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Experimental Study of Partial Replacement of Fine Aggregate and Cement with Copper Slag and Fly Ash

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Abstract: ***Experimental work carried out by partial replacing of fine aggregate and cement with copper slag and fly ash in concrete. Objective of this work is to study the various performances of normal mixture and concrete mixed with copper slag and fly ash with different proportion. Various test like as compressive strength, split tensile test, flexural strength test and durability tests are taken. Copper slag and fly ash replaced in the ratio 20%, 40%, 60% and 10%, 20%, 30% by weight of fine aggregate and cement in concrete. This study showed that strength increases with increasing amount of copper slag and fly-ash up to an optimum value, beyond which strength starts to decrease with further addition of copper slag and fly ash.***
Keywords: copper slag, fly ash, concrete, fine aggregate.

I. INTRODUCTION

Concrete is the best imperative material for the construction of all high rise structures and many substructures. In the present situation, because of nonstop development in populace, quick industrialization and the going with advances including waste transfer, the rate of release of toxins into the climate, Fly-Ash and copper slag are not many of the modern side-effects which turns out from shoot heater amid metal extraction process. In numerous nations, there is a shortage of natural aggregates that is appropriate for development, while in different nations the utilization of aggregates has expanded as of late, because of increments in the development Industry. Utilization of modern result, for example, foundry sand, fly ash remains, and slag can reply in huge improvement to a great extent in industry vitality productivity and ecological introduction. The use of modern waste or optional materials has supported the creation of bond and cement in development field. New results and waste materials are being produced by different ventures. Dumping or transfer of waste materials causes ecological and medical issues. In this way, reusing of waste materials is an incredible potential in solid industry. For a long time, side-effects, for example, fly fiery debris; silica smoke and slag were considered as waste materials. Concrete arranged with such materials indicated improvement in usefulness and strength contrasted with ordinary cement and has been utilized in the development of intensity, substance plants and submerged structures. Over ongoing decades, concentrated research ponders have been done to investigate all conceivable reuse strategies. . Construction waste, blast furnace, steel slag, coal fly ash and bottom ash have been accepted in many places as alternative aggregates in embankment, roads, pavements, foundation and building construction, raw material in the manufacture of ordinary Portland cement pointed out by Teikthyeluin et al (2006). Copper slag is an industrial by-product material produced from the process of manufacturing copper. For each ton of copper creation, about 2.2 huge amounts of copper slag is produced. It has been evaluated that from the world copper industry (Gorai et al 2003).Although copper slag is broadly utilized in the sandblasting business and in the assembling of grating apparatuses, the rest of discarded with no further reuse or recovery. Copper slag has mechanical and synthetic attributes that qualify the material to be utilized in concrete as halfway swap for Portland cement or as a substitute for aggregates. For instance, copper slag has various great mechanical properties for total utilize, for example, magnificent soundness qualities, great abrasion and great strength detailed by (Gorai et al 2003). Copper slag likewise shows pozzolonic properties since it contains low CaO. Under enactment with NaOH, it can display cementitious property and can be utilized as halfway or full substitution for Portland bond. The usage of copper slag for applications, for example, Portland bond substitution in cement or as crude material has the double advantage of taking out the expense of transfer and bringing down the expense of the solid. The utilization of copper slag in the solid business as are position for bond can have the advantage of diminishing the expenses of transfer and help in ensuring the earth. In spite of the way that few examinations have been accounted for on the impact of copper slag substitution on the properties of Concrete, further examinations are fundamental so as to get an extensive understanding that would give a building base to permit the utilization of copper slag in cement.

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II. LITERATURE REVIEW

Al-Jabri et al (2009, 2011) investigated the performance of high strength concrete made with copper slag as a replacement for fine aggregate at constant workability and studied the effect of super plasticizer addition on the properties of High Strength Concrete made with copper slag.

They observed that the water demand reduced by about 22% for 100% copper slag replacement. The strength and durability of High Strength Concrete improved with the increase in the content of copper slag of upto 50%. However, further additions of copper slag caused reduction in the strength due to increase in the free water content in the mix. Also, the strength and durability characteristics of High Strength Concrete were adversely affected by the absence of the super plasticizer from the concrete paste despite the improvement in the concrete strength with the increase of copper content. The test results also show that there is a slight increase in the density of nearly 5% with the increase of copper slag content, whereas the workability increased rapidly with increase in copper slag percentage.

