



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 7, July 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com



Investigation on Properties of Rubberized Concrete

Nilkanth Gosavi¹, Prof. Abhijeet Galatage²

PG Student, Department of Civil Engineering, MIT-SOE, MIT ADT Pune, Maharashtra, India¹

Asst. Professor, Department of Civil Engineering, MIT-SOE, MIT ADT Pune, Maharashtra, India²

ABSTRACT: One of the environmental difficulties is waste tyre rubber. The rising use of automobiles in our country has contributed to a rise in trash disposal. In this study, the qualities of conventional concrete as a reference and rubberized concrete are investigated and described. The important criteria are the rubber ratios as aggregate replacements. Crumb tyre rubbers were utilised to replace coarse aggregates in four different proportions by volume. The objective of this project was to build prototype rooms for experimental testing. Four 1mx1mx1m rooms were casted for each mix proportions. The first prototype will have traditional PCC lean mix walls. The other three will have rubberized concrete walls in proportions of 6%, 12%, and 18% by weight of aggregates. A comparison was done between combinations having varying percentages of crumb rubber to establish the optimum crumb rubber content, and the test results were also compared to standard concrete. Compression and Split Tensile tests were performed to investigate the hardened properties of concrete. To determine the modulus of rupture properties of concrete Flexure test was also conducted. The results reveal that replacing natural coarse aggregates with crump-chip tier rubber in excess amount reduces mechanical characteristics of the concrete mix (compressive, flexural and splitting tensile strength).

KEYWORDS: Crumb rubber, PCC lean mix, flexure, compressive, tensile strength.

I. INTRODUCTION

"Energy cannot be created nor destroyed"; it is the foundation of human intellectual and spiritual thinking. Energy is constantly susceptible to cycles. The so-called waste of one operation is actually a raw ingredient for another. A waste material is one that has been improperly placed or is lying unused. As a result, it is necessary to determine the best location for a specific waste item to be used or recycled. The current work is concerned with the utilisation of tyre waste, which is a solid waste generated in massive quantities. With the exponential growth in the number of automobiles in India over the last few years, the demand for tyres as original equipment and replacement has increased as well. The number of discarded tyres generated in India is not known, but the rising usage of road transportation will undoubtedly present a problem of waste disposal in the near future. If the average life of the tyres used in these cars is 10 years after rethreading twice, the total number of trash disposable tyres each year will be on the order of 112 million or more.

Tyre recycling, also known as rubber recycling, refers to the process of recycling vehicle tyres (or tyres) that are no longer fit for use on cars owing to wear or irreparable damage (such as punctures or wear and tear). Because of the vast number produced and their longevity, these tyres are among the greatest and most significant sources of trash. The same features that make waste tyres such an issue also make them one of the most re-used waste materials, since the rubber is incredibly robust and can be repurposed in various goods. Each year, about one tyre is thrown by every person. Tires are also frequently recycled for use on basketball courts and in the production of new shoe items. Decomposing of the waste tires is one of the most important issues around the world. There are many methods to recycle wasted tires, one method is to grind them into small particles in different sizes and reuse it in a variety of rubber and plastic products, thermal incineration of worn-out tires for the production of steam or electricity, and use of tire rubber in asphalt mixes.

One of the easiest and cheapest ways to get rid of waste tires was to burn them. Burning tires produces benzene compounds emissions that harm people, plants and animals in addition to the harmful effect on the global warming. The burning process produces harmful powder that can adversely affect the soil fertility. Using rubber tires to produce fuel isn't economic and produces low quality fuel in comparison with petroleum products. Rubber can be used in several applications such as construction of roads, water barriers, geotechnical field, retaining walls, in concrete mixes and other applications. One of the possible ways to get rid of the tires disposal in landfills is to use the rubber content



existing in the tires after passing through chemical and mechanical processes in concrete mixes as partial replacement of fine or coarse aggregate. Adding rubber to concrete mixes produces Rubberized Concrete mixes. Several studies about adding rubber to the concrete mix showed that adding rubber can enhance several properties of concrete such as ductility, energy dissipation and sound absorption.

Waste tyre rubber is one of the world's most serious environmental issues. With increased automotive production, massive volumes of waste tyre must be disposed of. Many nations have prohibited the dumping of waste tyre rubber in landfills due to the increasing depletion of existing trash disposal locations. The primary goals of this study were to give additional scientific data to justify the implementation of laws or incentive-based strategies to promote tyre reuse. This research focuses on utilizing crumb tyres to replace a portion of the natural coarse aggregates used in concrete mixtures in India. The current experiment aims to evaluate the influence of tyre waste blending on several concrete characteristics such as heat insulation and sound insulation. Tyre waste shall be utilised in different amounts as a replacement for coarse and fine aggregates. These investigations will provide a safe and environmentally sound manner of disposing of tyre waste.

