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Experimental Analysis of Partial Replacement of Coarse Aggregate with Marble Waste in Concrete

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***Abstract*— Now a days we are faced with an important consumption and a growing need for aggregates because of the growth in industrial production, this situation has led to a fast decrease of available resources. On the other hand, a high volume of marble production has generated a considerable amount of waste materials; almost 70%of this mineral gets wasted in the mining processing and polishing stages which have a serious impact on the environment. The processing waste is dumped and threatening the aquifer. Therefore, it has become necessary to reuse these wastes particularly in the manufacture of concrete products for construction purposes. This experimental study presents the variation in the strength of concrete when replacing aggregates by waste marble from 0% to 100% in steps of 25%, 50%, 75% & 100%. M20 grade of concrete were taken for study of slump value is reducing for more % of replacing the stone dust. The compressive strength of concrete cubes at the age of 7, 14 and 28 days were obtained at room temperature. From test result it was found that the maximum compressive strength is obtained only at 50% replacement of coarse aggregate by waste marble at room temperature. This result gives a clear picture that waste marble can be utilized in concrete mixtures as a good substitute for coarse aggregate giving higher strength.**

***Keywords*—Waste material, Industrial production**

I. INTRODUCTION

At present no construction activity is possible without using concrete. It is the most common material used in construction worldwide. The main reason behind this is because of its high strength, durability and workability. The total world consumption of concrete per year is about one ton for every living human being. Man consumes no materials except water in such tremendous quantities. Due to privatization and globalization, the construction of important infrastructure projects like Highways, Airports, Nuclear plants, Bridges, Dams etc. in India is increasing year after year. Such developmental activities consume large quantity of precious natural resources. This leads not only faster depletion of natural resources but also increase the cost of construction of structures.

In view of this, people have started searching for suitable other viable alternative materials which could be used either as an additive or as a partial replacement to the conventional ingredients of concrete so that the existing natural resources could be saved to the possible extent, and could be made available for the future generation. In this process, different industrial waste materials such as fly ash, blast furnace slag, quarry dust, tile waste, brick bats, broken glass waste, waste aggregate from demolition of structures, ceramic tiles, electronic waste of discarded old computers.

II. OBJECTIVES OF STUDY

- To find out the application of Marble waste in conrete.
- To replace coarse aggregate by the Marble waste in various percentage (0%, 25%, 50%, 75%, 100%).
- To study the compressive strength and split tensile strength of hardened concrete specimen.
- To find out the percentage use of Marble waste feasible for construction.

Scope of the work

- *Behavior at Different Curing Times:* Evaluating the effect of marble waste on the long-term performance of concrete (beyond 28 days of curing) to determine if higher marble waste content affects concrete performance over extended periods.
- *High-Performance Concrete (HPC):* Investigating the effects of marble waste in high-strength or high-performance concrete mixes, which require stricter control over the quality and properties of the materials used.
- *Self-Compacting Concrete (SCC):* Examining the impact of marble waste as a partial replacement in self-compacting concrete, which demands a higher degree of flowability and stability.
- *Lightweight Concrete:* Evaluating marble waste in lightweight concrete, considering its possible effects on reducing the overall density of concrete without compromising strength.

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III. METHODOLOGY

A methodology for prediction of long term properties of Waste marble concrete is presented, based on an extensive literature review of international experimental campaigns on this type of environment, friendly concrete. The methodology presented is based on the previous determination of the main properties of aggregates, primary and recycled and alternative the 28 day compressive strength of concrete made with those aggregates. The methodology is validated, based on a graphical analysis of the most important properties of hardened concrete. It is concluded that the methodology can predict the long term performance of recycled aggregate concrete as compare with an equivalent conventional concrete and that this prediction can be used to adept structural design this material.

Cement

A cement is a binder, a substance used for construction that sets, hardens and adheres to other materials to bind them together.

Properties of Cement

Sr. No.	Characteristics	Value obtained	Standard value
1.	Normal consistency (%)	30%	26%-33%
2.	Initial setting time (min.)	32	Not less than 30
3.	Final setting time (min)	596	Not less than 600
4.	Fineness (%)	8%	<10
5.	Specific gravity	3.15	3.15

Specific gravity of waste marbles:

Empty weight of pycnometer (W1) = 0.565kg

Empty weight of pycnometer + 1/3rd height of coarse aggregate (W2) =1.014kg

Empty weight of pycnometer + 1/3rd height of coarse aggregate +

Remining height of water (W3) = 1.675kg

Empty weight of bottle + water (W4) =1.388kg

$(w2-w1)/(w4-w1)-(w3-w2)$

$(1.014-0.565)/(1.388-0.565)-(1.675-1.014)$

Specific Gravity of Coarse Aggregate = 2.88

Impact value for waste marbles: -

Weight of mould (w1) =1.814 kg

Weight of mould + weight of aggregate passed through 13.5mm sieve and

Retained on 10mm sieve (w2) =2.468 kg

WA=$w2-w1$ = 2.468 - 1.814

= 0.654 gms.

