Experimental Approach on Strength Characteristics of Concrete on Partially Replacing Sand with Waste Foundry Sand and Cement with Marble Dust Powder

Rajni, Vipasha Rishi, Himanshu Guleria

Abstract: ***As the demand of concrete structures is more now days and to emphasizing the usage of eco-friendly materials in concrete, in this project the cement is partially replaced by marble dust powder and sand is partially replaced by waste foundry sand. The practical examination has been carried out in order to determine the strength characteristics of concrete. Moreover, the effect of replacing various percentages of marble dust powder and waste foundry sand on the compressive strength, splitting tensile strength (Indirect tensile strength) & flexural strength has been observed and compared with conventional concrete mix of M30. Marble dust powder and waste foundry sand (MDP 0%:WFS 10%),(MDP0%:WFS 10%),(MDP 10%:WFS 10%),(MDP 10%:WFS 15%),(MDP 15%:WFS 10%),(MDP 15%:WFS 15%) has been used as the partially replacement of cement and sand. As per the investigation, better results are at (MDP 10%: WFS 15%) for all cubes, cylinders and beams.***

Index Terms: Control mix (CC), Marble dust powder (MDP), Waste foundry sand (WFS), Tensile strength, Compressive strength, Flexural strength.

I. INTRODUCTION

GENERAL: The modernism of concrete technology can decrease the utilization of natural resources and energy sources. Economical and easily available waste materials are costless and widely available, which can be easily replaced by cement and sand in concrete. Marbles are mainly used in flooring purpose in building construction. A large amount of waste is produced during the working of processes like sawing, grinding and polishing. Hence marble is the better option of replacement with cement. This project explains the possibility of using the marble dust powder in concrete manufacturing as the partial replacement of cement. The sand which can no longer be reused is removed from the foundry and is termed as foundry sand. Because of high silica content and containing mostly natural sand material in it, it cannot be disposed of easily. Its properties are similar to the properties of natural or manufactured sand. So that waste foundry sand is being partially replaced with the normal sand.

II. MATERIALS AND METHODS

A. Marble Dust Powder

Marble dust powder is taken from the marble computing plants during the cutting, shaping, and polishing. Marble powder was collected from the Soami marble, Kharar. Sieved by IS-90 micron sieve before mixing in concrete.

Fig.1 Marble dust powder

Table 1 Physical properties of marble dust powder

Physical Characteristics	Value
Loss of ignition	43.63
Specific gravity	2.63
Fineness(kg/m^3)	350
Color	White
Water absorption	0.97%

Table 2 Chemical properties of marble dust powder

Chemical characteristics	Value
SiO_2	13.8
CaO	43.2
MgO	2.70
AI_2O_3	2.50
Fe_2O_3	1.9
SO_3	0.07
K_2O	0.60
Cl	0.03
Na_2O	0.90

B. Waste Foundry Sand

Waste foundry sand is obtained from bhopari metal industry. The physical and chemical properties of foundry sand used in this project are listed in Table 3 and Table 4 respectively.

Fig 2. Waste foundry sand

Table 3 Chemical properties waste foundry sand

Chemical Characteristics	Value
Silicon dioxide	87.91
Aluminum oxide	4.70
Ferric oxide	2.96
Calcium oxide	1.26
Magnesium oxide	1.15
Sodium oxide	0.97
Potassium oxide	0.65

Table 4 Physical properties of waste foundry sand

Characteristics	Value
Specific Gravity	3.15
Consistency	32%
Initial Setting Time	30 min
Final Setting Time	600

C. Cement

The Portland Pozzolona cement has been used. Physical properties of cement are shown in Table 5.

Table 5.Physical properties of cement

Characteristics	Value
Specific Gravity	3.15
Consistency	32%
Initial Setting Time	30 min
Final Setting Time	600

D. Fine Aggregates

Aggregates passing through 4.75mm IS Sieve & retained on 150 microns have been used. The specific gravity of fine aggregates found to be 2.72.

E. Coarse Aggregates

The aggregates are locally accessible. 50% are of 10-12 mm size and the remaining 50% are of 20mm size. The specific gravity of coarse aggregates found to be 2.72.

F. Water

Normal water available in the University has been used for concreting and curing, guidelines as per IS-456:2000

III. MIX DESIGN

In India generally, mix design is carried out using Indian standard codes IS 456-2000, & IS 10262-2009. In this dissertation work, M30 grade has been designed of 1: 1.92: 3.01 by volume and the water-cement ratio of 0.45 has been used.

