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Experimental Study on Partial replacement of Cement with Paper sludge Ash, Glass Fiber and Coarse Aggregate with Recycled Tyre Waste

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ABSTRACT: Portland cement is the most important ingradient of concrete and is a versatile and relatively high cost material. Large scale production of cement is causing environmental problems on one hand and depletion of natural resources on other hand. This work examines the possibility of using waste paper sludge ash to produce a low cost concrete by combining the various ratios of cement with waste paper sludge ash in concrete in concrete as a supplementary cementitious material was tested as an alternative to fiber reinforced concrete. The disposal of the waste tyres in landfills is a major issue handled by the local local municipalities and government sectors. This new problem gave an idea of recycling of waste tyres instead of filling them in bare lands. In this study, waste paper sludge ash was partially replaced from 6%, 12% and 18% in cement, recycled tyre waste replaced by coarse aggregate at 20% and addition of the glass fibers at different proportions of 0.15%, 0.3% and 0.45% are used in the M25 mix and tested for its compressive strength, split tensile strength and flexural strength upto 28 days of strength and compared with conventional concrete. Test result shows that by the replacement of cement with waste paper sludge ash at 12% and glass fiber of 0.3% gives maximum strength.

KEYWORDS: Waste Paper Sludge Ash, Glass Fibers, Recycled Tyre Waste, M25 Mix, Compressive strength, Split Tensile Strength, Flexural Strength and Conventional Concrete.

I. INTRODUCTION

In modern time, construction is the main part of structural development of the nation. Concrete is the most important part of the construction whose manufacturing composed of components such as cement, aggregates, water and admixtures. In the construction, concrete is used to meet all the requirements such as strength, workability, durability and fire resistance. As we know growth of industrialization is increased day by day, due to which large amount of waste is also produced this is the major drawback to dispose safely. Hence to control this problem the reuse of recycle of the waste can also be done. Hence the waste generated by the industries and agriculture field can be used as a substituent construction material, so that production of natural resources can be easily done and disposal of harmful waste can be reuse and reduced. In present, due to rising construction work, the need of raw material such as aggregates etc. also raise the increase in demand of concrete. So this is based on the reuse of the waste paper sludge ash (WPSA) and recycled tire waste in concrete. Both the materials used in this investigation are waste generated by factories.

II. MATERIAL USED:

In this research work various materials like cement, fine aggregates, coarse aggregate, waste paper sludge ash, glass fiber and recycled tyre waste.

2.1 CEMENT :

Cement is the most important properties of concrete and acts as a binding material. Regular Portland cement is one of the maximum widely used sort of Portland cement. Ordinary Portland cement has initial setting time is not less than 30 minutes and final setting time not greater than 10 hours. Various features of OPC is classifies into three grades i.e. 33 grade, 43 grade and 53 grade. In this investigation, grade 53 OPC was used.

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Table 1: Physical Properties of Cement

SR. NO.	CHARACTERISTICS	UNITS	RESULTS	VALUE SPECIFIED
1.	Consistency		30%	25-30%
2.	Specific Gravity		2.89	3.15
3.	Setting time (1) Initial (2) Final	Minutes	 89 390	 30 (minimum) 600(maximum)
4.	Compressive Strength (1) 3 days (2) 7 days (3) 28 days	Mm2	 15.3 24.3 39.7	 23 33 43
5.	Fineness	m2/kg	268	
6.	Le-chat expansion	mm	0.5	10
7.	Autoclave expansion		0.11	0.8

2.2 COARSE AGGREGATE:

Aggregates mostly used for manufacture of concrete are sand, gravel, broken bricks, saw dust etc. coarse aggregates are those materials which is retained on IS Sieve no. 4.75. Locally available coarse aggregate were used in this investigation having the sie of 10mm and 20mm.

Table 2 : Properties of Coarse Aggregates (IS: 383-1970)

SR. NO.	CHARACTERISTICS	VALUES
1	Colour	Grey
2	Shape	Angular
3	Maximum Sie	20mm
4	Specific Gravity	2.73
5	Fineness Modulus	6.99

2.3 FINE AGGREGATE:

Fine aggregates are those materials which are passing through 4.75mm IS sieve were obtained from locally available river. The fine aggregate is classified to fall under different one i.e. one I to IV as per the recommendations of IS: 383-1970.

