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Partial Replacement of Sand with Marble Dust in Concrete

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ABSTRACT
Concrete is a widely used material in the world. Based on global usage it is placed at second position after water. Common river sand is expensive due to excessive cost of transportation from natural sources. River sand is most commonly used fine aggregate in the production of concrete poses the problem of acute shortage in many areas and continuous usage has started posing serious problems with respect to its availability, cost and environmental impact. So Engineers began to search for alternative for fine aggregate. The basic objective of this study was to identify alternative source of good quality aggregates. The present investigation has been undertaken to study the effect of Marble dust on the mechanical properties of concrete, when marble dust is replaced with fine aggregate in different percentages The main parameter investigate were cube compressive strength. In this work, M25 grade concrete mix was developed using IS method of mix design. Specimens of dimension of 150 x 150 x 150mm cubes were cast for compressive strength of concrete specimens. The test results indicate that with the use of replacing Marble dust by fine aggregates in different percentages i.e. 0%, 5%, 10%, 15%, 20%, 25%, 30%, 30% and 40%. For evaluation of strength parameters each grade of concrete for each proportion in the form of cubes casted for testing at 3 days, 7days and 28 days periods. The compressive strength increases with the increase in percentage of Marble dust up to 30%. Marble dust can be replaced without affecting the target strength.

I. INTRODUCTION

Rapid urbanization in developing countries such as India is creating a shortage of adequate housing in cities. Using artificial aggregates for quality concrete is a natural step to mitigating this problem. The worldwide consumption of fine aggregate in concrete production is very high, and several developing countries have been countered difficulties in meeting the supply of natural fine aggregate in order to satisfy the increasing needs of infrastructural development in recent years. To overcome the stress and demand for river fine aggregate, research sand practitioners in the construction industries have identified some alternative materials such as flyash, slag, limestone powder and siliceous stone powder. In India attempts have been made to replace river sand with Marble dust. The successful utilization of Marble dust as fine aggregate would turn this waste materials that causes disposal problem into a valuable resource. The utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete. The main objective of the present investigation is to evaluate the possibilities of using Marble dust as a replacement to fine aggregate. Present investigation aimed at to study, 5%, 10%, 15%, 20%, 25%, 30%, 35% and 40% of traditional fine aggregate was replaced with Marble dust. Compressive strengths were found after 3 days7 days and 28 days of curing. Concrete is an artificial material in which the aggregates both fine and coarse are bonded together by the cement when mixed with water. The concrete has become so popular and indispensable because of its inherent in concrete brought a revolution in applications of concrete. Concrete has unlimited opportunities for innovative applications, design and construction techniques. Its great versatility and relative economy in filling wide range of needs has made it is very competitive building material. Concrete solidifies and hardens after mixing with water and placement due to a chemical process known as hydration. The water reacts with the cement, which bonds the other components together, eventually creating a stone-like material. Concrete is used to make pavements, architectural structures, foundations, and motorways/roads, bridges/overpasses, parking structures, brick/block walls and footings for gates, fences and poles, reservoirs, pools. Famous concrete structures include the BurjKhalifa (world's tallest building), Hoover Dam, the Canal and the Roman Pantheon There are many types of concrete available, created by varying the proportions of the main ingredients. By adding or by substitution for the cementations and aggregate phases, the finished product can be tailored to its application with varying strength, density, or chemical and thermal resistance properties. Water is then mixed with this dry composite, which produces a semi-liquid that workers can shape (typically by pouring it into a form). The concrete solidifies and hardens to rock-hard strength through a chemical process called

hydration. The water reacts with the cement, which bonds the other components together, creating a robust stone-like material. "Chemical admixtures" are added to achieve varied properties. These ingredients may speed or slow down the rate at which the concrete hardens, and impart many other useful properties. "Reinforcements" are often added to concrete. Concrete can be formulated with high compressive strength, but always has lower tensile strength. For this reason it is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water. "Mineral admixtures" are becoming more popular in recent decades. The use of recycled materials as concrete ingredients has been gaining popularity because of increasingly strict environmental legislation, and the discovery that such materials often have complimentary and valuable properties. The most important of these are fly ash, a by-product of coal-fired power plants, and silica fume, a by-product of industrial electric arc furnaces, Metakaolin, from steel industry. The use of these materials in concrete reduces the amount of resources required as the ash and fume acts as a cement replacement. This displaces some cement production, an energetically expensive and environmentally problematic process, while reducing the amount of industrial waste that must be disposed in landfills. Concrete is the world's most consumed man-made material. With the advancement of technology and increased field of applications of concrete and mortars, the strength, workability, durability and other physical and chemical properties of the ordinary concrete need modifications to make it more suitable by situations. There is a necessity to control the increasing cost and scarcity of cement. Under these circumstances the use of admixtures is found to be an important alternative solution. The use of pozzolanic materials in cement concrete paved a solution for modifying the properties of the concrete, controlling the concrete production cost, to overcome the scarcity of cement, the economic advantages disposal of industrial wastes etc. The use of pozzolanic materials in concrete paved a solution for

