Performance Study of Concrete with Marble Dust and Waste Foundry Sand as Partial Substitutes for Cement and Fine Aggregate

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ABSTRACT

In good concrete the ingredients must be of right proportioned, cohesive enough to be transported, placed in such a way that ingredients must not segregated from each other. Moreover the good concrete must be workable and can be compacted. In mixing of fresh concrete and in curing of hardened concrete water is necessary. To modify property of concrete some chemical & mineral admixture are used.

Also the emerging trends in engineering divert the interest of researchers towards the usage of waste material in concrete. Many of the waste materials are already in use such as fly ash, rice husk ash, silica fume and blast furnace slag. These materials are termed as supplementary cementitious materials as they are used as a partial replacement of concrete. But researches are still on-going on other waste materials for their use in concrete such as rubber tires, waste glass, egg shell etc. The present work is directed towards developing a better understanding on strengths characteristics of concrete using marble dust powder as a partial replacement of cement and waste foundry sand as a partial replacement of sand. Before further discussion, it shall be better to have a knowledge and clear understanding about the foundry sand and marble waste and their properties and performances.

Marble dust powder and foundry sand were used in proportion of 2.5 % and 5% replacement of cement and sand respectively. Optimum results were found at 2.5 % Mable dust and 2.5 % foundry sand combination use.

Keywords: *Fly Ash, Silica Fume, Compressive Strength,M25 Concrete, Flexural Strength, Split Tensile Strength, Concretecuring, Durability.*

I. INTRODUCTION

In good concrete the ingredients must be of right proportioned, cohesive enough to be transported, placed in such a way that ingredients must not segregated from each other. Moreover the good concrete must be workable and can be compacted. In mixing of fresh concrete and in curing of hardened concrete water is necessary. To modify property of concrete some chemical & mineral admixture are used.

Also the emerging trend in engineering diverts the interest of researchers towards the usage of waste material in concrete. Many of the waste materials are already in use such as fly ash, rice husk ash, silica fume and blast furnace slag. These materials are termed as supplementary cementitious materials as they are used as a partial replacement of concrete. But researches are still ongoing on other waste materials for their use in concrete such as rubber tires, waste glass, egg shell etc. The present work is directed towards developing a better understanding on strengths characteristics of concrete using marble dust powder as a partial replacement of cement and waste foundry sand as a partial replacement of sand. Before further discussion, it shall be better to have a knowledge and clear understanding about the foundry sand and marble waste and their properties and performances.

Marble dust powder

Now a day's marble waste is one of the causes of environmental problems around the world. Therefore, max. Utilization of marble waste in various industrial sectors, especially the construction, agriculture, glass and paper industries would help to protect the environment. Concrete is the most widely used construction material in the civil construction work because of its high structural strength and stability. Concrete is a heterogeneous mix of cement, aggregate (coarse and fine aggregate) and water. Now a days the cost of these materials are increased so, we need to

look at a the cost of building materials especially cement. One of the recent advancement in construction industry is replacement of materials in concrete. The replacement of materials offers cost reduction, energy way to reduce savings and protection of environment.

II. SCOPE

The present work concerns the investigation of strength property of concrete in corporation with waste foundry sand and marble dust powder .In particular, the performances of concrete at different percentage of waste foundry sand and marble dust powder as a partially replacement with sand and cement is investigated. The strength is measured by testing compressive test, split tensile and flexural test, workability test.

Scope of the Study

Marble dust powder at various rate on different properties and employments of marble dust powder sooner rather than later to make this a valuable building material to enhance the nature of building development industry. Different kind of study that can be in corporated with marble dust powder may be listed below.

- Marble dust is a brilliant material for concrete in building structure.
- The characteristics strength of concrete can be studied with marble dust and other type of by product.
- Earthquake effect on marble dust concrete structure.
- Further study on durability of marble dust concrete and Study of marble dust concrete varying water cement ratio.

Foundry sand is basically fine aggregate. It can be used in many of the same ways as natural or manufactured sands. This includes many civil engineering applications such as embankments, flow able fill, hot mix asphalt (HMA) and Portland cement concrete (PCC). Currently, approximately 500,000 to 700,000 tons of foundry sand are used annually in engineering applications. The largest volume of foundry sand is used in geotechnical applications, such as embankments, site development fills and road bases. The advantages of this study are :-

- To provide some information about the use of foundry sand
- Beneficial and Economical value to local people
- New attempt during the test and methods required to overcome the problems
- Have chances to explore the use of local waste material in steel industries

Summary

In this chapter scope of the study has been discussed. In next chapter available literature have been discussed.