IV. EXPERIMENTAL WORK

The size of moulds used for the cubes is (150x150x150) mm, 42 in number. Cylinders of 150mm height, 300mm diameter,42 in number and beams of (100x100x500)mm,42 in number. The final strength of cubes, cylinders, and beams has been tested after 7 and 28 days curing. Compression testing machine has been utilized for testing the compressive strength of cubes and split tensile strength of cylinders and the flexural testing machine has been used for finding the flexural strength of the beams.

V. RESULTS AND DISCUSSIONS

A. Compressive Strength of cubes

The specimens for the concrete cubes have been tested for 7 days & 28 days in order to determine the initial strength after 7 days and final strength after 28 days. The cubes are tested in the compression testing machine; the results are shown in Table.6

Table 6. Compressive strength test results

Percentage of marble dust powder and waste foundry sand	7 days Strength of cube (N/mm^2)	28 days strength of cube (N/mm^2)
CC 0%	22.89	34.26
0% MDP : 10% WFS	31.51	40.85
0% MDP : 15% WFS	30.49	41.08
10%MDP:10%WFS	32.56	42.58
10% MDP: 15% WFS	33.26	44.22
15% MDP: 10% WFS	32.11	42.56
15% MDP : 15% WFS	32.89	41.25

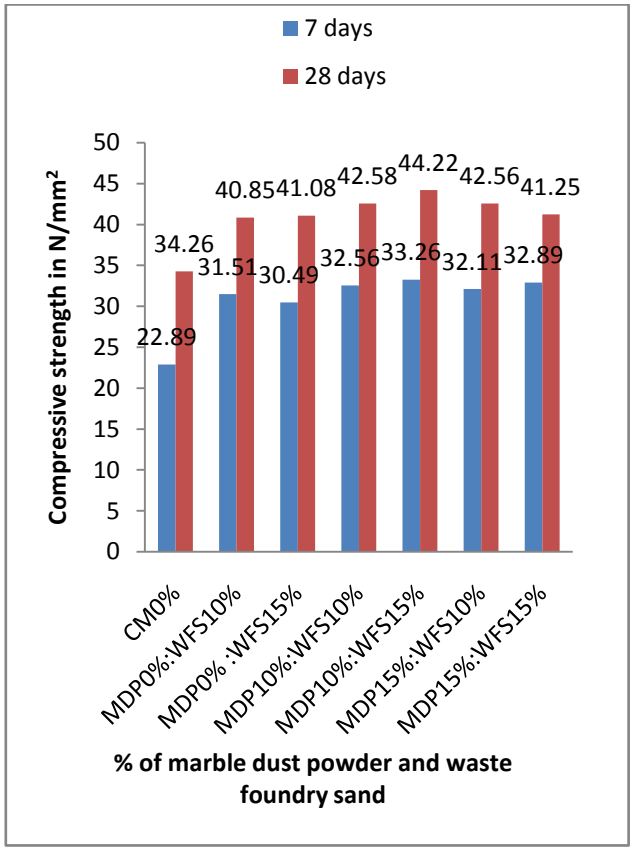

Fig. 3 Compressive strength of cubes

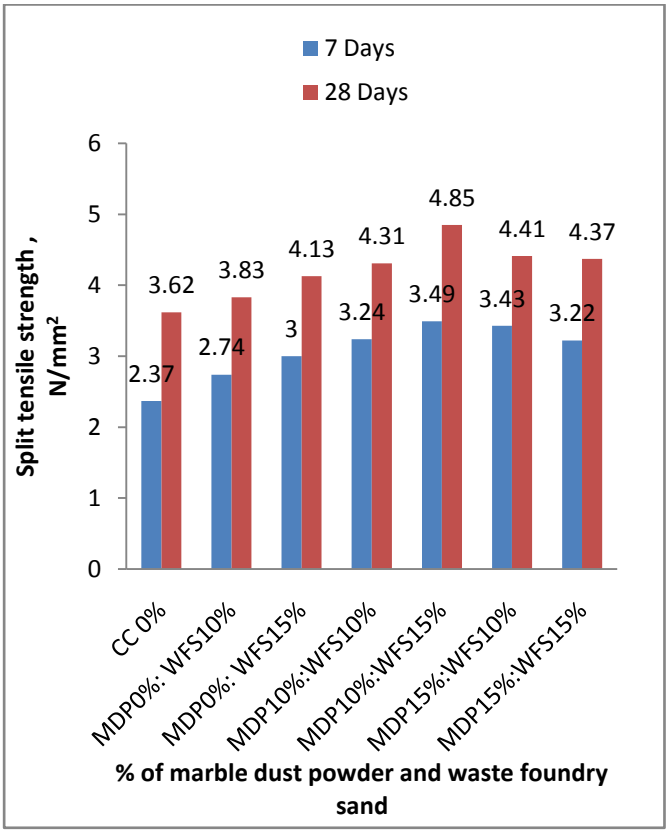

Fig. 4 Split tensile strength of cylinders

B. Split Tensile Strength

Total 42 cylinders have been tested in compression testing machine, the testing has been done for 7 and 28 days in order to find the split tensile strength of cylinders, and the results are shown in Table. 7

