International Journal of
Advances in Scientific Research and Engineering (ijasre)
E-ISSN : 2454-8006
Vol.3, Special Issue 1 Aug - 2017

Evaluation of Structural Performance of Pervious Concrete Containing Waste Tire Rubbers

Prathibha V S[1,a], Gyanen Takhelmayum[2,b]

[1]Post graduate Scholar and [2]Assistant professor

Transportation engineering and management

School of civil engineering

REVA University, Bengaluru, India.

ABSTRACT

Pervious concrete provides a sound solution for managing storm waters in built environments where the water runoff as well as the natural recharge of the groundwater is an important issue. The use of pervious concrete is also commonly related to other environmental benefits such as the urban heat Island reduction, traffic noise absorption, and pollutant filtering. At present the disposal of waste tires is becoming a major waste management problem in the world. Hence efforts have been taken to identify the potential application of waste tires in civil engineering projects. In this context, our present study aims is to investigate the optimal use of waste tire rubber as fine aggregate in pervious concrete composite. The properties of rubberized plain pervious concrete in terms of the mechanical properties and the permeability were investigated. Two types of rubber (crumb rubber and tire chips) were used in the production of rubberized plain pervious concrete mixtures which obtained by partially replacing the fine aggregate varying from 5% to 20% were considered as experimental parameters. The results are compared with non-rubberized pervious concrete (control) mixture. Rubber incorporated pervious concretes had lower compressive strength, splitting tensile strength, and modulus of elasticity with the increased percentage of replacement. Pervious concretes produced in this study fulfil this requirement as the minimum compressive strength being 4.2 MPa in the mix 20TC (tire chips). Permeability coefficients (K) of the rubberized pervious concretes fell between 0.025 and 0.61 cm/s which are recommended limits for pervious concretes.

Keywords: Pervious Concrete, Waste Tire Rubbers, Compressive Strength, Splitting Tensile Strength, Modulus Of Elasticity And Permeability Coefficients (K)

---

1. INTRODUCTION

1.1 General

Pervious concrete is mainly used to infiltrate the storm water into the ground. The waste tire rubber is used as the alternative for the fine aggregates. Two types of rubber were used crumb rubber and tire chips. The pervious concrete has been used more commonly due to its benefits in dropping the runoff water and recovering the ground recharge and also improves the skid resistance of the pavement.

Pervious concrete is a special type of concrete with high porosity which allows the water to percolate into in so it can reduce the surface runoff and allows the groundwater recharge. The pervious concrete is made with large sized aggregate and less or no fine aggregate. It is regularly used in parking areas, low traffic areas, pedestrian walkway etc. Pervious concrete functions like storm water infiltration sink and allows the storm water to infiltrate the soil over a huge area as a result facilitating precious groundwater recharge. The mixture of pervious concrete has the water cement ratio of 0.28 to 0.4 and with avoids content of 15 to 25% [1]. Disposal of waste tires has been a major problem in the cities all around the world. Generally, the cheapest and easiest way to dispose the used tires is by burning them. But the pollution due to release of huge smoke makes this method unacceptable and it is hazardous to the environment. Conventional concrete pavement has less capability of water and air permeability which had a contradictory to the environment. Therefore, the increasing interest on the use of rubber waste as a aggregates in concrete pavements has encouraged the researchers to investigate the performance of the pervious concretes containing waste tire rubber. Therefore, recycling of the waste tires can be done. Creative solutions to meet the challenge of tire discarding problem involve the use of waste tire rubber as a substitution for the aggregates in road construction [3]. In this experiment two types of waste rubber were used crumb rubber (CR) and tire chips (TC). These are replaced for total volume of fine aggregates in different mix identifications like 10CR, 20CR, 10TC, 20TC, 5CR 10TC and 5CR 5TC and were tested for its mechanical and permeability properties. The tests were conducted after 7 days and 28 days of curing.

1.2 OBJECTIVES:

The main aim of the study is to evaluate the mechanical properties and hydraulic performance of pervious concrete containing various size of waste tire as a replacement of fine aggregate varying from 0% to 20%

1. Waste tire rubber were replaced for total volume of fine aggregates in different mix identifications like 10CR, 20CR, 10TC, 20TC, 5CR 10TC and 5CR 5TC and were tested for its mechanical and permeability properties.
2. The mechanical properties like compressive strength, flexural strength, split tensile strength, modulus of elasticity were determined.
3. Hydraulic performance like permeability and clogging were evaluated.

