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Experimental Investigation of Sand Replacement by Foundry Sand and Adding Human Hair Fibre on Concrete

S.Navothana priyadharsini[1], M.Ajith kumar[2], S.Ananth[3], B.Guruselvan[4], M.Mani varma[5]

[1]*Assistant professor, Department of Civil Engineering, Sri Vidya College of Engineering and Technology, Virudhunagar, Tamilnadu, India*
[2,3,4,5] *Student, Department of Civil Engineering, Sri Vidya College of Engineering and Technology, Virudhunagar, Tamilnadu, India*

Abstract - *Now a days good quality natural river sand is not readily available; it is to be transported from a long distance. These resources are also exhausting very rapidly. So there is an urge to find some alternative to natural river sand. This paper demonstrates the use of waste foundry sand (WFS) as a partial replacement by fine aggregate and adding human hair fibre in concrete. Fibre reinforced concrete provides good flexural strength with less crack developments. So an attempt has been made to achieve improved strength results using hair as fibre in conventional concrete. Human hair is strong in tension, non-degradable and is available in abundance. This paper has confirmed the effect of human hair on concrete in compressive strength and split tensile strength with 30% WFS by weight of fine aggregate. Experimental were conducted on concrete cubes & cylinders at the age of 7 days & 28 days with different percentages of hair fibre as 0%, 2.5%, 5%, 7.5% by weight of cement and compared with that of conventional concrete.*

***Key Words*: Foundry sand, Human hair fibre, Fibre reinforced concrete, Compressive strength, Split tensile strength**

1.INTRODUCTION

Concrete is the most widely used construction material. Concrete is a mixture of paste and aggregates (rocks). The paste, composed essentially of Portland cement and water, coats the surface of the fine (small) and coarse (larger) aggregates. The word concrete comes from the Latin word "concretus" (meaning compact or condensed), the perfect passive participle of "concrescere", from "con"- (together) and "cresure" (to grow).Concrete was used for construction in many ancient structures. Natural sand has been used widely in construction activities and is diminishing day by day. At present due to the unavailability of natural sand, manufactured sand produced from quarries are widely used for mass production of concrete. Very soon in the near future there will be a scarcity for manufactured sand also. Use of recycled products is the new trend in industry and researchers are keen to find a new material that fit for the right purpose. Here waste foundry sand can be effectively utilized as partial replacement of natural sand or manufactured sand. Human hair is a waste material and there is no proper method for the disposal of this non-bio degradable hair which causes enormous environmental problems. The usage of hairs as a fibre reinforcing material in concrete is to investigate their impact on the mechanical properties of the concrete and also in controlling cracks such usage remains as an alternative way for disposing hair. The concrete with the composition of Partial replacement of 30% foundry sand and adding human hair fibre in the ratio of 0%, 2.5%, 5% and 7.5 %.

1.1 Fibre Reinforced Concrete(FRC)

Fibre reinforced concrete is concrete containing fibrous material which increases its structural integrity. It contains short discrete fibres that are uniformly distributed and randomly oriented. Fibre includes steel fibres, glass fibres, synthetic fibres and natural fibres – each of which lends varying properties to the concrete. In addition, the character of fibre-reinforced concrete changes with varying concretes, fibre materials, geometries, distribution, orientation, and densities. Fibre is a small piece of reinforcing material possessing certain characteristic properties. They can be circular or flat. The fibre is often described by a convenient parameter called "aspect ratio". The aspect ratio of the fibre is the ratio of its length to its diameter.

1.2 Hair Fibre Reinforced Concrete(HFRC)

Fibre reinforced concrete can offer a convenient, practical and economical method for overcoming micro-cracks and similar type of deficiencies. Since concrete is weak in tension hence some measures must be adopted to overcome this deficiency. Human hair is strong in tension; hence it can be used as a fibre reinforcement material. Hair Fibre (HF) an alternate non-degradable matter is available in abundance and at a very cheap cost. It also creates environmental problem for its decompositions. 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 economise concrete and to reduce environmental problems. Experiments were conducted on concrete beams and cubes with various percentages of human hair fibre i.e. 0%, 2.5%, 5% and 7.5% by weight of cement. For each combination of proportions of concrete one beam and three cubes are tested for their mechanical properties. By testing of cubes and cylinders we found that there is an increment in the various properties and strength of concrete by the addition of human hair as fibre reinforcement.

