experienced before. 5G technology is offering the services in different fields like Documentation, supporting electronic transactions (e-Payments, e-transactions) etc. As the customer becomes more and more aware of the mobile phone technology, he or she will look for a decent package all together, including all the advanced features a cellular phone can have. The 5G design is based on user-centric mobile environment with many wireless and mobile technologies on the ground. WWWW that is World Wide Wireless Web allows complete wireless communication with almost no limitation, Multi-Media Newspapers, watch TV programs with the clarity as to that of an HD TV.*

Keywords: *1G, 2G, 3G, 4G, 5G, WWWW.*

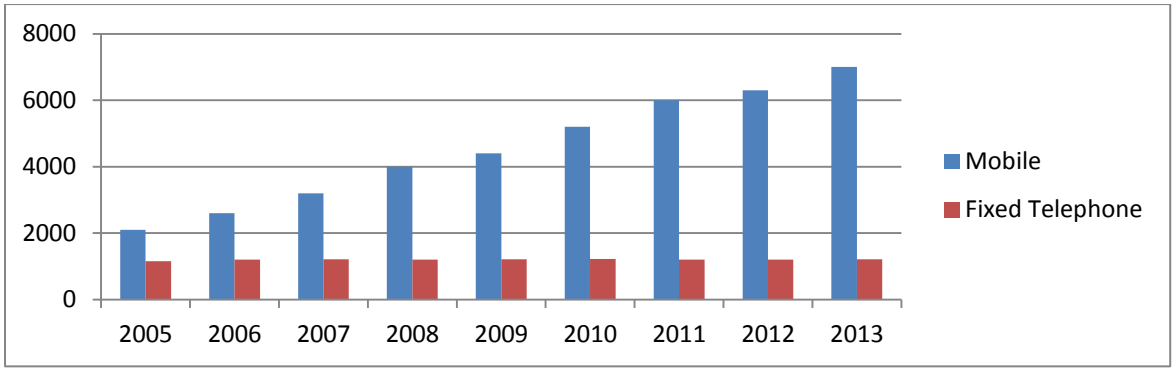
I. INTRODUCTION

Since the last few years there has been a phenomenal growth in the wireless industry. Widespread wireless technologies, increasing variety of user-friendly and multimedia-enabled terminals and wider availability of open source tools for content generation has lead encouraged user-centric networks [1]resulting in a need for efficient network design. There has been a shift from fixed to mobile cellular telephony, resulting in Network Planning and Optimization related services coming in to sharp focus. Evolution of wireless access technology is about to reach its fourth generation. Wireless access technology have formed different evolutionary path but with a common aim related to performance and efficiency. The First generation has fulfilled the basic mobile voice, while the Second generation has dealt with capacity and coverage. The third generation focused for higher data rate, multimedia support and spread spectrum followed by Fourth generation providing access to wide range of telecommunication services including advanced mobile services, along with a support for low to high mobility application. Figure 1 reflects the evolution of network technologies [2][3][4]&[5]



[Figure 1]. Mobile Cellular Network Evolution Timeline

By [4]5G should build an important role with more services, data, use and benefits to the upcoming generation over 4G. 5G will be smarter technology with no limits and to interconnect the whole world without limits. The upcoming life style will be different with uninterrupted access of information and interconnection. The use of mobile/cellular phones is increasing in the last 8 years. The growth of mobile phones or cellar phone users is compared [6] with fixed phones is shown in Figure 2. We argue that as the number of users increased then the management of mobile phone phones becomes more complex. If the complexity and requirement increases then the new technologies with models are required to manage the system. In this paper we analyzed and compare the various techniques of renowned researchers in the same field.



[Figure 2]. Growth of Mobile Users (in Billion)

The world has seen a lot of changes in the realm of communication. Today we no more use landlines. Everyone possesses a mobile phone that functions 24X7. Our handsets not only keep us connected with the world at large but also serve the purpose of entertainment gadget. From 1G to 2.5G and from 3G to 5G this world of telecommunications has seen a number of improvements along with improved performance with every passing day.[7]

II. THE EVOLUTION OF "G FROM 0 TO 5TH GENERATION

2.1 0G (Zero Generation Mobile System)

At the end of the 1940's, the first radio telephone service was introduced, and was designed to users in cars to the public land-line based telephone network. In the 1960's, a system launched by Bell Systems, called, Improved Mobile Telephone Service (IMTS), brought quite a few improvements such as direct dialing and more bandwidth. The very first analog systems were based upon IMTS and were created in the late 60s and early 70s. [8]

2.2 1G Technology

The first generation of mobile phones was analog systems that emerged in the early 1980s.More popularly known as cell phones. 1G- technology replaced 0G technology.1G wireless networks used analog radio signals. Through 1G, a voice call gets modulated to a higher frequency of about 150MHz and up as it is transmitted between radio towers. This is done using a technique called Frequency-Division Multiple Access (FDMA). But its fail in some field such as in terms of overall connection quality, 1G compares unfavorably to its successors. It has low capacity, unreliable handoff, poor voice links, and no security at all since voice calls were played back in radio towers, making these calls susceptible to unwanted eavesdropping by third parties. [2]

2.3 2G Technology

Second-generation (2G) mobile systems were introduced in the end of 1980sand finished in the late 1990s, was planned mainly for voice transmission with digital signal and the speeds up to **64kbps.**. Compared to first-generation systems, second-generation (2G) systems use digital multiple access technology, such as TDMA (time division multiple access) and CDMA (code division multiple access). Consequently, compared with first-generation systems, higher spectrum efficiency, better data services, and more advanced roaming were offered by 2G systems. In the United States, there were three lines of development in second-generation digital cellular systems. The first digital system, introduced in 1991, was the IS-54 (North America TDMA Digital Cellular), of which a new version supporting additional services (IS-136) was introduced in 1996.Meanwhile, IS-95 (CDMA One) was deployed in 1993. 2G communication is generally associated with global system for mobile (GSM) services, The bandwidth of 2G is 30-200 KHz. Second Generation (2G) wireless cellular mobile services was a step ahead of First Generation(1G) services by providing the facility of short message service(SMS) unlike 1G that had its prime focus on verbal communication [10].

2.4 2.5G Technology

It is used to describe 2G-systems that have implemented a packet switched domain in addition to the circuit switched domain. 2.5 G can provide data rate, up to 144 kbps. GPRS, EDGE and CDMA 2000 were 2.5 technologies.

2.5 3G Technology

3G uses Wide Brand Wireless Network with which clarity is increased. 3G telecommunication networks support services that provide an information transfer rate of at least 2Mbps.In EDGE, high-volume movement of data was possible, but still the packet transfer on the air-interface behaves like a circuit switches call. Thus part of this packet connection efficiency is lost in the circuit switch environment. Moreover, the standards for developing the networks were different for different parts of the world. Hence, it was decided to have a network which provides services independent of the technology platform and whose network design standards are same globally. Thus, 3G was born [11]3G is not one standard; it is a family of standards which can all work together. An organization called 3rd Generation Partnership Project (3GPP) has continued the work by defining a mobile system that fulfills the IMT-2000 standard. In Europe, it was called UMTS (Universal Terrestrial Mobile System), which is ETSI-driven. IMT2000 is the ITU-T name for the third generation system, while cdma2000 is the name of the American 3G variant. WCDMA is the air-interface technology for the UMTS. The main components includes BS (Base Station) or nod B, RNC (Radio Network Controller), apart from WMSC (Wideband CDMA Mobile Switching Centre) and SGSN/GGSN. 3G networks enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. The first commercial 3G network was launched by NTT Do Co Mo in Japan branded FOMA, based on W-CDMA technology on October 1, 2001 [12]3G operates at a range of 2100MHz and has a bandwidth of 15-20MHz. High speed internet service, video chatting are the assets of 3G.With the help of 3G, we can access many new services too. One such service is the GLOBAL ROAMING. Another thing to be noted in case of 3G is that Wide Band Voice Channel that is by this the world has been contracted to a little village because a person can contact with other person located in any part of the world and can even send messages too. There is also a concern that in many countries 3G will never be deployed due to its cost and poor performance. Although it is possible that some of the weaknesses at physical layer will still exist in 4G systems, an integration of services at the upper layer is expected.[9]

2.6 4G Technology

The first successful field trial for 4G was conducted in Tokyo, Japan on June 23rd, 2005. NTT Do Co Mo was successful in achieving 1Gbps real time packet transmission in the downlink at a moving speed of about20km/h. To use 4G services, multimode user terminals should be able to select the target wireless systems. In current GSM systems, base stations periodically broadcast signaling messages for service subscription to mobile stations. However, this process becomes complicated in 4G heterogeneous systems because of the differences in wireless technologies and access protocols. To provide wireless services at anytime and anywhere, terminal mobility is a must in 4G infrastructure. Terminal mobility allows mobile clients to roam across geographic Boundaries of wireless networks. There are two main issues in terminal mobility: location management and handoff management. With location management, the system tracks and locates a mobile terminal for possible connection. Location management involves handling all the information about the roaming terminals, such as original and current located cells, authentication information etc. On the other hand, handoff management maintains ongoing communications when the terminal roams. Mobile IPv6 (MIPv6) is a standardized IP-based mobility protocol for IPv6 wireless systems. In this design, each terminal has an IPv6 home address. Whenever the terminal moves outside the local network, the home address becomes invalid, and the terminal obtains a new IPv6 address (called a care-of address) in the visited network [13] The design and optimization of upcoming radio access techniques and a further evolution of the existing system, the Third Generation Partnership Project (3GPP) had laid down the foundations of the future Long Term Evolution (LTE) advanced standards-the 3GPP candidate for 4G [14]. The target values of peak spectrum efficiency for LTE Advanced systems were set to 30bps/Hz and 15 Bps/Hz in downlink and uplink transmission respectively. Apart from the multiple access schemes, enhanced multiple-input multiple-output (MIMO) channel transmission techniques and extensive coordination among multiple cell sites called coordinated multipoint (CoMP) transmission/reception were accepted as the key techniques for LTE [15]

III. WHAT IS 5G TECHNOLOGY ?

Fifth generation of wireless mobile network which will begin in 2015s. It has almost no limitation which makes it isolated or completed wireless communication. Mobile users not had experience of such a highly advance technology [16]An end user can also connect their 5G mobile phones with their desktops to have internet connection. It totally supported World Wide Wireless Web (WWWW). This communication technology merges all enhanced benefits of mobile phones like dialing speed, MP3 recording, cloud storage, HD downloading in instant of seconds and much more that you had never imagined.[17]

IV. WWWW

Worldwide wireless web (WWWW), i.e. comprehensive wireless-based web applications that include full multimedia capability beyond 4G speeds[18]The wireless Web refers to use of the World Wide Web through a wireless device, such as a cellular telephone or personal digital assistant (PDA).The wireless Web refers to use of the World Wide Web through a wireless device, such as a cellular telephone or personal digital assistant (PDA). Wireless Web connection provides anytime/anywhere connection to e-mail, mobile banking, instant messaging, weather and travel information, and other services. In general, sites aiming to accommodate wireless users must provide services in a format displayable on typically small wireless devices. It is estimated that 95% of wireless Internet devices being manufactured today use the Wireless Application Protocol (WAP) developed by Ericsson, Motorola, Nokia, and Unwired Planet (now Phone.com) for presenting content. The wireless Web is not gaining in popularity as quickly as some have predicted. The low bandwidth of today's wireless service, relatively high usage charges, and small and difficult-to-use input and output devices contribute to impeding growth, a condition that has been referred to as "wapathy" (WAP apathy).[19]WWWW that is World Wide Wireless Web, allows complete wireless communication with almost no limitation, Multi-Media Newspapers, watch TV programs with the clarity as to that of an HD TV. To enjoy this technology, mobile hardware must improve and provide larger phone memory, quicker dialing speed, more clarity in audio and video etc [20].The idea of WWWW, World Wide Wireless Web, is started from 4G technologies. The following evolution will based on 4G and completed its idea to form a REAL wireless world. Thus, 5G should make an important difference and add more services and benefit to the world over 4G; 5G should be a more intelligent technology that interconnects the entire world without limits.5G will be the completed version of WWWW, World Wide Wireless Web, to form a real wireless world with no more limitation with access and zone issue.[21]

V. HARDWARE OF 5G [22]

1) UWB Networks: higher bandwidth at low energy levels. This short-range radio technology is ideal for wireless personal area networks (WPANs). UWB complements existing longer range radio technologies –such as Wi-Fi, WiMAX, and cellular wide area communications – that bring in data and communications from the outside world. UWB provides the needed cost-effective, power-efficient, high bandwidth solution for relaying data from host devices to devices in the immediate area (up to 10 meters or 30 feet).
2) Bandwidth**:** 4000 megabits per second, which is 400 times faster than today's wireless networks.
3) Smart antennas.
a. Switched Beam Antennas: Switched Beam Antennas support radio positioning via Angle of Arrival (AOA) information collected from nearby devices.
b. Adaptive Array Antennas: The use of adaptive antenna arrays is one area that shows promise for improving capacity of wireless systems and providing improved safety through position location capabilities. These arrays can be used for interference rejection through spatial _altering, position location through direction ending measurements, and developing improved channel models through angle of arrival channel sounding measurements.
4) Multiplexing: CDMA (Code Division Multiple Access) CDMA employs analog-to-digital conversion (ADC) in combination with spread spectrum technology. Audio input is first digitized into binary elements. The frequency of the transmitted signal is then made to vary according to a defined pattern (code), so it can be intercepted only by a receiver whose frequency response is programmed with the same code, so it follows exactly along with the transmitter frequency. There are trillions of possible frequency-sequencing codes, which enhance privacy and makes cloning difficult. [22]

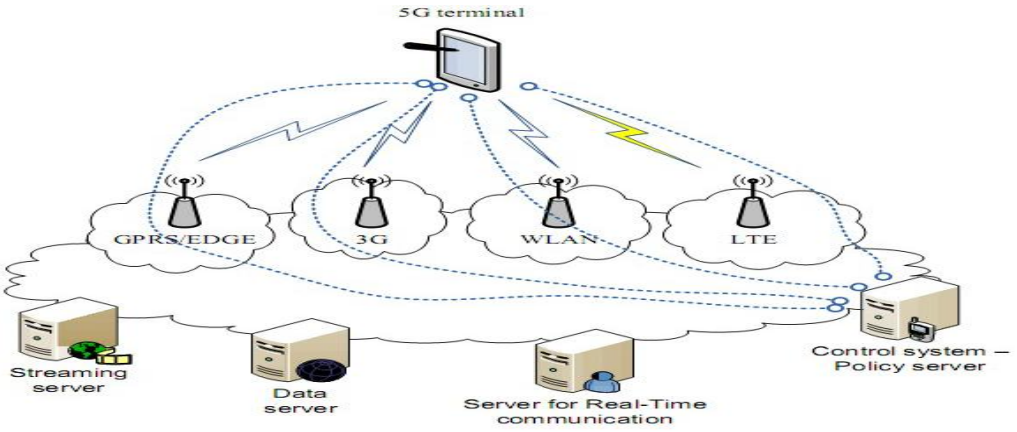
VI. SOFTWARE OF 5G [22]

1)5G will be single unified standard of different wireless networks, including LAN technologies, LAN/WAN, WWWW- World Wide Wireless Web, unified IP & seamless combination of broadband.
2) Software defined radio (SDR), Packet layer, Implementation of Packets, Encryption, Flexibility, Anti-Virus.

VII. BASIC ARCHITECTURE OF 5G TECHNOLOGY

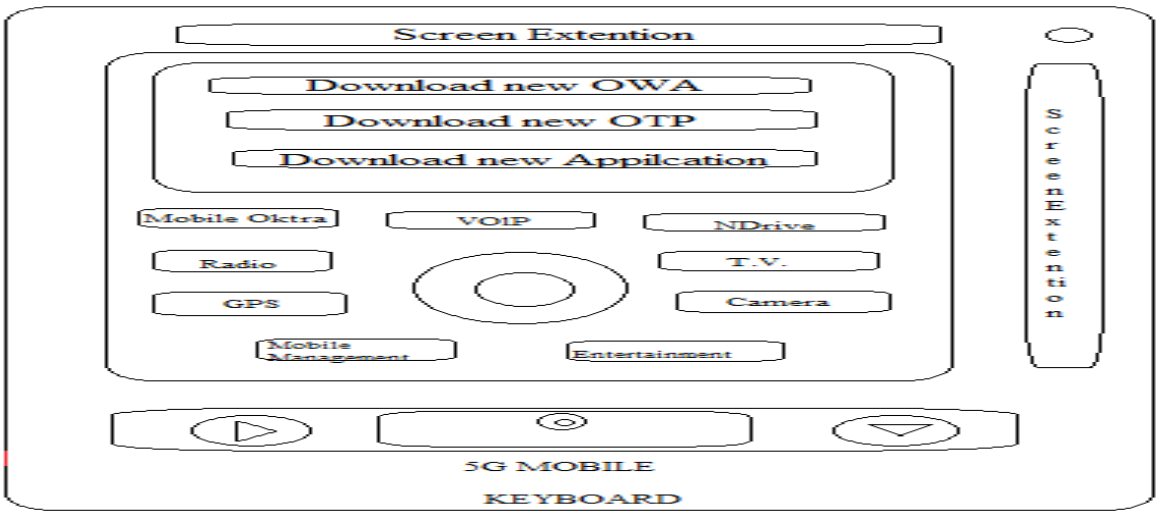
Basic functional architecture of 5G technology shows in figure 3.In figure 3, Fifth generation mobile systems model is all-IP based model for wireless and mobile networks interoperability. The All-IP Network (AIPN) is capable to fulfill increasing demands of the cellular communications market. It is a common platform for all radio access technologies. The AIPN uses packet switching and its continuous evolution provides optimized performance and cost. In fifth generation Network Architecture consist of a user terminal (which has a crucial role in the new architecture) and a number of independent, autonomous Radio Access Technologies (RAT). In 5G network Architecture all IP based mobile applications and services such as Mobile portals, Mobile commerce, Mobile health care, Mobile government, Mobile banking and others, are offered via Cloud

Computing Resources (CCR). Cloud computing is a model for convenient on-demand network access to configurable computing resources (e.g., networks, servers, storage, applications, and services). Cloud computing allows consumers to use applications without installation and access their personal data at any computer with internet access. CCR links the Reconfigurable Multi Technology Core (RMTC) with remote reconfiguration data from RRD attached to Reconfiguration Data Models (RDM). The main challenge for a RMTC is to deal with increasing different radio access technologies. The core is a convergence of the nanotechnology, cloud computing and radio, and based on All IP Platform. Core changes its communication functions depending on status of the network and/or user demands. RMTC is connected to different radio access technologies ranging from 2G to 3G and 4G. Interoperability process criteria and mechanisms enable both terminal and RMTC to select from heterogeneous access systems.



