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Experimental Study on Concrete by Partial Replacement of Cement with Human Hair, Glass Fiber and Course Aggregate with Plastic Chips

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Abstract - *Concrete is a very hard composite construction material made by mixing together cement, fine aggregate, coarse aggregate and water. Concrete is the most popular construction material on earth. In this research work, M-25 grade of concrete is used for determine the compressive strength, flexural strength and split tensile strength is development of concrete mixes with human hair fiber in different proportions (0%, 2% and 2.5%), glass fiber (0%, .2%, .3%, .4%) and plastic chips (0% and 20%) at curing ages of 7days and 28 days. After certain percentage, the addition of human hair fiber is increases compressive strength will be decreases. It is observed that the addition of human hair in the mix, led to reduction in the bleeding of concrete, but it is good material to replace in producing high performance concrete. With the increase in %age of human hair in the concrete mix gets harsher and less workable. The result shows that the addition of human hair enhances the binding properties; micro cracks control, imparts ductility and also increases the spelling resistance. Overall, the experimental findings would motivate more research in this direction for long-term performance to extend the usage of this cost- effective type of fiber in structural applications.*

Key Words: **Human hair fiber reinforced concrete (HHFRC), Concrete, Compressive Strength, Flexural Strength, Split Tensile Strength and workability.**

1.INTRODUCTION

Concrete is a widely used material in the building industry, and it is made up of three major ingredients: cement, sand, coarse aggregate, and water. Hydration is the active process that occurs when cement reacts with water. Calcium silicate hydrates (CSH), calcium hydroxide, and calcium hydroxide and calcium aluminates hydrates are generated during the hydration process. It has a stronger compressive strength than tensile strength. Fibers are used to reinforce such weaknesses as tensile strength in construction materials like concrete. Fiber is a small piece of reinforcing material with unique qualities. Horsehair has traditionally been used as a fiber in mortar and straw in mud bricks. Asbestos fibers were employed in concrete in the early 1900s, and the notion of composite materials emerged in the 1950s, with fiber reinforced concrete being one of the themes of attention.

Since the introduction of fiber reinforcing concrete in the 1940s, extensive testing has been carried out on numerous fibrous materials to discover the true qualities and advantages of each concrete product. Joseph Monier, a French gardener, devised fiber reinforced concrete in 1849 and patented it in 1867. Addition Concrete fibers are commonly utilized to prevent plastic and dry shrinkage cracking.

1.1 LITERATURE REVIEW

Yang Yu et al. (2016) - Studied that the effect of strain rate, relative humidity and temperature are evaluated. Hair exhibits a high tensile strength that is 150-270 MPa, which is significantly dependent on strain rate and humidity. Strain rate sensitivity, approximately 0.06-0.1, is comparable to that of other keratinous materials and common synthetic polymer, the structure of the internal cortex and surface cuticle is affected by the large tensile extension.

S. Aishwarya et al. (2017) - The objective of this project work is to compare the strength characteristics of M-20 grade hair fibre reinforced concrete with conventional concrete. It was found that M-20 grade concrete with 2% human hair fibre shows an increase in compressive strength of 8.69% and 8.27% at curing periods of 7 days & 28 days respectively when it compared with the plain cement concrete. Thus, use of human hair in concrete will also reduce the land pollution apart from being an alternate building material. It is a better way to use human hair which otherwise is an unutilized waste material. There is an increment in the strength of concrete by the addition of human hair as fibre reinforcement which makes it suitable for alternative additive in concrete for enhance its mechanical properties.

Ragul et al. (2018) - This work aims to making use of this non-degradable material for increasing the strength of recycled plastic. Human hairfibre is used as a reinforcement in high density polyethylene forming a polymer matrix composite, composite sample were made using 3%, 5%& 10% of human hair by weight and then the mechanical properties of them were evaluated.

