

EXPERIMENTAL STUDY ON MECHANICAL PROPERTIES OF CONCRETE CONTAINING MARBLE POWDER AS PARTIAL REPLACEMENT OF CEMENT AND GRANITE POWDER AS FINE AGGREGATE

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Abstract - The present article aims to study the effect of using marble powder and granite powder, resulting from ornamental stone industry, as cement and sand respectively replacement on the properties of fresh and hardened concrete mixes. In this research the experiment is done for M30 and M40 grade of concrete. Granite powder 0%, 10%, 15%, 20% and marble powder 10%, 15% replace with fine aggregate and cement respectively. The workability of fresh concrete mixes was determined by using slump test. Compressive strength and split tensile strength tests were conducted to evaluate hardened properties of concrete mixes for 7 and 28 days. Acid attack and Sulphate attack tests were conducted to evaluate durability properties for 56 days.

Key Words: Concrete, marble powder, granite powder, compressive strength, split tensile strength, durability tests, cement

1. INTRODUCTION

Concrete is mostly widely used man made construction material and it is largest production of all the materials used in construction industry. Concrete is made by cement, coarse aggregate, sand, water and sometimes with require admixtures. It is difficult to fully replace concrete with any other materials in construction field. The high utilities levels of the natural raw materials accompanied by vast expansion of the constructing and building projects in the new urban communities, led to the need to search for effective alternative solutions for the preserving of the natural low cost and nonrenewable resources in the same time. These alternative solutions are represented in the in the recycling of the industrial wastes such as ornamental stone industry wastes that are accumulated in considerable amounts with zero or low economic values. The Ordinary Portland Cement is one of the mainly significant and major ingredients used for the production of good quality concrete and has no choice in construction field. During the process of production of cement involves emission of huge amount of carbon dioxide gas into atmosphere which causes green house

and global warming effects. There are so many alternatives which partially replace with cement and showing good results like fly ash, red mud, rice husk ash, silica fume. Marble powder is a waste material which can also use in concrete to get the good strength.

The project aims to study of concrete properties by partial replace cement with marble powder and sand with granite powder.

Table - 1: Physical Properties of Cement

Physical value	Value
Colour	Gray
Specific gravity	3.15
Initial setting time	57
Final setting time	400

2. OBJECTIVES

- To find out optimum amount of marble powder as replacement of cement and granite powder as a replacement of fine aggregate.
- To find out mechanical properties of concrete prepared from partial replacement of cement by marble powder and fine aggregate by granite powder.
- To determine the durability properties of concrete which partial replacement of cement by marble powder and fine aggregate by granite powder.
- To compare all mechanical properties and durability properties with normal control mix and other mixes.

3. BACKGROUND LITERATURE

According to this paper “Effect of replacement of cement with marble dust powder on properties of concrete” by Sonu pal, Amit Singh, Prof N. kisku uses of various marble dust powder particles added in concrete 0% to 30% and three different water to binder ratios (0.5 constant). highest compressive strength and split tensile strength was reached with the replacement of 10%.

According to this research paper “Durability performance of structural concrete containing silica fumes and marble industry waste powder” by Ali Khodabakhshian, Mansour Ghalehnavi, Jorge de Brito. An experimental investigation of durability properties carried out on 16 different types of concrete mixes containing marble waste powder (MWP) and silica fume (SF) as partial replacement of ordinary portland cement. Compressive strength significantly increased when SF replace 10% with OPC. 5% replacement of cement with MWP led to an increased compressive strength about 4%.

According to this research paper “An investigation on effect of partial replacement of cement by waste marble slurry” by Manpreet Singh, Anshuman Srivastava, Dipendu Bhunia. An experimental study of waste marble slurry (WMS) as partial replacement of cement (0% to 25%). Marble slurry incorporated concrete shows increase mechanical properties at 15% replacement by weight of cement as compare to normal control mix.

4. MATERIAL

4.1 Cement

Most widely used cement in the world for production of concrete, mortar, stucco and nonspecialty grouts is Ordinary Portland Cement (OPC). Ordinary Portland cement available mainly three type grades based on its strength namely OPC 33, OPC 43 and OPC 53. A grade indicates the compressive strength achieved after 28 days of setting. OPC 53 grade of cement is used when we need higher strength concrete or mortar at economic condition.

4.2 Fine Aggregate

The particles which pass through 4.75 mm sieve and retained on 150 microns is particle is known as fine aggregate. River sand is use as fine aggregate in concrete. The fine aggregate is divided into four zones as per IS 383:1963.

4.3 Coarse Aggregate

In this work size of coarse aggregate is used up to 20 mm. This aggregate is important constitute of concrete. The larger size of coarse aggregate effects on the thickness of rib.