[Figure 3]. Functional Architecture of 5G Wireless Technology.

Below figure 4 shows the system model that proposes design of network architecture for 5G mobile systems, which is all-IP based model for wireless and mobile networks interoperability. The system consists of a user terminal (which has a crucial role in the new architecture) and a Number of independent, autonomous radio access technologies. Within each of the terminals, each of the radio access technologies is seen as the IP link to the outside Internet world. However, there should be different radio interface for each Radio Access Technology (RAT) in the mobile terminal. For an example, if we want to have access to four different RATs, we need to have four different accesses specific interfaces in the mobile terminal, and to have all of them active at the same time, with aim to have this architecture to be functional. Applications and servers somewhere on the Internet. Routing of packets should be carried out in accordance with established policies of the user. Application connections are realized between clients and servers in the Internet via sockets. Internet sockets are endpoints for data communication flows. Each socket of the web is a unified and unique combination of local IP address and appropriate local transport communications port, target IP address and target appropriate communication port, and type of transport protocol.[23]



[Figure 4].5G mobile designs [24]

VIII. WORKING CONCEPTS OF 5G NETWORKS

As stated earlier, 5G will be completely user centric i.e. nothing is hidden from user. It will have new error prevention schemes that can be installed through internet anytime and have modulation methods and software defined radios.[25]5G will be a collaboration of networks and individual network handle user mobility. This network will be based on Open Wireless Architectures as it has Physical Access Control Layer i.e. OSI Layer. OSI layer are shown in table 1.

Application Layer	Application(Services)
Presentation Layer	
Session Layer	Open Transport Protocol
Transport Layer	
Network Layer	Upper Network Layer
	Lower Network Layer
Data link Layer	Open Wireless Architecture
Physical Layer	

Table 1: OSI Layers in 5G Terminal Design. [26]

IX. KEY CONCEPTS OF 5G

1. Real wireless world with no more limitation with access and zone issues. **[27]**
2. Wearable devices with AI capabilities.
3. Internet protocol version 6 (IPv6), where a visiting care-of mobile IP address is assigned according to location and connected network.
4. One unified global standard.
5. Pervasive networks providing ubiquitous computing: The user can simultaneously be connected to several wireless access technologies and seamlessly move between them (See Media independent handover or vertical handover, IEEE 802.21, also expected to be provided by future 4G releases). These access technologies can be a 2.5G, 3G, 4G or 5G mobile networks, Wi-Fi, WPAN or any other future access technology. In 5G, the concept may be further developed into multiple concurrent data transfer paths.**[27]**
6. Cognitive radio technology, also known as smart-radio: allowing different radio technologies to share the same spectrum efficiently by adaptively finding unused spectrum and adapting the transmission scheme to the requirements of the technologies currently sharing the spectrum. This dynamic radio resource management is achieved in a distributed fashion, and relies on software defined radio.**[27]**
7. High altitude stratospheric platform station (HAPS) systems.
8. World Wide wireless web (WWWW), i.e. comprehensive wireless-based web applications that include full multimedia capability beyond 4G speeds.
9. Dynamic Ad hoc Wireless Networks (DAWN), essentially identical to Mobile ad hoc network (MANET), Wireless mesh network (WMN) or wireless grids, combined with smart antennas, cooperative diversity and flexible modulation.[7]
10. Group cooperative relay:-A major issue in beyond 4G systems is to make the high bit rates available in a larger portion of the cell, especially to users in an exposed position in between several base stations. In current research, this issue is addressed by cellular repeaters and macro-diversity techniques, also known as group cooperative relay, as well as by beam division multiple access (BDMA).[7]

X. COMPARISON OF ALL GENERATION

Comparison of different Generation is shown Table-2.

Generation Features	1G	2G	3G	4G	5G
Years	1980s	1990s	2000s	2010s	2020s
Definition	Analog	Digital Narrow band circuit data, Packet	Digital Broadband Packet Data	Digital Broadband Packet All IP	Not Yet

		Data		Very high throughput	
Keywords	Analog	Digital personal	Global world standards	High data rates High mobility IP Based	High data rates High mobility IP Based
Data Bandwidth	2 kbps	64 kbps	2 Mbps	200 Mbps	1 Gbps
Standards	AMPS	TDMA, CDMA, GSM, GPRS	WCDMA	Single unified standard	Single unified standard
Technology	Analog cellular	Digital cellular	Broadband with CDMA, IP technology	Unified IP & seamless combination of broadband, LAN, WAN & WLAN	Unified IP & seamless combination of broadband, LAN, WAN, WLAN & WWWW
Services	Mobile technology (Voice)	Digital voice, SMS, Higher Capacity packetized	Integrated high quality audio, video & data	Dynamic information access, wearable Devices	Dynamic information access, wearable Devices with AI capabilities
Multiplexing	FDMA	TDMA, CDMA	CDMA	CDMA	CDMA
Switching	Circuit	Circuit & Packet	Packet	All packet	All packet
Core Network	PSTN	PSTN	Packet network	Internet	Internet
Handoff	Horizontal	Horizontal	Horizontal	Horizontal & Vertical	Horizontal & Vertical
Systems	Analog cellular Analog cordless	Digital cellular Digital cordless Mobile	3G cellular Max data rate: 2 Mbps	4G cellular Broadband access Min data rate: 2-20 Mbps	5G cellular Min data rate: 20-100 Mbps

Table-2: Comparison of all Generation in Communication.

XI. ADVANTAGES OF 5G TECHNOLOGY

5G aims at providing myriad of services to the end users at high speed. The applications developed to avail these services are highly user friendly minimizing the interaction between the application and the user. For example, integration of speech recognition technology in the user interfaces would ease the use of the applications for every layman.

a**.** Mobility and Interoperability: Multiple standards of 4G restrict the user's mobility and interoperation across different networks. 5G targets at providing a unified global standard which will facilitate global mobility and service portability. In other words, end user can subscribe to different services from different service providers using the same mobile device.

b. Terminal and Network heterogeneity: Terminal heterogeneity refers to the different types of terminals in terms of the size, weight, display features, power consumption, etc. Network heterogeneity means the different types of access networks like WiMAX, Wi-Fi (Wireless Fidelity), UMTS (Universal Mobile Telecommunications System) and so forth which differ in their coverage area, data rate, latency and data loss rate. Each of these terminals and services cater to different user requirements. In 5G, all these terminals and networks will provide common services independent of their capabilities. This is also called as service personalization.

c. High Performance*:* Low transfer rates of 4G restrict the user's ability to take advantage of the rich multimedia contents across the wireless networks. 5G is expected to provide wireless download speeds of above 1Gbps in local area network (LAN) and 500 Mbps in wide area network (WAN), about 260 times greater than the 3G wireless networks.

d. Lower power consumption*:* Battery technology has not been able to keep pace with the growing telecom industry. 3G devices required one battery while 4G required two batteries. Battery drain is a persistent problem of wireless devices. 5G aims at breaking this directly proportional rule. Shorter communication links is one of the few solutions proposed to cater to this requirement.

e. User Choice: High data transfer rates and ubiquitous coverage of 5G networks would provide users access to large repository of data and services. Users would have flexibility to filter these data and services as per his preferences by configuring the operational mode of their devices, so that he can preselect the service features he wants to use. For an example, user in a mall interested in buying clothes should receive alerts about various discount offers on clothes rather than about the other accessories.

f. Network Convergence*:* Network convergence is the efficient coexistence of multimedia, voice and data communication within a single network. Currently the telecommunication environment is divided into wireless and fixed line communication. To avail these different kinds of services, the end user require different devices such as cellular phones, fixed line phones, laptops and PDA's. Once the fixed mobile convergence is in place in 5G, the distinction between these services will disappear. The current 4G technology is not able to capture the market share as done by the fixed line services partly because of its low bit rates of 384kbps and because of the high costs associated with these services. But with the emergence of 5G aiming at global integrated IP based network, the wireless sector will be able to match the fixed line sectors in terms of both costs and speed. 5G will lead to convergence in terms of both devices and services.

g.DataBandwith**:**5G provides data bandwidth of 1 Gbps or higher. It is a great service in wireless communication.

h. Smart Networking*:* 4G is based primarily on cell or base station WAN design. 5G aims at building hybrid networks utilizing both the Wireless LAN concept and WAN design. Thus, the world would have base stations everywhere providing ubiquitous network coverage to users at high speed. For example, a user walking on road is browsing internet using GPRS (General Packet Radio Service-WAN design). The moment he enters a mall with Wi-Fi (LAN design), seamless hand-over from GPRS to Wi-Fi would take place without the user's knowledge.

XII. APPLICATIONS OF 5G TECHNOLOGY

The 5G technology applications are set to evolve in a multiplatform environment. 4G applications will be available across various wireless technologies like LTE, Wi-Fi, etc. and also in devices like cell phones, laptops-readers, digital cameras, printers and so on. 4G applications are very likely to be extended and improved versions of the existing 3G services, but it is still unclear what the capacity of 4G will hold for the mobile world. Some of the applications of 5G networks are [28-31]:

a. Education: For people who are interested in lifelong education, 4G provides a good opportunity. People anywhere in the world can continue their education through online in a cost effective manner.

b. Crisis management: Natural disasters can cause breakdown in communication systems. In today's world it might take days or weeks to restore the system. But in 4G it is expected to restore such crisis issues in a few hours.

c. Virtual Presence: This means that 5G provide user services at all times, even if the user is off-site. Virtual navigation: 4G provides users with virtual navigation through which a user can access a database of the streets, buildings etc. of large cities. This requires high speed data transmission.

d. Security: This layer also branches across all the layers of the 5G network architecture which perform the function of authentication, authorization, encryption, establishment and implementation of service policy agreement between the various vendors.

e. Tele-Medicine**:** 5G will support remote health monitoring of patients. A user need not go to the hospital instead a user can get videoconference assistance for a doctor at anytime and anywhere.

f. Tele-geo processing applications: This is a combination of GIS (Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.

g. Artificial Intelligence**:** More applications combined with artificial intelligent (AI) as human life will be surrounded by artificial sensors which could be communicating with mobile phones.

h. Travelling**:** Introducing the launch of new mobile phone apps; the use of Bluetooth & NFC technology integrated smartphones in the passenger travel process. Technology is likely to play a role in re-ordering these phases over the next decade, allowing, for example, people to experience a destination virtually before transit, or to seek inspiration and share information live, while they are travelling and experiencing a place.

i. Economic growth: Economic growth is supported because these technology changes allow consumers and businesses to benefit from high-value wireless data and content services. This relationship had not yet been explicitly quantified yet.

XIII. THREATS OF 5G IMPLEMENTATION

The following threats are expected from the application implementation of 5G network as a future system.
i). since all the network operators and service providers would share a common core network infrastructure, compromise of a single operator will lead to the collapse of the entire network infrastructure, if not carefully guide against.
ii). Third-parties can masquerade as legitimate users resulting in theft of service and billing frauds can easily arise.
iii). since 5G is a secure IP based solution it will be vulnerable to all the security threats as the current Internet world.
iv). on the lines of email-spam, the Spam over Internet telephony (SPIT), the new spam over VoIP may become serious and become serious threats.
v). Spooling attacks can lead to misdirected communication and internet banking related frauds.
vi). Eavesdropping and interception of private communications.
vii). Phishing attacks, stealing bank account details and other secured information, are more likely.

XIV. CONCLUSIONS

Mobiles have become very essential part of our everyday life. Their current development is the outcome of various generations. In this paper we review introduction to 5G technologies, Key concepts of 5G, and advantage of 5G technology, applications, and wireless network architecture for 5G wireless technologies. The new coming 5Gtechnology is available in the market in affordable rates, high peak future and much reliability than its preceding technologies. Fifth generation technologies offers tremendous data capabilities and unrestricted call volumes and infinite data broadcast together within latest mobile operating system. Fifth generation should make an important difference and add more services and benefits to the world over 4G. Fifth generation should be more intelligent technology that interconnects the entire world without limits. This generation is expected to be released around 2020. The world of universal, uninterrupted access to information, entertainment and communication will open new dimension to our lives and change our life style significantly.

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The Scenario of Brazilian Amazon Transportation Infrastructure in the Natural Hazards Context

Rafael Almeida Flores, Claudio Fabian Szlafsztein.
[1] *Civil Engineer, M.Sc. in Development Planning.*
[1] *Ph.D. in Geography. Federal University of Pará Researcher and Professor.*

Abstract: *The development of a region is related, in part, to its ability to establish relations with other regions and the efficiency with which it operates internally and streamlines their intra relations. The study of the impacts in the availability of transport infrastructure in regional development interests by the influence it has on the location decisions of investment. The network of transport infrastructure in the Brazilian Amazon region is susceptible to interruptions in its functioning by pressures arising from the interaction of coupled human and natural systems, impacting regional development mainly by isolating regions raising concerns about human security of local residents and the economic development to the extent that regional production does not circulates temporarily, eliminating one of the economy dynamics main stages. The susceptibility indicators of transport infrastructure system in the Amazon are unclear and this study presents disruptions causes, frequency, potential risks and impacts in this system functioning.*
Key words: *Disasters; Roadways; Transportation; Infrastructure; Development.*

I. INTRODUCTION

For many years, the Amazon region of Brazil has been considered immune to the hazard of natural disasters. However, in recent years, extreme natural events, increasing their magnitudes and frequencies, has manifested itself in urban and rural areas in this region. Consequently, this territory has been exposed to the impacts of some technological and natural hazards, most being associated with droughts, floods, fires and erosion of soils, rivers and coastal areas (SZLAFSZTEIN, 2012). The interaction between the natural environment behavior in and the facilities built interests in the context of environmental discussions of changes in climate and sustainable development planning. This way of thinking the future considers the supply chains improvement, transportation logistics, the exploitation of natural resources and other factors and should be the agenda of research aimed at understanding and promote regional development. Theme researchers have focused their attention on the relationship between natural disasters and vulnerability to these populations that have not focusing so much on the role played by the development components, such as the infrastructure of the region. This approach focuses on infrastructure development study as promoter but also as agent impacted by natural phenomena. This is done not only through the answers that are given by the company to mitigate the effects of damaging effects, but mainly by highlighting the increased susceptibility of infrastructure disaster.

This study describes how the infrastructures are affected by natural hazards in the Amazon, causing a delay in regional development by presenting non-functional periods due to disasters. The development of a region is related, in part, to their ability and efficiency to establish relations with other regions, as well as its efficiency to operate their internal relations. This depends on the existing systems to transport services, information, people and goods (eg. land transport, water and air). Without this infrastructure there is no way to get the labor force to move to the place of production, it cannot carry the raw material and it is not possible for the potential consumer market has access to the product. Dependent regions of only one form of transport leaving its population susceptible to isolation. This way you can think relations between transport infrastructure, economic growth and regional disparities as development components. Araújo (2006) indicates that the issue of transport infrastructure is a structural problem to the Brazilian development, in that it does not provide adequate and balanced conditions between regions.

Infrastructure facilities are necessary for the functioning of a society, grouping a set of interconnected structural elements that support the entire development framework (SULLIVAN, 2003). These are roads,

bridges, water supply, sewage systems, distribution networks for energy and telecommunications, which are the physical components of networks that provide goods and services essential to make possible, sustainable and better conditions lifetime (FULMER, 2009). These elements fulfill a key role in social, economic and institutional of a society. Socially, the infrastructure promotes adequate housing, work, health, education, leisure and security. Economically, the infrastructure based on the development of productive activities, i.e. the production and marketing of goods and services. And institutionally, provides the means to develop the political and administrative activities (ZMITROWICZ e ANGELIS NETO, 1997). Some infrastructure (eg. communication systems, water supply, transport) are classified as lifelines for providing essential conditions of movement of persons, goods, services and information (PLATT, 1991), being systems and facilities that are also important elements of response and emergency recovery after natural disasters (MCEER, 2013) therefore, are vital infrastructure lines to the development and growth of a company, having, therefore, a growing concern to understand their vulnerability to damage and breakages during disasters (DALZIELL e NICHOLSON, 2001).

