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EXPERIMENTAL STUDY AND ANALYSIS ON THE EFFECT OF M40 CONCRETE ON THE DURABILITY STRENGTH PROPERTIES WITH PARTIAL REPLACEMENT OF SAND WITH COPPER SLAG

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ABSTRACT

Today, rapid industrialization has led to an increase in the demand for housing. Due to its environmental impact, the use of plant sand for concrete production is limited. The shortage of lime and concrete for the production of high-quality aggregates was solved by the partial replacement of gravel with copper sulfide. The research paper reviews some experimental studies on the effect of copper sulphide as a partial replacement of sand on the performance of concrete. In this paper, an experimental study was conducted to investigate the effect of copper sulfide as a fine admixture on the accommodation of concrete. Copper slag is a by-product of copper production, which contains a large amount of iron oxide and silicate and is chemically stable. In this study, experimental work was carried out on M40 concrete for a comprehensive study. Several concrete samples were prepared by modifying the satisfactory mix with copper sulfides varying from 0% to 100% in specific proportions at intervals of 20% (0%, 20%, 40%, 60%, 80% and 100%). The effect of acids such as (H2 SO4 and HCl) and the effect of sulfates such as (Na2 SO4, and MgSO4) on hardened concrete samples affect the hardened concrete samples and the variation in weight loss and compressive strength is determined. According to the results of the investigation, the best ratio of using copper sulfide for fine aggregate in concrete is optimized and the results obtained are compared with the version between the concrete samples replaced with ordinary Portland cement and sand and the compression results and the version with concrete weight. The test results show that copper sulfide can be used as a satisfactory aggregate in concrete.

Keywords: potassium sulfate; magnesium sulfate; concrete; copper slag; gas permeability; granular slag; M40 concrete.

1. Introduction

The use of modern waste or discretionary substances promotes the production of concrete and cement in the improvement department. Different businesses are creating new results and waste. Dumping waste can cause natural problems. Thus, waste reuse is of great practical importance for solid collection. For a long time, side effects such as fly ash, silica fume, and slag were considered waste. The matrix prepared by this texture offers enhanced performance and durability compared to ordinary cement because of its electrically controlled strength, which can be used to develop synthetic plants and underwater structures. Inside and outside turns are equipped to find every possible way of use in the available decades. Copper slag is obtained from the scrap business. Head over to the overview to check open-door copper slag as an option for sand in a solid mix. In today's environment, due to the environmental hazards and real adverse nature of the biological system, vehicle extraction and sand mining have become the dominant test. Some investigations have been completed to limit the true effects of land, using results such as copper slag as a fractional option for flawless totals. There are several meetings on the use of copper slag as the current total production. This is the result of the copper refining and refining process. If copper slag is used as a substitute for natural sand, we can provide a substitute material for natural sand, which is environmentally friendly and cost-effective in terms of concrete [1].