Table 7. Split Tensile Strength Test Results

Percentage of marble dust powder and waste foundry sand	7 days strength of Cylinders (N/mm^2)	28 days strength of Cylinders (N/mm^2)
CC 0 %	2.37	3.62
0% MDP : 10% WFS	2.74	3.83
0% MDP : 15% WFS	3.00	4.13
10% MDP: 10% WFS	3.24	4.31
10% MDP: 15% WFS	3.49	4.85
15 % MDP: 10% WFS	3.43	4.41
15% MDP : 15% WFS	3.22	4.37

C. Flexural strength

The beams have been tested for the flexural behavior of hardened concrete. The flexural strength for 7 and 28 days curing are shown Table.8

Table 8. Flexural strength Test of Beams

Percentage of marble dust powder and waste foundry sand	7 days strength of Beams (N/mm^2)	28 days strength of Beams (N/mm^2)
CC 0%	3.44	4.71
0% MDP : 10% WFS	3.47	4.48
0% MDP : 15% WFS	3.69	5.06
10%MDP : 10% WFS	3.79	4.86
10% MDP : 15%WFS	4.48	5.75
15 % MDP : 10%WFS	4.09	5.26
15% MDP : 15%WFS	4.00	5.12

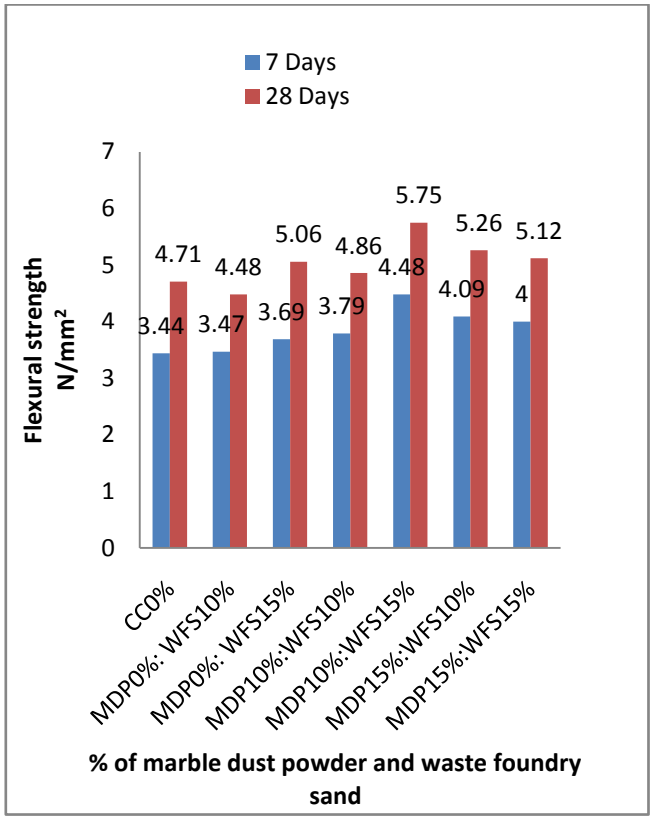

Fig. 5 Flexural strength of beams

VI. CONCLUSIONS

From the respective study following conclusion can be seen:

1. As per the investigation, better results are at (**MDP 10%: WFS 15%)** for all cubes, cylinders and beam.
2. The compressive strength of Concrete increases up to **(MDP 10%: WFS 15%)** and starts decreasing for the further % values.
3. The split tensile strength of concrete increases up to **(MDP10%: WFS15%)** and starts decreasing for the further % values.
4. The flexural strength increases up to **(MDP 10%: WFS 15%)** and starts decreasing for the further % values.
5. To save the environment, MDP and WFS may be used as a better partial substitute of cement and sand in concrete.
6. Waste foundry sand and marble dust waste both wastes can be effectively used in the concrete mix as an eco-friendly construction material.
7. The use of marble waste powder represents good performance due to proficient micro filling ability.

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