EXPERIMENTAL INVESTIGATION ON STRENGTH PARAMETERS OF CONCRETE REPLACING CEMENT BY MARBLE DUST IN CONCRETE WITH DIFFERENT DOSAGES FOR M25 AND M30 GRADE CONCRETE

[1]Sahukari Avinash, [2]Dr. N. Victor Babu,

[1]M.Tech. Student, [2] Head of Department,
[1]CIVIL Department,
[1]BABA INSTITUTE OF TECHNOLOGY AND SCIENCES, Visakhapatnam, India.

***Abstract*— Construction industry is one of the major sectors that causes negative effects on the environment. In this generation, we can observe the rapid urbanization and industrialization which was leading to the increase in the construction of the projects. So, in the construction of any structure concrete is main material to be used in completion of structure. Concrete is a mixture of several ingredients but the main ingredient is cement which helps to bind together of remaining ingredients. But, the cost of cement is high and the production of cement requires huge amounts of electricity and fuel, which radiates in the form of heat, noise and fuel such as carbon dioxide (CO2), nitrous oxides (NO), sulfur dioxide (SO2) and carbon monoxide (CO). But it is important in concrete. So, in order to fulfill the requirement the cement can be replaced with cementitious material i.e. marble dust. In this research work, the concrete specimens are casted and cured with portable water. An experimental study is made on the nature of marble dust and its influences on the properties of fresh and hardened concrete. In the present study, an attempt has been made to investigate the strength parameters of concrete made with partial replacement of cement by marble dust. Moreover, no such attempt has been made in substituting marble dust with cement for low/medium grade concrete i.e M20 & M30.**

***Index Terms*— Concrete, carbon dioxide (CO2), nitrous oxides (NO), sulfur dioxide (SO2) and carbon monoxide (CO).**

I. INTRODUCTION

Concrete is a composite material composed of water, aggregate, and cement. Concrete is used in large quantities; almost everywhere mankind has a need of structure. It is very tough to find an option for concrete in construction, which is durable and economic. Concrete is a mixture of several ingredients but the main ingredient is cement which helps to bind together of remaining ingredients. But, the cost of cement is high but it is important in concrete. So, in order to fulfill the requirement the cement can be replaced with cementitious material i.e. marble dust.

The primary objective of this investigation is to study the strength characteristics of marble dust concrete of M20 (low grade concrete) & M30 (medium grade concrete) by conducting destructive tests like compressive, split tensile and flexural strength test. In the present study, an attempt has been made to investigate the strength parameters of concrete when cement is replaced with marble dust by adding at various percentages like 0%, 5%, 10%, 15%, 20%, 25%, and 30%. Moreover, no such attempt has been made in replacing with the waste material i.e. marble dust at highest percentages to prepare M20 and M30 grade of marble dust concrete. The strength characteristics are calculated at 7, 28 days and compared the test results with the nominal mix of concrete.

II.LITERATURE REVIEW

H.Y. Aruntas. Et.al (2010) The use of agricultural and industrial waste products as raw materials in the construction industry is investigated extensively. These products are inexpensive and help in environmental sustainability, as environmental pollution is thus reduced. This study focused in investigating the properties of fresh, physical and hardened concrete blended with marble (MP) and tile powder (TP) of several proportions, such as 0%, 5% (2.5%MP + 2.5%TP), 10% (5%MP + 5%TP), 15% (7.5%MP + 7.5%TP), and 20% (10%MP + 10%TP) by weight. A total of 60 concrete cylinders were cast with 0.45 water/cement ratio, 1:1.96:2.14 mix ratio, and were cured for 7 and 28 days.

