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EVALUATION OF THE MECHANICAL BEHAVIOUR OF CONCRETE WITH STRESS MARBLE AND CRUMB RUBBER AS PARTIAL REPLACEMENT AGGREGATE

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ABSTRACT

Concrete is a man-made composite material in which fine and coarse particles are linked together by cement when combined with water and solidified over time. It serves as one of the most often used construction materials. The expanding auto manufacturing industry presently creates many discarded tires worldwide. Tyre disposal continues to seriously threaten both human health and environment protection. Similarly, the marble business generates a huge amount of trash during mining and processing. The debris is deposited on open ground, causing numerous environmental issues. The primary purpose of this research is to employ marble debris as a substitute for traditional coarse aggregate and crumb rubber material as a partial substitution for fine aggregates in M30 grade concrete mix at varied percentages to build concrete. It also has the added benefit of protecting natural aggregates and preventing environmental contamination. It is an effective method for increasing the mechanical properties of concrete, and its effect on characteristics such as flexural strength, compressive strength and split tensile strength will be studied.

Key words: *Mechanical Behaviour, concrete, Stress Marble, Crumb Rubber, strength.*

1. INTRODUCTION

During the quarrying and extraction stages of the marble business, a significant quantity of debris is generated. The debris was dumped on open terrain, causing numerous environmental issues. Because vehicle tires are hardly used as crumb rubber in most parts of the globe, they are Alternatively burned or buried in ground, which are damaging to the atmosphere and contribute to global warming. Waste tyres rubber is a little piece or powdered form of tyres created after removing steel thin wire from the tyres. This study aims to dispose of waste tyre rubber, which is employed in concrete mixes as a substitute for sand aggregate at various proportional to acquire better engineering qualities of concrete. This has the extra advantage of saving natural aggregates used in the creation of concrete, which are becoming less available. The use of rubber from reusable waste tyres could assist both the environment and the building sector. Experiments were conducted to determine the viability of using marble waste as a coarse aggregate and crumb rubber as a sand aggregate in concrete. As a result, instead of being disposed of as waste, marble waste and scrap tyres can be used as aggregates. The primary goal of this research is to use crumb rubber as a partial replacement for fine gravel in asphalt and waste marble as a partial replacement for coarse aggregate in concrete. M30 concrete is utilized here. The cubes were then immersed in regular potable water for 28 days. Ordinary Portland cement (OPC) per IS 1489: 1991(part 1) Waste tyre rubber in various percentages of 5%, 7.5%, 10%, 12.5%, and waste marble in various percentages of 10%, 20%, 30%, 40% were included to concrete for compressive, flexural, and split tensile strength. The compression strength is determined according to IS 516-1979, tensile strength is determined according to IS 5816:1999, and flexural strength is determined according to ASTMC 78. The acquired values are compared to controlled specimens.

2. Literature Review

M K Haridharan and R Bharathi Murugan (2017) showed the results of a study on the effect of crumb rubber on the compressive strength, flexural strength of concrete, and static modulus of elasticity. Experiments were carried out in this study to determine the Above-mentioned strength of concrete mixtures in which natural sand was partially substituted with crumb rubber (WTCR). Natural sand was replaced with 5 various percentages of WTCR by volume (5%, 10%, 15%, 20%, and 25%). The primary goal of the investigation inquiry is to determine the link between the flexural strength and static modulus of elasticity of concrete with WTCR. The experimental static modulus of elasticity and flexural strength measurements were compared to theoretical values. The mechanical strength of concrete cubes and cylinders decreased as WTCR content increased. Concrete flexural was enhanced up to 15% of WTCR replacement. Flexural strength is reduced when the percentage of WTCR replacement exceeds 15%. For all percentage sand replacements using WTCR, the measured flexural strength was more than the expected flexural strength by difference national codes. WTCR mixed concrete had a lower static modulus of elasticity than control concrete, but it could sustain considerable deflection and displacement due to the characteristics of rubber. it is typically more flexible in that it can withstand greater deformation. The control of modulus of elasticity and WTCR concrete achieved experimentally was smaller than estimation.

