AN EXPERIMENTAL INVESTIGATION ON PARTIAL REPLACEMENT OF FINE AGGREGATE BY WASTE MARBLE POWDER

Anne Mary J [1], Robin B[2],Prashanth M[3] & Ranganathan C[4]

[1]Assisstant professor, Department of Civil Engineering, Veltech Dr. RR & Dr. SR University, Avadi, Tamilnadu, India
[2, 3&4] IV year, Department of Civil Engineering, Veltech Dr. RR & Dr. SR University, Avadi, Tamilnadu, India

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Abstract - Concrete is the important component used in the construction field all over the world, where the fine aggregate is generally natural sand. Leaving the waste materials to the environment directly can cause environmental problem. Hence the reuse of waste material has been in current industrial trend. Marble stone industry generates both solid waste and stone slurry. Marble is one of the important materials used in the construction industry. In India the amount of marble waste produced is 6 million tones/year. In that marble powder is replace by sand the research is carried out by using M25 grade concrete with replacement of 0%, 5%, 10%, 15% marble powder by sand and is carried out to determine the optimum percentage of replacement at which maximum compressive strength and also split tensile strength is achieved. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. In this replacement 10% has given highest compression and spilt tensile strength.

1.INTRODUCTION

Leaving these waste materials to the environment directly can cause environmental problem. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. Marble is a metamorphic rock resulting from the transformation of a pure limestone. Waste marble dust is one such material which can be used to replace sand as fine aggregate.

1.1 Objectives

The present study is aimed at utilizing Waste marble powder as fine aggregate in concrete, replacing natural sand. Marble is one of the most important materials used in buildings since ancient times, especially for decorative purposes In order to determine the effect of the WMD with respect to the curing age, standard mechanical properties of concrete are to be analyzed at the curing ages of 7, 14, 28 days.

1.2 CONCRETE

Concrete is a composite material composed of coarse aggregate bonded together with fluid cement that hardens over time. Most concretes used are lime-based concretes such as Portland cement concrete or concretes made with other hydraulic cements, such as cement found. However, asphalt concrete, which is frequently used for road surfaces, is also a type of concrete, where the cement material is bitumen, and polymer concretes are sometimes used where the cementing material is a polymer

1.3 WASTE PRODUCTION IN INDIA

Presently in India, about 960 million tonnes of solid waste is being generated annually as by-products during industrial, mining, municipal, agricultural and other processes [1]. Of this 350 million tonnes are organic wastes from agricultural sources; 290 million tones are inorganic waste of industrial and mining sectors and 4.5 million tones are hazardous in nature. To safeguard the environment, efforts are being made for recycling different wastes and utilise them in value added applications. Their recycling potentials and environmental implication are reported and discussed in details. The amount of waste generated in India per year is shown in Figure 1.1.

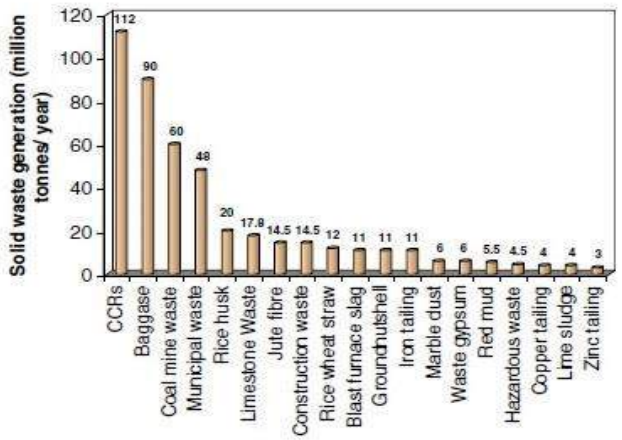


Figure 1 the amount of waste generated in India per year

1.4 INFLUENCE OF MARBLE DUST AS PARTIAL REPLACEMENT OF CEMENT IN CONCRETE

The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large amounts of marble dust are generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble sludge dust in concrete production as partial replacement of cement. In INDIA, the marble and granite stone processing is one of the most thriving industry the effects if varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated[2].Slump and air content of fresh concrete and absorption and compressive strength of hardened concrete were also investigated. Test results show that this industrial bi product is capable of improving hardened concrete performance up to 10%, Enhancing fresh concrete behaviour and can be used in architectural concrete mixtures containing white cement. The compressive strength of concrete was measured for 7, 14 and 28 days. In order to evaluate the effects of marble dust on mechanical behavior, many different mortar mixes were tested.