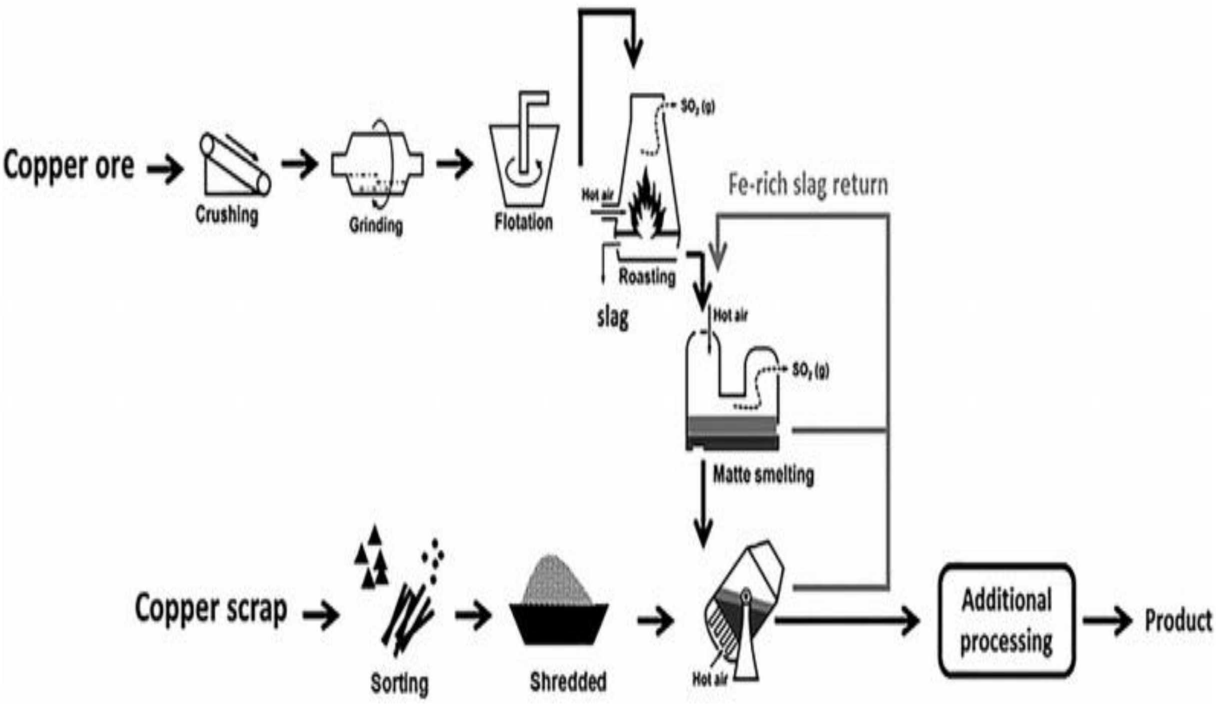

Figure 1. Production of copper slag.

Table 1. Physical properties of copper slag.

Property	Normal values
Color	Black, glassy
Grain shape	Angular, versatile
Hardness	7 months
Special shooting	3.61
Bulk density	1750 kg/m^3
pH	7.0
Conductivity at 25 ° C	4 mS/m
Weight loss on ignition	4%
Moisture content	<0.1%
Precision module	4.55

Table 2. Chemical properties of copper slag.

Content	Percent
Silicon oxide (SiO_2)	25-35
Free silica	<0.5
Alumina (Al_2O_3)	2-9
Iron oxide (Fe_2O_3)	45.55
Calcium oxide (CaO)	2-9
Magnesium oxide (MgO)	1-5
Copper oxide (CuO)	0.7
Sulfates (SO_4)	0.2
Chloride (Cl)	0.003

2. Literature review

The use of copper slag as a medium replacement for similar strong disadvantages in quality and strength has been achieved. The main purpose of this assessment is to determine the quality and strength of the matrix, the material is mainly used to replace 10%, 20%, 30% and 40% of its total amount [9]. The conclusion is that the addition of copper slag to concrete increases the density of concrete. Experimental observations represent the replacement of copper slag added to improve the mechanical properties of cement to increase the mechanical properties of cement by 30%, and the copper slag quality of structure 1 mixture to maintain 45.42 N/mm^2: 1.4: 2.6. Increase W/C by 0.4. The mechanical strength properties and effects of copper slag as a fractional replacement of the matrix were discussed [2]. Using two unique types of concrete M30 and M40, copper slag replacement rates range from 0 to 100%. The degree of modified copper slag is 0%, 10%, 20%, 30%, 40%, half, 60%, 80% and 100%. After the shape was projected, the mechanical strength of the matrix was monitored at 7 days and 28 days. The increase in the compressive strength of the rated strength was determined above. 70% of the most extreme compressive strength for M40 concrete copper slag reached 20% instead of 44.44 MPa, the most remarkable compressive strength in 28 days was achieved for semi-set copper slag and found about 53.105 MPa, standard mixing (32, 33 with N). /mm^2 and 47.11 N/mm^2). Focused exploration expertise on providing cement with finer aggregate than copper slag. The fine aggregate was replaced with 0% (control mix), 20%, 40% and 60% copper slag weight levels. The sensitivities of fresh matrix and hardened cement were tested. Mechanical strength was evaluated on days 3, 7, 14 and 28. By using copper slag in concrete, there is a significant increase in the properties of the matrix. Adding 40% copper slag to concrete as a fine aggregate upgrade can improve the quality properties of the hard material. For M20 solid, it is 25.58 N/mm^2 in 28 days [3]. The strength of cement concentrates with the addition of copper slag was investigated and this work presents the follow-up effect of a preliminary report on various erosion and strength experiments on concrete with copper slag as a partial replacement of sand and concrete. In this experimental work, M20 grade concrete was used and tests were conducted for different percentages of copper slag filled with concrete from 0 to 60% sand, and from 0 to 20% concrete [4]. Focusing on the strength of copper slag, the use of copper slag in sulfate-exposed cement reduced the compression of concrete by 5%, 10%, 15% by 57.4%, and 63.4% by compressing copper slag while reducing sulfate deterioration. effectively reduces % and 64.7% lower expansion than cement without copper slag. Copper slag-forced cement introduced adequate compression quality in controlling sulfate contrast and hard examples [5]. The report presents the evaluation results of various durability experiments on a matrix composed of additives and copper slag as independent partial replacements of concrete and sand. In this, the M30 grade of cement was conducted and tests were coordinated with different rates of copper slag and mineral additives. When separated from ordinary cement, the mechanical strength of the mixture containing additives and copper slag used in the matrix is achieved by up to 10-20% [6]. A concrete test was carried out by replacing copper slag halfway with fine aggregate and clay with coarse aggregate, which produced an M40 mixture. Copper slag is used as a fractional trade for small variations in the volume of 20%, 40% and 60% in ordinary cement and tested for ideal quality. The highest compressive strength achieved is 58.54Mpa at 40% copper slag replacement at 28 days compared to normal M40 concrete. The hardness of cement depends on the rapid infiltration test of chloride, which causes erosion due to the rapid migration of chloride particles into the solid [7].

