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Performance of Saw Dust Ash Blended OPCLaterized Concrete in Sulphate Environment

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Abstract:*The performance of saw dust ash blended ordinary Portland cement laterized concrete in sulphate environment was investigated. 100mm cubes of 1:2:4 mix proportion and 0.75 water/cement ratio were cast. The concrete specimen were exposed to magnesium sulphate solution for 7, 14, 28 and 56days. The compressive strength of the cubes were measured at the end of the exposure periods.The results indicate that the compressive strength of the sawdust ash(SDA) blended ordinary Portland cement (OPC)laterized concrete decreased with increasing SDA content and increased with increasing curing age in water. The compressive strength of laterized concrete decreased with increasing* $MgSO_4$ *concentration, except at 56-day where it was noticed that at 3%* $MgSO_4$ *concentration, SDA laterized concrete experienced a slight increase in strength.The study concluded thatthe pozzolanic activity of sawdust ash enhanced the resistance of laterized concrete to sulphate attack at exposure period of not earlier than 56days.*

Keywords:*Durability, Saw dust ash, Compressive strength, Sulphate, Laterized concrete*

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I. INTRODUCTION

The growing concern over the impact of buildings on environment has led to increasing demand for more environmentally friendly buildings constructed with cheap but durable building materials. In the context of concrete, which is the predominant building material, it is necessary to identify not only less expensive but more environmentally friendly alternative materials as substitutes to more expensive conventional ones such as cement, steel, sand, granite, gravel and wood. In recent years, many researchers have established that the use of laterite as a substitute for the conventional fine aggregate component of concrete (sand) or as a supplementary fine aggregate can effect a drastic reduction in construction cost and also provide more environmentally friendly concrete. According to Mehta, cited in [1], the three fundamental elements for supporting an environmentally friendly concrete technology for sustainable development are the conservation of primary materials, the enhancement of the durability of concrete structures, and a holistic approach to the technology. With respect to conservation of primary materials, the principal action to be taken in order to reduce utilization of non-renewable resources and its negative impact on the environment is reduction in the consumption of cement, aggregates and water. Along these lines, [2-10] have demonstrated that laterite as a partial or whole replacement for sand in the fine aggregate fraction of concrete is one of the best alternative materials for production of environmentally friendly concrete.

The demand to reduce the high cost of conventional building materials in the construction industry without reducing the quality has prompted many researchers in developing countries to embark on researches towards the utilization of locally available material such as lateritic soils and this material is affordably cheap. Though lateritic soils have been used in the construction industry as a substitute for the fine aggregate in concrete, there have not been accepted standards as regards their performance characteristics [11]. This makes it not to be acceptable in real construction practice today though the cost of producing laterized concrete is lower than normal plain concrete. Laterized concrete is a form of concrete in which its fine aggregate (sand) is partially or wholly replaced by laterite.

The high cost of construction has led some countries in Europe and America to manufacture pozzolana cements so as to reduce the demand on Portland cement and some industrial wastes have been used for a number of years as cement and concrete components; examples include fly ash, silica fume, slag, and a host of others as reported by [12]. Among these pozzolanas is sawdust ash, which according to[13]has been shown to react chemically with the calcium hydroxide released from the hydration of Portland cement to form cement compounds. It acts as a retarder prolonging the setting times, reduces the heat of hydration, encourages a healthier environment by reducing green gas emission and abundantly available as a waste [13].

Sawdust ash as apozzolan

Sawdust has been used in concrete for at least 30 years but not widely used [14]. Sawdust is the by-product of wood which is generally regarded as waste and has to be burnt or disposed of. Sawdust ash has been used by various researchers in replacement of cement and its behaviour as a pozzolanic material in concrete has been established.[10] described the use of sawdust ash(SDA) as a cement replacement and discovered the compressive strength of specimens with replacement levels ranging from 10 to 30% cured for periods of 3 to 90 days showed a decreasing strength with higher ash content. The 28-day split tensile strength of SDA concrete specimens showed a similar trend. The SDA concrete was observed to gain rapid strength at later ages, indicating a pozzolanic activity of the ash. Although only concrete with a 10% replacement level attained the 20 N/mm² designed strength at 28 days, test results indicate that SDA concrete can attain the same order of strength as conventional concrete at longer curing periods. Although seriously limited by its low compressive strength, sawdust ash concrete can be made to perform well in certain floor and wall applications. SDA is mostly carbon but it contains all the elements that are not combustible. Other elements like Fe, Al, Na, Si, K and lot of others have been sometimes found to be present. As such, it is necessary to first find out the correct chemical composition of sawdust and compare it with that of ordinary Portland cement (OPC); this will go a very long way to explain the rationale behind the behaviour of sawdust ash as a pozzolana. The pre-treatment of sawdust is very necessary if it is going to be used as a concrete aggregate because it contains soluble carbohydrates such as sugar aromatic oils and tannin which delay or may entirely prevent the setting of the cement.

