Investigation Performance by Relatively Substitution of Cement and Coarse Aggregate by Fly ash and Waste Tire Rubber in Concrete

Netravati Y Banasode

M.Tech Student & Department of Civil Engineering, S.G.B.I.T. Belagavi, Karnataka, India.

Abstract - *One billion of used automobiles tires are produced per year. This is not easily biodegradable even after a lengthy duration landfill treatment. The usage of tire will reduce the environmental problems and increases savings of natural resources. At present the disposal of waste tires is becoming a major waste management problem in the world. It is estimated that 1.2 billion of waste tire rubber produced globally per annum. Only 11% of post-consumer tires are exported and 27% are sent to stockpiled, landfill or dumped illegally and 4% is used for civil engineering works. Fly ash is also a by-product from various industries. The use of fly ash in cement concrete as a partially replacement of cement. Using* M_{25} *grade of concrete and replacement of coarse aggregate and cement by 5%, 10%, 15% of tire rubber and 15% of fly ash. Tests on concrete are NDT, destructive and deformation is analyzed by Ansys software. It was finalized that concrete strength increased with increase in fly ash content and reduced with increase in tire rubber.*

***Key Words*: Tire, Fly Ash (F.A), Compressive Strength, Flexural Strength, Ansys software.**

1. INTRODUCTION

Concrete plays the main role in construction of Civil Engineering works. Billon tons of raw material uses in construction field each year, is the highest consumer of raw material in the global. Concrete is the maximum useful material in construction liable for the depletion of natural resources and increases the shortage of the ingredients such as steel, cement, and aggregates consequently there is a large demand for these materials in the commercial sector. In the background, there is higher requirement for different materials substance from the wastes. Over years, extraction and erosion of natural aggregates from water bodies like river beds, lakes etc. has shown in more environmental problem. Erosion of the present status shows in flooding and landslides. Moreover, the filtrating of rainwater conclude by deposits of natural sand is being lost; therefore polluted water is used for person utilization. So that officialdom is made some rules for removal of the aggregate and smashing. Come out from this we have to substitute in place of naturally available aggregate for the construction. So that in this paper used waste truck tire rubber of the size 20mm. It changes workability of the concrete and lowers demand of the water. The usage of fly ash in the concrete is decreases bleeding and segregation. This shows the improvement of concrete mixtures. In concrete Class F and Class C Fly Ashes is more major resistance of the sulfate and alkali aggregate reaction. Fly Ash has a lesser heat of hydration and decreases external cracking. This decreases the permeability and adsorption so that increases chemical resistance of concrete. The cost of the fly ash is less than the cement depending on transportation. And more over fly ash is very cheap.

2. MATERIALS USED

Coarse Aggregates (C.A) coarse aggregate were obtained in crushed form were of granite-type. The natural coarse aggregate is of angular shaped crushed granite with maximum size of 20mm and its specific gravity is 2.77 respectively.

Tire Aggregates (T.A) The waste rubber tire is not biodegradable easily and even after a longer period of landfill treatment. So that reuse of waste rubber tire is another method. The waste rubber tire chipped to the required size is substitute of coarse aggregate and crumb rubber tire for the fine aggregate. Waste rubber tire is used for different utilizations like, in cement kiln it is used as fuel, playground matt, erosion control, highway crash barriers, guard rail posts, noise barriers, and in asphalt pavement mixtures. And also used as feedstock for making carbon black, and in marine environment as artificial reefs. In construction industry, reuse of the waste rubber tire is an optimistic material because of its lightweight, elasticity, energy absorption, sound and also properties of heat insulating. In the project the concrete compressive strength in which substitution of the coarse aggregate by wastes rubber tires.

Fly Ash (F.A) Class-F fly ash was procured from "West Coast Paper Mills", Dandeli (Karnataka) and is used as one of the primary raw materials. And its specific gravity is 2.25 respectively.

Cement - Ordinary Portland cement (OPC) of 43-grade conforming to IS8112:1989 is used throughout this investigation. Cement is a most important constituent in concrete and well known binding material has occupied an indispensable place in the construction work.

Water - Fresh water with pH value of 7 available from local sources free from deleterious materials was used for mixing and curing of the mixes in this investigation.

3. Methodology

The mix proportioning procedure for the concrete was done according to IS 10262: 2009. The proportioning is carried out to achieve specified characteristics at specified age, Workability of fresh concrete and durability requirements. Concrete grade M 25 was proportioned according to the procedure as mentioned in the code.

