Effects of Human Hair and Waste Tyre Rubber Fibers on Concrete

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Abstract— Concrete is mainly used in cases where we need to resist compressive forces as concrete is stronger in compression but relatively weaker in tension. This weakness in concrete can be mitigated by using fibres as reinforcement in the concrete mix. Waste materials in the form of human hair and tyre rubber cause environmental pollution. Hair and waste tyre rubber can be recycled and used effectively in the concrete as reinforcement in fibre form. In this work first human hair content viz., 0%, 1.5% & 3%, by weight of cement for M30 grade concrete were studied by determining the strength properties (compressive, tensile and flexural strength) at3, 7 and 28 days, respectively. The trends showed that there is significant increase in compressive strength (4.9 %) at around 1.5% human hair content which then shows a decreasing trend (~ 2.4% at 3% human hair content) on further increase in human hair content. Then an approximate optimum percentage of human hair content (~ 1.5% by weight of cement in this study) that yielded better mechanical properties namely, compressive, tensile and flexural strength than the conventional concrete (control mix) has been chosen. Human hair content of 1.5 % by weight of cement is mixed with different rubber content of 1.5 %, 3% and 4.5 % by volume of concrete to study the mechanical properties of the concrete at 3,7 days and 28 days. By testing of cubes, beams and cylinders, a significant increase in flexural strength (~8.9 % increase) and tensile strength (~5.7% increase) of concrete was observed due to the addition of human hair and tyre rubber as fibre reinforcement. However there is a decrease in compressive strength though not so much significant (~2% decrease).

Keywords: Concrete, Human Hair and Waste Tyre Rubber Fibers, fine aggregate

I. INTRODUCTION

Due to speedy mechanization and suburbanization in the country lots of infrastructure developments are taking place. This rapid development led to increased dumping of waste materials. Vehicle tyres which are being discarded to landfills make unique and significant part of solid wastes. The tyres that are piled in stocks also pose countless kinds of fitness, ecological and commercial risks through air, water and soil pollution. Tyres owing to their shape pile water for longer periods and as they have impermeable nature, this provides upbringing environment for pests and mosquitoes. Tyre burning, that was the simplest and inexpensive process of removal, resulting severe fire hazards. Once burnt, it is much tough to quench as the 75% allowed space can pile large quantity of unrestricted oxygen. In accumulation, the rest precipitate after being burnt pollutes the soil. Tyres can similarly contaminate soil and water by lubricant which is produced on burning them. An expected 1000 squillion tyres spread the finish of their valuable lives all year [1]. In today's era vast amounts of tyres are previously stored (entire tyre) or landfilled (torn tyre), 3000 million abstruse EU and 1000 million in the US [9]. Through the time 2030 the quantity of tyres from motorized vehicles is supposed to grasp 1200 million demonstrating principally 5000 million tyres to be rejected in a steady basis. Landfilling with tyres is the cause for a stern environmental hazard. Mainly waste tyre removal areas add to the decrease of biodiversity, likewise the tyres grasp poisonous and solvable constituents. Secondarily although it is hard to burn unwanted tyres. Once tyres start burning down due to inadvertent causes, high temperatures are created and lethal vapors are created. The high temperature makes the tyres to liquefy, hence producing oil which will pollute earth and water.

II. LITERATURE REVIEW

Sandeep Yerabati (2017) studied the "Effect of Human Hair Mixed with Tyre Waste (Rubber) On Properties of Concrete". Hair reinforced concrete mixed with rubber offers a practical and economical method for overcoming micro-cracks and similar type of deficiencies. Fibres are usually used in concrete to control plastic shrinkage and dry shrinkage cracking and also to lower the permeability of concrete. This is an attempt to find the possibilities of using hair as fibre reinforcement in concrete, thereby forming an alternative way for the safe management of hair waste.

S.A Kanalli studied "polymer fibre reinforced Concrete in comparison with conventional concrete pavement". Road transportation is undoubtedly the lifeline of the nation and its development is a crucial concern. The traditional bituminous pavements and their needs for continuous maintenance and rehabilitation operations points towards the scope for cement concrete pavements. There are several advantages of cement concrete pavements over bituminous pavements. This paper emphasizes on polymer fibre reinforced concrete pavements, which is a recent advancement in the field of reinforced concrete pavement design. A comparative study of these pavements with the conventional concrete pavements has been made using Polypropylene fiber waste as fiber reinforcement.