Figure 2. Pictures showing cubes immersed in H_2SO_4, HCl, Na_2SO_4, and $MgSO_4$.

Table 3. Weight loss an compressive strength for acid attack ($H_2 SO_4$).

Q. No	% replacement of M is sulphide	Weight of cubes before and after bathing (kg		Compressive strength after 28 days (N/mm ^{2})	
		Before work shit on the water	After a shitty job	Before work shit on the water	After a shitty job
1	0	2.626	2.265	42.88	32.10
2	20	2.591	2.383	44.22	31.89
3	40	2.718	2.363	44.66	32.80
4	60	2.841	2.447	41.11	29.95
5	80	2.886	2.633	38.88	31.20
6	100	2.885	2.671	38.00	35.16

3. Production of copper slag

Copper slag is obtained by refining the mat and is also considered by refining the copper. An important element of the cleaning charge is sulfide and oxides of iron and copper. The mixture also contains oxides such as SiO_2, Al_2O_3 CaO and MgO, iron, copper, sulfur, oxygen and their oxides, which usually control the science and physical structure of the cleaning base. The main factor is the oxidizing/reducing ability of the gases used to heat and soften the charge, expressed by [8-13]. By following the above procedure, copper-rich matte (sulphide) and copper slag (oxides) are obtained in liquid form. During the refining process, the expansion of the silicon oxide was strengthened by the oxides and strengthened silicate anions. Finally, the process produces a copper slag phase, a sulfide from the matte phase, because the tendency to form anionic complexes is low. Silicate is added in very small amounts to completely extract copper, helping to fix copper with SiO_2.The composition of the material is balanced by the expansion of lime and alumina. At 1000-1300^{0}C, slag is removed from the heater in a liquid state. As the liquid slowly cools, it forms a thick, hard glass-like object. Granular slag is obtained by cooling the hot liquid mat (Fig. 1. Table 1. Table 2).

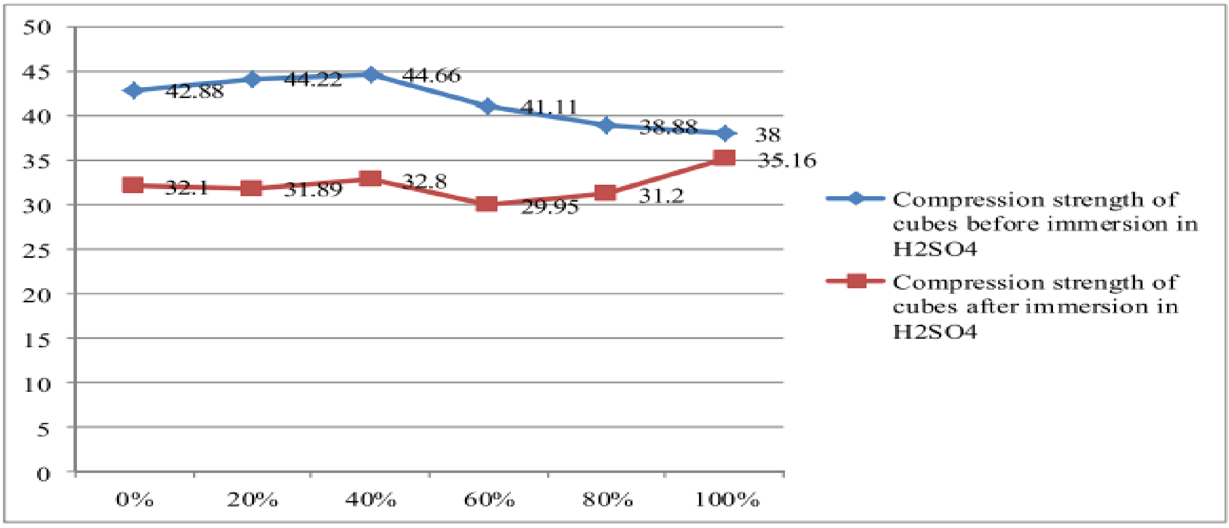

Figure 3. A graph showing the compressive strength before and after exposure to acid ($H_2 SO_4$).

