AN EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF RUBBERIZED CONCRETE

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Abstract - *This study investigates the mechanical properties of M30 rubberized concrete with varying rubber content (5%, 10%, 15%, and 20%). Rubberized concrete is developed by partially replacing fine aggregates with rubber particles, aiming to enhance sustainability and reduce waste. The results show that while compressive, tensile, and flexural strengths decrease with increasing rubber content, workability improves. The paper concludes that 10% rubber content offers the best balance between strength and flexibility, making it a suitable option for non-structural applications.*

Key Words: **Rubberized Concrete, M30 Grade, Mechanical Properties, Compressive Strength, Workability, Sustainability**

1. INTRODUCTION

Concrete is a widely used construction material due to its high compressive strength and versatility. However, the environmental impact of concrete production has driven research into sustainable alternatives. Rubberized concrete, which incorporates waste tire rubber particles as a partial replacement for fine aggregates, offers environmental benefits by recycling waste materials and reducing landfill use. This paper focuses on the mechanical properties of M30 rubberized concrete and aims to determine the optimal percentage of rubber content for practical applications.

2. LITERATURE REVIEW

The literature on rubberized concrete highlights its potential as a sustainable construction material by incorporating waste tire rubber as a partial replacement for traditional aggregates. Several studies emphasize the impact of rubber particles on mechanical properties, durability, and environmental benefits.

2.1 Mechanical Properties:

Research has consistently shown that increasing rubber content in concrete results in reduced compressive and tensile strength (Khan & Ahmed, 2020; Riaz & Choudhury, 2021). However, rubberized concrete exhibits improved impact resistance, flexibility, and energy absorption, making it suitable for non-structural applications (Mousa & Elgawady, 2023). Studies have also explored the influence of particle size, with finer rubber particles yielding better integration and less strength reduction compared to coarser particles (Abdulaziz & Alesawy, 2023; Kumar & Sinha, 2021).

2.2 Durability and Environmental Performance:

Rubberized concrete's resilience in a range of environmental circumstances has been thoroughly investigated. Research shows that rubber particles improve fracture propagation control and resilience to freeze-thaw (Jin & Wu, 2023; González & López, 2021). Further research is necessary since prolonged exposure to adverse conditions, like dampness and chemical attacks, can impair performance (Liu & Zhang, 2022; Wang & Li, 2023). Furthermore, the utilization of leftover rubber in concrete promotes sustainability by lessening the environmental impact of building materials and landfill garbage (Mikhael & Shih, 2022).

2.3 Practical Applications and Structural Performance:

Rubberized concrete has been found suitable for applications requiring energy absorption and flexibility, such as road pavements, sound barriers, and earthquake-resistant structures (Hossain & Hasan, 2022). While the reduced structural strength limits its use in high-load-bearing applications, optimization techniques, including fiber reinforcement and hybrid mixes, are being explored to enhance performance (Barros & Nunes, 2021; Neto & Fernandes, 2023).

4. Comparative Analysis with Conventional Concrete:

Comparative studies highlight that rubberized concrete has lower density, making it a viable option for lightweight construction (Corinaldesi et al., 2017; Yadav & Ghosh, 2021). However, challenges such as reduced workability and mix uniformity require further research to improve handling and placement techniques (Ahn & Lee, 2022).

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3. METHODOLOGY

Concrete mix designs were prepared for M30 grade following IS 10262:2019 guidelines. Rubber particles were added as a percentage of fine aggregates, ranging from 5% to 20%. The following tests were conducted to evaluate the mechanical properties:

- **Compressive Strength**: Tested as per IS 516:1959.
- **Tensile Strength**: Determined through split tensile strength tests.
- **Flexural Strength**: Assessed using beam specimens.
- **Workability**: Measured through the slump test.
- **Durability**: Evaluated through chloride ion penetration tests.

The mix proportions used are presented in Table 1.

Table -1: Mix Proportions of M30 Rubberized Concrete

Rubber Content (%)	Cement (kg/m^3)	Fine Aggregates (kg/m^3)	Coarse Aggregates (kg/m^3)	Rubber Particles (kg/m^3)	Water (L/m^3)	Water-Cement Ratio
0	400	600	1200	0	180	0.45
5	400	570	1200	30	180	0.45
10	400	540	1200	60	180	0.45
15	400	510	1200	90	180	0.45
20	400	480	1200	120	180	0.45

4. RESULTS AND DISCUSSION

The test results are summarized in Table 2.