Adhul Prakash et al. (2019)-This paper compares the strength and durability of ordinary concrete with hair fibre reinforced concrete of M-20 grade with 0%, 0.5%, 1%, 1.5%, 2% addition of hair by weight of cement. Experimental findings in overall studies would encourage further research

in that direction for long term performance to extending this cost-effective type of fibres for use in structural application. Strength and durability tests were conducted on hair fibre reinforced concrete and the results shows that there is an increase in compressive strength by 12% and 22% increase in flexural strength on addition of 1% hair fibre by weight of cement.

Jamil Matarul et al. (2019) -In this study Human Hair Fibre (HHF) is used as the admixture in concrete mix design to reinforce the concrete. With one of the characteristics of (HHF) as strong in tension, its potential to become alternative concrete reinforcement is significant. Experiments were conducted on concrete beams with the addition of different percentage of human hair fibre that is 0%, 0.5%, 1.0%, 1.5% & 2.0% by weight of concrete. Flexural strength is investigated. From the testing it is found that there is an increment of flexural strength up to 24% of the concrete with the addition of 2.0% (HHF) as fibre reinforcement.

A. Muralidharanet al. (2020) -Present studies has been undertaken to study the effect of human hair on plain cement concrete on the basis of its compressive, crushing, flexural strength and cracking control to economics concrete and to reduce environmental problems. Basically, most of cement-based mixtures are likely shrinkage. Experiments were conducted on concrete beams and cubes with various percentages of human hair fibre i.e., 0%, 1% & 2% by weight of cement and the length of the fibres in each case varied between 15 and 60mm.

1.2 MATERIALS USED

Cement: Ordinary Portland Cement is the type of cement employed in this study.

Fig. 1 Cement

Ordinary Portland cement is a bonding material with cohesive and adhesive qualities that allows it to connect together various construction materials and compacted assemblies. It has a minimum initial setting time of 30 minutes and a maximum setting time of 10 hours.

Fine Aggregate: Aggregates are those materials, which when bounded together by cement, from mortar or concrete. Fine aggregates passing through 4.75 mm sieve were obtained from locally available river. Aggregate provides better durability & greater volume stability to concrete. Fine aggregate fills up the voids in coarse aggregates & thus strong concrete with less quantity of cement is obtained by using fine aggregate.

Fig. 2 Fine Aggregate

Coarse Aggregate: Locally available coarse aggregate were used. Tests such as the specific gravity, fineness modulus sieve analysis were conducted to find the physical properties of coarse aggregate according to IS: 383-1970.

Fig. 3 coarse aggregate

Human Hair Fiber: Fibers human hair is extremely strong, light weight and robust material. Human hair fiber also provides thermal insulation and reinforcement in concrete structure. Human hair fiber can be flattened into a sheet or

Fig. 4 Human hair fiber

woven into a fabric. The effects are studied by varying the human hair fiber content from 0% and 2%.

Glass Fiber: Glass fiber consists of extremely fine fibers of glass that consists of fusion of calcium, aluminum and alkali metals. They are available in the forms of roving, woven roving's and chopped strands mats. The effects are studied by varying the glass fiber content from 0%, .2%, .3% and .4% Glass fiber used in composites offer a wide mix of mechanical, thermal, chemical, optical and electrical characteristics and that is unaffected by water and other reactive liquids.

Fig. 5 Glass fiber

Plastic Chips: Plastic chips were used to replace coarse aggregate for making concrete. Research work consist of casting cubes, cylinders and beams to study the effects of plastic chips on the compressive strength, split tensile strength and flexural strength of concrete. The effects are studied by varying the plastic chips content from 0% and 20%.

Water: Portable water was used in this investigation according to Indian standard code, IS 456-2000. Because it actively participates in the chemical reaction with cement, water is a significant component of concrete. It is the last expensive ingredient of concrete mix. Water should be free of alkalis, acids, oils, salts, sugar, organic materials, plant growth, and other things that could harm bricks, stone, concrete, or steel.