S. Selvakumar and R. Venkatakrishnaiah (2015) mixed concrete by IS:10262-2009 for grade M30 concrete. The concrete were cast and utilised to assess the mechanical strength. They evaluated for 7 and 28 days of fine aggregate substitution of 5%, 10%, 15%, 20% waste tire rubber. Finally, they concluded that the mechanical strength of waste tire rubber concrete with 5% replacement is 38.66 N/mm2, which is greater than the strength of regular concrete, which is 36.73 N/mm2 after 28 days. The mechanical strength of waste tire rubber concrete with 10% replenishment is 33.47 N/mm2. The flexure of waste tyre rubber is lesser than that of conventional concrete. In splitting tensile strength, the same reduction in strength was observed as in conventional concrete. As a result, discarded tire crumb rubber has decreased bonding ability, which affects the concrete strength.

Hasan S, and Ahan Arel (2016) examined the recycling of leftover stress marble in specimen concrete manufacturing. He replaced binding cement with stress marble and used stress marble as aggregate in the creation of concrete. When natural sand is substituted with marble dust at a ratio of 15-75%, mechanical strength rises by 21-27%. At a full percentage of replacement ratio, coarse stress marble aggregates produced greatest performance. Furthermore, waste marble in coarse aggregate form outperforms waste marble in dust form in terms of mechanical qualities. Marble powder replaced with cement in amounts of 20% or more was found to hurt the strength of compression and workability of concrete. Replacing binding cement with 5-10% marble dust increases mechanical qualities while lowering CO2 emissions from cement manufacturing by 12%. Filler material for up to 75% with the help of marble dust of the cement weight increases the compressive strength by 42% and the splitting tensile strength by 42%.

Roshan Lal and Kuldeep Kumar (2014) investigated the mechanical properties of concrete composed of coarse aggregates with partial replacement by waste granite and stress marble aggregates in 3 various percentages by weight of coarse aggregates: 20% (10% waste granite + 10% stress marble), 30% (15% waste granite + 15% stress marble), and 40% (20% waste granite + 20% stress marble), and he discovered that replacement of 25% and 36% increases Mechanical strength. However, a minor loss in compressive strength is observed for the 40% substitution of waste granite and stress marble particles with major aggregates.

3. Methodology

3.1 Material Properties

OPC grade of 53 complying with IS12269-2013 have a specific gravity of 3.15, while fine sand has a 2.65 specific gravity. Maximum coarse stone size of 20 mm with 2.7 specific gravity same as stress marble and specific gravity of tire rubber is used. 1.2.

3.2 Replacement Ratio Selection:

The next stage is to choose a weight-based substitute for waste tire rubber for fine aggregate and a weight-based replacement for waste marble instead of coarse aggregate. Replacement of tire rubber at 5%, 7.5%, 10%, and 12.5% with fine aggregate, and replacement of waste marble at 10%, 20%, 30%, and 40%.

3.3 Test Specimen Casting:

Specimens were cast in M30 Grade by mass ratio mix proportions with 0.40 water-cement ratios. The materials are mixed in a hand mixer after the moulds of the cube of size 15 cm x 15 cm x 15 cm, cylinder of size 15 cm x 30 cm, and prism of size 10 cm x 10 cm x 50 cm are set on a flat surface. After 24 hours, the moulds are stripped. The test specimens are soaked in water for 7, 14, and 28 days.

3.4 Fresh Concrete Properties

3.4.1 Slump Test

Slump testing is a method for determining the consistency of concrete. It is an indirect measure of the consistency or stiffness of concrete. The M30 grade concrete was tested, and the results indicate that as compared to regular concrete, all of the rubber substituted with fine aggregate concrete fared badly. As a result, workability with a water-cement ratio of 0.40 is ideal.

3.5 HARDENED CONCRETE PROPERTIES

3.5.1 Compressive Strength

Compression testing is used to determine the breaking strength of hardened concrete. The compression tests are carried out on a 150mm150mm150mm cube. The strength was measured on days 7, 14, and 28. The strength of concrete at each age was determined by taking the average of three readings. According to IS 516-1959, the ultimate strength is measured after the specimens fail to withstand additional stresses.

3.5.2 Split Tensile Strength

At 7, 14, and 28 days, split tensile measurements were carried out on cylindrical specimens 150mm in diameter and 300mm in height. The specimens are evaluated using an IS 5816-1999 compression testing equipment.

3.5.3 Flexural Strength

The objective of the investigation is to determine the ultimate load-carrying capacity of the prism specimens. The specimen is exposed to two-point the loading process, and the load at collapse is recorded. It measured on prism specimens 100x100x500mm for 7, 14, and 28 days according to ASTM C 78.