In the Brazilian Amazon natural disasters negatively impact a region whose development is already shows problems, with particular emphasis on economic and environmental activities in the most vulnerable population (eg. poverty in urban areas and in rural communities). The situation tends to get worse considering the forecast usage scenarios more intense and extensive forest and increased occupation in the cities, as well as the intensification of climate change in the Amazon. In this regard, a major challenge is to develop and implement risk management policies, strategies and measures that may suit regional peculiarities (SZLAFSZTEIN, 2012). Disaster is understood as any interruption in the natural cycle of development of any person, population, society, economic activity and etc. Therefore, it is any event that, somehow, has this feature to stop the development. The United Nations (UN) defines natural disasters as the consequences of impacts, damages from extreme or intense natural phenomena on a socioeconomic system, which exceed the capacity of the system affected to eliminate or live with the impact (UN-ISDR, 2009).

The understanding of the relationship between infrastructure and natural disasters to cause impacts to development is related to the concept of vulnerability, which can be analyzed from the relationship between exposure to a particular risk (susceptibility) and the level of adaptation to a defined area, activity, population or infrastructure features at a specific time (IPCC, 2007; PENTEGUEL, 2010). Susceptibility is defined as the set of characteristics and circumstances, to which the infrastructure is submitted, which make this is susceptible to the damaging effects of a hazard, regardless of exposure (UN-ISDR, 2009). The negative impacts - such as interruption of roads, telecommunications and shortages - are perceived by users (eg drivers, passengers and goods transported owners.) The service provided by the infrastructure dedicated to the effective and efficient transport of goods, raw materials, people and information is vulnerable in this context. This means that if a road by which carries a commodity becomes less efficient due to heavy traffic, the erosions on the track that cause narrowing of the road or temporary interruption of the road with or without alternative routes, the impact is perceived in daily activities of the population, thus an impact on regional development. The existing hierarchy We highlight the impacts exemplified here, since not only transport is replaced by a higher cost for having to stay longer on the highway (ex. Perishable loads and cooling dependent), but also activities in one of the locations depending on the highway (eg. gas stations, or raw material for the final consumer of the product).

Thus, this article aims to describe the scenario in which the Amazonian transportation infrastructure is in the Amazon in the context of natural disasters, presenting a systematic, organized and distributed in space disaster occurrence data on federal highways in northern Brazil and discussing how the relationship between the operation of the infrastructure and natural disasters acts simultaneously as impactful agent and as a driver of regional development. A spatial database outages transport infrastructure in the Brazilian Amazon as a result of natural disasters appears. It discusses the existence of patterns in the occurrence of disasters that correspond to the hazards that originate, considering the location in the study area.

II. MATERIALS AND METHODS

2.1 Disasters Spatial Distribution

A survey of documents from the regional journals in the period between 2011 and 2014 has been made, which included civil defense agencies, fire departments and the National Department of Transport Infrastructure (DNIT). These sources are news portals G1 Amazonas, Pará G1, G1 Maranhão, D24AM News, Estradas, A Critica, A Tarde, O Impacto, the Diário do Pará newspaper, Folha da Boa Vista, Jornal do Brazil, Correio do Estado and reports made by the Brazilian Army Engineering and Construction Battalion (BEC) and the DNIT. Search sites on the Internet were the first information access channel, which was later supplemented by the reports and exchange of e-mails of DNIT representatives of the states of Pará and Amazonas. This information, cataloged in spreadsheets organized by event date, the interruption location (city, state, coordinated geographical), the road interruption cause were the source of information and the database integrating a geographic information system. The sequence "disaster, impacts and response" was used to read the news

report that these steps that have developed in the course of perception of the disaster. All data sources report that occurred as follows: a. Disaster (heavy rain, river flood); b. Primary impact (highway interruption); c. Secondary impacts (floor drains or rupture, isolation, row of stationary vehicles) and; d. Response type (alternative methods of transportation by water, deviations guided by the Federal Highway Police - PRF). With Google Maps the reference point informed in the event description was located. The intersection with bodies of water or other roads served to the point location, allowing its coordinated be saved. Intersections of rivers or other perpendicular axes to highways served as references (Figure 1). In cases without this feature we used the "Routes" tool to locate the point by measuring its distance to the beginning of the highway km count.

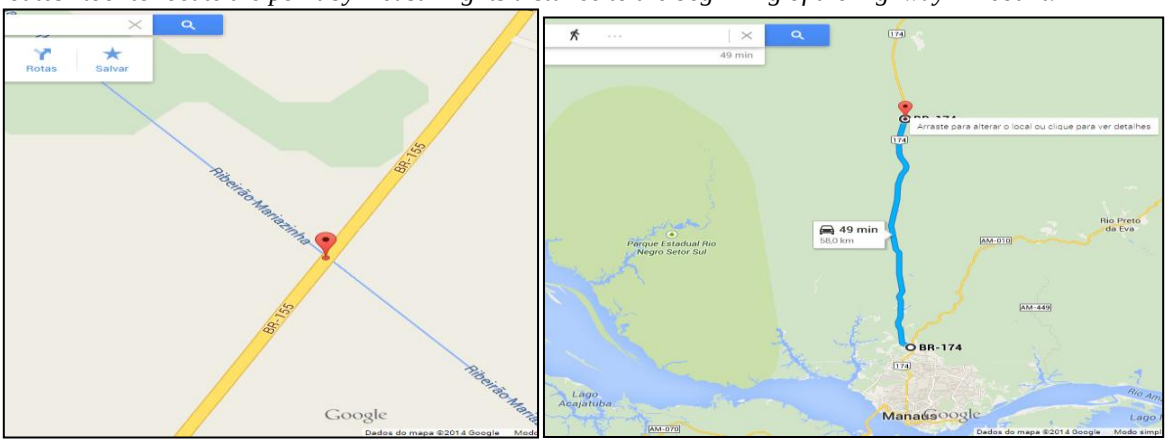

Figure 1. Geographic coordinates obtained for preparation of maps

The maps were developed with geographic information systems (GIS) by inserting a layer of points representing the coordinates written text file (.txt) with three columns: code, latitude and longitude (Figure 2). Thus it was possible to plot on a file layer the points, as well as provide them with features icons that distinguish them from each other. The event classification by type of interruption is done through five files named "highways cuts" and characterized by the type of originating event: erosion (ER), pipe rupture (RT), break bridges (RP), flood (IN) and Muds (AT). Each one of these files makes up a group of pictures corresponding to a layer on the map. Thus, each event type may be represented by an icon type, differentiating map the cause of the interruption at each point. Each text file contains a number of coordinates for the type of event, numbered according to the totality of cases. This file type organized in tables the coordinates to be inserted in the software and generate the maps.

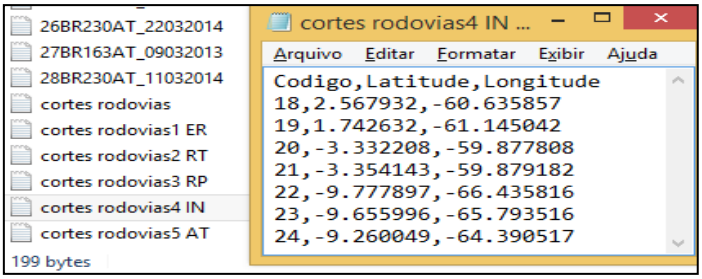

Figure 2. Geographical coordinates numbered and sorted for map-making.

2.2Characterization of the Study Area

The northern Brazil is composed by the states of Acre, Amapá, Amazonas, Pará, Rondônia, Roraima and Tocantins, which contain watersheds of major proportions and with great potential for water transportation and presents a low density road network. The Legal Amazon encompasses the states mentioned above plus the states of Maranhão and Mato Grosso. In addition, the North Region has 16.3 million inhabitants (IBGE, 2013), which represents 8% of the brazilian population. Depending on the historical and territorial formation of the Amazon, this population lives in cities subjected to isolation with broken roads, usually concentrating near rivers and other bodies of water, including populations of urban centers and rural communities, subject to the impacts of disasters. The Amazon forest is classified in three types: the land forest, the flooded forest (always flooded) and lowland (sporadic flooding) (ATLAS NATIONAL GEOGRAPHIC, 2008). It is a heterogeneous territory divided into six states and 310 municipalities (in Brazil), covering 3,575,951 km² and representing approximately 40% of the national territory. Despite the intense exploitation of natural resources, 62% of this area is original forest cover and about 20% is already impacted. In addition to the forests and their biodiversity, the region has a huge amount of mineral resources and has become, since the 1980s the latest agricultural frontier of the country. (SZLAFSZTEIN, 2012).

As hydro geological system, the Amazon basin stands out for its influence on the global climate and carbon cycle (RICHEY et al., 2002 MELACK et al., 2004). In addition to the human pressures, this system is under risk because of recent floods and extreme droughts (CHEN et al, 2010 TOMASELLA et al, 2010; MARENGO et al., 2008), windstorms, earthquakes, soil erosion of river banks and coastal areas as well as natural or arson (SZLAFSZTEIN, 2003; EGER and AQUINO, 2006; MAIA et al, 2008) that major impacts on the Amazon population dependent on rivers for transportation, energy, food (PAIVA, 2013). Flood plains are formed by sediments just above the water level periodically. The Amazonian plateau has maximum altitude of 200 m and is formed by sediments. It is heavily compartmentalized by streams of drainage network and rivers, with steep topography. The crystalline shells are located north and south of the sedimentary basin, very flat with this, so that the contact is only marked by the area of the waterfalls of the tributaries of the Amazon River, with this area altitude above 200 m (ENVIRONMENT BRAZIL, 2014). Presents extensive wetlands flooded (HESS et al., 2009) with a complex water flow mechanism (ALSDORF et al., 2007), and heavy precipitation with high spatial and temporal variability, with hydro climatic regime contrasting in their different regions (ESPINOZA et al., 2009) (Figure 4).

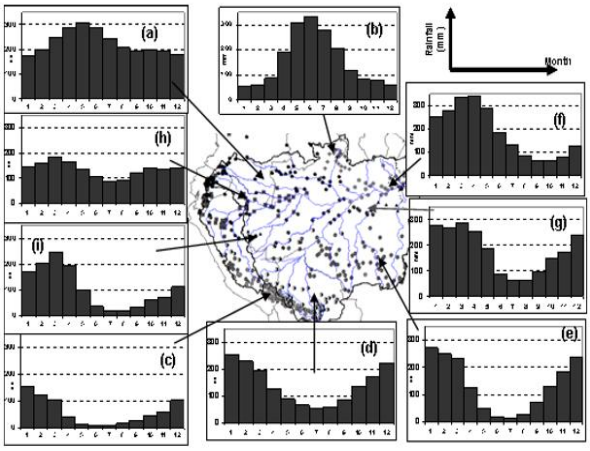

Figure 3. Variability of rainy season in the Amazon.

Source: ESPINOZA, 2014.

2.3 Theoretical Framework

Risk is the interaction product between human decisions and the ecosystem in which people are inserted. The risk assessment involves the analysis of the likelihood of occurrence of a disaster resulting from the destruction or disruption of the highway activities. This concept involves two main components: a natural hazard and the preparation of the population. The first corresponds to the probability of a natural phenomenon causing positive or negative consequences in a component of the company, corresponding to the second component, has a degree of preparation to deal with that event. The higher this preparation, the lower the disaster risk. Hazards are those elements present in the physical environment that are harmful to man and are caused by forces beyond him (Burton, 1978), and, more specifically, all atmospheric, hydrological, geological phenomena, the location, severity and frequency, have the potential to affect humans, their structures or their unfavorably activities (OAS, 2014). The consequences of highways by natural hazards interruptions includes the cost of any repair work (eg. Bridge repairs, reconstruction of road sections) as well as the economic cost of the trips were discontinued, the first being absorbed by the administrator and the second by users. The costs of the users depend on the duration of the interruption, the largest distances in alternative routes or losses derived from the option to postpone or give up the trip. The probability of a certain magnitude disaster occur in any year is uncertain. For some specific disaster there is a low probability of having an event of sufficient magnitude to disrupt the pathway, thus being an estimate of the probability of closing limited historical data. In this way, add up to subjective aspects previously mentioned the uncertainty of trying to predict the hazards (DALZIELL and NICHOLSON, 2001).

According Szlafsztein (2012), disaster is any interruption in the natural cycle of development of the activities of any person, population, society or economic activity, among other components of a society. The relationship between disaster and disaster risk, therefore, is given by the way in which society deals with the probability of being affected by a hazard, since the risk may be lower if the preparation of the population to receive that hazard is greater, being the opposite also applies. It is considered an event such as disaster when at least one of the following conditions are identified: 10 or more people have died as a result of the event; 100 or more people have been affected; Has been declared the emergency and public authorities; Has been requested international assistance (CRED, 2009). In Amazon there are hazards related hydro climatic phenomena (eg. floods and

droughts), earthquakes, winds, soil erosion (land division, margins of rivers and coastal areas). Naturally occurring disasters in the region are becoming more frequent and intense, droughts and floods highlighting (MARENGO et al, 2011; SENA et al, 2012; TOMASELLA et al, 2012.).

2.4 Scenario of research on evaluation of disasters and infrastructure

The lifeline engineering aims to develop mechanisms that act on two main fronts to mitigate the effects of hazards to roads: recovery measures and emergency surgery reconstruction with quick access to the event, which includes risk mapping throughout the extension of roads, and the development of alternative routes that operate based on the classification of the type of vehicle is running and that they consider the possibility that these alternatives are also affected by the disaster in addition to driving conditions, fuel availability and other services basic equivalent to those available on the main road, managing to reduce the dwell time and the frequency with which this occurs. The study of natural hazards and risks is more developed in places where there are hazards of magnitude more easily perceived by the population, by abruptly these hazards. The relationship between the components agents involved in a management program (technical tools, administrative and social) can be analyzed with a simplified organizational framework: the PSIR cycle (Pressure, State, Impact and Response). This methodology evaluates the steps and components of the event. When climatic and anthropogenic pressures cause partial or total imbalance in the environment the first effects are changes in the state of soil, water, habitat and cover and land use. This imbalance results in impacts such as pollution, degradation, change and migration, affecting the natural processes, the use and protection of resources and socio-economic activities. Vulnerability and impacts assessments also provide a starting point for the determination of effective corrective actions to mitigate the impacts and restore the original condition as soon as possible through support policies spontaneous or planned responsive character. This means that both the total or partial mitigation of the causes of imbalance or adapt to new conditions are necessary. Adaptive responses aimed mainly reduce system vulnerability, however, it can also cause changes in pressure (SZLAFSZTEIN, 2005). These relationships are checked when the pressures generate impacts that are perceived by society. This perception may be, in addition to physical damage, through financial losses. According Dalziell and Nicholson (2001), the economic costs of the road closure depend on the possibility of using alternative routes while it is closed, and the reason the closing occurs. Due to the correlation between the road conditions through the network from a natural event, such as a flood, the effects of which will be spread over a large geographical area. You must also interpret the vulnerability of alternative routes. The interpretation of this simultaneity in the Amazon region may consider flood areas within basins with a considerable area and enable the interrupt snippets that would be alternatives.

III. RESULTS AND DISCUSSIONS

3.1Disruptions Description

Items 4.1.1 to 4.1.3 occurred by pavement layers erosion. 4.1.4 to 4.1.12 disruptions is given by the rupture of the culvert pipe system greide. The events described in items 4.1.13 to 4.1.16 occurred by breaking bridges or part of them wear. 5.1.17 4.1.23 occurrences are caused by the flooding of the highway due to full rivers and finally 4.1.24 to 4.1.27 disruptions were due to the inability traffic road conditions due to accumulation of sludge called here as Muds.

4.1.1 In the BR-174 highway an erosion of the component layers of the road damaged the structure, causing the disruption of the upper layer of the floor. This led to traffic disruption. The incident occurred in the Presidente Figueiredo county (AM), to 117 km from the capital of that state, Manaus (Figure 4). The region was isolated for access of land vehicles of any kind until the work was performed recovery (G1 AMAZONAS, 2014).

Figure 4. BR-174. Disruption by erosion. 117 km from Manaus. Source: G1 Amazonas, 2014.

4.1.2 The BR-174 highway, in the stretch between the cities of Manaus (AM) and Boa Vista (RR), was partially banned by the erosion that only allowed the traffic light vehicles and pedestrians. This occurred in 58 km in the state of Amazonas, and the response was through the installation, by the DNIT, a metal bridge to the release of the traffic of all types of vehicles as the work of the infrastructure recovery was not started (DNIT, 2014).

