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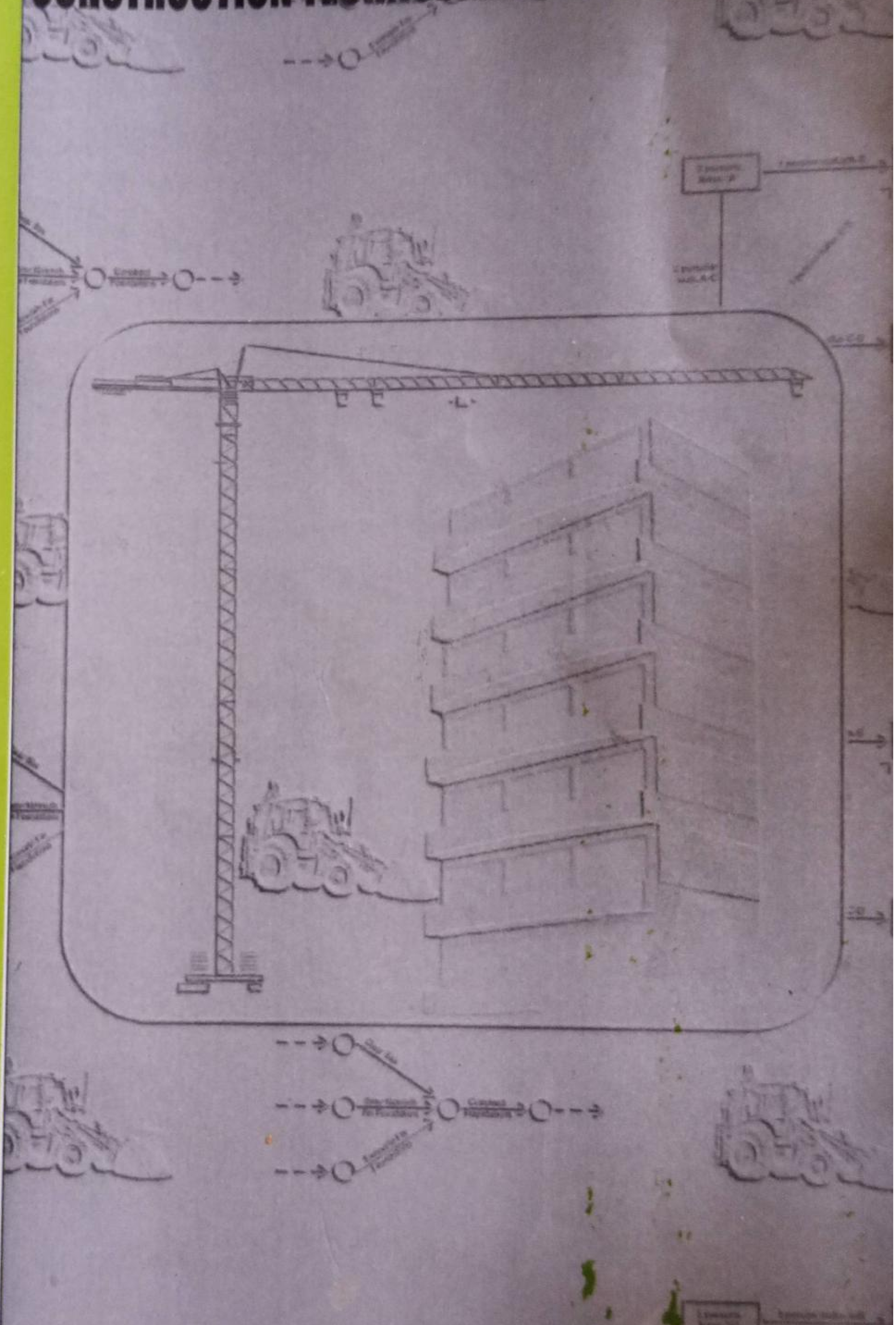

Department of Building, Faculty of Environmental Sciences, University of Jos, Nigeria.

