American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-6, Issue-1, pp-28-31
www.ajer.org
Research Paper Open Access

Effect of Partial Replacement of Cement by Ground-Granulated Blast-Furnace Slag and Fine Aggregate by Marble Slurry on Properties of Concrete

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ABSTRACT:*The aim of this study is to evaluate the performance of partial replacement of cement (OPC- 43 grade) with Ground-granulated blast- furnace slag and Fine aggregate by Marble slurry a mineral admixture in concrete. GGBS is produced by quenching molten iron slag in water or steam, to produce a glassy, granular product that is then dried and ground into the fine powder. And Marble slurry is a waste product from marble industries constitutes one of the environmental problems all over world. In this study partial replacement of OPC (43-grade) by GGBS up to 20% by total weight of OPC and Fine aggregates up to 40% by Marble slurry. This study investigates the performance of concrete mixture in terms of compressive strength of cube, flexural strength of beam and splitting strength of cylinder for 7 days and 28 days respectively.*

Keywords: *Concrete, Compressive strength, Ground-granulated blast – furnace slag, flexural strength, Marble slurry.*

I. INTRODUCTION

In this project we have investigates the results of properties on concrete by partial replacement of cement OPC (43-grade) up to 20% with Ground-granulated blast furnace slag and fine aggregate replaced up to 40% by Marble slurry by conducting following testing are slump test, density test, compressive strength test, flexural strength test, splitting tensile strength test and Strength was observed greater than the target strength. We have compare with base paper then have found greater strength by partial replacement of GGBS with cement and Marble slurry with fine aggregate.

Kishan lal jain (2016)have experimental program to effect on strength properties of concrete by using GGBS by partial replacing cement and addition of GGBS without replacing cement. In this study partial replacement of cement OPC (43-grade) by Ground-granulated blast furnace slag which varies from 5% to 25% at interval of 5% by total weight of OPC. This study calibrates the performance of concrete mixtures in terms of slump, compressive strength, flexural strength and splitting tensile strength test for 7 days and 28 days respectively.

Raj.p.singh kushwah (2015) have experimental study on utilization of marble slurry in cement concrete replacing of fine aggregate. Utilization of marble slurry in cement concrete replacing sand is 30%. Which is showing equal strength as of control i.e 1:2:4 cement concrete 0% marble slurry. As per results of practical examination this material marble slurry shows a good and acceptable strength when added in cement mortar and cement concrete both (replacing sand). It can be used as a filer material (up to 30% replacing sand) showing same strength as of control.

II. SELECTION OF ADMIXURE

1. **Introduction:** Concrete is obtained by mixing cement, sand, aggregate and water is required proportions with or without a suitable admixture.
2. **Supplementary cementious materials (SCMs):**Now days, strict environmental pollution controls and regulations have produced an increase in the industrial wastes and subgrade by products which can be used SCMs such as Ground-granulated blast furnace slag, fly-ash, silica fume and marble powder etc.
3. **Ground-granulated blast furnace slag:** It can also be utilizing high range of water reducer to improve compressive strength or as a super workability aid to improve flow. GGBS is known as produce high strength concrete and is used in two different ways as a cement replacement in order to reduce the cement content (usually for economic reasons) as an additive to improve concrete properties (in both fresh and hardened states).

2.1Advantages of supplementary cementious materials: the main benefits of SCMs are their ability to replace certain amount of cement and still able to display cementious property. The fast growth of industrialization has resulting in tons and tons by product or waste materials, which can be used as SCMs such as GGBS, flyash , silica fume , steel slag and marble slurry etc.

III. SELECTION OF MATERIALS

Marble dust: Marble has been commonly used as building materials since the ancient times. The industry disposal of the marble slurry material constitutes one of the environment problems all over the world. Marble blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% to 30% the original mass in waste in the form of dust. Marble dust is settled by sedimentation and then dumped away which results in environmental pollution. Various types of waste are generated during processing of marble are as follows: a) Dressing waste b) Cutting waste c) Polishing waste.

