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COMPARISON OF CONVENTIONAL CONCRETE WITH PARTIAL REPLACEMENT OF COARSE AGGREGATE WITH MARBLE WASTE IN CONCRETE

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ABSTRACT: Marble industry produces large amount of waste during mining and processing stages. This waste is dumped on to open land which creates a lot of environmental problems. The main objective of this study was utilization of marble waste as a partial replacement for conventional natural coarse aggregate in concrete. Experimental investigations were carried out to examine the feasibility of use of marble waste as a coarse aggregate in concrete. Conventional natural coarse aggregate was replaced by marble aggregate in different percentages 40%, 60%, 80% by weight. The concrete formulations were prepared with a constant water–cement ratio 0.50. The compressive strength on 7th day, 14th day and 28th day of those cubes are tested. Compressive strength of all concrete mixes containing marble aggregate shows upward trend till 80% replacement level. The natural aggregates can be replaced by marble aggregates in Concrete mixes. Hence, Marble waste can be used as aggregates instead of dumping it as waste.

KEYWORDS: Marble waste, aggregate, compressive strength.

1. INTRODUCTION

The stone has played significant role in human endeavours since earliest recorded history. Marble ranks the largest produced natural stone in the world and it accounts for 50% of the world's natural stone production. Approx 85% of production of marble in India is from Rajasthan state .The marble mining industry has come up significantly in recent past. Rajasthan has around 4000 marble mines and about 1100 marble gang saws (processing plants). The industry involves mines, processing plants, cutters for the production of tiles for walls and floors, household articles. The industries produce a lot of waste of marble in the form of powder/slurry and pieces of irregular size of stones. The waste generated during the quarrying operations is mainly in the form of rock fragments (called "Stones" in the common parlance). The stones obtained from the quarries are usually dumped in empty pits in the forest area; thereby creating huge amounts of waste. There is absolutely no method of systematic disposal of waste in the quarrying areas. The waste & overburden is dumped on forestland, Roads, riverbeds, pasture lands & agricultural fields leading to widespread environmental degradation. There is no segregation of the overburden from the stones thereby causing a loss of fertile top soil. The quarry operations express their inability in proper segregation and disposal of waste. In the present study, the generated waste was used in M30 grade concrete as a replacement of conventional coarse aggregate in different percentages 40%, 60%, 80% by weight. The idea of working on concrete mixes was maximum utilization of marble waste which saves the natural resources.

2. LITERATURE REVIEW

Binici et al. (2012)[3]:

In a study by the marble waste was used as 100% replacement for natural coarse aggregates by weight in concrete with constant water–cement ratio 0.4. River sand and ground blast furnace slag (GBFS) were used as fine aggregate. It was reported that compressive strength, Flexural strength, Splitting tensile strength and young's modulus of elasticity of concrete prepared with GBFS as fine aggregate and marble waste as coarse aggregate was 3–6%, respectively higher than thatof concrete with river sand as fine aggregate and marble waste as coarse aggregate. In case of water absorption by immersion and depth of carbonation, the behaviour of concrete containing marble aggregate shows similar results to that of control concrete. Part of this generated waste was used in preliminary studies by several researchers in medium strength concrete mixes in the past.

Sudarshan D. et.al (2005)[4]:

The main objective of this study was utilization of marble waste as a replacement for conventional natural coarse aggregate in concrete. Experimental investigations were carried out to examine the feasibility of use of marble waste as a coarse aggregate in concrete. Conventional natural coarse aggregate was replaced by marble aggregate in different percentages 0–100% by weight. It was observed that workability of concrete mixes containing marble aggregate was 14% more than that of control concrete. The average compressive strength of all the concrete mixes containing

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marble aggregate increased by 40% and 18% at 7 and 28 days, respectively.

Osman Gencel(2006)[5]:

Marble industry produces large amounts of waste marble – what causes environmental problems. In paving blocks based on two cement types we have partly replaced aggregate with waste marble. Physical and mechanical tests were performed on blocks so produced. The cement type turns out to be an important factor. Mechanical strength decreases with increasing marble content while freeze-thaw durability and abrasive wear resistance increase. Waste marble is well usable instead of the usual aggregate in the concrete paving block production.

Jay P. Chotaliya. et.al (2011)[6]:

The study is based on the use of waste marble chips as concrete aggregate. The high consumption of raw material like coarse aggregate will result in shortage of such aggregate in future. This will result in environmental damage because of the associated mining and disposal work. Presently large amount of marble waste is generated in marble stone processing in marble industries. Therefore, by this study it is intended to investigate the possibility of using these waste marble as aggregate for concrete. Further, with the help of this study we intend to make economical concrete.

Alexandra Rosa. et.al (2003)[7]:

The main goal of this study was to evaluate the influence of the replacement of primary aggregates (PA) with marble aggregates. The conventional primary aggregates were replaced in the three families by coarse marble aggregates (CMA) at ratios of 20%, 50% and 100% of the total volume of aggregates. These mixes were tested in the concrete's fresh state for workability and density and in its hardened state for compressive strength, water absorption by capillarity and immersion, carbonation and chloride penetration.

