ISSN No:-2456-2165

Experimental Study on Concrete by Replacement of Fine Aggregate with Copper Slag, GGBS and M- Sand

[1]R.Anusuya, [2]D.Chandraleka, [3]S.Sarumathi, [4]G.Karthikeyan
[1,2,3]U.G student, [4]Assistant professor
Department of Civil Engineering
Ramco Institute of Technology, Rajapalayam, Tamil Nadu

Abstract:- Concrete is the most undisputable and indispensable material being used in infrastructure development throughout the world. Realization on the increasing demand for river sand supply in construction sector has inspired the current research to find alternative material to reduce the use of natural sand in concrete. Natural sand was partially replaced (0%-100%) with copper slag, GGBS and M-sand in concrete. Tensile strength, Compressive strength (cubes and cylinders) and Flexural strength up to 28 days and 7 days of age were compared with those of high performance concrete made with natural sand.

I. INTRODUCTION

Concrete is a widely used material in the world. Based on global usage it is placed at second position after water. Aggregates considered as one of the main constituent of concrete and occupy more than 70% of concrete mix. In which fine aggregate (sand) is about 35%of volume of concrete used in construction industry. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design.

Now a day's erosion of rivers and considering environmental issues, there is a scarcity of river sand. The non-availability or shortage of river sand will affect the construction industry; hence there is a need to find the new alternative material to replace the river sand, such that excess river erosion and harm to environment is prevented. Many researchers are finding different materials to replace sand. One of the major materials is copper slag (CS), GGBS (Ground Granulated Blast Furnace Slag) and M-sand (Manufactured sand). Using different proportion of these copper slag and GGBS along with sand the required concrete mix can be obtained.

One of the main objectives of this project is to determine the concrete strength of M30 Grade by partial replacement of sand by copper slag and GGBS. The concrete cubes were cast for different replacement level at an interval of 20 percent to determine compressive strength of concrete at different level of fine aggregate with copper slag, GGBS and M-sand.

II. PROPERTIES OF MATERIALS

A. Cement

A powdery substance made by calcining lime and clay mixed with water to form mortar or mixed with sand, gravel and water to make concrete. it is a binder, a substance that sets and hardens independently, and can bind other materials together.

S. No	Parameter	Test results
1	Type	PPC
2	Consistency	36%
3	Initial setting time	30mins
4	Final setting time	10hours

B. Aggregates

The relevant tests are to identify the properties of the aggregates that were intended to be used in this research were carried out. After that, corrective measures were taken in advance before proceeding to the mix proportioning. In general, aggregates should be hard and strong, free of undesirable impurities, and chemically stable. If these materials coat the surfaces of the aggregate, they will isolate the aggregate particles from the surrounding concrete, causing a reduction in strength.

- *M-sand*

Fine aggregate normally consists manufactured sand. The Manufactured Sand (MS) is a by-product of the crushing and screening process in the quarries. Quarry generates considerable volumes of quarry fines while crushing the rock into aggregates. It is also referred to as crushed rock sand, stone sand, crusher sand and crushed fine aggregate.

S.No	Parameter	Test results
1	Specific gravity	2.94
2	Fineness modulus	3.83%
3	Water absorption	0.74%

- *Coarse aggregate*

As coarse aggregates in concrete occupy 35 to 70% of the volume of the concrete. Gravel or crushed stone used as

ISSN No:-2456-2165

a coarse aggregate. Particle sizes larger than 4.75mm.Coarse Aggregate can come from several sources. Each of these sources can produce satisfactory aggregates depending on the intended use. Each parent material has advantages and disadvantages associated with it.

S.No	Parameter	Test results
1	Specific gravity	2.85
2	Fineness modulus	7.93%
3	Water absorption	0.5%

- *Copper slag*

Copper slag is considered as one of the waste materials which can have a promising future in construction industry as partial or full substitute of fine aggregates. For each ton of copper production, about 2.2 tons of copper slag is generated. The chemical traces such as copper, sulphate and alumina present in the slag are not harmful.

S.No	Parameter	Test results
1	Specific gravity	4.06
2	Fineness modulus	3.44%
3	Water absorption	0.35%

- *GGBS*

Ground granulated blast furnace slag (GGBS) is a by-product from the blast furnaces used to make iron. In India we produce 7.8 million tons of blast furnace slag. The temperature is about 1500 degrees centigrade can operated and fed with the mixture of iron ore, coke and limestone in careful manner.