2. EXPERIMENTAL PROGRAMME

2.1 Properties of Human Hair Fibre

The main element of hair composition is keratin. Keratins are proteins with long chains of amino acids that form the cytoskeleton of all cells of outer shell. Number of investigations clearly stated that sulphur is the main reason of strength of hair cords in front of disintegration in the face of environmental stress and these sulphur compounds are linked with amino acids at very high levels in hair cords. Sulphur in Amino acid molecules is adjacent to keratin protein till form disulfide chemical chains (chains are very strong and resistant to breakage). These chains are very resistant to acids disulfide performance, but in alkaline solutions they can decomposed. In fact alkaline environment looses the hair cords. The potential impact of reduced strength in the cement mortar is still a noteworthy but we have to mention that the purpose of this article is to investigate the impact of hair cord in control of shrinkage and cracks which are caused in normal concrete. Before the alkaline environment loose the hair cords, these cords may respond on purpose to their functions to prevent shrinkage.

Fig.1.Human Hair Fibre

Chemical Composition of Human Hair Fibre,

65-95% - weight proteins,
32% - water, lipid pigments and other components,
80% - Keratin (long chain polymers),
50.65% - carbon,
20.85% - oxygen,
17.14% - nitrogen,
6.36% - hydrogen,
5.0% - sulphur.

2.2 Properties of foundry sand

As a demand for concrete is in increasing day by day thus need of river sand also increasing. But the availability of river sand is limited and also taking river sand from river is banned now a days. Concrete is a composite material construction material made with aggregate, cement and water. If we use the artificial sand in concrete it should not give proper strength and various problems are occurred in concrete work. So it is basic need to find the alternative for sand. We can use the foundry sand as partial replacement of fine aggregate in concrete.

Fig.2.Foundry sand

2.3 Ordinary Portland Cement

Cement is defined as the product manufactured by burning and crushing to powder an intimate and well-proportioned mixture of calcareous and argillaceous materials. Cement is binding material in concrete which binds the other materials to form a compact mass. Generally OPC is used for all engineering construction works. The manufacture of OPC is decreasing all over the world in view of the popularity of blended cement on account of lower energy consumption, environmental pollution, economic and other technical reasons. In this project work 53 grade OPC cement is for experimental study.

Tab.1.Properties of Cement

S.No	Properties	Value
1.	Specific Gravity	3.15
2.	Initial Setting Time	28 min
3.	Final Setting Time	3 hours

2.4 Aggregates

Fine Aggregates:

In conventional concrete, river sand as fine aggregate. Sand is a mass of finely crushed rock. It is either crushed naturally as seen on the sea shore, in river beds or in deserts, or it is artificially produced in crusher plants near rock. Sand is classified according to the shape of its particles, which differs depending on where the sand came from originally. It is also graded according to the size of its grains. A concrete with better quality can be made with sand consisting of grounded grains rather angular grains. Aggregate that pass through a 4.75 mm IS sieve and having not more than 5 percent coarser material are known as fine aggregate. Main function of fine aggregate is to fill the voids in between coarser particles and also helps in producing workability and uniformity in mixture.

Fig.3.Fine Aggregates

Tab.2.Properties of Fine Aggregate

S.No	Properties	Values
1.	Zone	II
2.	Specific Gravity	2.74
3.	Water absorption	1.0%

Coarse Aggregates:

The aggregate having size more than 4.75 mm is termed as coarse aggregate. The graded coarse aggregate is described by its nominal size i.e. 40mm, 20mm, 16mm, 12.5mm etc. 80mm size is the maximum size that could be conveniently used for making concrete. Crushed stone aggregate with a maximum particle size of 12.5mm and 20mm was obtained from local quarry & was used as coarse aggregate. The Flakiness and Elongation Index were maintained well below 15%.

Fig.4.Coarse Aggregate

Tab.3.Properties of Coarse Aggregate

S.No	Properties	Values
1.	Specific Gravity	2.74
2.	Water Absorption	0.5%
3.	Size of Aggregate	20mm

3. MIXING AND CASTING

3.1 Mixing Proportion

1. Cement = 383 kg/m3
2. Water = 153.26 lit
3. Fine aggregate = 715 kg/ m3
4. Coarse aggregate = 1271 kg/ m3
5. Chemical admixture = 1.915 lit/m3
6. Water Cement ratio = 0.40

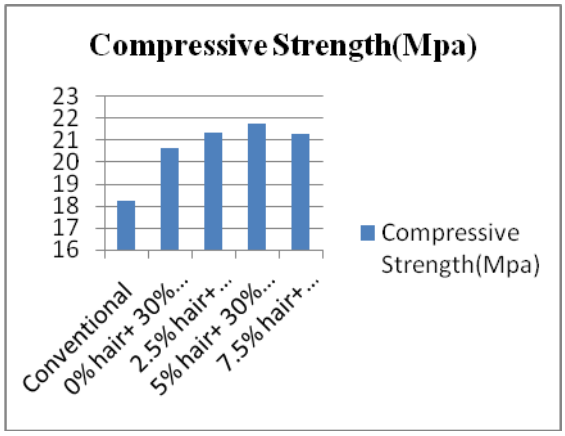
Mix Ratio = 1: 2.35: 3.5

In this Project, we use M25 concrete for conventional concrete and 0% of hair + 30% of foundry sand, 2.5% of hair + 30% of foundry sand, 5% of hair + 30% of foundry sand, 7.5 % of hair + 30% of foundry sand. Its proportion is 1:2.35:3.5. The Water cement ratio is 0.4.