II. LITERATURE SURVEY

Influence of shredded rubber from waste tyres on concrete strength was investigated by **S. Mitoulis [1]**. In this study shredded particles from waste tyres were used to replace the 20mm size aggregate in different percentages (5%, 10% and 15% in volume). Concrete without these additives were also tested. The experimental results show a reduction of the compressive strength as the percentage of rubber particles increases. Four point bending test conducted on six samples of each specimen also unveil a reduction in the flexural strength and bending capacity of concrete as the rubber content increases. Deflection at failure of the rubberized concrete is more than that of the plain concrete which unveils the ability of the rubberized concrete to withstand larger deformations than the plain concrete.

A. Sharma [3] The aim of this study is achieved to use of rubber waste as partial replacement of fine aggregate to produce rubberize concrete in M30 mix. Different partial replacements of crumb rubber (0, 5, 10, 15 and 20%) by volume of fine aggregate are cast and test for compressive strength, flexural strength, split tensile strength and stress-strain behaviour. The results showed that there is a reduction in all type of strength for crumb rubber mixture, but slump values increase as the crumb rubber content increase from 0% to 20%. Meaning that crumb rubber mixture is more workable compare to normal concrete and also it is useful in making light weight concrete. It is recommended to use the rubberized concrete for non-structural applications.

S. M. Shtayeh [6] aims to explore the potential utilization of crumb rubber from used tires in various types of Portland Cement Concrete (PCC) for the production of non-structural PCC with special applications requiring attention to thermal and noise insulation, and material elasticity. Fine aggregate (beach sand) was replaced using the volumetric method by used crumb tires at different percentages of replacements for the various types of PCC. Analysis showed that the compressive strength, density, and modulus of elasticity decrease as the percent replacement by crumb rubber increases. Water absorption increased as the percentage of replacement increased and slump did not show significant change. Abrasion resistance, noise insulation and thermal insulation increased as the percent replacement increased. The research recommended that crumbed rubber be used for non-structural PCC, such as floor ribs, partitions, support stone structures, concrete board siding, concrete blocks, and other non-structural uses.

Concrete mixes containing waste crumb rubber untreated/treated with replacement percentages (3% and 6%) of fine aggregate were studied and those mixes were compared with traditional concrete mix to investigate the behaviour of untreated CRC and optimized treated CRC by **E. Emam [10]**. It was concluded that, compressive strength affected by positive value by increasing treated crumb rubber percentage. CRC shows reduction in the density of concrete in comparison to traditional concrete. By increasing rubber percentage, slump values decreased.

III. METHODOLOGY

The investigation is based on casting of four prototype rooms. The four prototype rooms are 1m x 1m x 1m in size and have 0.1m thick walls. A wooden mould is created for casting rooms. The exterior dimensions of the mould are 1mx1mx1m, while the inside dimensions are 0.8m x 0.8m x 1 m. A thorough examination was conducted out using a complete experimental programme, followed by findings analysis. Rubberized concrete mechanical properties were studied experimentally through compression tests, tensile strength tests, and flexure strength tests.



Compressive strength tests were performed on 150 mm x 150 mm x 150 mm cubes using a compression testing equipment with a capacity of 2000 kN. After being removed from the curing tank, the specimen was cleaned and dried. The testing machine's surface was cleaned. The specimen was put in the centre of the compression testing machine, and the load was delivered continuously, evenly, and without shocks, at a rate of 5 kN/sec. (500kg/cm²)/second, i.e. at a constant rate of stress. The load was gradually raised until the specimen broke. During the test, the maximum load taken by each specimen was recorded. The compressive strength was found after 7 and 28 days in order to compare the strengths for different percentage of crumb rubber in concrete with standard concrete. Compression strength was calculated by using the below equation.

$$\sigma_c = \frac{P}{A}$$

Split tensile test were performed on cylinder specimens of 150 mm diameter and 300 mm height in a compression testing machine.

The cylinder specimens were loaded up to their maximum split tensile load, and the Split tensile strength was calculated using the equation.

$$\sigma_t = \frac{2P}{\pi LD}$$

Where, σ_t is the split tensile strength (MPa); P is maximum load applied to the specimen; L is the length of the specimen (mm); D is the diameter of the specimen (mm).

