AN EXPERIMENTAL INVESTIGATION ON SELF CURING CONCRETE WITH PARTIAL REPLACEMENT ON FINE AGGREGATE WITH TYRE RUBBER & CEMENT WITH FLY ASH

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Abstract - *In recent decades, the worldwide growth of the automobile industry and the increasing use of cars as the main means of transport have tremendously boosted tyre production. This has generated massive stockpiles of used tyres. Extensive research projects were carried out on how to use used tyres in different applications. In order to properly dispose these millions of tyres, the use of innovative techniques to recycle them is important. Fly ash is added as 0%, 15% & 30% replacement for cement along with Rubber tyre as 0%, 3% & 6% respectively replaced for fine aggregate and the curing is kept constant as 1.5. Admixtures has been used in the concrete to achieve self-curing & high strength concrete. The use of fly ash is to partially reduce the emission of Co2. Fly ash is the waste by-product of thermal power plant and it has been well utilized in construction materials.*

Key Words: Self-curing concrete, Crumb rubber, Fly ash, Polyethylene Glycol, Partial replacement

I. INTRODUCTION

This paper presents to examine the experimental investigations of self-curing concrete with partial replacement of fine aggregate and cement with crumb rubber and fly ash respectively. This helps to find out different proportions in which the replacements can be done to attain more strength and durability.

This also emphasizes in finding out the best alternatives that can be used for construction. Using waste things can protect our environment from degradation. The result concentrates on obtaining a durable concrete retaining in its original form with quality and serviceability when exposed to environment.

II. Waste tyre rubber in concrete

Waste tyres have been used to partially replace the aggregates in concrete. Rubberized concrete is very weak in compressive and tensile strength.

But they have very good deformation properties. Concrete with tire rubber waste has higher set deformations than non-rubberized concrete. Ultimate strains on concrete failure load are higher for concrete with tyre rubber waste additive. Due to this, rubberized concrete provides high impact resistance. This behavior is beneficial for structures which require good impact resistance properties. Rubberized concrete can be used in non-load bearing members such as lightweight concrete walls, building facades, or other light architectural units. The other viable applications well suited for use in areas where repeated freezing and thawing occur, and can also be poured in larger sheets than conventional concrete.

III. Methodology

IV. MATERIAL PROCUREMENT AND PROPERTIES

A. General

Following are the materials used for the study, Crumb rubber (Crushed Tyre Rubber), Fine aggregate, Coarse aggregate, Cement, Fly Ash and Polyethylene Glycol.

B. Collection and Properties of Crumb Rubber

Finely graded crumb rubber is brought from Sidco, Malumichampatti, Coimbatore. It is prepared from the waste tyre rubber and available in different sizes. The Chemical composition of the material is given in Table.1.

Table 1 Chemical properties of eco sand

CHEMICAL	PERCENTAGE
SiO2	58-60%
Al2O3	2-3%
Iron	1-3%
MgO	0.4-1%
CaO	20-25%

Table 2 Physical Properties of Eco sand

PROPERTIES	RESULT
Specific gravity	2.40
Water Absorption	1.49%

C. Specific gravity

The particle size distribution of finely graded crumb rubber is same as that of the fine aggregate and the crumb rubber is available in the sizes of fine aggregate.

C. Polyethylene Glycol

Polyethylene glycol was purchased from Coimbatore. Polyethylene glycol has an excellent property of retaining moisture. PEG 400 is used in this study as it is more efficient as a self-curing agent. The properties of PEG 400 is given in Table.3.

Table 3 Properties of Polyethylene glycol

PROPERTIES	RESULT
Specific gravity	1.12 @ 27˚c
Molecular weight	400
Hydroxyl weight	300 mg KOH/g
Density	1.125 g/cm^3
pH	>6

D. Fine aggregate

Fine aggregate used for this study are Manufactured Sand (M sand). The properties of fine aggregate are given in Table.4.