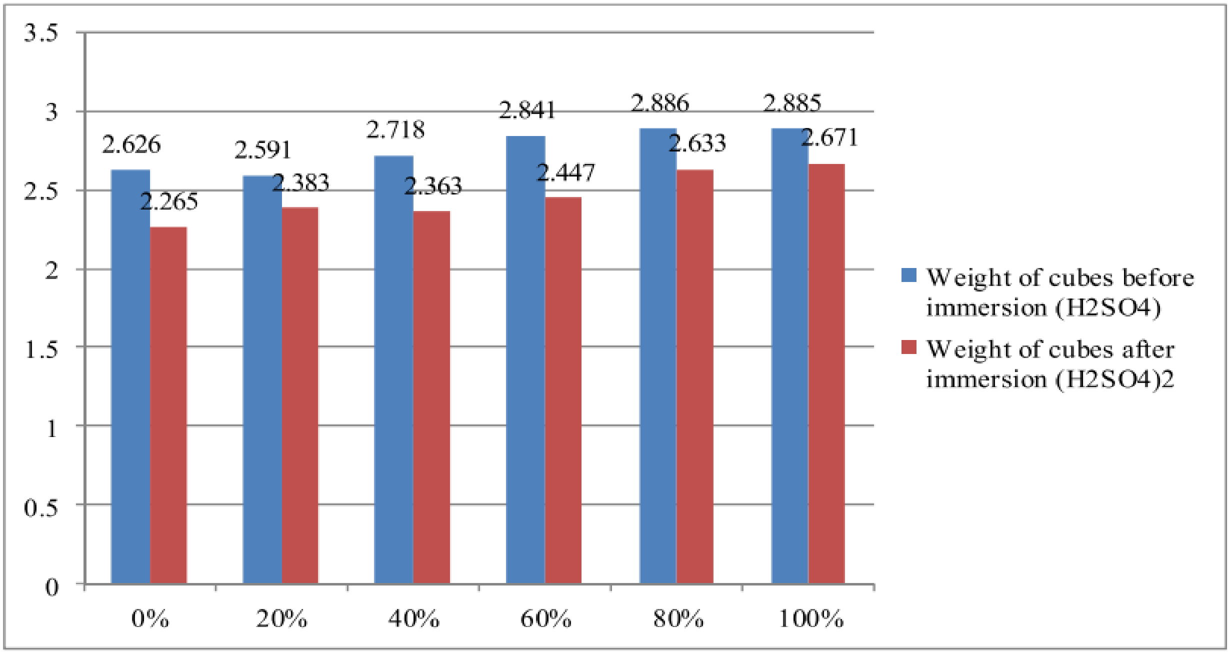

Figure 4. Graph showing weight loss of cubes (H_2SO_4) before and after exposure to acid.

Table 4. Weight loss and compressive strength for acid attack (HCl).

Q. No	% replacement of M is sulphide	Weight of cubes before and after bathing (kg		Compressive strength after 28 days (N/mm^2)	
		Before work shit on the water	After a shitty job	Before work shit on the water	After a shitty job
1	0	2.626	2.531	42.88	37.15
2	20	2.591	2.538	44.22	41.29
3	40	2.718	2.538	44.66	42.71
4	60	2.841	2.633	41.11	38.43
5	80	2.886	2.792	38.88	38.39
6	100	2.885	2.757	38.00	35.07