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NIGERIAN JOURNAL OF
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Editorial

Exactly twelve years ago, precisely in 1998 when Nigerian Journal of Construction Technology and Management (NJCTM) made its maiden appearance, Professor J. O. Kolawole (late) succinctly captured the vision of the Journal in the following words '... this vision is anchored on a desire to fill a vacuum by providing a focus on Nigerian (and indeed worldwide) expertise with required techniques, practices and areas of research in construction and allied disciplines'. The sustenance and development of this vision has indeed been a credit to his great foresight and selfless services while being pioneer editor-in-chief. Several other local and international editors enriched the NJCTM vision over the years, resulting in major editorial, quantitative and qualitative improvements as evidenced in the current edition. We are thankful for all these efforts, and recommend this edition to all construction researchers, students and practitioners.

The Journal management seizes this opportunity to congratulate the newly appointed Vice Chancellor of the University of Jos, Prof. Hayward Mafuyai, who emerged after a very keen selection process. We equally congratulate the new Dean of Environmental Sciences, Prof. A. C. Eziashi as well as the new Head of Building, by extension the editor-in-chief of NJTCM Prof. E. Achuenu. We wish these officers God's guidance and wisdom in running their new portfolios.

As an institution based journal, our major production challenge remains the unstable nature of academic calendar, giving rise to unfortunate irregularities in production schedule. As stability gradually returns to the system, the traditional two separate editions (June and December) will feature every year. Any inconvenience caused by the late arrival of this edition is therefore highly regretted.

Looking forward to seeing you in our subsequent volumes.

Prof. Yohana D. Izam (PhD), MNIOB, Registered Bldr. (CORBON)
Editorial Secretary

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EFFECT OF CHEMICALS ON THE COMPRESSIVE STRENGTH OF RICE HUSK ASH CONCRETE

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ABSTRACT
This paper is an empirical investigation on the effect of chemicals on the compressive strength of conc produced with partial replacement ofcement with 10 percent (%) of Rice Husk Ash (RHA). The princ characteristic measured was the concrete compressive strength after curing in chemical solutions of 5% H and10% $MgSO_4$28 and 56 days hydration periods.Test results show that RHA concrete exhibits better stre than 100% OPC concrete in $MgSO_4$ solution. The two specimens tested in H_2SO_4 performed poorly a days.The study concluded that OPC/RHA concrete proved resistant to $MgSO_4$ and can be recommende sulphate resistant additive in concrete production.

Keywords: Chemicals, Concrete, Compressive Strength, Rice Husk Ash and Resistant.

INTRODUCTION

Durability of Ordinary Portland Cement (OPC) concrete is defined as its ability to resist aggressive chemical, weathering action, abrasion, fire or other forms of deterioration. Chemical aggression has been known to produce devastating effects on concrete (Beeby, 1978; Fookes and Berry, 1984). According to Soroka and Setter (1980); Simm and Fookes (1989) chloride, nitrates, sulphate and many other salts when present in the environment of concrete could be individually and severely responsible for the reduction in the compressive strength of concrete as a result of their adverse effect on the quality of the concrete. Neville (1996) opined that calcium aluminates (C_3A) in porous concrete are more prone to attack by chemical aggression and the vulnerability of concrete to sulphate attack can therefore, be reduced by the use of cement low in C_3A or through the use of Portland Pozzolan Cement.

Pozzolan is defined as siliceous materials which in itself possess little or no cementitious properties but in finely divided form and in the presence of moisture, chemically react with $Ca(OH)_2$ at ordinary temperature to form compound possessing cementitious properties (Neville, 1981). They are incorporated as active addition or substitution to the OPC and concrete due to their capacity for reacting with lime, principally originated during the hydration of Portland cement (Zelie et.al, 2001). The result of this reaction is the formation of cementitious compounds (tricalcium silicate (C_3S)). This pozzolanic reaction (C_3S) modifies some properties of cement and the resulting concretes.

