Journal of Advanced Engineering Research
ISSN: 2393-8447
Volume 11, Issue 1, 2024, pp.115-119

EXPERIMENTAL INVESTIGATIONS ON FIBER REINFORCED CONCRETE BEAM WITH RECYCLED RUBBER

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ABSTRACT

Fiber reinforced recycled rubber beam can offer a perfect solution to meet the demands of sustainable structures with superior strength and flexibility. It combines rubberized concrete, steel fiber and percentage replacement of rubber and steel fiber to enhance the strength, stability, durability and overall performance. This paper presents the results of recent experimental investigations on rubberized concrete. Chipped and crumbed tire rubber particles were used to replace coarse and fine aggregate with varying percentages of replacement levels. The replacement levels selected were 25%, 50%, 75% and 100% by volume of the coarse and fine aggregates. Steel fibers were also added to the concrete mix to improve the performance of the concrete. The mechanical and fracture properties of the rubber concrete were examined. The optimal replacement ratio of the rubber particles have also been analysed to meet the strength requirements and fracture criteria.

Keywords - Recycled Rubber ; concrete, steel fiber ; Sustainability, fracture load

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1. INTRODUCTION

The waste tires has grown significantly an important issue for many nations in the modern era as a result of the transportation sector's explosive growth. Tires eventually reach a point in their life cycle where they can no longer be recycled and must be disposed of as waste. Tire disposal has emerged as one of the most significant environmental issues today, hence numerous studies have been carried out to assess the various disposal options.

Numerous investigations into the addition of tire-derived crumb rubber to concrete mixtures have been made. Powdered rubber is a waste tire that has been reduced in size and ground into tiny particles that range in size from 4.75 mm to 75µm, which can used as a partial replacement of fine aggregates and chipped rubber is a waste tire that has been reduced in size and ground into tiny particles that range in size from 5mm to 20mm, which can be used as course aggregate.

Steel fibers are one of the components that can improve the mechanical qualities of concrete. The compressive and flexural strength of concrete are improved by the addition of steel fibers. The straight, corrugated, and hookedend varieties of steel fibers mainly available. Hooked-end steel fibers have therefore been used in this study.According to the study the impact of steel fibers in three volume fractions (0.75, 1, 2%) has been examined for the mechanical characteristics of concrete.

The main objectives are

- The goal of the project is to create rubberized and fiber reinforced concrete that uses recycled steel fibers and powdered rubber to demonstrate greater impact resistance over conventional concrete.
- To research mixes that substitute aggregates with rubber products of various sizes, such as crumb rubber and powdered rubber, both with and without steel fiber.
- To investigate the impact of a rubberized steel fiber beam.
- To provide the strongest possible light beam.
- To understand the behavior of a rubberized fiber-reinforced beam.
- The ideal aggregate replacement % should be determined.

There has to be more research done on the impact of crumb rubber and steel fibers together on the mechanical characteristics of concrete. Therefore, crumb rubber and steel fibers were combined in this research project to examine their effects on the functionality of reinforced concrete beams. Various weight replacement percentages (0%, 25%, 50%, 75%, and 100%) of fine aggregates were replaced in part with rubber powder and crumb rubber. Additionally, 3 fractions of hooked end steel fibers (0.75%, 1%, and 2%) were added to the specimen's overall volume.

2. LITERATURE REVIEW

The appropriate aggregate replacement percentage should be determined to create a light beam that is as brilliant as feasible to understand the behavior of a rubberized fiber-reinforced beam.

Aggeregate is substituted in this by rubber powder and rubber crumb. By aggregate volume, the rubber composition ranged from 25%, 50%, 75%, and 100%. By adding more rubber, the slump was minimized. The compressive strength of the material decreases as the rubber content rises.

To the volume of the beam, steel fiber has been added to the concrete in three fractions (0.75%, 1%, and 2%). The flexural strength of the beam is increased by the increase in fiber content. Additionally, the steel fiber has hooked ends and measures 50 mm in length and 1 mm in diameter.

3. METHODOLOGY

3.1 MATERIAL

3.1.1.CEMENT

Ordinary Portland Cement (OPC) of 43 grade was used.

3.1.2.FINE AND COURSE AGGREGATE

The course aggregate used as aggregate came in two sizes of 10mm and 12.5mm and was blended to provide the desired mix. The fine aggregate was a mixture of 1.18mm -75micron.

3.1.3.FIBERS

Hooked steel fibers with 50mm length and 1mm diameter was used

Fig 1 steel fiber

3.1.4 RUBBER

The rubber was used of two types they are crumbed and powdered rubber. The powder was of size between 600 microns and passing through 75micron seive. The crumbed rubber was between the size of 5mm to 20mm.

Table 1 Physical and chemical properties of cementitious material.

Properties	Cement
Physical Properties	
Specific gravity	3.077
Standard consistency	30%
Setting time Initial	37 min
Setting time Final	303 min
Compressive Strength at 28 days	30.2 N/mm^2
Flexural strength at 28 days	5.03 N/mm^2

Table 2 Physical properties of fine and coarse aggregates.

Properties	Fine aggregate (Sand)	Coarse aggregate (Gravel)
Specific gravity	2.61	2.79
Water absorption	0.4	0.5
Maximum nominal size(mm)	-	12.5

3.2 EXPERIMENTAL METHODS

Both the compressive and flexural strength tests were performed. The universal testing machine (UTM) was used to administer the test. An 850x150x150mm beam specimen was used for the test.