Environmental damage due to slurry:

- The fine marble dust reduces the fertility of the soil by increasing its alkalinity.
- It has become a safety hazards on the highways along which it is dumped, due to its slippery nature when wet.
- It causes contamination of underground water resources.
- Air pollution and water pollution.

The area where the utilization of marble waste and marble slurry needs to be explored as a substitute for conventional raw materials is as follows:

- For manufacture of bricks (central brick research board, Roorkee)
- As a filler material for road and embankments.
- Making cement concrete (partially replaced by sand)
- Manufacture of Portland cement
- Manufacture of lime

Table no.1

Physical properties of marble slurry	Range	Chemical propertiesof marble slurry	Range
colour	White	Cao	28-35
texture	Powder	Mgo	10-14
Particle size	4.75mm- 75micron	Al_2o_3	1.09
Fineness modulus	0.92	Sio2	11.38
Natural moisture content	0% (if under proof)	Fe2o3	1.10
Solubility in water	Totally in soluble	So3	0.008
Densification	Lesser compare to cement	R2o3	1-2.5
Specific gravity	2.56	Loss of ignition	35-40

Fig:1 Marble slurry

Fig: 2 Ground-granulated blast furnace slag

- **Ground-granulated blast- furnace slag (GGBS):** Ground-granulated blast furnace slag is a by-product from the blast furnaces used in the iron manufacturing industry. GGBS is obtained by quenching molten iron slag (a by-product of iron and steel making) in water or steam, to produce granular product i.e. then dried and ground into a fine powder.

Table no. 2 Properties of Ground-granulated blast-furnace slag:

Analysis	**Range**
	Ground-granulated blast-furnace slag
Bulk Density (kg/m^3)	750-850
Surface Area (cm^2/gm)	8000
Particle Shape	Irregular
Particle Size	N/A
Specific Gravity	2.9
CaO (%)	30-34
Al_2O_3 (%)	18-25
Fe_2O_3 (%)	0.8-3.0
SO_3 (%)	0.1-0.4
MgO (%)	06-10
SiO_2 (%)	30-36

- **Chemical admixture:** It is use as admixtures primarily to reduce the cost of concrete construction. These are different types of admixtures i.e. accelerator, retarder, plasticizers and super plasticizers etc.
- **Super plasticizers,** also known as plasticizers or high range water reducers (HRWR) reduce water content by 12 to 30 percent and can be added to concrete with a low to normal slump and water cement ratio to make high slump flowing concrete in this thesis i.e. napthabased water reducing super plasticizer as per IS 9103:1999 used .The super plasticizers which is used for the experimental performance is kavassu plast SP-431/ shaliplast SP-431.
- These are the modern type of water reducing admixtures, basically a chemical or a mixture of chemicals that impart higher workability to concrete.

Three different purposes or a combination of these

- To increase workability without changing the mix proportion.
- To reduce the mix water and W/C ratio in order to increase the strength and improve the durability.
- To reduce both water and cement in order to reduce creep shrinkage and thermal strains caused by heat of cement hydration.
- **CONCRETE MIX DESIGN:**

OBJECTIVE: "Mix Design is the science of determining the relative proportions of the ingredients of concrete to achieve the desired properties in the most economical way."

PRINCIPLES OF MIX DESIGN:

- Workable mix
- Use as little cement as possible
- Use as little water as possible
- Gravel and sand to be proportioned to achieve a dense mix
- Maximum size of aggregates should be as large as possible, to minimize surface area of aggregates

CONCRETE MIX PROPORTIONING

- Mix proportion is process for mixing of cement, sand, coarse aggregate and water mainly in which it is required to keep balance of mixing ratio and mix has been conducted for Trial mix,& Control mix with Ground-granulated blast-furnace slag.
- **Trial Mix:** have been made on a concrete mix of standard ratio given in IS 456:2000 for M25 to know the exact strength of concrete. There have also been trials on three concrete mixes without using admixture and two trials taken with admixture (naphtha based super plasticizer) as per IS 10262:2009 for M25.

