AN EXPERIMENTAL INVESTIGATION ON THE USE OF CRUMB RUBBER AS FINE AGGREGATE IN CONCRETE

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Abstract *The environment is increasingly burdened by rubber waste due to the growth of the automobile industry. Burning rubber releases harmful fossil fuels and gases that pose risks to living beings. Therefore, recycling rubber is essential, especially in the construction sector, where it can be used for pavements and building materials. Rubber exhibits excellent elastic, thermal, and fire-resistant properties, making it valuable in various applications. Crumb rubber, which consists of finely crushed rubber particles, can replace sand in concrete. To assess the viability of crumb rubber in construction, we need to conduct experiments to evaluate its effects on the compressive strength, tensile strength, and workability of different grades of concrete. In place of aggregates, the study employed 0%, 10%, 20% 30% and 40% crumb rubber. We test the rubberized concrete's Workability Test, Flexural, Compressive and Split Tensile strengths. As the rubber content in rubberized concrete grows, the slump first rises and then begins to fall. Increase The compressive strength of rubberized concrete is lower than that of regular concrete at first, but it increases with time. Furthermore, a 10% NaOH solution was added to the cement mixture to enhance the crushed rubber's stickiness. In this work, a concrete mix was designed for experimental purposes with a goal strength of 20 MPa. Measurements of compression force, Flexural and split test were taken on days 7 and 28. The findings showed that by including 10% crumb rubber, the concrete's volume weight was decreased by 3%. The separation and compression forces were found to be decreasing as the quantity of crumb rubber rose. As the rubber aggregate content increases by 20%, the crack resistance drops by 10% and the compressive strength drops by 26%. Incorporating crushed rubber into fine aggregate mixes in quantities more than 20% is not advised.*

Key Words: concrete, crumb rubber, compression strength, slump.

1. INTRODUCTION

A composite material, concrete, is created by gradually drying a mixture of finely powdered liquid cement and other additives. The largest environmental issue that contemporary society is confronted with tire trash. Mobility has grown in popularity within the automobile industry with the modernization of society during the industrial revolution. New problems with rubber waste have emerged because of this shift in approach. The issue of tire trash is gaining significant attention in the environmental community. Approximately one billion tires are used annually.

There are already a lot of pipes in storage or buried with dirt; tires in landfills are a big threat to the environment. Furthermore, used tire landfills contribute to biodiversity loss due to the soluble or poisonous substances contained in tires. Secondly, this danger persists regardless of how difficult it is to ignite old pipes. When tires catch fire from excessive heat, harmful gases, and other factors, the tubes inside the tire melt. All throughout the globe, people have already dumped millions of tires. In this we look at two types of rubber: one made from recycled tires, and another that might replace part of the rubber in rubber cement. Finding out how the properties of concrete are impacted by rubber chips from used tires is the main goal. Instead of using rubber chips, this method evaluates the properties of both wet and dry concrete using coarse particles of varying sizes.

Recycling just a portion of the rubber from old tires is possible; the remaining portion is used for making roads. Another option is to build an artificial reef; however, this has been subject to cast doubt on practical. In addition to finding the use in cement kilns, scrap tires may be thermally decomposed in the absence of oxygen to produce low-value materials like carbon black via the pyrolysis process. Using pipes as an aggregate substitute in concrete may improve the strength and sound insulation characteristics of the final product. Extraction of rubber aggregates from waste may be accomplished in two ways: mechanically at ambient temperature or cryogenically below the glass transition point.

To augment the fine's, crushed rubber is made in the second step, while flake rubber is made in the first stage to substitute for the raw aggregates. The most important information on the characteristics of concrete that contains recycled tire rubber is examined Considerations like as waste particle size, replacement quantity, and the impact of waste treatment on both the fresh and hardened concrete properties are also addressed. Buildings in areas prone to earthquakes and other uses requiring substantial dynamic behavior, such railway sleepers, are best suited for concrete. This material has a variety of pre-retaining uses, including noise barriers.

Scrap tire rubber

Recycling of scrap tire rubber

Shredded or chipped rubber

Instead of gravel, this tire will be used. This tyre has two halves that must be separated. I'm going to create gum now. Tire dimensions range from 100 to 230 mm in width and 300 to 430 mm in length at the conclusion of the first step. Changing the scale, the second step cuts from 100 to 150 mm. The grinding process produces are known as "shredded particles" and their sizes range from 13 to 76 mm.

Chipped rubber

Objectives of the study

1. The main aim is to identify the usage of recycled materials in concrete as it enhances the mechanical properties of concrete.
2. Crumb rubber was replaced by volume of fine aggregate from 5% to 30% in Concrete.
3. The rubberized concrete is tested for slump and compression strength to find the Workability and Compressive strength.
4. According to the various percentages of Crumb Rubber as Fine Aggregate in Concrete Increased workability upto 10% but decreases at higher percentages due to reduced cohesion.
5. If excess amount of rubber is mixed the strength will be reduced, which is not desirable. So, the proportion of crumb rubber to be mixed in this study as mentioned above percentage.

