The M30 and M40 concrete classes' strength and durability qualities were tested using copper slag and eggshell powder.

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Abstract:
Concrete is always expected to be stronger and more durable than in the past while beingcost and energy efficient. Moreover the major advantages that concrete possesses over theconstruction materials have to be conserved. The possibility of being fabricated practicallyanywhere, the ability to make the form imposed by the shape of a mould and a low cost ofcomponents and manufacture. These factors have driven advances in improving the performance of concrete over years and continue to do so the need for improving the performance of concrete and concern for the environmental impact arising from the continually increasing demand for concrete has lead the growing use of alternative material components.
An experimental investigation will be conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various durability tests will be conducted on such concrete of M30 grade and M40 grade to know the compressive strength, split tensile strength by varying proportions of copper slag (CS) with fine aggregates by 0%, 5%, 10%, 15%, 20% and 25% and Egg shell powder(ESP) as cement by 0%, 5%, 10%, 15%, 20%, 25% by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag as a partial replacement of fine aggregates.
Key words: Copper Slag,EggshellPowder,Compressive Strength, Split Tensile Strength

I. Introduction

Throughout the field of construction, cement and concrete production is facilitated by the use of industrial waste or secondary materials. Different companies produce new by-products and waste materials. Waste materials processing or disposal is causing environmental and safety issues. Recycling waste materials in the concrete sector therefore represents a great opportunity. By-products like fly ash, silica fume and slag have been considered waste materials for many years. Concrete prepared with these materials demonstrated improved workability and durability over normal concrete and was used for fuel, chemical plants and underwater structures. Intensive research to investigate all possible forms of recycling have been undertaken in recent decades. Building waste, explosive furnace, steel slag, ash of coal fly and low ash, as alternative aggregates in soil, highways, flooring, foundations and building, as raw substances for development of the ordinary Portland cement, as pointed out by Teikthyeluin et al (2006) have been accepted in many areas.

Copper slag is a material from an industrial by-product created by the copper process. About 2.2 tons of copper slag are produced for each ton of copper output. The copper industry in the world is estimated to produce about 24.6 million tons of slag (Gorai et al 2003). While copper layer is widely used in the sand blasting and abrasive tool manufacturing, the rest is disposed of without further recycling or reuse. The copper layer is mechanically and chemically defined as a component replacement for portland cement or as a substitute for aggregates for the material that is to be used in concrete. Copper slag for example has a variety of favourable mechanical characteristics for combined use, such as good soundness, good abrasion resistance, and recorded stability (Gorai et al 2003). Copper slag also has pozzolanic characteristics as it has low CaO. When activated by NaOH, cemented properties may be shown and can be used to substitute Portland cement either partially or completely. Copper slag has the double benefit of minimizing waste disposal costs and reducing the costs of concrete by using them for applications such as Portland concrete replacement or as a primary material.

II .Literature review

The experimental studies of Gowsika et al. (2014) on powdered eggshell (ESP) as partial replacement for cemented concrete. At 28 days of curing time ESP was substituted in 5, 10, 15,20, 25,30 percent by weight of cement and a

