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Behavior of Concrete with GGBS-Cement and Human Hair Fine Aggregates Substitutions

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Abstract - The present study aims at exploring the effect of Human hair and GGBS re- placements on different properties of concrete and finding the efficient and alternate way for disposing the solid wastes to reduce the pollution generated from these wastes. The research focuses on both structural as well environ- mental implications of both human hair and GGBS. The different specimens consisting of both GGBS and human hair were casted and tested on CTM. The results of control specimens were also determined and comparisons of different samples have been illustrated in both graphical as well as in tabular form. From research findings it has been found that there is improvement in strength parameters of concrete with the incorporation of human hair along with GGBS. Strictly from the research it is observed that the maximum strength derived is at 1% human hair and 20% GGBS replacements. With the addition of both waste materials there is reduction in dead load of the structure thus this exploration would turn out to be quite useful for those structures where emphasis is on using lightweight materials.

Key Words: Concrete, GGBS, Human Hair, Waste etc.

1. INTRODUCTION

In this present era there is huge necessity of fast and economic construction thus in order to achieve that various construction companies are incorporating admixtures into their into their construction process. One among them is the specific use of ground granulated blast furnace slag (GGBS) and human hair fiber which are both solid waste materials generated from industries and from human beings respectively. Concrete is used everywhere around the world to make the dream come true as the visualizing design adapted. Concrete is solid block made out of cement, water and aggregates. In real terms aggregates doesn't play the crucial role of binding but it's the filler material which are added that reduces voids in the dense matrix. Binding but it's the filler material which is added that reduces voids in the dense matrix. Concrete is used to construct various elements like beams, slabs, domes, foundations and columns so concrete quality and economy is a must in this specified elements. Utilizing waste materials is really a benefit as it will help in huge decline in level of environmental deterioration but also parallel extraction of natural vital resources like fine aggregates, cement is also reduced. Concrete is very weak in tension and also has less tensile strength. So there is good chance of formation of micro-cracks may later propagate to larger area thus causing a brittle failure. Incorporating hair fibre in concrete can prove a wise move as hairs are good crack arresters hence it will increase the tensile strength of con- Crete. Addition of hair fibres can help in reducing permeability and also help in controlling plastic shrinkage of concrete. Hence hair fibres in concrete will make concrete more homogeneous and isotropic in existence. GGBS which is ground granulated blast furnace slag is a waste material derived from manufacturing industries. India which is hugely populated where infrastructure development is heading at a faster pace in which cement is enormously consumed which is directly causing pollution in the environment. Hence partially substituting cement with GGBS will help in keeping a check on environmental degradation. Replacing GGBS with ordinary Portland cement will help in elevating the strength properties of concrete.

2. Material and Method:-

2.1. Test on Cement:-

The test on cement was carried for finding out its var- ious physical properties using the following codes [IS 4031(part 3),IS 4031(part 4), IS 4031(part 5), IS 2720(part 3)]. The properties are given in table

Table 1 Result of Cement

Sr. No	Result of cement	Result Value
1	Fineness (%)	1.32
2	Consistency (%)	32
3	Specific Gravity	3.17
4	Soundness (cm)	0.28
5	Initial setting time(minute)	30
6	Final setting time(Hr.)	8.6

2.2. Test on fine Aggregate:

The physical properties of fine aggregates were found out by conducting various tests on sand Arivalagan (2014). The properties are given in table 2.

Table 2 Result of Fine Aggregate

Sr. No	Result if F.A.	Result Values
1	Fineness modulus	2.21
2	Specific gravity	2.72

2.3 Test on coarse aggregate (C.A.):- The test on coarse aggregates has been carried out to find out the values of all the physical Properties of 20mm and 10mm aggregates by following codes [IS 12386 (part3)].

Table 3 Result of Coarse Aggregate

Sr. No	Result if F.A.	Result Values
1	Specific gravity	2.67
2	Water absorption	0.15

2.4. Ground granulated blast furnace slag (GGBS):-

It is a waste material that is obtained as a by-product of iron manufacturing industries when iron is hugely 1500 degrees and the melted liquid generates powder that is later called as GGBS.

