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Difference between strength by Schmidt hammer test and destructive compressive test of concrete having partial replacement of sand by marble dust

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Abstract: *Concrete is a mixture of aggregate, cement and water and plays a dynamic role in infrastructure development. The problem we are facing is a growing demand for industrial production and an increase in the consumption of aggregates, which immediately led to a decrease and a lack of aggregates. This situation must show new specific options for researchers. Because of the large amount of marble is produced. During the formation, the marble is ground and marble dust is obtained as a by-product. This study focuses on the performance of marble dust as a partial substitute of sand in concrete mixtures. The purpose of this study was to study the effect of marble dust on the strength of concrete as a partial substitute for fine aggregate (sand) in concrete and also to study the difference in strength between the Schmidt hammer and the destructive test. Marble Concrete was obtained by replacement of marble dust with 5%, 10%, 15%, 20%, 25% and 30% to fine aggregates led to the formation of cylindrical concrete samples and finally compared to the control of cylindrical concrete samples. Cylindrical concrete samples were casted and cured and compression tests were performed for 14 and 28 days using the Schmidt hammer test and the destructive compression test using standard test procedure. The study shows that substitutes to marble powders of 5%, 10%, 15%, 20%, 25% and 30% as fine aggregates increase the compressive strength of normal concrete. The maximum value of this unit is 10% in 14 days and 10% in 28 days. By comparing the difference in strength between the Schmidt hammer test and the destructive compression test, the average strength difference between for 14 and 28 days was 17.2% and 14.9% respectively.*

Keywords: *Marble dust, Schmidt hammer test, Destructive compressive strength*

I. INTRODUCTION

Marble is produced in different countries of the world. In most countries, we produce enough marble to meet our needs. However, various classes of marble, design and quality make it possible to exchange national and continental exchanges. The marbles are mainly produced worldwide in Italy. It represents about 20% of the world marble production. After Italy's contribution, the world's second largest marble producer is the People's Republic of China, which accounts for 16% of world marble production. India was third in this game. It represents 10% of the total emissions in the world. The country is Spain. That part is 6%, which is more than the collective production in some countries. The production volume of these four countries is almost half of the world marble production. The remaining 50% is produced in other countries of the world. According to the U.S. The Geological Survey Institute, the national marble production decreased in 2006 compared to 2005. Currently, marble is used as a tile. Over time, people have learned countless ways to use natural resources. Progress in all areas and aspects of our lives have caused a series of problems. A problem is pollution. It affects not only our personal life but also the entire ecosystem [1].

Most factories cut water into rocks under the flow of water harmful to residents. It throws a heavy rejection in the form of white mud here and there. These technologies have not been developed and are not in use. This is one of the causes of soil contamination and the influence on agricultural products is more serious. It can be used aggressively in glass, in fertilizers, in the paper industry. Marble residues on marble ashes are also one of the environmental problems [2].

Limestone, 5%, 10% and 15% of substitute brown sands (fine aggregate) will examine the mechanical properties and distinguish the compressive strength of the concrete. In another study, granite and marble were used as recycled aggregates to study the strength, durability and freshness of concrete. The results show that also the mechanical properties increase, making the cement vital and chemically resistant [3].

Part of the marble dust is replaced by sand and cement. Or partially added to the concrete. With marble dust, on the other hand, maintaining a cement or a calculated mixture of sand, marble dust and different sand can provide up to 10% of compressive strength with similar operational performance [4].

The study concluded that marble dust tends to improve the physical and mechanical properties of ceramic tiles by adding 15-20% of red ceramic. In this study it was also found that it improves the performance of self-compacting sand by increasing the marble content from 155 kg / m 3 to 350 kg / m 3. The performance in the fresh state is increased by increasing the particles from 29 cm to 35 cm and released the flow time of the funnel V 6 seconds to 1.5 seconds. With the increase in wheat flour content, compressive strength decreased to 28 days [5].