III. LITERATURE REVIEW

Overview

There are many materials now a days available that can be added to concrete as a partial or full replacement of any of the basic component of concrete. we choose marble dust powder and waste foundry sand for our research work. We have gone through a series of available literature. It has been discussed below.

P.A. Shirule et al. (2012): In this paper the compressive strength and split tensile strength was measured and cement used is 53 grade. M20 grade with nominal mix 1:1.5:3 as per (IS 456-2000) was used and a water cement ratio of 0.5. Marble powder were added in concrete in step of 5% (0%, 5%, 10%, 15%, 20%). 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 10% use of marble waste in concrete there is 27.4% increase in initial compressive strength.

Hassan A. Mohamadien (2012): In this paper author studied in Replacement and addition ratio of both marble powder and silica fume with cement content separately at 0%, 5%, 10%, 15%, 20%, 30% and 50 % by weight were investigated. The mechanical properties of mortar were measured in terms of compressive strength was observed at 15% replacement ratio for each the marble powder and silica fume separately. Using marble powder up to 15% as an additive materials enhancement the compressive strength up to 31.5% The maximum value for compressive strength was obtained with the use of 15% silica fume as a partial replacement and the percentage of the increasing 48.3%.

Bouziani Tayeb et al.(2011): In this paper studies the effect of marble powder content (MP) on the properties of the sand concrete (SCSC) at fresh and hardened states. The experimental properties of the fresh prepared mixes tested

are the mini-slump flow, the V-funnel flow time and viscosity. At the hardened state in determined is the 28-day compressive strength. The effect of MP content on evolution in the mini-slump flow and the Funnel time flow are respectively illustrated. The increase of MP dosage in SCSC increases both of the mini-slump flow and the V funnel flow time and the positive effect of MP on the fluidity of SCSC The addition of MP to SCSC requires an increase in water/cement ratio, which leads to a decrease in compressive strength at 28 days.

IV. RESEARCH GAP

Available literature showing the studies similar to our proposed work have been studied and the research gap was obtained from the available literature. In this chapter the areas where proper information was not available have been discussed under research gap.

Research Gap

The following conclusions may be drawn from past experimental work.

- It is found that compressive strength of concrete mix is increases with increase in percentage of waste foundry sand as compare to regular concrete.
- There is an enhancement in the strengths for respective replacement of aggregate with incorporation of foundry sand with natural sand
- The failure modes are similar for both natural sand and foundry sand. The use of foundry sand for concrete works is demonstrated in compression, split tensile strength
- The flexural strength of concrete for M20, M30, M40 grades of concrete increases with addition of waste marble powder up to 15%replacement by weight of cement and furthers any addition of waste marble powder there was slight decrease in strength as compared to conventional concrete.
- the split tensile strength of concrete for M20, M30, M40 grades concrete, it is observed that the split tensile strength of concrete increased up to 10% replacement of cement by waste marble powder and decreased with further increase, this may be due to its filling effect and growth of hydration products in concrete.
- The workability for M20, M30, M40 grades of concrete increased with increase in % of waste marble powder up to 20% replacement by cement.

It has been found that there is no research done before on the combination of waste foundry sand and marble dust powder .so this present research will be using the both waste foundry sand and marble dust as a partial replacement of sand and cement in concrete. And investigate the strength properties of concrete in corporation with waste foundry sand and marble dust powder.

Summary

It has been found that there is no proper result on properties of concrete with plastic aggregates. every research shows different results and many researches are in different directions.

V. OBJECTIVE OF THE STUDY

Overview

The materials we are using for our research are waste materials but their chemical composition shows that they can be used to enhance the properties of the concrete. So it is up to us that how effectively we make use of these materials so that these materials can be used in service of mankind.

Objective of the study

The properties of concrete that can be modified using Plastic are its

a) compressive strength
b) split tensile strength
c) flexural strength

There are some other important properties of concrete will also be under consideration such as workability, compaction, bleeding and segregation of concrete.
So the objective of the study is to find the optimum quantity of the plastic aggregates that can be used in concrete.

VI. METHODOLOGY

Overview
The aim of this study to understand the effect of plastic coarse aggregates on properties of concrete. The literature available was studied and then experimental work was started. The various tests carried out on materials and concrete has been discussed. The research methodology adopted has also been discussed in this chapter.

