

## Encapsulating the Validity of Human Hair as a Fiber in Concrete Mix Design

Shaaqib. A. Mansuri<sup>1</sup>, Chandni. M. Patel<sup>2</sup>, Yash. U. Shah<sup>3</sup>, Renuka. K. Goswami<sup>4</sup>, C.B. Mishra<sup>5</sup>

<sup>1, 2, 3, 4</sup>(Final Year Students, Civil Engineering Department, BVM Engineering College, India)

<sup>5</sup>(Associate Professor, Civil Engineering Department, BVM Engineering College, India)

**Abstract:** In a cutting-edge era, we're approaching swiftly to the headway of inventions which has prompted an increase in the sum and kind of waste being produced, prompting a waste transfer emergency. One of the impeccable biological fibers is the human hairs which is regular constituent as non-degradable civil waste in India every year as three to four tons. A single fiber of hair can withstand the load of 100-150 grams. Hair is versatile and it is equipped for recapturing its unique position on expulsion of the deformation load and additionally, it is exceptionally strong in tension. Over the most recent couple of years, biological fibers have turned into an appealing fortification for polymeric composites from economical and biological perspective. There is an increase in the environmental awareness on the planet which is getting to be conspicuous to researchers, architects and scientists as an alternative support for FRP (fiber reinforced polymer) composites, because of their minimal cost, genuinely great mechanical properties, high aspect quality, good control over plastic shrinkage, dry shrinkage cracking and furthermore lowers the permeability of concrete. By utilizing human hair in concrete, the issue of waste can be decreased as well. Subsequently, the present survey paper reports the endeavors of analysts who have tried the attainability and relevance of the human hair in concrete mix design as results in change of mechanical properties of cement.

**Keywords:** Fibers, FRC, Human Hair, Mechanical Properties, Waste Material.

### I. INTRODUCTION

Fiber-strengthened concrete has been quickly developing all through the building business since engineers and contractors holders began to perceive its numerous advantages. Macro and steel fibers are invaluable for industrial undertakings, while stealth and micro fibers are valuable for residential works. The idea of utilizing fibers as reinforcement isn't new. Fibers have been utilized as reinforcement since many years. Generally, horsehair was utilized in mortar and straw in mud blocks. In the 1900s, asbestos fibers were utilized in concrete. In the 1950s, the idea of composite materials appeared and fiber-reinforced concrete was one of the subjects of interest. Once the health dangers related with asbestos were found, there was a need to discover a replacement for the substance in concrete and other building materials. By the 1960s, steel, glass (GFRC), and engineered, (for example, polypropylene) fibers were utilized in concrete. Investigation into new fiber-strengthened concretes proceeds with today. Increment in Toughness and Durability, Reduced Cracking, Improved Freeze-Thaw Resistance, and lessen Effects of Shrinkage and better aesthetics. The mechanical conduct of fiber strengthened concrete (FRC) depends to a great extent on the associations between the fibers and the cement matrix: adhesion; friction and mechanical bond incited by complex fibers geometry or by disfigurements or different treatments on the surface of the fiber.. (10)

### II. HUMAN HAIR FIBER

Human hair is non-degradable waste material abundantly found day to day life. It is very common and major constituents in municipal waste streams. Most common interest in hair is focused on hair growth, hair types and hair care, but hair is also an important biomaterial primarily composed of protein, notably keratin. Keratins are proteins, long chains (polymers) of amino acids. In terms of raw elements, on an average, hair is composed of 50.65% carbon, 20.85% oxygen, 17.14% nitrogen, 6.36% hydrogen, and 5.0% sulphur. Amino acid present in hair contain cytosine, serine, glutamine, threonine, glycine, leucine, valine and arginine. The hair contains a high amount of sulphur because  $\alpha$ -amino acid cysteine ( $\text{HO}_2\text{CCH}(\text{NH}_2)\text{CH}_2\text{SH}$ ) is a key component of the keratin proteins which is tough, insoluble and incredibly strong. Studies show that this waste material can provide variety of benefits to the concrete. Hair is used as a fibre because it has a high elasticity which is equivalent to that of a copper wire with comparable width. Hair, a non-degradable matter is making an

ecological issue so its utilization as a fiber fortifying material can minimize the issue. It is additionally accessible in wealth and with ease. It fortifies the mortar and keeps it from spalling .

### **III. LITERATURE REVIEW**

Kumar Shantverayya and Sugunashree SM in their study [1] (2017) “Performance of hair reinforced concrete” they showed that when concrete with 0.5% hair is contrasted and the plain cement concrete, it is discovered that there is an expansion of 15.98% in compressive quality and 5.88% in flexural quality. At the point when concrete with 1% hair is contrasted and the plain cement concrete, it is discovered that there is an expansion of 23.25% in compressive quality and 17.64% in flexural quality. At the point when concrete with 1.5% hair is contrasted and the plain cement concrete, it is discovered that there is an expansion of 36.33% in compressive quality and 35.29% in flexural quality.

