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Evaluation of the Properties of Hardened Concrete Produced by Waste Marble Powder

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ABSTRACT *Cement production requires a large amount of non-renewable resources such as raw materials and fossil fuels. Cement production causes environmental impacts at all stages of the process. These include atmospheric pollution in the form of dust and gas; noise and vibration during manipulation and sandblasting in the quarries; and limestone quarries are visible for long distances and can permanently disfigure the local environment. Cement production directly contributes to greenhouse gases through the production of carbon dioxide when calcium carbonate (lime and carbon dioxide) is heated and indirectly by using energy, especially if the energy inputs of fossil fuels. Raw materials and energy consumption generate emissions into the air, including dust and gas. These emissions not only degrade the air quality but also degrade human health. Scientific evidence indicates that atmospheric pollution caused by fossil fuel combustion causes a spectrum of health effects from allergy to death. Like today, marble is widely used in structures that increase the amount of waste generated by it. Since marble powder is the waste product obtained during the marble sawing and moulding process, which contains heavy metals that make water unsuitable for use. Marble powder creates environmental problems, but because of the high content of calcium oxide, which is cementing property, marble can be used as a partial cement replacement. In this study we have collected the residues of marble powder from the industry and we studied its effect on concrete in different proportions and compared the compression, tensile strength and curvature of cement and measured at 7, 14 and 28 days of healed. We also compare its durability. The main objective of this study is to develop useful concrete mixtures using residual marble powder as partial cement substitution.*

Keywords Marble Dust, Marble Powder, Hardened Concrete Properties, Waste Marble Powder, Concrete Modified With Marble Powder

INTRODUCTION

It is impossible to conceive a modern, non-cemented life. Cement is an extremely important construction material used for building and infrastructure development and a key to economic growth. Demand for cement is directly associated with economic growth and many emerging economies are struggling for rapid infrastructure development, highlighting the tremendous growth in cement production.

The cement industry plays an important role in improving the standard of living throughout the world by creating a direct employment and providing multiple waterfall benefits to the associated industries. Despite its popularity and profitability, the cement industry faces many challenges due to environmental problems and sustainability issues.The cement industry is a very important source of energy and contributes to climate change. The main health and safety issues associated with cement production are air emissions and energy utilization. Cement production requires a large amount of non-renewable resources such as raw materials and fossil fuels. Cement production causes environmental impacts at all stages of the process. These include atmospheric pollution in the form of dust and gas; noise and vibration during manipulation and sandblasting in the quarries; and limestone quarries are visible for long distances and can permanently disfigure the local environment. Devices to reduce dust emissions during quarrying and cement production are used by several companies that produce cement. More and more equipment is used to lock and separate exhaust gases.

Cement production directly contributes to greenhouse gases through the production of carbon dioxide when calcium carbonate (lime and carbon dioxide) is heated and indirectly by using energy, especially if the energy inputs of fossil fuels.

The cement industry produces about 5% of the global CO_2 emissions from man, of which 50% comes from the chemical process and 40% from combustion of fuel. The amount of CO_2 emitted by the cement industry is almost 900 kilograms of CO_2 per 1000 kilograms of cement produced. Raw materials and energy consumption generate emissions into the air, including dust and gas. Toxic metals and organic compounds are released when industrial waste is burned in the cement kiln. Other sources of dust emissions include clinker coolers, shredders, shredders and materials handling equipment. These emissions not only degrade the air quality but also degrade human health. Scientific evidence indicates that atmospheric pollution caused by fossil fuel combustion causes a spectrum of health effects from allergy to death. The results of several studies have shown that these emissions affecting human health in a variety of ways such as eye pruritus, respiratory diseases such as tuberculosis, chest pain, chronic bronchitis, asthma attacks, cardiovascular disease and even death premature. Finally, we must find the alternative cement option so that we can save the world and human life.