4.1.3 The BR-364 highway was banned for repairs motivated by an erosion that damaged the structure of the pavement. The traffic was allowed only in middle lane at km 232 and for small vehicles during maintenance (DNIT, 2014). After the action of DNIT to recover the road structure the truck and bus traffic has resumed normal conditions, thus reestablishing the freight service and people.

4.1.4 The BR-174 highway was banned in both directions because a concrete pipe gallery broke and tore a hole in the track, at km 83, near Presidente Figueiredo (AM) (Figure 5). This left many isolated communities. In response to PRF guided the road from Manaus and Boa Vista not to release for circulation to buses until the situation were normalized. In addition, the fire department helped transport people into commodities with a boat. Restoration work began on the same day (D24AM, 2011).

Figure 5. Disrupt in BR-174 by pipe rupture gallery. Source: D24AM, 2011.

4.1.5 A crater 14 m in the BR-010 highway, caused by the rapid increase in the flow of the stream Itaquimirim in Sao Miguel do Guama (PA), which broke the gallery of concrete pipes, stopped the vehicle traffic (G1 Pará, 2011) (Figure 6). There was isolation of the residents of the area near the 317 km (ROADS, 2011). Lane part was partially released on May 3, 2011, without the Asphalt (ORM, 2011). The answer given by PRF orientation deviation for holding by the users and the track repair work. According to the newspaper Diário do Pará (2011), during the five-day ban, drivers that use the BR-010 following north were driven by the PRF to follow the journey through a detour of 160 km on the state highway PA-140, passing the municipalities of Irituia, Captain Well and Capanema, to get to Santa Maria (Pará State).

Figure 6. BR-010 Interruption in Sao Miguel do Guama, Para. Source: G1 Pará, 2011.

4.1.6 Rupture of concrete pipes that formed the culvert to drain water caused the interruption of highway with traffic worked only half the road. In response was installed a temporary pedestrian bridge with steel cables, which served to bus passengers to be transferred to another vehicle, followed by the recovery of the road with drainage works, earthwork and paving. (Figure 7). The stretch is distant 70 km from Boa Vista (RR) and 3 km from the bridge over the river Uraricoera (FOLHA DE BOA VISTA, 2012).

Figure 7. A. Break the BR-174 tubes. Source: Folha de Boa Vista, 2012.

4.1.7 The Roosevelt river, which cuts the highway in Apuí (AM), overflowed and caused the rupture of the concrete pipe gallery with the destruction of road base layers (Figure 8). Apuí is 220 km south of Manaus and local communities were cut off for a week (A CRÍTICA, 2013). Civil defense sent a team to assess the damage and make a survey of the services that were needed for the recovery of the road. (G1 AMAZONAS, 2013).

Figure 8. BR-230 in Apuí (AM). Source: A Critica, 2013.

4.1.8 In the km 66 of the BR-401 highway, which connects Roraima to Guyana galleries formed by concrete pipes broke, preventing vehicle traffic (Figure 9). In response to state civil defense began the process of mapping other points of vulnerability in other highways so that the necessary steps be taken. In addition, the state board of infrastructure works performed that ended two days after the incident, reestablishing transit (A CRÍTICA, 2012).

Figure 9. Drain tubes Break in the BR-401 hughway. Source: A Critica, 2012.

4.1.9 In the BR-230 highway culvert of greide concrete pipe broke (G1 AMAZONAS, 2014) and stopped the vehicle traffic between the cities of Apuí and Humaitá (AM), the 455 and 591 km from Manaus, respectively, causing the isolation of nearby municipalities communities. (Figure 10).

Figure 10. Break tubes in the BR-230. Source: G1 Amazonas, 2014.

4.1.10 In the km 271 (Maranhão state), the BR-010 highway, a triple manhole, which is a system of three concrete pipes below the deck positioned to provide three channels of flow of water, was destroyed by heavy rains that fell in Imperatriz, Maranhão (Figure 11). Occurred near the village called 1,700 within that municipality. This made it impossible for any size of vehicle traffic, and only possible pedestrian traffic (G1 MARANHÃO, 2014). The event caused a jam vehicles of almost 10 km at the time of occurrence. The PRF advised at the time that highway users should drive through the city of Araguatins in order to Bethlehem, and through the city of Porto Franco (MA), towards St. Louis. With the ban on the Belém-Brasília highway, users chose to use roads in the central region of Maranhão state who have precarious situation (G1 MARANHÃO, 2014).

Figure 11. BR-010 in 02/2014. Source: G1 Maranhão, 2014.

4.1.11 In the Moraes de Almeida district, inserted location within the city of Itaituba (PA), there was a Drain tubes break that banned the BR-163 highway until the DNIT arrange the necessary repairs (DNIT, 2014).

4.1.12 In the state of Pará, the BR-155 highway was banned between the cities of Xinguara and Redemption. The breakup of a manhole in Marinette river, made the track assign, disrupting traffic in the area (Figure 12). The problem happened within a kilometer of the municipal capital (G1 PARA, 2014). The traffic was restored on 11.20.2014. DNIT built a diversion to allow the passage of vehicles. With the release of the track, began the recovery track (DNIT, 2014).

Figure 12. Culvert collapsed on the BR-155. Source: G1 Pará, 2014.

4.1.13 interruption occurred between Normandy municipalities (RR) and Paracaima (RR) for damage caused by the rise in Igarapé Javari level to the bridge structure on this body of water (A CRÍTICA, 2011).

4.1.14 In Imperatriz (MA), traffic on the BR-010 had been closed because it was committed to its structure (G1 Maranhão, 2014). Rainfall in the region also caused an increase in the volume of water from the stream Pond Surrounded. The strong current of Rio Grande Bar undertaken to bridge the connection structure with the ground-road (Figure 13).

Figure 13. A. damaged bridge on US-010. Source: G1 Maranhão, 2014.

4.1.15 Part of the bridge over the river Arataú, the BR-230 was shot down by the water Arataú river after a heavy rain that fell in the southwestern region of Pará (Figure 14). This bridge was built by the Brazilian Army three months before this event. The DNIT infrastructure analyst, Marcelo Paiva said the bridge reconstruction would begin only when the water level back to normal level. While this did not happen the transport service in the region was paralyzed (DIÁRIO DO PARÁ, 2014).

Figure 14. A. Rio Arataú damages bridge and passengers expect the transport service re-establishment. Source: Diário do Pará, 2014.

4.1.16 Due to the flooding river Tarauacá in Acre, BR-364 highway was partially interrupted because of damage at threshold (bridge connecting structure - ground) of the bridge in the municipality of Tarauacá (Figure 15). There was part of disruption of landfills that support the transition slab. The Regional Superintendent of DNIT assessed the damage to the head of the bridge and carried out works for stability and security to users (DNIT, 2014).

Figure 15. Bridge over the River Tarauacá (AC) with damage to its structure. Source: DNIT, 2014.

4.1.17 Among the City of Cornwall and the South region of the state of Roraima, vehicle traffic was stopped due to the full the White River that flooded parts of the BR-432 highway. (Figure 16A). The answer was through preventive traffic disruption by the PRF and the recovery depended on the water level of behavior, that is, the highway was used again when the water level was lower (A CRÍTICA, 2011).

4.1.18 In the region of Caracaraí in Roraima, the BR-174 highway was flooded due to the full Rio Branco (Figure 16B), which reached 10.55 meters above its normal level (A CRÍTICA, 2011). The traffic on that road was interrupted paralyzing transport services of persons and goods in the region.

Figure 16. A. BR-432 flooded with traffic stopped. B. BR-174 with traffic stopped in the city of Caracaraí, RR. Source: A Crítica, 2011.

4.1.19 Full of Wood River and its tributaries caused the flooding of the BR-319 highway in the state of Rondônia such that the 18 km stretch of that state, towards the town of Humaitá (AM) was impassable (DNIT, 2014) until the water level lowered.

4.1.20 At another point, full of the Madeira River and its tributaries caused the flooding of the BR-319 highway at km stretch of 20, near the city of Humaitá, in Amazonas state, which was forbidden (DNIT, 2014). The section, which is distant two kilometers of occurrence in the previous items was no traffic until the water level decrease.

4.1.21 The BR-364 highway, due to the full the Madeira River, flooded resulted in 871 km, with the traffic of all types of vehicles unable (DNIT, 2014). The vehicles transit was released only after the water level dropped.

4.1.22 The BR-364 highway, due to the full the Madeira River, flooded resulted in 871 km, with the traffic of all types of vehicles unable (DNIT, 2014). This is the same flooded stretch mentioned in the previous section, with the two-week difference.

4.1.23 In a joint decision between DNIT and PRF vehicle traffic on the BR-364 highway had been closed for security between the states of Acre and Rondonia due to heavy rains and flood in which was the Rio Madeira (ESTADÃO, 2014). The water level of the river Madeira, which lies in the region between the two states, was about 18 m above the normal level.

Figure 17. BR-364 highway flooded near Porto Velho (Rondonia State). Source: Correio do Estado, 2014.

4.1.24 On February 19, 2014, the Brazilian Army, in keeping with DNIT's request, has mobilized to minimize the problem, given that the contractors responsible for that section were not keeping the trafficability the highway and maintenance shuttle service (Figure 18A) (DNIT, 2014).

4.1.25 The Trans-Amazon highway Muds that had made it impossible to traffic in southwestern Pará (Figure 15B). The stretch between the city of Altamira and the area of construction of the hydroelectric plant of Belo Monte is the exact location occurred (GLOBO, 2012). The passage considered without traffic conditions has a length of 7 km and for its location, prevents traffic construction consortium machines hydroelectric plant of Belo Monte.

Figure 18. A. Mud in Trairão (PA), the Caracol location. B. BR-230 in Altamira-PA interrupted. Source: Brazilian Army, 2014. Globo, 2012.

4.1.26 The BR-163 highway, near Trairão (Pará State), was no vehicle traffic conditions due to mire (Figure 16A). A row of stationary vehicles graduated paralyzing any transportation service of persons or goods (G1 PARÁ, 2013). The service recovery was due to the change of time and decreased rainfall. There was no interference state for the recovery of the infrastructure.

4.1.27 A quagmire caused the interruption of traffic (Figure 16B) in the stretch between the cities of Novo Repartimento and Pacajá (Pará State) (DIÁRIO DO PARÁ, 2014). The recovery of the change depended on the decrease of the precipitation procedure. There was no state intervention related to the recovery of infrastructure.

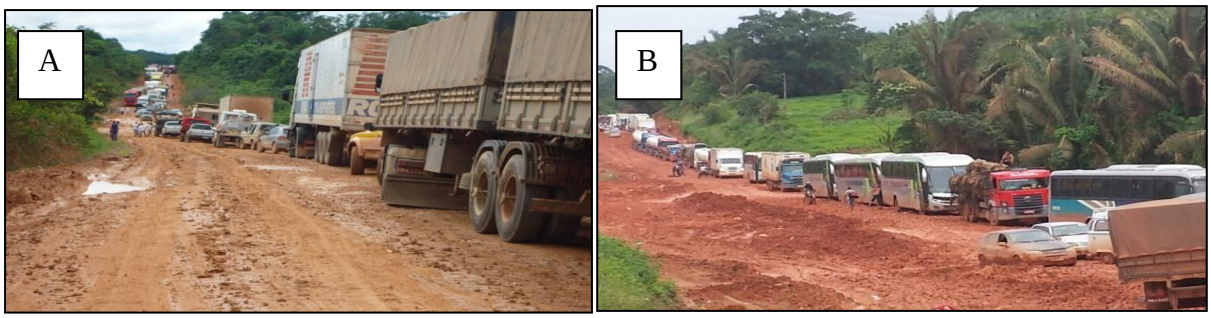

Figure 19. A. Mud on the BR-163. B. BR-230 between New Repartimento and Pacajá (Pará State) impassable. Source: G1 Pará, 2013. Diário do Pará, 2014.

Table 1. Reports sources, organized by item on text.

4.1.1-http://g1.globo.com/am/amazonas/noticia/2014/03/apos-chuva-asfalto-cede-e-rodovia-br-174-e-interditada-no-amazonas.html
4.1.2-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.3-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.4-http://www.d24am.com/noticias/amazonas/trecho-da-br174-desmorona-com-a-forte-chuva/18555
4.1.5-g1.globo.com/brasil/noticia/2011/04/cratera-interdita-rodovia-br-010-no-para.html
http://estradas.com.br/belem-brasilia-sera-liberada-ainda-hoje/
http://noticias.orm.com.br/noticia.asp?id=530365l
http://www.diariodopara.com.br/impressao.php?idnot=132189
4.1.6-http://www.folhabv.com.br/noticia.php?id=127867
4.1.7-http://acritica.uol.com.br/noticias/manaus-amazonas-amazonia-Cheia-complica-Apui-Sul_do_Amazonas-Rio_Roosevelt-transito-Transamazonica_0_871112882.html
http://g1.globo.com/am/amazonas/amazonas-tv/videos/t/edicoes/v/defesa-civil-avalia-interdicao-da-br-230/2430794/
4.1.8-http://acritica.uol.com.br/noticias/Trecho-BR-401-interrompe-Guiana-Roraima-Amazonia-Amazonas-Manaus-Roraima_0_693530702.html
4.1.9-http://g1.globo.com/am/amazonas/noticia/2014/02/com-fortes-chuvas-cratera-causa-interdicao-da-br-230-no-sul-do-am.html
4.1.10-http://g1.globo.com/ma/maranhao/noticia/2014/02/rodovia-belem-brasilia-esta-interditada-em-dois-trechos.html
4.1.11-http://g1.globo.com/pa/para/noticia/2014/11/aterro-sobre-rio-rompe-e-interdita-trecho-da-br-155-em-xinguara-pa.html
4.1.12-http://www.dnit.gov.br/noticias/atencao-usuario-trafego-na-br-155-pa-devera-ser-liberado-nesta-quinta-feira-20
4.1.13-http://acritica.uol.com.br/amazonia/BR-174-interdidata-causa-cheia-Roraima_0_494350609.html
4.1.14-http://g1.globo.com/ma/maranhao/noticia/2014/02/trafego-no-km-271-da-br-010-so-sera-regularizado-em-ate-90-dias-diz-dnit.html
4.1.15-http://www.diarioonline.com.br/noticias/para/noticia-307160-.html
4.1.16-http://www.dnit.gov.br/noticias/atencao-usuario-br-364-ac-encontra-se-parcialmente-interrompida-no-km-544
4.1.17-http://acritica.uol.com.br/amazonia/BR-174-interdidata-causa-cheia-Roraima_0_494350609.html
4.1.18-http://acritica.uol.com.br/amazonia/BR-174-interdidata-causa-cheia-Roraima_0_494350609.html
4.1.19-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.20-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.21-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.22-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.23-http://www.estadao.com.br/noticias/geral,cheia-historica-do-rio-madeira-praticamente-isola-acre,1132492,0.htm
4.1.24-http://www.dnit.gov.br/sala-de-imprensa/emergencias-chuvas/
4.1.25-http://globotv.globo.com/rede-globo/jornal-nacional/v/rodovia-transamazonica-no-para-esta-coberta-de-lama/1869874/
4.1.26-http://g1.globo.com/pa/para/noticia/2013/12/internauta-denuncia-condicoes-precarias-da-br-163-no-para.html
4.1.27-http://www.diarioonline.com.br/noticias/para/noticia-277456-.html

The occurrences are synthesized of highways interrupted between 2011 and 2014 in the study area (Table 1) according to the cause of each and accompanied by relevant data columns for the record. The location map that complements this information was developed with GIS software, from the location information of the news converted to geographical coordinates, based on technical DNIT manual about naming guidelines, classification and miles count on federal highways. This information was organized through interrupt spreadsheet construction ordering classifies the items according to the cause of the disaster impact. The column "item" refers to the order in which the records have been presented in the text, while "BR" refers to federal highway that was interrupted and discriminates each line in the reference code of each road. The "km" is complemented by the column "coordinated" and refers to the kilometers count that is used by the DNIT to place the road cut location. The column named "reference" reports the site employed by news source to describe the occurrence. In "UF" reports to state federative unit, while columns "Reason" and "Data" report the impact of the first order that triggers the interruption of the highway and date on which the incident occurred, respectively.

Table 1. Interruptions in federal highways in the Brazilian Amazon between 2011 and 2014.