S. Manivel, S. Nisanth Kumar, S. Prakashchandar, S. Anil Kumar [2] (2017) in their research “EXPERIMENTAL STUDY ON HUMAN HAIR FIBER REINFORCED CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY GGBFS” they inferred that the ideal measurement level of hair fiber expansion was observed to be 2%. Compressive quality and split elasticity of tests with 2% expansion of hair fiber expanded by 28.65% and 9.12% separately when contrasted and that of the regular examples.

Vijaya G. Hiwarkar ,Dr. P.S.Lanjewar, Abhilasha D. Bonode,Sonali V. Somnathe [3] (2017), in their endeavor made in” HAIR FIBRE REINFORCED CONCRETE”, concluded that The conduct of HFC, SFC and PCC are given in this undertaking. The heap conveying limit of steel fiber reinforcement concrete is more than hair re cement concrete. Be that as it may, when contrasted with HFC and PCC, the heap conveying limit of HFC is more than PCC.As we utilized the hair in concrete, the volume of material, for example, cement, C.A, F.A., is lessening .Therefore the HFC is helpful and vital than PCC.

Mridula Dwivedi , Dr. R.K. Dixit [4] (2017) in their study on ”Concrete Reinforced With Human Hair as Fibre”, stated that When 1% human hair added to cement concrete contrasted and plane cement concrete discovered 3.51% expansion in 7 days compressive quality test. At the point when 3% human hair added to cement concrete contrasted and plane cement concrete discovered 6.7% expansion in 7 days compressive quality test. At the point when 1% human hair added to cement concrete contrasted and plane cement concrete discovered 5.4% increase in 28 days compressive quality test. At the point when 3% human hair added to cement concrete contrasted and plane cement concrete discovered 13% expansion in 28 days compressive quality test. At the point when 1% human hair added to cement concrete contrasted and plane cement concrete discovered 28.48% expansion in 7 days flexural quality test. At the point when 3% human hair added to cement concrete contrasted and plane cement concrete discovered 73% expansion in 7 days flexural quality test. At the point when 1% human hair added to cement concrete contrasted and plane cement concrete discovered 36.35% expansion in 28 days flexural quality test. At the point when 3% human hair added to cement concrete contrasted and plane cement concrete discovered 56 % expansion in 28 days flexural quality test. Human hair is a waste material delivers consistent schedule and make an ecological issue so we can successfully use it in cement concrete and satisfy two purposes as quality gain the second one is squander administration. Break development and proliferation are especially diminished demonstrating that hair fiber strengthened concrete can have different applications in seismic safe and split safe developments, street asphalt developments and so forth. Uniform appropriation of hairs is the issue recognized in this investigation, since we found that hairs clubbed together, hard to isolate them. In near examination we found that in each exploration work they discovered some expansion in compressive quality and flexural quality both it demonstrates that human hairs effects development works.

Ajna Manaf Adarsh, M V Alphy Jomichan, George M Varghese [5] (2017), in their study “Hair Fibre Reinforced Concrete” concluded that Hair is utilized as an added substance in different rate by weight of cement in concrete. Quality and solidness tests were led on hair fiber fortified concrete and the outcomes demonstrates that there is an expansion in compressive quality by 12% and 22% expansion in flexural quality on expansion of 1% hair fiber by weight of cement. Increment in flexural quality demonstrates the decrease in miniaturized scale splits, which is a danger to strength. Expansion of 1% hair fiber by weight of cement indicates better outcome in quality when contrasted with different rates. Facilitate expansion demonstrates declination in result despite the fact that there is no misfortune not as much as the objective quality. Typical fortified concrete will be unfavorably influenced by the impact of dampness and other destructive specialists. The assault is because of the age of miniaturized scale breaks in the most recent phases of the concrete structures. The test outcomes demonstrate that because of the fuse of hair fiber, the strength characters can be lifted somewhat. From the sturdiness tests, it is seen that loss of quality is lessened by expansion of 1% hair by weight of cement. Thus, we can presume that hair filaments are a beneficial added substance to concrete, which reduces the break development, empowering the long existence of structures.

S.Aishwarya , John Sathiya Raj, Nidhe Narayan [6] (2017) in Experimental Investigation of “Hair Fibre Concrete as an Alternate Low Cost Building Material”, stated that Human hair waste can be successfully figured out how to be used in fiber fortified concrete developments According to the test performed it is seen that there is astounding addition in properties of concrete as indicated by the rates of hairs by weight of cement in concrete. The human hair fiber concrete has the high compressive quality contrasted with the typical Concrete. Better split rigidity was accomplished with the expansion of the human hair in concrete. The quality has expanded. At the point when contrasted with that of the ordinary concrete example. It is very much seen that the most extreme increment is seen in the expansion of 1.5 % hair fiber, by weight of concrete, in all the blends. Break development and proliferation are particularly diminished demonstrating that FRC can have its applications in seismic safe developments. The expansion of human hairs to the concrete not just changes different properties of concrete like rigidity, compressive quality yet additionally upgrades the coupling properties, miniaturized scale splitting control and furthermore increments spalling opposition. The split width is diminished to a more prominent degree.