Marble is a metamorphic rock formed when limestone is subjected to heat and pressure metamorphism. It consists essentially of calcite minerals ($CaCO_3$) and usually contains other minerals such as clay minerals, mica, quartz, pyrite, iron oxide and graphite. In metamorphic conditions, calcite limestone recrystallizes to form a rock that is a mass of braided calcite crystals. A correlated rock, dolomite marble, occurs when the stomach is subjected to heat and pressure. Chemically, marbles are crystalline rocks consisting essentially of calcite, dolomite or serpentine minerals. Other mineral components vary from source to source. Quartz, muscovite, tremolite, actinolite, micro line, talcum, garnet, osterite and biotite are the main mineral impurities, while SiO_2, limonite, Fe_2O_3, manganese, $3H_2O$ and FeS_2 (pyrite) are the main chemical impurities associated with marble. The main raw limestone impurities (for cement) that can affect the properties of the completed cement are magnesium, phosphate, lead, zinc, alkaline and sulphide. Geologists use the term "marble" to refer to metamorphic limestone; however, stonemasons use the term broadly to understand metamorphic limestone. Marble is commonly used for sculpture and as building material. Marble has been used in construction for thousands of years.

These day marbles are widely used in construction work. A large amount of waste is generated during the sawing, polishing and polishing process. The result is that marble waste that is 20% of total extracted marble has reached millions of tons. In general, marble waste is discharged to any well in the vicinity or in the empty space near the marble processing industries, even though the reported areas have been marked to pour the same. The advancement of a specific technology can reduce the consumption of natural resources and energy sources and reduce the burden on pollutants on the environment. At present, large quantities of marble powder are generated in natural stone processing plants with a significant impact on the environment and man. This leads to increased environmental risks as dust pollution extends over a wide area. In the dry season, the dust dries, floats in the air, flies and deposits in crops and vegetation. In addition, the deposition of such a large amount of fine debris creates necrotic ecological conditions for flora and fauna that change landscapes and habitats.

Accumulated wastes also contaminate surface water and groundwater reserves. Now a day marble waste is one of the causes of environmental problems around the world. Therefore, the maximum use of marble waste in various industrial sectors, construction, agriculture, glass and paper, would help to protect the environment. Concrete is the most widely used construction material in civilian construction due to its high structural strength and stability. Concrete is a heterogeneous mixture of cement, aggregate (coarse and fine aggregate) and water. The main objective of this study is to investigate the usability of marble powder in partial cement replacement in concrete. The effect of cement marble residual marble has been studied by conventional concrete tests without marble powder with different amounts of partial marble powder replacement cement. In India, stone and granite marble processing is one of the most prosperous industries if the effects have been studied different contents of marble powder on the physical and mechanical properties of fresh and hardened concrete. the content of fresh concrete and the absorption and compression strength of hardened concrete have also been investigated. The test results show that this bi-industrial product is able to improve the performance of hardened concrete up to 10% by improving the performance of fresh concrete and can be used in concrete cement mixtures containing white cement. Concrete compression strength was measured for 7, 14 and 28 days. To evaluate the effects of marble powder on mechanical behaviour, many different premixes have been tested.

RESEARCH SIGNIFICANCE

The main purpose of this research is to investigate the possibility of utilizing waste marble powder generated during cutting and polishing process in marble factories in order to reuse it in cement and concrete production. Physical and mechanical properties of hardened concrete made of marble powder modified cement were investigated. The effect of marble powder Testing specimens were prepared by blending marble powder with cement and sand in 0.0%, 5.0%, 10.0%,15.0%, 20.0% and 25.0% replacement ratios by weight.

EXPERIMENTAL PROGRAM

Materials

Cement - Ordinary Portland Cement 53 grade were used.

Coarse Aggregate - Locally available

Fine Aggregate - Locally available

Water – Normal

Marble Powder - Locally available

Methodology

In this study, properties of hardened concrete produced by waste marble investigated in detailed manner. All results are compared suggesting that waste marble could utilize in concrete. As a result of literature, utilization of waste marble in conventional concrete mix. Waste marble powder was used as binder in cement. Experiments were carried out for hardened concrete in literature were compressive, flexural, and splitting tests. All results were analyzed for each study in detailed manner and these results were tabulated.

CONCRETE MIX

Mixing was done in a standard drum-type mixer. Course and fine aggregate were first mixed in dry state until the mixture be- come homogenous. All binder materials(cement, and marble powder) were added to the dry mixture, and mixing continued until the mixture become homogenous. The concrete mixes were designed at fixed water–cement ratio of 0.50. the concrete mixes were designed to have a near constant slump in the range of 90–110mm.

