PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH WASTE TIRE RUBBER

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These days, the research community is paying close attention to solid waste management. Because they are not biodegradable, accumulating waste tires have emerged as a significant issue among other solid trash. The majority of discarded tire rubber is utilized as fuel in a variety of businesses, including brick and cement kilns, thermal power plants, and others. Regretfully, this type of use is expensive and harmful to the environment. In order to safeguard the environment, using leftover tire rubber to prepare concrete has been considered as an alternate method of disposing of such garbage This study aims to systematically identify the various qualities required for the design of a concrete mix containing coarse tire rubber particles as aggregate. The M20 grade concrete has been selected as the reference concrete specimen for the current experimental inquiry. Rubber chips from scrap tires have been utilized in place of traditional coarse aggregate in amounts of 1%,3%, and 5%.

Key words:, *Coarse aggregate, Rubberized concrete, Management, environmental friendly, Non – biodegradable. flexural strength, different mix, split tensile strength, and compressive strength.*

1. INTRODUCTION

Cement and aggregates are the two most important components of concrete, which is one of the building materials used the most extensively and constantly around the world. Moreover, these aggregates are commonly thought of as inert filler for concrete, but in reality, they have qualities that affect the concrete's physical, thermal, and occasionally chemical composition. Owing to the high demand for concrete in the construction industry, alternative materials made from waste or recycled resources must be used to protect the natural coarse aggregates. As recycling results in the utilization of waste tires with a minimal environmental impact and maximizes the conservation of natural resources, it is the optimum management method for junk tires. Rubberized concrete is commonly utilized in initiatives relating to development, like roads or traffic signals, recreation areas, and ramps that are resistant to skids. Along with this new real estate, it is anticipated that these Concretes can be utilized in building applications; low-unit requirement panels rail-roads to secure rails to the ground, weight, tiles for roofs, etc. serious issue with rubber disposal of tire trash and other related shortages natural coarse aggregates for use in building then, in order to resolve these issues, it is crucial to employ tires that have been recycled as an aggregate that can offer the resolution to two significant issues, namely environmental issues produced by tire waste and the loss of natural resources as a result. The weight of the concrete is reduced with shredded rubber. The demand for concrete and its constituent materials, such as aggregate, is high due to the rise in construction activities. Waste tire rubber can therefore be used in place of this need. Nonetheless, the project's main goal is to investigate if rubber tire waste may replace some of the mineral coarse particles in concrete.

The overall goal of this research is to assess the qualities of concrete that is generated when natural fine particles are partially substituted with locally sourced recycled tire rubber. This study's specific goals are to: (i) observe some physical properties of the concrete mix that are made from waste tire aggregates; (ii) determine the concrete mix's flexural and split tensile strength using different percentage replacements; (iii) interpret and discuss test results from various laboratory mixes; and (iv) compare test results from crumb rubber concrete with regular concrete.

2. LITERATURE REVIEW

- A. Chandra - The improper disposal of worn tires is a serious environmental issue that affects the entire planet. It contaminates the soil and plants, creates uncontrolled fires, and serves as a mosquito breeding ground. Finding alternate uses for these tires is therefore desperately needed, with a focus on recycling the used tire. Excellent for structural purposes, concrete is regarded as a necessary component of human society and modern civilization. It is now theoretically possible to utilize used tires in concrete, and the resulting material is referred to as lightweight concrete. This study examines the viability of strengthening and safeguarding the environment by utilizing scrap tires as chips of varying sizes in concrete .In this work, we describe the application of rubberized concrete in structural and non-structural elements and demonstrate its suitability for the material, as well as its applications, drawbacks, and advantages for further research.

- Pravin Shelke, Rohan Kadam, Atul Naykodi, and Deepak Parakh - In recent years, the disposal of waste glass and worn-out tires has become a significant problem in India because these materials have limited uses and require melting and remoulding in order to be used to make new tires. In addition to increasing pollutants, this process emits hazardous gasses into the atmosphere that are bad for both the environment and living things. Since silica is the primary component of glass, it can aid in AAR, which occurs in all varieties of concrete. Quarries provide natural coarse aggregate, which means that if current usage trends continue, these quarries will likely run out of material in a few decades. This meant that a long-term solution to the ongoing issue was required. In light of this, this study has evaluated experimentally the viability of using waste tires in place of coarse aggregate and waste glass in place of fine aggregate for building new roads. On aggregates, simple mechanical and physical tests have been performed. Fine aggregates, on the other hand, were evaluated for compressive strength using cast blocks. The physical qualities of coarse aggregate have significantly improved, according to experimental data, when discarded tires are substituted for up to 15% of the coarse aggregate. The testing findings also showed that waste glass can replace fine aggregate by up to 10%.