Research methodology
The methodology adopted for this study is given below:

1. Literature study was done on the available data on use of marble dust and foundry sand in concrete.
2. Materials were collected.
3. Test related to properties of cement and aggregates were performed.
4. Proportion of different mixes was selected on the basis of available literature.
5. Mix design for different proportions of concrete was decided and tests were performed to obtain the mechanical properties of different mixes.

Table 1.1: Percentage use of marble dust and foundry sand

S. No.	Concrete Name	Natural Coarse Aggregates (NCA) %	Plastic Coarse Aggregates (PCA) %
1	M1	0	0
2	M2	2.5	2.5
3	M3	2.5	5
4	M4	5	2.5
5	M5	5	5

Fine aggregates
Locally available river sand was used asfine aggregates. It was available at nominal cost. Various test confirming to IS:383-1970 were performed. The physical properties and sieve analysis results are given in table 1.2 and table 1.3 respectively

Figure.1Fine aggregates

Table 1.2 physical properties of Fine aggregates

S. No.	Property	Value Obtained
1	Type	Natural River Sand
2	Specific Gravity	2.61

3	Fineness modulus	2.55
4	Grading Zone	III

Table 1.3Sieve Analysis of Fine Aggregates

S. No.	Sieve size	Material retained (grams)	Percentage retained	Percentage passing	Cumulative percentage
1	4.75 mm	5	0.50	99.50	0.50
2	2.36 mm	59	5.90	93.60	6.40
3	1.18 mm	136	13.60	80.00	20.00
4	600 microns	243	24.30	55.70	44.30
5	300 microns	415	41.50	14.20	85.80
6	150 microns	122	12.20	2.00	98.00
7	Pan	20	2.00		
					∑F=255.00

Fineness Modulus = $\frac{\sum F}{100} = \frac{255}{100} = 2.55$

Coarse Aggregates

Locally available crushed stone aggregates were used. Tests were performed as per IS:383-1970 for various properties of aggregates. 10mm and 20mm size of coarse aggregates were used. The various properties of Coarse Aggregates are given in table1.4

Figure.2 Coarse Aggregates

Table 1.4: physical Properties of Coarse aggregates

S No.	Property	Values Obtained
1	Maximum Size	20
2	Specific Gravity 10mm 20mm	 2.66 2.65
3	Total water absorption (%)	1.76

4	Fineness modulus 10mm 20mm	 6.11 6.99
5	Flakiness Index	8.8%
6	Elongation Index	28.4%
7	Aggregate Impact value	17.2%

Design Of Concrete Mix

Concrete mix is the way by which we choose the different constituents used in the concrete and deteremining their amount and by taking care about the economy and various properties of the concrete like workability, slump value , strength criteria etc. For designing the concrete mix we followed IS:10262-2009. A design mix for M25 grade od concrete was prepared and trial mixes were prepared to check the mix design and to adjust amount of admixture and

Water cement ratio. The following parameters were used for mix design

- Grade of concrete = M25
- Type of Cement = OPC-43 Grade
- Brand of Cemenat =ACC
- Admixture Used = RHEOPLAST SP-450
- Fine Aggregates =Zone III
- Specific Gravity of Cement = 3.16
- Specific gravity of FA = 2.61
- Specific Gravity of C.A
- 10mm = 2.66
- 20mm =2.65
- Moisture content of FA =4%

The design mix proportion adopted for M25 grade mix is given in table 1.5

Table 1.5 Mix Proportion for M25 grade Concrete

Unit of Batch	**Cement (Kg)**	**Fine Aggregates (Kg)**	**Coarse Aggregates(Kg)**		**Water (Kg)**	**Admixture**
			10mm	20mm		
Cubic meter content	320	608	512	768	124.8	3.2
Ratio	1	1.90	1.60	2.40	.39	0.01

Testing of Concrete

After casting, specimens were tested after 7, 14 and 28 days of curing. In this article, the procedure adopted for testing of specimens for various properties like compressive sterngth, split tensile strength and flexure strength have been discussed

Compressive Strength

To test the compressive strength of concrete, cube specimens were used. The test were performed according to IS 516-1959. The casted specimens were placed in curing tank. At the age of testing that is after 7, 14 and 28 days of curing, they were taken out of the tank and surface dried. They should be dried under shade not under direct sunlight or in oven. Specimens were then placed in Compression Testing Machine (CTM). The rate of loading was then set

at 140Kg/m3/minute or 5.2 KN per second. The load was applied and the peak load at which the apecimen fails was noted.
Compressive strength = P/A
Where, P = load in KN and A = Area of cross section

Figure.3 Setup for Compressive strength

Split Tensile Strength
The tensile strength is obatained by placing the cylinder in the CTM, so that the compressive force acts horizontally. The failure occurs along the vertical axis due to the tension developed in transverse direction. It was also tested for 7 days, 14 days and 28 days. The rate of loading was 2.1 KN per second.

