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Use of Marble Dust in Polyethylene Fibre Reinforced Concrete

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Abstract*: This experiment is an investigation into using marble dust as a replacement of cement to some extent in polyethylene fibre-reinforced concrete (PFRC). One of the by-products of the marble industry called marble dust has an eco-friendly alternative that can be used in reducing the usage of cement and make concrete more sustainable. In order to determine the effect of the varying percentages of the marble dust (5%, 10%, and 15%) on the mechanical properties of the PFRC mix such as the compressive strength, tensile strength, and durability, different proportions of the marble dust were added to the PFRC commercially available mix and maintained at a fixed ratio of 6:1. There is an added resistance to crack and increased toughness by adding polyethylene fibre, and the marble dust has an influence on workability and strength development. The outcomes indicate that subbing parts of the marble dust up to 10 percent enhances strength without compromising on the fibre efficiency. The current research instigates the sustainability in construction, waste minimisation through the combination of industrial waste coupled with advanced fibre reinforcing technologies to produce lightweight concrete solutions that are environmentally friendly and durable.*

Keywords*: Flexural strength, Marble dust, Split Tensile Strength, Polyethylene fibre, Compressive strength*

I. Introduction

The ubiquitous type of construction material in the world is concrete, which is produced with dire environmental effects; largely carbon emissions occur during cement production. To curb these issues, professionals are coming up with sustainable alternatives such as adding in the concrete mixes the components of industrial waste. One of such material is marble dust which is a by product of marble manufacturing countries which can to some extent substitute cement. Not only will the use of marble dust alleviate trash disposal issues but also lessen the requirement of cement and thus increase the use of environment-friendly construction methods [1].

Concrete is blended with polyethylene fibres to enable it to gain tensile strength, hardness and resistance to crack formation thus increasing durability and structural capability. Reinforcement of polyethylene (PFRC)-fuelled marble dust is one of the relevant methods of invention of long-lasting and high-performance concrete.

In this study, it examines the effects of partial cement replacement by marble dust in PFRC, with a view to enhancing their mechanical and durability properties and also increase the recycling of building waste as well as environmental sustainability.

II. Objectives and Scope

The major aim of such a study is to evaluate the effect of partial Replacing cement with marble dust on the mechanical and durability parameters of poly ethylene fiber reinforced concrete (PFRC). The objective of the study in details is to determine the maximum possible concentration of marble dust addition that would not compromise the compressive strength, tensile strength, and workability. Moreover, the research is also meant to establish the interaction between the polyethylene fibres and the marble dust in enhancing the resistance to crack and toughness.

Concrete mixes with variable concentration of marble dust (normally 0%, 5%, 10%, and 15%) that are combined with a constant amount of polyethylene fibres will be prepared in this study. There will be standard tests to be carried out to determine the strength, durability, and workability standards. The project is aimed at providing motivation on the use of sustainable construction through the use of industrial waste and enhanced performance of concrete, which may be used in both non-structural as well as structural segments where the application may require better performance in exhibiting durability and environmental-friendliness [2-5].

III. Experimental Investigations

The experimental work is on the analysis of the mechanical and durability aspects of polyethylene fibre reinforced concrete (PFRC) using marble dust as a partial substitute to cement. The concrete composite consisted of ordinary Portland cement (OPC), fine and coarse aggregate, polyethylene fibres, water and marble dust. The polyethylene fibres were added continuously, at the rate of 0.5 (volume percent) of concrete; and the marble dust was used as the cement replacement and various proportions were used (0, 5, 10, and 15 weight percent).

Cubes (150mm x 150mm x 150mm), cylinders (150mm x 300mm) and prisms were shaped as the concrete example of each proportion of mix [4]. The specimens were cured with water at 7, 14 and 28 days. The strength has been tested against compressive strength, split tensile strength, flexural strength and durability.

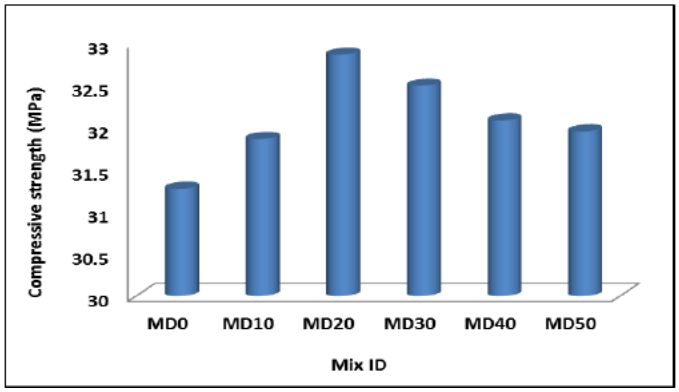

Fig 1: Compressive strength

The freshly mixed-up concrete was run through slump test in order to check the workability. The small size of marble dust particles reduced the workability, slightly and polyethylene fibres increased cohesion. The test results were compared with all mixtures in order to find out the perfect marble dust content. The aim of the experiment will be to determine the possibility of using marble dust and poly ethylene fibres in achieving a sustainable concrete mix that will be durable and high performance and can be used in construction.