- Shahid Rasool Tarry - The pre-treatment of rubber particles and their partial replacement of traditional rock aggregates are the main foci of this study endeavour. Before being employed in the concrete, the rubber aggregates are surface treated with cement paste and sodium hydroxide for optimal results. The concrete is M20 grade. Results: When treated rubber aggregates were added, the resultant concrete's compressive strength increased significantly. This can be deemed quite satisfactory given the easy and affordable availability of used tires and the fact that the concrete's 28-day compressive strength was recovered to over 90% when untreated rubber aggregates were used. This much compressive strength is enough for treated rubberized concrete for its use in different areas where compressive strength is not much important like in floors and concrete road pavements. Flexural and split tensile strength is found to be higher than that of the normal concrete but only when treatment is given to the rubber aggregates before using them. Workability is decreased. Flexibility gets increased and due to the lower unit weight of the rubber particles, it is also lighter than the normal concrete. These enhanced properties can be helpful in using this concrete in flexible slabs and as light weight concretes.

- Er. R.P. Mahla2-Rahul Mahla1 These days, the research community is paying close attention to solid waste management. Because they are not biodegradable, accumulating waste tires have emerged as a significant issue among other solid trash. The majority of discarded tire rubber is utilized as fuel in a variety of businesses, including brick and cement kilns, thermal power plants, and others. Regretfully, this type of use is expensive and harmful to the environment.In order to safeguard the environment, using leftover tire rubber to prepare concrete has been considered as an alternate method of disposing of such garbage. This study aims to systematically identify the various qualities required for the design of a concrete mix containing coarse tire rubber particles as aggregate. The reference concrete specimen for this experimental inquiry is the M20 grade concrete. Rubber chips from scrap tires have been substituted for traditional coarse aggregate as coarse aggregate.

- Ishtiaqalam, Umerammarmahmood, Noumankhattak - Every year, the world produces an enormous amount of rubber. Its slow breakdown and subsequent degradation of the environment make it difficult to dispose of in the environment. In this situation, it would be preferable to reuse the rubber. Rubber wastes were recycled by adding them to concrete as coarse aggregate, and their various qualities—such as ductility, compressive strength, and tensile strength—were examined and contrasted with those of regular concrete. Consequently, it was discovered that, in comparison to regular concrete, rubberized concrete is less ductile, more resilient to cracks, and has a lower compressive strength. A small amount of silica can be added to rubberized concrete to boost its compressive strength.

- Recycled tire rubber was employed by Biel and Lee in concrete mixes prepared with magnesium oxychloride cement, where fine crumb rubber was used to substitute aggregate up to 25% by volume. Tests on compressive and tensile strength showed that using magnesium oxychloride cement leads in improved bonding. The researchers found that if the aggregate's volume is restricted to 17% rubber content, structural applications would befeasible.

3.PROJECT OBJECTIVE

- To assess the fresh and hardened qualities of concrete made by substituting locally accessible waste tire rubber for a portion of the coarse aggregate.
- To ascertain the impact of varying tire rubber proportions in the mixture. that is, (0%, 1%, 3%, 5%)
- The objective is to ascertain the cubes' strength after seven and twenty-eight days and compare it with regular concrete.
- To ascertain the % change in cube strength after 7 and 28 days.
- To lessen the strain on naturally occurring materials by substituting scrap tire rubber for aggregate.

4. MATERIALS

MATERIALS TO BE USED

The different materials will be used in this investigation are

- 53 Grade Ordinary Portland cement
- Fine Aggregate
- Coarse Aggregate
- Rubber Crumb
- Water

Cement: Cement is a binder, a material that can bond other materials and sets and hardens on its own. For this investigation, regular Portland cement of grade 53 will be utilized. Sand: After appropriate sieving, use fine sand. The primary purpose of sand is to provide volume economy as an inert substance.

Fine aggregate: The fine aggregate conforming to zone II according to IS: 383-1970 will be used. The fine aggregate used was obtained from a crushed stone source. The specific gravity of the sand used was 2.52. The sand obtained was sieved as per IS sieves (i.e. 4.75mm, 2.36mm, 1.18mm, 600microns, 300 microns, and 150 microns).

Coarse aggregate: Crushed granite will be used as coarse aggregate. The coarse aggregate according to IS: 383. 1970 will be used. Maximum coarse aggregate size used is 20 mm.

Rubber Crumb : The rubber used in this research work is from the tread of a truck tyre tube which is the part of the tyre. It is cut down manually to the size coarse aggregates. The size of the rubber aggregates is kept around 20mm..

Water: Potable water will be used in the experimental work for both mixing and curing purposes.

5. EXPERIMENTAL PROGRAMME

The purpose of the experimental program was to add patial rubber crumb to concrete at weights of 1%, 3% and 5% in order to test the strength of concrete. The workability, compressive strength, split tensile strength, and flexural strength were the main objectives of the experimental program. The qualities mentioned above were studied using mix M20. Table No. 1 provides the experimental program's layout.