IV. RESULT ANALYSIS

WORKABILITY TEST RESULT: Design is done on the basis of slump 100mm-120mm and the slump was found 118 mm for M25 grade concrete many variations have seen while checking for slump of different concrete mixes.

Fig.3 Slump test

Table: 3 Slump on Replacement of OPC by Ground-granulated blast-furnace slag and fine aggregate by Marble slurry For M25 Grade

S.NO.	Mix (CEMENT +GGBS)&(SAND+MS)	Slump (mm)
1	OPC+GGBS (100+0)&SAND+MS(100+0)	118
2	OPC+GGBS(80+20)&SAND+MS(92+8)	132
3	OPC+GGBS (80+20)&SAND+MS(84+16)	145
4	OPC+GGBS (80+20)&SAND+MS(76+24)	150
5	OPC+GGBS (80+20)&SAND+MS(68+32)	154
6	OPC+GGBS (80+20)&SAND+MS(60+40)	159

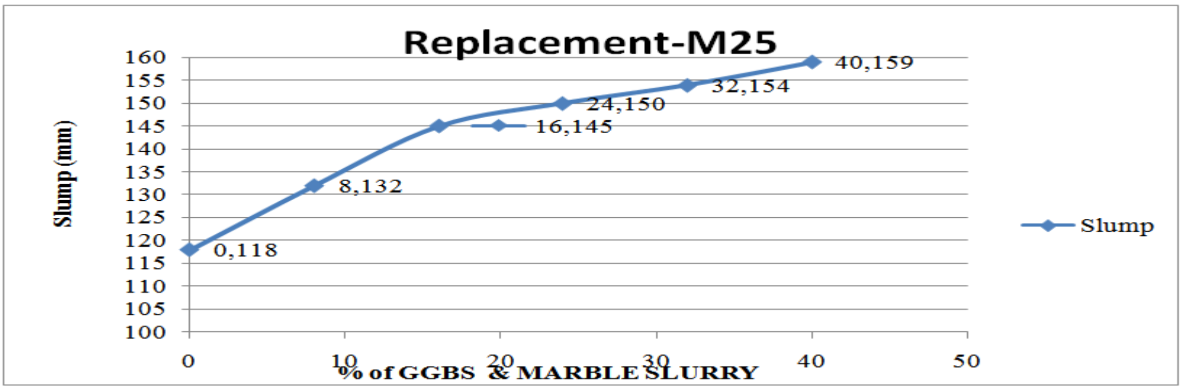

Fig. 4 Effect on Replacement of OPC by Ground-granulated blast-furnace slag and fine aggregate by Marble slurry For M25 Grade

- **COMPRESSIVE STRENGTH:** The compressive strength of GGBS and Marble slurry mixes was measured with cube specimen of size 150mm (length) x 150mm (width) x150mm (depth).The specimens were tested after curing for 7 days and 28 days fully immersed in water tank as per IS 516:1959 for method of tests for strength of concrete.

Table: 2. 7 and 28 days compressive strength of cube on Replacement of Ground- granulated blast furnace slag into OPC and Marble slurry with Fine aggregate with M25 grade concrete.