Table 3 : Physical Properties of Fine Aggregates

SR. NO.	PHYSICAL PROPERTIES	OBSERVATION	UNITS
1	Appearance	Dark Grey	-
2	Specific Gravity	2.65	-
3	Water absorption	1.43	%
4	Moisture Content	0.17	%
5	Bulk Density (Loose)	1672	Kg/m3
6	Bulk Density (Compacted)	1900	Kg/m3

2.4 WASTE APER SLUDGE ASH:

Waste paper sludge was obtained from paper industries. It was then sun dried and incinerated so as to convert it into ash. As waste paper sludge ash contains high amount of silicon dioxide SiO_2, it may provide extra strength to concrete.

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Table 4 : Chemical composition of Waste Paper Sludge Ash

Property	Value
Silicon Dioxide	59.47%
Calcium Oxide	8.69%
Alumina And Ferric Oxide	10.45%
Magnesium Oxide	3.13%

2.5 GLASS FIBER:

Glass fibers contain silica more than 50% and other components like aluminium, calcium and magnesium oxide and borate. Glass fibers are used in this research by 0.15%, 0.30% and 0.45% by weight.

Table 5 : Properties of Glass Fibers

PROPERTY	VALUE
Density	2.7
Tensile strength (MPa)	1700
Modulus (GPa)	72
Percent Elongation	2.3

2.6 RECYCLED TYRE WASTE:

In this study, possible use of tire in concrete for partial coarse aggregate replacement to provide possible solution for tire waste management as well as aggregate resource conservation. We replace the tire with coarse aggregate at 20% of aggregate used.

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Table 6 : Physical Properties Of Tyres

SR. NO.	PHYSICAL PROPERTIES	TYPICAL VALUES
1	Particle Sie	4.75 to 10mm
2	Abrasion	0
3	Water Absorption	0
4	Specific Gravity	1.09
5	Tensile Strength (kg/cm2)	35 (minimum)
6	Elongation Break	200%or 2L

III. EXPERIMENTATION

Compressive Strength: To check the performance of concrete, at the compressive power of concrete 150mm cubes are cast and tested, 20mm maximum sie of aggregate are used. After casting all the specimens were placed in water tank for curing at ages of 7 days, 28 days. The test results are presented here for the compressive strength of 7 days and 28 days testing.

Split Tensile Strength: Split tensile was performed on the cylinders 150mm dia and 300mm height on compression testing machine. The failure load was recorded to find out the split tensile strength. In cylinder combined percentage of sludge ash and adding glass fiber and recycled tyre waste in which maximum strength is obtained used t get optimized strength.

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Flexural strength: Flexural strength is also referred to as modulus of rupture. In the present investigation, sie of the beam (100×100×500mm). Number of beams were casted and tested as per IS: 516-1959. The load is applied continuously at a rate of 180 kg/cm2/minute. The load is applied till the specimen fails and the maximum load at failure is recorded. The position of the crack is measured.

IV. OBSERVATIONS

COMPRESSIVE STRENGTH

Table 7 : Shows compressive strength after various ages in N/mm^2

MIX	Average compressive strength of concrete in N/mm^2	
	7 days	28 days
M	19.41	34.72
M1	25.32	37.23
M2	26.14	38.85
M3	25.44	37.97
M4	26.13	37.74
M5	27.24	39.34
M6	26.22	38.46
M7	25.29	36.61
M8	26.37	38.23
M9	25.81	37.35