Table 1: details of specimens cast.

Sl.no	Nature	M20		
		Cube	Cylinder	Prism
1.	PCC	2	2	2
2.	1%	2	2	2
3.	3%	2	2	2
4.	5%	2	2	2

- The size of each cube is 150 X 150 X 150mm.
- The size of each cylinder is 150mm in dia & 300mm in height.
- The size of each prism is 100 X 100 X 500mm.

5. CASTING PROGRAMME:

The examples were cast using cube, cylinder, and beam casting techniques, material preparation, and material weighing in compliance with IS:10086-1982. As per IS 516: 1959, concrete is mixed, compressed, and dried. While the simple cube, cylinder, and prism samples were cured for 7 and 28 days in a water pond, the specimens were cured for 7 and 28 days at room temperature under cover. The amount of material required per cubic meter of concrete for the intended M20 grades of concrete is shown in Table 2.

Sl.No	Replacing %rubber with C.A	Cement (Kg/m^3)	Fine aggregate (Kg/m^3)	Coarse Aggregate (Kg/m^3)	Amount of Rubber Aggregate Added (Kg/m^3)	Water Cement Ratio
1	0%	383	543.67	1251.84	-	0.50
2	1%	383	543.67	1239.32	12.52	0.50
3	3%	383	543.67	1214.28	37.56	0.50
4	5%	383	543.67	1189.248	62.59	0.50

Table 2: materials required per cubic meter of concrete. And With different quantities of rubber

6. SAMPLE PREPARATION AND TEST

For this research tire crumbs are used as a substitute for coarse aggregate in the context of this study. Concrete cubes were cast with a 0.5 water/cement ratio and a [M20] 1:1.5:3 mix design. all components were well combined to guarantee homogeneity. Within the range of 0-5%, different types of coarse aggregate material were partially substituted. After compacting the concrete on the mould, the cubes were allowed to sit at room temperature for 24 hours before being moved into the curing tank.

Tests on the hardened concrete included particle size distribution, water absorption, consistency and setting time, slump, compressive strength, split tensile strength, and flexural strength. The specimens were examined for both mechanical and physical qualities. Every test was administered in compliance with the Indian Standard.

7. RESULT AND DISCCUTION

Compressive strength:

As seen in picture 1, a compression machine was used for this test. The device was used to test the composite concrete specimens depicted in figure 2 for compressive strength. Additionally, composite concrete samples with varying rubber compositions (0%, 1%, 3%, and 5%) were used for this test. In the concrete samples, recycled rubber particles were employed in part lieu of sand. Following 7 days for the control sample and 28 days for the composite sample, respectively, the samples were all examined.

$f_c = P/A$, where, P is load & A is area

Fig 2- Compressive strength of concrete

Fig 3- Crack formation

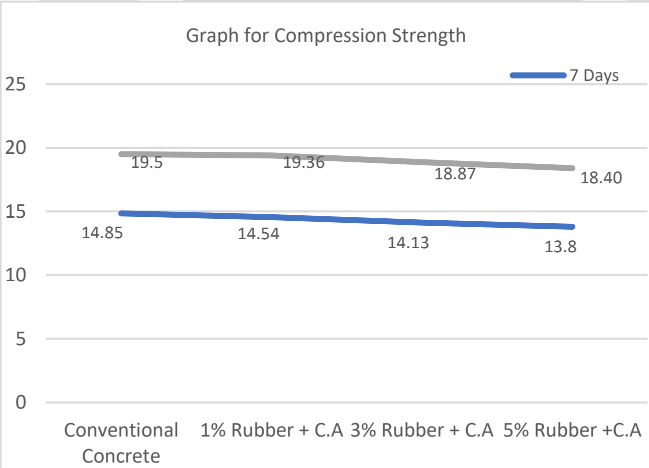

Fig-3 Compressive strength of cubes

The compressive strength of the cube specimens after 7 and 28 days of curing, respectively, is displayed in Figure 3. In the investigation, concrete samples with 5% rubber had the lowest compressive strength (13.8 N/mm2), whereas concrete samples with 1% rubber had the maximum compressive strength (14.54 N/mm2). Therefore, it may be said that 1% of rubber is the ideal quantity to add to concrete.