II. EXPERIMENTAL PROCEDURES

Materials

Laterite, sharp sand, washed granite, saw dust and ordinary Portland cement were the major materials that were used in this research work. All the materials were sourced from within Ile-Ife in Ife Central Local Government Area of Osun State, Nigeria. The cement was manufactured by West Africa Portland Cement at Sagamu and conformed to the requirements of [15]. The granite used as coarse aggregate had a uniform size not exceeding 19mm while the laterite and sharp fine aggregate were of maximum size of 5mm. The saw dust was burnt in open air and sieved with a 212µm in order to have a fine uniform grain distribution. Preliminary tests were done to ensure compliance with the established standards.

Specimens

The test specimen was 100mm cube meeting the requirements of [16]-1, [17]-3 and [17]-2. The wooden modes were fabricated in compliance with[17]-1 specifications.

Exposure and testing

The control specimens were cured in accordance with [17]-2. The curing method that was adopted in this research was wholly water-submerged as it has been adjudged to be the best method for laterized concrete [18]. The main specimens were in a similar manner exposed to 3% and 5% solutions of magnesium sulphate up to a period of 56days. The compressive strength test was carried out by using ELE 2000kN compression testing machine conforming to [17]-4&6 in accordance with[17]-3.

III. RESULTS AND DISCUSSION

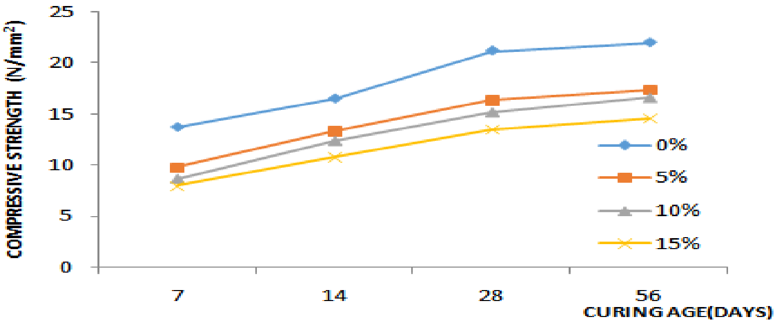

Figure 1.1: Variation of compressive strength of normal concrete with curing ages in water at various percentage replacement of SDA

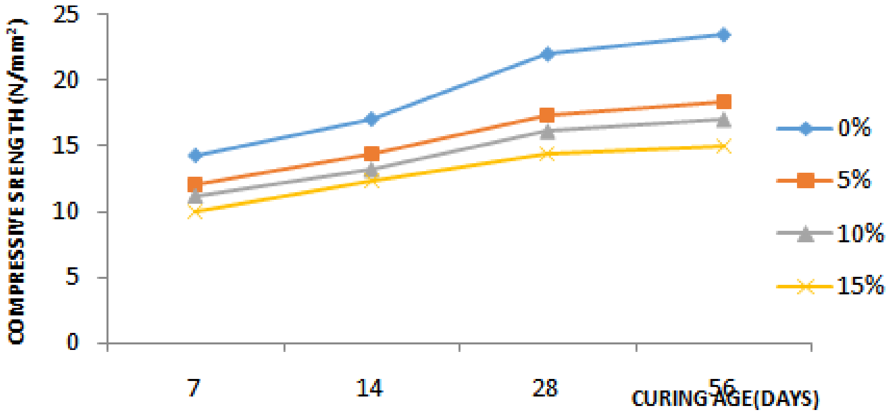

Figure 1.2: variation of compressive strength of laterized concrete with curing ages in water at various percentage replacement of SDA