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mixing proportion of 1:3 by a chemical composition and strength properties of ESP in cements mortier. For compression, over and above 5 percent of ESP replacement, admixtures such as saw dust ash, fly ash and microsilica have been utilized to pump up the power. In contrast with traditional concrete, it was found that replacement of 5 percent ESP with 10 percent micro silica leads to the high strength of hard concrete. The properties of eggshell concrete powder as cement substitute were investigated by Amaranth Yerramala et al., (2014). During 7th and 28thday curing times 5, 10, 15% of ESP for cement and tests were determined for specific characteristics of hardened concrete. The findings suggest that adding flyash along with ESP is positive up to 15 percent over the control of concrete. The absorption property has decrease with the reduction in permeable vacuum. The absorption has decreased with force and increased with water absorption. This paper substitutes partial volume of cement with powder from the fused cement, as at the end of 28 days it is noted that a 5 percent rise in weight and strength of up to 30%. In order to obtain the force which decreased by over 5%, some mineral admixtures, such as fly ash, silica and saw dust must be strengthened by replacement. This scenario shows that the strength properties of concrete are improved by 5% ESP with 10% micro silica, ash fly, replacing dust. The ESP has been replaced by 10 % , 20% and 30% of the ESP has been replaced by 5 % , 10% and 15% by the ESP, and studies on seventy-four days and twenty-eight days have been carried out for well-healed specimens. [3]Praveene Kumar et al. ,(2015) experimentally tested on partial cement replacement with eggshells. The strength also increases by up to 15 per cent without the application of silica fume, but economically speaking, ESP is necessary to achieve a stronger strength.The comparative research on Eggshell cement with partial cement replacement with Fly Ash was submitted by Dhanalakshmi and others(2015). Two wastes are used as a partial replacement for cement here and different materials have been obtained. The application of fly ash to maximum ESP concrete has demonstrated improved density and workability. [5] [5] [5]

The substitution of cement by eggshell powder was examined by Mohamed Ansari et al. , (2016). The characteristics were substituted by 10, 15 and 20 percent ESP replacement in cement for concrete. Results show that ESP replacement is successful at about 10 to 15% and further intensity is reduced. [6]Monisha et al . (2016) have experimentally researched eggshell powder and polypropylene fiber concrete. The following paper offers the substitution of fine aggregates of ESP 20% and polypropylene fiber in the range of 0, 0.2 and 0,4%. Similar to standard concrete 7, 14 and 28 days of curing time, the strength properties are obtained. The test results indicate that 20% of fine aggregates substituted by ESP have adequate resistance and 0.2% of polypropylene fiber by concrete weight have been reached by grade M20. The mechanical features of concrete with the use of eggshell ash and rice ash as a partial substitute for cement have been studied by the

III .Objective of the study

Since copper slag and egg shell power is seen as a waste product and the land that can be dumped every day has a major effect on the environment, therefore, we use copper slag in building. Copper slag has many applications in relation to its use in building but is just a little percentage point.

The principal aim is to research how copper slag can be used in concrete as a fine aggregate. It includes the knowledge of the strength parameters of concrete including compressive strength, division of tensile strength, flexural strength in which fine adds copper slag and egg shell powder are substituted by 0% (5% +5%), (15% +10%), (15% +15%), +20% (25% +20%) and (30% +30%)

IV .Methodology

One of the main aims of examining the various properties of concrete and hardened concrete materials is the development of a concrete technologist for a specific strength and durability of a concrete mix. Because of the wide varying material properties, the conditions at the site , particularly the exposure condition, and the condition required for a particular task for which mix is designed, the design of the concrete mix is not a simple task. Concrete mixing design requires a full understanding of different characteristics of the various component materials, their effect on the site, their effect on hardened concrete and the dynamic inter-relationships between the variables in cases of alteration of these conditions. All these complicate and complicated the task of mix design. In addition to knowledge of material properties and properties

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of plastic concrete, the design of the concrete mix also requires broader expertise and concreting experience. Even then, the proportion of concrete materials found in the lab requires changes and adjustments according to the field conditions.

Mix design can be defined as the process of selecting the correct concrete ingredients and of determining their relative proportions as economically as possible with a concrete producing object of some minimum strength and durability. Secondly, the minimum strength and reliability listed are to be archived. The second goal is to make concrete the most cost-effective method. The cost depends primarily on two factors: material costs and material costs. As cement costs much more than other materials, we primarily concentrate on the use of cement as small as possible, which is compatible with strength and durability.