Dahiru and Zubairu (2008) assessed the properties of concrete made with RHA as partial replacement of OPC in concrete production and observed appreciable increase in compressive streng concrete at 10% replacement level. This res therefore investigated the suitability of RH partial replacement of OPC in productic sulphate resistant concrete as further study work of Dahiru and Zubairu (2008).

MATERIALS AND METHODS

Materials

The materials used for the research work Rice Husk Ash (RHA), Fine Aggregate (Coarse Aggregate (Gravel), Ordinary P Cement (OPC) (Dangote Brand), Magnesium Sulphate ($MgSO_4$) and Su Acid.(H_2SO_4). The Rice Husk used was o from Samaru Rice Milling Factory and bu ashes through the use of Electric Furr Industrial Design Centre, Zaria. Rice Hu converted into ashes at control tempera 650^0C for six hours. The ash obtained w grinded in grinding machine and sieved to fineness. The coarse aggregate used was granite stones obtained from a single qu along Sokoto-Zaria road opposite Sc Aviation Technology Zaria. The aggreg sieved using standard sieves and the one in 10 and 20mm sieves were used to pro test samples. The fine aggregate (sand) naturally, occurring clean sharp river san sieved using standard BS 4.75mm siev remove impurities and only those tha through the sieve was used for the test production. Ordinary tap water, which wa drinking, was used for the research work. Magnesium Sulphate ($MgSO_4$) and Sulph (H_2SO_4) used for the research were obta Chemistry Laboratory of Ahmad University, Zaria. They were prep different percentage (%) concentrations th

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method of chemical water addition (H_2SO_4) and chemical water dissolution ($MgSO_4$). Thus, 5% H_2SO_4 and 10% $MgSO_4$ ware prepared and used for the research work.

Physical Properties of Materials

The specific gravity of the sample of RHA and sand were determined in the Laboratory in accordance with the requirement of ASTM C 127 – 93. The compacted and uncompacted bulk density of each material was determined by the method recommended by BS 812: Part 2 (1975). The moisture content test of samples of RHA and sand were determined in accordance with BS 1377: Part 2 (1975).

Specimens Production and Compressive Strength Test

The materials used for the production of the concrete specimens for the research work comprised of cement, RHA, fine aggregate (sand) and coarse aggregate. They were mixed thoroughly in the mix ratio 1:2:4 (cement: fine aggregate: coarse aggregate) with w/c ratio of 0.65 for 100% OPC cubes and 0.65 for the cubes with pozzolan. Absolute volume method of calculation was used to determine the quantities of materials used for the research. Physical properties such as workability, setting time and soundness of the mix were determined in accordance with ASTM C 143-78, ASTM C 451 – 89 and BS 4550: (1992) respectively, after which eighteen (18) concrete cubes were produced for RHA/OPC specimen and (18) for the control. Specimens were cured in ordinary water, 10% $MgSO_4$ and 5% $H_2SO_4$by complete immersion method and then tested at 28 and 56 days respectively to determine their compressive strength.

Preparation of Aggressive Chemical

The chemical aggressions used for the experimental work were 5% H_2SO_4 and 10% $MgSO_4$. They were prepared in accordance with ASTM C 1012 and ASTM 452 recommendations. ASTM C 1012 and ASTM 452 recommend 5% Sulphate solution to carry out sulphate attack on OPC concrete.

Testing Procedures in Aggressive Medias

Specimens (RHA/OPC and 100%OPC) were completely immersed in chemical solution of 5% H_2SO_4 and 10% $MgSO_4$. Some specimen cubes from RHA and 100% OPC were also immersed in ordinary water at the beginning of the aggressive test which served as control. Specimens in chemicals were covered with polythene leather to prevent air interruption which could affect the concentration of the chemicals. At 28 days curing periods, three cubes from RHA and 100% OPC were removed from each chemical solution (5% H_2SO_4 and 10% $MgSO_4$) and ordinary water. They were thoroughly rinsed with clean tap water and air-dried in the laboratory for some minutes and then tested to determine their 28 days compressive strength. This was also repeated at 56 days.