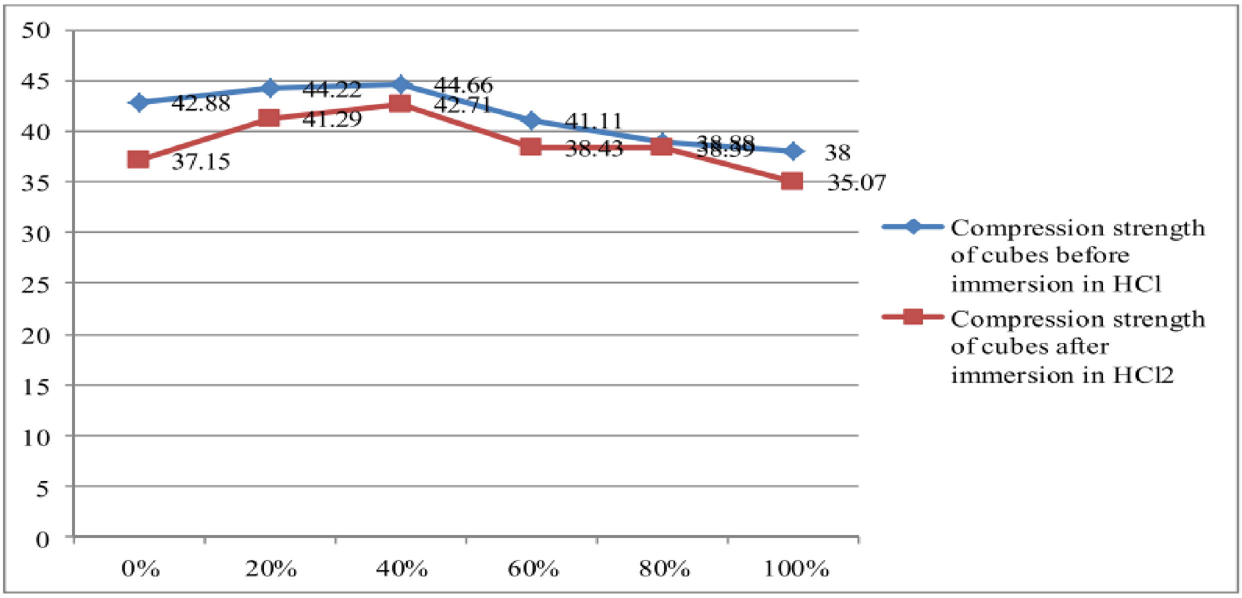

Figure 5. Graph showing compressive strength before and after acid (HCl).

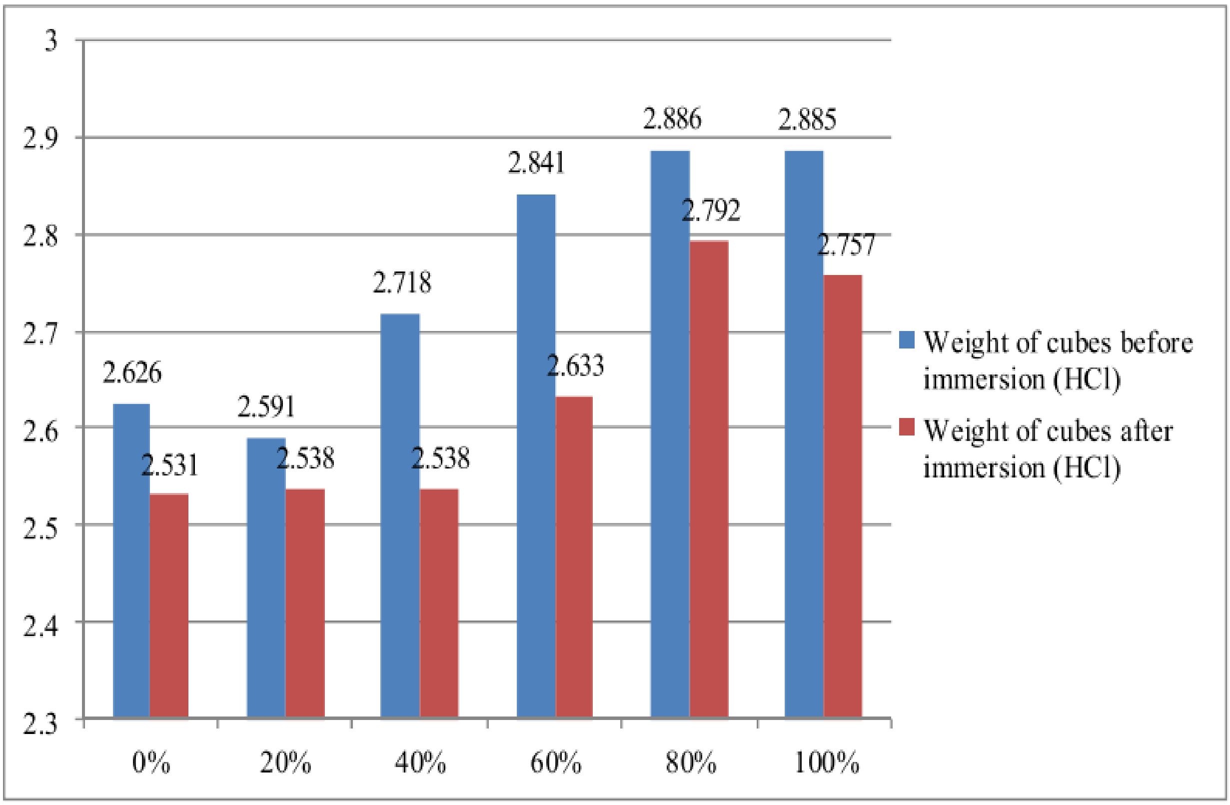

Figure 6. Graph showing weight loss of cubes (HCl) before and after acid exposure.