Table 2: Mechanical Properties of M30 Rubberized Concrete

Property	Conventional Concrete (0% Rubber content)	Rubberized Concrete (5% Rubber)	Rubberized Concrete (10% Rubber)	Rubberized Concrete (15% Rubber)	Rubberized Concrete (20% Rubber)
Compressive Strength (MPa)	40	37	34	30	28
Tensile Strength (MPa)	4.0	3.3	3.2	2.9	2.7
Flexural Strength (MPa)	5.0	4.7	4.3	4.0	3.7
Workability (Slump, mm)	75	80	85	90	95
Density (kg/m^3)	2400	2350	2300	2250	2200
Water Absorption (%)	2.0	2.5	3.0	3.5	4.0
Durability (Chloride Ion Penetration, Coulombs)	1200	1500	1800	2000	2200

- **Compressive Strength:** The data indicate a reduction in compressive strength with increasing rubber content. Rubberized concrete with 5% rubber has a compressive strength of 37 MPa, decreasing to 28 MPa at 20% rubber content. This decrease is attributed to the lower strength of rubber particles compared to traditional aggregates.

- **Tensile Strength:** Similar to compressive strength, tensile strength also decreases with increased rubber content. The tensile strength drops from 4.0 MPa in conventional concrete to 2.7 MPa at 20% rubber content.

- **Flexural Strength:** Flexural strength is less affected than compressive and tensile strengths but still shows a decrease with increasing rubber content. The reduction from 5.0 MPa to 3.7 MPa suggests reduced resistance to bending.

- **Workability:** Rubberized concrete demonstrates improved workability with increasing rubber content, as evidenced by higher slump values. This improvement in workability is beneficial for handling and placing concrete.

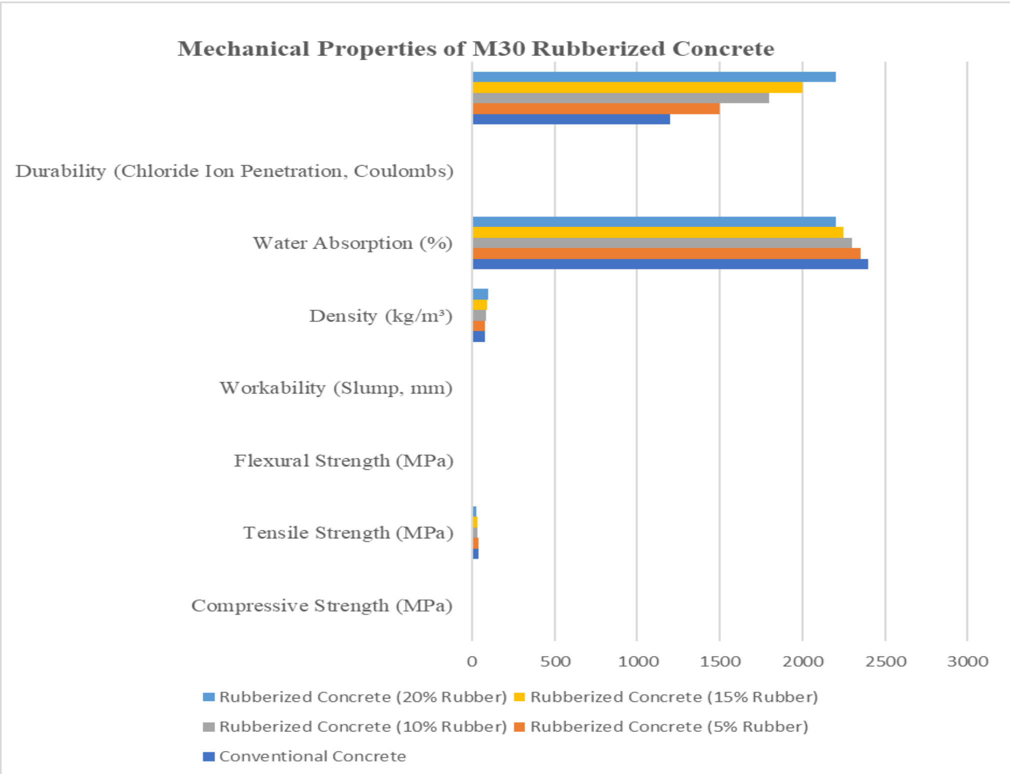
- **Density:** The density of rubberized concrete decreases with increasing rubber content. The density drops from 2400 kg/m^3 in conventional concrete to 2200 kg/m^3 at 20% rubber content, reflecting the lower density of rubber particles.

- **Water Absorption:** Rubberized concrete exhibits higher water absorption compared to conventional concrete, with values increasing from 2.0% to 4.0% as rubber content rises. This increased absorption is due to the porous nature of rubber particles.

- **Durability:** Chloride ion penetration increases with higher rubber content, indicating reduced durability. The penetration values range from 1200 Coulombs for conventional concrete to 2200 Coulombs at 20% rubber content.

5. CONCLUSION

The results demonstrate that incorporating rubber particles into M30 concrete affects both mechanical properties and workability. A **10% rubber content** offers the best compromise between strength and flexibility, making it suitable for non-structural applications where moderate strength is acceptable. However, durability considerations must be addressed when using rubberized concrete in harsh environments. Further research is recommended to enhance the durability of rubberized concrete through chemical additives or coatings on rubber particles.



Graph 1: Mechanical Properties of rubberized concrete

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