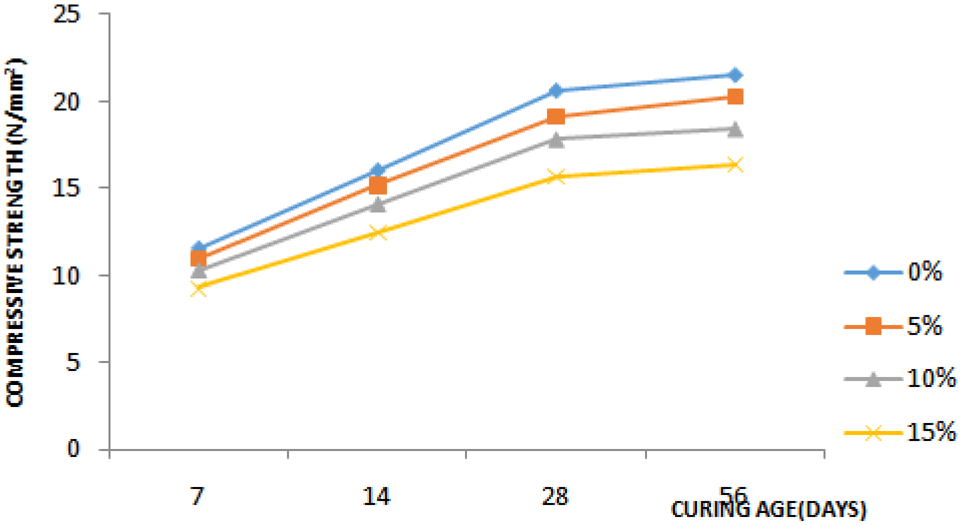

Figure 1.3: variation of compressive strength of normal concrete with curing ages in 3% $MgSO_4$ at various percentage replacement of SDA

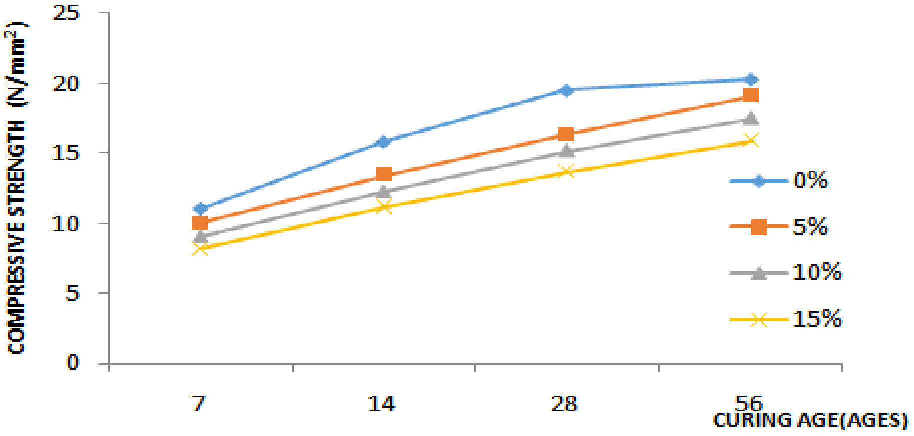

Figure 1.4: variation of compressive strength of laterized concrete with curing ages in 3% $MgSO_4$ at various percentage replacement of SDA

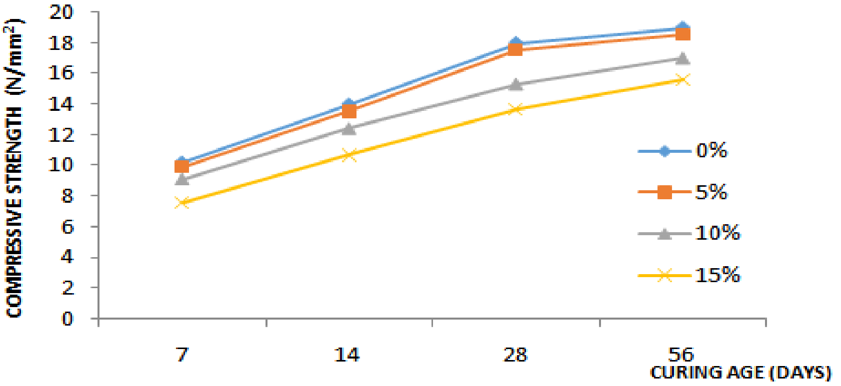

Figure 1.5: variation of compressive strength of normal concrete with curing ages in 5% $MgSO_4$ at various percentage replacement of SDA