Table 1. Mix design

Total Material For 1 m^3		
1	Cement	394.32 Kg/m^3
2	Water	197 litres
3	F. A	646.49 Kg
4	C. A	1188.34 Kg
5	W/C Ratio	0.50

PHYSICAL AND CHEMICAL PROPERTIES OF MARBLE POWDER

Table 2. Physical Properties

Sr. No	Properties	Test Result	
		Marble Powder	Cement
1	Specific Gravity	2.67	3.15
2	Colour	White	Grey
3	Form	Powder	Powder
5	Sieve	0.90 Mm	0.90 Mm

Table 3. Chemical Properties

Sr. No.	Content	Chemical Test On		Requirement as Per IS: 12269-2013
		M.P	cement	
1	Silica	2.24%	0.93%	Shall be between 0.80 and 1.02 %
2	Aluminium and Iron Oxide	2.38%	1.23%	Not less than 0.66 %
3	Insoluble Residue	N. A	2.46%	Not more than 4%
4	Magnesia	5.54%	3.83%	Not more than 6%
5	Total Sulphur	0.48%	2.48%	Not more than 3.5%
6	Loss on Ignition	39.2%	2.7%	Not more than 4%
7	Chloride	N. A	N. A	Not more than 0.1%

TEST RESULTS

Compressive Strength

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The test will perform at 7 days and 28 days.

Fig.1: Performing Compression Test on Cub

The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression platens. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned with the centre of thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/cm2/minute until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