Khalifa S. Al-Jabri , Abdullah H. Al-Saidy, Ramzi Taha has investigated the performance of high strength concrete (HSC) made with copper slag as a fine aggregate at constant workability and studied the effect. Copper slag can be used as an alternative material for coarse and fine aggregate, since it gives better performance in all the corrosion tests conducted and permeability is less when compared with control concrete. Hence Copper slag can be utilized as sand replacement material without affecting the durability properties of concrete. Copper slag can be used as a potential alternative to coarse aggregate/fine aggregate used in concrete and mortars.

Tusharkumarg Chauhan, The substitution of normal assets in the assembling of concrete and sand is the present issue in the present development situation.

Fly-Ash, Copper slag and Ground Granulated Blast Furnace Slag (GGBFS) are modern by-product materials delivered from the way toward production of coal, copper and iron. Utilization of Fly-Ash, Copper slag and GGBS does lessen the expense of development as well as diminishes the effect on condition by expending the material by and large considered as waste item. current investigation with limit the expense of cement and sand with concrete grade M20 by examining the mechanical conduct of this concrete mix by incomplete supplanting with, for example, Fly-Ash, Copper slag and GGBS in concrete mix.

In this examination, incomplete supplanting of Cement with Fly-Ash and Sand with Copper Slag and coarse aggregate with GGBFS considered.

Trial consider is led to assess workability and strength characteristics of hardened concrete have been surveyed by somewhat replacing cement with GGBS, and sand with Copper Slag. The bond has been supplanted by Fly-Ash as needs be 10% and sand has been supplanted by Copper slag in like manner 30% dependent on past research paper. Coarse aggregate has been supplanted by GGBFS likewise (without Fly-Ash and Copper slag), 20%, 40%, 60%, 80% and 100% for M20 mix. concrete mix were created, tried and looked at regarding compressive, flexural and split rigidity with the ordinary cement.

1) *Aim:* To find the effect of replacement of cement and fine aggregate with fly-ash and copper slag in Concrete
2) *Objectives:* The main objective of this work is to examine the properties of concrete by replacement of fine aggregate by copper slag, and also to scrutinize the following:

a) To design and proportion the concrete mix for M30 grade concrete, as per the recommendation of IS: 10262:2009.
b) To find the optimum proportion of copper slag and fly ash that may be used as replacement substitute material for fine aggregate and cement.
c) To find out compressive, tensile and flexural strength of concrete by using copper slag and fly-ash in concrete specimens by partially replacing**.**
d) To study the effect of copper slag and fly ash on durability of concrete

III. MATERIALS

1) *Cement:* Cement is a binder, a substance that sets and hardens independently, and binds different materials together along many varieties of cements are accessible within the market. The commonly used cement is Portland cement. Portland cement of 53 grades was used for the investigation. The specific gravity of Portland cement was 3.15
2) *Coarse Aggregate:* The coarse mixture is that the largest part of concrete .It's with chemical stable material. It reduces the drying shrinkage and different dimensional changes occurring on account of movement of moisture. The Rigid broken granite stones were used as coarse aggregate in concrete. Size of coarse aggregate was used in the examination is 10mm. The specific gravity of the coarse aggregate was found to be 2.68.

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3) *Fine Aggregate:* The most significant function of the aggregate is to assist in manufacturing workability and regularity in mixture. The fine mixture additionally assists the cement paste to carry the coarse aggregate particle in suspension. This action helps plasticity in the mixture and avoids the possible segregation of paste and coarse aggregate. It should be durable, clean and be free from organic substance. It shouldn't contain any considerable quantity of clay balls and harmful impurities like alkalis, salt, coal, decayed vegetation etc. River sand will be used as fine aggregate. The specific gravity of sand is found to be 2.56.
4) *Water:* Water is important ingredient of because it actively participates within the chemical action with cement. The water, which is used for manufacture concrete should be fresh and free from dangerous impurities like oil, alkalis, acids etc. Nearby available drinking water was used in this work.
5) *Fly Ash:* Coal is a predominant business fuel in India, where numerous mines are worked by Coal India and different auxiliaries. Creation of hard coal was 358.4 Mt.; while use was 407.33 Mt. India is the 6th biggest power producing and expending nation in world. Fly ash can be assumed as the world's fifth biggest raw material asset. An expected 25% of fly ash in India is utilized for cement creation, development of streets and brick fabricate. The fly ash remains use for these designs is required to increment to about 32 Mt by 2009- 2010



Fig.1. Fly Ash

Presently, the vitality division in India creates more than 130 Mt of FA every year and this sum will increment as yearly coal utilization increments by 2.2%. The huge scale stockpiling of wet fly ash remains in lakes takes up much profitable horticultural land roughly (113 million m 2) and may result in serious ecological debasement sooner rather than later, which would be not good for India.

