© 2019 IJSRST | Volume 6 | Issue 3 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
Themed Section: Science and Technology

An Experimental Study on Properties of Strength of Concrete by Partial Replacement of Fine Aggregate with Copper Slag and Cement with Egg Shell Powder for M30 Grade Concrete

Mohd Imran, Syed Saad Ali, Boda Vinod, Ramavath Sanjeev, Shaik Abdul Rasheed, Mohammed Ismail Khan

mohdimran7262@gmail.com,Syedsaadali410.sa@gmail.com,vinodboda016@gmail.com, rathodsanju1013@gmail.com rasheedrash766@gmail.com, mdismailkhan@lords.ac.in

Department of Civil Engineering, LORDS Institute of Engineering and Technology, Hyderabad, Telangana, India

ABSTRACT

Concrete is always expected to be stronger and more durable than in the past while being cost and energy efficient. Moreover the most important benefits that concrete possesses over the construction materials got to be preserved. The possibility of being fabricated practically anywhere, the ability to make the form imposed by the shape of a mould and a low cost of components 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 scum as a partial replacement of fine aggregates in the concrete mix design. Various durability tests will be conducted on such concrete of M30 grade to know the compressive strength, split tensile strength, strength by varying proportions of copper scum (CS) with fine aggregates by 0%, 5%, 10%, 15%, 20%,and Egg shell powder (ESP) as cement by 0%, 5%, 10%, 15%, 20% by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper scum as a partial replacement of fine aggregates.

Keywords: Cement, Copper Scum, Fine aggregate, Egg Shell Powder

I. INTRODUCTION

The utilization of industrial waste or secondary materials has inspired the assembly of cement and concrete in construction field. New by-products and waste materials are being generated by numerous industries. Dumping or disposal of waste materials causes environmental and health problems. Therefore, recycling(reuse) of waste materials may be a great potential in concrete trade. For many years, outgrowth(side product) such as fly ash, silica fume and scum were considered as residue materials. With such materials concrete showed improvement in workability and sturdiness compared to old-fashioned concrete and has been used at intervals the event of power, chemical plants and under-water structures. Over recent decades, intensive research studies have been carried out to explore all possible reuse methods. Construction furnace, waste, steel scum, coal ash and bottom ash are accepted in many places as numerous aggregates in hill, roads, pavements, foundation and building construction.

Copper scum is an industrial outgrowth material made from the process of producing copper. For every ton of copper production, about 2.2 tons of copper scoria is generated. It has been calculable that approximately 24.6 million tons of scum are generated from the world copper industry. Although copper scum is widely used in the sand blasting industry and in the manufacturing of abrasive tools, the remainder is disposed of without any further reuse or reclamation. Copper scum(slag) possesses chemical and mechanical properties that qualify the material to be used in concrete as a partial replacement for hydraulic cement or as a substitute for aggregates. For example, copper scum has a number of favourable impersonal properties for aggregate use such as excellent soundness, abrasion resistance and stability. Copper scum(slag) also conjointly exhibits pozzolanic properties since it contains low CaO. Under activation with NaOH, it will exhibit building material property and might be used as partial or full replacement for cement. The utilization of copper scum for Portland cement replacement in concrete, or as raw material has the dual benefit of eliminating the cost of disposal and lowering the cost of the concrete. The use of copper scum/scoria within the concrete business as a replacement for cement will have the good thing about reducing the prices of disposal and facilitate in protecting the surroundings. Despite the very fact that many studies are according on the result of copper scum replacement on the properties of Concrete, further investigations are necessary in order to obtain a comprehensive understanding that would provide an engineering base to permit the utilization of copper slag(scum) in concrete.

II. SCOPE AND OBJECTIVES:

As the copper scum and egg shell power considered to be a waste product and the land for its dumping increasing day by day showing a serious impact on environment, hence to reduce it we are making use of copper scum in construction field. Although copper scum has many uses but to a limited extent when it compared to its use in construction.

The main objective is to study the feasibility of use of copper slag as fine aggregate in concrete. The scope of the work includes knowing the strength parameters of concrete such as compressive strength, split tensile strength, flexural strength in which copper slag and egg shell powder replaced with fine aggregates and cement By 0%,(5%+5%),(10%+10%),(15%+15%),(20%+20%) using M30 grades of concrete.