Compressive Strength = W / A

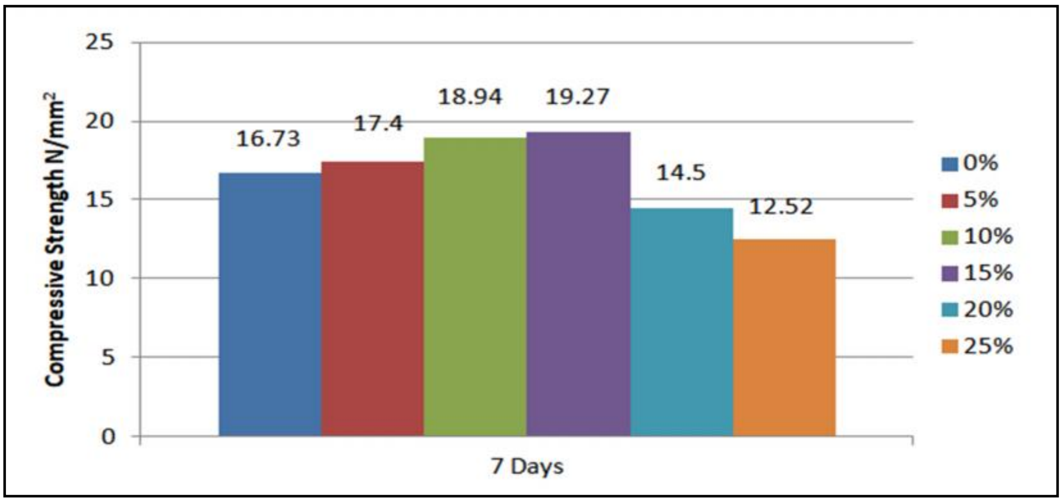

Fig.2: Average 7 Days Compressive Strength

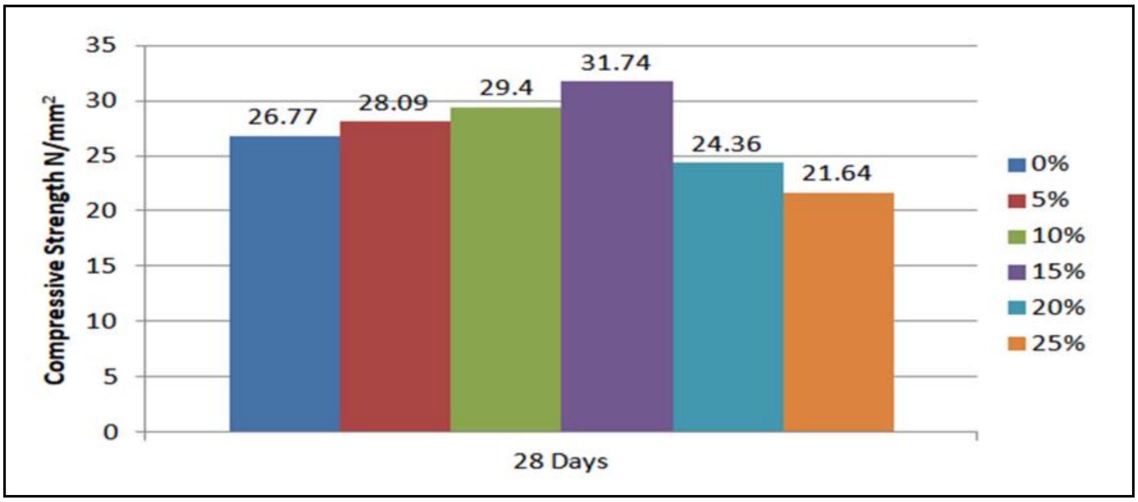

Fig.3: Average 28 Days Compressive Strength

Tensile strength

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed.

Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The test will perform at 7 days and 28 days.

Fig.4: Performing Splitting Tensile Strength Test on Cylinder

The bearing surfaces of the testing machine shall be wiped clean and any loose sand or other material removed from the surfaces of the specimen which are to be in contact with the compression platens. In the case of cubes, the specimen shall be placed in the machine in such a manner that the load shall be applied to opposite sides of the cubes as cast, that is, not to the top and bottom. The axis of the specimen shall be carefully aligned with the centre of thrust of the spherically seated platen. No packing shall be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to bear on the specimen, the movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increased continuously at a rate of approximately 140 kg/cm2/minute until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The maximum load applied to the specimen shall then be recorded and the appearance of the concrete and any unusual features in the type of failure shall be noted.