4.4 Marble powder and granite powder

The marble and granite both are building materials. Nowadays this stone is more and more use in building for elegance. This both materials prepared in stone industry plant. To give the better shape and size of marble and granite lots of waste generated. Sludge generated by sawing, cutting and polishing process of stone with water. The marble and granite sludge were collected on wet form from ornamental stone industry plants. This prepared grinding sludge is known as powder. Both marble and granite powder generated by this process. This both materials are by product of stone industry

5. EXPERIMENTAL STUDY

5.1 Mix design

Mix design was done for M40 High performance concrete as per Indian standard IS10262:2019. Initially all material test were done then mix design calculation prepare. After various mix proportion created then various mechanical and durability test conducted.

Table - 5.1: Mix Proportion for 1m³

Water	Cement	FA	CA	Total
197.16	492.90	688	1102	2480
0.40	1.00	1.40	2.24	5.04

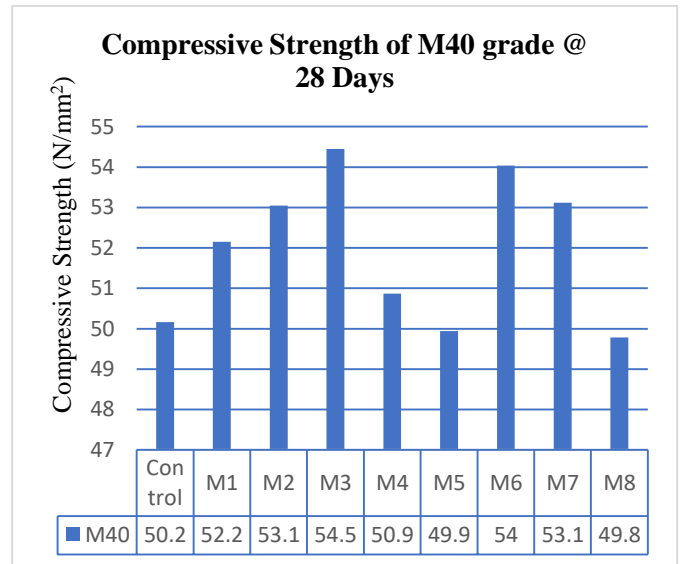
5.2 Testing of Specimens

Compressive strength was completed in accordance with IS 516-1959. The moulds of size having 150x150x150mm are used. Compaction is done either by mechanical vibrator or by hand tamping. Each layer of the concrete should be compacted well and the compaction should not be less than 35 strokes per layer using tamping rod then test at 7 and 28 days in universal testing machine. The determination of tensile strength can be done by split tensile strength test of concrete. This test was done as per IS 5816-1999. A cylindrical mould of having standard size of 300mm length and 150mm diameter is used for the test. Specimen tested at 28 days in universal testing machine. The flexure strength test is the optimal tool for calculating tensile strength. the standard size of beam specimen is 150x150x700mm and tested at 28 days in universal testing



Fig-5.1 Casting Process

15	10	54.04
15	15	53.12
15	20	49.78



Charts-6.1: Compressive Strength of Cube

6. TEST RESULT AND DISCUSSION

6.1 Compressive Strength Test:

The Compressive Strength Test is used to determine the concrete's compressive strength. It was completed in accordance with IS 516-1959. The moulds of size having 150x150x150mm are used.

The compressive strength can be calculated as per the following formula.

Compressive Strength (MPa) = (Failure load) / (c/s area of cube specimen)

Table-6.1: Compressive Strength for M40 grade High performance Concrete

Marble powder (%)	Granite powder (%)	Avg Strength at 28 days
0	00	50.16
10	00	52.15
10	10	53.05
10	15	54.45
10	20	50.87
15	00	49.94

6.2 Split Tensile Strength Test

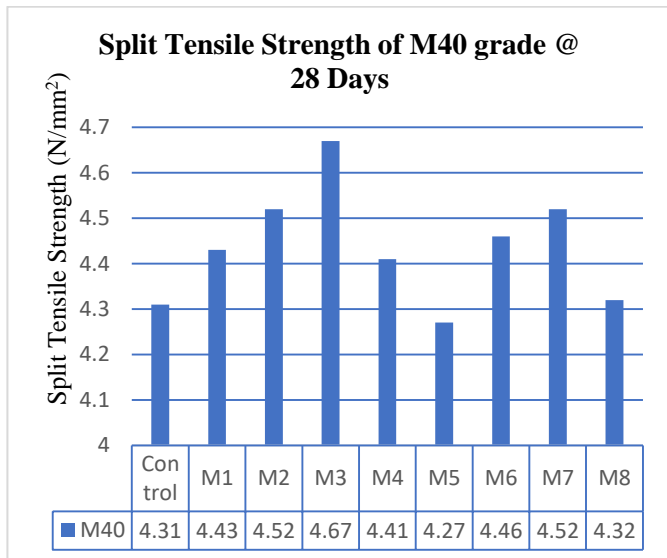
This test was done as per IS 5816-1999. A cylindrical mould of having standard size of 300mm length and 150mm diameter is used for the test. Specimen tested at 28 days in universal testing machine.