III. MATERIAL DESCRIPTION

A. Cement

Cement is a binder, a substance used in construction that sets and hardens and can bind other materials together. The most crucial style of cement are used as a component in the production of mortar in masonry, associate degreed of concrete- that could be a combination of cement and associate degree combination to make a robust building material.

Fig 1 : Ordinary Portland cement 53 grade

The ordinary Portland cement of 53 grade is used in accordance with IS: 12269-1987.

B. Aggregate

- "Aggregate", is a broad class of coarse granular material utilized in construction, including gravel, sand, crushed stone, slag, reused concrete and geo-synthetic aggregates. Aggregates area unit the foremost deep-mined materials within the world.
- Aggregates are fine coarse in concrete materials added to cementitious mixtures to improve the robustness of that mixture.

C. Coarse aggregate:

- Crushed stone aggregate of 20mm size is brought from nearby quarry. Aggregates of size more than 20mm size are separated by sieving. Tests are carried in order to find out the
- Those particles that are predominantly retained on the 4.75 mm (No. 4) sieve and will pass through 3-inch screen. Economical mixing is directly proportional to coarse roughness of the aggregate. An equivalent volume of small pieces offer more surface area of particles than larger pieces. Reduction in cement and water requirements is only achieved by using largest permissible maximum size of coarse aggregate. Usage of maximum size of coarse aggregates can result in interlock and form arches or obstructions within a concrete form. That allows the area below to become a void, or at best, to become filled with finer particles of sand and cement only and results in a weakened area.

Fig 2 : Coarse aggregate

D. Fine Aggregate:-

- Regionally available natural sand, free from organic matter is used. The result of sieve analysis confirms it to Zone-II (according to IS: 383-1970).The tests conducted and results plotted below.
- Those particles passing the 9.5 mm (3/8 in.) sieve, almost entirely passing the 4.75 mm (No. 4) sieve, and preponderantly preserved on the 75 µm (No. 200) sieve are called fine aggregate. For exaggerated workability and for economy as mirrored by use of less cement, the fine aggregate should have a rounded shape. The purpose of the fine aggregate/mixture is to fill the voids in the coarse aggregate and to act as a workability agent.

Fig 3 : Fine aggregate

E. Copper Scum:-

- The copper scum which we used had collected from a dealer of 'Hindustan copper limited' at Vishakhapatnam. The wholesale price of the copper slag is about ₹650/ton and is also economical to use copper slag at the places where it is available.
- Copper scum is a outgrowth of copper extraction(methods used to obtaining copper from its ores) by smelting(applying heat to ore). During smelting, impurities become scum which floats on the molten metal. Slag that is quenched (the rapid cooling of a workpiece) in water produces angular granules to obtain certain material properties which are disposed of as waste or utilized as discussed below.
- Copper Scum is mainly used in surface blast-cleaning and in construction.
- Copper Scum can be used in concrete production as a partial replacement for sand. It is used as a building material, formed into blocks. Such use was common in areas where smelting was done. The granulated slag (<3 mm size fraction) has both insulating and drainage properties which are usable to avoid ground frost in winter which in turn prevents pavement cracks. The usage of this scum reduces the usage of primary materials as well as reduces the construction depth which in turn reduces energy demand in building. Due to the same reasons the granulated scum is usable as a filler and insulating material in house foundations in a cold climate. Numerous houses in the same region are built with a scum insulated foundation.