1.5 MARBLE DUST

Marble is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Marble may be foliated. Geologists use the term "marble" to refer to metamorphosed limestone; however, stonemasons use the term more broadly to encompass unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material. Marble is a rock resulting from metamorphism of sedimentary carbonate rocks, most commonly limestone or dolomite rock. Metamorphism causes variable recrystallization of the original carbonate mineral grains

1.6 METHODOLOGY

a)literature review.

b)Mix design for concrete proportion has been developed as per IS 10262 – 1982.

c) Casted and cured the concrete specimens as per Indian standards procedures.

d) The characteristic strength of hardened concrete specimen was tested as per IS 456 – 2000.

e) Finding the optimum strength of optimum replacement of

2. LITREATURE REVIEW

Baboo Rai the author of a recent paper in this field of articles [1]. Partial replacement of cement and usual fine aggregates by varying percentage of marble powder and marble granules reveals that increased waste marble powder (WMP) or waste marble granule (WMG) ratio result in increased workability and compressive strengths of the mortar and concrete. .Dr.Vijaya Sekhar Reddy Rai the author of a recent paper in this field of articles [2]. The replacement is done partially and fully in the various proportions like 0%, 25%, 50%, 75% and 100% and its effect on properties of concrete were investigated. The study indicated that waste marble dust can effectively be used as fine aggregate replacement (up to50%) without substantial change in strength. Nitisha Sharma the author of a recent paper in this field of articles [3]. As marble powder is the waste product, obtained during the process of sawing and shaping of marble by parent marble rock, contains heavy metals which makes the water unfit for use. Marble powder creates environmental problems. .Deepankar Kumar Ashish the author of a recent paper in this field of articles [4]. The compressive strength and ultrasonic pulse velocity were tested for seven different series prepared by partially replacing cement, sand with WMP at

proportions of 0-15% by weight separately and in combined form. Finally, all of the data were compared with each other & it was observed that the addition of WMP such that would partially replace the sand and cement separately at particular proportions. Pradeep Mehla the author of a recent paper in this field of articles [5]. The various tests conducted for this purpose were Compressive Strength, Flexural Strength, Split tensile Strength and durability and workability of concrete. The concrete mix for different specimens was made by taking 15% against cement and sand individually and 30% against combined cement and sand.

3. Materials used

3.1. Cement

The most common cement used is an ordinary Portland cement grade 43. The Type 1 is preferred according to IS269-1976, which is used for general concrete structures. Out of the total production, ordinary Portland cement accounts for about 80…90%. Many tests were conducted on cement; some of them are consistency tests, setting tests, soundness tests, etc.

Table 1

Properties of cement

SI.NO	PROPERTY OF CEMENT	VALUES
1	Grade of cement	**53**
2	Fineness of cement	**4**
3	Specific gravity	**3.15**
4	Initial setting time	**30 min**
5	Final setting time	**10 hrs**

3.2. Aggregate

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect

economy. One of the most important factors for producing

workable concrete is good gradation of aggregates. Good

grading implies that a sample fractions of aggregates in

required proportion such that the sample contains minimum

voids. Samples of the well graded aggregate containing

minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste will mean less quantity of cement and less water, which will further mean increased economy, higher strength, lower shrinkage and greater durability. Aggregate comprises about 55% ofthe volume of mortar and about 85% volume of mass concrete. Mortar contains a size of 4.75 mm and concrete

a) Coarse Aggregate

The fractions from 80 mm to 4.75 mm are termed as coarse aggregate.

b) Fine aggregate

Those fractions from 4.75 mm to 150 microns are termed as fine aggregate. Contains aggregate up to a maximum size of 150 mm.

Tale 2

Properties of fine aggregate and coarse aggregate

SL.NO	PROPERTIES	FINE AGGREGATE	COARSE AGGREGATE
1	Specific gravity	2.36	2.71
2	Fineness modulus	2.60	8.64
3	Bulk density	1724	1561
4	Water	0.75	5.6

3.3 Water

Water is an important ingredient of concrete as it participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is required to be considered very carefully.

3.4 Marble powder

Marble is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Marble may be foliated. Geologists use the term "marble" to refer to metamorphosed limestone; however, stonemasons use the term more broadly to encompass unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material. Marble is a rock resulting from metamorphism of sedimentary carbonate rocks, most commonly limestone or dolomite rock. Metamorphism causes variable recrystallization of the original carbonate mineral grains

Table 3

Properties of marble dust

NO	PROPERTIES	MARBLE DUST
1	Fineness modulus	2.65
2	Specific gravity	2.60
3	Bulk density(kg/m^3)	1724

4. Mix Design

A mix M25 grade was designed as per Indian Standard method and the same was used to prepare the test samples. The design mix proportion is done in Table 4.

