Study on Concrete with Waste Tyre As Replacement for Aggregate

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Abstract— Concrete is a construction material. It has cement, fine aggregate, coarse aggregate and water in proper mix proportion as per IS code 10262-2009. In addition to ordinary concrete the waste tyre rubbers are addad to the concrete.The percentage replacement of waste tyre fine aggregate (<4.75mm) used in this project are 2.5%, 5%,7.5%, and 10% and the percentage replacement of waste tyre coarse aggregate used in this project are 12.5%, 25%,37.5% and 50%. The coarse aggregates are 60% of size 10mm to 20mm size and 40% of 4.75mm to 10mm size for better compaction and to avoid voids during casting and surface finishing. The objective of this project is to determine the compressive strength, split tensile strength and flexural strength at which concrete cube, cylinder and prism fails.

The concrete strengths of compression, split tension and flexure values varies with in a limit of 20%. Hence it is concluded that fine aggregate and coarse aggregate tyre waste can be used upto 5% and 25% for compressive strength, 7.5% and 37.5% for split tension tensile strength and 2.5% and 12.5% for flexural strength replacement in concrete with loss of strength up to 20%.

1. INTRODUCTION

Now days vehicles are increased according to their population density of particular country. At the same time the tyre wastage also increased. Every year about 3.2 million tonnes of used tyres (part worn + end of life tyres) are generated in EU27+NO+CH, of which 2.5 million tonnes are either recycled or recovered. This amounts to approximately 250 million units. The remaining tyres are taken into account for this research. Stocked tyres pollutes both land, water and air. Now a days it create hazardous health issues like dengue because of enormous amount of mosquito's live in tyre stocks leads to dangerous ecology. The waste tyre fired it emit dangerous gases like hydrogen sulphide (H2S) and dangerous odour to environment. It should be controlled by adding some natural concrete materials like replacement of fine aggregate and coarse aggregate into the concrete. Studies were conducted on rubberized concrete in which waste tyre rubber was substituted for aggregates or cement. Reduction in compressive strength limits their applicability in structural buildings. This research is mainly concentrates on concrete elements of highly seismic zone area because of the building damage reduce the injuries of human lives due to light weight concrete. It also concentrates on temporary structures like mass floor concrete, security room, partition walls etc.

2. LITERATURE REVIEW

2.1 Akinwonmi et al,

This research paper shows the usage of shredded tyre and crumb tyre solid bricks with0% tyre replacement as control then followed by 5%, 7.5%, 10%,12.5%, 15%, 17.5% and 20% separately for both shred and crumb rubber materials. The results of the compressive test show that by replacing the aggregate by 2.5 % shredded tyre, the compressive strength increased by about 8.5% but at 5% replacement and beyond, the compressive strength decreased. The waste tyre use up to 2.5% replacement.

2.2 El-Gammalet al,

The compressive strength and density of concrete is obtained by replacing recycled F.A and C.A tyre rubber waste into the concrete mix. 2 different forms of waste rubber tyre waste (i.e chipped & crumb) have been used in the study. The usage of chipped tyre waste into full replacement of coarse aggregate reduce the density (about 30% reduction) and compressive strength (about 90% reduction) compared to controlled mix.

2.3 Skripkiunas et al:-

This paper shows the details of deflection behavior of concrete specimen. The rubber additives were used as fine aggregate replacement in concrete mixtures by 3.2 % of aggregates weight.

3. MATERIALS

Cement: Cement is a primary binding material. It binds together for both fine aggregate, coarse aggregate and water. The cement used in this research is OPC 53 grade with specific gravity of 3.15. The used cement confirming to IS 12269-2013. The initial setting time of this cement is 30 minutes and the final setting time is 6 hours.

Fine aggregate: Fine aggregate is a secondary material in concrete. It fills the gap of coarse aggregate and gives smooth surface finish of concrete. The fine aggregate used in this research confirms to IS: 383-1970 with specific gravity of 2.6 and corresponding to the location of zone II.

Coarse aggregate: The coarse aggregate is a tertiary material in concrete. It gives better compressive strength to concrete. In this research the coarse aggregate size used from greater than 4.75mm to 10 mm (40%) and 10mm to 20mm (60%). The specific gravity of coarse aggregate is 2.70. Water absorption of coarse aggregate is 0.5%.