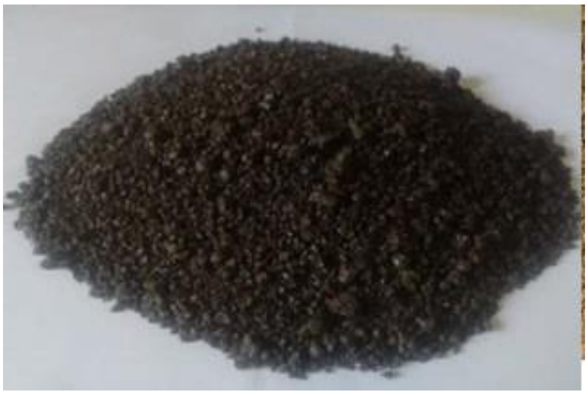


Fig 4 : Copper scum

F. Egg Shell Powder:-

- Eggshell consists of certain mutually growing layers of CaCO3, the deepest layer-maxillary 3 layer grows on the outlying egg membrane and creates the base on which palisade layer constitutes the thickest part of the eggshell. The top layer is a vertical layer capped by the organic cuticle.
- The Egg shell usually which are given, is used as an alternate for the cement since the shell is made up of Calcium. A combination of Egg shell with silica fumes are used in different combinations to find the feasibility of using the Egg shells as an alternate to cement Egg shell powder replaces 10%, 20% and 30% in addition with the silica fume by 5%, 10%, 15% of weight of cement. Concrete is solid and Compressive check, Tensile and Flexural tests were disbursed to search out the most effective combination which ends in optimum share of strength.
- In the present work, egg shells which was a residue material will be collected from bakeries, fast food restaurants and are sun dried. Stored egg shell will be powdered in flour mill. The grinded egg shells were sieved through the 90 micron sieve size and then packed to use it in the cement replacement.

Chemical Test Report on Egg Shell Powder Sample

Source of sample : Sample supplied by the customer
Customer's Reference : Letter No. NDRKIT/2019-20/909 Dated 10.03.2019
Period of test :15.03.2019 to 15.04.2019
Condition of sample :Satisfactory

Sr No	Parameter Tested	Results(% by mass)
01	Calcium Oxide(CaO)	52.15
02	Magnesium Oxide(MgO)	0.60
03	Silicon Dioxide(SiO_2)	1.22
04	Alumina(Al_2O_3)	0.28
05	Ferrie Oxide(Fe_2O_3)	0.16
06	Chloride(Cl)	0.011

Fig 5 : Egg Shell Powder

G. Water:-

- Generally potable water should be used. This is to ensure that the water is reasonable free from such impurities as suspended solids, organic matter and dissolved salts, which may adversely affect the properties of the concrete, especially the setting, hardening, strength, durability, pit value, etc.

IV. EXPERIMENTAL WORK

Mix Design:-

Mix design is the method of choosing appropriate ingredients of concrete and deciding their relative propositions with the item of manufacturing concrete of bound minimum strength and durability as economically as attainable. With the given materials, the four variable factors need to be considered in connection with specifying a concrete mix are:

1.Water –cement ratio.
2.Cement – aggregate ratio.
3.Gradation of the aggregates.
4.Consistency.

The various factors affecting the mix design are:

a) Compressive Strength:-

It is one among the foremost necessary properties of concrete and influences several different expressible properties of the hardened concrete. The mean Flexural Strength required at a specific age, usually 28 days, determines the nominal water-cement ratio of the mix. The other issue moving around the strength of concrete at a given age and cured at a prescribed temperature is the degree of compaction. According to Abraham's law the strength of absolutely compacted concrete is reciprocally proportional to the water-cement magnitude relation.

b) Workability:-

The degree of workability needed depends on 3 factors. These are the amount of reinforcement ,the size of the section to be concreted, , and the method of compaction to be used.

c) Maximum Nominal size of Aggregate:-

In general, larger the maximum size of aggregate, smaller is the cement requirement for a particular water-cement ratio, because the workability of concrete increases with increase in maximum size of the aggregate. However, the Flexural Strength tends to increase with the decrease in size of aggregate.IS 456:2000 and IS 1343:1980 recommend that the nominal size of the aggregate should be as large as possible.

d) Grading and Type of Aggregate:-

The grading of aggregate(mixture) influences the combo proportions for a specified workability and water-cement quantitative relation. Coarser the grading throw are going to be combine which might be used. Very lean combine is not fascinating since it does not contain enough finer material to create the concrete cohesive. The type of aggregate influences powerfully the aggregate-cement quantitative relation for the required workability and stipulated water cement quantitative relation. An important feature of a satisfactory aggregate is that the uniformity of the grading which might be achieved by combination completely different size fractions.

e) Quality Control:-

The degree of control can be estimated statistically by the variations in test results. The variation in strength results from the variations within the properties of the combination ingredients and lack of management of accuracy in batching, mixing, placing, curing and testing. The lower the distinction between the mean and minimum strengths of the combination lower are the cement-content needed. The issue dominant this distinction is termed as quality control.