Table 5. Weight loss and compressive strength for acid attack ($MgSO_4$).

Q. No	% replacement of M is sulphide	Weight of cubes before and after bathing (kg		Compressive strength after 28 days (N/mm^2)	
		Before work shit on the water	After a shitty job	Before work shit on the water	After a shitty job
1	0	2.626	2.590	42.88	41.75
2	20	2.591	2.541	44.22	42.46
3	40	2.718	2.647	44.66	43.32
4	60	2.841	2.735	41.11	39.66
5	80	2.886	2.805	38.88	36.82
6	100	2.885	2.775	38.00	36.50

4. Experimental investigation

The test proportions are mainly used to study the durability properties of cement by using copper slag as a proportion of 20%, 40%, 60%, 80% and 100%. For each test, the norm of two samples of each mix was analyzed once after 28 days of curing and was used to verify normality. Weight loss for shape examples and compression quality is determined over 28 days.

Table 6. Weight loss and compressive strength for sulfate attack (Na_2SO_4).

Q. No	% replacement of M is sulphide	Weight of cubes before and after bathing (kg		Compressive strength after 28 days (N/mm^2)	
		Before work shit on the water	After a shitty job	Before work shit on the water	After a shitty job
1	0	2.626	2.538	42.88	41.35
2	20	2.591	2.460	44.22	43.22
3	40	2.718	2.607	44.66	41.57
4	60	2.841	2.693	41.11	39.38
5	80	2.886	2.772	38.88	36.75
6	100	2.885	2.671	38.00	36.25

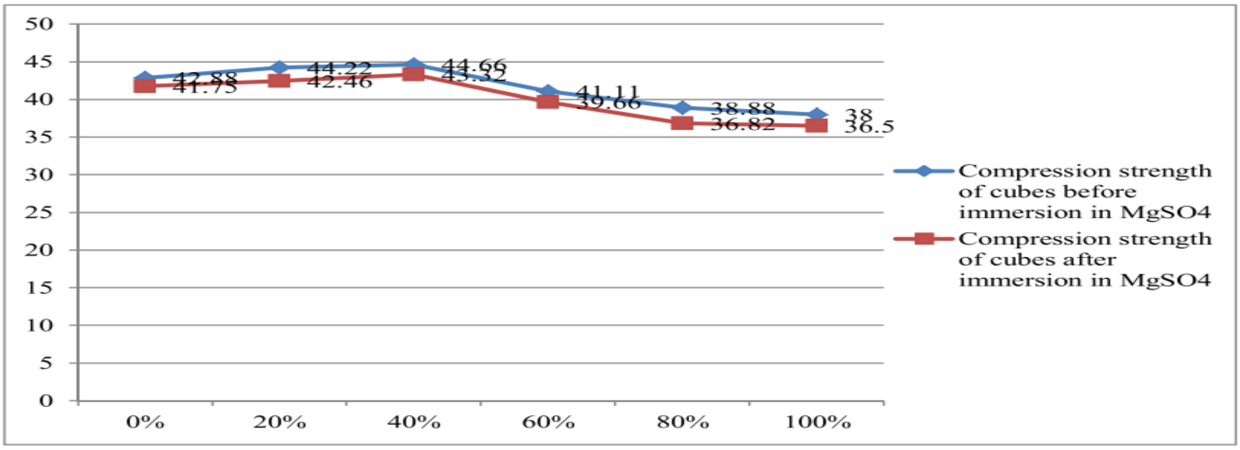

Figure 7. A graph showing the compressive strength before and after exposure to sulfate ($MgSO_4$).