4. Results

4.1 Compressive Strength

a. As the percentage of crumb rubber increases, the strength of compression drops.

b. It is unaffected by the presence of waste marble.

c. The compressive strength of Mix 1 exceeds 91% replacement of Waste Tyre Rubber and Waste Marble.

4.2 Split Tensile Strength Test

It replaces 94% of the waste tire rubber and waste marble in Mix1.

4.3 Flexural Strength Test

Flexural strength exceeds 94% of the replacement of Waste Tyre Rubber and Waste Marble in Mix 1.

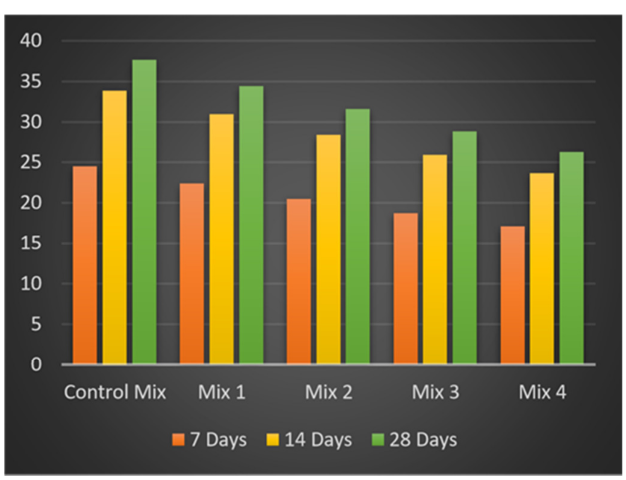

Fig. A Compressive Strength Test at 7, 14 & 28 days

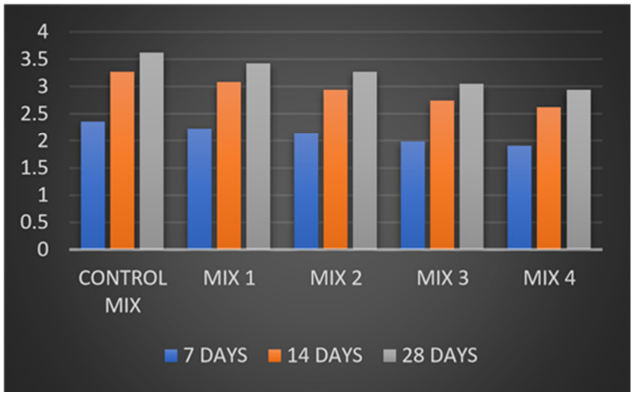

Fig. B Split Tensile Strength Test at 7,14 & 28 days

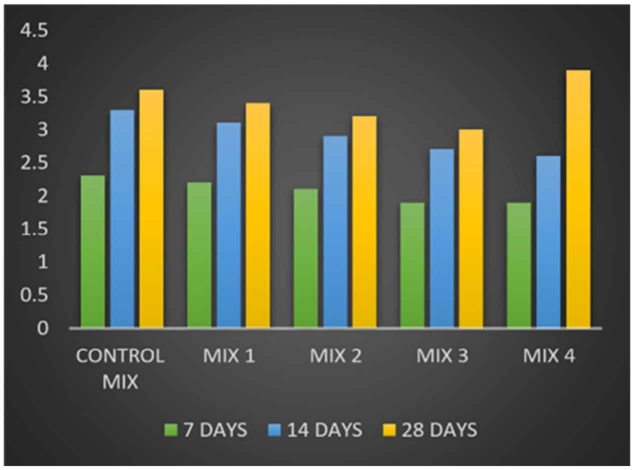

Fig. C Flexural Strength Test at 7, 14 & 28 days

Conclusion

1. The quantity of rubber rose which reduced the density of the concrete, resulting in lightweight concrete.
2. Although crumb rubber was used in very small amounts in concrete, it significantly decreased the amount of abandoned tire rubber in the ecosystem since the area of the particular surface was greater than the density..
3. The compressive strength of Mix 1 achieves 91% replacement of Waste Tyre Rubber and Waste Marble.
4. The split tensile strength in Mix 1 is 94% of the replacement of Waste Tyre Rubber and Waste Marble.
5. The flexural strength of Mix1 achieves 94% replacement of Waste Tyre Rubber and Waste Marble.
6. Overall, a 5% efficient and effective mix provides appropriate strength in all three tests.
7. This concrete is better suited to non-structural members, pavement, floors, and concrete highways.

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