M30 Mix design:-

Stipulation for proportioning:

a) Grade designation : M30

b) Type of cement : OPC 53 Grade conforming IS 12269

c) Maximum nominal size of aggregate : 20mm

d) Minimum cement content : 320 kg/m3 (IS 456:2000)

e) Maximum water-cement ratio : 0.45 (Table 5 of IS 456:2000)

f) Workability : 100-120mm slump

g) Exposure condition : Moderate (For RC)

h) Method of concrete placing : Pumping

j) Degree of supervision : Good

k)Type of aggregate : Crushed Angular Aggregates

m) Maximum cement content : 360 kg/m^3

n) Chemical admixture type : Super Plasticizer ECMAS HP 890

Test data for materials:

a) Cement used: OPC 53 Grade conforming IS 12269

b) Specific gravity of cement:3.15

c) Chemical admixture : Super Plasticizer conforming to IS 9103 (ECMAS HP 890)

d) Specific gravity of :

1) Coarse aggregate 20mm : 2.67

2) Fine aggregate : 2.65

3) GGBS : 2.84 (JSW)

e) Water absorption:

1) Coarse aggregate : 0.5 %

2) Fine aggregate (sand) : 2.5 %

f) Free (surface) moisture:

1)Coarse aggregate: Nil (Absorbed Moisture also Nil)

2) Fine aggregate : Nil

g) Sieve analysis:

1) Coarse aggregate: Conforming to all in aggregates of Table 2 of IS 383
2) Fine aggregate : Conforming to Grading Zone II of Table 4 of IS 383

Target strength for mix proportioning:

fck =fck + 1.65 s

where

fck = target average compressive strength at 28 days,
fck = characteristics compressive strength at 28 days, and
s = standard deviation.

From Table I of IS 10262:2009, Standard Deviation, s = 5 N/mm2. Therefore, target strength = 30 + 1.65 x 5 = 38.25 N/mm

Selection of water cement ratio :

Adopted maximum water-cement ratio = 0.44. From the Table 5 of IS 456 for Very severe Exposure maximum Water Cement Ratio is 0.45 0.44 < 0.45 Hence ok.

Selection of water content:

From Table 2 of IS 10262:2009, maximum water content for 20 mm aggregate = 186 litre (for 25 to 50 mm slump range)

Estimated water content for 100 mm slump = 186+ (6/186) = 197 litre.

(Note: If Super plasticizer is used, the water content can be reduced upto 20% and above.)

Based on trials with Super plasticizer water content reduction of 20% has been achieved, Hence the arrived water content = 197-[197 x (20/100)] = 158 litre.

Calculation of water content:

Adopted w/c Ratio = 0.44
Cement Content = 158/0.44 = 359 kg/m3
From Table 5 of IS 456, Minimum cement content for 'Moderate' exposure conditions 320kg/m3
= 359 kg/m3 > 340 kg/m3 hence ok.

Proportion Of Volume Of Coarse Aggregate And Fine Aggregate Content :

From Table 3 of (IS 10262:2009) Volume of coarse aggregate corresponding to 20 mm size aggregate and fine aggregate (Zone II) for water-cement ratio of 0.50 =0.62 .

In the present case water-cement ratio is 0.44. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As the water-cement ratio is lower by 0.06. The proportion of volume of coarse aggregate is increased by 0.02 (at the rate of -/+ 0.01 for every ± 0.05 change in water-cement ratio).

Therefore, corrected proportion of volume of coarse aggregate for the water-cement ratio of 0.44 = 0.64

NOTE – In case the coarse aggregate is not angular one, then also volume of coarse aggregate may be required to be increased suitably based on experience & Site conditions.

For pumpable concrete these values should be reduced up to 10%. Therefore, volume of coarse aggregate =0.64 x 0.9 =0.576.

Volume of fine aggregate content = 1 – 0.576= 0.424.