RESULTS AND DISCUSSIONS

Chemical Analysis of RHA

Table 1: Chemical Analysis of RHA

Constituent	SiO_2	Fe_2O_3	Al_2O_3	MgO	L.O.I
%composition	69.5	2.16	4.50	1.50	4.52

The chemical analysis of RHA used for the research is presented in Table 1. The percentage total content of silicon dioxide (SiO_2), iron oxide (Fe_2O_3) and aluminum oxide (Al_2O_3) on RHA was observed to be 76.16% which is greater than the minimum of 70% specified in ASTM C 618-94. ASTM C 618 – 94 stipulates that the percentage total content of SiO_2, Al_2O_3 and Fe_2O_3 in any pozzolan should not be less than 70%. The L.O.I obtained was 4.52. The value obtained is less than the 12% maximum required for pozzolans (ASTM C 618 -94, 1994)

Results of Physical Properties of Materials

Table 2: Physical Properties of RHA and Sand

S/NO	Properties	Sample Type and Description	
		RHA	Sand
1	Specific Gravity	2.15	2.65
2	Compacted Bulk Density (kg/m³)	670 1600	
3	Loose Bulk Density (kg/m³)	540	1490
4	Absorption Capacity (%)	27.55	-
5	Moisture Content (%)	2.04	-

Table 2 shows the results of physical properties of the materials used for the research. The specific gravity of RHA is within the range of 1.9 to 2.4 recommended for pulverized fuel ash (Neville, 1981) and also similar to the values reported by Dashan and Kamang (1999); Oyetola and Abdullahi (2006) on Acha Husk Ash (AHA) and RHA which was 2.12 for AHA and 2.13 for RHA. The specific gravity of the sand was found to be 2.65. The value obtained falls within the limit for natural aggregates which ranges from 2.6 to 2.7 (Neville and Brooks 2002).

The compacted bulk density of RHA was found to be 670 kg/m^3 The values obtained is close to the one reported by Al-khalaf and Yusuf (1984) on the compacted bulk density of RHA which was found to be 740 kg/m^3 while Oyetola and Abdullahi (2006) reported a value of 530 kg/m^3. In comparison, the bulk density of RHA is less than the bulk density of OPC (1440kg/m^3), this means that RHA is a lightweight material. The compacted bulk density of sand was found to be 1600kg/m^3. This value is very close to the range given for bulk density before excavation of sandy soils which ranges from 1650 Kg/m^3 to 1850kg/m^3(BS812:2 (1975)).

Results of Workability Test

Table 3: Workability of the Pastes

Paste Sample	W/c Ratio	Degree of Workability Slump(mm)	Compacting Factor
100% OPC	0.6	10	0.74
RHA/OPC	0.65	6	0.72

The results of the workability tests on the two specimen show that the slumps for 100% OPC and that of 10% replacement of RHA was found to be 10 and 6mm which indicates low workability (ASTM C 143-78).The result of the compacting factor test on the two pastes was also found to be 0.74 and 0.72 which also indicates low workability (Orchard, 1973).The compacting factor test on the two pastes is close to the range of 0.85 – 0.92 recommended by Orchard (1973) for roads and slabs concrete. It was observed from the tests results that mix containing 10% replacement of RHA have lower slump than that of 100% OPC. This was due to the high un burnt carbon content in RHA which made it to absorb more water than 100% OPC paste. This agreed with the findings of Dashan and Kamang (1999) on Acha Husk Ash (AHA).