$$T = 2P/\pi LD$$

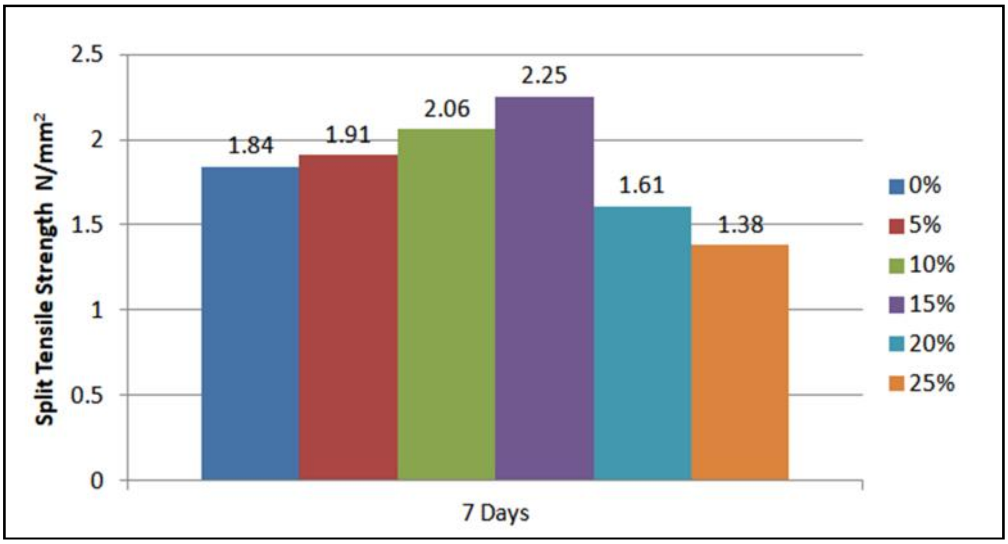

Fig.5: Average 7 Days Tensile strength

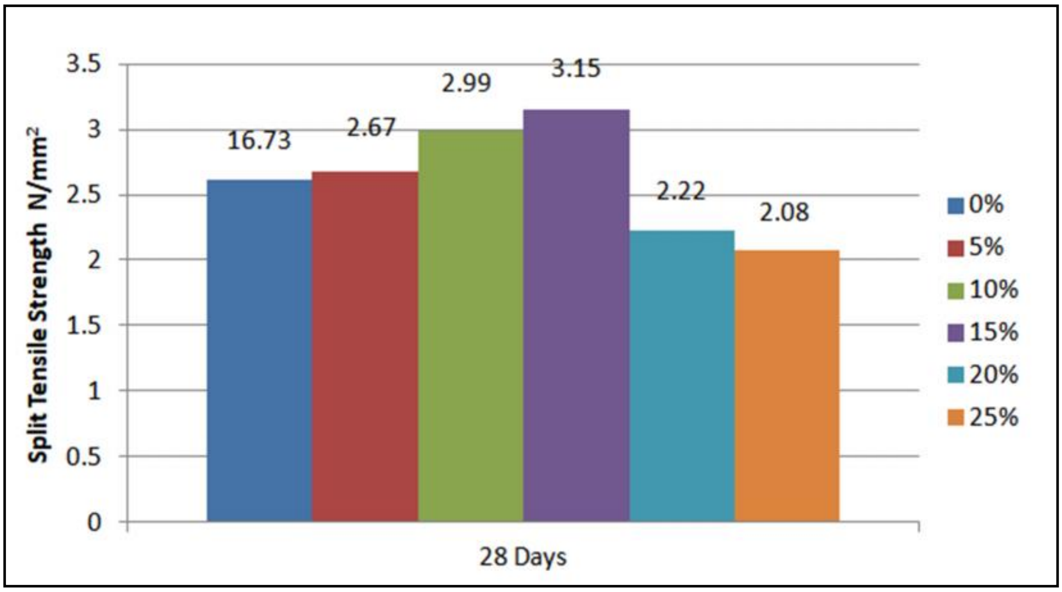

Fig.6: Average 28 Days Tensile strength

Flexural strength

Specimens stored in water shall be tested immediately on removal from the water and while they are still in the wet condition. Surface water and grit shall be wiped off the specimens and any projecting fins removed. Specimens when received dry shall be kept in water for 24 hours before they are taken for testing. The test will perform at 7 days and 28 days.

The bearing surfaces of the supporting and loading rollers shall be wiped clean, and any loose sand or other material removed from the surfaces of the specimen where they are to make contact with the rollers. The specimen shall then be placed in the machine in such a manner that the load shall be applied to the uppermost surface as cast in the mould.

Fig.7: Performing Flexural Strength Test on Beam

The axis of the specimen shall be carefully aligned with the axis of the loading device. No packing shall be used between the bearing surfaces of the specimen and the rollers. The load shall be applied without shock and increasing continuously at a rate such that the extreme fibre stress increases at approximately at a rate of loading of 400 kg/min for the 15.0 cm specimens. The load shall be increased until the specimen fails, and the maximum load applied to the specimen during the test shall be recorded. The appearance of the fractured faces of concrete and any unusual features in the type of failure shall be noted.