4. Mix Proportion

Preparation of Specimen: For the preparation of Cube and Beam firstly the control mix named as controlled concrete and 11 experimental combination of mixes. For each combination of Cube and Beam specimens were casted for the age of 28 days curing. The cube specimens were casted for compressive strength test, rebound hammer test and ultrasonic pulse velocity test and the beam specimen were casted for the purpose of flexural strength of tire aggregate concrete. Mix proportion:- 1:1.95:3.89 is obtained by the Indian standard method of Mix design for M-25 grade of concrete.

Curing of Specimen: The test specimens casted were kept in water tank for 28 days after curing the specimens were left to air-dry.

5. Results and Discussion

Observations made and the results of various tests performed on fly ash and Rubber tire concrete. The observations were made on physical properties of specimen. The variation in workability, compressive strength, flexural strength, ultrasonic pulse velocity and rebound hammer are discussed in detail with different replacement of fly ash and Rubber tire.

Table 5.1: Compressive strength of grade M_{25} concrete cubes

Sl.NO	Mark	%of fly ash	% of tire	Compressive strength(MPa)
1	TR0FA0	0	0	29.77
2	TR0FA5	5	0	30.07
3	TR0FA10	10	0	30.37
4	TR0FA15	15	0	30.45
5	TR0FA20	20	0	29.67
6	TR5FA0	0	5	23.11
7	TR10FA0	0	10	21.33
8	TR15FA0	0	15	14.67
9	TR5FA15	15	5	26.22
10	TR10FA15	15	10	23.55
11	TR15FA15	15	15	17.33

Fig 5.1: Compressive strength of grade M_{25} concrete cubes

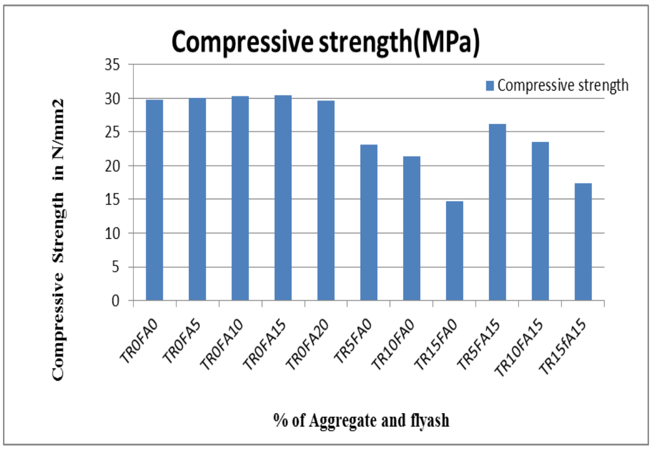


Table 5.2: Ultrasonic pulse velocity of cube grade M_{25} concrete cubes

Sl. No	Mark	% of fly ash	% of tire	ultrasonic pulse velocity(Km/s)
1	TR0FA0	0	0	4.5
2	TR0FA5	5	0	3.97
3	TR0FA10	10	0	4.17
4	TR0FA15	15	0	4.35
5	TR0FA20	20	0	4.25
6	TR5FA0	0	5	4.2
7	TR10FA0	0	10	3.81
8	TR15FA0	0	15	2.71
9	TR5FA15	5	15	4.38
10	TR10FA15	10	15	3.9
11	TR15fA15	15	15	2.88