6) *Copper Slag*



Fig.2. Copper Slag

Copper slag is by result of the production of copper. Huge measure of copper slag is created as waste overall amid the copper refining process. River Sand is regular type of fine aggregate utilized in the cement production. Be that as it may, as a result of expanded expense and enormous scale exhaustion of sources choices for river sand are being considered. There have been numerous elective materials with comparable physical and synthetic properties of Sand discovered (Marble powder, lime stone waste, heater slag and welding slag, stone residue and so forth.) and research have been completed to check the reasonableness of its utilization as incomplete substitution of sand.

Copper Slag is a mechanical side-effect copiously accessible close copper creating ventures having comparable physical &chemical properties of Sand can be considered as an option in contrast to the river sand. This will help in settling a noteworthy worry of modern waste transfer alongside diminished expense of development

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IV. EXPERIMENTAL RESULTS AND DISCUSSION

Test carried out on of fresh concrete as well as test on hardened concrete is carried out.

1) *Workability:* Workability is a measure of the ease with which a fresh mix of concrete or mortar can be handled and placed. For various mixes the concrete were prepared. In the fresh concrete, the slump conetest and compaction factor test were carried out.
2) *Testing of Fresh Concrete:* Slump cone test, Compacting factor test
3) *Testing of Hardened Concrete:* Compressive strength test**,** Split tensile test**,** Flexural strength test**,** Durability tests

Table.1. Results of Slump cone and compacting factor

Mix no	Replacement of Cement with fly ash	Replacement of fine aggregate with copper slag	Slump (mm)	Compacting factor
1	0	0	60	0.82
2	10	20	68	0.86
3	20	40	73	0.90
4	30	60	78	0.92