Item	BR	km	Reference	State	Date	Type	Coordinate		Item	BR	km	Reference	State	Date	Type	Coordinate	
							Lat	Long								Lat	Long
4.1.1	174	118	Presidente Figueiredo	AM	2/3/14	Erosion	-1.96	-60.03	4.1.13	433	99	Normandia - Paracaima	RA	6/6/11	Break Bridge	3.93	-60.35
4.1.2	174	58	Manaus	AM	5/3/14		-2.47	-60.03	4.1.14	010	1388	Imperatriz	MA	17/2/14		-5.38	-47.47
4.1.3	364	232	Porto Velho	RO	24/3/14		-9.65	-65.51	4.1.15	230	2172	Marabá – Altamira	PA	28/10/14		-3.86	-50.44
4.1.4	174	83	Presidente Figueiredo	AM	1/4/11	Drain tube break	-2.42	-60.03	4.1.16	364	544	Rio Tarauacá	AC	20/11/14		-8.15	-70.74
4.1.5	010	317	São Miguel do Guamá	PA	24/4/11		-1.65	-47.49	4.1.17	432	185	Cantá - Sul de Roraima	RR	6/6/11	Flood	2.56	-60.63
4.1.6	174	581	Paracaima	RR	18/4/12		3.42	-60.89	4.1.18	174	632	Caracaraí	RR	6/6/11		1.74	-61.14
4.1.7	230	3698	Apuí	AM	23/2/13		-7.68	-60.87	4.1.19	319	18	Sentido Humaitá	RO	17/2/14		-3.33	-59.87
4.1.8	401	66	Roraima-Guiana	RR	3/5/12		3.14	-60.26	4.1.20	319	20	Sentido Humaitá	RO	17/2/14		-3.35	-59.87
4.1.9	230	280	Apuí – Humaitá	AM	17/2/14		-7.88	-61.45	4.1.21	364	871	Jací-Paraná	RO	18/2/14		-9.77	-66.43
4.1.10	010	271	Imperatriz–Açailândia	MA	17/2/14		-5.23	-47.51	4.1.22	364	800	Prox. Ponte rio Jací-Paraná	RO	27/2/14		-9.65	-65.79
4.1.11	163	2843	Moraes de Almeida	PA	28/2/14		-6.24	-55.62	4.1.23	364	2884	Jaci-Paraná - Porto Velho	RO	19/2/14		-9.26	-64.39

4.1.12	155		Xinguara	PA	19/11/14		-7.12	-49.94
4.1.24	163	3009	Caracol / Trairão	PA	18/2/14	Mud	-4.99	-56.18
4.1.25	230	2413	Altamira	PA	22/3/14		-3.17	-52.04
4.1.26	163	3006	Trairão	PA	09/3/13		-5.01	-56.18
4.1.27	230	2162	Novo Repartimento	PA	11/3/14		-4.04	-50.29

a. Thematic Map

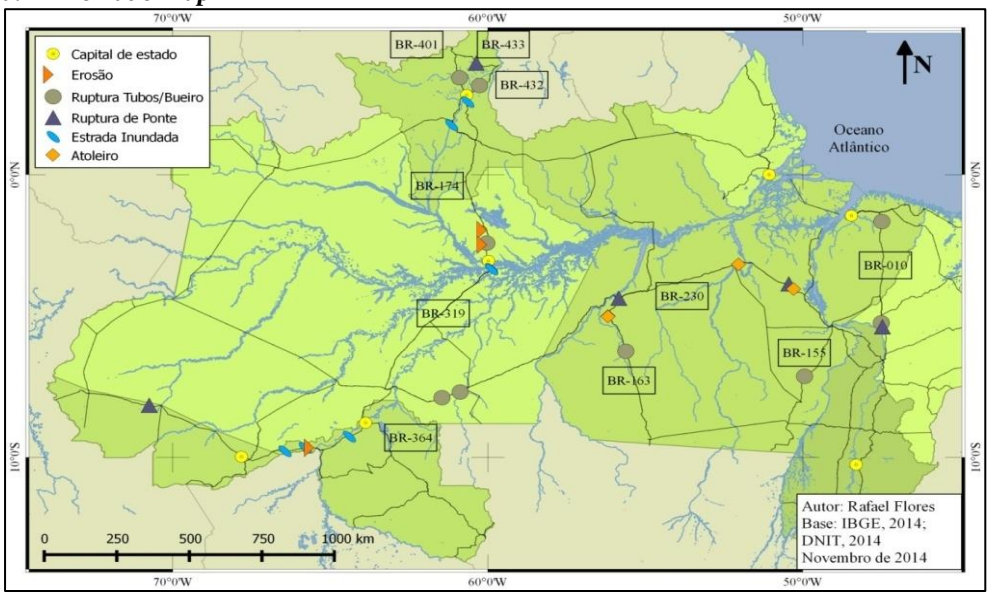

Figure 1. Disruptions Location.

Figure 9 is the result of an overlay to the bases of political and administrative boundaries of the states of the North region of a layer made with the coordinates of the points raised in disaster work. Spreadsheet X, Y coordinates used were constructed from the survey of the occurrence of disasters in official bodies such as the repair works and report resulting from rains developed by DNIT through their regional in the states, and not official media, as newspapers and magazines of the transportation area. These coordinates were obtained based on the location in the informed sources, informed by kilometer. To find the point of interruption DNIT manual naming and guidance, available at web site, was used.

b. Assessment of impacts and costs of natural disasters in infrastructure

The roads in the North are public concession, that is, their management and maintenance are the responsibility of the Brazilian State, which has a permanent cost to the recovery by rebuilding stretches of road affected by natural phenomena. This cost recovery should be differentiated from the maintenance cost (which is related unscheduled repairs) so that the DNIT annually offers budget estimate that constantly changes to deal with the emergency recovery - the Annual Work Plan and Budget . According to the representative of this body in Para, the plan, although it is prepared based on the costs of previous years and indexes of materials and construction services, is always subject to changes in the form of additives to the emergency nature of works to be executed . Bids are carried out so that the winning company should be left to the service for a period of two years, extendable this contract for two more years. This means that the company prepares its proposal according to the Duck and the values are modified according to the needs and the highways that damage. Beyond the control of costs be diffuse, the body only performs the transparency of information since 2012. From this perspective and with the market view of the companies, the roads more convenient for them to be in charge are those that continuously present recovery needs emergency.

The DNIT bids are made based on the 8.666 / 1993 Federal Law which sets rules for public administration bidding and contracts. In addition to the legal aspect, the body regulates this by using two main platforms: CREMA (Contract Restoration and Maintenance) and SICRO2 System (Road Costs). The first is a platform for

the development needs of the project, using a methodology that reflects the needs and solutions for highway segment. The second platform provides basic unit costs for the acquisition of each service, and the basis for the composition of budget spreadsheets that drive the bidding process. However, it is necessary to emphasize that these plans are continually overcome in terms of amounts allocated to such works. Legally, the contracts are then made lasting two years, renewable for another two years and, during which the contractor is up to perform maintenance on particular stretch. The hiring process does not include infrastructure emergency recovery, which are motivation for budget additives.

To be the object of the recovery bids and maintenance of roads, this body provides unit costs of inputs and services to the composition of budget spreadsheets to be published and crowded by companies. Unfortunately, budgets are related to maintenance of roads estimates for each year, making it inaccurate and inefficient for public management of this infrastructure. There are monitoring mechanisms of the measurements of the works that are made available to the public through the DNIT page, however, as interruptions on roads occur diffusely geographically and no fixed or known cost, the cost ends up always be greater, according to the representative organ, Mario Bahia. Some examples of these tools are the CREMA and the Electronic Bulletin Measurements (BEM). The first is a method to make hiring companies contemplating more ways to control expenses for emergency works, while the second allows people to access the measurements made by the body. This information helps to control works for the organ, but are still in early stage of implementation, which still does not allow performance evaluation, or are not effective for cost reduction in the long-term management, which controls the cost preventively maintain the stretch and prevents future state spending recovery.

With this reality expenses difficult to quantify the cost analysis is by means of comparative reading and classification of damage to infrastructure (Table 2). Column cost is a function of recovery time and track demand. Thus, the analysis considered the highway BR-010 in a hypothetical situation with the same interrupt identical conditions would have a higher cost than a highway BR-155 has a higher demand, while referring to the infrastructure and is not employed. This is because the most requested service requires less recovery time, which is reflected in higher cost of procurement and implementation of road recovery services themselves, as well as construction of temporary alternatives such as steel bridges, for example. Thus the categorization is organized by type of interruption, the cost highlighted in a three color graduation: Green light for what you read as no cost or zero investment, dark green for low cost and red for high cost of recovery. This division into categories is critical to the infrastructure cost analysis be combined with the damage analysis related to the cessation of transport of people and goods service and assess the economic impact of disasters.

Table 1. Costs and damages to infrastructure.

Event	Impact	Process			Recovery cost (time and need)
		Impact Description	Services Description	Recovery	
5.1.1	Erosion	Sudden perception. Erosion disintegrates pavement layers to create an empty layer that causes the collapse of the affected stretch.	Excavating and Paving	Fast. Emergency nature of work for reconstruction of the affected stretch.	High
5.1.2				Slow. Bridge to traffic alternative to the works of excavation carried out.	Low
5.1.3				Slow. Excavation work of achievement for stretch rebuilding	Low
5.1.4	Drain tube break	Sudden perception. Required flow greater than design flow in the pipes in intense precipitation function, resulting in the disintegration	Drainage, embankment and paving.	Slow. Reconstruction started on the same day with orientation of PRF to not use the highway by users.	Low
5.1.5				Fast. Excavating performed in five days. Available alternative.	High
5.1.6				Slow. Bridge to traffic alternative until the work of drainage and earthworks carried out.	Low
5.1.7				Slow. Civil defense sent a team to assess the damage and slapping.	Low
5.1.8				Fast. Civil defense started mapping process of vulnerabilities. Work was completed two days.	High
5.1.9				Slow.	Low

5.1.10		gallery		Fast. Emergency nature of work completed after five days	High
5.1.11				Slow.	Low
5.1.12				Slow. Alternative misuse of finished work the next day.	High
5.1.13	Break Bridge	Sudden perception. Break structural elements of bridge or damage to the bridge-road connection	Reconstruction of the structure of the bridge and the bridge-road link	Fast. Connection of the reconstructed bridge-road.	Low
5.1.14				Fast. Connection of the reconstructed bridge-road.	High
5.1.15				Slow. Bridge reconstruction work was necessary and possible only after the river level drops.	High
5.1.16				Fast. Connection of the reconstructed bridge-road.	High
5.1.17	Road flooding	Slow perception gradual process of flooding. Damage to infrastructure are perceived (when they exist) after	No service required. Pavement recovery if traffic damage the road is submerged	No recovery. Infrastructure was not damaged	Low or zero
5.1.18					Low or zero
5.1.19					Low or zero
5.1.20					Low or zero
5.1.21					Low or zero
5.1.22					Low or zero
5.1.23				Slow. Damage to the floor structure of the layers as a function of the transit of big vehicles detected after the disaster ends.	High
5.1.24	Mud	Slow perception gradual process of soil saturation. Damage to infrastructure are perceived gradually.	Drainage, earthwork and paving.	Fast. Work carried out for making the road layers through earthworks completed five days after the interruption.	High
5.1.25				Slow. DNIT evaluation expected within five days after the interruption.	Low
5.1.26				Which depends on the slow change in time and decreasing precipitation. There was no state intervention.	Low or zero
5.1.27				Slow, which depends on the rain behavior change. There was no state intervention.	Low or zero

V. DISCUSSIONS

Given the pressures on the system, the state in which it was before the imbalance, the perceived impacts and responses implemented to mitigate the impact or adapt to it, identified in each case a way of dealing with disasters , making it possible to interpret the hazards to which the road transport system is subject in the Amazon. Sustainable development occurs, in part, by the existence and availability of reliable infrastructure that allows for safe movement of goods and planned time, making the region attractive for investments with an availability of goods and better services in the local entered into the system. From this perspective, at the time of data collection we tried to confront what is considered as a sequence of events and proper actions by managers with what happened to see that so far is the management of roads in the region to are safe and reliable. The study of spatial projections and the representation of information in space are seen as key elements of infrastructure management. Currently, the organs dedicated to this type of state management in the study area do not have or do not provide the public information represented in this manner, making their preparation as well as justified is interesting, as it enables the reading of the phenomena according to their location and their geographical, social and economic context. With this procedure it was possible, as we have done, discuss the phenomena from the perspective of the natural environment in which they are their points and question the impacts due to the axis or in the vicinity of cities, rivers or other medium components that relate to that score.

Regarding the ways in which the roads are destroyed, in whole or in part, there were different conditions, locations, and, consequently, the reasons for each of the five types of roads for interruption raised in this study: erosion, tube rupture culverts, bridges break, flooding and Muds. With the map reading in conjunction with the description of the event can be established certain standards interruptions. This is realized when the local switching relates to the description of biophysical environment where one road is located, such as where there is greater variability in precipitation occurs interruption by the rupture of the system drains and galleries working with higher flow rates than projected . Erosion problems were observed in the BR-364 and BR-174 highways. This disruption cause is related to the construction process and road maintenance. Erosion occurs on adjunctive high ground to low ground. It is known that the wear and erosion is soil and rocks, usually because of weathering. In these events the erosion of interest are the cause rain and river, related to rainfall and flooding of rivers, respectively. These phenomena arise by the action of water wearing layers of soil that make up the affected roads. It is understood, therefore, that intense and extreme precipitation relate to such interruptions. In addition, the events in the far north of the country occur in May and June, while the others occur in the first months of the year. This is because much of Roraima state is in the Northern Hemisphere and has its rainfall regime with another configuration, concentrating the most intense rainfall in these months.

The drain tube break occurs in remote regions of the central axis of the Amazon basin. These disruptions are related to the greater difference in flow between more and less rainy periods. This interpretation is justified by the fact that the tube rupture occurs in the system by the occurrence of greater than the flow tube design flow, causing the collapse of the gallery, in turn dimensioned for smaller flows, causing damage to the pavement structure . These cases are located in areas where there are large variations in water accumulation, either by the occurrence of extreme precipitation or by very high rainfall variability. Interruptions of roads related to partial or total collapse of bridges relate to conditions similar to those affecting the drains pipes: large variations in water flow between the rainy periods, affecting the systems that do not support the increased flow. These cases were registered in the BR-230, BR-010 and BR-433. In addition to the conditions described above adds up to poor or nonexistent maintenance of these bridges, and old, have lagged projects with 50 or more years old, which no longer meet current traffic conditions, exacerbating the problem. By being specific infrastructure elements, detection of problems on bridges is easier than raising a highway needs, with sufficient carrying out bids from the state for their recovery or reconstruction, although cases such as the bridge over the Mojú river in the state of Pará, collapsed since March 2014 (DIARIO DO PARA, 2014), show that the state action to solve problems with bridges does not show the efficiency and effectiveness desirable, too delaying in recovering the infrastructure creating only alternative mechanisms such as ferries to mitigate the impact of not carrying anything.

Being phenomena caused by saturation of the soil, the Muds are amplified by the use of roads without construction or maintenance of drainage network, which causes the accumulation of water on the axis of the road. This is due to the need for transportation to supply certain locations. It was observed that this type of interruption has little or no action of the managing agent of the highway to be overcome, getting your recovery subject to rainfall and depending on traffic decrease this scheme. This has great representation of lack of infrastructure management in Brazil in relation to natural hazards. It is common in the Amazon, the interruption of roads quagmires for long periods, which can be months, even attractive to practitioners trails off road. This is the non-availability infrastructure that the study describes when the road even if there is not drivable for ordinary vehicles.

VI. CONCLUSION

The construction of the spatial database of interruptions on highways in the Amazon, and can describe the cases, was the basis for the following steps of the thesis were developed. The point location a on a highway is commonly reported through the kilometer reference. However, for lack of information or the domain of this leads to reports that do not properly locate the breakpoint. A frequent example in the collection of information was the wrong counting miles on a road informed by the news or technical report, being held from the state line or from some influential city that was near, when the count should be done, according DNIT, from the starting point on the route and should not start to move to another state. Although the technical manual of this body guided this location, as I said, this did not stop being an obstacle organizing information in this way.

Because the location cannot be well presented by the news, when it came to newspapers or magazines, the data had to go through a processing until they were clear and ready to serve as an object of analysis. More difficult than the search, it becomes more complex management costs, causing them to become fuzzy and difficult to interpret. In this sense, the development of the database has organized information but also serves as a guide for one to better manage and make this information available to the public. The survey process cases led to the perception of geographical space relations, building characteristics and features of the biophysical environment. Note that the natural characteristic present in a region makes it quite likely that the impact will

happen and gets to be frustrating as certain highways are built, of course, are not appropriate to the medium in which they are embedded. This raises questions concerning the motivation why this happens, emerging hypotheses about the suitability of the construction and maintenance contracts made between the state and business. This reflection interests to create and enhance the sense in the population and in public administration, as this part of the path to sustainable development. Through the categorization and classification of types of disasters that impact the highways in the Amazon can think about applying the same process for other types of infrastructure that, somehow, the disrupted affect the development of a society. This region contains a large geographical extent and therefore presents conditions of rainfall, hydrology and very diverse geological formation. This contributes to the occurrence of the events studied. However, it is important and perhaps the most important of the study highlight the weak and almost nonexistent performance monitoring and maintenance of vital lines of transport in the region. Although in contrast to more populated areas and economically developed country such as the South and Southeast, would not give the highway concession to private enterprise, its maintenance is essential for certain aspects of regional development. Recently began the process of granting of BR-163 highway stretches in the Mato Grosso state. That is to say that the biggest problem is not, as is commonly presented, the natural environment is too strict with his regime of rainfall and river flow with large basins, but the management of vital infrastructure lines in the Amazon is deficient and needs investment to provide a new channel development to the country.

