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Compressive Strength of Concrete Using Hair Fibre and Lathe Scraps

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ABSTRACT: The need of the hour at this point is to protect the environment in as many ways as possible. We used waste products such as hair fibres and lathe scraps in our study and determined their positive effect in the properties of concrete. Using these materials will not only reduce the cost of the project, but also reduce the environmental impact caused due to these products. An experimental study was conducted in which we used concrete mix grade M20 and studied the mechanical behaviour of this concrete after partial replacement of cement with hair fibres and lathe scrap. The cement was first replaced by hair fibre in the range of 0% (no hair fibre), 1.5% and 2.5% by weight of cement for M20 mix, and then, with lathe scrap in the range of 1% by the weight of cement for M20 mix. The concrete mixtures produced were tested and compared in terms of compressive strength with a nominal mix concrete of grade M20.

KEYWORDS: Compressive Strength, Hair Fibre, Lathe Scrap, PPC

I. INTRODUCTION

India as a country, especially a developing one, is generating a tremendous amount of waste from various industries, of which only a miniscule amount is being reused in other activities. Waste disposal and its treatment is also not up to par. If this problem is not tackled as soon as possible, we will have some serious issues to deal with. Hence, we need to start using the waste products from various industries effectively. Hair Fibres are non-biodegradable materials and are generated in abundance. They are also quite common in municipal streams and lead to environmental pollution. Because of their physical and chemical properties, they have great amounts of tensile strength, nearly equal to copper wire of same diameter. They also increase the properties of concrete significantly. Bagasse fibre, a by-product of sugar industry, is also a waste product which has capacity to be used in construction industry as ash. Nearly 3 Tonnes of bagasse is produced for every 10 Tonnes of sugarcane crushed. It is observed that bagasse ash has pozzolanic properties. Hence, it improves both compressive strength and tensile strength of concrete. Steel Scraps, waste products from lathe industry also exhibit high tensile properties and increase the properties of concrete specimen tremendously. The paper presents the effects of partial replacement of cement by lathe scrap and hair fibres and compares the changes in properties from a nominal mix for 14 days and 28 days.

II. RELATED WORK

Belani Et al. "The study examined the various properties of fly ash bricks made by adding human hair to a fly ash brick mix. The fibres were replaced within the range of 0.1-0.7% by weight of fly ash. The crushing strength increases significantly compared to fly ash bricks".

Jain D Et al. "The study focuses on the effect of human hair on plain cement concrete with various percentages of human hair fibre i.e. 0%, 1%, 1.5%, 2%, 2.5% and 3% by weight of cement. Increment was observed in the various properties and strength of concrete"

Kumar Et al. "This study uses human hair reinforced epoxy composites with different contents of human hair i.e. 0%, 10%, 20%, 30% and with shifting length of human hair i.e. 0.5, 1, 1.5 and 2 cm. It is observed that there is significant influence of human hair reinforcement".

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Antony Et al. “The study has human hair as fibre reinforcement in concrete with 0%, 1.5% and 2% hair by weight of cement. It is observed that there is remarkable increment in properties of concrete”.

Meikandaan Et al. “Studied the effect of steel fibre on plain cement concrete by adding fibres 0%, 1%, 2%, 3%, and 4% by weight of concrete There is an increment in the various properties and strength of concrete by the addition of steel as fibre reinforcement.”

Nila V. M Et al. “The study has human hair as fibre reinforcement in concrete with 0%, 1.5% and 2% hair by weight of cement. It is observed that there is remarkable increment in properties of concrete”.

Ucol Ganiron Jr. Et al. “The study added small percentage of human hair into the asphalt cement mixture with percentage of hair 3%, 6% and 8% percentage by weight of bitumen. It is observed that the asphalt-cement mixture with hair 2% to 6% by mass of bitumen is much stronger as compared to asphalt cement mixture without hair.”

Kumar Et. al. “Hair as an Innovation to the field of Fibre Reinforced Concrete forms a very rigid structure in the molecular level, which is able to offer the thread both flexibility and mechanical resistance.”

Naik Et al. “Studied the concept of using horse hair as a fibre reinforcement material with various percentage of horse hair fibre i.e. 0%, 1% and 2% by weight of cement. It is observed that the increment in properties of concrete was proportional to the percentage of horse hair by weight in concrete.”

Nila V M Et al. “The study uses human hair as a fibre reinforcement material. with 0%, 1.5% and 2% hair by weight of cement, the maximum increase was noticed in the addition of 2% hair fibre, by weight of concrete, in all the mixes.”

