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ASSESSMENT OF STRUCTURAL PERFORMANCE OF RUBBERIZED BRICKS USING WASTE TYRE RUBBER

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Abstract— Waste tyres have a substantial detrimental influence on the environment owing to their considerable volume, non-biodegradability, susceptibility to combustion, and function as a breeding habitat for mosquitoes and several other pests. The use of waste tyre rubber for the production of environmentally-friendly rubberized bricks serves as a method for mitigating the issue of waste disposal, so contributing to the reduction of resource depletion and environmental deterioration. The aim of this study was to evaluate the practicality of using waste tyre rubber as a partial replacement for sand in the manufacturing of rubberized fly ash bricks. The purpose was to provide evidence that WTR waste may be effectively used in the construction sector. Waste tyre rubber was used as a substitute for sand, with proportions ranging from 10% to 30%. The effectiveness of the green rubberized fly ash bricks was evaluated by analyzing its compressive strength, water absorption, porosity, thermal conductivity, and microscopic properties. The results of this research suggest that the compressive strength of rubberized bricks decreased somewhat in proportion to the extent of replacement. At a sand replacement rate of 10% with waste tyre rubber the bricks exhibited the greatest compressive strength of 10.73 MPa and water absorption rate of 16.68%. The findings indicate that WTR exhibits promise as a viable option for replacing up to 30% of sand in the production of environmentally sustainable construction bricks.

Keywords— Waste tyres, Rubberized bricks, Sustainable construction, Solid waste management, Eco-friendly materials

I. INTRODUCTION

o What Are Rubber Bricks?

Rubber bricks are a type of eco-friendly building and paving material made primarily from recycled rubber, such as old car tires. These bricks are designed to mimic the size and shape of traditional concrete or clay bricks, but they offer additional benefits such as flexibility, durability, and shock absorption.

How Are Rubber Bricks Made?

The process of making rubber bricks typically involves the following steps: Collection of used rubber products (mainly tires). Shredding and grinding the rubber into granules or crumb rubber. Mixing the rubber with binders, color pigments, and additives. Molding and curing under heat and pressure to form solid bricks. Some manufacturers may also add sand or other aggregates to enhance strength and texture.



II. LITERATURE REVIEW

1. **Neela Deshpande, S. S. Kulkarni et al.** In this paper an attempt is made to design concrete of 25Mpa using artificial sand, Shredded rubber, and Crumb rubber as a source of aggregate is made using IS 10262:2009 also, the shredded rubber particles were coated with NaOH solution and use the same in concrete. The paper concluded after various lab tests that the properties of shredded rubber as compared to the artificial fine aggregate or Conventional coarse aggregate are not very encouraging. However, an attempt to use them in concret as percentage replacement can be done. The

tests were done on hardened concrete show that the use of rubber aggregate in concrete mixes produces a significant reduction in concrete compressive strength with increasing rubber aggregate content. The use of NaOH to coat the shredded rubber contributes to a slightly higher compressive strength which can be thought about for potential use in structural applications.

2. **Sukhada R H, Prof. Suhas R et al.** In the present study effort has been done to use the industrial rubber waste in the experimental study on the Rubber Paver Blocks. The work carried out aims to produce sustainable, eco-friendly, low cost, and low maintenance paver blocks which can sustain heavy vehicular loads. Here they had replaced fine aggregate with crumb rubber in 5%, 10%, 15%, and 20% after conducting various lab tests the paper concludes that as the percentage of rubber increases the slump value increases which means that workability increases at the same time compressive strength decreases. So, the conclusion drawn from the present study is, full replacement of the rubber is not possible. But partially replacement of the rubber is possible up to certain percentages.
3. **Me. Neeraj Kumar Gupta, Dr. Ajay Swarup et al.** In this research scrap tire is used in powder form, the objective was to partially replace fine aggregate with rubber powder in concrete. The study includes experimenting with different mixes and conducting tests on the specimen. The replacement was done as 10%, 20%, and 30%, for 10% replacement the compression test result was obtained after 28 days of curing which shows a result of 35.13N/mm². Thus, the paper concluded that replacing 10% of fine aggregate with rubber powder can satisfy the requirement of the concrete mix as per IS specification.

III. METHODOLOGY

Based on the literature examined it can be deduced that waste tyre rubber has been largely used in various research to incorporate it into concrete production. Nevertheless, the use of this technique in brick manufacturing has been restricted to a limited number of research investigations. Furthermore, a comprehensive analysis of the current corpus of scholarly works has shown a significant scarcity of

research investigating the production procedure of a conventional benchmark brick via the integration of fly ash, sand, and cement, while substituting sand with waste tyre rubber.

This research investigates the mechanical characteristics of a material composed of fine powder obtained from the waste produced by the tyre production industry. The evaluation included the assessment of compressive strength, water 198 Proceedings on Engineering Sciences, Vol. 06, No. 1 (2024) 197-206, doi: 10.24874/PES.SI.24.02.002 absorption, porosity, thermal conductivity, efflorescence, and microscopic characteristics for both the control sample and samples including (WTR) as a substitute for cement.



A. Collection of Materials

The materials required for the preparation of rubberized bricks include Ordinary Portland Cement (OPC), fine aggregate (sand), rubber tyre pieces, and water. Cement acts as the primary binding material that holds all components together and provides strength to the brick. Sand gives body, stability, and proper texture. Rubber tyre pieces, cut into small uniform sizes, are used as a partial replacement for aggregates, improving flexibility and promoting recycling of waste materials. Water is essential for mixing and hydration of cement, ensuring proper strength development.