Table 4 Properties of GGBS

Sr. No.	Properties of GGBS	Observed value
1	Color	Off white
2	Specific gravity	2.72
3	Bulk density	1179
4	Silicon dioxide	38
5	Calcium dioxide	49

2.5. Human Hair: The natural fibre in the form of human hair is an excellent partial substitute material for fine aggregate as shown in figure 2.The very important and vital composition of human hair is keratin. Due to the presence of keratin which are proteins which tie up with the long chains of amino acids thereby creating an outer shell for the hair fibre. The hair fibres could arrest the microscopic cracks thereby preventing further elongation of cracks.

Table 5 Properties of Human hair

Sr. No	Properties of human Hair	Observed Values
1	Length (cm)	5
2	Diameter (micron)	100 to 110
3	Aspect ratio	454 to 500
4	Optimum hair replacement with sand (%)	1

Figure:-

Fig.1 (GGBS)

Fig.1 (Human Gair)

3. Results and discussion

3.1. Compressive Strength:- From the table 6 it can observe that for M20 grade of concrete with 15% and 20% GGBS replacement the compressive strength has increased by 6.62% and 7.56% respectively for 28days of curing. Again M25 grade with 15% and 20% GGBS replacement the compressive strength got increased by 7.03% and 8.15% respectively for 28 days of curing.

Table 6 Compressive strength

Grade	M_{20}			M_{25}		
Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
Control mix	17.62	21.6	24.42	21.17	26.04	29.2
1% Human hair + 15% GGBS	18.06	21.85	26.22	21.88	26.56	31.76
1% Human hair + 20% GGBS	20.16	22.29	26.72	22.16	27.23	31.69

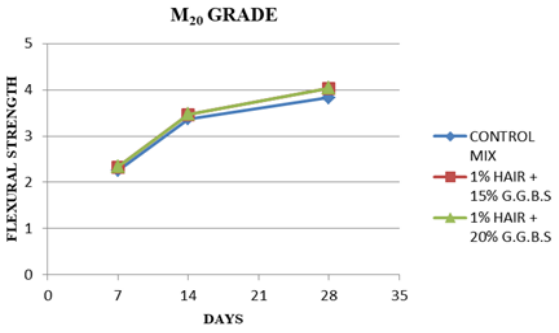

Fig. 3 CS vs DAYS

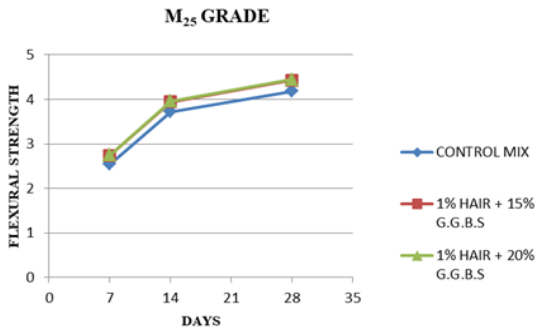

Fig. 4 CS vs DAYS

From the above both figure 3 & 4 it can be concluded that for M20 and as well as M25 grade by replacing GGBS and human hair in concrete there is an elevation in the compressive strength of concrete when compared to control mix.

3.2. Flexural Strength: From the table 7 we can observe that for M20 grade of concrete with 15% and 20% GGBS replacement the flexural strength has increased by 4.96% and 5.19% respectively for 28days of curing. Again M25 grade with 15% and 20% GGBS replacement the flexural strength got in- creased by 5.64% and 6.06% respectively for 28days of curing.

Table 7 Flexural strength

Grade	M_{20}			M_{25}		
Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
Control mix	2.36	3.47	3.73	2.74	3.92	4.38
1% Human hair + 15% GGBS	2.43	3.56	4.13	2.64	3.84	4.33
1% Human hair + 20% GGBS	2.44	3.57	4.14	2.65	3.86	4.35