4.1 **Mix Design of Conventional Concrete (M30)**

The next step is the design of the concrete

Step 1 :Target Mean Strength

$$f'_{ck} = f_{ck} + 1.65 \times \sigma = 30 + 8.25$$

$$= 38.25$$

Table 1 Assumed Standard Deviation
(*Clauses* 3.2.1.2, A-3 *and* B-3)

Sl No. (1)	Grade of Concrete (2)	Assumed Standard Deviation N/mm² (3)
i)	M 10	3.5
ii)	M 15	
iii)	M 20	4.0
iv)	M 25	
v)	M 30	5.0
vi)	M 35	
vii)	M 40	
viii)	M 45	
ix)	M 50	
x)	M 55	

NOTE — The above values correspond to the site control having proper storage of cement; weigh batching of all materials; controlled addition of water; regular checking of all materials, aggregate grading and moisture content; and periodical checking of workability and strength. Where there is deviation from the above, values given in the above table shall be increased by 1 N/mm².

Phase 2: Ratio of W / C

• For 25 N / mm2 concrete compressive strength the graph defined in IS10262,w / c shall be taken as 0.46.
• For mild condition, the w / c ratio from Table 5 of Is 456 is 0.45
• Hence the ratio is 0,45 as w / c, at least of two values. •

Stage 3: Value for Water

From Table 2 of IS10262, conclude that the 20 mm of the total volume is used. Accordingly, the maximum water content is 186 kg.

$$\text{Water content} = 186 \times 1.06 = 197.16$$

Table 4.2: Water Content

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Table 2 Maximum Water Content per Cubic Metre of Concrete for Nominal Maximum Size of Aggregate
(*Clauses* 4.2, A-5 *and* B-5)

Sl No.	Nominal Maximum Size of Aggregate mm	Maximum Water Content[1] kg
(1)	(2)	(3)
i)	10	208
ii)	20	186
iii)	40	165

NOTE — These quantities of mixing water are for use in computing cementitious material contents for trial batches.

[1] Water}content corresponding to saturated surface dry aggregate.

4.2 Calculation Of Coarse Aggregate And Fine Aggregate

The region of the fine aggregate has been assigned Zone 1 of IS10262 and the corresponding coarse aggregate volume of 20 mm is 0,62 if the w / c is 0,5; our w / c is 0,46 and the effective coarse aggregate volume is 0,6, with the coarse aggregate volume 0,608 for w / c 0,42.

and hence volume of fine aggregate is 1 - 0.608 = 0.392

Table 4.2: Zone classification

Table 3 Volume of Coarse Aggregate per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate
(*Clauses* 4.4, A-7 *and* B-7)

Sl No.	Nominal Maximum Size of Aggregate mm	Volume of Coarse Aggregate[1] per Unit Volume of Total Aggregate for Different Zones of Fine Aggregate			
		Zone IV	Zone III	Zone II	Zone I
(1)	(2)	(3)	(4)	(5)	(6)
i)	10	0.50	0.48	0.46	0.44
ii)	20	0.66	0.64	0.62	0.60
iii)	40	0.75	0.73	0.71	0.69

[1] Volumes are based on aggregates in saturated surface dry condition.

Step 6 : Mix Proportion

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$$\text{volume of concrete} = 1\text{m}^3$$

$$\text{volume of cement} = \frac{438.13}{(3.2\times1000)}$$

$$= 0.136\text{m}^3$$

$$\text{volume of water} = 197.16$$

$$= 0.197\text{m}^3$$

$$\text{Absolute weight of all materials except total aggregates} = 1 - (0.136 + 0.197)$$

$$= 0.667$$

$$\text{volume of coarse aggregate} = 0.667\times0.61\times2.68\times1000$$

$$= 1090.41\ \text{m}^3$$

$$\text{volume of fine aggregate} = 0.667\times0.39\times2.52\times1000$$

$$= 655.52\ \text{m}^3$$

Step 7: Mix Ratio
438.13:655.52:1090.41
1:1.49:2.48

V .Data analysis

Materials used

5.1 Cement:

Cement is the important required material for the construction of concrete. Cement is a well-known construction material and has engaged a vital place in construction work. There is a change of cement obtainable in market and each type is used under convinced illness due to its singular properties such as colour and arrangement of cement. The physical properties of cement, chemical composition of cement are shown in Table-1 and Table-2 respectively.

