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INVESTIGATION BASED ON PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH WASTE TYRE RUBBER IN CONCRETE

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ABSTRACT: At present the disposal of waste tyres in becoming a major waste management problem in the world. It is estimated that 1.2 billions of waste tyre rubber produced globally per year. It is estimated that 11% of post consumertyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering projects. Hence efforts have been taken to identify the potential applications of waste tyres in civil engineering projects. In this context, our present study aims to investigate the optimal use of waste tyre rubber as coarse aggregate in concrete composite. M30 grade by replacing 10%, 20% and30% of tyre aggregate with coarse aggregate and compared with regular M30 grade concrete.

KEYWORDS: waste tyres, concrete, compressive strength, tensile strength, flexural strength

1. INTRODUCTION

1.1 GENERAL:

With the development of modern society's aftermath of industrial revolution, the mobility within automobile sector got momentum. The offshoot of this pragmatic revolution gave rise to new dimensions of problems in the form of rubber garbage. Tyre rubber wastes represent a major environmental problem of increasing significance. An estimated 1000 million tyres reach the end of their useful lives every year. At present enormous quantities of tyres are already stockpiled or landfilled; Tyre landfilling is responsible for a serious ecological threat. Mainly
wastetyres disposal areas contribute to the reduction of biodiversity also the tyres hold toxic and soluble components. Secondly although waste tyres are difficult to ignite, this risk is always present.

Once tyres start to burn down due to accidental cause's high temperature take place and toxic fumes are generated besides the high temperature causes tyres to melt, thus producing an oil that will contaminate soil and water. St illmillions of tyresare just being buried all over the world. Tyre rubber wastes are already used for paving purposes; however, it can only recycle a part of these wastes.

1.2 OBJECTIVE & SCOPE

1.To study the durability properties of M30 grade of concrete reinforced by rubber aggregate
2.To identify and study the basic engineering properties like compression strength of the concrete
3. To compare the properties of conventional concrete

2. METHODOLOGY

2.1. CEMENT

2.1.1. Consistency test

Procedure:

- Take 300 g of cement
- Mix it with 28 % of water
- Now put the mix in the mould of the apparatus
- Fix the plunger of size 10 mm diameter and 50 mm length
- Let off the pin and note the reading
- Continue the procedure until we get the reading between 5-7 cm
- Note the consistency of cement in percentage

2.1.2. Specific gravity test

Procedure:

- Weigh of the specific bottle in dry (W_1)

- Fill the bottle with water and weigh the bottle (W_2)
- In dry the specific gravity bottle and fill it with kerosene and weigh (W_3)
- Pour some amount of the kerosene out and introduce a weighted quantity of cement (say about 60 g) into the inclined position until no further air bubble rise to the surface. Fill the bottle to the top with kerosene and weigh it (W_4)

2.1.3. Fineness test

Procedure:

- Take the 100 g of cement
- Put the entire sieve in the sieve shaker and put the cement on top of the sieve.
- Then rotate the sieve shaker for 15 minutes.
- Now remove the sieve form the sieve shaker.
- Note the weight of cement retained on the IS sieve.

2.2. FINE AGGREGATE TEST

2.2.1. Fineness modulus test

Procedure:

- Take the 1kg of sand.
- Arrange the sieve from IS 4.75mm sieve to 150µ in descending order.
- Put the entire sieves in the sieve shaker and put the sand on top of the sieve.
- Then rotate the sieve shaker for 15 minutes.
- Now remove the sieves from sieve shaker.
- Note the weight of sand retained on each of the IS sieve.

2.2.2. Specific gravity test

Procedure:

- Take the empty pycnometer dry (W_1).
- Fill the pycnometer with sand (W_2).
- To fill the pycnometer with sand and water (W_3).
- Dry the pycnometer and fill it with distilled water and weigh (W_4).
- Specific gravity

- $$G = \frac{W2-W1}{(W2-W1)-(W3-W4)}$$

2.2.3.Water absorption test

Procedure:

- Take 200gms of oven dried fine aggregates (W1)
- Weight of the wet coarse aggregate(W2)
- Percentage of absorption=(W2 –W1)/ W1x 100

2.3 COARSE AGGREGATE

2.3.1.Fineness modulus test

Procedure:

- Take 10 kg of broken stone .
- Arrange the sieve sizes from IS 40 mm to 4.75 mm.
- The entire sieve in the sieve shaker and put the the gravel on top the sieve.
- The rotate the sieve about 15 minutes.
- The remove the all sieves from the sieve shaker .
- Note the weight of stone retained on each IS sieve.