Flexural strength Test:

The beam specimens were subjected to two-point loading tests on a universal testing apparatus in order to generate a pure bending. The specimen's surface was free of sand or other debris, and the machine's bearing surface was meticulously cleaned. Until the specimen failed and could no longer hold the strain, the applied two-point bending stress was increased gradually and at a consistent rate. It was recorded what the specimen's greatest load was if the specimen breaks at the middle third of the span then the modulus of rupture is given by

$f_{rup} = (WL)/(bd^2)$

if the specimen breaks at a distance of 'a' from any of the support then the modulus of rupture is given by

$f_{rup} = (3Wa)/(bd^2)$,
where,
W is load at failure
L is length of specimen
b is width of specimen
d is depth of specimen

Fig-4 Flexural Testing Machine

Fig-5 tested specimens

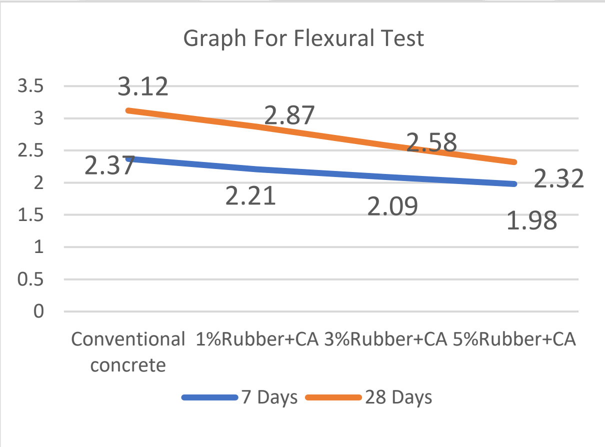

Fig-6 Flecural strength graph for 7&28 days Test

The behavior of concrete with crumb rubber cannot be the same as that of regular concrete. % of crumb rubber is declining when compared to 28 days strength and 7 days flexural strength. When comparing crumb rubber-containing concrete to regular concrete, the flexural strength of the former diminishes. On the other hand, Figure 6 compares the flexural strength of the succeeding concrete mix to that of regular concrete at 7 days and 28 days.

Split tensile strength

This test creates tensile strains normal to the plane by applying compressive line loads along a vertical symmetrical plane, which splits the specimen. The split tensile strength has been calculated using the formula that was developed using the theory of elasticity. The test is performed on cylindrical specimens with a bearing strip made of perfect 3 mm plywood that is roughly 25 mm broad. As seen in Figure 4, the specimen is positioned in the machine. The comparative analysis and results of the suggested concrete mixes for the split tensile strength at 7 and 28 days are displayed in Figure 9.

$f_{split} = 2\ P/\pi DL$, where, P is load, D is dia of cylinder, L is length of cylinder.

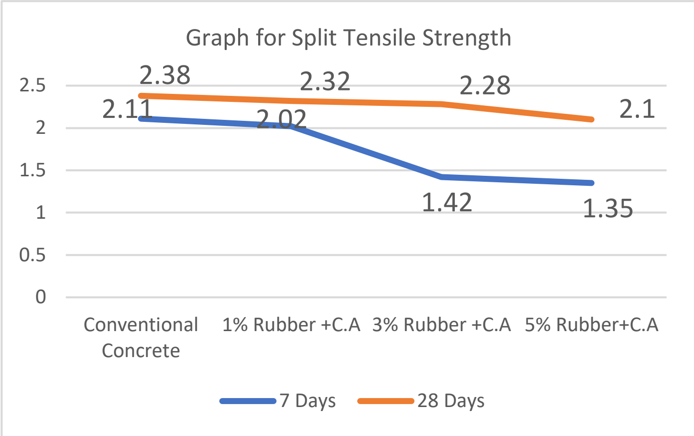

fig-4 Split tensile machine Fig-5 Split Tensile result graph

The findings for rubberized concrete indicate that splitting tensile strength declined as rubber aggregate content increased, much like what was seen in the flexural strength test. In contrast to the decrease in flexural strength, the splitting tensile strength was, nevertheless, comparatively little affected.

CONCLUSIONS

- The workability and slump of concrete were greatly improved by using recycled rubber tires. It was observed that when the proportion of rubber in each sample rose, the slump grew.
- Since rubber reduces the density of concrete, it can be utilized in place of concrete in light-weight concrete.
- As more tire rubber is replaced, the concrete's compressive strength declines.
- Despite concrete's declining strength, there is a large demand for it, therefore it can be utilized as a partial replacement, according to the literature review and experimental research.
- The strength attained in 7 days by the rubber tire is 14.54 N/mm 2, and in 28 days, it is 18.40 N/mm 2, according to the results of a comparison examination between the rubber tire and broken bricks used to partially replace the aggregate.
- The rubber tire's flexural strength is decreasing; after 7 days, it is 1.98 N/mm 2, and after 28 days, it is 2.32 N/mm 2.
- The rubber tire's split tensile strength after seven days is 2.02 N/mm2 and after twenty-eight days is 2.32 N/mm2, respectively.
- In circumstances when the requirements of normal loads, low unit weight, medium strength, high toughness, etc. are satisfied, rubberized concrete mixtures may offer a feasible alternative. Lightweight concrete walls and other lightweight architectural components are examples of these non-load bearing components.

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