Research on management of public infrastructure should be improved and their study should be encouraged to first show its weaknesses and then create thinking management systems in the future, considering its wear, future development needs and future natural conditions, in particular taking into account climate change. That's the way it should be seen the relationship between the management of infrastructure and the natural conditions of a region, represented by infrastructure that provides services such as clean water or transport and natural behaviors such as floods or droughts. With regard to the management of transport infrastructure, should be thought of the current development in which it is the country, but also think the future needs are human needs or to be imposed by the natural environment.

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Analyzing the Influence of Mineralogy on Strength Properties of Carbonate Rock in Sagamu and Ewekoro, Ogun State, Nigeria

Okewale, Ismail Adeniyi
Department of Mining Engineering, School of Engineering and Engineering Technology, The Federal University of Technology, Akure, Nigeria.

ABSTRACT: *The research analyzed the influence of mineralogy on strength properties of carbonate rocks in Sagamu and Ewekoro in Ogun State, Nigeria. The research was conducted using the rock samples collected from the two locations. Sagamu has coordinate (latitude $6^0 45^1$N and longitude $3^0 35^1$E) and Ewekoro has coordinate (latitude $6^0 35^1$N and longitude $3^o 12^1$E).The result of modal analysis from the thin section shows that Sagamu has the mineralogical composition of 79.5% calcite, 13.5% quartz and 7.0% opaque while Ewekoro has 77.5% calcite, 17.0% quartz and 5.5% opaque. The rebound hardness result shows that Sagamu has an average value of 32.3 while Ewekoro rebound hardness value has an average of 35.1. The result of uniaxial compressive strength as estimated from the correlation chart between average density and Schmidt hardness shows that Sagamu has average strength of 61.8 MPa while Ewekoro has an average uniaxial compressive strength of 72.4 MPa. The point load strength index for Sagamu has an average value of 1.6 MPa while Ewekoro has an average value of 1.8 MPa. The tensile strength as estimated from point load strength index for Sagamu has an average value of 2.5 MPa while Ewekoro has an average value of 2.7 MPa. The results show that sagamu has higher percentage of calcite, lower percentage of quartz and higher percentage of opaque mineral compared with Ewekoro with lower percentage of calcite, higher percentage of quartz and lower percentage of opaque mineral. Ewekoro has higher hardness and strength values compared with sagamu and these can be attributed to higher percentage of quartz.*

Keywords: *Mineralogy, Schimdt hardness, Uniaxial compressive strength, Point load strength index and Tensile strength.*

I. INTRODUCTION

Rocks exhibit a vast range of properties which reflect vast varieties of structures fabric and compound, some basic properties measurements which are essential for describing rocks are physical and mechanical properties (Bell, 1992). Intact rock strength is a major rock property of rock material and governs the behaviour of a rock mass to the force field of its physical environment. Standard determination of rock strength is by means of Unconfined or Uniaxial Compressive Strength (UCS) test. In most rock mass classification systems, analytical and numerical determination of intact rock strength is essential for characterizing intact rock strength (Robert and Marco, 2002). The strength of intact rock is one of the prime parameters used to classify the quality of rock mass and the determination of rock strength by the in-situ test is the most preferable and reliable method of testing (Zainab *et al*., 2008). Mechanical properties of rock are characterized by the reaction of rocks to the effect of a force of its environment and it depends on the nature of rock substance, the stratigraphy of rock, rock defects and testing methodology. Mechanical strength of a rock is the property of opposing destruction by an external force, either static or dynamic. The rocks give maximum resistance to compression normally, as the tensile strength is not more than 10 or 15% of the compressive strength. This is due to the fragility of rocks, to the large quantity of local defects and irregularities that exist and to the small cohesion between the particles which they are constituted. Examples of mechanical rock properties are: Hardness (the resistance of rock to abrasion), Elasticity (the ability of rock to change form or volume under the effect of external force and return to original form shape when the force is removed), tensile strength (maximum stress, a rock under tension can withstand until it disintegrates) and compressive strength (maximum stress that a rock under compression can withstand until it disintegrates).The rock strength fundamentally depends on its mineralogical composition. The mineral strength depends upon the size of the crystals and diminishes with their increase.

Uniaxial Compressive Strength (UCS) of an intact rock is a basic parameter for rock classification and rock mass strength criteria. Therefore, the strength characteristics of rocks are usually considered to be necessary for design of rock structures, stability of rock excavations and working of mine rocks (Ojo and Olalaye, 2002).

II. Material and Methods

2.1 Location of the Study Area

The study areas are Sagamu and Ewekoro both in Ogun State. Ogun State lies within the latitude 6.2 ^{c}N and 7.8 ^{c} N and longitude of 3.0 ^{c}E and 5.0 ^{c}E. Sagamu has coordinates of 6 ^{c}45^{l}N and 3 ^{c}35^{l}E while Ewekoro has latitude of 6 ^{c}35^{l}N and longitude 3 ^{c}12^{l}E. This is as shown in Figure 1.

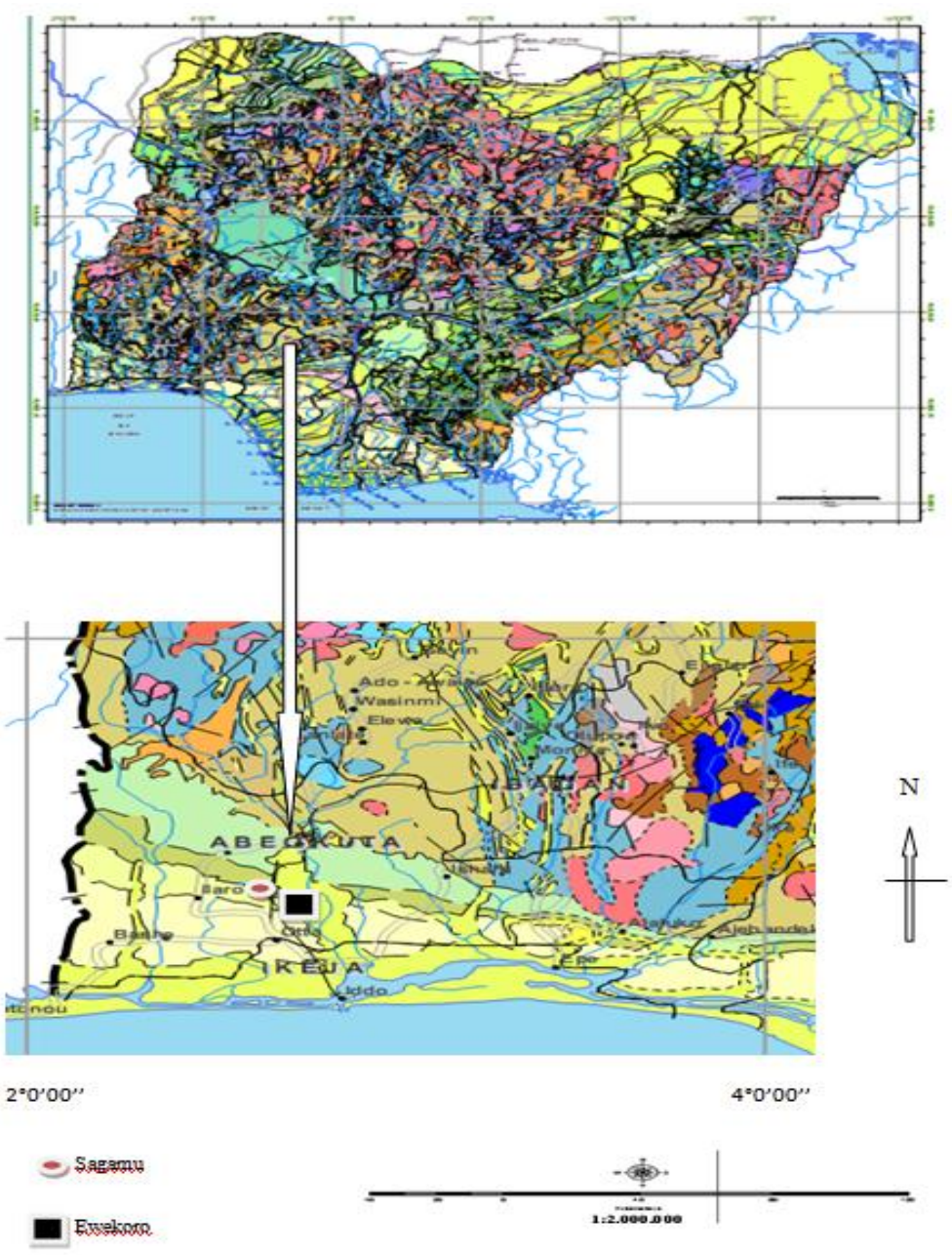


Figure 1: Geological Map of Sagamu and Ewekoro Deposit Extracted from Geological Map of Nigeria

2.2 Sample Collection, Preparation and Testing

Rock samples were collected at the Sagamu and Ewekoro mine faces after the fragmentation of limestone. The samples were taken for laboratory analysis for the determination of mineralogical composition and strength properties. Sagamu samples were labelled S1 to S5 while Ewekoro samples were labelled E1 to E5. Preparations of these samples were done according to ISRM and ASTM standards.

2.3 Mineralogical Composition

The laboratory work involved preparation of thin section of the samples, study of the thin section under the microscope and taken the photomicrograph of the samples. The procedures for thin section preparation are: impregnating, cutting, trimming, grinding, lapping, mounting, further grinding, lapping, further trimming, covering, washing, drying and labelling. The slides were then carefully studied under microscope to identify the mineralogical composition of the samples. The modal analysis technique was used to estimate the percentage of each mineral present in the samples. The modal analysis (Tables 1 and 2) of the samples involve taking three different count of each mineral from different part of the slide and adding all the count to calculate the percentage of each mineral present in the rock sample. Also, photomicrographs of the slides were taken to show features of geological interest as shown in Fig. 2 and 3.

2.4 Determination of Hardness

The determination of the hardness of the samples involves the use of Schmidt hammer on lump of the rock samples. The rebound value of the Schmidt hammer was used as an index value for the intact strength of the rock material. The measured test values for the samples were ordered in descending order. The lower 50% of the values were discarded and the average upper 50% values obtained as the Schmidt Rebound hardness. The procedures followed the standard suggested by ISRM (1989) and the results presented in Tables 3 and 4.

2.5 Determination of Uniaxial Compressive Strength

The Schmidt hammer was first used on the samples to determine the rebound number. The values obtained were arranged then correlated using Deere and Miller (1966) chart to determine the uniaxial compressive strength of the rock. The results obtained are presented in Tables 3 and 4.

2.6 Determination of Point Load Strength

The point load strength values were determined in accordance the procedures suggested by ISRM (1985) using equations 1, 2, 3 and 4.

$$I_s = {}^{P}/_{D_e{}^2} \quad (1)$$

where I_s is the point load strength index (MPa), P is the failure load (KN) and D_e is the equivalent diameter (mm).

$$D_e{}^2 = \frac{4A}{\pi} = \frac{4DW}{\pi} \quad (2)$$

where D is the distance between load contact points (mm), W is the width of the sample (mm) and A is the minimum cross-sectional area of the loading points.

$$F = \left(\frac{D_e}{50}\right)^{0.45} \quad (3)$$

where F is the correction factor.

$$I_{S(50)} = FI_S \quad (4)$$

where $I_{S(50)}$ is the corrected point load strength index.

The results obtained are presented in Tables 3 and 4.

2.7 Determination of Tensile Strength

The tensile strength of the rock samples was estimated based on the relationship suggested by Brook (1993) and ISRM (1989) which shows the general relationship between the point load strength (I_s) and the tensile strength (T_o) as expressed in equation 5 and the results presented in Tables 3 and 4.

$$T_o = 1.5I_{s50} \quad (5)$$

III. Results and Discussion

3.1 Results

Table 1: Modal Analysis of Samples from Sagamu

Mineral Present	1st Count	2nd Count	3rd Count	Total	Percentage (%)
Calcite	40	47	37	124	79.5
Quartz	5	6	9	21	13.5
Opaque	3	4	4	11	7.0
Ground Total				156	100

Table 2: Modal Analysis of Samples from Ewekoro

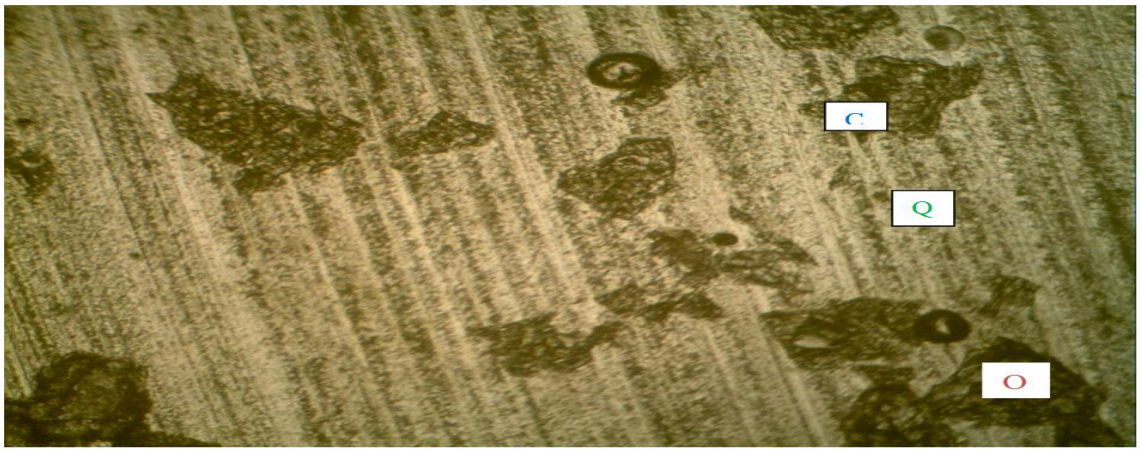
Mineral Present	1st Count	2nd Count	3rd Count	Total	Percentage (%)
Calcite	40	40	37	117	77.5
Quartz	6	8	12	26	17.0
Opaque	2	2	4	8	5.5
Ground Total				151	100

Table 3: Experimental Results of Strength Properties of Samples from Sagamu

Rock code	Rebound Hardness	Point Load Strength (MPa)	Tensile Strength (MPa)	Uniaxial Compressive Strength (MPa)
S1	33.7	2.185	3.278	63.6
S2	32.3	2.061	3.092	63.5
S3	32.3	1.604	2.406	61.9
S4	32.2	1.241	1.862	60.4
S5	32.1	1.104	1.656	59.4

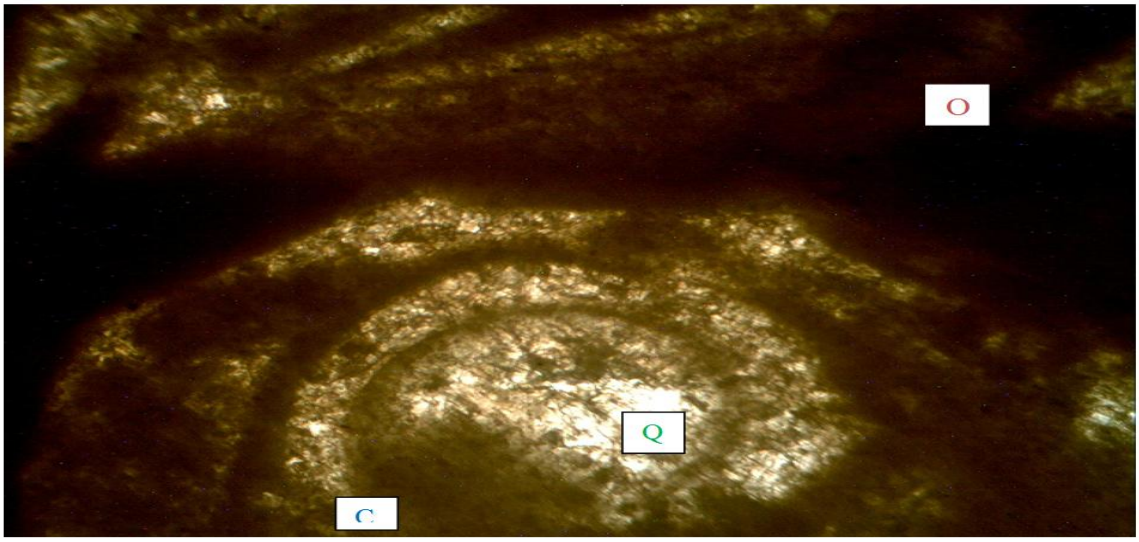
Table 4: Experimental Results of Strength Properties of Samples from Ewekoro

Rock code	Rebound Hardness	Point Load Strength (MPa)	Tensile Strength (MPa)	Uniaxial Compressive Strength (MPa)
E1	36.4	3.363	5.045	77.2
E2	36.4	1.609	2.414	75.5
E3	34.8	1.453	2.180	74.8
E4	34.0	1.238	1.857	70.8
E5	34.0	1.194	1.791	63.7



C – Calcite, Q - Quartz, O- Opaque

Figure 2: Sagamu Photomicrograph



C – Calcite, Q - Quartz, O- Opaque

Figure 3: Ewekoro Photomicrograph

3.2 Discussions

The analysis of minerals shows that Sagamu sample has 79.5% calcite, 13.5% quartz and 7% opaque while Ewekoro sample has 77.5% calcite, 17% quartz and 5.5% opaque as shown in Tables 1 and 2. The high quartz content of Ewekoro accounts for its high strength value. The Schmidt hammer rebound number for Sagamu samples varies from 32.1 to 33.2 as shown in Table 3 and Ewekoro sample has rebound number of 34.0 to 36.4 as shown in Table 4.