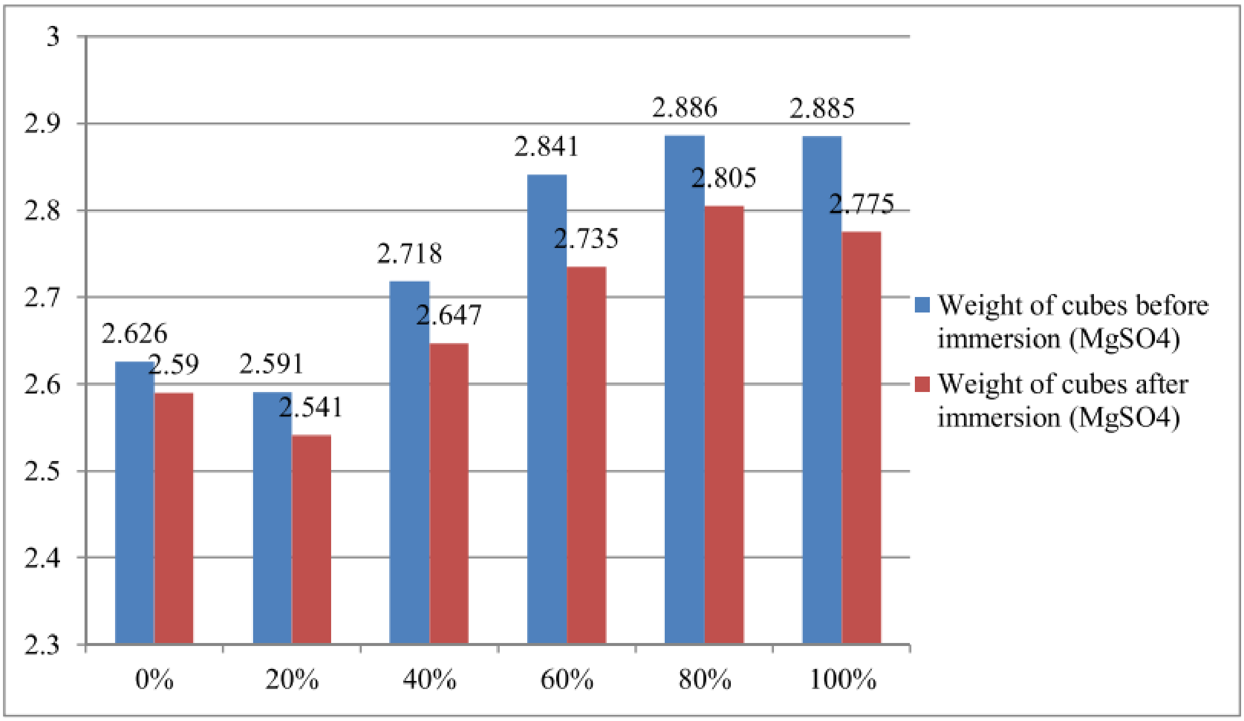

Figure 8. Graph showing weight loss of cubes before and after sulfate attack ($MgSO_4$).

4.1. Mixing ratio

As per Indian Standard IS 10262:2009, the nominal mix is for M40-grade concrete. Specific solid mixtures are made from copper slag, on the other hand, from fine aggregates with mass fractions of 0%, 20%, 40%, 60%, 80% and 100%. The water-cement (w/c) ratio is set as 0.40 in all percent replacement of copper slag (Figure 2).