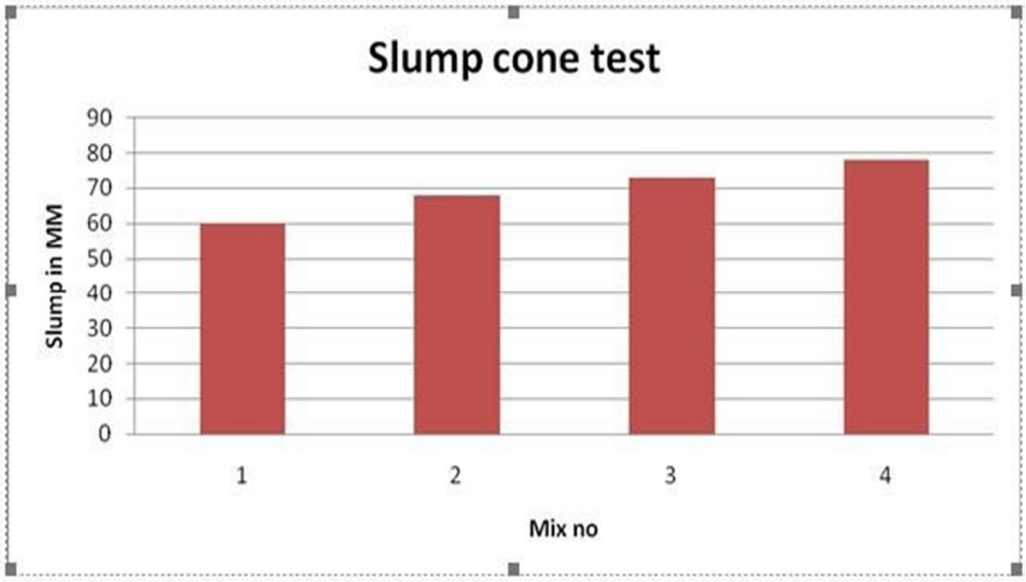


Fig.3. Slump cone test

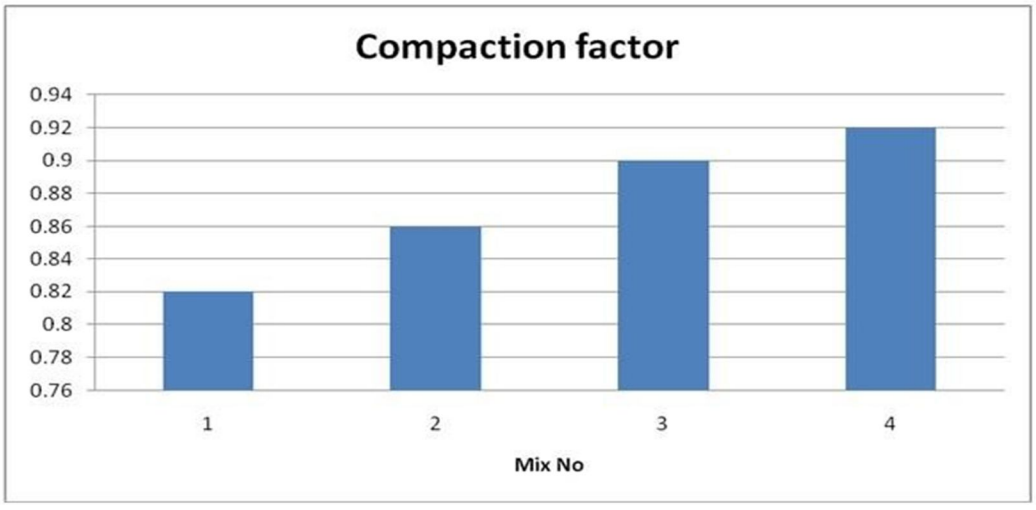


Fig.4. Compacting Factor Test

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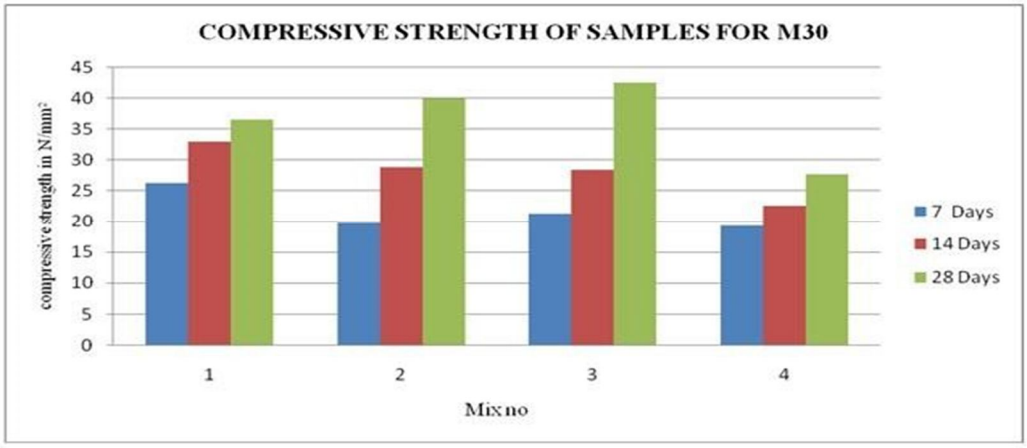