III. MATERIALS USED

A. Water

Water is the greatest central material in concrete. It gives cement the adhering property. Quality and measure of water added decide the quality, quantity, stability and rate of formation of the adhesive material that binds the aggregates. It also controls the workability of concrete. The more the water content (up to certain limit) the more is the workability. The mechanical properties of toughened concrete as compressive, flexural strength and toughness also depend on hydration products of cement and there by depend on water content

B. Cement

In this research work the main binding material that was used was the Ordinary Portland Cement of 43 grade. The cement that has been used in the research was purchased from a local cement store, and the cement used was Khyber Cement, which is processed by Khyber cement private limited having its processing unit in Jammu and Kashmir. Cement is a material which when added to water exhibits cohesive and adhesive properties that help in holding the aggregates together to create a concrete mass.

C. Fine Aggregate

Clean fine aggregate have been utilized to perform this research and that was purchased from local store, in Ganderbal District of Jammu and Kashmir.Generally regular sand is being used as the fine aggregate. Quarry dust or dust from stone crushers are also utilized as fine aggregate. Fine aggregate form a main share of concrete matrix. Natural besides artificial sand can be utilized as fine aggregate. 3) Coarse Aggregate.

D. Coarse Aggregate

The Coarse aggregate which has been used in this research work were irregular machine made and was obtained from the grinding mill located at Lasjan near Bypass in Srinagar, Jammu and Kashmir. It is generally comprises of crushed stones like granite. Sometimes gravel or broken bricks are also utilised as coarse aggregates. Coarse aggregate occupy the most part of the concrete matrix and contribute towards weight and strength of the hardened concrete.

E. Fibres

This consists of short discrete materials that might be metallic or polymeric, used as composing reinforcement for concrete structures. We have used rubber tyres and human hair as fibres. Fibres are mixed with rest of the components of concrete to form the matrix and add certain properties to it. Human hairs were brought from barbers shops in the vicinity of Srinagar.

IV. MIX DESIGN

Mix design for M30 grade of concrete as per IS 10262:2009 is given below:

Mix Design Calculations

Stipulation for proportion

1) Grade of concrete = M30
2) Type of cement = OPC 43 grade
3) Exposure conditions= Moderate
4) Type of aggregate= Crushed angular
5) Size of aggregates = 20% of 20 mm & 80% of 10 mm
6) Size of rubber fibres = 30 mm × 6 mm (approx.)
7) Specific gravity of rubber tyre = 1.14

S.No	Cement	FA	CA		Water
			20mm	10mm	
1	1	1.65	0.57	2.31	0.45

V. METHODOLOGY

The research will be conducted on high strength concrete with mix grade of M40. In this research the workability, compression strength, and flexural strength of the specimen will be tested and will be presented in the form of a graph comparing the properties with conventional concrete. The curing period for the specimen will be 3 days, 7 days and 28 days. For calculating the compressive strength test, using the compression testing machine following are the brief idea about the number of cubes that are to be casted.

No. of cubes to be casted

S.No	Replacement %	Convential
1	0	9
		Cubes with HH
2	1.5	9
3	3	9
	Replacement at 1.5% HH	Cubes with HH+RT
4	1.5	9
5	3	9
6	4.5	9

VI. RESULTS AND DISCUSSIONS

The slump gets affected by the addition of human hair. The trend shows there is decrease in slump on increasing human hair content.