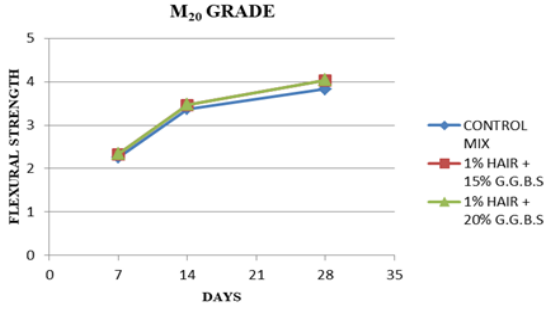

Fig. 5 CS vs DAYS

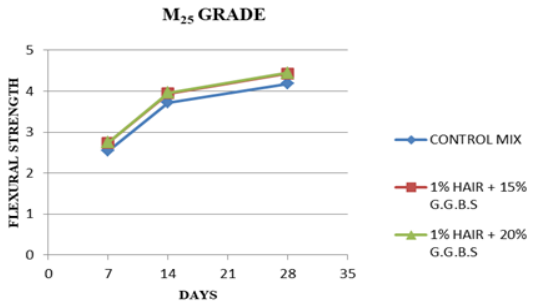

Fig. 6 CS vs DAYS

3.3. Split Tensile Strength: From the above table 8 we can observe that for M20 grade of concrete with 15% and 20% GGBS replacement the split tensile strength has increased by 2.84% and 3.58% respectively for 28days of curing. Again M25 grade with 15% and 20% GGBS replacement the split tensile strength got increased by 2.93% and 4.33% respectively for 28days of curing.

Table 8 Flexural strength

Grade	M_{20}			M_{25}		
Days	7 Days	14 Days	28 Days	7 Days	14 Days	28 Days
Control mix	2.31	3.48	3.66	2.56	3.43	3.87
1% Human hair + 15% GGBS	2.41	3.42	3.77	2.64	3.66	3.89
1% Human hair + 20% GGBS	2.43	3.44	3.80	2.68	3.71	3.95

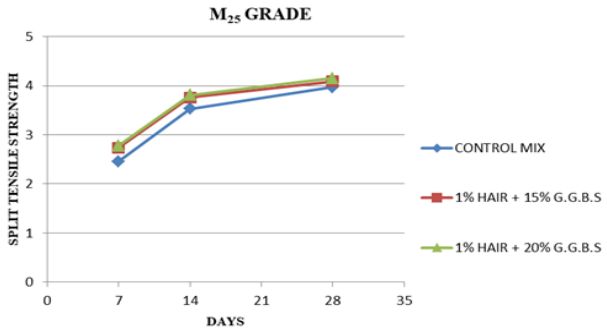

Fig. 7 CS vs DAYS

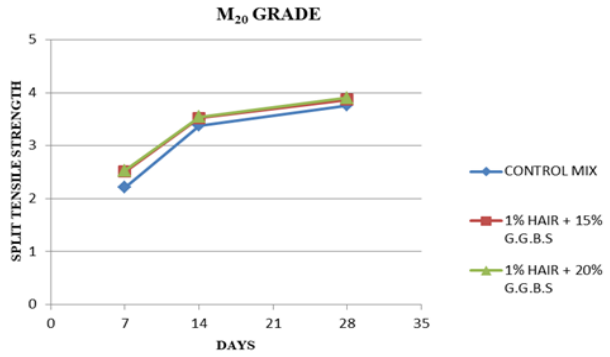

Fig. 8 CS vs DAYS

4. Conclusions

Incorporating of human hair fibres in the concrete makes the concrete lighter in weight. On addition of hair fibre in combination with GGBS in concrete, dead load gets decreased thereby reducing the deflections caused in heavy structures under their own weight. The optimum percentage of replacement of human hair is found as 1% beyond which the strength starts dropping. For M20 and M25 grade of concrete it is found that there is 7.56% and 8.15% hike in compressive strength for 20% GGBS and 1% human hair replacement. When the percentage of replacement of GGBS is beyond 20% there is serious decline in the compressive strength. Also the flexural strength is observed to elevate by 5.19% for M20 and a increase of 6.06 % for M25 when 20%GGBS and 1% human hair replacement is performed as compared to control mix. For split tensile strength it is finally concluded that for M20 grade with 20% GGBS and 1% human hair replacement there is 3.58% increase in strength and for M25 grade a 4.33% hike in strength as compared to control mix for 28days of curing.

As economy is moving at a faster pace, infrastructure development is catching its place therefore such alternate reuse of disposed waste materials in concrete proves to be the most ecofriendly and efficient way from both environmental point of view as well as taking engineering aspects into consideration.

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