$$MR = 3PL / 2bd^2$$

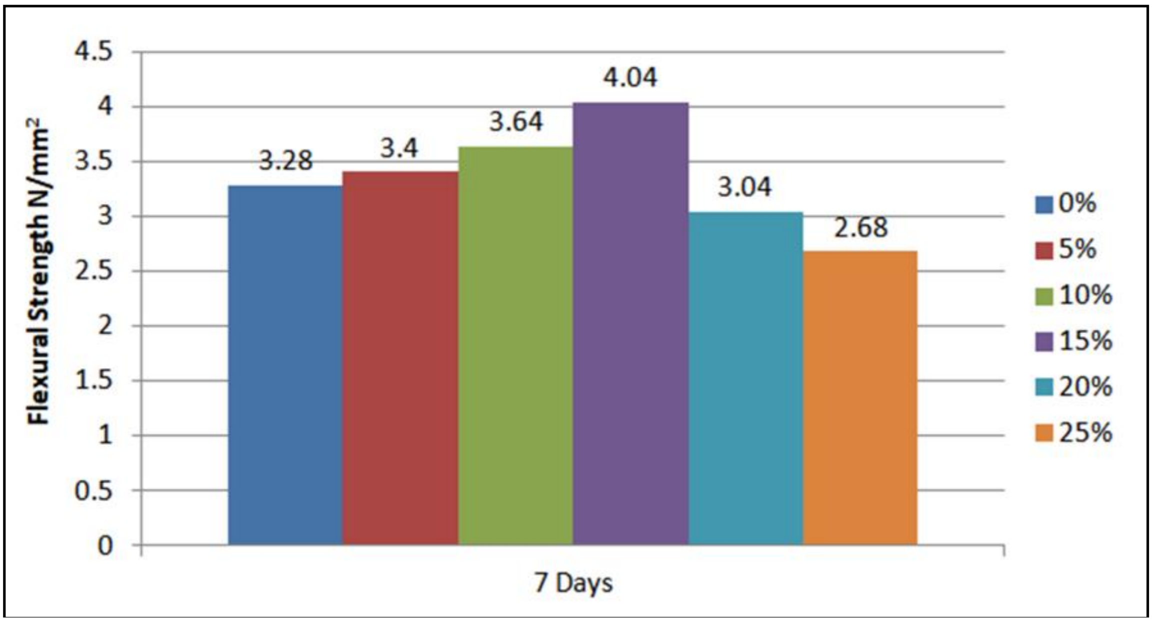

Fig.8: Average 7 Days Flexural strength

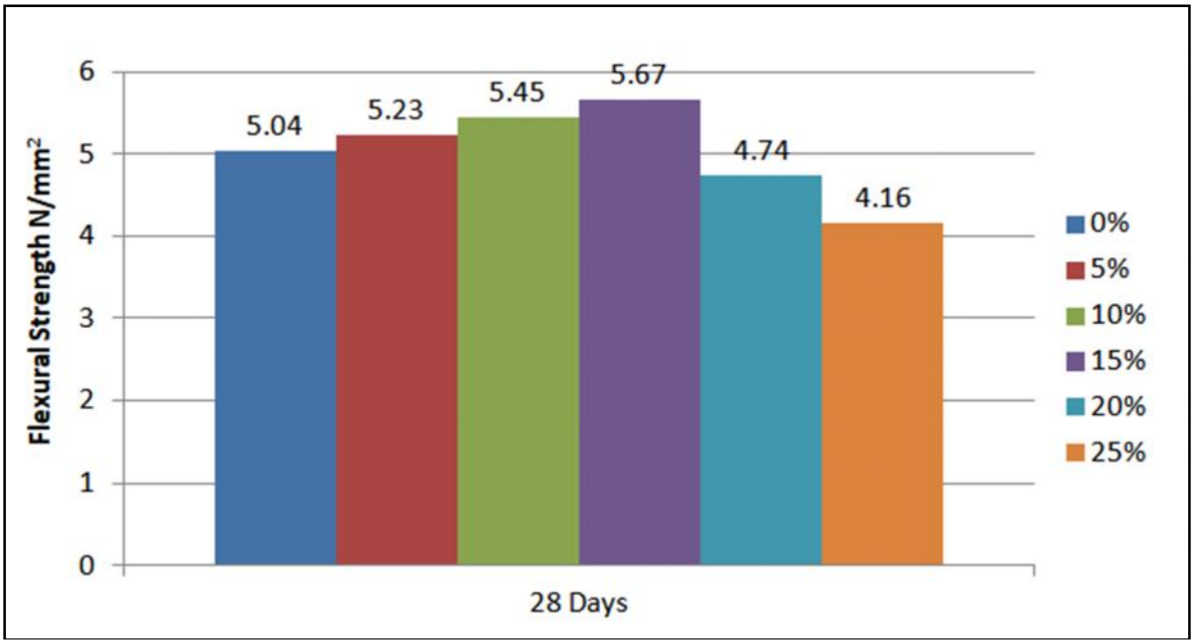

Fig.8: Average 28 Days Flexural strength

CONCLUSIONS

Based on the investigation reported in this study, the following conclusions can be drawn:

1. The compressive strength of cement mortar increases by the use of marble pwder as cement replacement
2. The Compressive Strength Flexural Strength and Tensile Strength of concrete made with 15.0% marble powder as cement has been found to be great result compare than control mix.
3. In general, the use of marble dust as cement replacement has more significant effect on the mechanical properties of concrete.

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