Fig.6 Mixing Of Concrete

2. RESULTS AND DISCUSSIONS

The concrete mix were designed for M-25 grade with constant water cement ratio of 0.475respectively as per the IS code 10262-2009. The concrete mixes with the same water cement ratio were prepared fresh and hardened properties like compressive strength, split tensile strength and flexural strength at 7 days and 28 days were studied.

2.1 METHODOLOGY

Table 2.1: Methodology for proposed work

S.No.	Designation	cement %	Fine Agg. (%)	Coarse Agg. (%)	W/C	Human Hair (%)	Glass Fiber (%)	Plastic Chips (%)
1	M0	100	100	100	0.475	0	0	0
2	M1	97.8	100	80	0.475	2	0.2	20
3	M2	97.7	100	80	0.475	2	0.2	20
4	M3	97.6	100	80	0.475	2	0.2	20
5	M4	97.3	100	80	0.475	2.5	0.2	20
6	M5	97.2	100	80	0.475	2.5	0.2	20
7	M6	97.1	100	80	0.475	2.5	0.2	20

Table 2.2: Compressive Strength of Concrete after 7 days & 28 days

S.No	Designation	Compressive Strength in 7 days N/mm2	Compressive Strength in 28 days in N/mm2
1	M0	22.7	33.53
2	M1	23.27	34.5
3	M2	23.14	34.63
4	M3	22.82	33.8
5	M4	22.69	32.14
6	M5	22.59	33.23
7	M6	21.76	32.41

Compressive strength of concrete mix was tested at the ages of 7 days and 28 days by using CTM (Compressive Testing Machine). Table 1.1 shows 7 days & 28 days compressive strength of concrete with 20mm are maximum size of aggregate & 10mm are minimum size of aggregate with water cement ratio 0.475 are used.

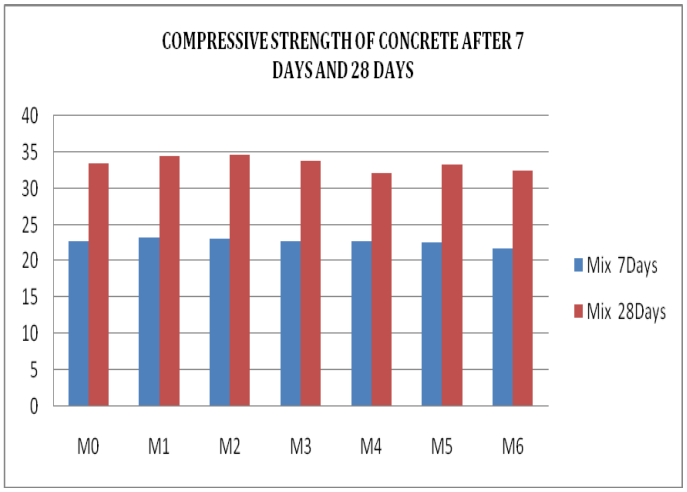

Chart 2.1: Bar Chart Of Compression Strength Of Concrete

Table 2.3: Average Split Tensile Strength In Concrete After 7 Days& 28 Days

S. No	Designation	Average Split Tensile Strength after 7 days	Average Split Tensile Strength after 28 days
1.	M0	2.05	3.08
2.	M1	2.24	3.32
3.	M2	2.23	3.44
4.	M3	2.08	3.31
5.	M4	1.79	3.08
6.	M5	2.27	3.25
7.	M6	2.02	3.06