All materials should be carefully selected and free from impurities to ensure good quality bricks. The rubber pieces should be uniformly sized to achieve proper bonding with cement paste. The sand must be clean and well-graded, and the cement should be fresh and free from lumps. Proper proportioning and quality of these materials play a vital role in determining the strength, durability, and overall performance of rubberized bricks.



B. Rubber Preparation

The preparation of waste tyre rubber is an important step in the production of rubberized bricks. Discarded vehicle tyres are first collected from scrap yards or waste sources and thoroughly cleaned to remove dirt, dust, oil, and other impurities. Any steel wires and textile fibers present inside the tyres are carefully removed to ensure purity of the rubber material. The cleaned tyres are then cut into smaller pieces and subjected to mechanical shredding to produce rubber particles. These particles are further processed into crumb rubber of required sizes, generally similar to fine aggregate, by grinding and sieving operations to achieve uniformity. Proper size distribution of rubber particles is essential to ensure better mixing and improved performance of the bricks. In some cases, the rubber particles are treated with chemical solutions such as sodium hydroxide (NaOH) to modify their surface characteristics and enhance bonding with the cement paste. After treatment, the rubber is washed and dried before use in the mix. This preparation process ensures that the rubber is clean, properly sized, and suitable for partial replacement of sand in brick production.



C. Mix Proportions

The mix proportion plays a crucial role in determining the strength and performance of rubberized bricks. In this study, a standard mix ratio of **1:3 (cement to fine aggregate)** is generally adopted. Waste tyre rubber is used as a partial

replacement for fine aggregate (sand) in varying percentages such as **0%, 5%, 10%, 15%, and 20%** by volume or weight. The 0% mix serves as the control sample, while the other mixes help in evaluating the effect of rubber inclusion on the properties of bricks. The materials are first dry mixed thoroughly to ensure uniform distribution of cement, sand, and rubber particles. Water is then added gradually to achieve a workable and consistent mix. Care is taken to maintain a proper water-cement ratio so that the strength of the bricks is not adversely affected. The variation in rubber content allows comparison of different mixes and helps in identifying the optimum proportion that provides a balance between strength, durability, and lightweight properties.



D. Curing process

The curing process is a critical step in the production of rubberized bricks, as it significantly influences their strength, durability, and overall structural performance. After the casting process, the moulded bricks are kept undisturbed for about 24 hours to allow initial setting. Once the bricks gain sufficient hardness, they are carefully demoulded and transferred to a curing environment. The bricks are then subjected to water curing, where they are either immersed in water tanks or regularly sprinkled with water to maintain adequate moisture content. Proper curing is essential for the hydration of cement, a chemical reaction that enables the development of strength in the bricks. Typically, curing is carried out for different durations such as 7 days, 14 days, and 28 days, with 28 days curing providing maximum strength. During this period, care must be taken to prevent rapid drying, as it may lead to cracks and reduced strength. Adequate curing improves the bonding between cement paste and rubber particles, enhances durability, and reduces water absorption. Therefore, maintaining proper curing conditions such as sufficient water, controlled temperature, and continuous moisture supply is essential to achieve the desired performance of rubberized bricks.



IV. TEST CONDUCTED

Water Absorption Test

The water absorption capacity of bricks was evaluated using a 24-hour submersion test. Pores may absorb water using this way. Before undergoing the testing, the brick samples were subjected to a drying process in an oven at a temperature of 150 degrees Celsius until a consistent mass was achieved.

After bringing the specimen to room temperature, the initial weight (W_1) was measured. After that, the samples underwent 24 hours entirely submerged in the liquid. Next, a damp towel was used to wipe the samples clean after they were taken out of the water. The samples were then weighed again, this time to record their wet weight (W_2).

Results:

Size of brick = $24 \times 11 \times 9$ cm

Dry weight of brick (W_1) = 2.5 kg (2500 g)

Water Absorption = $[(2900 - 2500) / 2500] \times 100$

Water Absorption = $(400 / 2500) \times 100 = 16\%$

Compressive Test

The compressive strength of the specimens was assessed as per the IS-12894 using Ticom company's 100-ton compression testing equipment, after a curing of 28 days. The Construction Services & Research Centre in Faridabad conducted compressive strength testing.

The applied load on the sample was incrementally augmented until it reached a threshold beyond which it was unable to maintain structural integrity. Upon reaching that juncture, the burden was alleviated. Subsequently, this numerical value was used to assess the magnitude of their strength in order to make a

comparison with the strength shown by the control sample.



Results:

Size of brick = $24 \times 11 \times 9$ cm

Loaded area (A) = $24 \times 11 = 264 \text{ cm}^2 = 26400$

mm^2 Maximum load at failure (P) = 140 kN = 140000

Compressive Strength = $140000 / 26400$

Compressive Strength = 5.30 N/mm^2

V. RESULTS AND DISCUSSIONS

The experimental investigation on rubberized bricks using waste tyre rubber shows that the inclusion of rubber significantly influences the physical and mechanical properties of bricks. From the compressive strength test, it is observed that the strength of the bricks decreases with an increase in rubber content. The conventional brick (0% rubber) exhibits the highest compressive strength, while bricks with rubber replacement show slightly lower values due to weak bonding between rubber particles and the cement matrix. However, at lower replacement levels such as 5% to 10%, the reduction in strength is not significant, and the bricks still possess adequate strength for non-load-bearing applications.

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