H. Hebhoub. Et.al (2011) Today 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.

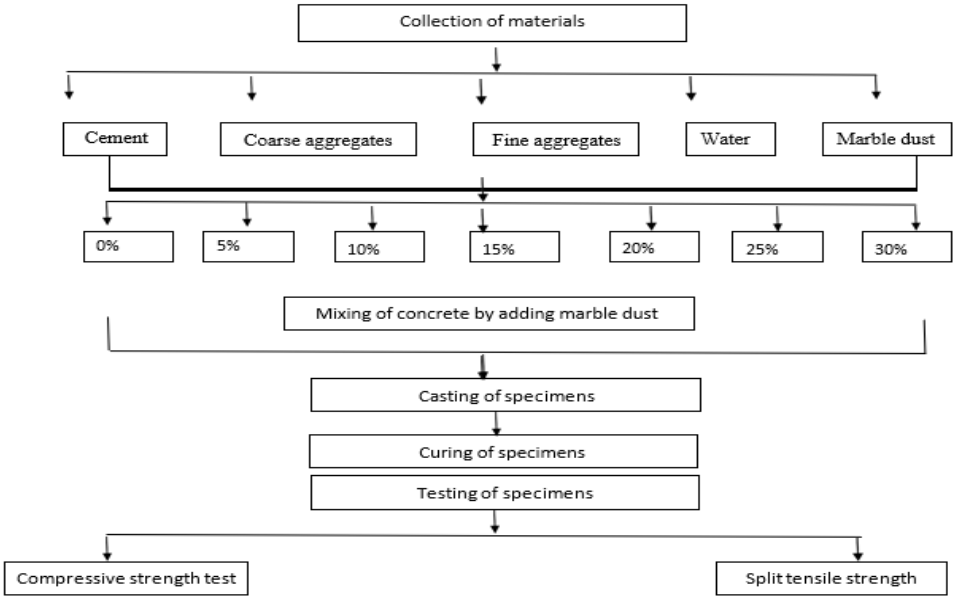
Ali A Aliabdo et al. (2013) In this research waste marble dust was utilized in cement and concrete production. Marble dust up to 15% as cement replacement has positive effects on steel concrete bond strength and maximum was at 10%. It was also observed that porosity also decreases with addition of marble dust in concrete. There was insignificant change in ultrasonic pulse velocity with use of marble dust in concrete.

A.D. Sakalkale et.al (2014) Concrete is the most important component used in the construction industry throughout the world, where the fine aggregate is generally natural sand. The use of sand in construction activities results in the excessive mining. Due to excessive mining, natural resources are getting exhausted, results in increase in scour depth and sometimes flood possibility.

Gopi R et al. (2017) In this paper marble powder was used as partial replacement for cement and checked for strength characteristics. It was observed that 15% replacement of cement by marble powder increases compactor factor. Even 15% replacement increases compressive, tensile strength by 14.53% and 14.25% respectively. Modulus of concrete also increases up to 7.1 % when they replaced by 15% of amount.

Bassam A. Tayeh (2018) In this research waste materials like glass, timber and marble powder used as partial replacement of cement in concrete and mechanical and physical properties were investigated. Researcher finds that workability decrease when we increase partial replacement of cement with these materials and optimum percentage is nearly strength of concrete is high when partially replaced by 10%. Use of these materials can diminish the utilization of concrete and the related vitality interest effect on air contamination and CO2 emission.

III.METHODOLOGY



3 MATERIALSANDTHEIRPROPERTIES

The Raw materials that are used in the production of concrete are mentioned below.

- Coarse aggregates
- Fine aggregates
- Cement
- Water
- Marble dust

3.2.1 COARSEAGGREGATE

The material whose particles are of size are retained on IS sieve of size 4.75mm is termed as coarse aggregate and containing only so much finer material as is permitted for the various types described in IS: 383-1970 is considered as coarse aggregate. Aggregates

are the major ingredients of concrete. They constitute 70-80% of the total volume, provide a rigid skeleton structure for concrete, and act as economical space fillers. Because at least three-quarters of the volume of the concrete is occupied by aggregate, it is not surprising that its quality is of considerable importance. The properties of aggregate greatly affect the durability and structural performance of concrete.