And tapping off the slag in periodically as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The quenching optimizes that the cementations properties and produces granules similar to coarse sand. Then dried the granulated slag and make it to fine powder.

S.No	Parameter	Test results
1	Specific gravity	2.85
2	Fineness modulus	3.18%
3	Water absorption	0.25%

C. Water

The quality of water plays a significant role in concrete production. Impurities in water may interfere with the setting of the cement, may adversely affect the strength of the concrete or cause staining of its surface, and may also lead to corrosion of the reinforcement.

III. MIX DESIGN

In this study, mix of concrete grade (M30) were produced with partial replacements of the fine aggregate by 0%,20%,40%,60%,80% and 100% of the CS, GGBS and M-sand. Moreover, a control mix with no replacement of the fine aggregate was produced to make a comparative analysis. The mix design process adopted was the Indian Standard Method. However, a certain amount of the fine aggregate was replaced by an equal volume of CS, GGBS and M-sand. Mix design for M30 (The mix design proportion is1:1.58:2.7:0.45) as per IS-10262-2009and IS: 456 – 2000. The main reason for selecting this concrete grades is that these are by far the most commonly used concrete grades for most of the concrete construction works and hence application of the research can be more feasible .

IV. REPLACEMENT PROPORTIONS

S.No	Replacement proportion	Mix designation
1	0%CS+0%GGBS+100%M-sand	M0
2	10%CS+10%GGBS+80%M-sand	M1
3	20%CS+20%GGBS+60%M-sand	M2
4	30%CS+30%GGBS+40%M-sand	M3
5	40%CS+40%GGBS+20%M-sand	M4
6	50%CS+50%GGBS+0%M-sand	M5

V. EXPERIMENTAL INVESTIGATION

A. Compressive Strength

The cube specimens were tested in the compression testing machine with the capacity of 200 tonnes. The upper / bearing surface of the machine is cleaned and kept free from the other loose particles and the; load is applied constantly at increased rate until the specimen got broken. The 28 days strength of cubes with various proportions is compared below.

Cube of size 150 mm X 150mm X 150mm concrete specimens were casting**.**

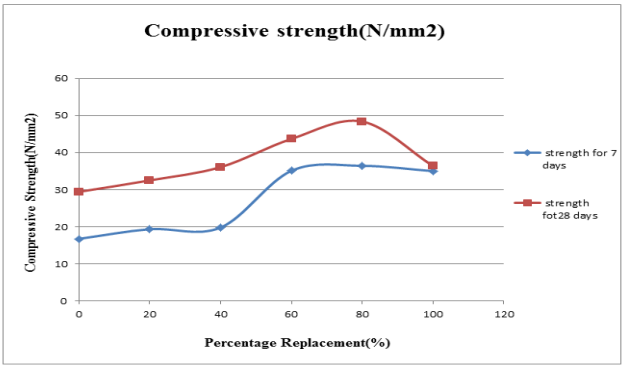

Fig 1:- Compressive strength

B. Spilt Tensile Strength

Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 100mm x 200 mm were casting using M50 grade concrete. Specimens with Nominal concrete and glass powder concrete (glass powder is partially replaced with Natural sand) were casted. During moulding, the cylinders were manually compacted using tamping rods. After 24 hours, the specimens were removed from the mould and subjected to water curing for 28 days. After curing, the specimens were tested for compressive strength using a calibrated compression testing machine.

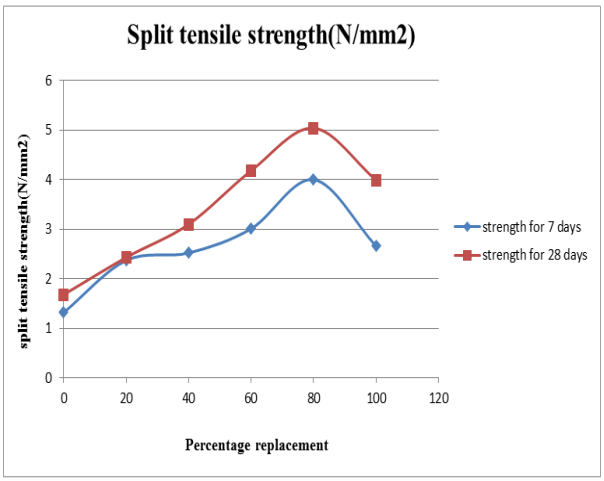

Fig 2:- split tensile strength

C. Flexural Strength

Flexural strength is the one of the measure of tensile strength of concrete. It is the ability of a beam to resist failure in bending. The beam specimens were tested in the universal resting machine to obtain the flexural strength of the beam. The beam specimens were tested in the universal resting machine to obtain the flexural strength of the beam is compared below.