The uniaxial compressive strength of the samples was estimated from the chart named after Deere and Miller, (1966). The uniaxial compressive strength of Sagamu varies from 59.4 MPa to 63.6 MPa as shown in Table 3. The strength classification is of moderate to high strength. The uniaxial compressive of Ewekoro sample varies from 63.7 MPa to 77.2 MPa as shown in the Table 4. The strength classification is of high strength.

The point load strength index is obtained from the laboratory results are shown in Tables 3 and 4. The point load strength index for Sagamu samples varies from 1.104 MPa to 2.185 MPa and that of Ewekoro samples varies from 1.194 MPa to 3.363 MPa. The strength classifications fall within the range of moderate to high strength class.

The tensile strength is obtained from uniaxial compressive strength and the results are shown in Table 3 and 4. The values for Sagamu samples range from 1.656 MPa to 3.278 MPa. The tensile strength values for Ewekoro samples range from 1.791 MPa to 5.045 MPa.

IV Conclusions

This research has analyzed the influence of mineralogical composition on strength properties of carbonate rocks in Sagamu and Ewekoro in Ogun State, Nigeria. Sagamu has the mineralogical composition of 79.5% calcite, 13.5% quartz and 7.0% opaque while Ewekoro has 77.5% calcite, 17.0% quartz and 5.5% opaque. The rebound hardness result shows that Sagamu has an average value of 32.3 while Ewekoro rebound hardness value has an average of 35.1. The result of uniaxial compressive strength as estimated from the correlation chart between average density and Schmidt hardness shows that Sagamu has average strength of 61.8 MPa while Ewekoro has an average uniaxial compressive strength of 72.4 MPa. The point load strength index for Sagamu has an average value of 1.6 MPa while Ewekoro has an average value of 1.8 MPa. The tensile strength as estimated from point load strength index for Sagamu has an average value of 2.5 MPa while Ewekoro has an average value of 2.7 MPa. The results show that sagamu has higher percentage of calcite, lower percentage of quartz and higher percentage of opaque mineral compared with Ewekoro with lower percentage of calcite, higher percentage of quartz and lower percentage of opaque mineral. Ewekoro has higher hardness and strength values compared with Sagamu and these can be attributed to higher percentage of quartz. This type of research should be carried out on other type of rocks.

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The Direct Assessment and Captive Costs Methods for Estimating the Economic Costs of Power Outages among Selected Industries in Nigeria

Hachimenum N. Amadi[1], Ephraim N.C. Okafor[2]
Department of Electrical & Electronic Engineering, Federal University of Technology, Owerri, Nigeria.

***ABSTRACT*:** *Due to frequent power outages, the typical Nigerian firm incurs huge costs arising from damaged equipment, lost output, spoiled materials, idle workers and restart costs. This paper developed mathematical models for the computation of the economic costs due to power outages in selected electricity intensive industries from the major industrial areas of Nigeria. This became necessary to optimize investment and operating decisions for adequate power outage mitigation measures.*

Keywords: *Electricity, Impact, Industries, Outages, Power outages costs*

I. INTRODUCTION

Provision of infrastructural services such as electricity, in most developing countries, is the sole responsibility of government. Confronted with ever dwindling revenue, however, most governments are unable to provide and maintain these infrastructures resulting in shortages in the supply of these services [1]. An electric power outage has many socio-economic consequences [2]. Preventing power outages therefore is important in order to avoid its adverse effects on both the economy and the social life of the people [3]. Understanding the impact of a power outage is vital to devising measures to curtail it. The magnitude of the cost of a power outage depends on several factors such as the duration of the outage, the time of day the outage occurred, the season of an outage, the frequency of an outage, the severity of the outage, the type of customer (whether industrial, service, residential or agricultural) and the character of the outage (whether the outage was anticipated or not) [3, 4, 5]. Among these factors, however, are two that have the greatest monetary significance. These are: the duration of the power outage and the character of the outage [6]. Frequent power outages in Nigeria arising from government inability to provide uninterruptible power supply has imposed a huge cost on the average firm operating in the country resulting from damaged equipment, lost output, spoiled materials, idle workers and cost of operation restarts. It is imperative, therefore, to quantify these costs in order to successfully optimize investment and operating decisions for adequate power outages mitigation and more efficient power sector.

II. METHODS OF EVALUATING POWER OUTAGES COSTS

Several methods have been evolved for the assessment of the customer costs of electric power outages [3, 5, 7]. See Table 1. The major categories commonly in use today include:

***Indirect Analytical methods*.** The indirect analytical method, also known as the Ratio of Gross Economic Output to Energy Consumption technique [8, 9], uses objective data such as electricity tariffs, gross national product of a country and the country's annual electricity consumption to ascertain the interruption costs otherwise referred to as the Customer Damage Functions (CDF). Some of the big advantages of this method of evaluating power outage costs are: its objectivity in using publicly declared, easy to access data like electricity prices and turnovers, straightforwardness and cheapness in estimating the value of outage costs. The method, however has some big disadvantages as well. For instance, many direct costs are usually not sufficiently captured and all indirect costs are virtually overlooked. Its results are also too broad and are therefore not very useful to the utilities for planning purposes [3, 7].

Case studies

Case studies are usually carried out after the occurrence of large and significant blackouts as in the case of the 1977 New York City blackout and covers both direct and indirect costs of power interruption [8, 9]. The direct costs of an outage often include loss of sales, loss of food, etc. while the indirect costs are comprised of emergency costs and losses resulting from some civil disorders that took place following the outage. Case studies have the unique advantage of dealing with more accurate data due to the fact that the study gets conducted soon after a real interruption. The major disadvantages of the method are the frequency of the large blackout events and the difficulty to draw an analogy between the large scale and the small scale blackouts [3, 9]. Previous studies show that the indirect costs are usually higher than the direct costs despite being very cumbersome to ascertain [3, 10]. Also, the study findings from case studies suffer great limitations imposed by geographic constraints as well as the characteristics and duration of the specific outage being studied [8].

Customer Surveys methods

Customer surveys methods employ the technique of asking questions in order to determine the costs of power outages and therefore require active mutual communication e.g. one-to-one interviews, telephone calls, and sending and receiving e-mails. Questions are often asked about the time of day when the outage occurred (whether during working hours or outside working hours), the duration of the outage, and the season of the year (whether summer or winter) [9]. The customer surveys methods are the most suitable for calculating outage costs because it affords sufficient and more accurate outage cost data for planning purposes [3, 11]. The methods have the disadvantages, however, of being very costly due to the fact that customer response rates to survey are usually low such that to get more accurate data, the questionnaire must be done to as many customers as possible. Besides, it requires much time and effort to design the survey, retrieve and analyse the respondent data [8].

Variations of the customer surveys methods include: The preparatory action method (PAM), that directly evaluates outage costs in terms of costs of mitigation measures required to avoid outage, the direct worth (DW) technique that evaluates the outage costs in terms of avoiding the impact of the outages [11] and the price proportional method that involves both the willingness to pay (WTP) and willingness to accept (WTA) techniques [3, 12]. In WTP, the survey asks the customers how much they are willing to pay for uninterruptible electricity supply. But in WTA, the survey seeks to understand how much the customers are willing to accept as compensation in case of an interruption in service supply [13]. Studies, however, show a pattern among the respondents to demand more compensation while unwilling to pay the amount of money that would otherwise be needed to provide them with the desired service for the same outage scenario. This causes much disparity between WTP and WTA results such that it is often advised that WTP and WTA results be never used in isolation while making outage cost evaluations.

Proxy methods

Proxy methods make use of an observable customer behaviour in order to estimate the cost of an outage. These power outage cost assessment approaches, consider that an industrial customer would rather prefer to rely on back-up generation until such a time when the marginal cost of additional back-up power would equal the expected marginal cost of an outage event [14]. Such choice by the consumer thus becomes an evidence of 'revealed preference' towards avoiding an outage [15, 16]. Proxy methods are widely known not to reveal much detail about consumer preferences and sometimes provide only an upper or lower limit on outage cost estimates. In order to obtain an outage cost, proxy methods also make numerous assumptions, and usually does not consider such helpful cost assessment factors like the duration of an outage, time or season of the outage, type of customer, etc. [8].

Power outage cost researches in Nigeria applied mostly the customer surveys methods and dates back to the 1960s when [17] used the production function approach (a variation of the customer survey method) to study power outage costs in the industrial and commercial sectors in Nigeria during 1965 and 1966. The problems with this study was that [17] used aggregated data for the manufacturing sector and thus omitted subsector effects of the power outages; besides, the study focused only on output loss for unsupplied electricity and ignored other equally vital costs such as raw material and equipment spoilage and the cost of auto-generation [1].

Another researcher, [18] adopted the self-assessment technique to study the cost of power outages on the household sector and focused on the high-income area of Lagos Island, Ikoyi, Victoria Island, Yaba and Surulere areas of Lagos state in Nigeria. He ended up with high cost estimates having concentrated his study only on the high-income area of the household sector in Lagos.

Yet [19] used the self-assessment survey to measure the adaptive costs to the business sectors in coping with infrastructural deficiencies in Nigeria. Their study shows that most firms in Nigeria adapt to the unreliability of publicly provided electricity by investing in backups. The problem with this study is the self-assessment approach used which suffers from the limitation of subjectivity.

Table 1: Previous studies on Cost of Power Outages

S/N	Study	Country	Sector	Methodology
1.	Ukpong (1973)	Nigeria	Industrial	Proxy method
2.	Ontario Hydro (1980)	Canada	Industrial	Survey
3.	Bental and Ravid (1982)	USA and Israel	Industrial	Proxy method
4.	Billinton, Wacker and Wojczynski (1982)	Canada	Industrial	Survey
5.	Billinton, Wacker and Wojczynski (1982)	Canada	Residential	Survey
6.	Iyanda (1982)	Nigeria	Residential	Survey
7.	Bernstein and Heganazy (1988)	Egypt	Industrial	Proxy method
8.	Doane, Hartman and Woo (1988)	Canada	Residential	Survey
9.	Lee and Anas (1992)	Nigeria	Industrial	Survey
10.	Caves, Herriges and Windle (1992)	USA	Industrial	Proxy method
11.	Uchendu (1993)	Nigeria	Industrial	Survey
12.	Matsukawa and Fuji (1994)	Japan	Services	Proxy method
13.	Beenstock, Goldin and Haitovsky (1997)	Israel	Business & Public	Proxy method
14.	Adenikinju (2005)	Nigeria	Manufacturing	Survey

Later, [20] considered the different types of outage costs e.g. material and equipment loss, value of unproduced output lost, etc. through a survey of various sectors covering the industrial and commercial firms in Lagos state. However, the study like [19] adopted the self-assessment survey approach widely known for subjectivity and possible exaggeration of figures by the respondents. Besides, the study was conducted within the Lagos metropolis only, thereby making generalisation of the results to other industrial areas of the country almost impossible.

Reference [21] estimated the adaptive costs of electricity failure on the Nigerian economy without due consideration of the short-term losses incurred by consumers such as raw material and equipment spoilage and lost output [1]. Their research was therefore not sufficiently comprehensive and generalizable.

Lastly, [1] adopted both the revealed preference approach [14, 15, 22] which allowed him to freely estimate the firms' willingness to pay for a reliable supply of electricity and the production approach which enable him estimate the potential losses to the firm from power outages. His approaches have the dual benefits of making inference of the mitigated costs arising from the installation of private generators possible thereby providing a basis for why firms still invest in their own electricity generation plants, high marginal cost of private generation notwithstanding. The approaches also allowed the losses due to power outages to be characterized based on firm size, location and sector of operations. A major drawback of his study is that it focussed on firms located along Lagos–Ibadan, Kano–Kaduna and Anambra–Imo axes [1] thereby capturing but marginally the industrial nerve-centres of the nation. The outcome of the study can therefore be hardly used to generalise to other parts of Nigeria.

III. THE METHODOLOGY FOR THIS STUDY

The afore-stated literature highlight some of the attempts to estimate the cost of electric power outages in Nigeria. This paper as an addition to these efforts, however, adopted the direct assessment and captive costs methodology in estimating the economic costs of the power outages among Nigerian industries – an approach different than any previously used by any researcher known to the authors of this paper. For instance, unlike any of the previous studies, this paper used a methodology which combines the full benefits of the direct and the

captive costs assessment methods and survey techniques. This makes it possible to ascertain both the direct cost of power outages to the respective industries and the costs incurred by each industry as it invests in backup facilities to mitigate power outages. Unlike previous attempts to evaluate costs of outages also, the study covered Lagos, Kano and Port Harcourt which, statistically speaking, are the most populous as well as the three most industrialised cities of the country. With stratified sampling design employed in the work, therefore, it is very possible to generalise the results of the research to all subsectors of industries in Nigeria irrespective of their sizes, business specialties and locations.

Two models were derived for this study. The first is the total direct cost model for the evaluation of power outages incurred by each of the industries selected for study. See Fig. 1. This model is expressed mathematically as:

$$T_{dc} = C_{dm} + C_{po} + C_{lb} + C_{de} + C_{er} + C_{rs} \quad \text{.....(1)}$$

The summation of the total direct cost for all the industries gives:

$$\sum_{i=1}^{N} T_{dci} =$$

$$\sum_{i=1}^{N} C_{dmi} + C_{poi} + C_{lbi} + C_{dei} + C_{eri} + C_{rsi} + ... + C_{dmN} + C_{poN} + C_{lbN} + C_{deN} + C_{erN} + C_{rsN}$$

.....(2)

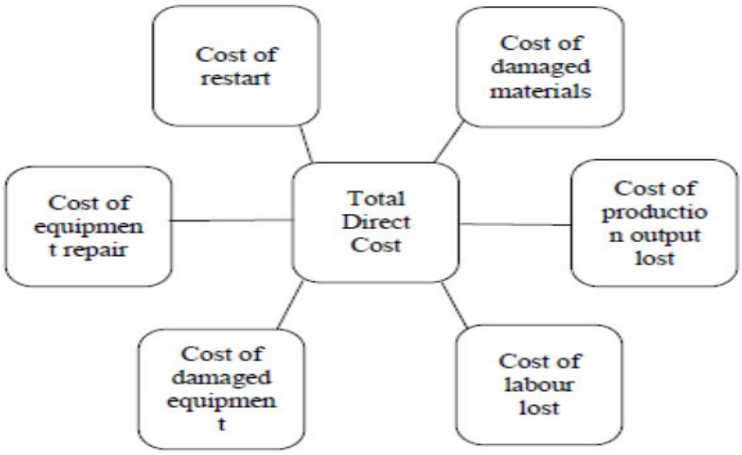

Fig. 1: Total direct costs due to power outage

Where,

T_{dc} = Total direct cost incurred by each industrial consumer

C_{dm} = Cost of damaged materials

C_{po} = Cost of production output lost

C_{lb} = Cost of labour lost

C_{de} = Cost of damaged equipment

C_{er} = Cost of equipment repair

C_{rs} = Cost of restart

N = Total number of industries selected for the study

The cost per unit of electricity in Kilowatt-hour lost ($/KwH) is expressed as:

$$C_{el} = T_{dc} / E_{ls} \quad \text{……(3)}$$

Where,

E_{ls} = Total units of electricity, in Kilowatt-hour, lost due to power outages

The second model is that of the total captive (indirect) cost derived from the cost of backup facilities put in place by each of the industrial consumer to mitigate power outage. Total captive cost or cost of backup facilities for each industry expressed mathematically,

$$T_{bc} = [(C_{bc} \text{ x } D_{fb}) + C_{bm} + C_{fc}] / E_{bp} \quad \text{……(4)}$$

Therefore the summation of the total captive cost for all the industries gives:

$$\sum_{i=1}^{N} T_{bci} = \sum_{i=1}^{N} [(C_{bci} \text{ x } D_{fbi}) + C_{bmi} + C_{fci}] / E_{bpi} + \ldots + [(C_{bcN} \text{ x } D_{fbN}) + C_{bmN} + C_{fcN}] / E_{bpN} \quad \text{……(5)}$$

Where,

C_{bc} = Purchase or capital cost of backup plant

D_{fb} = Depreciation factor of backup plant (assumed per annum)

C_{bm} = Annual maintenance cost of backup plant

C_{fc} = Annual cost of fueling backup plant

N = Total number of industries selected for the study

E_{bp} = Total units of electrical energy, in Kilowatt-hour, generated by backup plant per annum. Adding (2) and (5) yields:

Total cost in $ due to power outages,

$$T_{cpoi} = \sum_{i=1}^{N} T_{dci} + \sum_{i=1}^{N} T_{bci} \quad \text{……(6)}$$

IV. CONCLUSION

This paper successfully developed mathematical models for the computation of economic costs arising from power outages in selected electricity intensive industries in Nigeria. The direct costs and the captive (backup) costs assessment techniques are useful in estimating the costs directly incurred by the firm and the mitigation costs arising from the use of backup facilities in the event of a power outage. By including all the essential components e.g. the cost of damaged materials, production output lost, labour lost, damaged equipment, equipment repair, restart as well as purchase cost of backup plant, annual maintenance cost of backup plant and annual cost of fueling backup plant, etc. the paper covered almost holistically the industrial costs due to power outages. The results, therefore, are reliable for the purposes of industrial energy planning.