The stresses caused by bending moment are called as flexural stress. The ability of a member to resist bending deflection when load is applied on it is called as Flexural strength. It is stress in a material just before it yields in a flexure test. In this test, a rectangular section is bent until fracture or yielding using a three point flexural test technique. Flexural strength represents highest stress experienced within the member at its moment of yield. It is measured in terms of stress.

IV. RESULTS

Table I: Results of Compression Strength Test of Rubberized Concrete

Replacement of Coarse Aggregate	7 Days Strength (MPa)	28 Days Strength (Mpa)
0%		
Sample 1	21.65	32.4
Sample 2	21.4	32
Sample 3	21.50	32.5
Average	21.52	32.30
6%		
Sample 1	19.65	29.86
Sample 2	20.1	29.47
Sample 3	19.54	29.59
Average	19.76	29.64
12%		
Sample 1	17.4	26.68
Sample 2	17.35	26.35
Sample 3	17.20	26.15
Average	17.32	26.39



18%		
Sample 1	12.24	20.86
Sample 2	12.56	20.21
Sample 3	12.38	20.34
Average	12.39	20.47

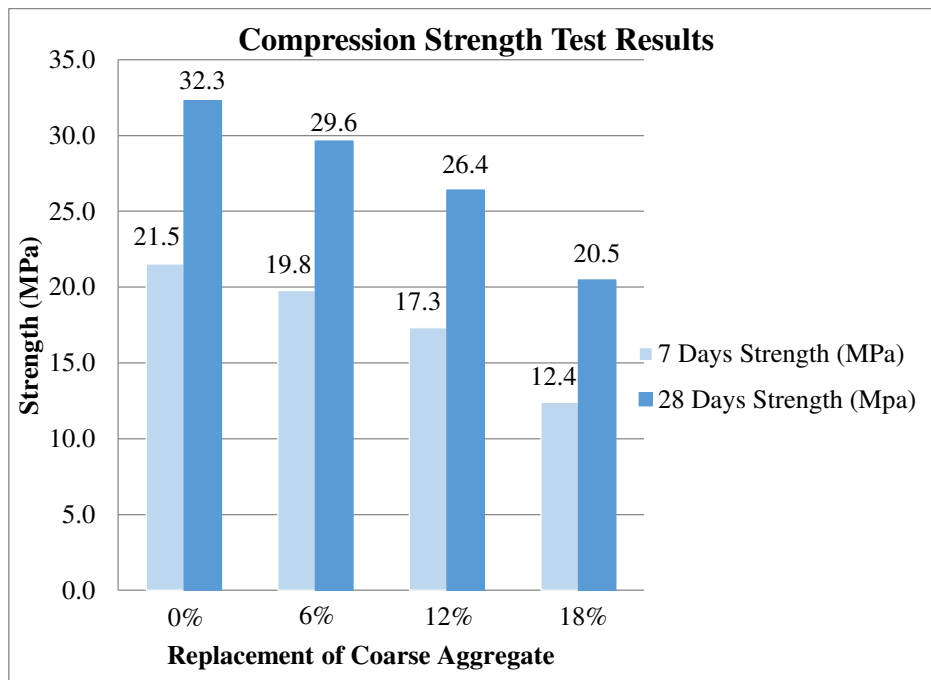


Figure 1: Compression Strength Test result for 7 & 28 days

Table II: Results of Split tensile Strength Test

% Replacement of Coarse aggregate with tyre crumbs	Failure load (kN)	Split Tensile Strength for 28 days F_{ct} (MPa)
0%	214.06	3.03
6%	180.16	2.55
12%	125.05	1.77
18%	109.50	1.55



Figure 2: Splitting failure of normal PCC lean mix concrete specimen



Figure 3: Splitting failure for 18% replacement by coarse aggregate concrete specimen

Table III: Results of Flexure Strength Test on rubberized concrete

% Replacement of Coarse aggregate with tyre crumbs	Maximum Failure Load (kN)	Maximum Deflection (mm)	Flexural Strength for 28 days (Mpa)
0%	33.80	3.4	5.54
6%	32.05	2.9	5.25
12%	30.31	2.4	4.97
18%	20.70	1.9	3.39