2.3.2.Impact value of coarse aggregate

Procedure:

- The impact machine rests upon a base plate so that it is rigid, and hammer guide columns are vertical. The aggregate passing to 12.5 mm and retained 10mm filled the cub.
- The cub is fixed firmly in position on the base of the machine.
- The test sample in placed in it and compacted by tamping of 25 stocks.
- The hammer raise to height of 380mm above the upper surface of the aggregate in the top.

- The crushed aggregate is removed from the cup and is passed on 2.36 mm IS sieve.

2.4 FRESH CONCRETE TEST PROCEDURE
2.4.1.Slump cone test
Procedure:

- The internal surface of mould is cleaned and free from moisture and any old concrete before commencing the test.
- The mould is placed on the smooth horizontal rigid and observation surface.
- Concrete mix is prepared in freshly.
- The mould is then filled in four layer each approximate ¼ of the height of the mould..Each layer 25 times tamping and taking case to evenly over the cross section.
- The mould is remove from the corner immediately by raising it slowly and carefully in vertical direction.
- This allowed the concrete to subside. The subside is referred on the slump on concrete.The different in between height of mould end that of height part of subsident is measured.

2.4.2.Flow table test
Procedure:

- The table is cleaned of all materials and is weld. The mould is kept on the center of the table.
- Each layer is rodded 25 times with tamping rod 1-6 cm in diameter and 11 cm long rounded at lower tamping rod.
- After the top layer is rodded evenly the excess of concrete which has over flowed the mould is removed.
- The diameter of the spread concrete is measure is above six(6) direction.

2.4.3.Compactor factor test
Procedure:

- The inner surface of the hopper and cylinder are greased.
- The weight of empty cylinder with it base (W_1) is determined.
- The sample of concrete to be test is placed in upper top to brim. The trap door is open so that concrete falls into lower hopper.
- Then trap door of lower hopper is open and the concrete is allowed to fall into cylinder.
- In such a case a blight poking by a rod may be required to see the concrete in portion. The excess concrete remaining about the top level of cylinder is then cut off with plane bladder.
- The outside cylinder is wiped clean the concrete is filled up with exactly up to top level.The cylinder is emptied and then refilled either concrete from same sample layer approximate 5 cm deep the layer are ramped and perfectly liberated so as to attain full compaction.

$$compaction\ factor = \frac{\text{weight of partially compacted concrete}}{\text{weight of fully compacted concrete}}$$

2.5 STRENGTH TESTING PROCEDURE

The standard size of concrete cube is 150mm X 150mm X 150mm and concrete beam of size 500mm X 100mm X 100mm and cylinder specimen of 150mm diameter and 300mm height were cast to determine the compressive strength and flexural strength and split tensile test of the concrete at 7 days and 28 days.The specimens were demoulded after casting and they are cured for 7 days and 28 days.

2.5.1. Compressive strength test

Procedure:

- Calculate the material required for the each mix proportion.

- The standard cube specimens of size 150mm x 150mm x 150mm were cast for each mix proportion.Fillmould in three layer each of approximately 50mm deep and each layer 25 times with tamping rod bucking can to distribute the strokes evenly the cross section.
- After the curing for required period the specimens were tested using compressive testing machine.
- The maximum load taken by specimen was recorded.Compressive strength is determined using the following formula

$$Compressive\ strength = \frac{\text{Maximum load (N)}}{\text{Cross sectional area (mm2)}}$$

2.5.2. Flexural strength test
Procedure:

- Calculate the material required for the each mix proportion.
- The prisms size 100mm x 100mm x 500mm were cast for required mix proportion.
- After curing for required period the specimens were tested.
- The modulus of rupture is calculate using the following formula

Modulus of rupture, $f_a = PL/bd^2$

Where, f_b = modulus of rupture in Mpa

P = Maximum load applied on the specimen

L = Length of the span on which specimen is support (400mm)

b = Width of the specimen

2.5.3.Split tensile test

Procedure:

- Cylindrical specimens of diameter 150mm and length 300mm were cast for required mix proportion.After the curing for required period the specimens were tested.
- The split tensile strength calculated using the following formula

Split tensile strength = 2P/πLD

Where, P is the compressive load on the cylinder

L is length of the cylinder ; D is the diameter of the cylinder

3. RESULTS AND DISCUSSIONS

Various tests had been conducted on materials and strength aspects had been tabulated from Tables 3.1 to 3.14 and graphs showing the variation in strength had been shown from Fig 3.1 to 3.6.