S.No	Mix (Cement+GGBS)&(Sand +Marble slurry)	Average For Compressive Strength(N/mm^2)	
		7 Days	28 Days
1	OPC+GGBS (100+0)&SAND+MS(100+0)	28.12	38.76
2	OPC+GGBS (80+20)&SAND+MS(92+8)	23.13	37.09
3	OPC+GGBS (80+20)&SAND+MS(84+16)	24.34	37.68
4	OPC+GGBS (80+20)&SAND+MS(76+24)	24.72	38.15
5	OPC+GGBS (80+20)&SAND+MS(68+32)	24.84	38.69
6	OPC+GGBS (80+20)&SAND+MS(60+40)	22.73	35.22

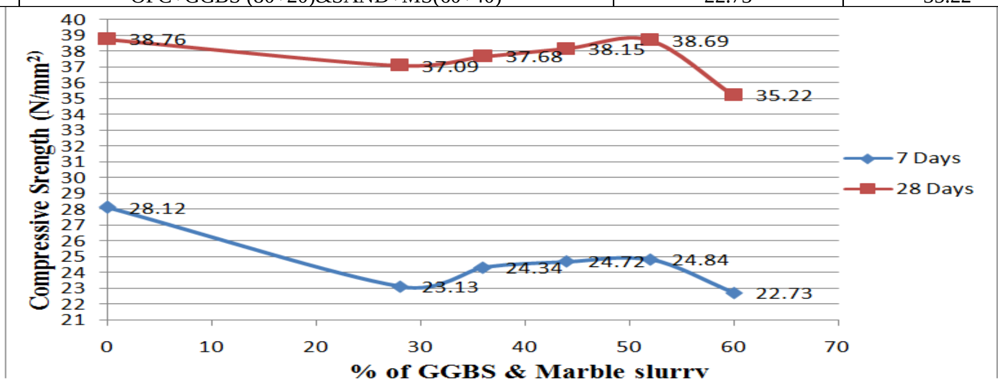

Fig. 5 Effect of Ground- granulated blast furnace slag and Marble slurry on concrete of M25 grade on replacement for 7 and 28 days compressive strength of cube

V. CONCLUSION

By Assess the results of slump test, density test, compressive strength test, flexural strength test and splitting strength test. The following conclusions have been given:

- On partial replacement up to 40% in interval of 8% of fine aggregate by marble slurry and up to 20% of cement by Ground –granulated blast-furnace slag, the slump of concrete mix is increased as compare to the slump of control mix concrete.
- Compressive strength was increased in mixes of M25, when partial replacement of GGBS and Marble slurry and higher strength was found on up to 20% addition of Ground –granulated blast- furnace slag by replacement of OPC and marble slurry up to 40% by replacement of fine aggregate with M25 grade.
- Flexural strength and splitting tensile strength was increased in mixes of M25 when partial replacement of OPC by GGBS and fine aggregates by Marble slurry and higher strength was found on up to 20% addition of Ground-granulated blast furnace slag by replacement of OPC and marble slurry up to 40% by replacement of fine aggregate with M25concrete grade.
- On 20% partial replacement of OPC by Ground-granulated blast-furnace slag and up to 40% of fine aggregate by Marble slurry of M25 grade concrete, compressive strength, flexural strength, splitting tensile strength was observed greater than the target compressive strength, flexural strength, and splitting tensile strength of normal M25 grade concrete.
- Using Ground- granulated blast furnace slag and Marble slurry wastes in concrete mix proved to be useful to solve environmental problems and reduce some extent the need of cement in large quantity. Therefore, it is recommended to reuse these wastes in concrete to move towards sustainable development in construction industry.

ACKNOWLEDGEMENTS

We express sincere thanks to **Er. Sachin Kumar (Assistant Professor)** in Civil engineering department SR Group of Institution, Jhansi for consistent encouragement and support for shaping our project thesis/dissertation in the presentable form.Words are inadequate in offering our thanks to **Er. Kaushal Prasad Verma (Assistant Professor**), **Dr. Archna lala Director of SRGI, Jhansi,**and **Er. Prince Bakna (H.O.D)** in civil engineering SR Group of Institution, Jhansi for his kind cooperation for our Thesis/ Dissertation. And also I would like to sincere thanks **Er. Rajpal Singh kushwah (Associate Professor)** for his kind cooperation for our thesis/ Dissertation.

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