Fig.5. Compressive strength test

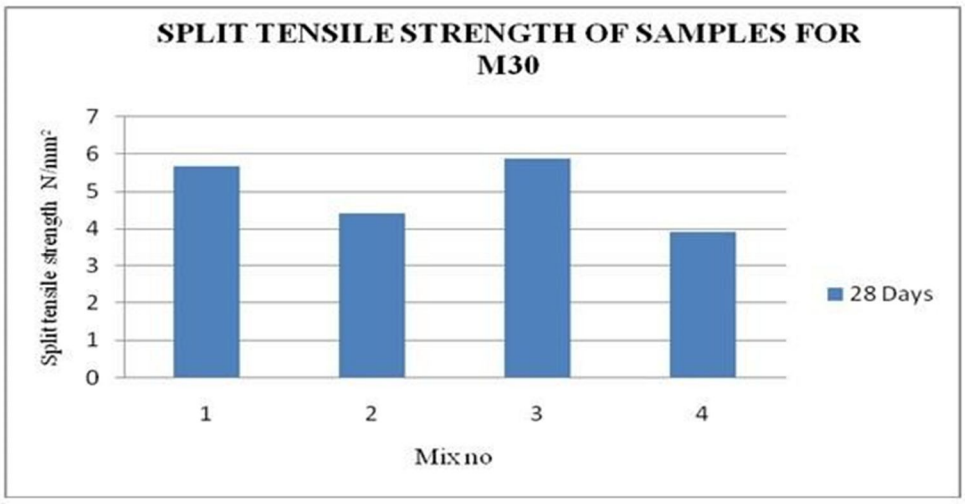


Fig.6. Split Tesile Test

A. Durability Test Results

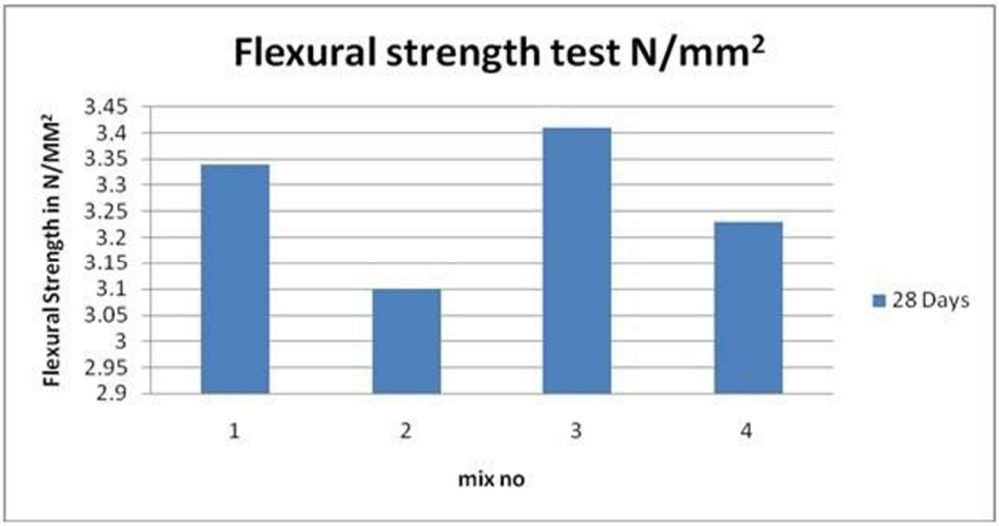


Fig.7. Flexural strength test

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Table.2. Durability test results

Mix no	Normal weight	Moisture weight	Results of Water absorption	Results of Acid attack	Results of Chloride attack
			% weight	% wt loss	% wt loss
1	8620	8670	0.58	2.43	2.9`
2	8860	8880	0.225	2.54	2.1
3	8950	8975	0.28	2.9	2.84
4	9053	9073	0.22	3.1	1.92