Figure 5.1- Ordinary Portland cement 53 grade

Table 5.1 Physical Properties of cement

Sl.no	Properties	Test value
1	Standard Consistency	34%
2	Initial Setting Time	35min
3	Specific Gravity	3.14
4	Fineness	3%

Table 5.2 Chemical Properties of Cement

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Sl.no	Oxide Contents	Percentage (%)
1	CaO	60.67
2	SiO2	17.25
3	Al2O3	3-8
4	Fe2O3	0.5-6.0
5	MgO	0.1-4.0
6	K2O, Na2O	0.4-1.3
7	SO3	1.3-3.0

5.3 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. The nearby quarry is brought with crushed stone aggregate 20 mm in size. Sizes of more than 20 mm are divided by sieves. Tests are performed to test the properties of aggregate

Figure 5.3- Coarse aggregate

Table 5.3 Physical properties of Coarse aggregate

Sl.no	Properties	Test Value
1	Specific gravity	2.67
2	Fineness modulus	4.75
3	Aggregate impact value	24.48%
4	Flakiness Index	12.56%
5	Elongation Index	42.24%

5.4 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.

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Figure 5.4-Fine aggregates

Table 5.4 Physical Properties of Fine aggregate

Sl.no	Properties	Test value
1	Specific gravity	2.7
2	Fineness Modulus	4.72
3	Bulking of fine aggregate	52%

5.5Copper 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.

Figure5.5-Copper slag

5.6 Egg shell powder

The egg shell wastelands in the poultry manufacturing have been highlighted because of its recovery potential. Egg shell waste is available in huge amounts from the food processing, egg breaking, and shading industries. The food indulgence industry is in need of investigation to find another methods for processing and using egg shells waste in an ecological friendly way. There is a need to find a low cost solution. Removal of egg shell waste are usually not income centers but cost centers. Therefore, the least cost of removal is most necessary.

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Figure 5.6- Egg shell powder

Table 5.6 Physical Properties of Egg shell powder

Sl.no	Properties	Test value
1	Specific gravity	2.44
2	Standard Consistency	39%
3	Initial setting time	38 min

VI .Results and Discussion

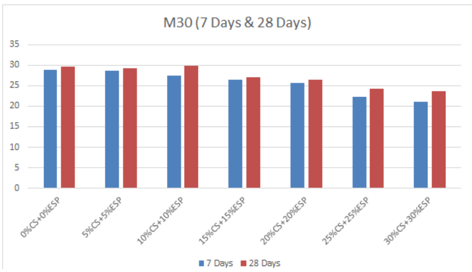
6.1 Introduction

The following chapter describes the compressive test results, preparing cubes from various blends that were previously mentioned, creating six cubes per blend, allowing compression testing on two cubes to be conducted on 7 days, 14 days and 28 days, while the average compression value is used as a compressive power.

Test results

Table 6.1 Compressive strength results

Sl.no	Type of concrete	M30(7 Days)	M30(28 Days)	M40(7 Days)	M40(28 Days)
1	0%CS+0%ESP	28.84	29.60	38.60	39.86
2	5%CS+5%ESP	28.60	29.20	37.24	37.44
3	10%CS+10%ESP	27.40	29.80	36.60	37.90
4	15%CS+15%ESP	26.40	27.00	35.40	36.20
5	20%CS+20%ESP	25.60	26.40	32.80	34.22
6	25%CS+25%ESP	22.20	24.20	32.20	33.45
7	30%CS+30%ESP	21.00	23.60	31.60	31.62