- Modifying the properties of the concrete
- Controlling the concrete production cost
- To overcome the scarcity of cement

II. LITERATURE REVIEW

A literature review of the characteristics and effects of Marble dust on concrete properties is presented in this chapter. Many studies have recently been conducted on Marble dust in cement concrete. The topics of their research included basic characteristics (physical and chemical), effect of Marble dust on fresh concrete properties, and effect of Marble dust on hardened concrete properties.

1. Experimental Study on Use of Waste Marble Dust in Concrete Aalok D, Sakalkale, G. D. Dhawale

2.Experimental Study on Concrete Using Waste Marble Powder and Quarry Dust as Partial Replacement of Cement and Fine Aggregate Dr.Suji D, Krishna Kumar S, Perarasan M, Niranjani E Department of Civil Engineering, Adithya Institute of Technology, Coimbatore-641 107, India Experimental Procedure

TESTS ON CEMENT

Specific Gravity Test:

According to IS 2720 – part – 3 Specific gravity is the ratio of the density of a substance compared to the density (mass of the same unit volume) of a reference substance. Apparent specific gravity is the ratio of the weight of a volume of the substance to the weight of an equal volume of the reference substance. The reference substance is nearly always water for liquids or air for gases. Fineness Test: According to IS 4031-1968 Fineness is defined as the surface area of cement particles per unit weight, means a greater number of particles per unit weight. If the percentage of fineness is more than 90 % the cement is supposed to be fresh, if it is less than 90 % than that Cement should be avoided to use.

Standard consistency Test:

According to IS 4031 (Part 4) 1988 The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a depth of 5 to 7mm from the bottom of the vicat mould.

Initial Setting and Final Testing Time Test:

According to IS 4031 (Part 5) 1988 The time period elapsed between the time of adding water to the cement to the time when the needle fails to pierce the mould for 5 + 0.5mm. The time period elapsed between the times of adding water to the cement to the time when the annular ring fails to make the impression on the mould is called the final setting time. Compressive Strength of Cement: According to IS 8112-1989 Compressive strength of cement is determined from mortar cubes of size 7.07 X 7.07 X 7.07c.m and cement to sand ratio 1:3. The strength is obtained for 3,7,28 days. The strength obtained on 28th day is called compressive strength of cement.

TESTS ON COARSE AGGREGATE

Water Absorption of coarse aggregate (IS: 2386-PART-3).Water absorption gives an idea of strength of aggregate. Aggregates having more water absorption are more porous in nature and are generally considered unsuitable unless they are found to be acceptable based on strength, impact and hardness tests.

Specific Gravity (IS: 2386- PART- 3)

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. The specific gravity test helps in the identification of stone.

Sieve Analysis (IS: 383- 1970)

A sieve analysis (or gradation test) is a practice or procedure used (commonly used in civil engineering) to assess the particle size distribution (also called gradation) of a granular material. The size distribution is often of critical importance to the way the material performs in use. A sieve analysis can be performed on any type of nonorganic or organic granular materials including sands, marble dust, clays, granite, feldspars, coal, and soil, a wide range of manufactured powders, grain and seeds, down to a minimum size depending on the exact method. Being such a simple technique of particle sizing, it is probably the most common method.

Crushing Value (IS: 2386 -PART- 4)

The aggregate crushing value provides a relative measure of resistance to crushing under a gradually applied compressive load. To achieve a high quality of concrete, aggregate possessing low aggregate crushing value should be preferred.

Fineness modulus

Fineness Modulus (FM) is used in determining the degree of uniformity of the aggregate gradation. It is an empirical number relating to the fineness of the aggregate. The higher the FM is, the coarser the aggregate.

Cube compressive strength test

According to IS 516-1959 After 28 days of curing, the cubes were taken out from curing tank, dried and tested using a compression testing machine. These cubes were loaded on their sides during compression testing such that the load was exerted perpendicularly to the direction of casting. The cubes were placed in the compression testing machine and the loads are applied gradually at a rate of 5KN/cm2/sec. The average value of the compression strength of three cubes was taken as the compression strength. The compressive strength of conventional concrete was found to be 32.81N/mm2.