Table 3.1: Properties of coarse aggregates

S.NO	Property	values
1	Specific gravity	2.67
2	Fineness modulus	6.01
3	Nominal maximum size	20mm

3.2.2 Fine aggregate

The size of the fine aggregate is below 4.75mm. Fine aggregates can be natural or manufactured. The grade must be throughout the work. The moisture content or absorption characteristics must be closely monitored. The fine aggregate as shown in Figure 3.2 used is natural sand obtained from the river Godavari conforming to grading zone-II of Table3 of IS: 10262-2009. The results of various tests on fine aggregate are given in Table 3.2. The fine aggregate shall consist of natural sand or, subject to approval, other inert materials with similar characteristics, or combinations having hard, strong, durable particles.

Fine aggregates

IV. MIX DESIGN

INTRODUCTION

In this chapter concrete mix design calculations for M20 and M30 grade concrete in detail werepresented.

4.2 REQUIREMENTS OF CONCRESTE MIXDESIGN

The requirements which form the basis of selection and proportioning of mix ingredients are:

- The minimum compressive strength required from structural consideration
- The adequate workability necessary for full compaction with the compacting equipmentavailable.
- Maximum water-cement ratio to give adequate durability for the particular site conditions.
- Maximum cement content to avoid shrinkage cracking due to temperature cycle in massconcrete.

4.3 Factors to be considered for mix design

- The grade designation, (the characteristic strength requirement of concrete).
- The type of cement influences the rate of development of compressive strength of concrete.
- Maximum nominal size of aggregates to be used in concrete may be as large as possible within the limits prescribed by IS: 456-2000
- The cement content is to be limited from shrinkage, cracking and creep.

- The workability of concrete for satisfactory placing and compaction is related to the size, shape, quantity and spacing of reinforcement and technique used for transportation, placing and compaction.

4.4 Design of M20 Grade (conventional Concrete)

Stipulations for Proportioning

a)	Grade designation	: M20
b)	Type of cement	: OPC 53Grade
(Confirming IS: 12269 (1987))		
c)	Minimum Cement content	: 300 kg/m³
d)	Maximum nominal size of aggregate	: 20 mm
e)	Maximum water –cement ratio	: 0.55
f)	Workability	: 70 mm (slump)
g)	Exposure condition	: Moderate
h)	Method of concrete placing	: Non Pumpable
i)	Degree of supervision	: Good
j)	Type of aggregate	: Crushed angular aggregate
k)	Maximum cement content	: 450 kg/m^3

Test Data for Materials

a)	Cement used	: OPC 53 grade
b)	Specific gravity of cement	: 3.14
c)	Mineral admixture	: ----------
d)	Specific gravity of	
1)	Coarse aggregate	: 2.67
2)	Fine aggregate	: 2.60
se)Water absorption		
1)	Coarse aggregate	: 0.5%
2)	Fine aggregate	: 1.0%
e)	Free (Surface) moisture	
1)	Coarse aggregate	: NIL
2)	Fine aggregate	: NIL
f)	Sieve analysis	
Coarse aggregate		: 6.01
Fine aggregate ofIS: 383)		: 2.32 (Confirming to gradingZone II of Table 2

MIX CALCULATIONS

The mix calculations per unit volume of concrete shall be as follows:

a) Volume of concrete = 1 m³

b) Volume of Cement = $\frac{\text{Mass of Cement}}{\text{Specific gravity of Cement}} \times \frac{1}{1000}$

= (367/3.14)X 1/1000 = 0.116 m^3

c) Volume of Water = $\frac{\text{Mass of water}}{\text{Specific gravity of Water}} \times \frac{1}{1000}$

= (161.67/1) X (1/1000) = 0.161 m^3

d) Volume of Admixture $\frac{\text{Mass of Admixture}}{\text{Specific gravity of Admixture}} \times \frac{1}{1000}$

= (7.34/1.145) X (1/1000) = 0.006m^3

e) Volume of all in aggregate = [a – (b + c+ d)]