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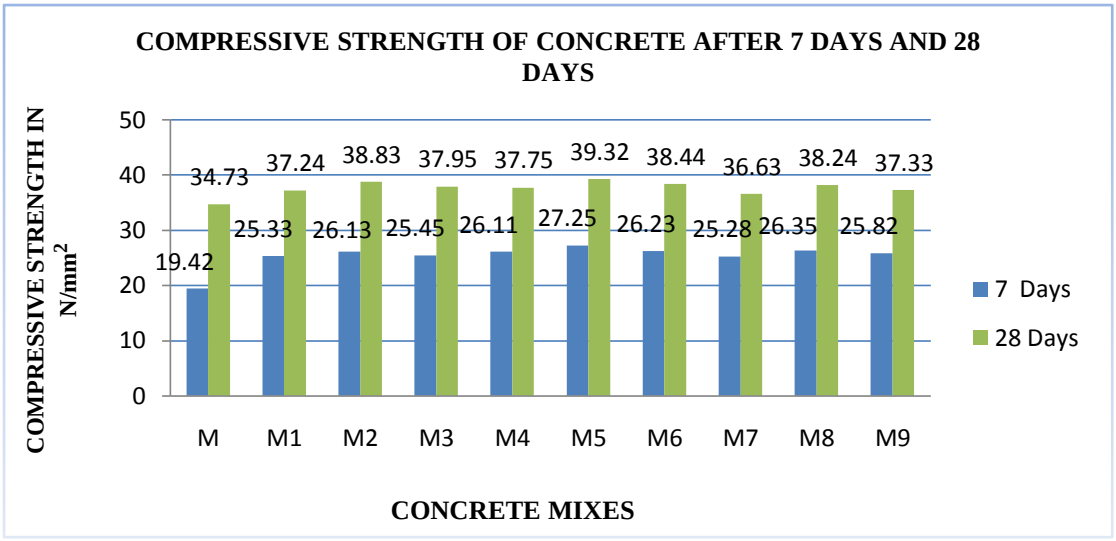

Fig. 5.2: Bar chart of compressive strength of concrete

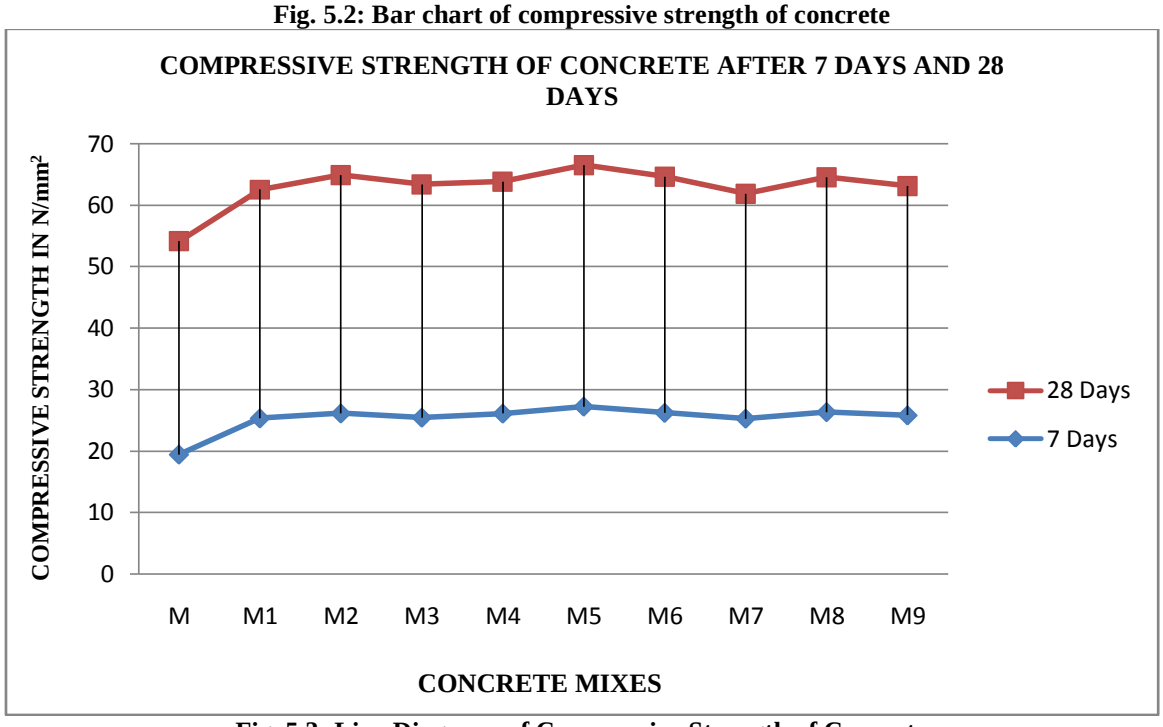

Fig. 5.3: Line Diagram of Compressive Strength of Concrete

SPLIT TENSILE STRENGTH

Table 8 : Shows Average Split Tensile strength of Concrete After Various ages in N/mm^2