Fig 5.2: Ultrasonic pulse velocity of cube grade M_{25} concrete cubes

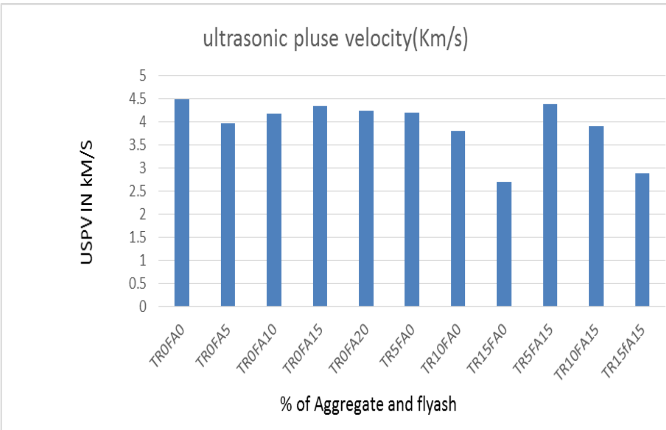


Table 5.3: Rebound hammer test results of grade M_{25} concrete cubes

Sl. No	Mark	% of fly ash	% of tire	rebound hammer test compressive strength (MPa)	destructive test compressive strength (MPa)	% of deviation
1	TR0FA0	0	0	29.25	29.77	1.746724891
2	TR0FA5	5	0	25	30.07	16.86065846
3	TR0FA10	10	0	27.25	30.37	10.27329602
4	TR0FA15	15	0	28.5	30.45	6.403940887
5	TR0FA20	20	0	28	29.67	5.628581058
6	TR5FA0	0	5	22	23.11	4.803115534
7	TR10FA0	0	10	17.5	21.33	17.95593061
8	TR15FA0	0	15	16	14.67	-9.066121336
9	TR5FA15	5	15	24.25	26.22	7.513348589
10	TR10FA15	10	15	20.25	23.55	14.01273885
11	TR15fA15	15	15	17	17.33	1.904212349

Table 5.4: Flexural strength test results of grade M25 concrete beams

Sl. No	Mark	% of fly ash	% of tire	Flexural strength(MPa)
1	TR0FA0	0	0	10.37
2	TR5FA0	0	5	7.26
3	TR10FA0	0	10	5.19
4	TR15FA0	0	15	4.15
5	TR5FA15	15	5	9.35
6	TR10FA15	15	10	6.25
7	TR15FA15	15	15	5.19

Fig 5.4: Flexural strength test results of grade M25 concrete beams

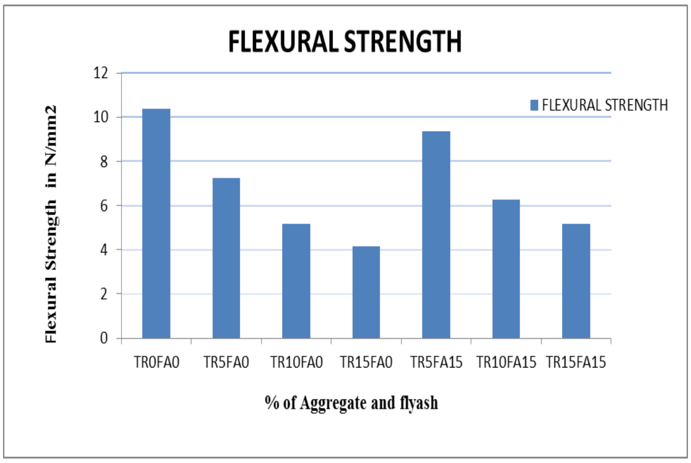
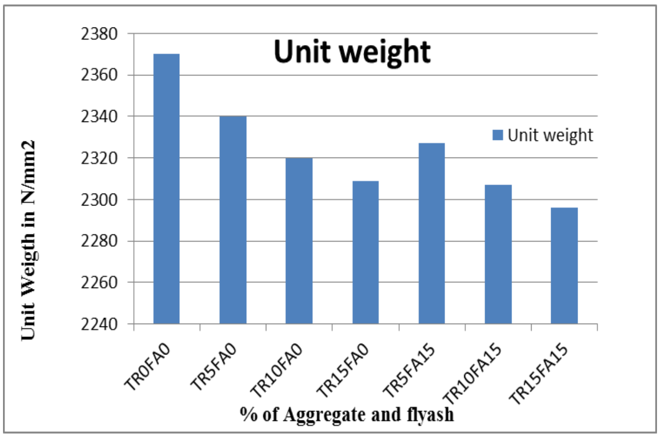


Table 5.5: Unit Weight test results of Beams grade M25 concrete beams

Sl. No	Mark	% of fly ash	% of tire	Unit weight (Kg/m^3)
1	TR0FA0	0	0	2370
2	TR5FA0	0	5	2340
3	TR10FA0	0	10	2320
4	TR15FA0	0	15	2309
5	TR5FA15	15	5	2327
6	TR10FA15	15	10	2307
7	TR15FA15	15	15	2296

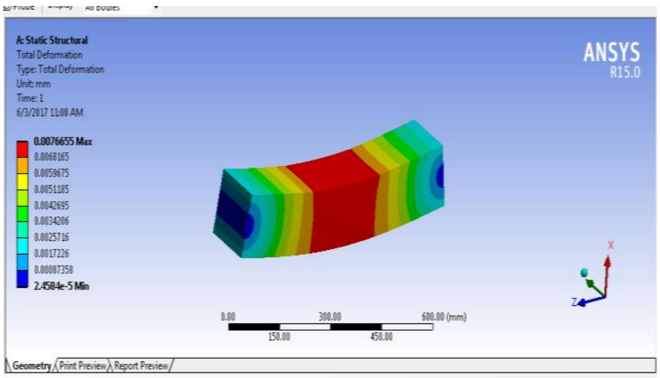
Fig 5.5: Unit Weight test results of Beams grade M25 concrete beams



4.2: Total Deformation and Equivalent

Stresses in the Analysis: The investigation of rubberized concrete element has been done using ANSYS to have a clear understanding about flexural behavior of beam. The modeling has been done using ANSYS R15.0 for analyzing the deflection patter in the beam element. The ANSYS analysis depicts stress distribution in the zones.