2. GRADATION CHART OF AGGREGATES

Table 1, Gradation of aggregates

IS SIEVE	GROUP A (20mm-12.5mm)	GROUP B (12.5mm-9.5mm)	GROUP C (9.5mm-4.75)	% PASSING
20	81	100	100	100
16	48	100	100	89.44
10	42	100	100	70.71
4.75	33	41	100	48.73
2.36	10	20	100	34.35
1	0.3	8.2	26.5	22.36
0.6	0	0	0.5	17.32
0.3	0	0	0	12.25
0.15	0	0	0	0

GROUP A (20mm passing 12.5mm retained) = 46%

GROUP B (12.5mm passing 9.5mm retained) = 36%

GROUP C (9.5mm passing 4.75mm retained) = 18%

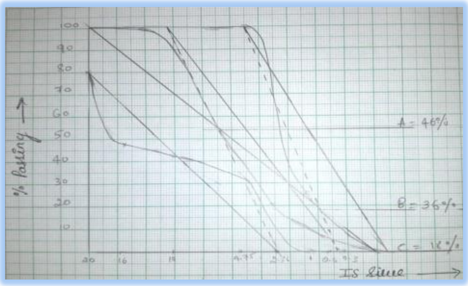


Fig.1, Ruthfuch Chart

3. PROPORTION TABLE

Table 2, Mix Design

Mix Id	**W/C**	**Cement (Kg/m^3)**	**Water (Kg/m^3)**	**Coarse Aggregate (Kg/m^3)**	**Fine aggregate (Kg/m^3)**	**Tire chips (Kg/m^3)**	**Crumb rubber (Kg/m^3)**
Control	0.36	355.55	125.73	1289.6	96.8	0	0
10CR	0.36	355.55	125.73	1289.6	87.12	0	9.68
20CR	0.36	355.55	125.73	1289.6	77.44	0	19.36
10TC	0.36	355.55	125.73	1289.6	87.12	9.68	0
20TC	0.36	355.55	125.73	1289.6	77.44	19.36	0
5CR 10TC	0.36	355.55	125.73	1289.6	82.28	9.68	4.84
5CR 5TC	0.36	355.55	125.73	1289.6	87.12	4.84	4.84
10CR 10TC	0.36	355.55	125.73	1289.6	77.44	9.68	9.68

2. RESULTS AND DISCUSSION

General 4.1

This chapter consists of various tests conducted and the results of tests conducted.

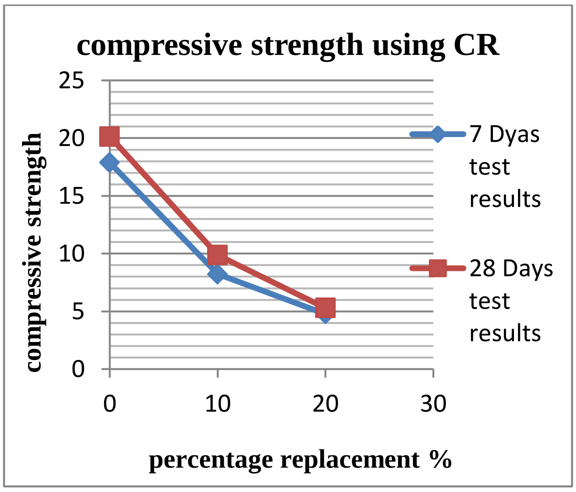
4.1.1 Compression Strength:

The specimen having a dimension of 150mm diameter and 300mm depth is tested under compression testing machine. The control mix had the compressive strength of 21.035 Mp at 28 days decreasing with the increase in percentage of rubber. The minimum compressive strength of 4.54 MPa was obtained at the mix 20TC in which Tire Chips were used.

$$\textbf{Compressive Strength} = \frac{\text{failure load}}{\text{cross sectional area}} \textbf{ Mpa}$$

Table 3, Combined Compression test results

Mix id	**Compression Strength (Mpa)**	
	7 Days	**28 days**
Control	17.885	20.15
10CR	8.23	9.88
20CR	4.775	5.30
10TC	6.66	7.44
20TC	6..37	7.2
5CR5TC	7.151	9.775
5CR10TC	6.91	7.775
10CR10TC	6.91	11.78



