

# Use of Human Hairs in Concrete

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**Abstract**— Human hair is a waste product and its disposal is concern for environment due to its non-biodegradable nature. The human hair possess similar properties to that of other synthetic fibers. The hair fiber reinforced concrete is the type of concrete the mixture of concrete with discontinuous discrete fibers which results in the tensile strength and also reduces the growth of micro cracks in the concrete. Hair fiber reinforced concrete is very effective and economical process to enhance the physical and mechanical properties of the concrete. In present study an attempt is made to review the use of human hairs in concrete and its properties. It is observed that hair fibers can successfully be used in concrete and it also results in improvement of mechanical properties of concrete.

**Key words:** fiber reinforced concrete, hair fiber, compressive strength, flexural strength, workability

## I. INTRODUCTION

Concrete is a versatile material mostly used in construction industry. concrete has enough strength in compression but it is weak in tension hence it should be reinforced either with steel or different types of fibers so that tensile strength of concrete can be increased and to make concrete strong, durable and less susceptible to tension. Fiber reinforced concrete is the mixture of concrete with discontinuous discrete fibers [1]. There are various type of fibers like steel, glass, synthetic fibers such as polypropylene fibers, and coconut fiber is used in concrete. There are additional chance to use completely different material as fibers in concrete, human hair being one in every of them and thought of as a junk. Human hairs accumulation causes several environmental problems; but, it can be conjointly used as fiber in concrete. Incorporation of human hairs to the concrete improves concrete properties such as compressive strength, binding properties, small cracking management alongwith resistance from spalling at reinforcement and concrete bond. Therefore, human hairs which are in relative abundance in nature and are non-degradable, provides good option in fiber reinforced concrete. A retardant of non-uniform distribution of hairs is visaged whereas victimisation them as fibers however it also can be solved by Electro-statically charging them. Hair acts like all alternative fiber, and have several benefits. Its high strength makes it adequate to use a copper wire with similar diameter. Hair being a non-degradable matter is making associate degree environmental downside thus its use as a fiber reinforcing material would minimize the matter. It is in abundance and at a really low price. It reinforces the mortar and prevents it from spalling [2].

## II. LITERATURE REVIEW

Hair is a proteinaceous fiber with a intermediate filaments attached in certain patters to the fiber, more details on its structural and molecular properties are in [3]. The extraordinary properties of human hair like its unique chemical composition, very slow degradation rate, higher

tensile strength, thermal insulation, great elastic recovery, scaly surface, and unique interactions with water and oils, has led to many diverse uses. Thompson [4] manufactured a hair-based composite material by manipulating a plurality of cut lengths of hair to form a web or mat of hair, and combining said web or mat of hair with a structural additive to form said composite material. Jain et al. [5] studied on hair fiber reinforced concrete and concluded that there is wonderful increment in properties of concrete according to the percentages of hairs by weight of in concrete. The addition of human hairs to the concrete improves various properties of concrete like tensile strength, compressive strength, binding properties, micro cracking control and also increases spalling resistance. Therefore, human hairs are in relative abundance in nature and are non-degradable provides a new era in field of FRC.

As shown below Fig. 1, the human hair is fixed in skin with follicle and provides good amount of structural benefit as it keeps placed in its position. This property is useful in hair reinforced concrete.

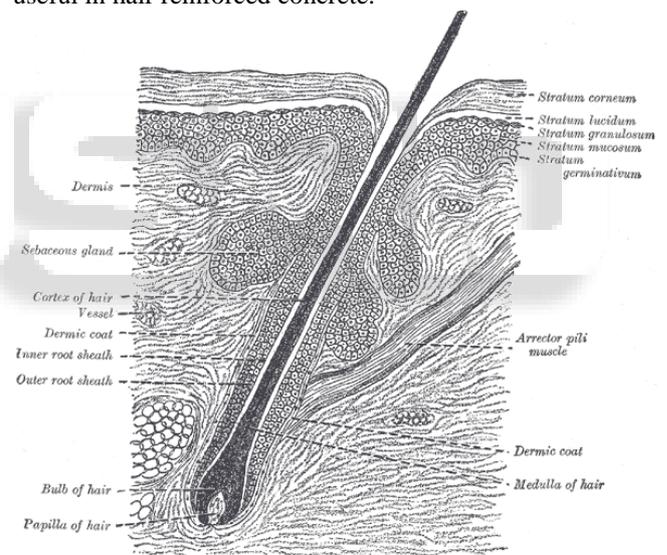


Fig. 1: Human hair fixed in skin at follicle (source Henry Vandyke Carter - Henry Gray (1918) Anatomy of the Human Body; Gray's Anatomy, Plate 944)

Volkin et al. [6] identified and characterized the processes leading to destruction of cystine residues. They compared proteins from different species, including those of thermophilic bacteria living near the boiling point of water.