S. No.	Percentage of Human hair (by weight of cement)	Slump (mm)
1	0	50
2	1.5	47
3	3	45

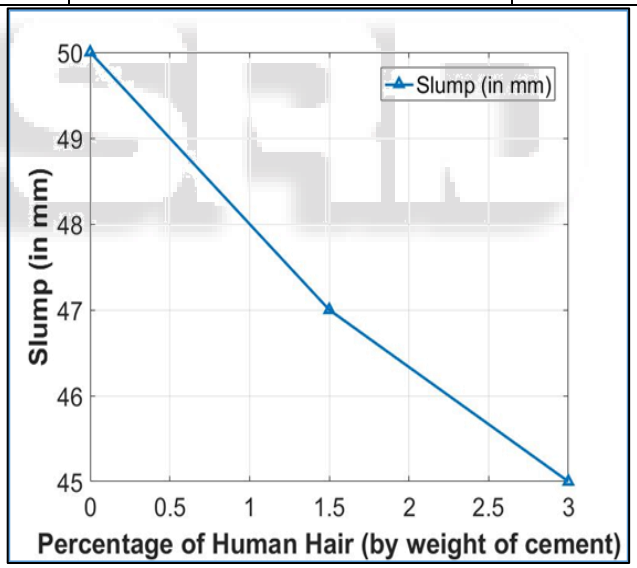

Fig. 1: Slump for different percentages (by weight) of Human Hair

The trend shows that the slump decreases with the increase in percentage of rubber fiber (by total volume of concrete). The reason for the same can be because of the interaction property of rubber with rest of the material in concrete is different which results in different followability (lower as compared to the control mix) of the concrete.

S. No.	Percentage of rubber fibre (by total volume)	Slump (mm)
1	0	50
2	1.5	48
3	3	45
4	4.5	42

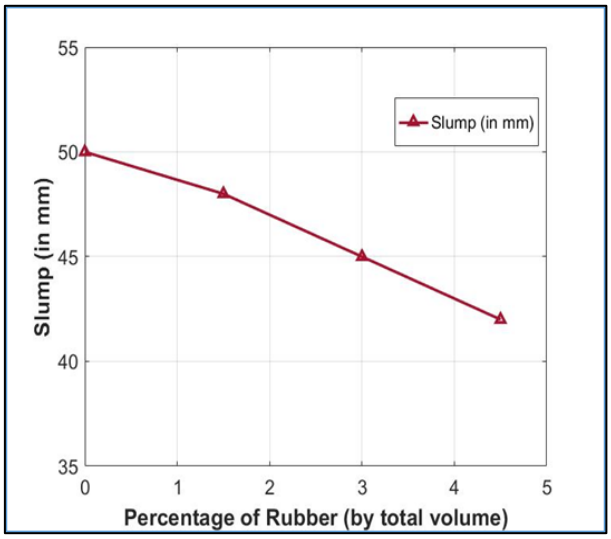

Fig. 2: Slump values for different percentages (by total volume) of rubber and 1.5 % human hair content (by weight of cement)

A. Compressive Strength of Concrete

Compressive strength is one of the most important characteristic properties of concrete. In the study the compression strength at different human hair content (by weight of cement) is tested. It is clear that there is an increase in the compressive strength when we add human hair in concrete but at the same time the trend shows on adding more and more human hair the strength starts to decrease. This behavior of concrete can be attributed to good bond strength of human hair which also fills the pores hence reducing void content. On further increasing the human hair content the cement content decreases which leads to decrease in strength of the concrete.

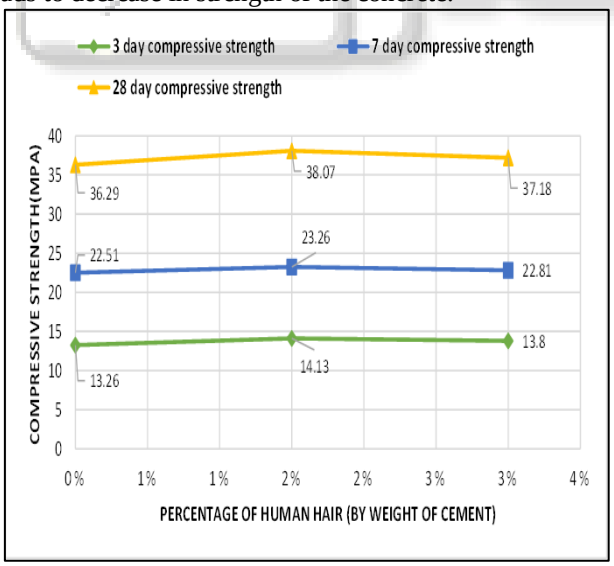

Fig. 3: 3,7 and 28 days Compression Strength for different percentages (by weight) of Human Hair.