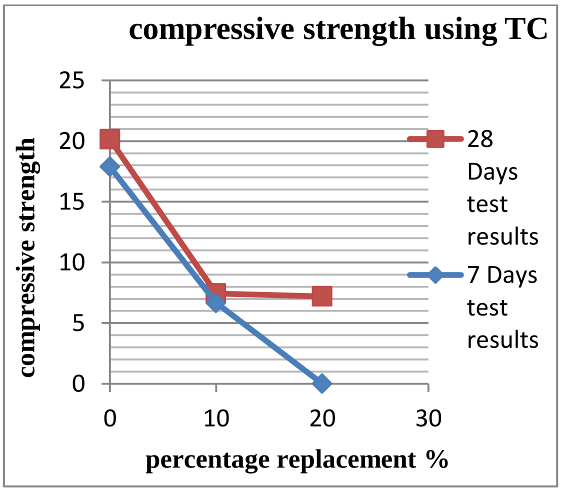
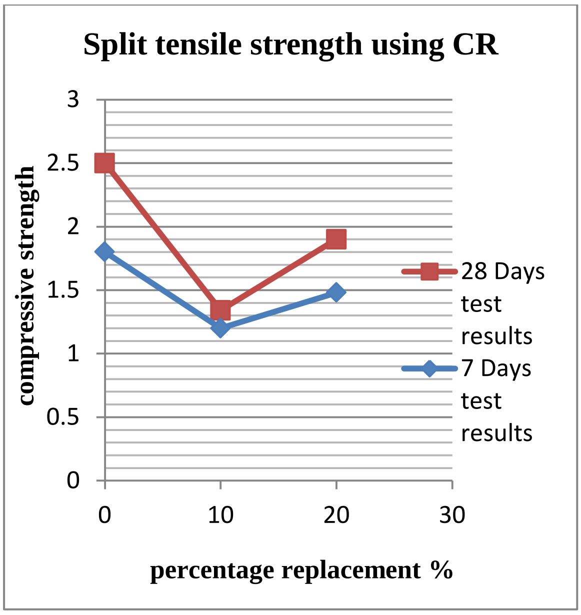


Fig.2, Compressive strength using CR Fig.3, Compressive strength using TC

4.1.2 Split Tensile Test

The specimen of 150diameter 300 heights was used to test split tensile strength after 7 days and 28 days of curing. Split tensile strength of 1.8 MPa of control mix reduced to 1.2 MPa by replacing rubber in the mix 10Tc and 20 TC. It lies between the permissible limit so that the result is acceptable.

Split Tensile strength = $\frac{2p}{\pi DL}$ **Mpa** Where, P = failure load (KN), D = diameter of cylinder (mm), L = length of cylinder (mm)



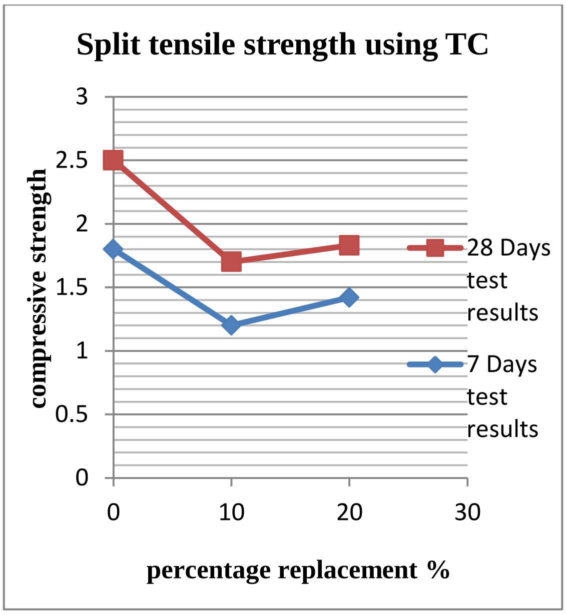


Fig 4, Split tensile strength using CR Fig 5, Split tensile strength using CR

Table 4, Split Tensile Strength Results

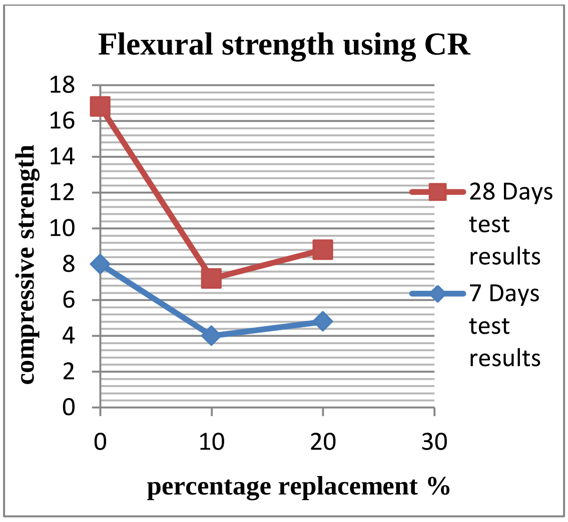
Sl. no	Replacement (%)	Strength (Kn)		average		Split tensile strength (Mpa)	
		7 days	28 days	7 days	28 days	7 days	28 days
1.	Control mix	135	180				
		120	180	127.5	180	**1.8**	**2.5**
2.	10CR	95	90				
		75	95	85	95	**1.2**	**1.34**
3.	20CR	125	135				
		85	135	105	135	**1.48**	**1.9**
4.	10TC	85	105				
		85	135	85	120	**1.2**	**1.7**
5.	20TC	100	125				
		100	135	100	130	**1.42**	**1.83**
6.	5CR 5TC	90	180				
		90	125	90	152.5	**1.27**	**2.15**
7.	5CR 10TC	90	125				
		90	110	90	117.5	**1.27**	**1.65**
8.	10CR 10TC	90	130				
		95	130	92.5	130	**1.34**	**1.83**