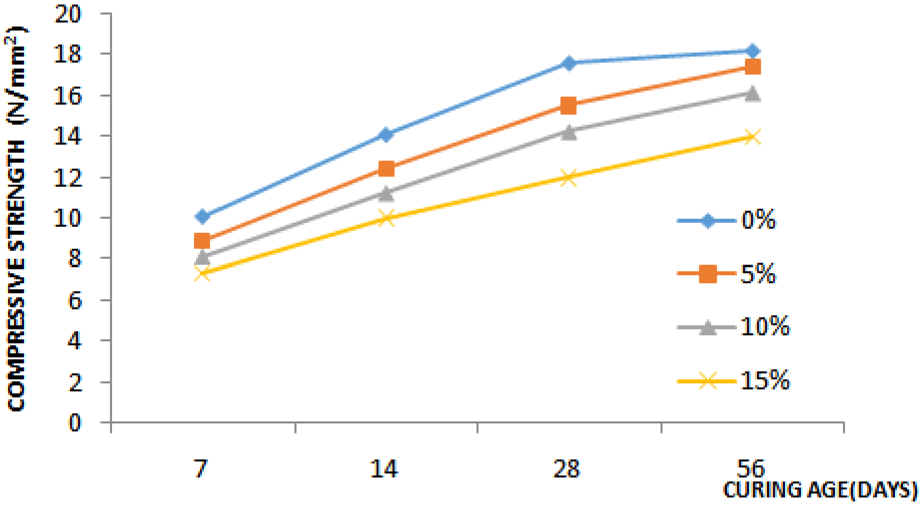

Figure 1.6: variation of compressive strength of laterized concrete with curing ages in 5% $MgSO_4$ at various percentage replacement of SDA

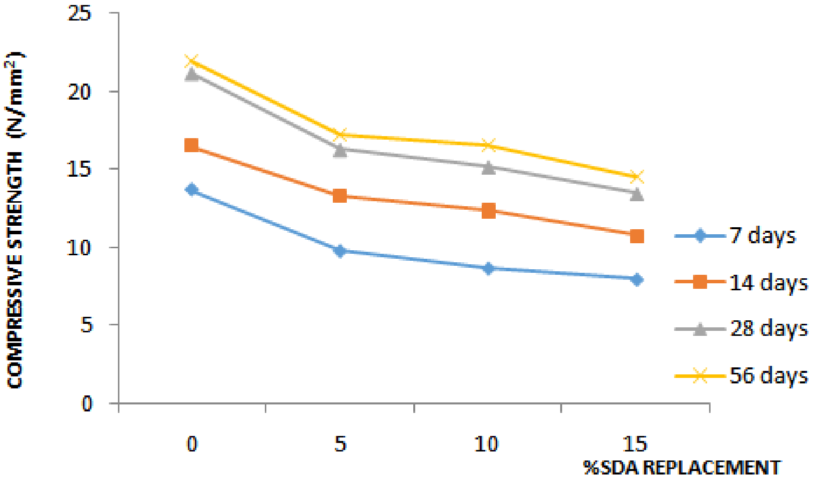

Figure 1.7: Variation of compressive strength of normal concrete corresponding to 7-56 days cured in water and percentage partial replacement of cement with SDA

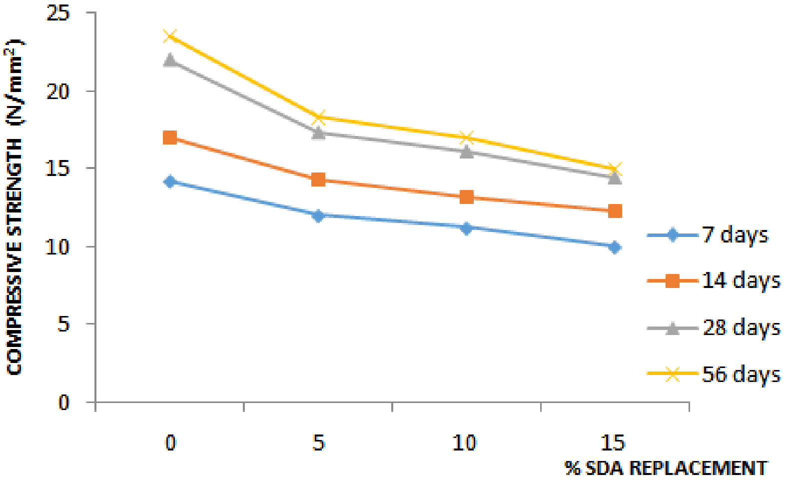

Figure 1:8: Variation of compressive strength of laterized concrete corresponding to 7-56 days cured in water and percentage partial replacement of cement with SDA