Marble powder performance mixture I-cement and sound, insoluble residue, sulfuric Shiozan 渣, initial and final settling time, fineness and consistency remains within the allowed limits of different criteria. Replacing cement with marble powder or powder shows different mechanical properties. The marble powder cement was replaced while focusing on research. When using marble powder instead of 5% cement, the compressive strength is considerable. The compressive strength is decreased when using marble powder at 10%, 15%, 20% instead of cement. In addition, the use of marble powder instead of 5-15% and 20% cement, fits high standards of EN 197-1 makes 43.5 MPa and 33.5 MPa [6].

The waste sludge is 1% bent in concrete up to 9%. The concrete specimens were cast and compared with the concrete. The results show the maximum resistance to bending and compression when 6% of marble sludge is added. The marble sludge can be added up to 9% and it has been concluded that it can be used as an additive in concrete [6].

Experiments show that the use of marble powder instead of cement increases the compressive strength of the mortar mixture. The test result shows that 10% of marble cement exchange will be the highest level of pressure. A further increase indicates a reduction in compressive strength. As the setting time increases from 14 days to 28 days, the intensity increases significantly [7].

II. OBJECTIVES

i. To investigate the effects of marble powder on concrete strength when used in concrete as partial re-placement of fine aggregate (Sand).
ii. To differentiate strength between Schmidt hammer test and destructive compressive test of marble concrete.

III. METHODOLOGY

A. Concrete Ratio

All programs and methods used in this project, According to specific criteria. For the proportion of concrete, weight ratio of cement, sand or marble for gross aggregate 1: 2: 4. This ratio is based on the relationship between Pakistan concrete and the local average. The concrete cement-water ratio is 0.65.

Schmidt hammer tests and destructively compression test on samples were performed on days 14 and 28 with or without the addition of marble dust. All materials used in this project will be obtained locally.

B. Concrete specimens

For this work first of all cylindrical specimens were prepared. A mix proportion of 1:2:4 with 0.65 water cement ratio to differentiate the mechanical properties after adding marble dust was considered for this study. The exact quantity of materials for each mix was calculated. The constituent of materials used for making the concrete were tested before casting concrete. The cement, fine aggregate, coarse aggregate was tested prior to the experiments and checked for conformity with relevant ASTM standards. Concrete was mixed using a tilting type mixer and specimens were cast using steel molds, compacted with tamper rod.

Table-1: No. of concrete samples for testing

Marble Replacement (%)	14 Days test	28 Days test
0%	2	2
5%	2	2
10%	2	2
15%	2	2
20%	2	2
25%	2	2
30%	2	2

C. Mixing of Concrete

First of all, ordinate concrete was prepared using drum mixer.

D. Curing

The samples were removed from molds after 24 hours and kept in curing tank for 14 days and 28 respectively. All the test specimens were cured under room temperature of 20-25 C. The specimens were subjected to local environmental conditions. The drinking water was used for curing.

IV. EXPERIMENTS PERFORMED

a) Cement

Table-2: Cement tests

Test	Standard	Aim
Fineness	ASTM C184-94	Fineness of hydraulic
Consistency	ASTM C191-08	Amount of water required to prepare cement paste

b) Sand and Marble dust

Table-3: Sand and Marble dust tests

Test	Standard	AIM
Sieve Analysis	ASTM C-136-05	Find Fineness modulus of sand
Specific Gravity	ASTM D-854-10	Specific gravity of sand

c) Coarse Aggregate

Table-4: Tests on Coarse aggregates.

Test	Standard	Aim
Gradation Test	ASTM C-136-01	Gradation of coarse aggregate
Water Absorption	ASTM C-127-04	Water absorption of coarse aggregate
Specific Gravity	ASTM C-127-04	Specific gravity of coarse aggregate

d) Fresh Concrete Test

Slump Test*:* To determine workability of concrete, slump tests were performed on each batch of concrete according to ASTM C143 M03.