Table 4 Physical properties of fine aggregate

PROPERTIES	RESULT
Specific gravity	2.68
Sieve analysis	Zone II
Water absorption	0.89%

E. Coarse aggregate

Coarse aggregate used for this study are in size of 20mm.

Table 5 Physical properties of coarse aggregate

PROPERTIES	RESULT
Specific gravity	2.79
Water absorption	2%

G. Cement

Ordinary Portland cement 53 grade is used for this study. Since the 53 Grade Cement is finely grinded as compared to 43 Grade Cement and hence the Surface parameter is higher for 53 Grade Cement. Strength Parameter, 53 Grade Cement signifies 53 MPa (Mega Pascal) compressive strength after 28 days of curing, as compared to 43 MPa for 43 Grade Cement. Hence the compressive strength development in 53 Grade Cement is higher for same curing times. Hydraulic Reactions, the formation of Cao-SiO2 gels proceed faster as compared to 43 Grade Cement and hence higher heat of hydration for the same concrete area. Hence 53 Grade Cement may require more curing as compared to 43 Grade cement. The properties of the cement are given in Table.6.

Table 6 Properties of cement

Description	Value
Grade	53
Fineness	2.5%
Specific gravity	3.15
Consistency	30%
Initial setting time	30 min
Final setting time	560 mins

V. MIX SPECIFICATIONS FOR DIFFERENT MIXES

The mix specification for M25 grade concrete is given in Table.7.

Table 7 Mix proportions

MIX	CEMENT %	FLY ASH%	M SAND %	CRUMBRUBBER %
M0	100	0	100	0
M1	100	0	90	3
M2	100	0	80	6
M3	95	5	100	0
M4	95	5	100	3
M5	95	5	90	6
M6	90	10	90	0
M7	90	10	80	3
M8	90	10	80	6

VI.TEST ON SPECIMENS

Testing of specimens plays an important role in controlling the quality and quantity of concrete. All the specimens casted were subjected to testing to study the effect of partial replacement of fly ash with respect to cement and crumb rubber with respect to fine aggregate on strength and durability of the concrete. Thus, the experiential investigations carried out was divided into the following categories. They are

Test1: Tests on Fresh Concrete

i. Slump Test
ii. Compaction Factor Test

Test2: Tests on Hardened Concrete

iii. Compressive Strength
iv. Split Tensile Strength
v. Flexural Strength

A. STUDY ON FRESH CONCRETE PROPERTIES

SLUMP TEST

The test was carried out on metallic mould in the form of frustrum of cone having an internal diameter as Bottom dia-20cm, Top dia-10cm and Height-30cm as specified by IS 1199 (1959). This concrete is properly poured and tampered in the mould to avoid the voids. The mould is removed immediately and allow the concrete to subside. This subside is referred as slump of concrete. The difference in level between the height of the mould and that of the highest point of the subside concrete is measured. The difference in height in mm is taken as slump of concrete.

COMPACTION FACTOR TEST

The test was designed for use in laboratory but it can also be used in the field on a specially prepared metallic moulds arranged in order as specified by IS 1199 (1959). This concrete is properly poured in the upper hopper and the trap door is open and the concrete is moved to lower hopper and the trap door is open and the concrete is allowed to fall in the cylinder. The weight of the cylinder is noted. The fully compacted concrete is filled into the cylinder and the weight is noted and the weights are applied in the formula to find compacting factor of the concrete.

A. STUDY ON STRENGTH PROPERTIES

COMPRESSIVE STRENGTH

The test was carried out on 150mm×150mm×150mm cubes as specified by IS 516-1959 (1989). This concrete is properly poured and tampered in the mould so as not to have any voids. After 24hours these concrete specimens are removed from the mould. The top surface of these concrete specimen should be made even, flat and smooth. After 7 and 28 days of curing these specimens are taken from the water and tested by compression testing machine. Load should be applied gradually at the rate of 140 $kg/cm^2/min$ till the specimen fails. Load at the failure should be noted. Three specimens where tested at each stage and average of the three specimens gives the crushing strength of concrete.