MIX	Average Split Tensile Strength of Concrete in N/mm^2	
	7 Days	28 Days
M	2.21	2.39
M1	2.34	2.59
M2	2.40	2.72
M3	2.34	2.64
M4	2.43	2.67
M5	2.49	2.80
M6	2.44	2.72

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M7	2.35	2.58
M8	2.41	2.71
M9	2.35	2.63

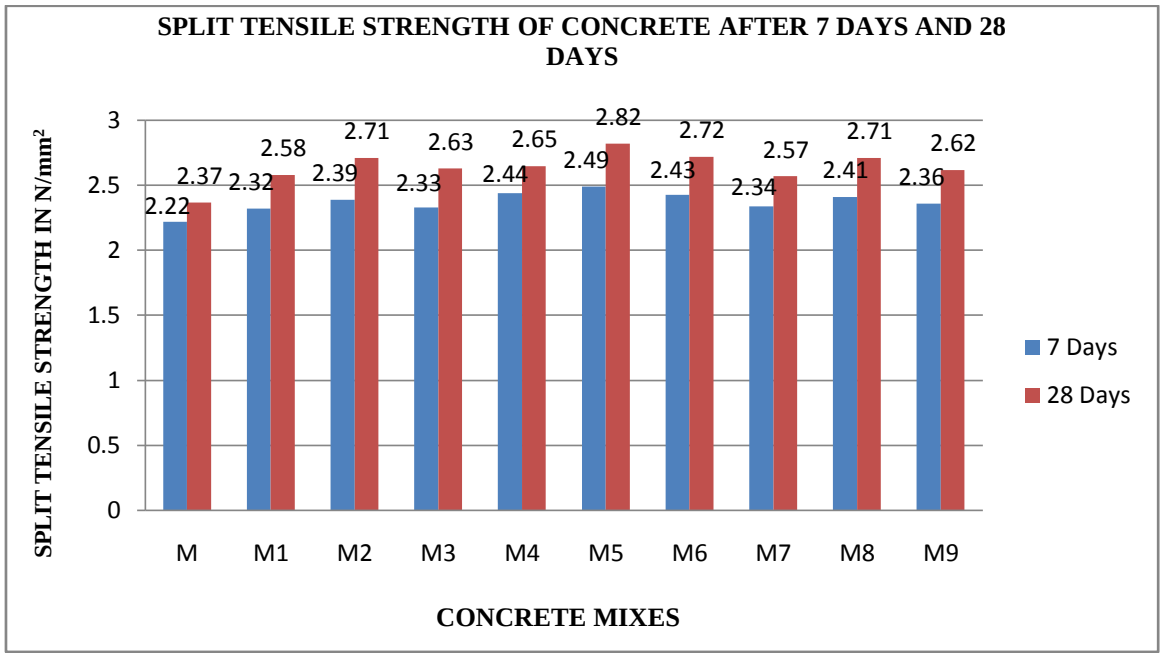

Fig. 5.5: Bar Chart of Split Tensile Strength of Concrete

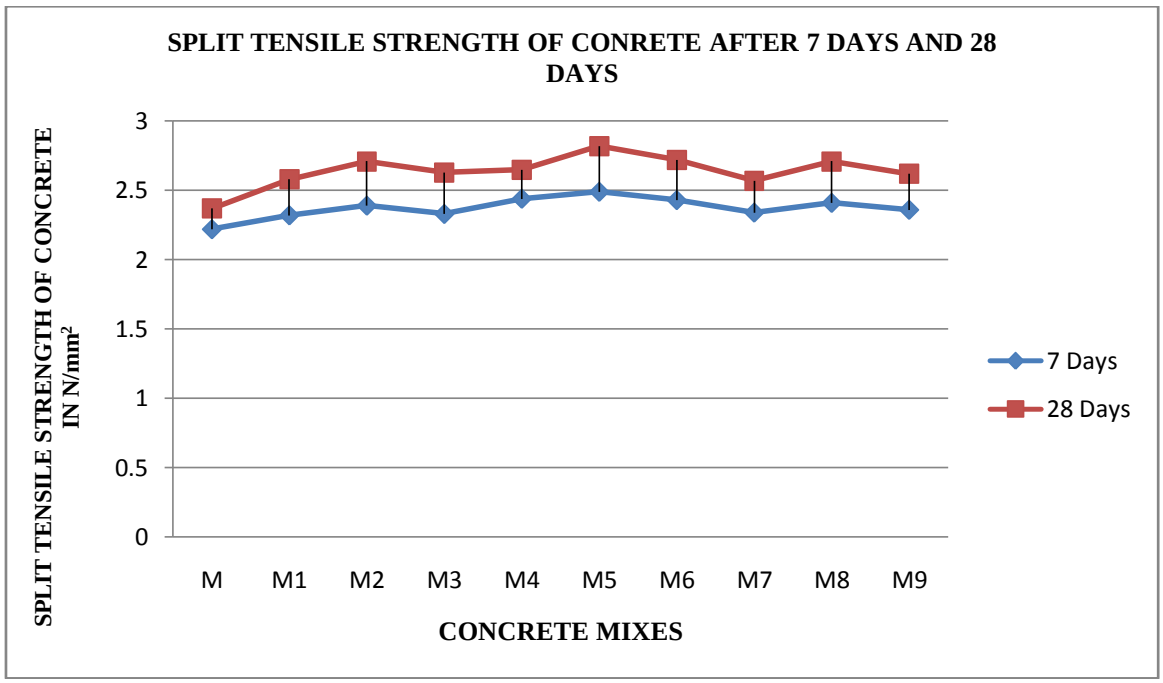

Fig. 5.6: Line Diagram of Split Tensile strength Of Concrete

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FLEXURAL STRENGTH

Table 9: Shows Average Flexural strength Of concrete After Various ages in N/mm^2

MIX	Average Flexural Strength Of concrete In N/mm^2	
	7 Days	28 Days
M	4.10	4.29
M1	4.22	4.75
M2	4.36	5.09
M3	4.18	4.95
M4	4.37	4.85
M5	4.51	5.19
M6	4.33	5.04
M7	4.31	4.72
M8	4.45	5.06
M9	4.27	4.91