3. MATERIALS AND METHODS

3.1 MATERIALS USED

3.1.1 Cement

Cement Portland cement of 53 Grade conforming to IS 12269 - 1987 was used for the Present experimental investigation. Its specific gravity is 3.15. The cement was tested as per the Indian Standards IS 4031-1988.

3.1.2. Fine Aggregate

Natural river sand confirming to Zone II as per IS 383 – 1987 was used. A specific gravity of 2.60 and fineness modulus of 2.64 was used as fine aggregate.

3.1.3. Coarse aggregate

An Aggregate is the important constituent in concrete. They give body to the concrete, reduce shrinkage and effect economy. The mere fact that the aggregate occupy 70-80 per cent of volume of concrete, their impact on various characteristics and properties of concrete is undoubtedly considerable. For this study the natural coarse aggregate was used two test, namely specific gravity and Sieve analysis for gradation, were performed.

3.2.4 Marble aggregate:

Marble waste used in this study was collected from a Jain Temple in Puzhal which is under construction. Specific gravity and water absorption of marble aggregate are presented. The nominal maximum size of marble aggregate used was 20 mm. It can be seen that water absorption of marble aggregate is about 10% of that of natural conventional aggregate. The particle size distribution shows that marble aggregate lacks finer fractions as compared to natural aggregate.

4. MATERIALS TESTING

4.1 Specific gravity of aggregate:

The specific gravity of an aggregate is considered to be a measure of strength or quality of the material. Stones having low specific gravity are generally weaker than those with higher specific gravity values. The coarse aggregate specific gravity test is used to calculate the specific gravity of a coarse aggregate sample by determining the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water.

4.2 Water absorption:

Porosity and absorption of aggregate will affect the water/cement ratio and hence the workability of concrete. Therefore water absorption of aggregate is determined.

4.3 Aggregate impact value:

The property of a material to resist impact is known as toughness. The aggregates should have sufficient toughness to resist their disintegration due to impact. The aggregate impact value is a measure of resistance to sudden impact or shock, which may differ from its resistance to gradually applied compressive load.

4.4 Aggregate crushing value:

The aggregate crushing value provides relative measure of the resistance of an aggregate to crushing under a gradually applied compressive load. The aggregate crushing value

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gives a relative measure of the resistance of an aggregate crushing under gradually applied compressive load.

4.5 slump cone test

The concrete slump test measures the consistency of fresh concrete before it sets. It is performed to check the workability of freshly made concrete, and therefore the ease with which concrete flows. It can also be used as an indicator of an improperly mixed batch. The test is popular due to the simplicity of apparatus used and simple procedure. The slump test is used to ensure uniformity for different loads of concrete under field conditions.

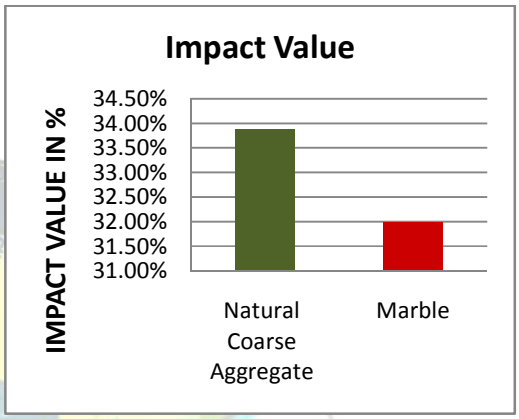
4.6 compaction factor test

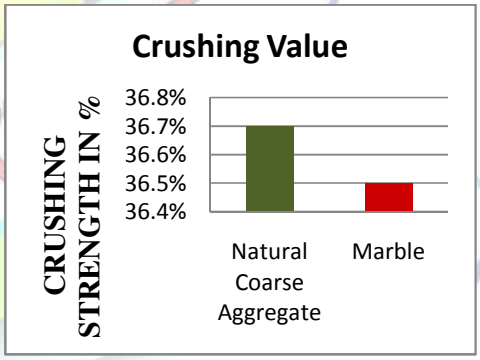
The ratio of the weight of partially compacted concrete to the weight of the concrete when fully compacted in the same mould. The Compacting Factor Apparatus is used to determine the compaction factor of concrete with low, medium and high workability.

5. The Experimental investigation:

The experimental investigation consisted of making M30 concrete with various proportions of marble aggregates as a replacement to Coarse aggregates and determining the Compressive strength of concrete. M30 mix was designed as per IS 10262:2009 and its mix ratio was found to be 1: 1.5: 2.4:0.5.The required materials were weighed and mixing of concrete was carried out manually. Cube specimens of size 150 mm x150 mm x 150 mm are casted. The specimens are de moulded after 24 hours of casting and the specimens are cured in tank for 7, 14 and 28 days. 150-175 mm or say 6-7 inches. So the value of slump is specifically mentioned along the mix design and thus it should be checked as per your location. As per Indian codes, compressive strength of concrete is defined as the compressive strength of concrete is given in the terms of the characteristic compressive strength of 150mmsize cubes tested at 28 days *(fck)*. The characteristic strength is defined as the strength of the concrete below which not more than 5% of the test results are expected to fall.

