An Experimental Study on Rubberized concrete

Sandhya Annasaheb Daud, Prof.R.S.Patil , Dr.G.R.Gandhe , Dr.S.D. Shinde

Department of Civil Engineering, Deogiri Institute of Engineering and Management Studies,

Chhatrapati Sambhajinagar-431005, Dr. Babasaheb Ambedkar technological University,

Lonere402103, Maharashtra, India

ABSTRACT : Modifications of construction materials have an important bearing on the building sector. Several attempts have been therefore made in the building material industry to put to use waste material products, e.g., worn-out tyres, into useful and cost effective items. Success in this regard will contribute to the reduction of waste material dumping problems by utilizing the waste materials as raw material for other products. The present proposal involves a comprehensive laboratory study for the newer application of this waste material in the preparation of fibrous concrete. The primary objective of investigation is to study the strength behaviour i.e. compressive and flexural strength, and impact resistance of rubberized concrete with different volume of crumb rubber. Parameter to be varied in Investigation: I. Volume variation of crumb rubber. The proposed work is aimed to study the effect of volume variation of crumb rubber on the compressive strength, flexural strength, split tensile strength Slump test & The relationship between stress and strain of the concrete.

Keywords — Crumb rubber, rubberized concrete, compressive strength, flexural strength, split tensile strength, Slump test .

1. Introduction : Management of waste-tire rubber is very difficult for municipalities to handle because the waste rubber is not easily biodegradable even after long-period of landfill treatment. However, the waste tire rubber is a promising material in the construction industry due to its lightweight, energy absorption, erosion control, sound and heat insulating properties. The rubberized concrete results show the following toughness and ductility and less unit weight compared with the regular concrete. Rubberized concrete, created by incorporating crumb rubber from waste tires as a partial replacement for aggregates, offers a sustainable alternative to traditional concrete. Experimental studies have shown that while rubberized concrete exhibits reduced compressive strength compared to regular concrete, it demonstrates enhanced properties like increased toughness, impact resistance, and improved durability against freeze-thaw cycles. The inclusion of rubber particles also helps mitigate the environmental impact of concrete production by recycling waste materials.

2.Objective of study : The main objective of the study titled *"An Experimental Study on Rubberized Concrete"* is to thoroughly examine the effects of incorporating waste rubber particles—such as crumb rubber and shredded tire rubber—into traditional concrete mixes. With the rapid urbanization and growth of the construction industry, there is an increasing demand for sustainable and eco-friendly alternatives to traditional building materials. At the same time, waste management, especially of non-biodegradable materials like rubber tires, has become a critical environmental concern. This study aims to bridge the gap between sustainable waste management and innovation in construction materials by analyzing the potential use of rubber as a partial replacement for conventional concrete aggregates.

3.Need for sustainable construction : The need for sustainable construction has become increasingly critical in the face of rapid urbanization, resource depletion, and environmental degradation. Traditional construction practices often rely heavily on non-renewable resources, generate significant amounts of waste, and contribute substantially to greenhouse gas emissions. These impacts have led to a growing awareness of the importance of adopting environmentally responsible and resource-efficient construction methods.

4.Scope and limitations of the study : The scope of this study is centered around the experimental investigation of the behavior and performance of rubberized concrete, where waste rubber from discarded tires is used as a partial replacement for fine or coarse aggregates. The study aims to understand the effects of rubber inclusion on various concrete properties such as workability, compressive strength, tensile strength, flexural strength, durability, and density. By analyzing different replacement levels (e.g., 5%, 10%, 15%, 20%), the study seeks to determine the optimal proportion of rubber that can be used without compromising the integrity of concrete.

5. Literature Review : Over the past few decades, the growing problem of waste tire disposal has encouraged researchers to explore sustainable ways to recycle rubber. One promising solution has been the incorporation of rubber particles into concrete, forming what is known as rubberized concrete. Various studies have been carried out globally to investigate the mechanical and durability properties of such concrete mixes. The consensus among many researchers is that although rubber inclusion may slightly reduce the compressive strength of concrete, it significantly enhances impact resistance, ductility, and energy absorption capacity, making it suitable for specific structural and non-structural applications.

several key materials are used, each playing a significant role in achieving the desired performance and sustainability goals. The primary binding material used is Ordinary Portland Cement (OPC), commonly of 43 or 53 grade, which conforms to IS 8112 or IS 12269. Clean water, free from salts, acids, and organic matter, is used for mixing and curing. It must meet the quality requirements of IS 456:2000 and have a pH not less than 6.

a) 1.Cement (Type And Grade):

Cement is the most essential binding material in concrete. It chemically reacts with water through the hydration process to form a hardened matrix that binds all the aggregates together. For rubberized concrete, the commonly used type is:

Type: Ordinary Portland Cement (OPC)

Grade: 43 or 53 Grade as per IS 269:2015

OPC 43 Grade develops a compressive strength of 43 MPa at 28 days, whereas OPC 53 Grade achieves 53 MPa at the same age. OPC 53 is preferred in high-strength concrete mixes, while OPC 43 is suitable for general civil construction. The choice depends on the target strength, environmental conditions, and economic considerations.

b) Fine Aggregate (Sand):

Fine aggregate fills the voids between coarse aggregates and provides workability and uniformity to the concrete mix. It also influences strength, density, and finish of the concrete.