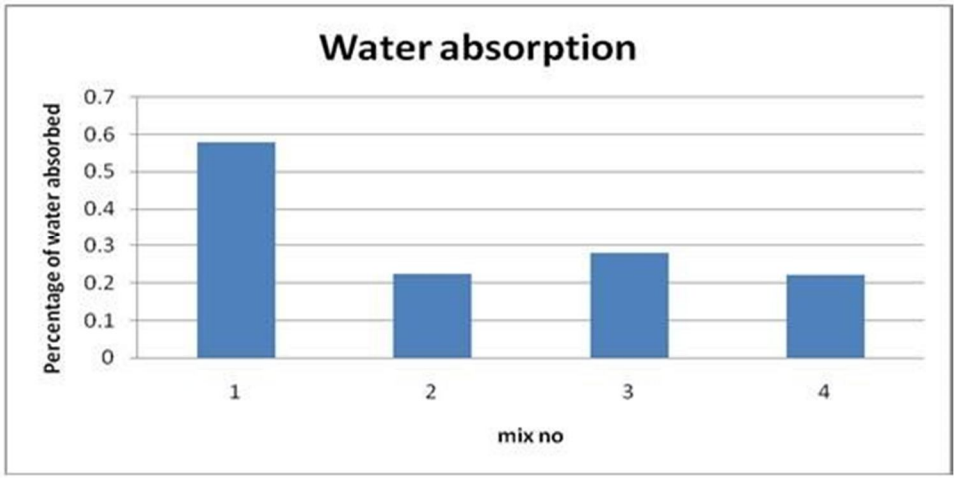


Fig.8. Water absorption test

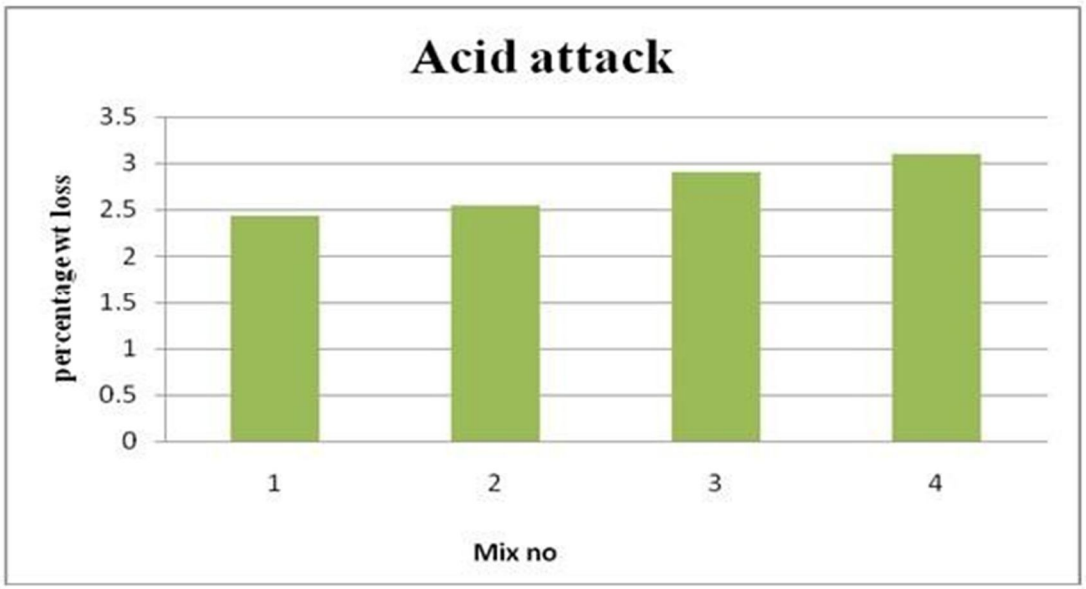


Fig.9. Acid attack test

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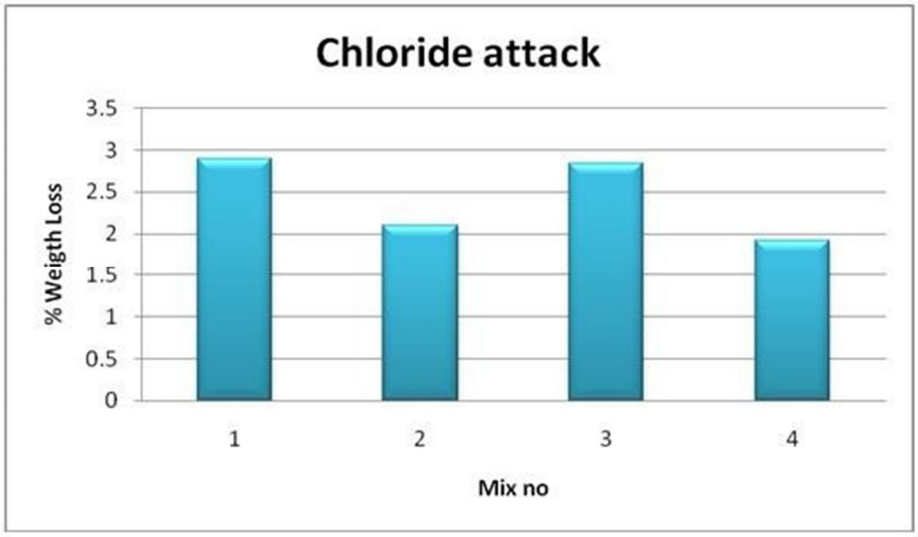


Fig.10. Chloride attack test

V. CONCLUSION

A. The replacement of cement upto 20 % of fly ash and fine aggregate by 40% of copper slag increases compressive strength by 16.41%, Split tensile strength by 3.74% and flexural strength test by 3.78% and beyond that proportion it decreases compare to normal concrete.

B. Workability of concrete can be increased by 13.33% with increase in percentage of copper slag and fly ash in concrete compared to normal concrete.