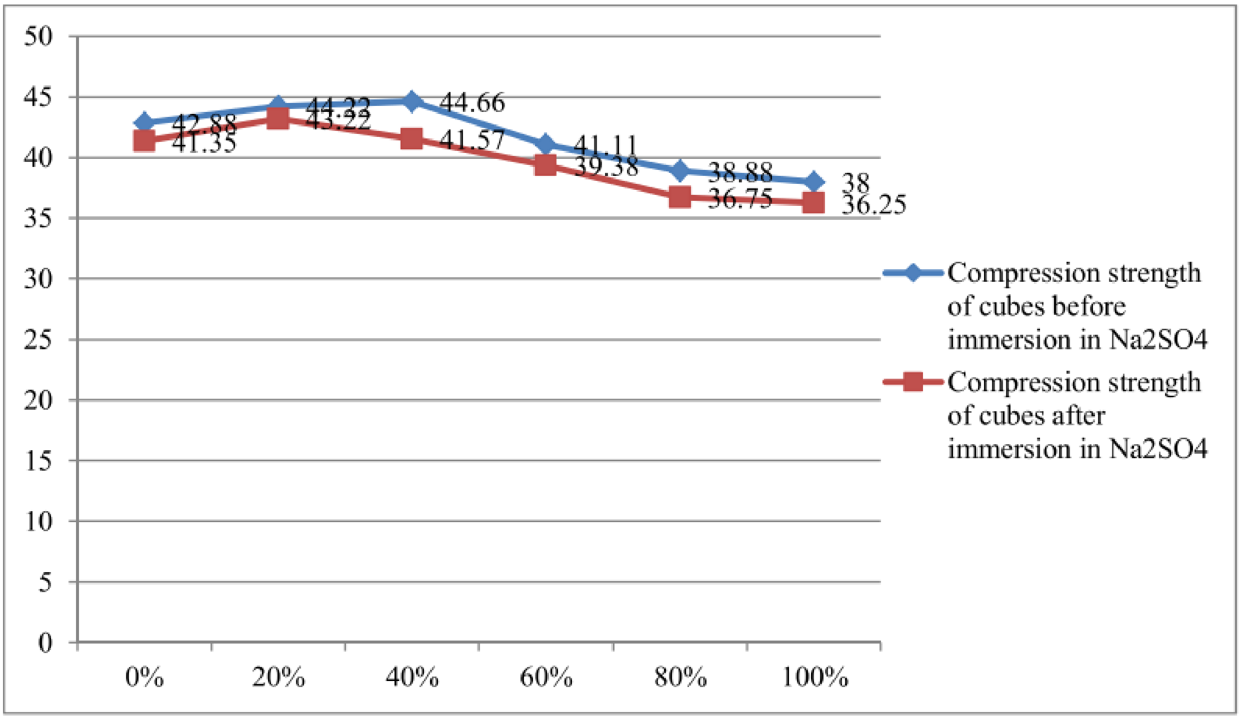

Figure 9. A graph showing the compressive strength before and after exposure to sulfate (Na_2SO_4).

5. Results

5.1. Endurance test

In this work, the durability of concrete is mainly done in 2 parts to calculate two types of effects on concrete.

i) acid attack

ii) ii) sulphate attack

A total of 48 cubes measuring 100mm X 100mm X 100mm are used to test the durability of concrete. All cubes were placed in normal hard water kept at 27°C for 28 days. After drying the cubes in water for 28 days, they are air-dried to remove moisture. After removing the moisture, the weight of the cubes is measured and the weights are made constant, and then 5% acid (H_2SO_4) and (HCl) and 5% sulfate salts (Na_2SO_4, $MgSO_4$) are added. ordinary water and it is diluted. After the dried cubes are placed in diluted water and they are dried in diluted acidic and basic solutions for 28 days. After drying the samples in a 5% diluted solution, they should be dried and the weight loss and the decrease in compressive strength under the action of acid and sulfate are calculated. From Table 3, it can be observed that due to the effect of H_2SO_4 on the concrete, a sharp decrease in the nominal mixture (0%) is observed, where its effect can be clearly shown if the cubes are replaced by copper slag are observed. H_2SO_4 decreases gradually, as the percentage of replaced copper slag in the cube increases, this is because iron oxide (Fe_2O_3) is relatively more in copper slag, while in concrete cubes, a high decrease in compressive strength occurs with a decrease in compressive strength. observed. Due to the high amount of calcium loss in the cubes at 100% replacement of copper slag, the effect of sulfuric acid is also shown graphically 3 and 4. The effect of hydrochloric acid is relatively low compared to the effect of sulfuric acid, but its surface became reddish and the weight and compressive strength decreased, as shown in Table 4: the results were better up to 40%. compared to the nominal mixture, a higher power drop is observed here at 80% and 100% replacement and the same is shown graphically 5 and 6. Compared with acid attacks, copper slag concrete samples treated with ($MgSO_4$) and (Na_2SO_4) were less affected by sulfate attack and showed better results. The results in Tables 5 and 6 show the effect of 5% magnesium sulfate and sodium sulfate solutions, and from the tables, it can be said that up to 60% better results are obtained compared to the acid effect, but the decrease in strength is less observed at 80% and 100%, graphical representations 6, 7, 8 and 9 are shown in Figs.

Conclusion

The use of copper slag as a prominent admixture solution in the concrete matrix increases the thickness of the solid, increasing the weight of the solid itself. According to the results of the durability studies, the weight loss of the concrete was reduced compared to the weight of the cube samples before acid placement. The acid attack showed greater weight loss and lower compressive strength compared to the compressive strength of cube specimens before acid (H_2SO_4, HCl) immersion. The effect of sulfate is very small on the concrete samples, and there is a slight difference in the weights and compressive strength values of the cube samples before and after immersion in a 5% dilute sulfate solution. Observation of the results shows that the compressive strength increases up to 40% replacement of copper slag in concrete and after 60% replacement of copper slag, the compressive strength decreases in both acid and sulfate. attacks.

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