Type: Natural river sand or Manufactured Sand (M-sand)

IS Specification: Conforming to IS 383:2016

Zone: Zone II or Zone III (based on particle size distribution)

Natural River Sand is smooth and rounded but may contain silt or organic impurities. M-Sand, produced by crushing rocks, is angular and ensures consistency. Clean, dry sand with a fineness modulus between 2.3 and 3.1 is ideal.

c) Coarse Aggregate:

Coarse aggregates provide the bulk of the concrete and contribute significantly to its compressive strength and durability.

Type: Crushed granite stone or gravel

Size: 10 mm to 20 mm nominal size

IS Specification: As per IS 383:2016

Crushed stone aggregates are angular with rough surfaces, ensuring better bonding with cement paste. The maximum size depends on the application and reinforcement spacing—typically 20 mm for general construction, and 10 mm for thin sections.

d) Water (Quality and Source):

Water is critical for the hydration of cement and the development of concrete strength. It also influences workability and curing.

Source: Potable tap water, groundwater, or clean river water

IS Specification: As per IS 456:2000

Water should be:

- Free from oils, acids, salts, sugars, organic materials, and industrial waste.
- pH value should not be less than 6.
- Total dissolved solids (TDS) should be within permissible limits.

e) Rubber (Crumb, Shredded, or Powdered):

Rubber is the innovative component in rubberized concrete, replacing a portion of the fine or coarse aggregate. It is made from recycled automobile tires and comes in various sizes and forms.

Types of Rubber:

Crumb Rubber: Small particles (0.5 mm to 4 mm), used as partial replacement for fine aggregate.

Shredded Rubber: Larger, irregular pieces (10 mm to 20 mm), used in place of coarse aggregate.

Rubber Powder: Fine rubber particles (<1 mm), acts as filler or additive.

f) Admixtures (If Any):

Admixtures are optional chemical ingredients added to concrete to enhance its performance and workability.

Type:

Superplasticizers: Improve flowability without increasing water content.

Retarders: Delay setting time, useful in hot climates.

Accelerators: Speed up setting time, helpful in cold weather.

Air-Entraining Agents: Improve resistance to freeze-thaw cycles.

5. **Mix Design Methodology :**

6.Methodology :

The casting of rubberized concrete specimens was carried out following standard practices to ensure consistency and quality. Initially, all required moulds were prepared by cleaning and applying a thin layer of oil to the inner surfaces to facilitate easy demoulding. The moulds used included standard cube moulds of 150 mm × 150 mm × 150 mm for compressive strength testing, cylindrical moulds of 150 mm diameter × 300 mm height for split tensile strength, and beam moulds (if needed) for flexural strength tests. All materials including cement, fine aggregates (sand), coarse aggregates, crumb rubber, and water were weighed accurately according to the designed mix proportions for different replacement percentages (5%, 10%, and 15%). The mixing process was carried out in a concrete mixer. First, dry materials such as cement, aggregates, and rubber were mixed thoroughly to ensure uniform distribution. After dry mixing, the required amount of water, along with any superplasticizer (if used), was added gradually to form a homogenous mix.

7. Observations And Results :

The experimental study showed that as the rubber content in concrete increased, workability and strength decreased. The slump test results indicated reduced workability with higher rubber percentages. Compressive and split tensile strengths were highest in conventional concrete and decreased with increased rubber replacement, though acceptable up to 10%. Despite reduced strength, rubberized concrete showed improved

Rubber %	Strength Reduction	Workability	Durability	Best Use
5%	~5–10%	Slightly affected	Slightly improved	Load-bearing+non-structural
10%	~15–25%	Moderate	Improved	Non-loadbearing+ pavements
15%	~25–35%	Low	Highly improved	Blocks,panels,sound barriers

ductility and crack resistance, making it suitable for certain non-structural and sustainable applications.

8. Conclusion :

The study concludes that rubber can be partially used in concrete as a fine or coarse aggregate replacement. While strength decreases with higher rubber content, up to 10% replacement provides acceptable strength and better ductility. Rubberized concrete offers a sustainable way to utilize waste rubber in construction, especially in non-structural and light-load applications.

9. References :

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