Weight of aggregate passed through 2.36mm sieve after compaction (WB) = 0.082 gms

WB / **WA** X 100 = 0.082/0.654 X 100

= 12.5%

Mixing design adopted for M20 grade concrete:

Grade designation: M20

Type of cement: OPC 53 grade

Maximum nominal size of Aggregate: 20 mm

Minimum cement content: 300 kg/m^3

Maximum water cement ratio: 0.55

Workability: 50 mm slump

Exposure condition: Mild (for RCC)

Degree of supervision: Good

Type of aggregate: Crushed angular aggregate

Maximum cement content: 450 kg/m^3

a)	Cement used	= OPC 53 grade
b)	Specific gravity of cement	= 3.15
c)	Specific gravity of:	
	Coarse Aggregate	= 2.65
	Fine Aggregate	= 2.60
d)	Water absorption:	
	Coarse aggregate	= 0.4%
	Fine aggregate	= 0.3%
e)	Free surface moisture:	
	Coarse aggregate	= Nil
	Fine aggregate	= Nil

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Mix Design Procedure

Step 1 :

f'ck = fck + 1.65 s

where,

f'ck =target average compressive strength at 28 days

fck =Characteristic compressive strength at 28 days and

s = standarddeviation

From table 1, standard deviation, s = 4 N/mm2.

Therefore, target strength =

20 + 1.65 x 4

=26.6 N/mm2.

Step 2 : Selection of W/C Ratio

From Table-5 of IS: 456-2000, maximum W/C ratio = 0.6,
Based on experience adopted w/c ratio as 0.55
0.55< 0.6, hence ok

Step 3 : Selection of water content

From table-2 maximum water content for size of

Aggregate 20 mm

= 186 litre

Step 4 : Calculation of cement content

Water-cement ratio =0.55

Water used = 186 liter

Cement content =186/0.55

= 338.18 kg/m3

As per IS: 456-2000. Table-5. Minimum cement content for mild exposure condition = 300 kg/m3.

338.18 kg/m3 > 300 kg/m3, hence O.K.

Step 5 : coarse aggregate and fine aggregate content

From Table-6, volume of coarse aggregate corresponding to 20 mm maximum size Aggregate and fine aggregate grading (Zone- II) for water cement ratio 0.50 = 0.6.

In the present case w/c = 0.55. Therefore, volume of coarse aggregate is required to be increased to decrease the fine aggregate content. As water-cement ratio lower by 0.05, the proportion of volume of coarse aggregate is increased by 0.01 (at the rate of -/+ 0.01 for every +/- 0.05 change in water-cement ratio).

Therefore, corrected proportion of volume of coarse aggregate for water- cement ratio of 0.55 = 0.6.
Therefore,

volume of coarse aggregate = 0.60-0.01 = 0.59

Volume of fine aggregate content = 1- 0.59 = 0.41

Step 6 : Mix Proportion for trial No 1

Cement = 338.18kg/m3

Water=186 lit

Fine aggregate =753.662 kg/m3 Coarse aggregate =1105.394kg/m3 w/cratio =186/338.18

= 0.55

Step 7: Mix Proportion (by mass)

Water	Cement	F.A.	C.A.
186 lit.	338.18 kg	753.662 kg	1105.394 kg
0.55	1	2.23	3.26

Mix Proportion (control concrete)

Mix Proportion

MATERIAL	DRY WT.	
Cement	338.18	kg/m3
Water	186	kg/m3
Fine aggregate	753.662	kg/m3
Coarse aggregate	1105.394	kg/m3
Water-cement ratio	0.55	

IV. CONCLUSIONS

- This research is an experimental approach to substitute natural aggregates by the waste marble aggregates; the concern is more scientific than economical and environmental.
- The results obtained demonstrated the performance of various concrete mixtures which may help to understand the behaviour of these marble aggregates. Therefore, the orientation of this research has shown that setting certain parameters has identified the best percentage of substitution for each type of aggregate.

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- From our project we have obtained the maximum compressive and split tensile values for 50 % replacement of aggregate with marble. Analysis of these results has revealed that the appropriate incorporation of marble waste aggregates can lead to interesting characteristics in terms of strength, indeed the use of marble aggregates resulted in a considerable increase in the compressive and split tensile strength.
- The enhancement in resistance is very significant for 25%, 50%, 75%and 100% of substitution.
- The concrete workability can be improved by the correct quantity of water and the correct proportioning and grading of the ‘‘sand” and the ‘‘gravel” which can provide practical formulations.
- The marble waste can be used as alternative aggregates for concrete and for many other purposes such as bricks manufacturing, road construction and landfills.

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