Graph 6.2 – 7 & 28 Days strength of different proportions of M30 grade concrete

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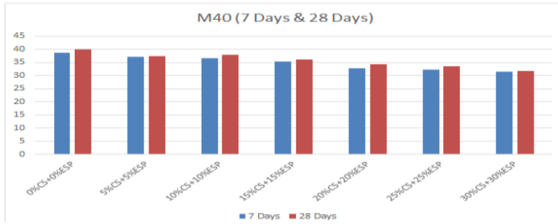
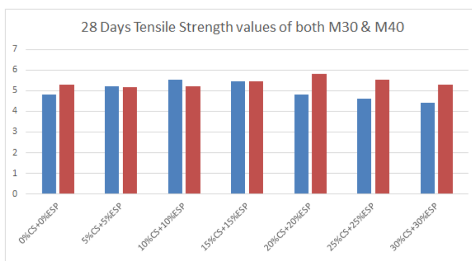


Graph 6.3 – 7&28 Days strength of different proportions of M40 grade concrete

6.3 Tensile Strength

Table 6.2 Tensile Strengths

Sl.no	Type of concrete	28 Days Tensile strength of M30	28 Days Tensile strength of M40
1	0%CS+0%ESP	4.82	5.28
2	5%CS+5%ESP	5.21	5.16
3	10%CS+10%ESP	5.53	5.20
4	15%CS+15%ESP	5.45	5.46
5	20%CS+20%ESP	4.80	5.80
6	25%CS+25%ESP	4.60	5.53
7	30%CS+30%ESP	4.40	5.30



Graph 6.4-28 Days Tensile strength of different proportions of M30 & M40 grade concrete

6.4 Compressive strength test with Sulphate attack

Table 6.3 Compressive strength test with Sulphate attack

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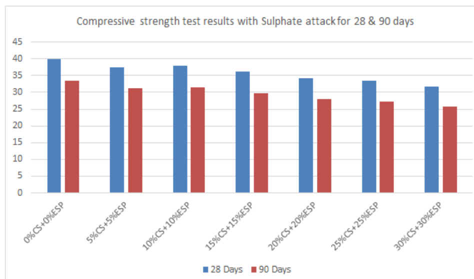
Sl.no	% replacement	Compressive strength of cube after 28 Days	Compressive strength of cube after 90 Days	%loss of compressive strength due to sulphate attack
1	0%CS+0%ESP	39.86	33.40	16.22
2	5%CS+5%ESP	37.44	31.13	16.84
3	10%CS+10%ESP	37.90	31.37	17.22
4	15%CS+15%ESP	36.20	29.82	17.60
5	20%CS+20%ESP	34.22	28	18.20
6	25%CS+25%ESP	33.45	27.30	18.40
7	30%CS+30%ESP	31.62	25.73	18.60



Graph 6.5- Compressive strength test results with Sulphate attack for 28 & 90 days

VI .Conclusion

1. The cement material, fine aggregates and gross aggregates have their material properties in line with IS code standards within reasonable limits, which means that we can use the materials for testing.

2. The drop cone value for copper slag concrete decreases with the amount of copper slag decreased so that the concrete was not working.

3. Copper slag concrete reduces compaction factor value with the rise of the copper slag level.

4. Concrete compressive force is overall 20% copper layer replacement and is the optimal benefit of 7 days treatment and 28 days treatment.

5. For cylindrical specimens, split tensile strength is optimum for 28 days of copper slag replacement at 20 percent.

3. The egg coating powder around the mixture surface can improve the carbonation rate and can in the long-term decrease the permeability. A thorough study of the carbonation cycle in the mix is therefore required.

7. Concrete workability was found to be reduced when the ESP and Copper Slag between 14% ESP and 20% Copper Slag.

8. Maximum bending strength is achieved at a maximum of 28 days at 14% ESP and 20% Copper Slag.

9. Maximum split tensile reached with a duration of 28 days and a duration of 40% coffee slag.
For better strength values in concrete grade M30 the substitution of 20 percent copper slack is usually useful.

10. The replacement of 20% to 40% of the copper slag is generally useful for better strength values in M30 grade of concrete.

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