TR0FA0: Substitution by 0% fly ash and 5% rubber tire in the concrete. The maximum total deflection result is obtained as 0.009245mm and equivalent stress obtained is as 2.2431MPa.



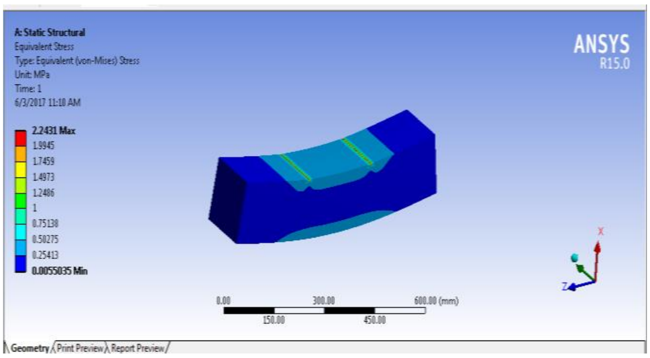


Table 5.6: Young Modulus of the Beam

Sl. No	Mark	% of fly ash	% of tire	Young's modulus(MPa)
1	TR0FA0	0	0	41791
2	TR5FA0	0	5	34561
3	TR10FA0	0	10	28064
4	TR15FA0	0	15	14132
5	TR5FA15	15	5	37202
6	TR10FA15	15	10	29242
7	TR15FA15	15	15	15870

Fig 5.7: Young Modulus of the Beam

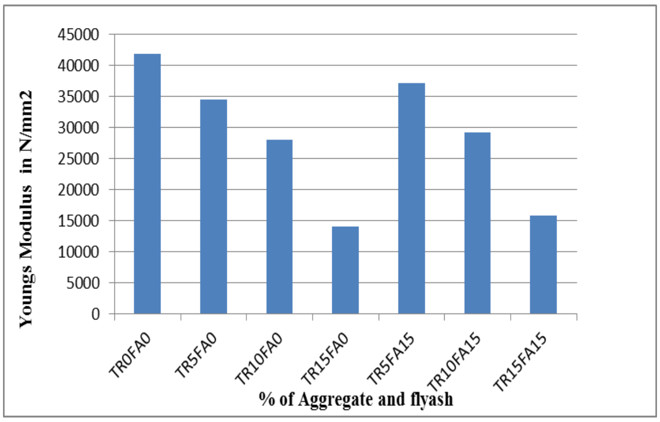
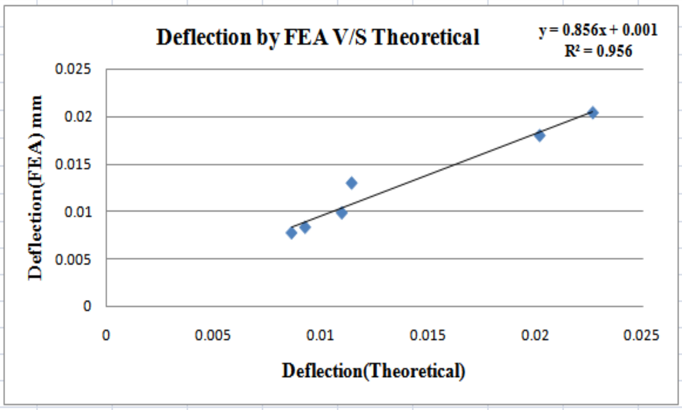


Table 5.8: Deflection [FEM and Theoretical] of the beam

Sl. No	Mark	% of fly ash	% of tire	Deflection(FEA) mm	Deflection(Theoretical) mm	% of deviation
1	TR0FA0	0	0	0.0076655	0.00691	9.855847629
2	TR5FA0	0	5	0.009245	0.00835	9.680908599
3	TR10FA0	0	10	0.011415	0.0103	9.767849321
4	TR15FA0	0	15	0.022668	0.0204	10.00529381
5	TR5FA15	15	5	0.0086111	0.00776	9.883754689
6	TR10FA15	15	10	0.010955	0.00987	9.904153355
7	TR15FA15	15	15	0.020186	0.018	10.82928763

Fig 5.8: Correlation graph for the Deflection by FEM and Theoretical



6. CONCLUSIONS

The utilization of fly ash and rubber tire in concrete does not just fill in as methods reusing waste tires and fly ash to cure the natural risks yet have demonstrated some encouraging outcomes. The accompanying is a portion of the fundamental conclusions drawn from the study research.