G.Sreevani, Smt. B. Ajitha in their experimental investigation [7] (2017), “Human Hair as Fibre Reinforcement in Concrete “suggested that Strength of concrete increments with the expansion of hair fiber. Expansion of 2% of hair fiber gives most extreme quality. Past 2% there is a decrease in quality. It was discovered that M20 review concrete with 2% human hair fiber demonstrates an expansion in compressive quality of 8.69% and 8.27% at relieving times of 7 days and 28 days separately when contrasted and the plain cement concrete. It's recommended that hair fiber strengthened concrete can be utilized as a replacement of plain cement concrete in minor works i.e non basic segments, for example, floors, asphalts, sunshades, lofts. It is a superior method to utilize human hair which generally is an unutilized/underutilized squander material.

Alok Jain, Anubhav Kumar Hindoriya [8] (2016) , in their study “Use of Human Hairs in Concrete “they concluded that It is seen that the greatest increment in compressive quality is seen in the expansion of 2% hair strands, by weight of cement. Flexural quality of the concrete is found to increment up to 5% - 15% then typical concrete, when hair filaments are utilized something like 1.5% - 2% by weight of cement. Break development and proliferation are especially diminished demonstrating that FRC can have its applications in seismic safe developments. It is to be noticed that most extreme increment in the compressive quality is watched for bring down review of concrete blends. Utilization of hair filaments in concrete diminished the usefulness up to 15-35% then ordinary concrete.

T.Naveen Kumar, Komershetty Goutami, Jinna Aditya, Kuppala Kavya, V.Raja Mahendar, Dr. R.C.Reddy and Shweta kaushik [9] (2015) in their endeavor “An Experimental Study on Mechanical Properties of Human Hair Fibre Reinforced Concrete (M-40 Grade)” they stated that From this test contemplate, it is discovered that the ideal substance of human hair fiber to be added to M-40 review of concrete is 1.5%. It is seen that there has been change in the properties of M-40 review of concrete as far as its compressive quality, flexural quality and split rigidity relating to the rates of hair by weight of cement in concrete. It was discovered that M-40 review concrete with 1.5% human hair fiber demonstrated an expansion in compressive quality of 7.22%, 7.21% and 8.18% at relieving times of 7 days, 14 days and 28 days separately when contrasted and the plain cement concrete (i.e., values comparing to 0% human hair fiber. Increment in the flexural quality was in the request of 27.60%, 20.93% and 23.56% for the same exploratory conditions at restoring times of 7 days, 14 days and 28 days individually. Thus the split elasticity recorded an expansion of 17.26%, 29.98% and 26.60% for the same test conditions at restoring times of 7 days, 14 days and 28 days separately. The expansion of human hairs to the concrete not just alters different properties of concrete like rigidity, compressive quality yet in addition upgrades the coupling properties, miniaturized scale breaking control and furthermore increments spalling opposition. The break width is lessened to a more noteworthy degree. It bestows malleability to a specific degree which can be seen in exploratory testing of shafts. It tends the shaft to curve and along these lines cautioning a long time before disappointment in this way upgrading wellbeing. As the level of human hair expands, the quality expanded up to 1.5% itself and afterward diminished. It's fundamentally the inclination of human hair that has a water retention limit of around 30% of its own weight. What's more, it is in sullied nature, the rate may increment to 45-half of its weight. Thus, and we add to concrete isn't adequately used by the cement, along these lines level of dehydrated cement builds substantially more. Subsequently it debilitates the structure and quality gets decreased.

Nila V. M, Raijan K.J, Susmitha Antony, Riya Babu M, Neena Rose Davis[10] (2015) in research,” Hair Fibre Reinforced Concrete” in their attempt concluded that , According to the test performed it is seen that there is exceptional augmentation in properties of concrete as per the rates of hairs by weight of cement in concrete. There was a general increment of 1-12% in the compressive quality of concrete and up to 5% in the flexural quality of concrete test examples by the expansion of hair strands in various amounts. It is all around saw that the most extreme increment is seen in the expansion of 2% hair fiber, by weight of concrete, in all the

blends. It is to be noticed that most extreme increment in the compressive quality is watched for bring down concrete blends, making the hair fiber fortified concrete best appropriate to use in the applications with those concrete blends. Split arrangement and spread are particularly lessened demonstrating that FRC can have its applications in seismic safe developments.

#### IV. CONCLUSION

The intricate investigation of the literature displayed, it demonstrates that human hair has a place in the field of cutting edge building materials science. Analysts have very much tried the achievability and appropriateness of the human hair as a composite fiber in different conditions and have discovered numerous accomplishments in their important fields. Hair fibers are beneficial added substance to concrete, which diminishes the crack arrangement and builds the durability of structure thereby reducing the problem of disposal and deterioration of environment.)

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