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Crumped rubber (CR): The crumb rubber is in the form of both fine aggregate size (less than 4.75 mm) as well as in coarse aggregate sizes (greater than 4.75mm). The waste tyres of same brand (Dunlop) are collected from puncher shops which is located near to St.Peter's University, Avadi, Chennai – 54. The maximum size of the rubber aggregate was 20 mm. Specific gravity of crumb rubber is 1.07. The specific gravity of coarse rubber is 1.14. Here also the proportion of coarse aggregate rubber size used from greater than 4.75mm to 10 mm (40%) and 10mm to 20mm (60%).

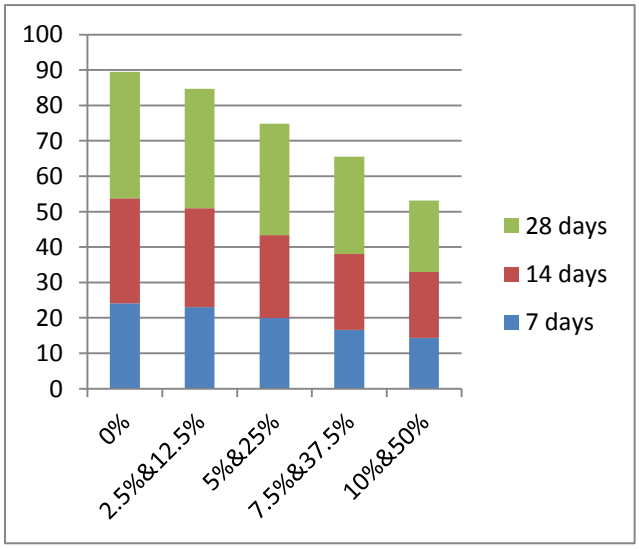
Water: Portable clean water has been used for concrete specimen casting and curing confirming to IS: 10262-2009.

4. RESULTS AND DISCUSSION

4.1 Compressive Strength:

Compressive strength test is a most common test of hardened concrete conducted on cube specimen. The concrete is prepared in the proportion as 0.62: 1: 2.2: 3.4. The concrete placed in moulds having forms of cubes with size as 150 x 150x 150 mm. The concrete, after being placed in moulds, is compacted in vibrating machine for 2 minutes and they are submerged in clean water for curing after 24hours of drying at room temperature. The cube specimen was tested by using UTM after 7days, 14days and 28 days curing and it is dried for normal conditions. The pressure application into the UTM machine is 1kN/m2throughout all the tests.

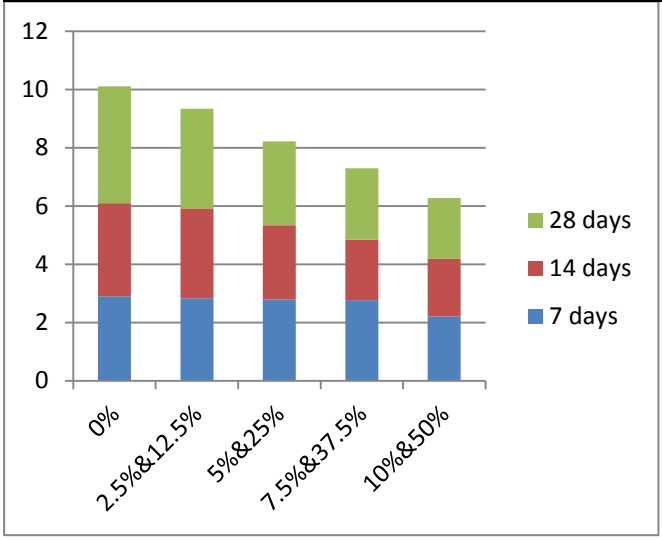
Replacement of fine aggregate by rubber and coarse aggregate by tyre	7days MPa	14days MPa	28days MPa
0%	24.07	29.73	35.66
2.5%and 12.5%	22.99	27.93	33.76
5% and 25%	19.92	23.47	31.47
7.5%and37.5%	16.65	21.34	27.63
10% and 50%	14.32	18.63	20.17



4.2 Split Tensile Strength:

Splitting tensile strength is obtained by applying force into cylinder specimen along its length at center of horizontal position of cylinders. The concrete placed in moulds having forms of cylinders with size as 150 mm diameter and 300mm height The concrete, after being placed in moulds, is compacted in vibrating machine for 2 minutes and they are submerged in clean water for curing after 24hours of drying at room temperature. The cube specimen was tested by using UTM after 7days, 14days and 28 days curing and it is dried for normal conditions. The pressure application into the UTM machine is 1kN/m2throughout all the tests.