1. Concrete which is prepared with waste tire and fly ash can be made use for a structure where there is low intensity of earth quake.
2. The optimum dosage of fly ash and tire for achieving maximum compressive strength of concrete (26.22 MPa) is 5% and 15% of tire and fly ash respectively.
3. The optimum dosage of fly ash and tire for achieving maximum flexural strength of concrete (9.35 MPa) is 5% and 15% of tire and fly ash respectively.
4. According to the NDT (ultrasonic pulse velocity test), the concrete with substitution by fly ash by15% and tire by 5% which showed very good quality.
5. Result showed for a particular mix flexural strength is more and corresponding deflection is less and vice versa.
6. Test result showed 5% rubber tire and 15% fly ash gives the good quality (compressive, flexural strength) of rubber tire concrete compared with the remaining proportions.

References

1. Rahul Mahla, Er.R.P. Mahla "Partial Replacement of Coarse Aggregate by Waste Tires in Cement Concrete" International Journal of Technical Research, Vol.4, Issue 2, Jul-Aug 2015.

2. Athire Radhakrishnan, Aswathy Das, Elson John "Effect of Crumb Rubber and Silica Fume in Concrete for Masonry blocks" International Journal of Innovative Research in Science, Engineering and Technology, Vol.5 , Issue 9, September 2016.

3. Muhammad A. Waris, Nehal N. Ali, and Khalifa S, Al-Jabri, "Use of Recycled Tire in Concrete for Partial Aggregate Replacement" International Journal of Structural and Civil Engineering Research Vol. 5 , No. 4, November 2016.

4. M.A. Yazdi, J. Yang, L. Yihui, H. Su "A Review on Appication of Waste tire in Concrete" International Journal of Civil, Environmental, Structural, construction and Architectural Engineering Vol. 9 , No. 12, 2015.

5. Vishal Porwal, Ravi Dwivedi " Studies on Tyre Aggregate Concrete with Fly ash" International Journal of Science and Research, ISSN(online):2319-7064, Index Copernicus Value (2013):6.14, Impact factor (2015):6.391.

6. Kotresh K.M, Mesfin Getahun Belachew "Study on waste tyre Rubber As Concrete Aggregates" International Journal of Scientific Engineering and Technology Research, Vol.3, Issue 4, (ISSN:2277-1581) 1 April 2014.

7. Ataria Robert Bennett "Mechanical Properties of Concrete Containing Waste Rubber Particles", Journal of chemical, Biological and Physical Sciences, May 2014- July2014, Vol.4, No. 3; 2599-2610.

8. Musa Adamu, O.A.U. Uche "Durability Properties of Concrete Containing Scrap Tyre as Fine & Coarse Aggregate in Concrete" International Journal of Scientific & Engineering Research, Vol.5 , Issue 11, November-2014.

9. Gregory Marvin Garrick "Analysis and Testing of Waste Tire Fiber Modified Concrete" May 2005.

10. T.Ishwariya "An Experimental Study on Partial Replacement of Coarse Aggregate by Crumb Rubber" International Research Journal of Engineering and Technology, Vol.3, Issue 6, June-2016.

11. Noralize Sofia Mohd Nor, Dr.Mohd Yunus Bin Ishak "Effect of various sizes of waste tyre Rubber shred on concrete strength" University Tekndogi Malaysia.

12. F. Pacheco-Torgal, Yining Ding, Said Jalali "Properties and Durability of Concrete Containing Polymeric wastes(Tire rubber and Polyethylene Terephthalate bottles)" Construction and Building Material 30(2012)714-724.

13. IS 516:1959 Indian standard, Methods of tests for strength of concrete.

14. IS 10262:2009 Indian Standard, Concrete mix proportioning –guidelines.

15. IS 456:2000 plain and Reinforced Concrete-Code of Practice is an Indian Standard -code of Practice.

16. IS: 455-1989:1989 43 grade Ordinary Portland Cement-Specifications.

17. BS 1881: part 203:1986 Recommendation for measurement of velocity of ultrasonic pulses in concrete.

BIOGRAPHY

Netravati Y Banasode.
M-Tech Student Civil Engineering Department in S.G.Balekundri Institute of Technology, Belagavi, 590010 Karnataka