Mix calculations:

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 m^3
b) Volume of cement = [Mass of cement] / {[Specific Gravity of Cement] x 1000}
= 359/{3.15 x 1000}
= 0.114m^3
c) Volume of water = [Mass of water] / {[Specific Gravity of water] x 1000}
= 158/{1 x 1000}
= 0.158m^3
d) Volume of chemical admixture = 1.75 litres/ m^3 (By Trial and Error Method used 0.4% by the weight cement)
e) Volume of all in aggregate = [a-(b+c+d)]
= [1-(0.114+0.158+0.004)]
= 0.724m^3
f) Mass of coarse aggregate= e x Volume of Coarse Aggregate x Specific Gravity of Fine Aggregate x 1000
= 0.724x 0.576 x 2.67 x 1000
= 1113 kg/m^3
g) Mass of fine aggregate= e x Volume of Fine Aggregate x Specific Gravity of Fine Aggregate x 1000

= 0.724x 0.576x 2.60 x 1000
= 798 kg/m³

Mix proportions :
Cement = 288 kg/m3
GGBS = 72 kg/m3 (20% By Total weight of Cement)
Water = 158 l/m3
Fine aggregate = 798 kg/m3 Coarse aggregate 20mm = 882 kg/m3
12mm = 223 kg/m3 (20% By Total weight of Coarse Aggregate)
Chemical admixture = 1.34 kg/m3 (0.4% by the weight of cement)
Density of concrete = 2430 kg/m3
Water-cement ratio = 0.47
Mix Proportion By weight = 1:2.21:3.09

Mix design for M30 grade concrete:
1:1.58:2.23 at w/c 0.45

V. RESULT AND DISCUSSION

5.1 Cement

Sr No	Test	Result	IS code used	Acceptable limit
1	Standard consistency of cement	6mm at 35% w/c	IS:4031:1996	W/c 28% - 35%
2	Initial and final setting time	45 minutes and 10 hours	IS:4031:1988	Min 30 mins and should not exceed 10 hrs

5.2 Coarse Aggregate:-

Sr No	Test	Result	IS code used	Acceptable limit
1	Fineness modulus	6.5	IS:2386:1963	6.0 to 8.0 mm
2	Specific gravity	2.90	IS:2386:1963	2 to 3.1 mm
3	Bulk density	1.50 g/cc	IS:2386:1963	-
4	Aggregate impact value	37.5	IS:2386:1963	< 45 %
5	Aggregate crushing value	26.6%	IS:2386:1963	< 45%

5.3 Fine Aggregate:-

Sr No	Test	Result	IS code used	Acceptable limit
1	Fineness modulus	4.305	IS:2386:1963	Not more than 3.2 mm
2	Specific gravity	2.43	IS:2386:1963	2.0 to 3.1
3	Bulk density	1.5424	IS:2386:1963	-
4	Bulking of sand	3.0%	IS:2386:1963	< 10%

5.4 Concrete Tests:-

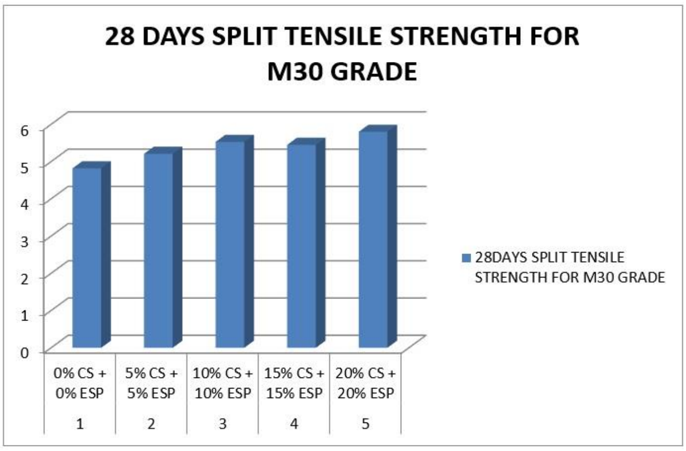
Fresh Concrete Tests Slump Cone Test:

S.NO	% REPLACEMENT	SLUMP OF M30 GRADE
1	0% CS + 0% ESP	0
2	5% CS + 5% ESP	25mm
3	10% CS + 10% ESP	25mm
4	15% CS + 15% ESP	35mm
5	20% CS + 20% ESP	50mm

5.5 Compaction Factor Test:-

S.NO	% REPLACEMENT	COMPACTION FACTOR FOR M30 GRADE
1	0% CS + 0% ESP	0.98
2	5% CS + 5% ESP	0.95
3	10% CS + 10% ESP	0.88
4	15% CS + 15% ESP	0.88
5	20% CS + 20% ESP	0.86