Khansaheb A.P. Et al. “The study deals with bagasse ash and hair fibre reinforced concrete with 5% bagasse ash and 1% of hair and concrete with 5% bagasse ash and 0.5% of hair. There is a considerable increase in strength.”

III. EXPERIMENTAL INVESTIGATION

Concrete samples were made using Portland Pozzolana Cement for M20 mix and were then evaluated for their compressive strength. The compressive strength test was conducted for varying quantity of hair fibre (1.5% and 2.5%) and lathe scrap (1%).

- 0% Hair Fibre or 0% Lathe Scrap
- 1.5% Hair Fibre and 0% Lathe Scrap
- 2.5% Hair Fibre and 0% Lathe Scrap
- 0% Hair Fibre and 1% Lathe Scrap

A. Material Properties

Tests of specific gravity and consistency were conducted on cement and the results are displayed in Table 1. For fine aggregates, specific gravity test and sieve analysis test were conducted and the results are displayed in Table 2 and Table 3 respectively. Same tests were conducted for coarse aggregates and the results are displayed in Table 4 and Table 5.

1) Cement:

Portland Pozzolana Cement Grade 43 conforming to IS 8112 is used.

Table - 1

Physical properties of Ordinary Portland Cement

Physical Properties	
Standard Consistency (%)	34
Specific Gravity	2.9

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2) Fine Aggregates:

Locally available natural sand is used as fine aggregate. Its physical properties and sieve analysis are as follows:

Table - 2

Physical properties of Fine Aggregates

Physical Properties	Observed values
Specific Gravity	2.64

Table - 3

Sieve Analysis of Fine Aggregates

IS Sieve Size	Weight retained (in grams)	Percentage weight retained (in grams)	Cumulative percentage of weight retained (in grams)	Percentage Passing
10.0mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	0	0	0	100
1.18mm	134	13.4	13.4	86.6
600µm	162	16.2	29.6	83.8
150µm	700	70	99.6	0.4
Pan	4	0.4	100	0

Fineness modulus of fine aggregate = $\sum F/100 = 2.426\%$

3) Coarse Aggregates:

Crushed stone with maximum 20mm graded aggregates (nominal size) are used.

Table - 4

Physical properties of Coarse Aggregates

Physical properties	Observed values
Specific gravity	2.72

Table - 5

Sieve analysis of Coarse Aggregates

IS Sieve Size	Weight retained (in grams)	Percentage weight retained (in grams)	Cumulative percentage of weight retained	Percentage Passing
40.0mm	62	1.24	1.24	98.76
20.0mm	3680	73.6	74.84	25.16
10.0mm	1250	25.1	99.84	0.16
4.75mm	4	0.08	99.92	0.08
Pan	4	0.08	100	0

Fineness modulus of coarse aggregates = $(\sum C+500)/100 = 8.7584$

Rubber chips of size 15mm*15mm and thickness 5mm each.

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B. Specimen Details

The specimens considered in the study were 24 in number and had a standard size of 150 mm X 150 mm X 150 mm.

Table - 6
Details of specimens

MIX	COMPOSITION	NUMBER OF CUBES
MIX A	M20 Nominal Mix	6
MIX B	1.5% Hair Fibre, 0% Lathe Scrap	6
MIX C	2.5% Hair Fibre, 0% Lathe Scrap	6
MIX D	0% Hair Fibre , 1% Lathe Scrap	6
TOTAL CUBES= 24		

C. Test Methods

Based on the quantities of the ingredients required for the mix, the quantities of hair fibre (1.5% and 2.5%) and lathe scrap (1%) were calculated. The hair fibres were obtained from various hair saloons across the city for free or at nominal prices. Whereas, the lathe scraps were obtained from various fabrication workshops. The hair fibres were cleaned with acetone, which was then allowed to evaporate before heating the fibres for a day in an oven at 120° C.

All the materials were hand mixed thoroughly until a uniform mixture of proper consistency was achieved. Before casting, the inner surfaces and the lips of the moulds were thoroughly doused in machine oil. The concrete was poured in the moulds layer by layer during which the fibres and scraps were added to each layer to ensure uniform mixing. The moulds were then compacted on a table vibrator, where the surface was finished using a trowel. After compacting the moulds were removed from the vibrator and allowed to rest for 24 hours, after which the hardened concrete blocks were removed from the moulds and put in the curing tank for 14 days (or 28 days, whichever required).