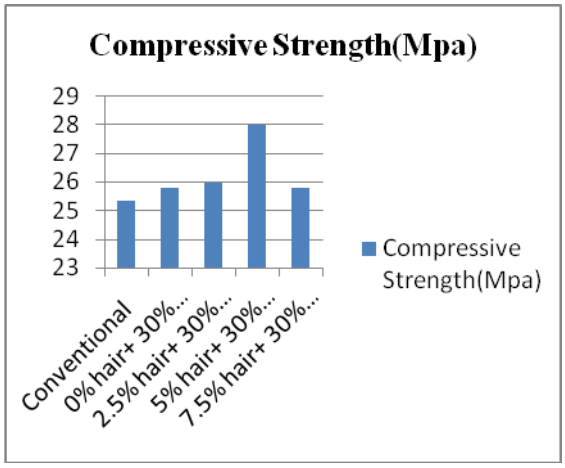
4. RESULTS AND DISCUSSION

4.1 Compressive Strength

The specimens are placed in the machine in such a manner that the load is applied to opposite sides of the cubes as cast. The axis of the specimen is carefully aligned with the centre of thrust of the spherically seated plate. A spherically seated block is brought to bear on the specimen; the movable portion is rotated gently by hand so that uniform seating may be obtained [4]. The compressive strength machine of 1000kN capacity is used, to apply the axial force of compression results for shown in Graph1 and Graph2.



Graph.1.Test Result (7 days)



Graph.2.Test Result (28 days)

Cube Compressive Strength

Fig.5.CC

Fig.6.HFRC

4.2 Split Tensile Strength

For tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were remoulded after 24 hours of casting and were transferred to curing tank where in they were allowed

to cure for 7, 14 and 28 days. These specimens were tested under compression testing machine. In each category, three cylinders were tested and their average value is reported. The Fig 7 and Fig 8 describes the strength.

Tensile strength was calculated as follows as split tensile strength:

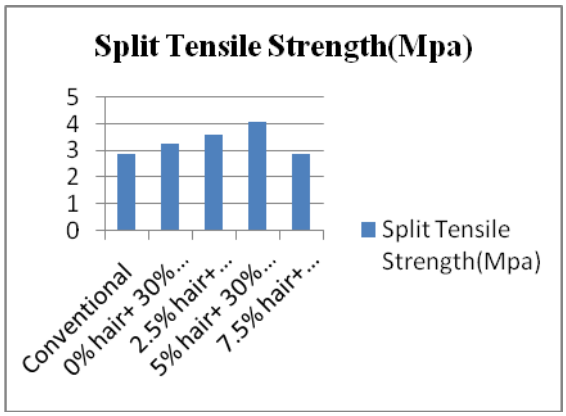
Tensile strength (MPa) = 2P / π DL,

Where,

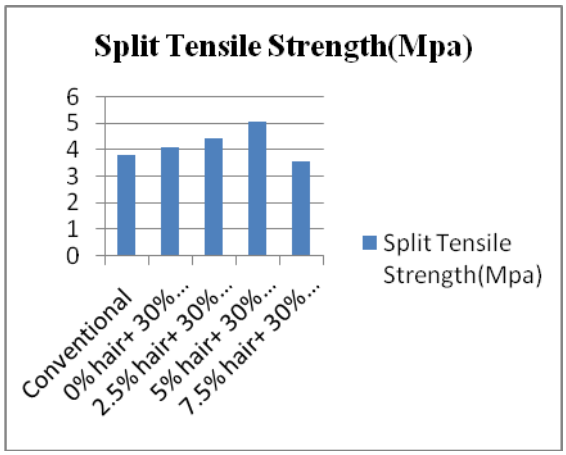
P = failure load,

D = diameter of cylinder,

L = length of cylinder.



Graph.3.Test Result (7 Days)



Graph.4.Test Result (28 Days)

Cylinder Split Tensile Strength

Fig.7.CC

Fig.8.HFRC

5. CONCLUSIONS

Thus the project is done and concluded that following:

1. Experiments were done and found that concrete with 5% partial replacement of fine aggregate with 30% WFS has improved compressive strength & split tensile strength. So 5% of human hair fibre is optimum percentage.
2. By addition of human hair fibre & WFS in concrete the disposal problem is reduced.
3. The construction cost will be reduced. So it is economical.

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