= 1-(0.116+0.161+0.006) = 0.717 m^3

f) Mass of coarse aggregate = f × Volume of CA × Specific gravity of CA x1000

= 0.717× 0.632 × 2.67 × 1000 = 1209.89 kg

g) Mass of fine aggregate = f× Volume of FA× Specific gravity of FA × 1000

= 0.717 × 0.368× 2.60 × 1000 = 686.02kg

Mix Proportions 1 m^3 Concrete for Trail

Cement	= 367.00 kg/ m^3
Water	= 161.67litre
Fine aggregate:	= 686.02 kg
Coarse aggregate	= 1209.89 kg
Water Cement ratio	= 0.44

Water	Cement	Fine aggregate	Coarse aggregate
0.44	1	1.86	3.29

V. EXPERIMENTAL WORK

5.1 INTRODUCTION

In this chapter, concepts of experimental work are presented. Objective of testing, i.e. ordinary Portland cement, fine aggregate, coarse aggregate and marble dust is used in process of manufacturing of concrete, workability of fresh concrete and testing of hardened concrete procedures are explained in details.

5.2 OBJECTIVE OF TESTING

It was proposed to investigate the properties of concrete, cast with addition of marble dust at various percentages and cured. In this experimental work, Physical properties of materials used in the experimental work were determined. Grades of concrete M20 and M30 is mixed and cured. The specimens were cured for 7 and 28 days and tested for strength characteristics by using compressive strength, split tensile, flexural strength.

Table 5.1 Specimens casted to find mechanical properties

Specimen Cast	Specimen Size(mm)	**% of marble dust added**							
		M20&M30 GRADE							
		0	**5**	**10**	**15**	**20**	**25**	**30**	
		Days		Days		Days		Days	
		7	**28**	**7**	**28**	**7**	**28**	**7**	**28**
Cubes	150x150x150	3	3	3	3	3	3	3	3
Cylinders	150x300	3	3	3	3	3	3	3	3
Beams	150x150x500	3	3	3	3	3	3	3	3

VI . OBSERVATIONS AND DISCUSSIONS

6.1 INTRODUCTION

In this chapter, the experimental observations discussed are presented. Observations of slump in respect of fresh concrete are noted. The test results such as compressive strength, split tensile strength and flexural strength of hardened concrete of M20 & M30 grade replacement of cement with marble dust at various proportions mixes at the ages of 7 days, 28 days are detailed both exposure conditions**.**

6.2 SLUMP CONE TEST

The slump cone test was conducted for all the seven mixes for both M20 and M30 grades of marbledust mix. Slump for different mixes are shown in Table 6.1 and 6.2

Table 6.1 Slump Cone Results of Marble dust mix

S. No	**Mix**	**Slump (mm)**
1	Nominal Mix for M20 grade	100
2	Marble dust -5% for M20 grade	95
3	Marble dust -10% for M20 grade	90
4	Marble dust -15% for M20 grade	90
5	Marble dust -20% for M20 grade	85
6	Marble dust -25% for M20 grade	80
7	Marble dust -30% for M20 grade	70

VII.CONCLUSIONS

In this study series of the experiments have been conducted on concrete with the addition of marble dust as partial replacement of OPC. In this study marble dust was used as partial replacement of OPC at different percentages that is 0%, 5%, 10%, 15%,20%, 25%, and 30% of the dry weight of the cement. the experiments were conducted on M20 & M30 grade of concrete as per relevant IS-code practice based on the test results obtained from this study the following conclusion can be drawn.

- From the compressive strength test results for both concrete grades i.e. M20 & M30, it is found thatwith the addition of marble dust the strength is increased than the conventional concrete.
- There is strength reduction with the addition of more than 25% of marble dust due to the impuritiespresent in marble dust like free lime, loss on ignition and other raw minerals.
- However the strength attained with the mix of marble dust complies with the target strength up to areplacement of 25%.

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