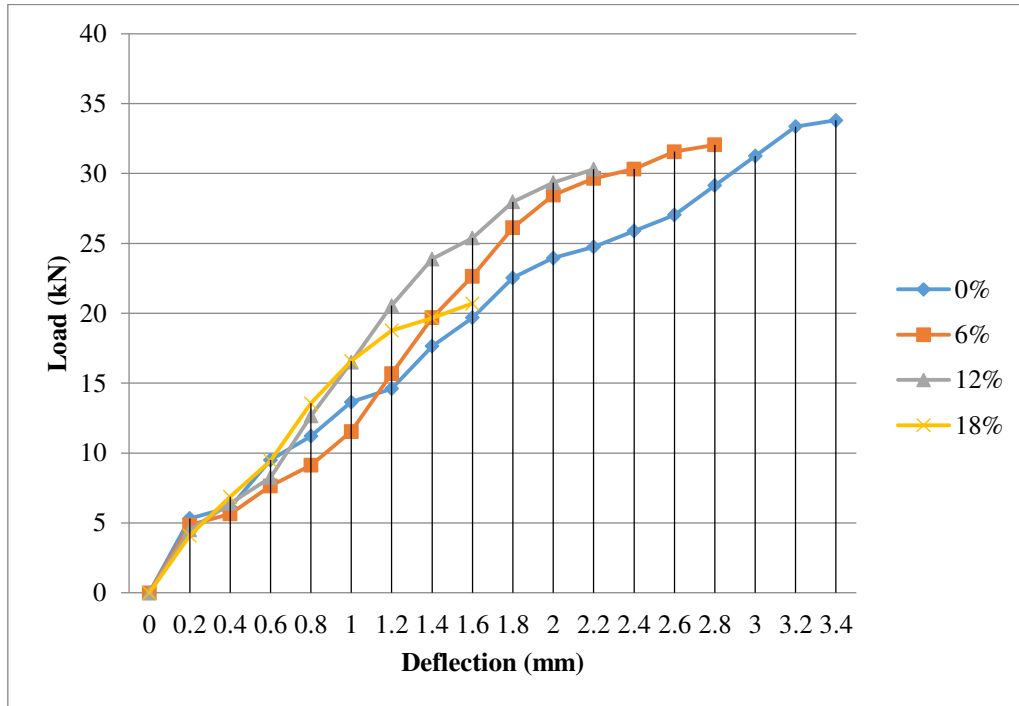


Figure 3: Load – Deflection Curve diagram for varying % rubber crumbs



Figure 4: Flexural failure of rubberized concrete

V. DISCUSSION

It was observed that there was a gradual decrease in compressive strength of concrete when the percentage of rubber content increases. Higher the rubber content in concrete, higher the reduction in compressive strength of concrete. The loss of compressive strength of concrete at 7 and 28 days compared to the control mix was 7.9%, 19.53%, 42.32% and



8.35%, 18.26%, 36.53% at 6%, 12%, 18% respectively. Strength of concrete is optimum for 6% of replaced rubber. Strength of concrete cube is indirectly proportional to percentage of rubber from 6% to 18% replacement of rubber. The flexural strength was decreased by adding rubber particles. It was observed that split tensile strength for sample containing 6% rubber aggregate was 16% less as compared to normal RCC concrete sample. Whereas, for 12% it was observed split tensile strength was 42% less than 0% replacement of rubber aggregate. For 18% split tensile strength observed was 48% less than that of normal RCC concrete sample. The concrete cylinders without rubber failed by splitting into two halves during the splitting tensile tests as shown in Figure 4.2, whereas the rubberized concrete cylinders displayed a more cohesive behaviour that is failing without splitting as shown in Figure 4.3. Increasing rubber content reduces the toughness of the concrete under increasing loading.

The failure mode of the specimen with 0% replacement of coarse aggregate shows that the failure of prism occurred at the centre. This is related to the homogeneity of the mix. In the mixes containing rubber particles, failure mode occurred not exactly in the centre this can be seen in Figure 4. From the Load – Deflection data from Figure 4.7 it was observed that deflection was maximum for specimen with 0% replacement of coarse aggregate i.e. 3.4 mm. For 18% replacement with tyre crumbs failure occurred at 1.9 mm deflection at load of 20.70 kN. With increase in percentage of scrap rubber tyres as coarse aggregate deflection occurs for lower values of force applied on the specimen.

VI. CONCLUSION

- 1) Compressive strength of concrete is decreasing with the increase in percentage of rubber proportions. The concrete cube with a 6% replaced rubber proportions results high strength among the cubes; thus this 6% proportion of rubber required to be adopted as the most suitable replacement percentage among the remaining percentages. As the cost of rubber is lower than aggregate, this is economically feasible to replace the coarse aggregate with rubber up to 6% so; it is safe to use the concrete with 6% replacement of rubber.
- 2) The split tensile strength of rubberized concrete with 18% replacement of coarse aggregates with tyre crumbs was decreased by up to 49% as compared to normal mix concrete.
- 3) The splitting tensile strength decreased when coarse aggregates replaced with crumb rubber. A gradual and continuous loss of mixes strength has happened when the waste tyre rubber replacement ratio increased.
- 4) Decrease in flexural strength in rubberized concrete is due to decrease in density of concrete, weaker bonds and increase in voids. The Flexural strength of rubberized concrete decreased by 39% for 18% replaced rubber aggregates to normal mix concrete.
- 5) The percentages waste tyre rubber replacement ratio more than 18% with natural aggregate in volume lead to a more negative effect in hardening properties of concrete while the ratio of 6 -12% have hardening properties near the normal concrete with better ductility.