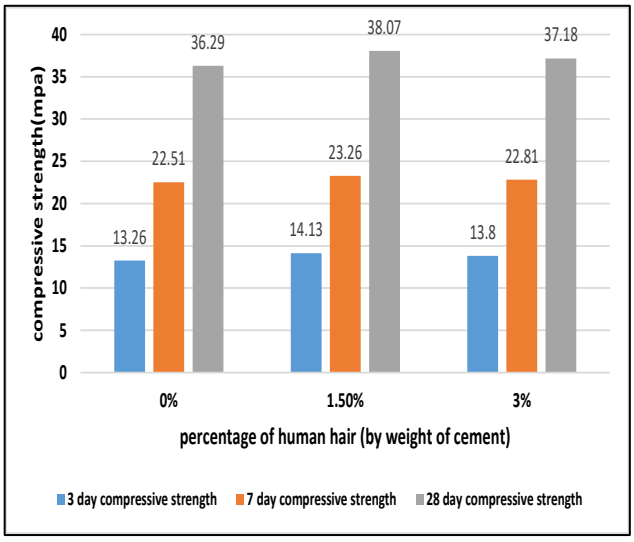

Fig. 4: 3, 7 and 28 days Compression Strength for different percentages (by weight) of Human Hair

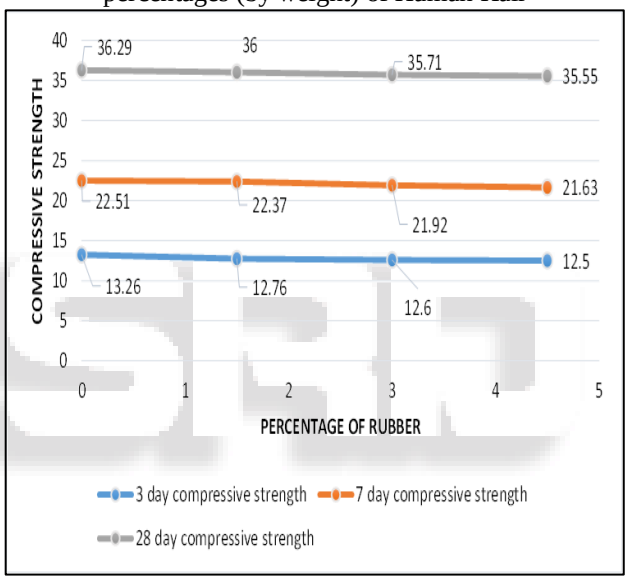

Fig. 5: 3, 7 and 28 days Compression Strength for different percentages (by total volume) of rubber at 1.5 % human hair content (M30).

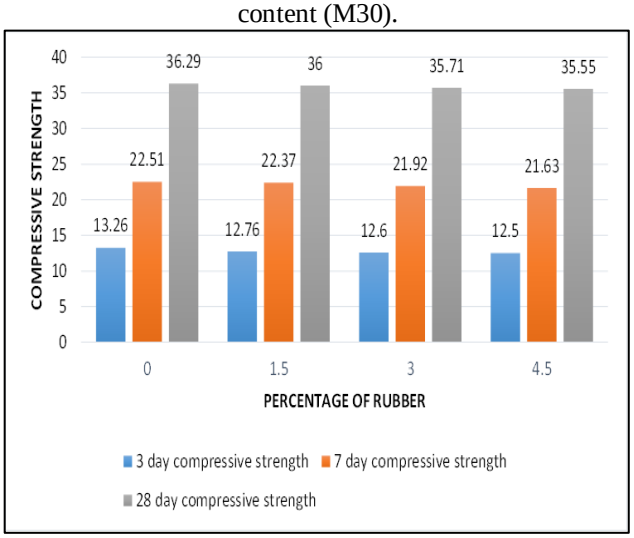

Fig. 6: 3, 7 and 28 days Compression Strength for different percentages (by total volume) of rubber at 1.5 % human hair content (M30).

VII. CONCLUSIONS

The following inferences have been drawn from the experiments done on concrete with human hair fibers and wasted tyre fibers:

1) Slump decreases with the increase in percentage of tyre rubber content. This is due to increase in stiffness of concrete and the surface properties of rubber are quite different when compared with aggregates.
2) Slump decreases with the increasing the percentage of Human hair content and the reason is mainly due to formation of balls resulting into increased resistance
3) There is a loss compressive strength in M30 (~ 2%) at 4.5 % rubber content by volume of concrete and 1.5 % human hair content by weight of cement M30 grade of concrete. This is mainly due to presence of rubber which cannot withhold much compressive forces.

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