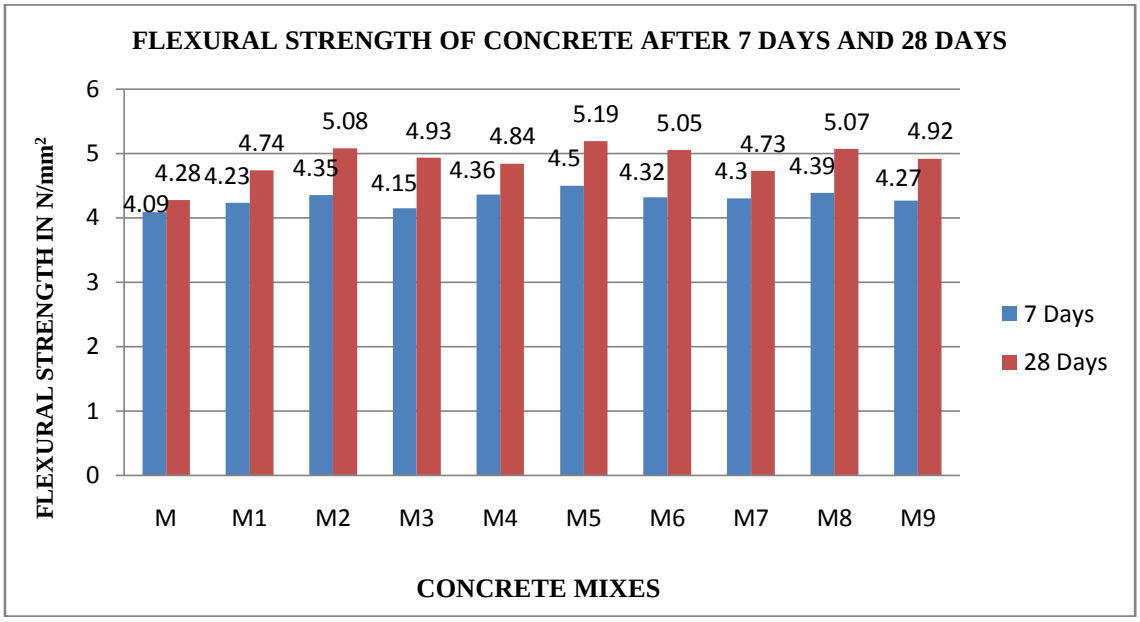

Fig. 5.8: Bar Chart Of Flexural Strength Of Concrete

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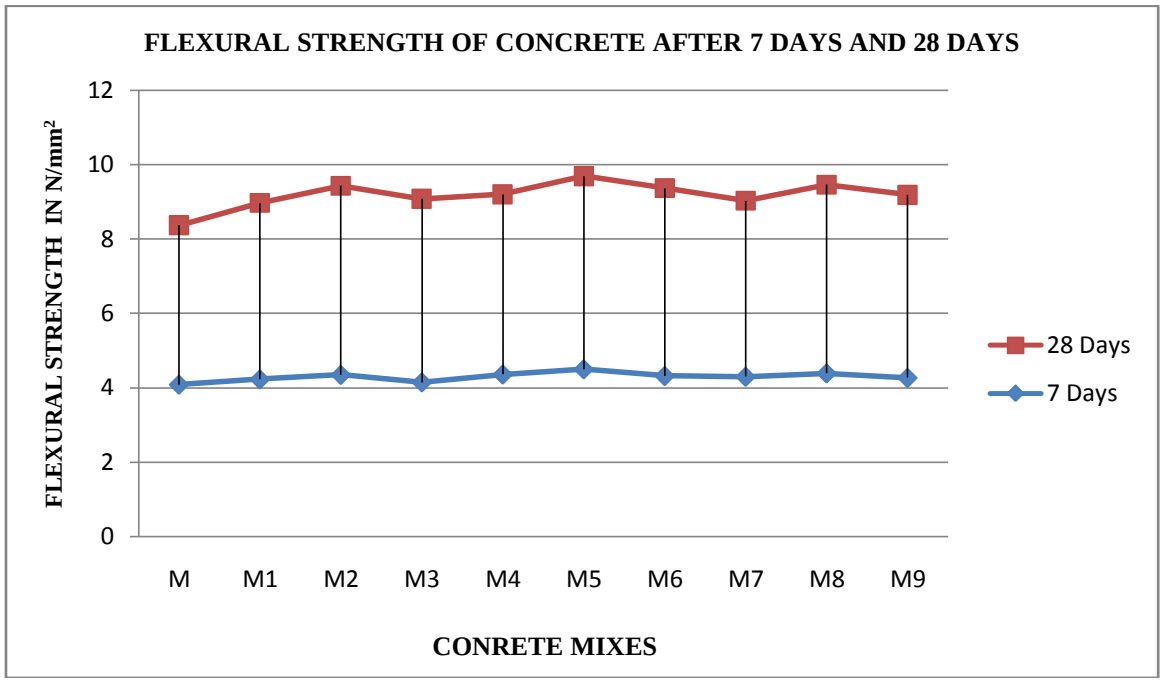

Fig.5.9: Line Diagram of Flexural Strength

V. CONCLUSION

Waste paper sludge ash used as an replacement in various percentage by weight of cement and glass fiber by weight of concrete. We also used recycled tire waste as an replacement with coarse aggregate. In Trial M5, replacement of 12% waste paper sludge ash by weight of cement, 0.3% glass fiber by weight of concrete and 20% recycled tire waste by weight of coarse aggregate shows better results in strength as compared to other percentage. Strength test was conducted on concrete and results shows there is 39.34N/mm^2 increase in compressive strength on Trial M5 by replacing 12% waste paper sludge ash and 0.3% glass fiber. Strength test was conducted on concrete and result shows that there is 2.80N/mm^2 increase in split tensile strength on Trial M5 by replacing 12% waste paper sludge ash and 0.3% glass fiber. Strength test was conducted on concrete and result shows that there is 5.190N/mm^2 increase in flexural strength on Trial M5 by replacing 12% waste paper sludge ash and 0.3% glass fiber.

VI. FUTURE SCOPE

1. Use waste paper sludge ash to produce low cost concrete by combining various ratios of cement and to reduce disposal and pollution problems due to waste paper sludge ash.
2. Using waste material as cement replacement can save the environment from pollutants and make concrete economical.
3. Tyre powder can be used as fine aggregate.
4. Tyre chips can be replaced by same sie of coarse aggregate.

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