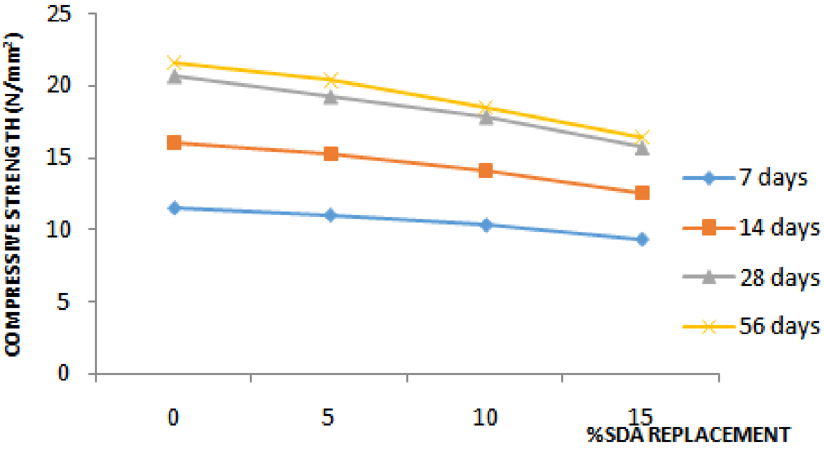

Figure 1.9: variation of compressive strength of normal concrete corresponding to 7-56 days cured in 3% $MgSO_4$ and percentage partial replacement of cement with SDA

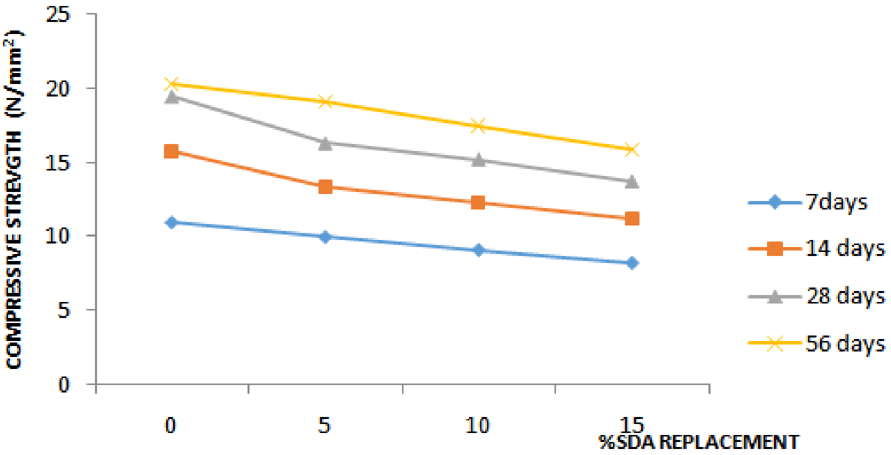

Figure 1.10: variation of compressive strength of laterized concrete corresponding to 7-56 days cured in3% $MgSO_4$ and percentage partial replacement of cement with SDA