Density and Compressive Strength Tests

Table 4: Average 28 and 56 Days Compressive Strengths of Specimens in 10% $MgSO_4$

Specimens	Compressive strengths (N/mm^2) Water (Control)	Compressive strengths (N/mm^2) 10% $MgSO_4$	Average density (Kg/m^3) Water (Control)	Average density (Kg/m^3) 10% $MgSO_4$	Percentage strength reduction (%)
	28 Days		28 Days		
100% OPC	28.80	27.55	2449.38	2459.26	4.34
OPC/RHA	24.30	22.30	2380.45	2400.00	8.23
	56 Days		56 Days		
100% OPC	31.60	28.42	2488.89	2479.01	10.06
OPC/RHA	28.25	27.66	2390.00	2409.88	2.09

Table 4 shows the densities and compressive strengths of sample specimens (RHA and 100% OPC) in 10% $MgSO_4$ at 28 and 56 days. At 28 days, the percentage strength reductions of RHA and 100% OPC were observed to be 8.23 and 4.34 respectively but at 56 days, the percentage strength reductions of RHA and 100% OPC in this chemical were observed to be 2.09, and 10.06 respectively. The percentage strength reduction of 100% OPC in the chemical at 28 days was observed to be lower than the percentage strength reduction of RHA but as hydration progressed (56 days) the percentage strength reduction of RHA was observed to be lower than the percentage strength reduction of 100% OPC. The densities of the specimens in this chemical solution were observed to be higher than their densities in ordinary water at 56 days. Increase in density of a specimen in $MgSO_4$ solution may mean that the specimen was not well compacted or being permeable to chemical that is denser than water and as a result, being penetrated by $MgSO_4$ which adds to the densities of the specimen due to crystal (gypsum ($CaSO_4$)) deposition on the pores of the specimen. Hence, the specimen with the higher density may mean the least resistant to sulphate attack.

...e 5: Average 28 and 56 Days Compressive Strengths of Specimens in 5% H_2SO_4

...mens	Compressive strengths (N/mm^2)		Average density (Kg/m^3)		Percentage strength reduction (%)
	Water (Control)	5% H_2SO4	Water (Control)	5% H_2SO4	
	28 Days		28 Days		
... OPC	28.80	22.67	2449.38	2350.61	21.28
...RHA	24.30	20.00	2380.45	2360.49	17.70
	56 Days		56 Days		
... OPC	31.60	20.98	2488.89	2350.61	33.61
...RHA	28.25	21.15	2390.00	2370.37	25.13

...e 5 shows the densities and compressive ...ghts of specimens in 5% H_2SO_4 at 28 and 56 ... High strengths reduction was observed in the ...imens tested in 5% H_2SO_4 at 28 and 56 days. ... percentage strengths reduction of RHA and ...% OPC at 28 days were observed to be 17.70 ...21.28 respectively. At 56 days, the percentage ...gths reduction of RHA and 100% OPC were ...rved to be 25.13 and 33.61 respectively.

In 5% H_2SO_4, reductions in densities were ...erved in the specimens at 56 days. Reduction in ...sity of a specimen in H_2SO_4 may mean that ...O_4 was too corrosive which led to loss of ...rtar on the specimen and the consequent ...uction in density of the specimen. Hence, the ...er the density of the specimen in H_2SO_4 may ...an the higher the resistance to attack by the ...rosive media (H_2SO_4).

...NCLUSIONS AND RECOMMENDATIONS

...nclusions

i. Appreciable value of compressive strength was obtained on RHA mix in chemical solutions of 10% $MgSO_4$. Therefore, RHA can be used as sulphate resistant additive in concrete production.

ii. RHA concrete has higher strength than 100% OPCconcere in chemical solutions of $MgSO_4$ at 56 days.

iii. RHA concrete performed poorly in chemical solution of H_2SO_4at 56 days.

RECOMMENDATIONS /AREA FOR FURTHER STUDIES

i. RHA is recommended for production of sulphate resisting cement.

ii. Tests different from compressive strength test such as tensile strength and shrinkage tests should also be carried out on the hardened OPC/RHA concrete.

iii. Effects of other sulphates different from $MgSO_4$ should be carried out on RHA concrete to further examine its performance in sulphates environment.

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