The Split Tensile Strength can be calculated as

$$\sigma_c = \frac{2P}{\pi DL}$$

where, P = load in KN
D= diameter of cylinder
L= Length of cylinder
σ_t =split tensile strength of specimen in N/mm^2

Figure.4 Setup for Split Tensile Strength

Flexure Strength Test
The flexure strength test is obtained for the beams. The beams were placed in CTM, but the arrangement for that is different. Additional setups were installed in the CTM. it includes 4 point load setup, two at bottom side and two at upper side. The rate of loading was 0.1 KN/second.
The flexure strength of the beam can be determined by using formulae,

$\sigma_c = \frac{3PL}{4bd^2}$} if crack occurs at the middle third span of the beam, or

$\sigma_c = \frac{3Pa}{4bd^2}$} if the crack occurs at the outer third span of the beam

Where, P = load in KN, L= length of the specimen
b= width of specimen, d= depth of specimen, and
a = distance between crack and the nearest support

Figure.5 Flexure Strength Test

VII. RESULTS AND DISCUSSION

Slump Test

Slump test was performed on freshly prepared concrete mixes to check the workability of concrete. Workability of concrete is defined as the ease to do work with it, without segregation. Workability of concrete is an important property of fresh concrete. Concrete should have good workability.

The concrete prepared for testing its mechanical properties was tested for its workability by Slump Test. The following apparatus was used for slump test:

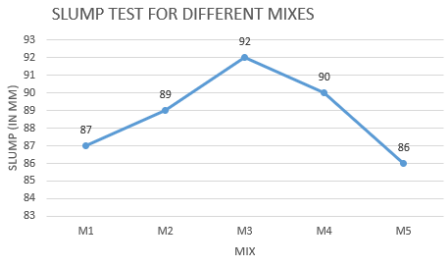
Mould: The frustum of a cone with following dimensions was used.

Height = 300mm
Bottom diameter = 200mm
Top diameter = 100mm

Table 1.6Slump test values for different mixes

S No.	Mix	Slump Value
1	M1	87
2	M2	89
3	M3	92
4	M4	90
5	M5	86

The result of slump test shows that there was firstly increase in slump upto 5% addition of plastic and then it start decreasing



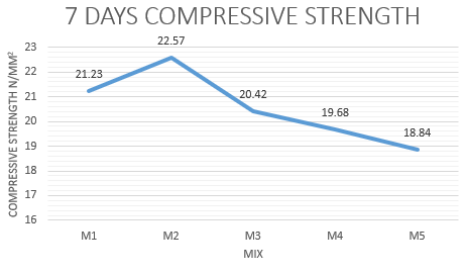
Compressive Strength Test

It is a test conducted on hardened concrete, to check the strength of concrete. The concrete specimens were put under the load per unit area of cross section in uniaxial compression under a fixed rate of loading. The compressive strength of concrete is expressed in N/mm2. We performed this test on standard cubes of size 150mmX150mmX150mm. Concrete mix with different proportions was prepared and filled into cube mould. It was then left for 24 hours for initial setting.

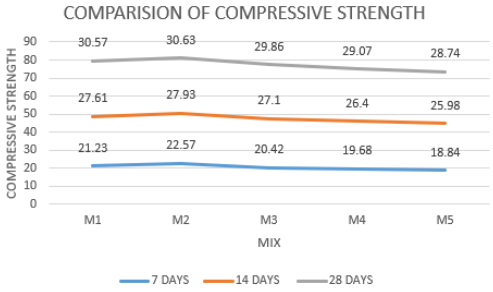
Table 1.7Compressive Strength Test

Mix Name	7 days strength (N/mm^2)	14 days strength (N/mm^2)	28 days strength (N/mm^2)
M1	21.23	27.61	30.57
M2	22.57	27.93	30.63
M3	20.42	27.1	29.86
M4	19.68	26.4	29.07
M5	18.84	25.98	28.74

Case I : Compressive strength after 7 days



Variation of compressive strength of concrete after 28 days



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