2. LITERATURE REVIEWS

Khalid (2013): In their study, the mechanical and dynamic properties of Self Compacting Rubberised Concrete (SCRC) were experimentally investigated. Crumb rubber from scrap tyres was used as a partial replacement for

Fine Aggregate (FA), Coarse Aggregate (CA) and combined Fine and Coarse Aggregate (FCA) at 5, 10, and 15 wt% proportions. The Dynamic Modulus and Ultrasonic Pulse Velocity decreased as the proportion of rubber substitution was increased, however SCRC has superior vibration damping behaviour in all cases with up to 230% enhancement in damping ratio and damping coefficient for the CR 15 wt% mix.

M.M. Rahman, M. Usman, Ali A. Al-Ghalib (2012): A series of laboratory investigations were undertaken on rubber modified self-compacting concrete (RMSCC) to study the workability of the mixture during its production and the fundamental mechanical and dynamic properties of cured specimens. The results showed that, compared to the self compacting concrete (SCC), the slump together with passing and filling ability of RMSCC mixtures are lower despite a higher dosage of super plasticizer in the fresh mixtures.

3. MATERIALS USED

OPC 53 Grade cement

Ordinary Portland cement (OPC) grade 53 is used, its composition and qualities are determined by the Indian Standards Organization. Cement can be defined as a cohesive and adhesive binding substance that allows different building elements to be assembled and produce a compact assembly. Typical/Normal One of the most popular types of Portland cement is Portland cement.

OPC 53 Grade Cement

Coarse aggregates

Coarse aggregates are particulates that are greater than 4.75mm. The usual range employed is between 9.5mm and 37.5mm in diameter. - Fine aggregates are usually sand or crushed stone that are less than 9.55mm in diameter. Typically, the most common size of aggregate used in construction is 20mm.

Coarse aggregates

Fine Aggregate

The fine aggregate used was IS 383. Aggregate fineness was obtained by near flow. Its thickness was 1.41 g/cc, density 2.68 and modulus of fineness 2.9. The remaining sand was passed through a series of IS sieves, each passing through diameters of 2.36, 1.18, 0.6, 0.3, and 0.15 mm. The sand remaining in each sieve was collected and stored for later use in different bags.

Sand used for work

Water

Potable water was used in the experimental work for both mixing and curing.

Crumb rubber

The residue left by old tires is called crumb rubber. Tire rubber is ground into suitably sized particles in rubber mills and then added to concrete as a filler.

Crumb rubber

Mix design of concrete used

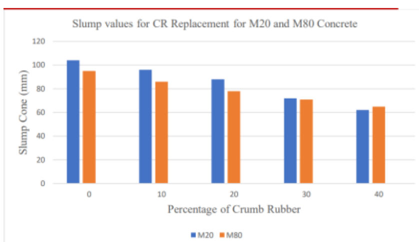
In this study M20 grade and M80 grade concrete are used to check the fresh concrete and hardened concrete test results as per the replacement of fine aggregates with crumb rubber.

Details of specimens cast

S. No	Crumb Rubber (%)	Cubes	Cylinders	Prisms
1	0	4	4	4
2	10	4	4	4
3	20	4	4	4
4	30	4	4	4
5	40	4	4	4

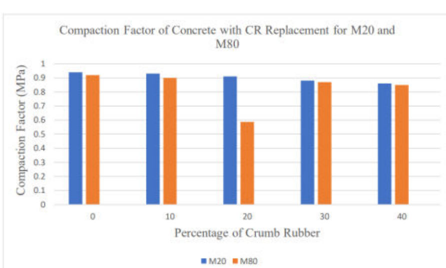
4. RESULTS AND ANALYSIS

Effect of crumb rubber on slump values of M20 and M80 concrete



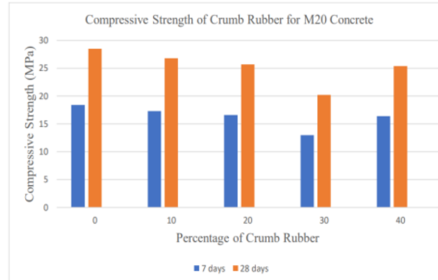
Slump values of concrete with CR replacement for M20 and M80 concrete