Table 3.1.Consistency of Cement

Cement (gm)	Water %	ml of water added	Needle Reading
300	26	78	48
300	28	84	35
300	30	90	21
300	32	96	30
300	34	102	0.7

Consistency of the cement , P =34%

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Table 3.2 Test results of fine aggregate

Sieve size	Weight retained (gm)	% Weight retained	% of passing	Cumulative weight retained
4.75 mm	10	0	98	10
2.36 mm	50	2	88	60
1.18 mm	50	12	78	110
600mic	95	22	59	205
300mic	175	41	24	380
150mic	85	76	7	465
75mic	35	93	-	500

Fineness modulus of fine aggregate = F/100 =247.14/100 =2.47

Table 3.3 Specific gravity test results

Weight of empty pycnometer , W 1 ingm	Weight of empty pycnometer + sand , W 2 in gm	Weight of empty pycnometer + sand + water , W 3 in gm	Weight of empty pycnometer + water , W 4 in gm	Specific gravity =(W2-W1)/((W2-W1)-(W3-W4))
456	1133	1677	1261	2.65

Table 3.4 Fineness modulus

Sieve size	Weight Retained (gm)	% Weight Retained	% of passing	Cumulative weight retained
40 mm	0	0	100	0
25 mm	780	7.80	92.2	7.80
20 mm	5580	58.80	33.40	66.60
16 mm	1080	10.80	22.60	77.40
12.5 mm	1640	16.40	6.20	93.80
10 mm	500	5.00	1.20	98.80
6.3 mm	74	0.74	0	100
Pan	46	0.46	0	100

Fineness modulus of fine aggregate = F/100

=539/100

=5.39

Table 3.5 Specific gravity of coarse aggregate

Weight of empty pycnometer , W 1 in gm	Weight of empty pycnometer +coarse aggregate , W 2 in gm	Weight of empty pycnometer + coarse aggregate + water , W 3 in gm	Weight of empty pycnometer + water , W 4 in gm	Specific gravity =(W2-W1)/((W2-W1)-(W3-W4))
456	1108	1670	1261	2.68

Table 3.6 Results of Slump cone test

Initial height of specimen	Height after lifting cone	Slump value in mm
30	25.4	46

Degree of workability is medium

Table 3.7 Compaction factor test

S.NO	W/C Ratio	Mass with partially compacted concrete (g) (W_2)	Mass with fully compacted concrete (g) (W_3)	Mass ($W_1 - W_2$) (g)	Mass ($W_3 - W_1$) (g)
1	0.45	19.03	11.49	11.812	0.923

Table 3.8 Compressive strength of cube for 7 days

% of addition of waste tyre rubber aggregate	Cube no .	Load in KN	Compressive strength in N/mm 2	Avg.
Control mix	1 2	526 528	23.37 23.46	23.41
10% of rubber aggregate	1 2	540 543	24 24.13	24.1
20% of rubber aggregate	1 2	596 599	26.48 26.62	26.55
30% of rubber aggregate	1 2	632 629	28.1 27.95	28.02

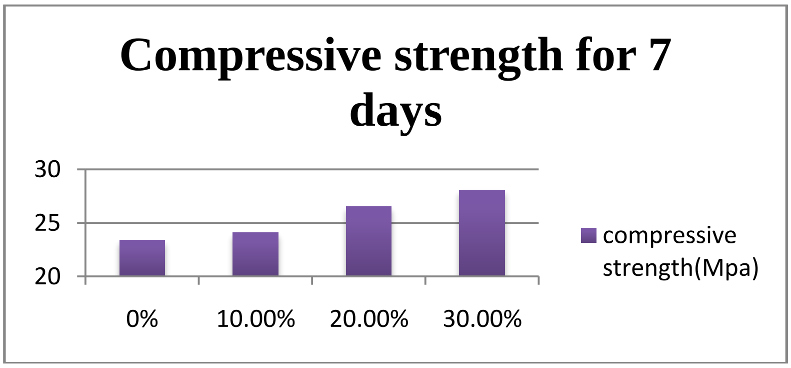

Fig 3.1 Compressive strength in 7 days

Table 3.9 Compressive strength of cube for 28 days

% of addition of waste tyre rubber	Cube number	Load in KN	Average Load in KN	Compressive strength in N/mm^2
CONTROL MIX	1. 2.	705 701	695.33	30.91
10% of rubber aggregate	1. 2.	724 727	725.5	32.24
20% of rubber aggregate	1. 2.	799 795	797	35.42