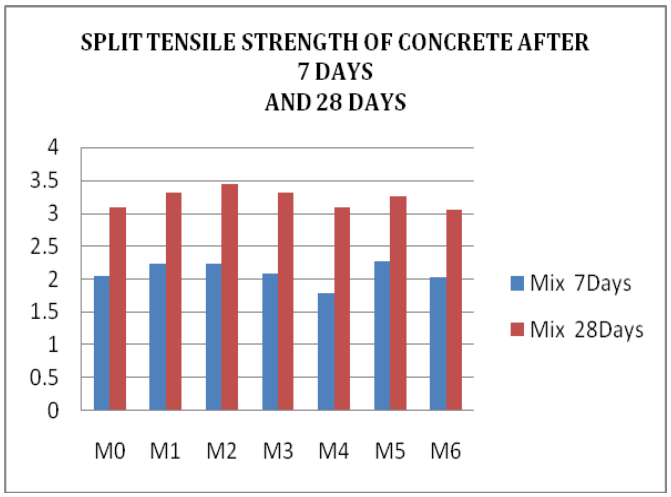

Chart 2.2: Bar Chart Of Split Tensile Strength Of Concrete

The split tensile strength of concrete was tested at the ages of 7 days and 28 days by using compression testing machine. The size of the cylinders was 150x300mm. The split tensile strength of the concrete with human hairs increases. Table 2.3 shows 7days and 28 days split tensile strength.

Table 2.4: Average Flexural Strength in Concrete after 7 days & 28 days (N/mm^2)

S.No	Designation	Flexural Strength after 7 days N/mm2	Flexural Strength after 28 days N/mm2
1	M0	2.35	3.46
2	M1	2.45	3.52
3	M2	2.59	3.59
4	M3	2.41	3.46
5	M4	2.22	3.36
6	M5	2.55	3.56
7	M6	2.22	3.26

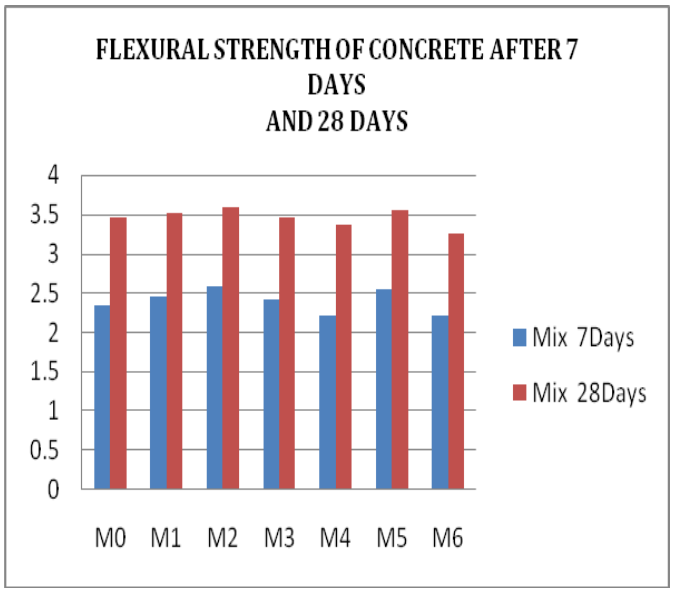

Chart 2.3: Bar Chart Of Flexural Strength Of Concrete

The flexural strength of concrete mix was measured at ages of 7 days & 28 days by using flexural testing machine. The size of beam was (150mmx150mmx750mm). The flexural strength was found to increase for all mixes at all days in comparison to control mix without any additive. Table 2.4 shows 7 day and 28 days flexural strength of concrete mix.

3. CONCLUSIONS

1. Strength and durability test were conducted on hair fiber reinforced concrete and the results show that there is a 3.59 increase in flexural strength on addition of 2% (M25) hair fiber by weight of cement.

2. Strength and durability test were conducted on hair fiber reinforced concrete and the results shown that there is a 3.44 increase in split tensile strength on addition of 2% (M25) hair fiber by weight of cement.

3. Strength and durability test were conducted on hair fiber reinforced concrete and the results shown that there is a 34.63 increase in compressive strength on addition of 2% (M25) hair fiber by weight of cement.

4. Addition of 2% Hair and 0.3% glass fiber by weight of cement and 20% plastic chips by weight of course aggregate shows better results in strength as compared to other percentage.

5. Hair is used as an accumulative in various percentages by weight of cement

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