C. Resistance to sodium chloride attack can be increased by 27.53% for copper slag concrete than that of conventional concrete.

D. Conventional concrete has more resistance to sulphate attack than that of concrete containing copper slag.

E. Water absorption of copper slag and fly ash is less as compared to conventional concrete.

F. Cost of materials indicates that percent of fine aggregate and cement reduction decreases the cost of concrete and at the same time strength increases.

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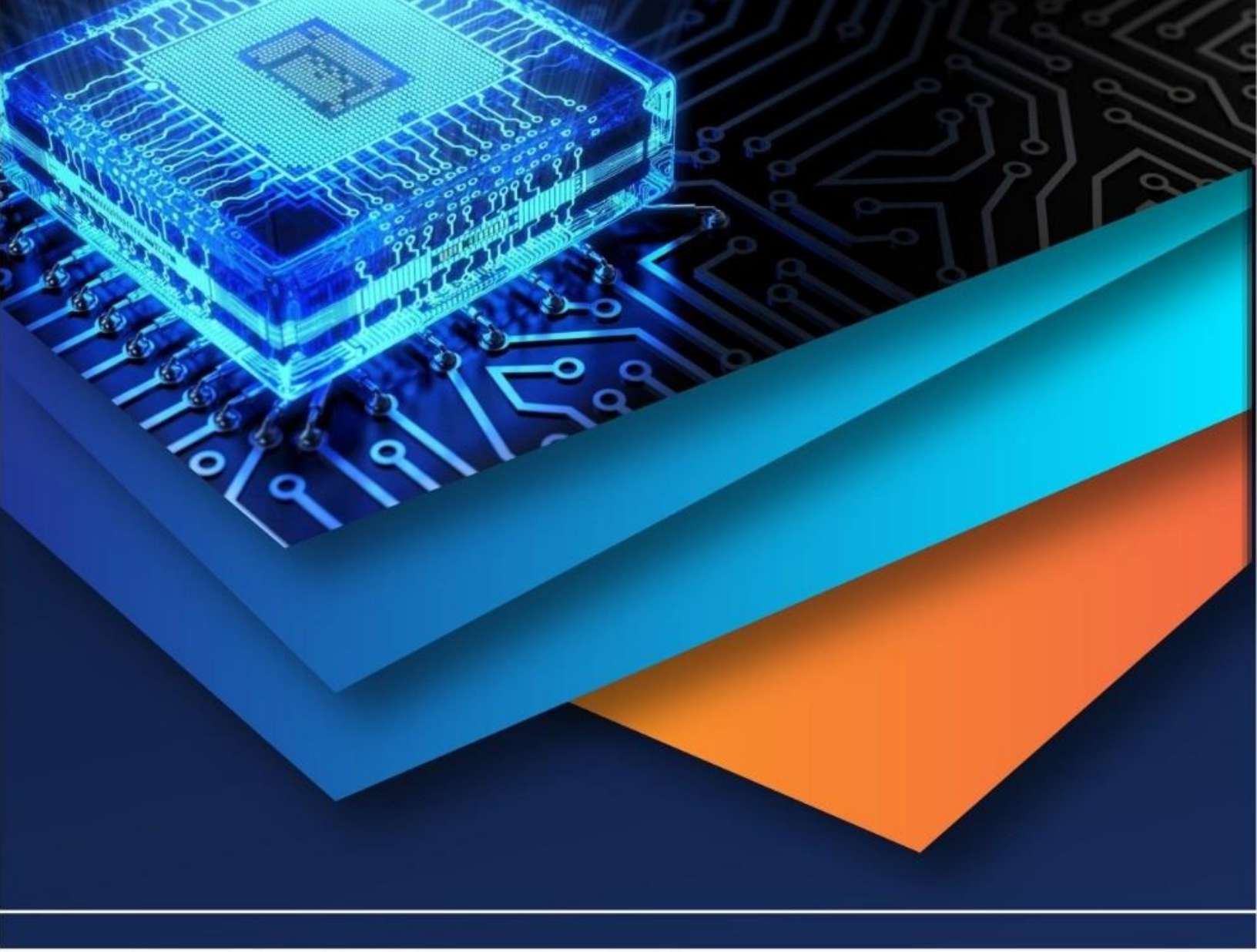
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