Compressive strength was conducted on the specimens using a 2000 kN compression testing machine for varying quantities of hair fibre and lathe scrap.

Compressive strength test was applied to the specimens as it is the most common measure of performance used by engineers around the world. Also, because test results from these tests help in quality control and for determining the scheduling of construction operations like form removal, etc. The test was performed on the specimens at both 14 days and 28 days to study the development of strength in the specimens.



(a)



(b)



(c)

Fig. (a) A collection of standard moulds doused in machine oil.

Fig. (b) Weighing the hair sample before cleaning it.

Fig. (c) Crushed specimen in the compression testing machine.

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IV. EXPERIMENTAL RESULTS

Specimens were tested after 14 days and 28 days and their strengths were noted in tabular form. They are listed down below. Table-7 lists out the 14-Day strength of 3 specimens of each Mix, and Table-8 lists out the 28-Day strength of 3 specimens of various mixes. It can be seen that there is a high variation in the strengths of various samples, hence the need to take average strength into account while comparing the mixes.

Table - 7
Compressive Strength of 14 day old specimens

Proportion	Load (kN)	Compressive Strength (N/mm ²)
Mix A	339	15.07
	412	18.31
	432	19.20
Mix B	640	28.44
	610	27.11
	605	26.89
Mix C	490	21.78
	650	29.89
	625	27.78
Mix D	615	27.33
	740	32.89
	900	40.00

Table - 8
Compressive Strength of 28 day old specimens

Proportion	Load (kN)	Compressive Strength (N/mm ²)
Mix A	435	19.33
	482	21.42
	455	20.22
Mix B	660	29.33
	535	23.78
	705	31.33
Mix C	555	24.67
	645	28.67
	495	22.00
Mix D	730	32.44
	820	36.44
	860	38.22

Chart 1 depicts the 14-day compressive strength of each of the 3cube specimens casted for various types of mixes.

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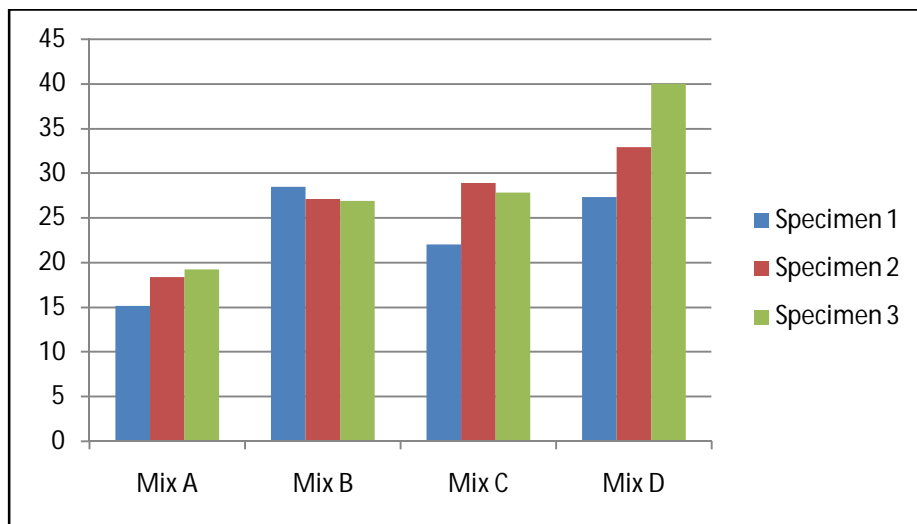


Chart 1: Strength of Cube Specimens after 14 Days (N/mm²)

Chart 2 depicts the 28-day compressive strength of each of the 3 cube specimens casted for various types of mixes.