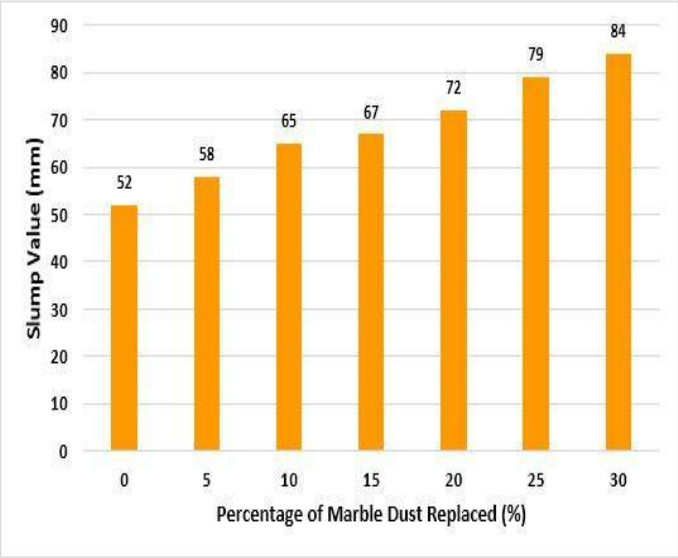

Figure-1: Concrete specimen cylinder under compression testing

e) Harden Concrete Test

i. *Destructive Compressive Test:* Destructive compressive test was performed on universal testing machine; the main aim of this test was to find compressive strength of concrete cylindrical samples. Procedure of test is performed according to ASTM C-39.

Figure-2: Concrete specimen cylinder under compression testing

ii. *Schmidt Hammer test:* It is also known as rebound hammer test. Schmidt hammer is a device used to check the compressive strength of hardened concrete. Schmidt hammer test is a non-destructive test usually perform on site.

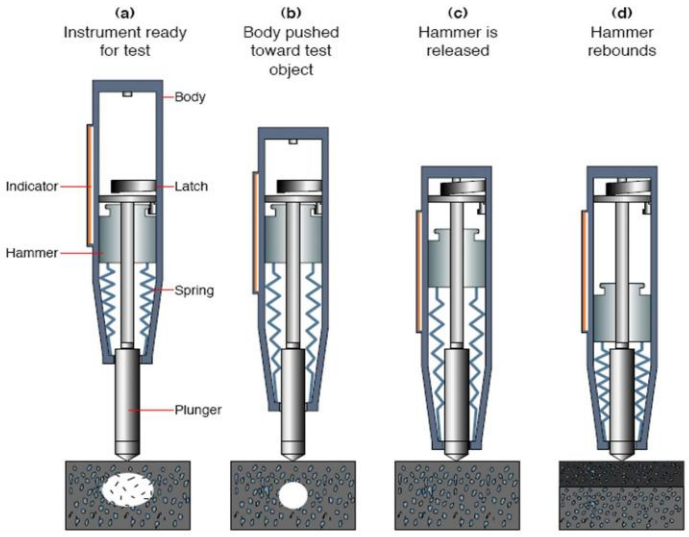

Figure-3: Schmidt Hammer Test

V. EXPERIMENTAL TESTS RESULTS

a. Destructive Compression Strength Result:

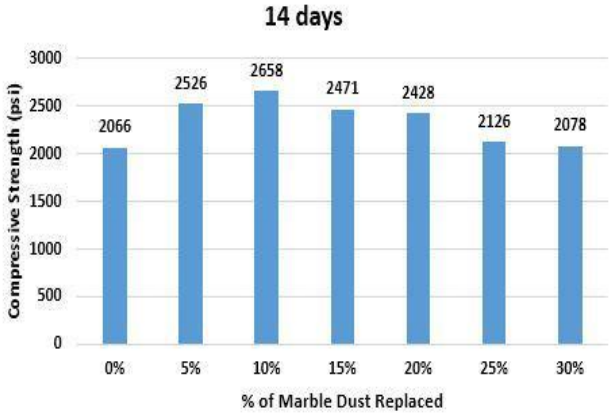

Figure-4: Compression strength result for 14 days conducted through universal testing machine