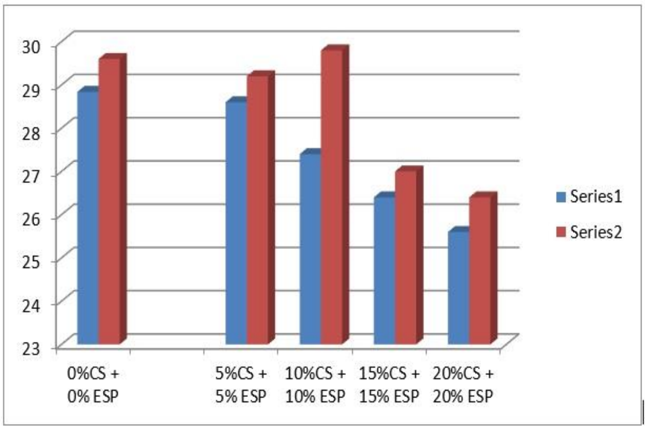
Graph : For M30 grade concrete:



5.6 Tests on Hardened Concrete Compressive Strength of Concrete:-

S.NO	% REPLACEMENT	COMPRESSIVE STRENGTH OF CONCRETE	
		M30 GRADE	
		7 DAYS	28 DAYS
1	0%CS + 0% ESP	28.84	29.60
2	5%CS + 5% ESP	28.60	29.20
3	10%CS + 10% ESP	27.40	29.80
4	15%CS + 15% ESP	26.40	27.00
5	20%CS + 20% ESP	25.60	26.40

Graph: Compressive strength for M30 grade concrete:

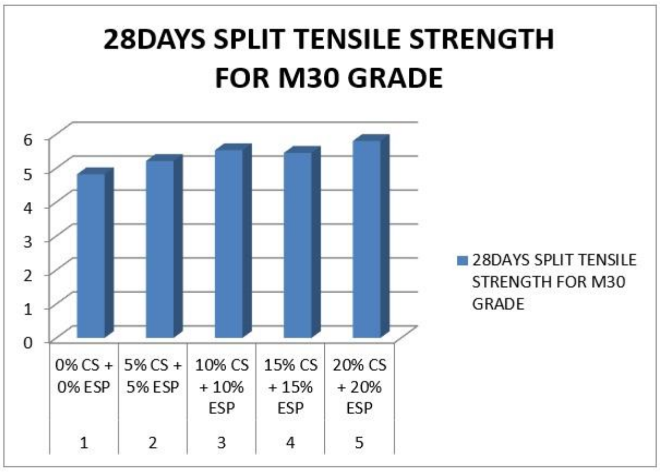


5.7 Split Tensile Test:-

Split Tensile Strength of Concrete

S.NO	%REPLACEMENT	28DAYS SPLIT TENSILE STRENGTH FOR M30 GRADE
1	0% CS + 0% ESP	4.82
2	5% CS + 5% ESP	5.21
3	10% CS + 10% ESP	5.53
4	15% CS + 15% ESP	5.45
5	20% CS + 20% ESP	5.80

Graph: Split tensile strength for M30 grade concrete



VI. CONCLUSION

1. The material properties of the cement , fine aggregates and coarse aggregates are within the acceptable limits as per IS code recommendations so we will use

materials for research.

2. Slump cone value for the copper slag and egg shell powder increases with increasing in the percentage of copper slag and egg shell powder so the concrete was not workable.
3. Compaction factor value of copper slag and egg shell powder decreases with increase in the percentage of both copper slag and egg shell powder.
4. The compressive strength of concrete is maximum at 10% replacement of copper slag and egg shell powder and is the optimum value for 7 days curing and 28 days curing.
5. The split tensile strength of concrete is maximum at 15% replacement of copper slag and egg shell powder for 28 days curing in M30 grade concrete and maximum at 10% replacement of copper slag and egg shell powder for 28 days curing.
6. So, the replacement of 10% to 20% of copper slag and egg shell powder is generally useful for better strength values in M30 grade of concrete.