MIX NO	MIX RATIO	CEMENT (KG/M^3)	FINE AGGREGATE (KG/M^3)	COARSE AGGREGATE (KG/M^3)	WATER
M1	CONVENTINAL	648.85	1101	NIL	186
M2	5% REPLACEMENT	616.41	1101	32.44	186
M3	10% REPLACEMENT	584	1101	64.85	186
M4	15% REPLACEMENT	551	1101	97.32	186

5. Details of the Experimental Study

5.1 Compressive Strength Test

150 mm × 150 mm × 150 mm concrete cubes were casting using M25 grade concrete. Specimens with ordinary Portland cement (OPC) and OPC replaced with marble powder at 5%, 10%, and 15%, levels were cast. During casting the cubes were mechanically vibrated by using a table vibrator. After 24 h the specimens were removed from the mould and subjected to water curing for 7 ,14 and 28 days. After curing, the specimens were tested for compressive strength using a calibrated compression testing machine.

5.2 split tensile strength test

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength. Split Tensile strength of concrete is tested on cylinders at different percentage of marble powder Content in concrete. The strength of concrete has been tested on cylinder at 7 days curing,14 days and 28 days. 7days test has been conducted to check the gain in initial strength of concrete. 28 days test gives the data of final strength of concrete at 28 days curing. At the time of testing the cylinder taken out of water and dried and then tested. it can be seen that marble powder improves the compressive and split tensile strengths of concrete. As the percentage replacement of cement with marble powder increases, the compressive and split tensile strengths increase, reach a maximum value and then decrease.