CASTING

According to IS 516-1959 The cubes were casted in steel moulds of having dimensions 150 x 150 x 150mm For all test specimens, moulds were kept on table vibrator for compaction. Concrete was poured in three layers into the mould and they are kept on vibrator for 2-3 minutes after they are removed and left aside. After 24 hours they are demoulded and specimens are kept for curing for a period of 3,7,28 days

III. RESULTS AND DISUSSION

The results of the present investigation are present both in tabular and graphical forms the interpretation of the results is based on the current knowledge available in the literature as well as on the nature o results obtained the significance of the result is assessed with reference to the standards specified by the relevant IS Codes

PHYSIAL PROPERTIES OF CEMENT

Table- Normal Consistency For Cement

Weight of cement	% of water	Amount of water added	Consistency (mm)
400	24	96	40
400	26	104	37
400	28	112	31
400	30	120	23
400	32	128	7

Normal Consistency of cement = 32%

Table-Physical Properties of Cement (OPC 53 GRADE) (IS 8112-1989)

S No.	Property	Value
1	Specific Gravity	3.05
2	Fineness of cement by sieving	5.5%
3	Setting Time Initial Setting time Final Setting time	 145 min 400 min
4	Compressive Strength 3 days 7 days 28 days	 28.35Mpa 29.35Mpa 54.95Mpa

The Physical properties of cement are within the limits as per within the codal provisions

PHYSIAL PROPERTIES OF COARSE AGGREGATES

Table- Sieve Analysis of Coarse Aggregate

Total weight of sample taken = 10Kgs.

S No.	IS Sieve	Weight Retained(Kg)	Cumulative Weight Retained	% Weight Retained	% Weight Retained
1	50 mm	0	0	0	0
2	40 mm	0	0	0	0
3	16 mm	4550	4550	45.50	45.50
4	12.5 mm	2250	6800	68.00	113.5
5	10 mm	1750	8500	85.00	198.5
6	3 mm	650	9200	92.00	295.5
7	4.75 mm	625	9825	98.25	388.75
8	2 mm	100	9925	99.25	488
9	1 mm	75	10000	100	588
Fineness Modulus =5.88			Total =588		

With replacement of fine aggregate with marble dust 3 days compressive strength increases with increase in percentage it is observed that at 20% and 25% there is small amount of increase in strength

The maximum percentage of increase of strength at 30 % is (15.98-14.84/14.84)*100 = 7.68% With replacement of fine aggregate with marble dust 7 days compressive strength increaseswith increase in percentage it is observed that at 20% and 25% there is nearly equal amount of increase in strength

The maximum percentage of increase of strength at 30 % is (23.36-21.84/21.84)*100 = 6.96%

With replacement of fine aggregate with marble dust 28 days compressive strength increases with increase in percentage it is observed that at 20% and 25% there is continuous increase in strength

IV. CONCLUSIONS

• The physical properties of Marble dust are satisfying the requirements of fine aggregate. The cost of concrete made with marble dust is less than conventional concrete because the availability Marble dust at less cost.

• The maximum compressive strength occurred at 30% replacement of fine aggregate and it was observed as 35.41MPa.

• Based up on the experimental investigations Marble dust available at Rajasthan region can be replaced as fine aggregate upto 40% without affecting the target strength.

• Based on this experimental investigation, it is found that Marble dust can be used as an alternative material to the natural river sand in future.

REFERENCES

[1]. IS 383:1970 Indian standard institution, Specifications of coarse and fine aggregates from natural sources of concrete, New Delhi.

[2]. IS 456:2007 Plain and Reinforced Concrete Code of Practice, Bureau of Indian Standards, New Delhi.

[3]. IS 516:1959, Method of tests for strength of concrete, Indian standard institution, New Delhi.

[4]. IS: 1199-1959. Indian Standard Methods of Sampling and analysis of concrete. Bureau of Indian Standards, New Delhi.

[5]. IS: 2386-1963 Part 1 to VIII. Indian Standard Methods of Test for Aggregate for concrete. Bureau of Indian Standards, New Delhi.
[6]. IS: 10262-2009 and SP 23:1982. Recommended Guidelines for concrete Mix. Bureau of Indian Standards, New Delhi.
[7]. Shetty, M. S., "Concrete technology," Chand S. and Co. Ltd, India (2009).
[8]. Gambhir, „CONCRETE TECHNOLOGY", Tata McGraw Hill Publishing Co Ltd., New Delhi.
[9]. Experimental Study on Use of Waste Marble Dust in Concrete G. D. Dhawale D. Sakalkale, R. S. Kedar Department of civil BDCE Wardha
[10]. Experimental Study on ConcreteUsing Waste Marble Powder and Quarry Dust as Partial Replacement of Cement and Fine Aggregate Dr.Suji D , Krishna Kumar S , Perarasan M , Niranjani E Department of Civil Engineering, Adithya Institute of Technology , Coimbatore-641 107.

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