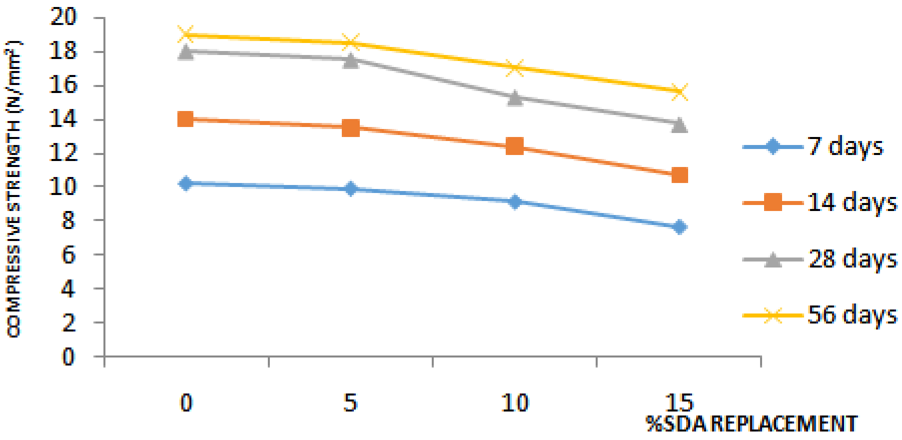

Figure 1.11: variation of compressive strength of normal concrete corresponding to 7-56 days cured in5% $MgSO_4$ and percentage partial replacement of cement with SDA

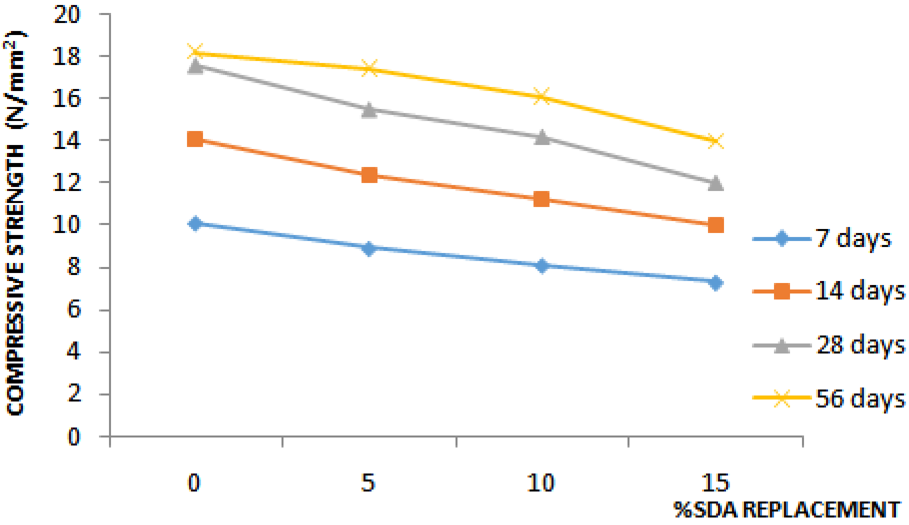

Figure 1.12: variation of compressive strength of laterized concrete corresponding to 7-56 days cured in5% $MgSO_4$ and percentage partial replacement of cement with SDA

IV. CONCLUSION

The following conclusions can be drawn from the experimental results and discussion of the study conducted using SDA as a partial replacement for cement in laterized concrete in sulphate environment.

1. Compressive strength ofSDA laterizedconcrete increased as its curing age increased. This was valid at all levels of SDA partial replacement of cement in the concrete. However, specimens exposed to magnesium sulphate solution experienced reduction in compressive strength after 28days.There was virtually no difference between the compressive strength pattern in SDA laterized concrete and laterized concrete exposed to magnesium sulphate solution except that the compressive strength of laterized concrete is always higher, up to 56days when SDA laterized began to exhibit higher strength. Specimens cured in water always had higher compressive strength.
2. Compressive strength decreased as the percentage replacement of cement with SDA increased and vice versa. This is true for all curing media, curing ages and exposure periods.
3. The compressive strength of SDA laterized concrete decreased with increasing $MgSO_4$ concentration visa-a-vis the control specimens up to 56-day where it was noticed that at 3% $MgSO_4$ concentration, SDA laterized concrete experienced an increased strength (when compared with conventional laterized concrete) which can be attributed to the fact that the pozzolanic effect of SDA took comparatively long periodtomitigate the degree of chemical attack ($MgSO_4$). The strength gained at later age by SDA laterized concrete indicates a pozzolanic activity of the sawdust ash. 10% SDA replacement of cement and 20% laterite content gave the optimum resistance to magnesium sulphate attack of laterized concrete.

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ATA Olugbenga." Performance of Saw Dust Ash Blended OpcLaterized Concrete in Sulphate Environment"American Journal of Engineering Research (AJER), vol.8, no.01, 2019,pp.146-152