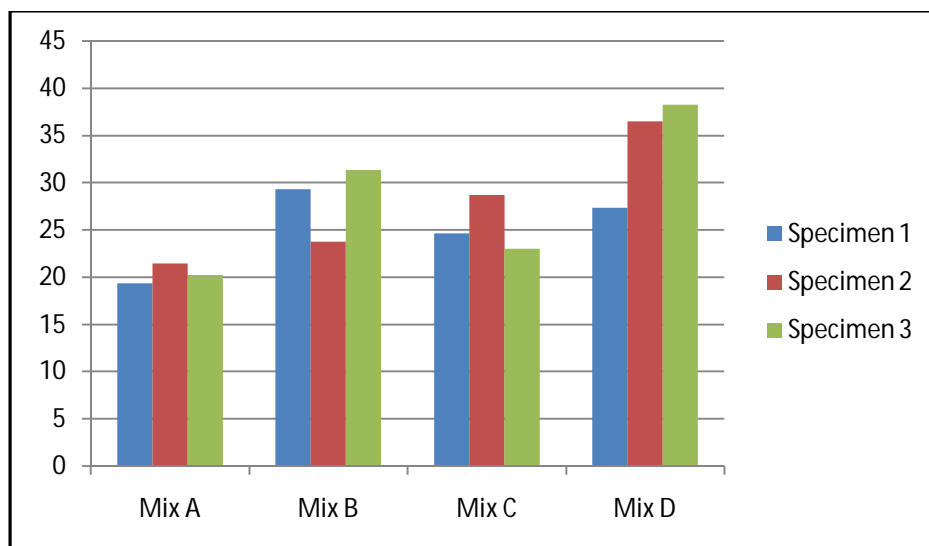


Chart 2: Strength of Cube Specimens after 28 Days (N/mm²)

For preparing Chart 3, average of the 3 values of compressive strength for each of the Mixes were calculated. Chart 3 compares the Average 14-Day compressive strength & Average 28-Day compressive strength of all the mixes with the 14-Day compressive strength & 28-Day compressive strength of M-20 grade nominal mix of concrete.

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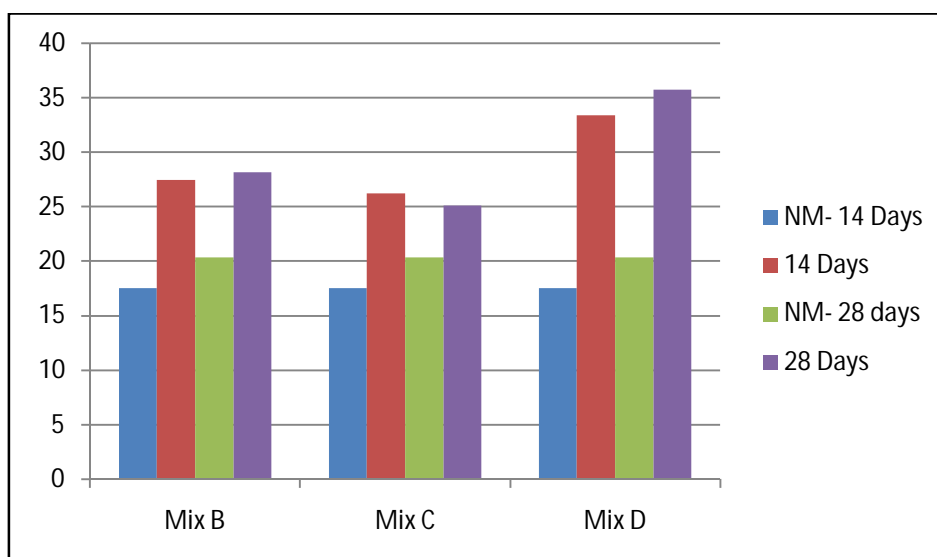


Chart 3: Comparison of Specimen strengths with that of Nominal Mix on corresponding days (N/mm²)

V. CONCLUSIONS

As shown in the analysis that introduction of fibre as reinforcement improves the compressive strength considerably. The types of fibre considered in the study were wastes such as Lathe scrap from lathe industry, and hair fibre from sources such as hair salons etc. Each type of fibre had its characteristics properties and limitations. The fibres had to be uniformly mixed and spread throughout the concrete mix. Thus, the manual method of distribution of hair fibres was adopted which proved to be quite efficient.

The compressive strength of concrete is one of the important and useful properties of concrete. In most structural applications concrete is employed primarily to resist compressive stresses thus our project primarily focuses on dealing with compressive strength. In those cases, where strength in tension or in shear is of primary importance, the compressive strength is frequently used as a measure of these properties. Therefore the concrete making properties of various ingredients of mix are usually measured in terms of the compressive strength. By testing of different mix it was observed that there is significant influence of fibre in determining the compressive strength. An increment in the various properties and strength of concrete, after the addition of fibre as reinforcement was observed.

Based on the experimental results the following points were observed with respect to the effect of fibre reinforcement on compressive strength of concrete.

- The most significant increase of compressive strength is obtained with addition of 1% lathe scrap.
- Results are more effective in hair fibre reinforcement when quantity of hair is kept 1.5% by weight of cement.
- Strength is slightly decreased when quantity of hair is kept at 2.5% by weight of cement.
- Using waste fibres such as lathe scrap and hair for reinforcement is one of the economical way for their use in an efficient manner.

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