30% of rubber aggregate	1. 2.	830 833	831.5	36.95

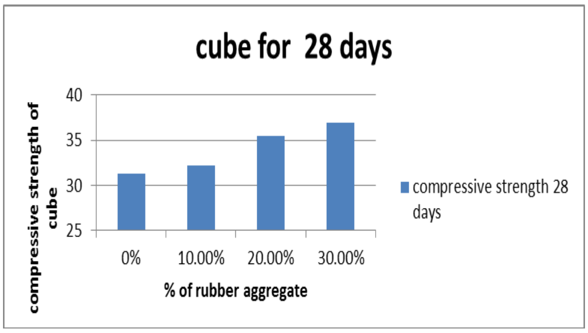

Fig 3.2 Compressive strength in 7 days

Table 3.10 Split tensile strength for 7 days

% of addition of waste tyre rubber	cylinder number	Load in KN	Average Load in KN	Split tensile strength in N/mm ^{2}
CONTROL MIX	1. 2.	27.2 27.4	27.26	3.85
10% of rubber aggregate	1. 2.	27.6 27.4	29.43	4.2
20% of rubber aggregate	1. 2.	30.6 30.8	30.6	4.34
30% of rubber aggregate	1. 2.	31.4 31.4	31.4	4.42

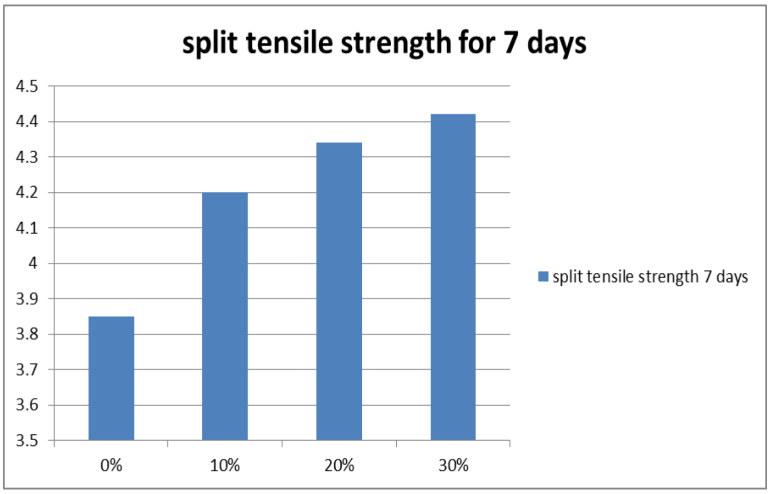

Fig 3.3Split tensile strength in 7 days

Table 3.11 Split tensile strength for 7 days

% of addition of waste tyre rubber	cylinder number	Load in KN	Average Load in KN	Split tensile strength in N/mm ^{2}
CONTROL MIX	1. 2.	31.15 31.16	31.15	4.45
10% of rubber aggregate	1. 2.	34.28 34.42	34.30	4.85
20% of rubber aggregate	1. 2.	36.37 36.35	36.36	5.175
30% of rubber aggregate	1. 2.	36.94 36.90	36.92	5.22