SPLIT TENSILE STRENGTH

The test was carried out on 150mm dia * 300mm length as specified by IS 5816-1999 (2004). This concrete is properly poured and tampered in the mould so as not to have any voids. After 24hours these concrete specimens are removed from the mould. The top surface of these concrete specimen should be made even, flat and smooth. After 7 and 28 days of curing these specimens are taken from the water and tested by compression testing machine. Load should be applied gradually at the rate of 140 $kg/cm^2/min$ till the specimen fails. Load at the failure should be noted. Three specimens where tested at each stage and average of the three specimens gives the crushing strength of concrete.

FLEXURE STRENGTH

Concrete is weak in tension and strong in compression. Directly measuring the tensile strength of concrete is very difficult. Concrete beams of size 700×150×150 mm is found to be dependable to measure flexural strength property of concrete. The systems of loading used in finding out flexural strength are central and third point loading. Flexural strength is expressed as modulus of rupture and it is given by (M/Z).

VII. RESULTS AND DISCUSSION

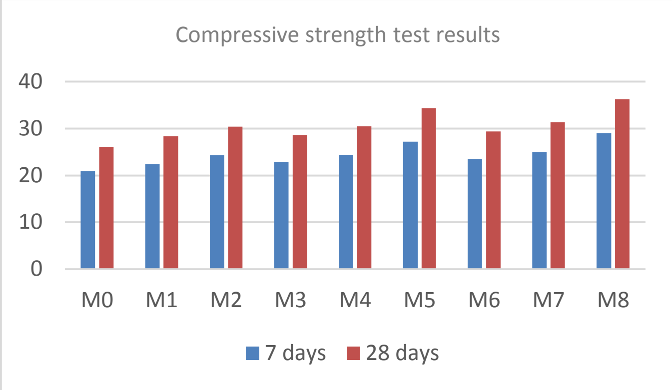
The results obtained from the experimental investigations were represented both in tabular form and graphical means.

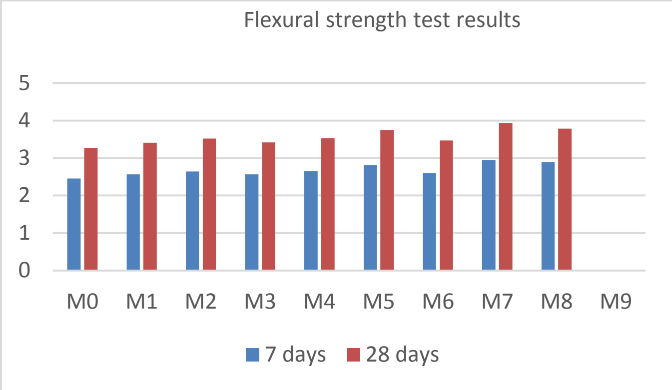
COMPRESSIVE STRENGTH TEST

It is one of the important characteristics. The concrete specimen of size 150 x 150 x 150 mm is casted and demolded after 24 hours. The 7th day and the 28th day tests are taken. The test results are taken in values and mentioned in graphical form. The values are tabulated as follows.

Table 8 Compressive strength at 7 and 28 days

Mix	Mix proportions		Compressive strength			
			7 Days		14 Days	
	Fly Ash	Rubber	Load (kN)	N/ mm²	Load (kN)	N/ mm²
M0	0	0	470.0	20.89	587.7	26.12
M1	0	3	504.0	22.40	638.1	28.36
M2	0	6	546.7	24.30	683.5	30.38
M3	5	0	515.3	22.90	644.2	28.63
M4	5	3	548.5	24.38	685.8	30.48
M5	5	6	612.0	27.20	773.5	34.38
M6	10	0	508.9	23.51	660.6	29.36
M7	10	3	562.7	25.01	705.6	31.36
M8	10	6	652.7	29.01	815.8	36.26





FLEXRAL STRENGTH TEST

The flexural strength test was carried out on prism of cross-section 150 mm × 150 mm × 700 mm. The flexural strength of concrete, strength increased from the replacement of fly ash 10% with cement and rubber 3% with M sand at 7 days and 28 days. The results of flexural strength for M25 grade concrete are tabulated.