6. Results & discussion





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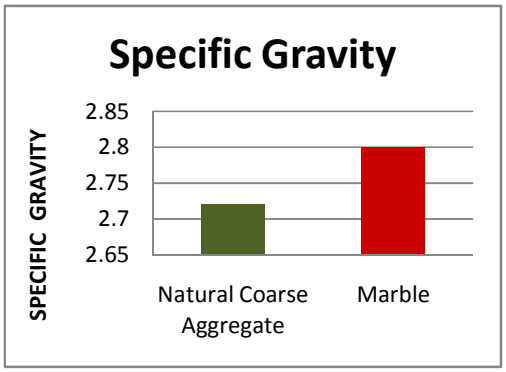

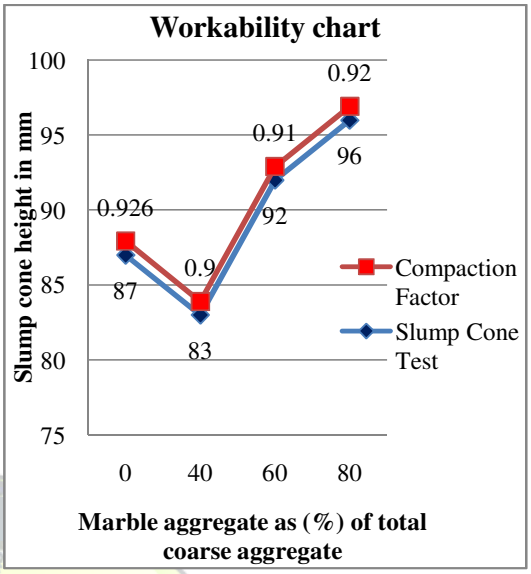

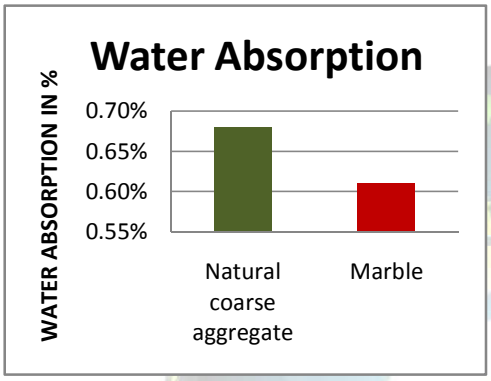

Sno	Physical Tests	Materials Test values	
		Natural Coarse Aggregate	Marble Aggregates
1	Specific Gravity	2.72	2.8
2	Water absorption	0.68%	0.61%
3	Impact value	33.87%	36.24%
4	Crushing strength	36.24%	35.88%

Compressive strength

The test results are also presented in table by increasing the marble aggregate the compressive strength values of concrete tends to increase at each curing age. Furthermore, the mean strength of concrete mixes with marble aggregate was 5-10% higher than the reference concrete. However, there is a slight decrease in compressive strength value concrete mix when 40% marble aggregate is used as compared with the others concrete mixes.

Workability of Concrete

Percentage of Replacement	Slump Cone Test	Compaction Test
0	87	0.926
40	83	0.9
60	92	0.91
80	96	0.92

Percentage of Replacement	Compressive Strength in N/mm2		
	7 Day	14 Day	28 Day
0 %	19.76	27.15	30.43
40 %	19.09	26.63	29.88
60 %	19.28	27.46	30.99
80 %	20.04	28.53	31.98

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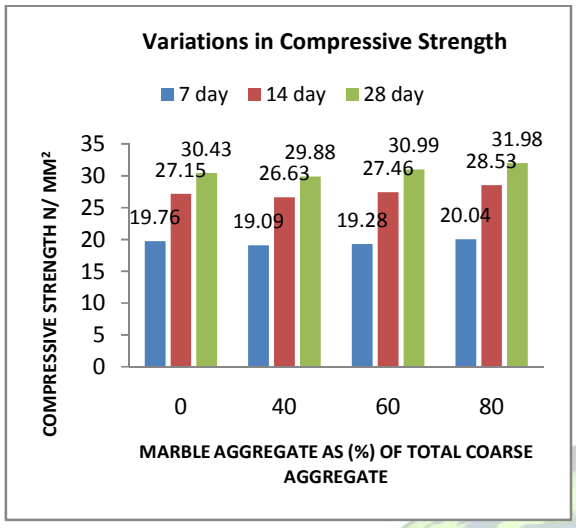

CONCLUSION

In this study, the effect of marble aggregate on the properties of concrete were investigated and it can be concluded that,

1) The workability of all concrete mixes containing marble aggregate increased as the percentage level of replacement of natural aggregates by marble aggregates increased.
2) Compressive strength of all concrete mixes containing marble aggregate shows upward trend till 80% replacement level.

It concludes that, the natural aggregates can be replaced by marble aggregates in Concrete mixes. Hence, Marble waste can be used as aggregates instead of dumping it as waste.

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