IV. Results and Discussions

The test data showed that there were considerable differences in mechanical and durability properties of polyethylene fibre reinforced concrete (PFRC) in different percentages of marble dust that was added as a partial cement substitute.

Addition of marble dust increased up to 10 percent compressive strength. With 10 percent of marble dust the mixture got highest strength and this was approximately 8-12 percent higher the control mixture. This is increased by the fact that, sodium smith coarse marble has a small particle size which enhances particle binding and reaction. Nevertheless, at the rate of 15%, strength somewhat diminished as a result of dilution of cementitious materials. The addition of polyethylene fibres positively influenced the tensile and flexural strength by significant amount in all mixtures. Microcracking's were decreased and ductility was made higher by the fibre network.

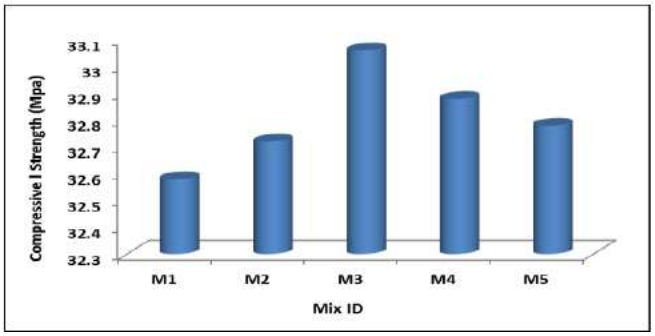

Fig 2: Polyethylene Fiber with Marble Dust

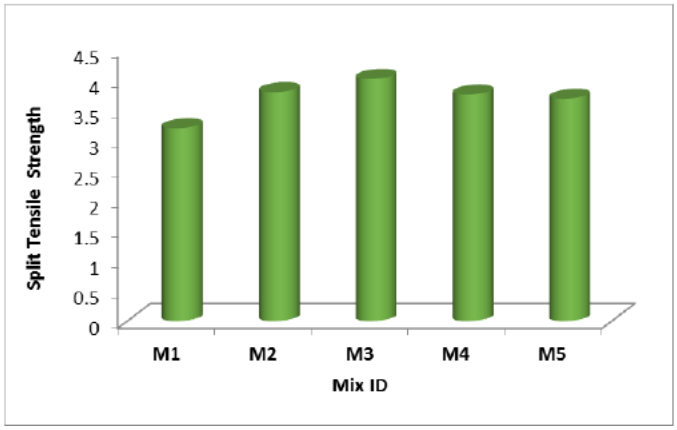

Fig 3: Split Tensile Strength

Owing to its fine texture, higher contents of marble dust reduced marginally workability, and fibres also influenced flowability. A slight sagging was retained by the balance of the water-cement proportion properly. Tests of water absorption and acid resistance demonstrated an improved durability of up to 10 percent marble dust. The porosity was reduced as well as the chemical resistance as the dense matrix formation was done. Porosity was more than 10 percent, which reduced durability.

In general, the mixture of polyethylene fibres with marble dust enhanced both strength and durability properties to the best level. A mix with 10 percent of marbles dust substitution demonstrated a balanced proportion among workability, mechanical properties, and sustainability, and this means that it could be used in the current sustainable concrete production [3-5].

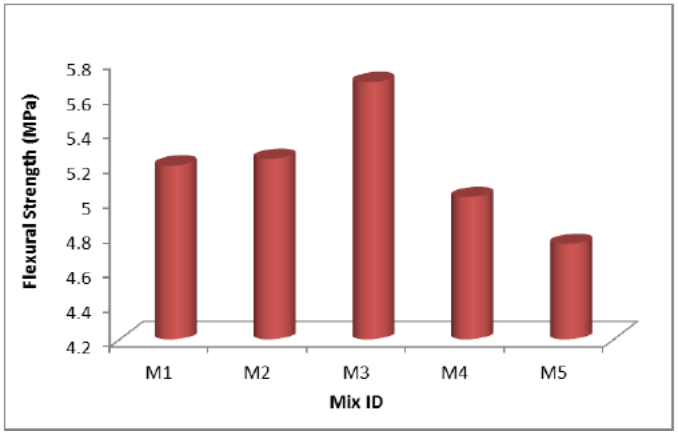

Fig 4: Flexural Strength of Marble Dust

V. Conclusion

The paper reveals that partial replacement of cement by marble dust in polyethylene fibre reinforced concrete (PFRC) enhances both mechanical properties and durability effectiveness to optimum levels. In particular, the compressive, tensile, and flexural strength were the highest when the concrete was replaced by approximate 10 percent of the cement with marble dust. This enhancement of crack resistance, ductility, toughness and the particle packing, due to the incorporation of polyethylene fibres and the reduction in porosity, due to the minute size of the particles of marble dust, resulted in a gain in strength. even though high marble dust percentage reduced strength and workability, the best suitable combination of performance and sustainability was found in the 10 percent mix. Efficient industrial waste utilization is a major factor that the paper will facilitate; industrial wastes take an ecologically positive and sustainable form that can support the present-day infrastructure.

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