Table 9 Flexure strength at 7 and 28 day

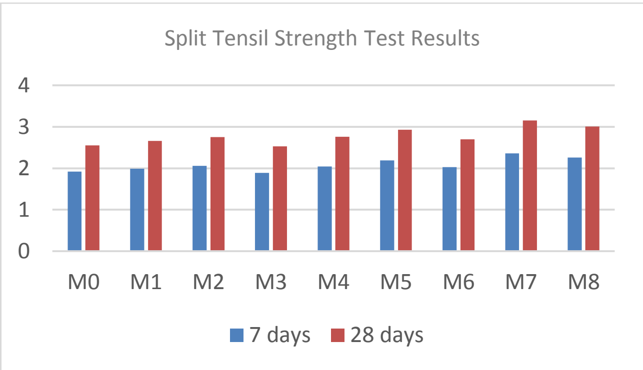
Mix	Mix proportions		Compressive strength			
			7 Days		14 Days	
	Fly Ash	Rubber	Load (kN)	N/ mm²	Load (kN)	N/ mm²
M0	0	0	11.8	2.45	15.7	3.27
M1	0	3	12.3	2.56	16.4	3.41
M2	0	6	12.7	2.64	16.9	3.52
M3	5	0	12.3	2.56	16.4	3.42
M4	5	3	12.7	2.65	17.1	3.53
M5	5	6	12.5	2.81	18.1	3.75
M6	10	0	12.5	2.60	16.7	3.47
M7	10	3	14.2	2.95	18.9	3.94
M8	10	6	13.9	2.89	18.2	3.78

SPLIT TENSILE STRENGTH TEST

The split tensile strength was carried out on cylindrical specimen of 150mm diameter and 300mm length. The split tensile strength of concrete, strength increased from the replacement of fly ash 10% with cement and rubber 3% with M sand at 7 days and 28 days. The results of split tensile strength for M25 grade concrete are tabulated.

Table 10 Split Tensile strength at 7 and 28 day

Mix	Mix proportions		Compressive strength			
			7 Days		14 Days	
	Fly Ash	Rubber	Load (kN)	N/ mm²	Load (kN)	N/ mm²
M0	0	0	135.6	1.92	180.2	2.55
M1	0	3	140.6	1.99	187.9	2.66
M2	0	6	145.5	2.06	194.3	2.75
M3	5	0	133.5	1.89	178.7	2.53
M4	5	3	144.1	2.04	194.9	2.76
M5	5	6	154.7	2.19	207.0	2.93
M6	10	0	143.4	2.03	190.8	2.70
M7	10	3	166.7	2.36	222.5	3.15
M8	10	6	159.7	2.26	212.7	3.01



VIII. CONCLUSIONS

Based on the experimental investigation concerning the compressive strength, split tensile strength and the flexural strength of concrete, the following observations are made while replacing fine aggregate and cement with different proportions of waste tyre rubber and fly ash respectively.

[1] The Fly ash is a locally available, low cost and an industrial waste whose disposal is a matter of concern likes construction waste. So, the Fly ash is replaced as 10% with the cement.

[2] The Waste tyre rubber satisfies the zone II gradation for the partial replacement of the sand with the incremental order of 3% (0% - 3%) and for making good concrete.

[3] From the experimental investigation it was found that Mix 7(M7) shows greater strength in compression with 38.8% increase in the strength compared to conventional concrete.

[4] Mix 8(M8) show greater strength in split tensile and flexural with a increase in strength of 23.5% and 20.4% respectively compared to the conventional concrete.

[5] From the experimental investigation it is found that this rubber concrete can be used in the low vibration areas which can produce good results compared to the conventional concrete.

[6] The cost of rubber concrete is found to be high in the small-scale industry due to the rate of waste tyre rubber but in case of large-scale industry the rubber concrete is less compared to the conventional concrete.

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