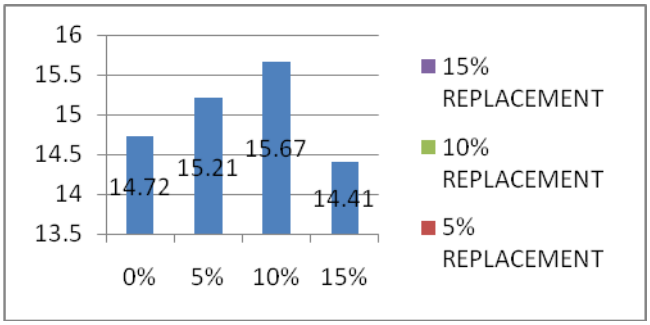
6. Results and Discussions

6.1 compression test results

The obtained results are given in graphs

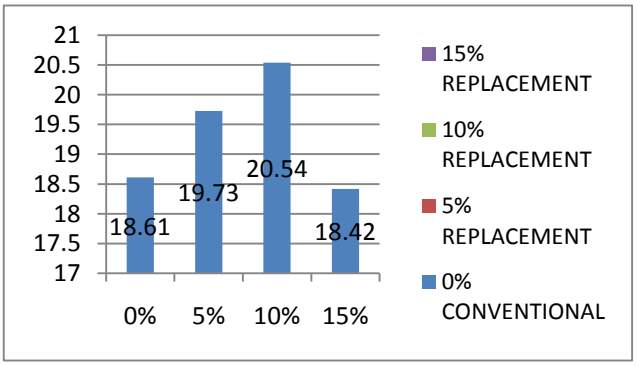
Graph 1

Compressive Strength of Cubes at 7 Days



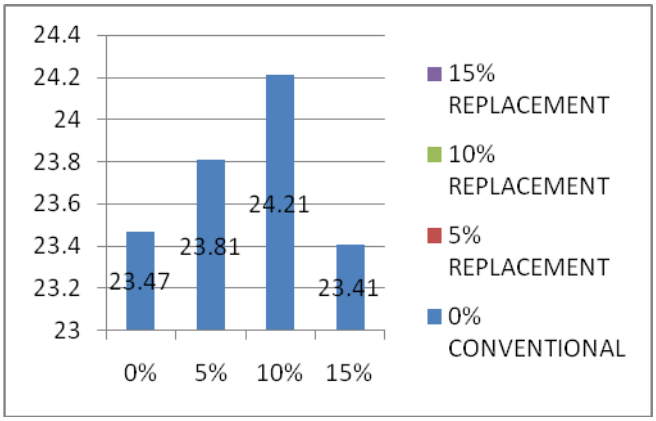
Graph 2

Compressive Strength of Cubes at 14 Days



Graph 3

Compressive Strength of Cubes at 28 Days

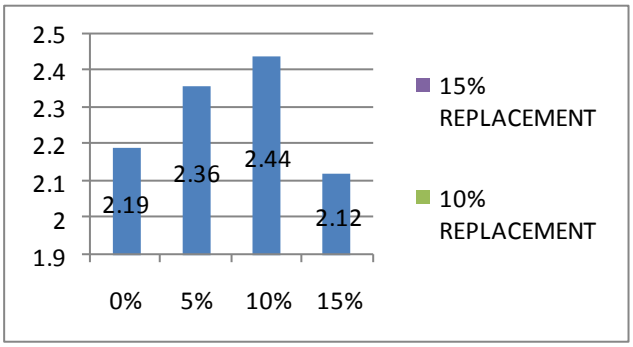


6.2 split tensile strength test results

The obtained results are given in graphs

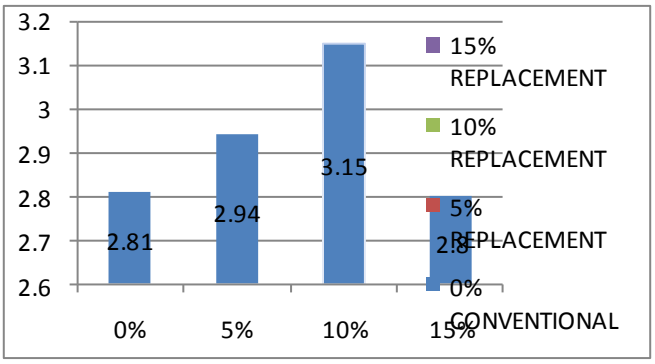
Graph 4

split tensile strength of cubes 7 days



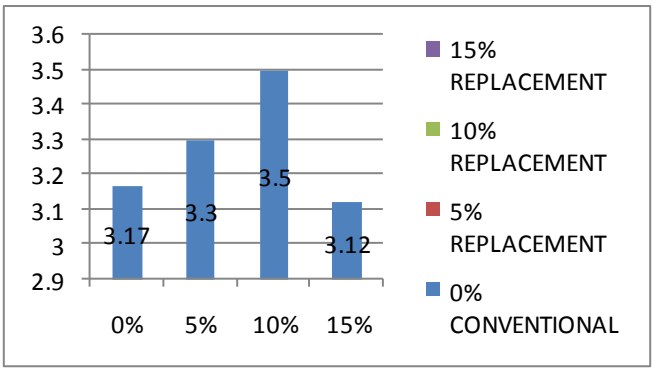
Graph 5

split tensile strength of cubes 14 days



Graph 6

split tensile strength of cubes 28 days



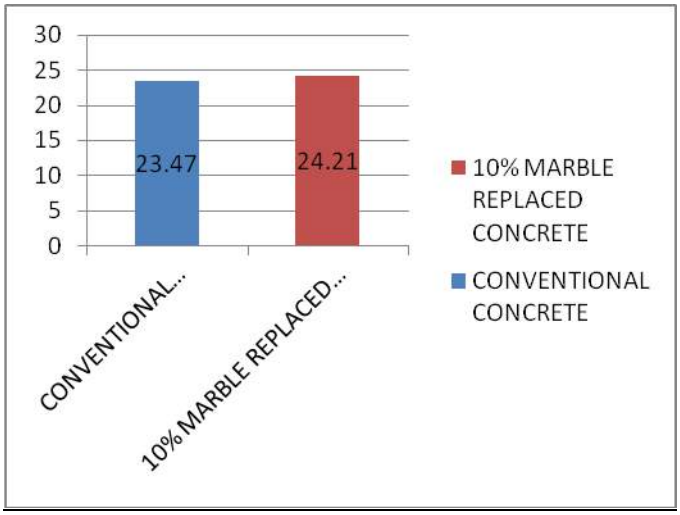
CONCLUSION

•Up to 10% replacement of Fine aggregate with waste marble there is a increase in all mechanical properties.

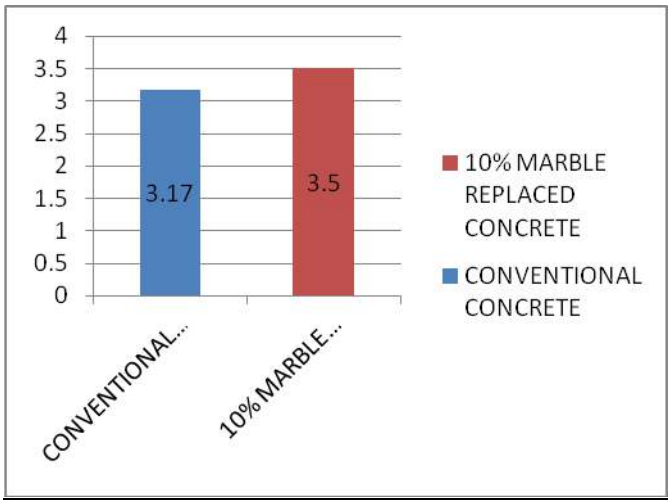
•The replacement of 10% of fine aggregate with waste marble powder attains maximum compressive and tensile strength.

•The optimum percentage for replacement of marble powder with fine aggregate and it is almost 10% cement for both cubes and cylinders.

COMPRESSION TEST RESULT



SPILT TENSILE STRENGTH TEST RESULT



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