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Network Dimensionality Estimation of Wireless Sensor Network Using Cross Correlation Function

Nadia Afrin[1], Md. Shamim Anower[2], Md. Ismail Haque[3]
[1]*Dept. of EEE, Pabna University of Science & Technology (PUST), Bangladesh*
[2]*Dept. of EEE, Rajshahi University of Engineering & Technology (RUET), Bangladesh*
[3]*Dept. of EEE, International Islamic University Chittagong (IIUC), Bangladesh*

Abstract- *Dimensionality estimation of a deployed network is very important for proper operation of Wireless Sensor Network (WSN). In this paper a process with Cross Correlation Function (CCF) is considered as a parameter for estimating dimensionality. The dirac delta functions, output of CCF mainly estimates network's dimensionality. Here underwater environment is considered but it can also be applied to any other WSN. At last a comparison between analytical and simulated result of CCF is done which leads to know the suitability of this process in finding the network dimensionality.*

Keywords-*Wireless Sensor Network (WSN), Network dimensionality, Cross Correlation Function (CCF), Dirac delta function.*

I. INTRODUCTION

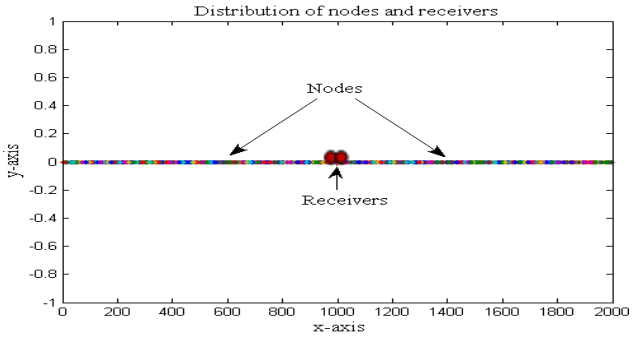
Nowadays WSN is widely used for weather forecasting (Tsunami, Earthquake, and Climate change detection); enemy detection in border area, communication in remote area etc. and in recent years research on applying WSN in underwater has become a great concern. Underwater Wireless Sensor Network (UWSN) is keeping a great contribution in disaster alleviation [1], pollution detection [2], security concern etc. In WSN the number of the active nodes can vary during operation which has a great impact on network analysis. The number of these active nodes can be estimated by using CCF [3] [4], where the CCF depends on the position of the nodes or the dimensionality of the network. Therefore, the main concern of this paper is to determine the dimensionality of WSN.

The formation of CCF has significant dependency on the network dimensionality. By analysing the CCF formation a decision can be made about the dimensionality of the network that is, whether the nodes are oriented in one dimension (1D), two dimension (2D) or three dimension (3D) in space. This process is applied for determining the dimensionality of deployed unknown network. A deployment strategy for 2D and 3D underwater acoustic network is proposed in [5] to determine the minimum number of sensors to be deployed to achieve optimal sensing and communication coverage.

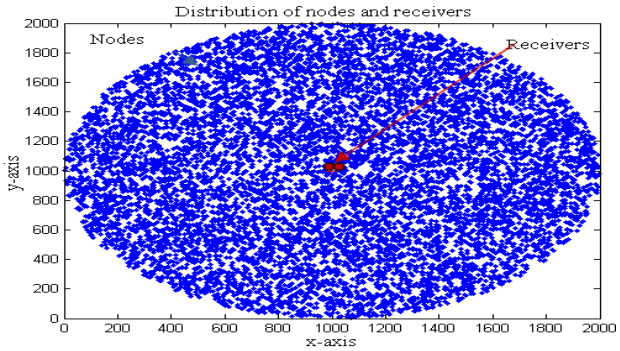
In this paper, network with different dimensionality (1D, 2D, 3D) is analysed. As the shape of the dirac delta function, output of CCF varies with the variation of the network dimensionality, so by determining the CCF for a network, dimensionality of it can be determined.

II. Networks with Different Dimension

In this paper, three types of network- 1D, 2D, 3D is analysed. Each of the networks has been designed with ten thousand (10,000) transmitting nodes which are distributed through a linear line for 1D network, along a circle and a sphere for 2D network and 3D network respectively. In addition, two probing nodes or two receivers are placed at the centre position of each network. The receivers placed at centre will measure the CCF for the signals coming from the transmitters. The distribution of nodes (10,000) are shown in fig (1).It can clearly be seen that the uniform node distribution for 1D, 2D and 3D network is a straight line, a circle and a sphere respectively.



(a)



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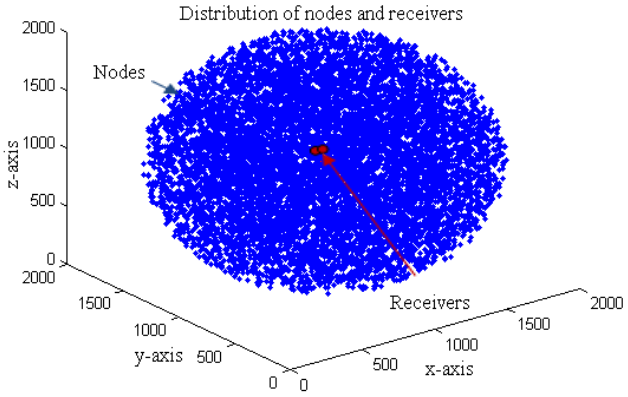


(c)

Figure1: Distributions of (10,000) nodes in (a) 1D; (b) 2D; and (c) 3D

III. Formation of CCF

In order to determine the CCF for a network at first from receivers (probing nodes) probe request is send to the transmitting nodes and as a response the transmitting nodes send back Gaussian signals to the receivers [6]. Then the Gaussian signals from all transmitting nodes are summed at the receivers and cross correlates the summed signals to find the CCF.

Two sensors with location at x_1 and x_2 for 1D, (x_1, y_1) and (x_2, y_2) for 2D, (x_1, y_1, z_1) and (x_2, y_2, z_2) for 3D are placed. Probe request from these sensors is given to the 10000 transmitting nodes and they give back Gaussian signal. The Gaussian Signal $s(t)$ is the response of a transmitter, which will reach to the two sensors with different time delay $\tau_1$and τ_2, therefore, the signals at two sensors are as follows:

$$s_1(t) = s(t - \tau_1) \quad (1)$$

$$s_2(t) = s(t - \tau_2) \quad (2)$$

Total signals received by two sensors are:

$$s_1(t) = \sum_{n=1}^{N} s_n(t - \tau_{n1}) \quad (3)$$

$$s_2(t) = \sum_{n=1}^{N} s_n(t - \tau_{n2}) \quad (4)$$

Where N= Transmitting nodes number=10000.

The Cross Correlation of these signals is:

$$C(T) = \int_{-\infty}^{+\infty} s_1(t) s_2(t - \tau) dt \quad (5)$$

The output of the CCF takes a form of series of deltas. The possible positions of those deltas define by bins, b:

$$b = \frac{2 \times d_{DBS} \times S_R}{S_p} - 1 \quad (6)$$

From equation (6) it is clear that bins can vary by varying distance between sensors, $d_{DBS}$and sampling rate, S_R for a fixed medium for which velocity of propagation, S_p is fixed. In this case there are 11 bins that means the possible positions of delta functions are 11.

IV. CCF by Simulation

The constructed CCF from the simulation shows different results for different dimensionality which is shown in fig (2).CCF for 1D network contains only two dirac deltas at 1st and 11th bin with equal strength shown in fig 2(a),CCF for 2D network is a series of dirac which contains a variation in the magnitude with a width of bin having centered at 6th bin of 11th bins shown in fig 2(b),CCF for 3D network is a series of dirac deltas of uniform magnitude through the width $2d_{DBS}$ having centered at 0 shown in fig 2(c).

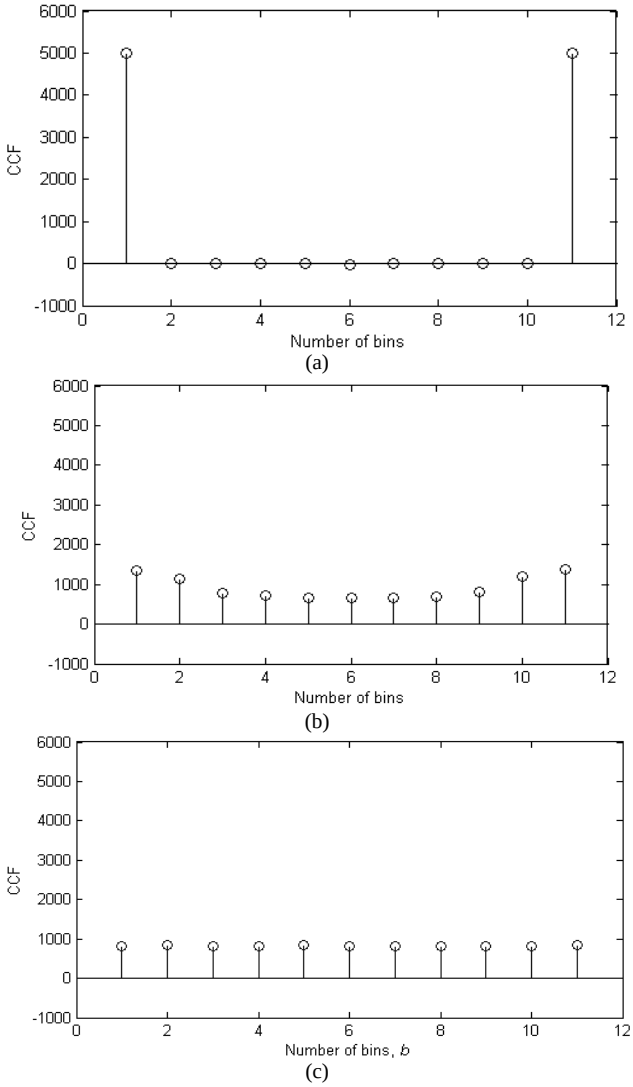


Figure2: CCFs versus *b*: (a) 1D; (b) 2D; and (c) 3D

V. CCF by Analytical Analysis

In this section, the theory regarding this phenomenon will be discussed. By Cross Correlating two time delayed signals of a Gaussian signal will cause an output of dirac delta function. For Several Gaussian signals there will be dirac delta functions spread over a distance of $2d_{DBS}$(which is divided equally into several bins).The location of the dirac delta function is determine by the delay difference between the two signals,$(\tau_1 \sim \tau_2)$.

In [5], it is shown that the deployment of nodes of equal delay difference follows a hyperbola. The dirac deltas for all the transmitting inside a hyperbola will be placed at the edge of that hyperbola.

For 1D network there are only two hyperbolas with equal area so the dirac deltas will be placed at only two points (edges of two hyperbola). Shown in the figure 3(a).For both 2D network and 3D network there are 11 hyperbolas.

There is same area of each hyperbola in 3D network so the dirac delta functions in 3D network will have a uniform strength. But in 2D network area of hyperbolas are not same and maintain a difference shown in figure 3(b) so the dirac deltas will also maintain a difference between their strength.

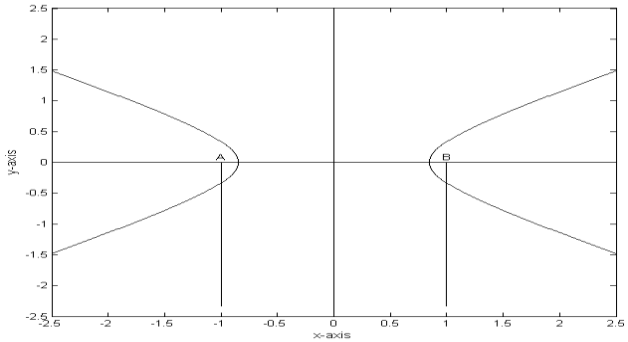
The area of two hyperbolas shown in fig (4) is calculated using the trapezoidal rule of numerical integration.

From fig (4) the area inside hyperbola is:

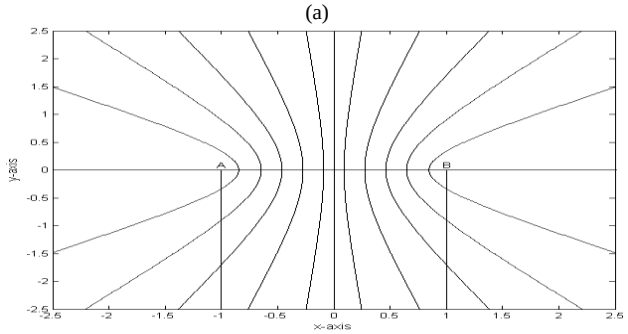
$$\text{Area, } A_1 = \text{Area, } A_3 - \text{Area, } A_2 = 1.7\text{m}^2 \quad (7)$$

The number of deltas at the bin at location A is:

$$\frac{2 \times Area, A_1}{Total\ Area} \times 100\% \approx 13.6\% \quad (8)$$



(a)



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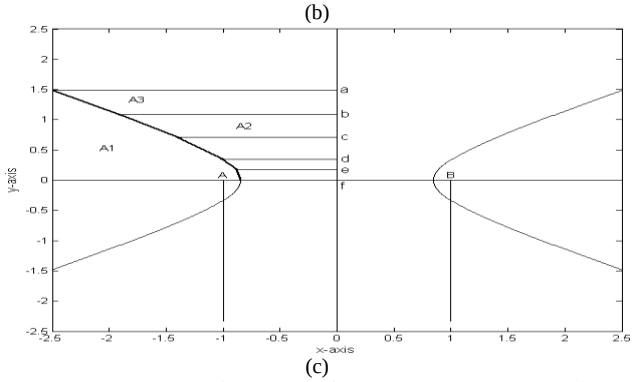
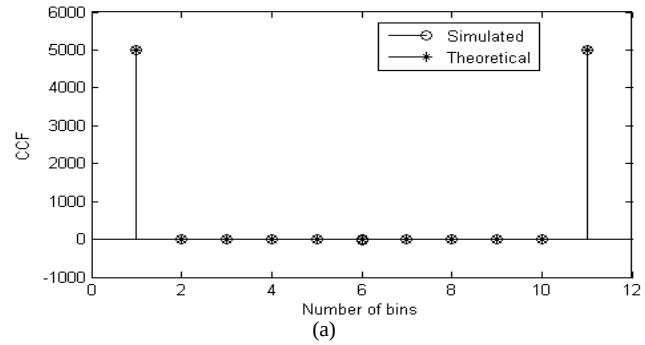


(c)

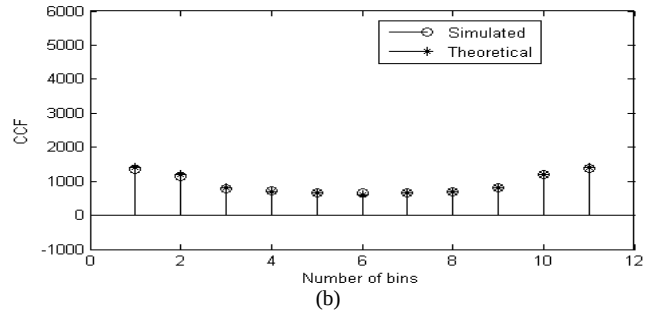
Figure 4: Representation of hyperbolas for theoretical distributions of CCFs:
(a) 1D; (b) 2D; and (c) 3D

VI. Results

Assuming the deltas and the no. of nodes are of equal strength, the theoretical estimation using equations (7) and (8) plotted in figure (5), with imposing the simulated result on it to find the comparisons between the simulated and theoretical result. It is seen that the theoretical and simulated results matches in every cases.



(a)



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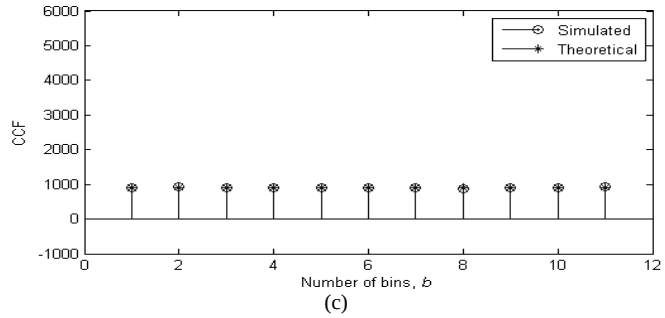

(c)

Figure 5: Simulated and theoretical distributions of CCFs:
(a) 1D; (b) 2D; and (c) 3D

VII. Conclusion

For determining the dimensionality of Ad-hoc network after deployment here we use Cross Correlation of several Gaussian signals from transmitting nodes. The process is done for a large number of transmitting nodes. The output, dirac delta function contains strength dependent on the transmitting nodes. For differentiating the CCF output results for 2D and 3D it is must to have large number of transmitting node. This is the major drawback of the process for finding the dimensionality of a network using Cross Correlation function. In future, we intend to overcome this limitation and determine the dimensionality for all type of network.

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