Effect of crumb rubber on compaction factor of M20 and M80 concrete

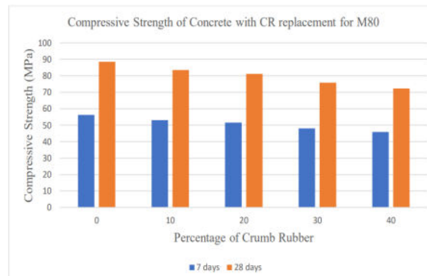


Compaction factor of concrete with CR replacement for M20 and M80

Effect of Compressive Strength with CR replacement

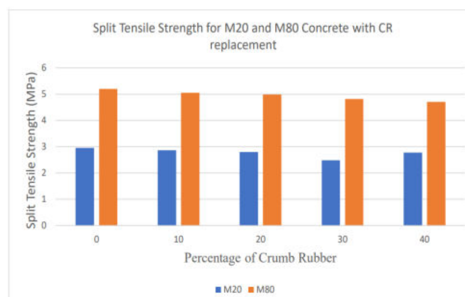


Compressive strength of M20 concrete with CR replacement



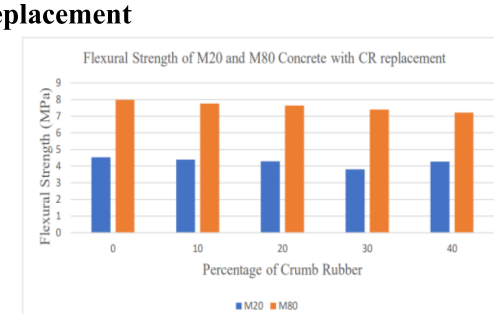
Compressive strength of M80 concrete with CR replacement

Effect on Split Tensile Strength with CR replacement



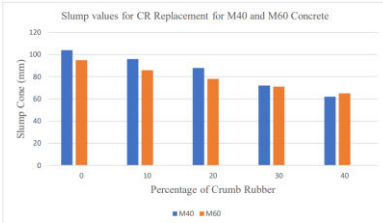
Split Tensile strength for M20 and M80 concrete with CR replacement

Effect on Flexural Strength with CR replacement



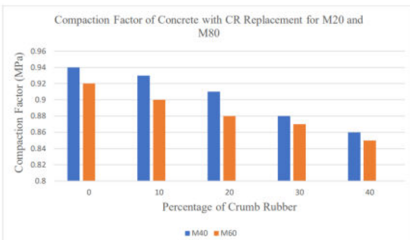
Flexural strength of M20 and M80 concrete with CR replacement

Effect on Workability with CR Replacement for M40 and M60 Concrete



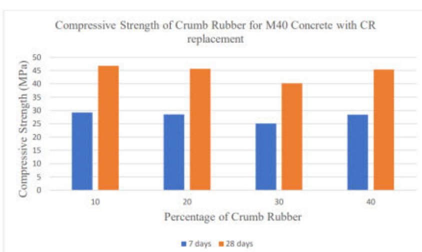
Slump values of M40 and M60 concrete with CR replacement

Effect of crumb rubber on compaction factor of M40 and M60 concrete



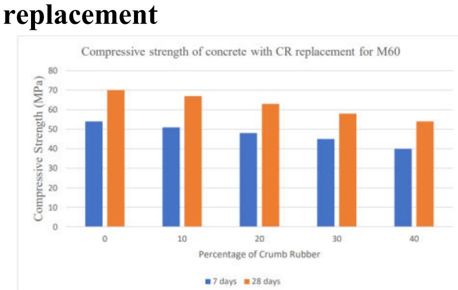
Compaction factor of M40 and M60 Concrete with CR replacement

Effect of Compressive Strength with CR replacement



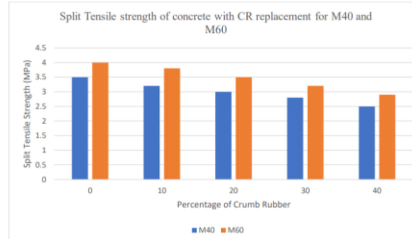
Compressive strength of M40 concrete with CR replacement

Compressive strength of M60 concrete with CR replacement



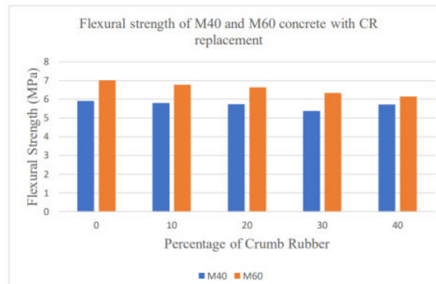
Compressive strength of M60 concrete with CR replacement

Effect on Split Tensile Strength with CR replacement



Split tensile strength of concrete with CR replacement for M40 and M60

Effect on Flexural Strength with CR replacement



Flexural strength of M40 and M60 concrete with CR replacement

5. CONCLUSIONS

From this experimental study the following conclusions were made

1. Using elastic sections instead of the usual thick overall greatly reduces its usefulness.
2. As the quantity of rubber pieces used as replacements increases, the compression and damping qualities deteriorate.
3. The mechanical characteristics of crushed rubber have evolved due to its widespread usage in concrete.
4. Using waste elastics at a rate of 20% instead may degrade the mechanical qualities in each major grade by 5-10%.
5. When the replacement levels of the elastic residues climb to 30% and 40% in each major degree, the mechanical properties decline too.
6. Instead of employing regular raw rubber, it was determined that lumped elastomer may be used to make a material that is lightweight, eco-friendly, and productive.

7. Adding 20% rubber to concrete improved all the attributes while preserving most of its fresh and hardened properties.

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