Table-6.2: Split Tensile Strength for M40 grade Concrete

Marble powder (%)	Granite powder (%)	Avg Strength at 28 days
0	00	4.31
10	00	4.43
10	10	4.52
10	15	4.67
10	20	4.41
15	00	4.27
15	10	4.46
15	15	4.52

15	20	4.32
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15	20	45.20
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Charts-6.2: Split Tensile Strength of Cylinder



Fig-6.1 Testing of Specimen

6.3 Acid attack and Sulphate attack test

The most significant characteristics of High-Performance Concrete are its superior toughness over standard concrete. The resistance of concrete to acid attack can be studied by determining the loss of compressive strength at 56 days or variation in compressive strength of concrete cubes after 28 days and at 56 days immersed in Hydrochloric acid (HCL) and for sulphate attack in (Na₂SO₄).

Table-6.3: Acid attack test

Marble powder (%)	Granite powder (%)	Compressive strength due to HCL (N/mm ²)
0	00	44.15
10	00	47.35
10	10	48.70
10	15	50.92
10	20	46.39
15	00	44.27
15	10	50.14
15	15	48.49

7.CONCLUSIONS

- The workability of concrete increase with the increase in Marble Powder and Granite Powder content M30 and M40 grade concrete. The workability reaches its maximum at 15% and 20% respectively replacement of marble powder and granite powder.
- The replacement of Ordinary Portland Cement by Marble Powder and Fine Aggregate by Granite Powder gave improvement in concrete properties such as Compressive Strength and Split Tensile Strength.
- Optimum replacement of Marble Powder and Granite Powder is 10% and 15% respectively as replacement of cement and fine aggregate for M30 and M40 grade concrete at 7 days and 28 days.
- The replacement of Ordinary Portland Cement by Marble Powder and Fine Aggregate by Granite Powder improves the durability against Acid Attack and Sulphate Attack.
- Concrete losses only 6.21% and 6.48% of its strength for M30 and M40 grade of concrete respectively compared 12.72% and 12% in normal concrete against acid attack when replacement of cement by 10% Marble Powder and Fine Aggregate by 15% Granite Powder.
- Concrete losses only 5.42% and 5.54% of its strength for M30 and M40 grade of concrete

respectively compared 9.08% and 9.20% in normal concrete against acid attack when replacement of cement by 10% Marble Powder and Fine Aggregate by 15% Granite Powder.

IS 2386:1963 method of test for aggregate for concrete

IS 516:1959 Methods of tests for strength of concrete

REFERENCES

[1] Abhishek Jain, Rajesh Gupta, Sandeep Chaudhary, "Performance of self-compacting concrete comprising granite cutting waste as fine aggregate" Construction and Building Materials Vol. 221 – 2019

[2] Ali Khodabakhshian, Mansour Ghalehnovi, Jorge de Brito Elyas Asadi Shamsabadi, "Durability performance of structural concrete containing silica fume and marble industry waste powder" Journal of Cleaner Production Vol. 170 – 2017

[3] B. Srinivasa Rao, G. Gowri Sankara Rao, "Experimental Studies on M20 Grade Concrete by Partial Replacement of Fine Aggregate with Granite Powder" International Journal of Recent Trends in Engineering & Research Vol. 4 – 2018

[4] Deepanshu Patel, Parin Bodiwala, Prof. Tejas Joshi, Dr. Urmil Dave, "To Study the Properties of Concrete as a Replacement of Cement with Marble Dust Powder" International Journal of Civil Engineering and Technology Vol. 7 – 2016

[5] Kalyani Gaddam, Lakshmi Adathodi, "Performance of Concrete with Waste Granite Powder" International Journal of Civil Engineering and Technology Vol. 10 – 2019

[6] Molakani Pavan Kumar, Smt. K. Chandrakala, "Characteristic Studies on Concrete by Partial Replacement of Fine Aggregate with Waste Granite Powder" International Journal of Engineering Research & Technology Vol. 8 – 2019

[7] P. Velumani, P. Manikandan, "Steel Mill Scale Waste and Granite Powder Waste in Concrete production – An Experimental Study" Materials Today: Proceedings – 2020

[8] Shehdeh Ghannam, Husam Najmb, Rosa Vasconez, "Experimental study of concrete made with granite and iron powders as partial replacement of sand" Sustainable Materials and Technologies – 2016

IS code:

IS 456:2000 plain and reinforced concrete

IS 10262:2019 concrete mix design procedure

IS 383:2016 Course and fine aggregate for concrete – specification required