Fig:2 Beam Mould

3.2.1EXPERIMENTAL SETUP

Mix proportion was done and the sample quantity was analysed. The proportion was in the ratio of 1:2.2:3.3 and the water content ratio was 0.39. The initial test for the materials were conducted.

The casting of beam was done in 850X150X150mm specimen. A total of 48 beam including the control beam was casted.

The control beam was made with cement, fine aggregate, course aggregate and water. The reinforcement of 10mm dia bars as main bars and stirups of 8mm dia 10mm c/c is provided. For the rubberised concrete beam steel fiber and rubber were added in addition to the control beam.

Curing was given to the beam for 28 days and the compressive and flexural test was done.

3.2.2EXPERIMENTAL PROCEDURE

The experimental step were as follows,

- Mix calculation - Mix proportion was done and M30 mix was considered for the casting of specimen. As per the mix the ratio was 1:2.2:3.3.
- The materials were quantified and loaded - Analysing the amount specimen neede to be casted as per M30 mix the material were loaded.
- The initial test for the specimen were conducted - The initial test such as specific gravity, water absorption, etc were conducted
- The casting of cube and prism - The flexural and compressive strength of the materials was done.
- The specimen was demoulded and kept for water curing for 28 days and the result obtained was

Workability	Medium slump
Compressive strength at 28 days	30.02N/mm^2
Flexural strength at 28 days	5.03N/mm^2

- Casting of control beam - A specimen of 850X150X150 was casted. It was done to compare the specimen behaviour and to analyse the properties of the rubberised concrete beam with control beam.
- Demoulding and water curing for 28 days
- Casting of rubberised concrete beam with steel fiber - Concrete beam with different fraction of steel fiber and rubber were casted

Fig 3 casted specimen

a) Beam with 0% rubber content

Three set of 3 beam were casted without rubber content, only steel fibers in different fraction (0.75%,1%,2%). Workability test was conducted on the concrete mix. The casting and demoulding was done and the beam was kept for 28 days water curing and the compression and flexural test was done.

b) Beam with 25%rubber content

In this three set of 3 beam with 25% of rubber replaced with aggregate were casted with different fractions of steel fiber. Workability test was conducted on the concrete mix. The casting and demoulding was done and the beam was kept for 28 days water curing and the compression and flexural test was done.

c) Beam with 50% rubber content

In this three set of 3 beam with 50% of rubber replaced with aggregate were casted with different fractions of steel fiber. Workability test was conducted on the concrete mix. The casting and demoulding was done and the beam was kept for 28 days water curing and the compression and flexural test was done.

d) Beam with 75% rubber content

In this three set of 3 beam with 75% of rubber replaced with aggregate were casted with different fractions of steel fiber. Workability test was conducted on the concrete mix. The casting and demoulding was done and the beam was kept for 28 days water curing and the compression and flexural test was done.

e) Beam with 100% rubber content

In this three set of 3 beam with 100% of rubber replaced with aggregate were casted with different fractions of steel fiber. Workability test was conducted on the concrete mix. The casting and demoulding was done and the beam was kept for 28 days water curing and the compression and flexural test was done.

4. RESULTS AND DISCUSSIONS

The observations obtained for 0%rubber crumbs was

Steel fiber	0.75%	1%	2%
Crack load	55kN	57kN	60kN
Maximum load	59kN	62kN	78kN
Compressive strength at 28 days	26N/mm^2		

Table 3 observatioon for 0% rubber beam

Steel fiber	0.75%	1%	2%
Crack load	55kN	57kN	60kN
Maximum load	59kN	62kN	78kN
Compressive strength at 28 days	26N/mm^2		

Table 4 observatioon for 25% rubber beam

Steel fiber	0.75%	1%	2%
Crack load	55kN	57kN	60kN
Maximum load	59kN	62kN	78kN
Compressive strength at 28 days	26N/mm^2		

Table 5 observatioon for 50% rubber beam

Steel fiber	0.75%	1%	2%
Crack load	55kN	57kN	60kN
Maximum load	59kN	62kN	78kN
Compressive strength at 28 days	26N/mm^2		

Table 3 observatioon for 75% rubber beam

Steel fiber	0.75%	1%	2%
Crack load	55kN	57kN	60kN
Maximum load	59kN	62kN	78kN
Compressive strength at 28 days	26N/mm^2		

Table 3 observatioon for 100% rubber beam

The result were obtained for a crumbr rubber with steel fiber are

- The concrete mix have high workability and toughness
- The beam produced is light in weight
- More energy absorption
- Low water absorption characteristics
- Increase in impact and abrasion resistance properties
- Lower maintenance and
- Increased durability

5. CONCLUSION

Based on the experimental study described in this paper, the general conclusions that follow. With modifications to the materials' properties, the ratios of the constituents in the mixture, the curing process, and the use of admixtures and additives, any other inquiry for crumbrubber replacement for aggregate concrete mixtures may differ.The following inferences can be made from this study:

- With an increase in the amount of rubber used as a partial replacement for fine particles and coarse aggregate, the workability and unit weight of concrete mixtures drop. Additionally, adding steel fibers will make the unit weigh more.
- Compressive strength decreases as the percentage of rubber increases. However, the use of steel fibers can lessen this adverse impact.

Rubberized concrete has a useful application. The rubberized concrete mixture offers a variety of beneficial qualities, such as lower density, higher toughness, and higher impact resistance, compared to ordinary concrete, although generally having a reduced compressive strength that may restrict its use in certain structural applications. Rubberized concrete's light weight and low density can be employed in construction using lightweight concrete to produce more cost-effective designs

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