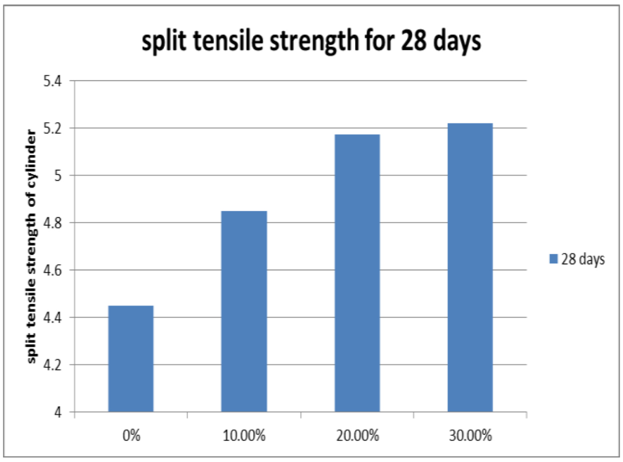

Fig 3.4 Split tensile strength in 28 days

Table 3.12Flexural strength for 7 days

4% of addition of recron 3s fibre	beam number	Load in KN	Flexural strength in N/mm ^{2}
CONTROL MIX	1.	16.21	3.365
10% of rubber aggregate	1.	16.73	3.47
20% of rubber aggregate	1.	17.55	3.68
30% of rubber aggregate	1.	18.14	3.76

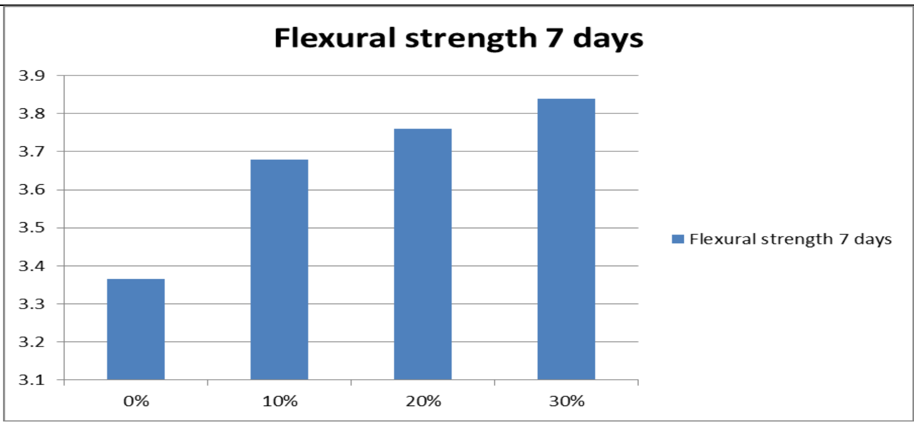

Fig 3.5Flexural strength in 7 days

Table 3.13 Flexural strength for 28 days

% of addition of waste tyre rubber	Beam number	Load in KN	Flexural strength in N/mm^2
CONTROL MIX	1.	18.76	3.895
10% of rubber aggregate	1.	20.45	4.245
20% of rubber aggregate	1.	21.84	4.53
30% of rubber aggregate	1.	22.07	4.61

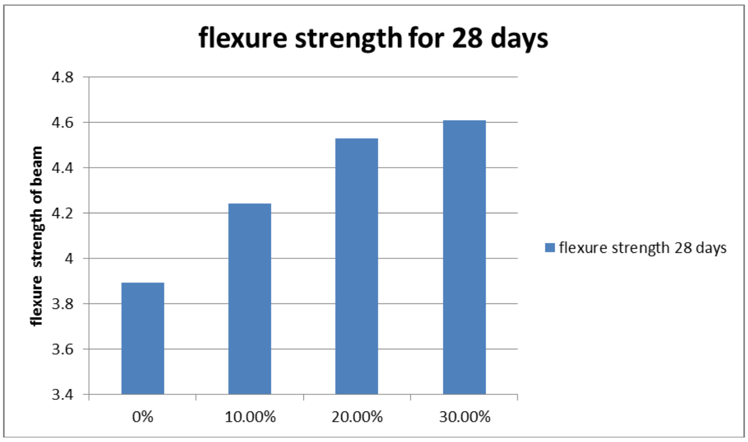

Fig 3.6 Flexural strength in 28 days

4. CONCLUSION

The rubberized concrete does not reduce the cost and even reduce the environmental impacts of concrete itself, but it helps eliminate the waste tire stockpiles and reduce the potential threats of the stockpiles to the environment. Volumetric portions ranging 10% to 100% replacements of coarse aggregate were tested for fresh and hardened concrete properties. Nine mixtures were batched in two phases.

The first phase was designed to examine if there is a promise to replace coarse aggregate by tire chips in pavement concrete mixtures. And the second phase was to investigate the optimum cement content among the mixtures. This study evaluated and reported the fresh concrete properties including slump, air content, unit weight, and hardened properties including compressive, flexural, splitting tensile strengths, permeability and freeze/thaw resistance of rubberized concrete mixtures.

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