Gupta [7] studied on Human Hair “Waste” and Its Utilization. Through this it has been concluded that the human hair has a large number of uses in areas ranging from agriculture to medicine to engineering industries.

Hu et al. [8] studied on Protein-based composite biomaterials which can be formed into a wide range of biomaterials with tunable properties, including control of cell responses. They provided new biomaterials which is an important need in the field of biomedical science, with direct relevance to tissue regeneration, nano medicine, and disease treatments. Human hair is considered as a waste material in

most parts of the world and it is found in municipal waste streams which cause numerous ecological issues. Babu et al. [9] studied on bio-based polymers and concluded that it has widely increased the attention due to environmental concerns and the realization that global petroleum resources are finite.

Hernandez et al. [10] studied on keratin which is a fiber which is found in hair and feathers. Keratin fiber has a hierarchical structure with a highly ordered conformation, is by itself a biocomposite, product of a large evolution of animal species. Through this it has been concluded that the keratin fibers from chicken feathers shows a eco-friendly material which can be applied in the development of green composites.

### III. MATERIALS

#### 1) Cement:

Ordinary Portland cement of grade 43 with initial setting time of 35 minutes and final setting time of 465 minutes is used. Other properties of cement in mix design are as provided in supplier sheet.

#### 2) Water

Potable water or tap water is generally acceptable for mixing and curing concrete. Water used for mixing is checked to be free from oil, acid, organic materials etc. or other substances that may be harmful for concrete. Conforming to IS 456 :2000.

#### 3) Fine Aggregate :

Sand is used as a filler material in construction activities; generally sand passing through 2.36 mm IS sieve is taken. Sand having minimum 20 % fineness and washed is good for concrete.

#### 4) Coarse Aggregates :

The coarse aggregate used is of nominal grade 20mm in size, crushed angular shape and free from dust

#### 5) Human hair :

Locally available human hairs are used in the study. It is collected from hair salon, having length 10-60mm and cross section 18-100µm.

### IV. MANUFACTURING PROCESS

The production of fibers reinforced concrete is based on mix design. Proportioning method is also used for lower grade of concrete. Concrete mixing is done with help of concrete mixing machine and manual mixing. Coarse aggregate, fine aggregate, and cement are taken in to mixer machine and mixed thoroughly. Manual distribution of hair is adopted to overcome the problem of non-uniform distribution of hair in concrete. Water was added steadily in mixer machine. Once the concrete is mixed thoroughly it is poured in the moulds of cubes, cylinders and beams. It is taken care the inner surfaces of the moulds were coated with oil before pouring so that they can be easily demoulded after 24 hours. Concrete is poured in three layers and each layer is tamped 25 times with tamping rod and then vibrated for sufficient time. The top surface was levelled with trowel and finished properly. Once the concrete is set thoroughly, the cube, cylinders and beams is demoulded and immersed in curing tank containing water at normal temperature for the required time period.

### V. PROPERTIES

Use of human hairs improves the various properties in the concrete like tensile strength, compressive strength, binding properties, micro cracking control and also increases spalling resistance. Compressive strength for lower grade concrete, when hair fibers are used up to 1% to 1.5%, is maximum while increase in compressive strength for higher grade concrete is vary slightly. Flexural strength for lower grade concrete is increased up to 5- 10% and around 4% for higher grade concrete [11]. Ultimate strength at 28 day is higher compare to strength at 7day but rate of increase in strength is higher at initial stage [12]. Increase in compressive strength & Poisson's ratio when percentage of hair Fibers used varied from 0 to 2% and by increasing percentage of Fibers at 2.5 % of hair Fiber the values of compressive strength & Poisson's ratio were decreased [13]. Workability of concrete is greatly reduced up to 35% when hair fibers are used. The use hair fibers increase the tensile strength of the concrete and also improves the bonding.

### VI. CONCLUSION

Following conclusion is drawn from the current study;

- 1) It is observed that the maximum increase in compressive strength is noticed in the addition of 2% hair fibers, by weight of cement.
- 2) Flexural strength of the concrete is found to increase up to 5% -15% then normal concrete, when hair fibers are used up to 1.5% - 2% by weight of cement.
- 3) Crack formation and propagation are very much reduced showing that FRC can have its applications in seismic resistant constructions.
- 4) It is to be noted that maximum increase in the compressive strength is observed for lower grade of concrete mixes.
- 5) Use of hair fibers in concrete reduced the workability up to 15-35% then normal concrete.

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