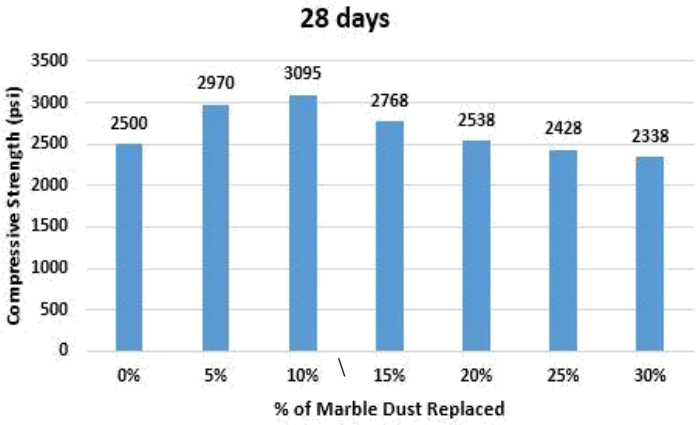

Figure-5: Compression strength result for 28 days conducted through universal testing machine

b. *Schmidt Hammer Test:*

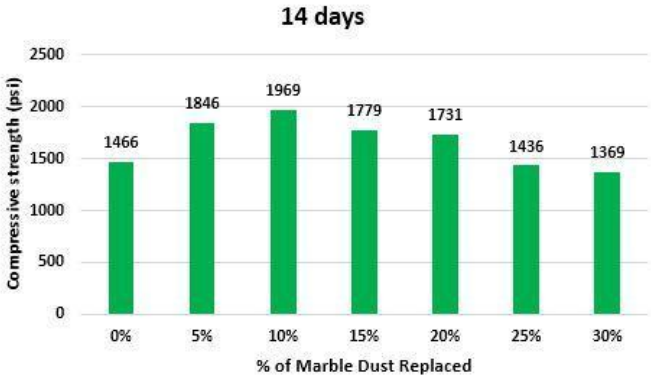

Figure-6: Schmidt hammer result for 14 days

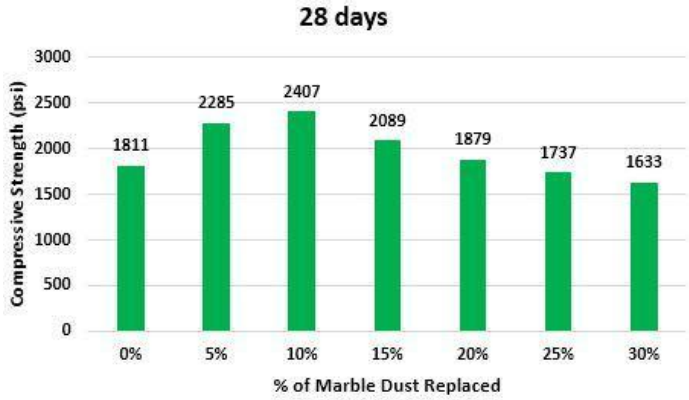

Figure-7: Schmidt hammer result for 14 days

VI. RELATION AMOUNG STRENGTH

Results studied shows that marble dust can be replaced up to 10%. Comparing 10% replacement strength with control concrete can be shown below:

A. *Destructive Compressive Strength*

1) 14 Days Strength:

Strength at 0% of marble = 2066 psi

Strength at 10% replacement of sand by marble = 2658 psi

Increase = (2658-2066/2066) * 100= 28.65%

Hence increase of strength of 10% replacement of sand by marble for 14 days by destructive compressive test =26.58%

2) 28 Days Strength:

Strength at 0% of marble = 2500 psi

Strength at 10% replacement of sand by marble = 3095 psi

Increase = (3095-2500/2500) * 100= 23.8%

Hence increase of strength of 10% replacement of sand by marble for 28 days by destructive compressive test =23.8%

B. *Schmidt Hammer Compressive Strength*

1) 14 Days Strength:

Strength at 0% of marble = 1466 psi

Strength at 10% replacement of sand by marble = 1969 psi

Increase = (1969-1466/1969) * 100= 34.3%

Hence increase of strength of 10% replacement of sand by marble for 14 days by Schmidt hammer test =26.58%

2) 28 Days Strength:

Strength at 0% of marble = 1811 psi

Strength at 10% replacement of sand by marble = 2407 psi

Increase = (2407-1811/2407) * 100= 32.9%

Hence increase of strength of 10% replacement of sand by marble for 28 days by Schmidt hammer test =32.9%

C. Difference Between Schmidt Hammer Test and Destructive Compressive Test of Marble Concrete:

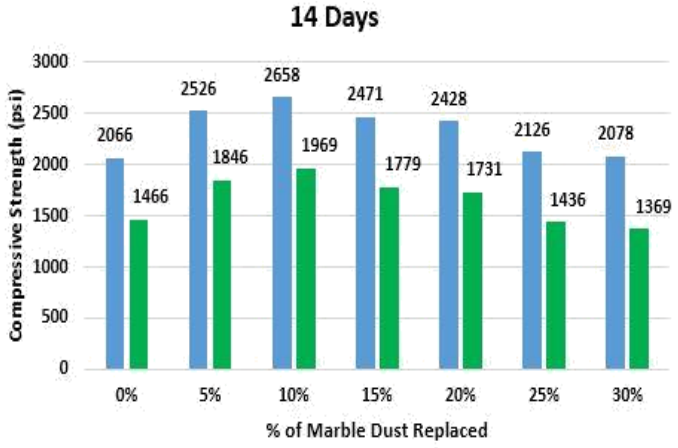

Figure-8: 14 days strength difference

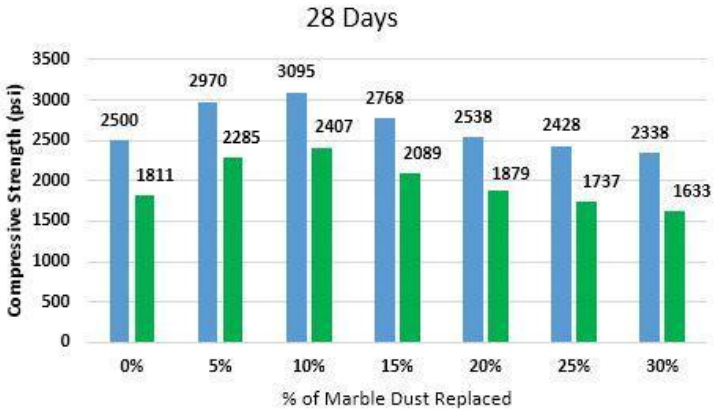

Figure-9: 28 days strength difference

VII. CONCLUSIONS

- The physical properties of marble dust were found suitable for its proposed use.
- Concrete with marble dust gives a good workability.
- Compression cylinders of 5%, 15%, 20%, 25% and 30% marble concrete tested after 14 and 28 days gives a considerable increase in strength against ordinary concrete.
- The peak value of strength by Schmidt hammer test and destructive compressive strength is on 10% Replacement at 14 days and 28 days period respectively.

The average strength difference between Schmidt hammer test and destructive compressive test is 17.20% and 14.97% at 14 and 28 days period respectively.

VIII. RECOMMENDATIONS

- Marble dust/powder in concrete can be used as a partial replacement of sand up to 10.
- There is average strength difference between Schmidt hammer test and destructive compressive test of marble concrete is 14%-17%.

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