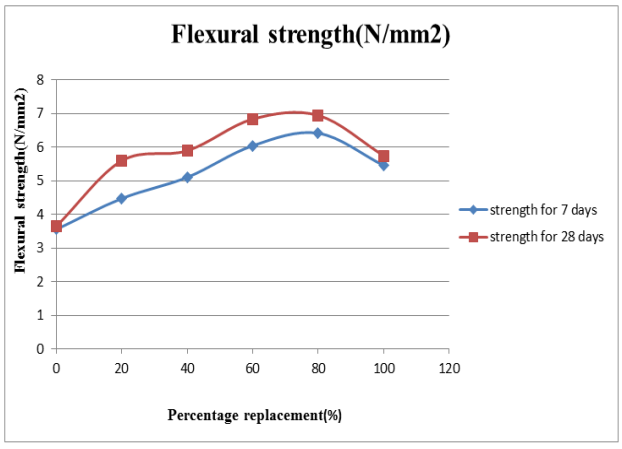

Fig 3:- Flexural strength

VI. DISCUSSION

Based on the results of the experimental investigation on concrete made with CS, GGBS and M-sand, the reason for the variation observed is summarized as follows.

- The compressive strength of concrete with CS, GGBS and M-sand is more than the conventional concrete.
- Split tensile strength of concrete increases forces and GGBS. The reason for variation is the shape and texture of CS and GGBS.
- Flexural strength (modulus of rupture) of concrete increase. The reasons for variation are the shape and texture of the CS and GGBS.

VII. CONCLUSION

From this experimental study following points can be drawn: After testing of 5 blended cement samples (0% to 100 % replacement of fine aggregate by CS, GGBS and M-sand) with an increment of 20 %, it can be said that the optimum use of alternate material is 80% as a partial replacement of fine aggregate by CS, GGBS and M-sand.

In the production of HSC, industrial wastes played a predominant role in replacement of fine aggregates. For sand replacement, CS and GGBS was satisfied strength factor.

VIII. ACKNOWLEDGMENT

I have taken efforts in this project. However, it would not have been possible without the kind support and help of many individuals and organizations. I would like to extend my sincere thanks to all of them. I am highly indebted to Mr.G.Karthikeyan, Assistant Professor, Ramco Institute of Technology, for his guidance and constant supervision as well as for providing necessary information regarding the project & also for his support in completing the project.

REFERENCES

[1]. M. V. Patil, Y. D. Patil, G. R. Veshmawala"Performance of Copper Slag as Sand Replacement in Concrete", International Journal of Applied Engineering Research ISSN 0973-4562 Volume 11, Number 6 (2016) pp 4349-4353.

[2]. MeenakshiSudarvizhi. S, Ilangovan. R, Ilangovan "Performance of Copper slag and ferrous slag as partial replacement of Sand in Concrete" International Journal of Civil and Structural Engineering Volume 1, No 4, 2011 ISSN 0976 – 4399.

[3]. Jyoti R .Mali, PiyushBagual, YogeshBiyani, Pradippandhare, HemnantBafna, Mandar Joshi "Partial Replacement of Fine Aggregate with GGBS" Advance Research Ideas and Innovations in Technology ISSN: 2454-132X Impact factor: 4.295 (Volume3, Issue2).

[4]. V.V.Venkataramareddy "suitability of manufactured sand (M-sand) as fine aggregate in mortars and concrete" (CSIC project sponsored by Department of Mines and Geology) CP 6597/0505/11-330
[5]. Gulden Cagin Ulubeylia, RecepArtir "Sustainability for Blast Furnace Slag: Use of Some Construction Wastes" Procedia - Social and Behavioral Sciences 195 (2015) 2191 – 2198.
[6]. IS 456- 2000 "Plain and Reinforced Concrete -Code of Practice" Bureau of Indian Standards, New Delhi, India.
[7]. IS 516- 1959 "Methods of Tests for Strength of Concrete "Bureau of Indian Standards, New Delhi, India.[12] IS 516- 1999 "Splitting Tensile Strength of Concrete, Flexural strength of concrete -Method of Test" Bureau of Indian Standards, New Delhi, India.[13] IS 10262- 2009 "Recommended Guidelines for Concrete Mix Design" Bureau of Indian Standards, New Delhi, India.