VII.REFERENCES

[1] Brindha, D and Nagan, S (2010). "Utilization of copper slag as a partial replacement of fine aggregate". International Journal of Earth Sciences and Engineering,Vol.3, No.4, pp.579- 585

[2] Wei Wu, Weide Zhang, Guowei Ma "Optimum content of copper slag as a fine aggregate in high strength concrete" Materials and Design, Elsevier science Ltd, Vol. 31, 2010, pp. 2878– 2883.

[3] Pazhani K, Jeyaraj R, "Study on durability of high performance concrete with industrial wastes", Peer-reviewed & Open access journal, ATI- Applied Technologies & Innovations, Vol. 2, Issue 2, August 2010, pp. 19-28.

[4] Khalifa S Al-Jabri, Abdullah H Al-Saidy, Ramzi Taha, "Effect of copper slag as a fine aggregate on the properties of cement mortars and concrete", Construction and Building Materials,Vol. 25, 2011, pp. 933 – 938

[5] Mostafa Khanzadi, Ali Beholds(2009), " Mechanical properties of high strength concrete incorporating copper slag as coarse aggregate" , Construction and Building Materials 23 pp 2183–2189.

[6] Meenakshi Sudarvizhi, S. and Ilangovan, R. "Performance of copper slag and ferrous slag as partial replacement of sand in concrete", International Journal of Civil and Structural Engineering, Vol.1, No.4, 2011.

[7] Chavan, R.R. and Kulkarni, D.B. "Performance of copper slag on strength properties as partial replacement of fine aggregate in concrete mix design", International Journal of Advanced Research and Studies, Vol.2, No.4, pp.95-98, 2013.

[8] IS: 10262 – 2009, Concrete Mix Proportioning, Bureau of Indian Standards, New Delhi

[9] IS 516 (1959): Method of Tests for Strength of Concrete [CED 2: Cement and Concrete]

[10] IS 2386-1 (1963): Methods of Test for Aggregates for Concrete, Part I: Particle Size and Shape [CED 2: Cement and Concrete]

[11] IS 2386-3 (1963): Methods of test for aggregates for concrete, Part 3: Specific gravity, density, voids, absorption and bulking [CED 2: Cement and Concrete

[12] IS 4031-1 (1996): Methods of physical tests for hydraulic cement, Part 1: Determination of fineness by dry sieving [CED 2: Cement and Concrete]

[13] IS 4031-4 (1988): Methods of physical tests for hydraulic cement, Part 4: Determination of consistency of standard cement paste [CED 2: Civil Engineering]]

[14] IS 4031-5 (1988): Methods of physical tests for hydraulic cement, Part 5: Determination of initial and final setting times [CED 2: Civil Engineering]

[15] IS 4031-11 (1988): Methods of physical tests for hydraulic cement, Part 11: Determination of density [CED 2: Cement and Concrete

AUTHOR'S PROFILE:

Mr. MOHD IMRAN graduated from the Jawaharlal Nehru Technological University, Hyderabad. His special fields of interest include concrete technology and structures.

Mr. SYED SAAD ALI graduated from the Jawaharlal Nehru Technological University, Hyderabad. His special fields of interest include concrete technology and structures.

Mr. BODA VINOD graduated from the Jawaharlal Nehru Technological University, Hyderabad. His special fields of interest include concrete technology and structures.

Mr. RAMAVATH SANJEEV graduated from the Jawaharlal Nehru Technological University, Hyderabad. His special fields of interest include concrete technology and structures.

Mr. SHAIK ABDUL RASHEED graduated from the Jawaharlal Nehru Technological University, Hyderabad. His special fields of interest include concrete technology and structures.

MOHAMMED ISMAIL KHAN has been working as a Assistant Professor with teaching experience of 3 years in Lords Institute of Engineering and Technology. His special fields of interest include E-TABS and AUTOCAD.

Cite this article as : Mohd Imran, Syed Saad Ali, Boda Vinod, Ramavath Sanjeev, Shaik Abdul Rasheed, Mohammed Ismail Khan , "An Experimental Study on Properties of Strength of Concrete by Partial Replacement of Fine Aggregate with Copper Slag and Cement with Egg Shell Powder for M30 Grade Concrete", International Journal of Scientific Research in Science and Technology (IJSRST), Online ISSN : 2395-602X, Print ISSN : 2395-6011, Volume 6 Issue 3, pp. 43-52, May-June 2019. Journal URL : http://ijsrst.com/IJSRST19634