Replacement of aggregate by rubber fine aggregate and coarse aggregate by tyre	7Days (N/mm^2)	14Days (N/mm^2)	28Days (N/mm^2)
0% a	2.90	3.19	4.02
2.5% and 12.5%	2.83	3.07	3.43
5% and 25%	2.79	2.54	2.88
7.5% and 37.5%	2.76	2.08	2.45
10% and 50%	2.20	1.98	2.09



4.3 Flexural Strength:

Replacement of Fine Aggregate by crumb rubber and coarse aggregate by tyre	7days (N/mm^2)	14days (N/mm^2)	28days (N/mm^2)
0%	5.95	6.98	7.77
2.5% and 12.5%	5.60	5.98	6.88
5% and 25%	4.53	5.08	5.60
7.5% and 37.5%	4.47	4.98	5.29
10% and 50%	4.20	4.62	4.87

Flexural strength is computed by applying load over the prism of size 500mm x 100mm x100 mm at center and two simply supports are fixed below the prism at 50mm from each ends of prism along the length direction.

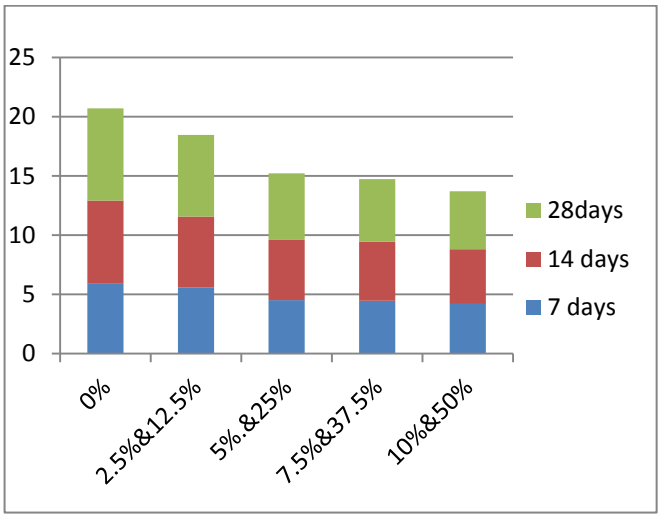


Fig 3.Flexural Strength

5. CONCLUSION

1. The compressive strength, split tensile strength and flexural strength is reduced according to the addition of tyre waste. But the value is with in 20% is acceptable.
2. The compressive strengths at 7days, 14days and 28 days for the normal concrete (0%) are 24.07 N/mm2, 29.73 N/mm2 and 35.66N/mm2and are higher than all the waste tyre replacement concrete. Theminimum values for 10% fine aggregate tyre replacement and 50% of coarse aggregate tyre replacements are 14.32N/mm2, 18.63N/mm2 and 20.17N/mm2 .
3. The split tensile strengths at 7days, 14days and 28 days for the normal concrete (0%) are 2.90 N/mm2, 3.19 N/mm2 and 4.02N/mm2 whichis higher than all the waste tyre replacement concrete. The minimum value for 10% fine aggregate tyre replacement and 50% of coarse aggregate tyre replacements are 2.20N/mm2, 1.98N/mm2 and 2.09N/mm2.
4. The flexural strengths at 7days, 14days and 28 days for the normal concrete (0%) are 5.95 N/mm2, 6.98 N/mm2and7.77N/mm2which is higher than all the waste tyre replacement concrete. The minimum value for 10% fine aggregate tyre replacement and 50% of coarse aggregate tyre replacements are 4.20N/mm2, 4.62N/mm2 and 4.87N/mm2.
5. Based on the study carried out, the reduction in strength is about 20% for the following cases:
   a) Compressive strength at 28 days with fine aggregate 5% and coarse aggregate of 25% with rubber.
   b) Splitting tensile strength at 28 days with fine aggregate 4% and coarse aggregate of 20% with rubber.
   c) Flexural strength at 28 days with fine aggregate 4% and coarse aggregate of 20% with rubber.
6. Hence it is concluded that fine aggregate and coarse aggregate can be used up to 4% and 20% replacement in concrete with loss of strength up to 20%.

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