4.1.3 Flexural strength:

Flexural strength is one of the methods to measure the tensile strength of the concrete

$$G = \frac{PL}{bd^2} \text{ Mpa}$$

Where, G = Flexural strength, P = load at failure (KN), L = length of the specimen (mm), B = width of the specimen (mm), D = depth of the specimen (mm)



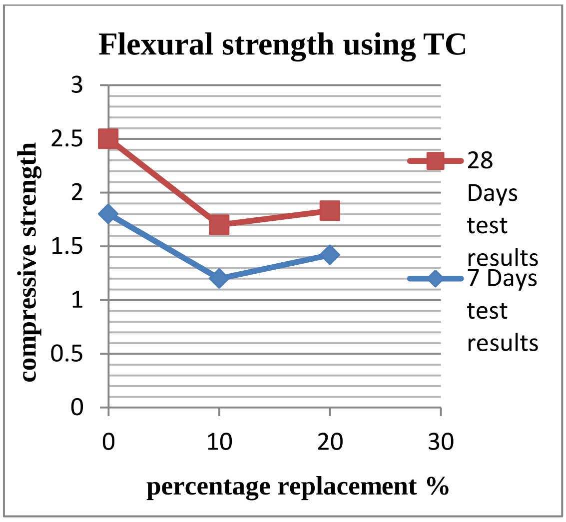


Fig 6, Flexural strength using CR   Fig 7, Flexural strength using CR

4.1.3 Permeability test:

The effect of rubber particles on the permeability of pervious concretes was to reduce the permeability coefficient (K). For example, K value of the control mix was 0.48 cm/s which reduced to 0.24 cm/s at the mix identification of 20TC.

Table 5, Permeability Co-efficient test

SL NO.	MIX ID	PERMEABILITY CO-EFFICIENT (cm/s)
1.	Control	0.48
2.	10CR	0.38
3.	20CR	0.25
4.	10TC	0.32
5.	20TC	0.24
6.	5CR5TC	0.3
7.	5CR10TC	0.29
8.	10CR10TC	0.27

3. CONCLUSION

- Rubber incorporated pervious concretes had lower compressive strength, splitting tensile strength, and modulus of elasticity with the increased percentage of replacement.
- Pervious concretes produced in this study fulfil this requirement as the minimum compressive strength being 4.2 MPa in the mix 20TC (tire chips).
- Split tensile strength of 1.8 MPa of control mix reduced to 1.2 MPa by replacing rubber in the mix 10Tc and 20 TC. It lies between the permissible limit so that the result is acceptable.

- The flexural strength of pervious concrete increases as the percentage of waste tire rubber used increases. The flexural strength of pervious concrete with 0% rubber is 16.8 and the maximum value 15.2 obtained at mix proportion of 10CR 10TC
- Permeability coefficients (K) of the rubberized pervious concretes fell between 0.25 and 0.48 cm/s which are recommended limits for pervious concretes.

REFERENCE

[1] Mehmet Gesog˘lu, Erhan Guneyisi, Ganjeena Khoshnaw, Suleyman _Ipek, Investigating properties of pervious concretes containing waste tire rubbers 2014; 206–213

[3] Kotresh K.M, Mesfin Getahun Belachew, Study On Waste Tyre Rubber As Concrete Aggregates 2014; ISSN : 2277-1581

[4] Karthik .H obla, Pervious concrete an overview

[5] Rahul Mahla, Er. R.P. Mahl, Partial replacement of coarse aggregate by waste tires in cement concrete , Department of Civil Engineering, OITM, Hisar .2015; International Journal of Technical Research (IJTR)

[6] Dhawal Desai, Pervious Concrete – Effect of Material Proportions on Porosity.

[7] S.O. Ajamu1, A.A. Jimoh2, Evaluation of Structural Performance of Pervious Concrete in Construction 2012.

[8] Siddique R, Naik TR. Properties of concrete containing scrap-tire rubber – anOverview 2004

[9] Son KS, Hajirasouliha I, Pilakoutas K. Strength and deformability of waste tyrerubber-filled reinforced concrete columns. Constr Build Mate 2011; 25:218–26.