REFERENCES

1. **Rana Hashim Ghedan ,Dina Mukheef Hamza.** “Effect Of Rubber Treatment On Compressive Strength And Thermal Conductivity Of Modified Rubberized Concrete” (*Journal Of Engineering And Development, Vol. 15, No.4, (2011) ISSN 1813- 7822*)
2. **Dr. Stergios Mitoulis ,Ataria Robert Bennett.** “Effect of waste tyre rubber additive on concrete mixture strength” (*British Journal of Environmental Sciences Vol. 4, No. 4, pp.11-18 October 2016*)
3. **Parveen , Sachin Dass , Ankit Sharma.** “Rubberized Concrete: Needs of Good Environment (Overview)” (*ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 3, Issue 3, March 2013*)
4. **Hesham M. Fawzya , Suzan A. A. mustafab , Fady A. Elshazly.** “Rubberized concrete properties and its structural engineering applications – An overview” (*The Egyptian International Journal of Engineering Sciences and Technology Vol. 30 (2020) 1–11*)
5. **Mr. Gorde Pravin, Mr. Chothe Onkar, Rahekwar Shalini D, Chaudhari Komal K.** “Effect of Partial Replacement of Coarse Aggregate and Fine Aggregate by Scrap Tyre Rubber: A Review” (*International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 12 | Dec 2018*)
6. **Osama A. Abaza, Saleem M. Shtayeh.** “Crumbed Rubber for Non-Structural Portland Cement Concrete Applications” *Dirasat, Engineering Sciences, Volume 37, No. 2, 2010*
7. **Jemimah Carmichael.M. Prince Arulraj.G, Rijo Mathew, Jerome Joshy, Alok Alex.** “Effect of Nano Silica Fume and Crumb Rubber on the Mechanical Properties of Concrete” *International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-8, Issue-3S, 2019*
8. **Robert B. Ataria, Yong C. Wang.** “Mechanical Properties and Durability Performance of Recycled Aggregate Concrete Containing Crumb Rubber”



9. Ankit R. Bagul, Prof. R.M.Jadhav “Investigation on Sound and Heat Insulation Properties of Rubberized Concrete” *JETIR October 2020, Volume 7, Issue 10.*
10. **EsraaEmam, SamehYehia** “Experimental Study on Enhanced Crumb Rubber Concrete” *International Journal of Scientific & Engineering Research* Volume 9, Issue 2, February-2018.
11. **IshtiaqAlam,UmerAmmarMahmood,NoumanKhattak** “Use of Rubber as Aggregate in Concrete: A Review” *International Journal of Advanced Structures and Geotechnical Engineering* ISSN 2319-5347, Vol. 04, No. 02, April 2015
12. **Samar Raffoul, Reyes Garcia, KyprosPilakoutas, Maurizio Guadagnini, Nelson Flores Medina**, “Optimisation of rubberised concrete with high rubber content: an experimental investigation” *Construction and Building Materials* Volume 124, 15 October 2016, 391-404
13. **Ali AbdulameerKadhim ,Hayder Mohammed Kadhim** “Experimental investigation of rubberized reinforced concrete continuous deep beams: A review” *Journal of King Saud University – Engineering Sciences.*
14. **Najib N. Gerges, Camille A. Issa, Samer A. Fawaz** “Rubber concrete: Mechanical and dynamical properties: Case Study” *Case Studies in Construction Materials.*
15. **Akhilesh Das Gupta** "Effect of waste tyre rubber in the concrete" *International e-Conference on Sustainable Development & Recent Trends in Civil Engineering*
16. **BlessenSkariahThomas, Ramesh Chandra, GuptaVinu, JohnPanicker**“Recycling of waste tire rubber as aggregate in concrete: durability-related performance” *Journal of Cleaner Production* Volume 112, Part 1, 20 January 2016, Pages 504-513



INNO SPACE
SJIF Scientific Journal Impact Factor
Impact Factor: 8.118



ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 **9940 572 462**  **6381 907 438**  **ijirset@gmail.com**



www.ijirset.com

Scan to save the contact details