

Influence of Marble Dust as Partial Replacement of Cement in Normal Curing Concrete

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Abstract— Marble stone industry generates both solid and stone slurry and as per previous survey solid waste generation is more in marble stone industry, in and about 40% of waste is formed, that is around 68 million tones .So by dumping these wastes to the land may cause environmental problem and also effect the fertility of the soil. Therefore the scientific and industrial community must take responsibility towards more sustainable practices. There are many reuse and recycling solutions for industrial bi-product both at an experimental and in practical application. The physical, chemical and mechanical properties of the waste are studied. In this present study, concrete mix was prepared according to IS 10262:2009 and experimental studies were carried out to investigate the strength properties of M30 concrete made with various mixes. Properties studied include compressive strength, flexural strength and split tensile tests of hardened concrete. Marble dust used was 0%, 5%,10%,15%,20%.And also strength will be compared with conventional concrete.

Keywords— Marble Dust (MD), Pozzolanic cement (PPC), Compression Test, Split Tensile Tests, Flexural Tests.

I. INTRODUCTION

A. General

Concrete is by far the most widely used construction material today. The versatility and flexibility in concrete, its high compressive strength and the discovery of the reinforcing and pre-stressing techniques which help to make up for its load tensile strength have contributed largely to its widespread use. We can rightly say we are in age of concrete. But nowadays due to rapid growth in construction cement is very costly. Also due to large growth in industrialization there is a large amount of wastes generated, which is hazardous to environment and living beings. To overcome above problems wastes generated can be used as alternative materials. Marble dust (MD) can be used as replacement for cement.

B. Marble Dust

About 68 million tons of marble solid dust is produced all over the world. It is the waste product formed in marble quarry and industries which may cause environmental pollution. And some of the chemical properties of marble dust are listed below.



Fig 1 Marble Dust

Table 1 Chemical Composition of Marble Dust

Test Conducted	Test Result
Silica SiO ₂	9.04
Alumina Al ₂ O ₃	0.88
Iron oxide Fe ₂ O ₃	0.86
Calcium oxide Cao	49.77
Magnesium	0.71

II. LITERATURE REVIEW

A. General

An attempt is made with marble dust as a partial replacement of cement in the concrete. The main aim of this study is to present an overview of research work carried out by various researchers in the field of marble dust and replacement of cement.

B. Study on concrete properties using marble dust as partial replacement cement and also other aggregates.

- Valeria Corinaldesi et al.(2005),has studied the characteristics of marble powder and found that marble powder showed a very high blaine fineness value of about 105m²/g with 90% of passing 50µm-sieve and 50% under 7µm.And several cement pastes were prepared using marble powder ,with and without adding any super plasticizers and by varying the water to cement ratio. And results shows that 10% of sand can be replaced by marble powder provided maximum compressive strength at about same workability [3].
- HanifiBinici et al.(2007), has studied some mechanical properties of concrete containing marble dusts and limestone dusts were investigated. This study says that marble dust and limestone dust has good workability and abrasion resistance is comparable to conventional concrete. Therefore, the studied Marble dust and Limestone dust used for more durable concrete production [2].
- M.Shahul.Hmeed et al.(2009), has studied that marble sludge and quarry rock dust showed improved pozzolanic reaction, micro-aggregates filling and concrete durability. This study says, the feasibility of the usage of quarry dust and marble sludge powder as hundred percent substitutes for natural sand concrete. And study also says that 14% strength has been increased than conventional concrete. Application of green concrete is an effective way to reduce environment pollution and improve durability of concrete under severe conditions [5].
- Fakher J (2009), has studied that producing eco blocks used in buildings from marble sludge through maximum possible substitution of sludge for sand and other components of the mixed materials used in block manufacturing was investigated. The experiments results and their theoretical interpretation show that suitable incorporation of marble sludge can result in building blocks can result in building blocks of 15cm with superior properties in terms of water absorption (7%. The compressive strength at age 28 days only reached (195.08KN or 7.8N/mm²)[4].
- Husam Al Hamaiedh (2010), has studied that ceramic industry is capable of incorporating and reusing different types of industrial waste products. Recently, the reuse of ornamental stone cutting sludge slime in this industry is becoming a common practice. This study investigates the changes in the physical and mechanical properties of the produced ceramic tiles from the raw materials containing marble sludge slime produced in the ornamental stone processing industry in Jordan. Here the partial replacement of kaolin, feldspar and CaCO₂ by sludge slime is done and results says that all the sludge slime can be consumed successfully in ceramic production, which would decrease the expensive management of the residues with landfill and preserve an equivalent amount of natural mineral resources (pentonite), thus increasing the environmental sustainability [1].

III.OBJECTIVES AND AIM

The main objectives of this investigation is an attempt to compare the strength parameters like compressive strength, split tensile strength, flexural strength of normally cured M30 grade of conventional concrete mix and also comparing properties of concrete produced by the partial replacement of cement by marble dust in four batches (i.e., 0 %, 5 %, 10 %, 15 %, 20 %) replacement both in fresh state and hardened state.

A. Aim of the work

- This study attempts to find the strength and optimum replacement of cement by Marble Dust.
- To determine the strength of concrete when marble dust is replaced with cement.
- And also strength and cost comparison between concrete with marble dust as cement replacement and conventional concrete.

IV.MATERIALS AND METHODS

A. Cement

In the present work PPC fly ash based cement is used throughout the work .Physical properties are as shown below.

Table 2 Physical properties of PPC

Characteristics	Obtained Value	Standard Value
Normal Consistency	33%	25% - 33%
Initial Setting	100min	Not less than 30 min.
Final Setting	220min	Not grater then 600 min.
Specific Gravity	3.00	3.15
Fineness	0%	Shall not exceed 10%

B. Fine Aggregates

The test were conducted as per IS 2386(Part 3): 1963, 4.75mm down size fine aggregates is used. Physical properties are shown below [6] [8].

Table 3 Physical Properties of Fine Aggregates

Characteristics	Obtained Value
Specific Gravity	2.7
Water Absorption	2.0%
Fineness Modulus	2.71
Grading	Zone II
Surface Moisture	Nil

C. Coarse Aggregates

The test were conducted as per IS 2386(part3):1963, 20mm and down size coarse aggregate is used. Physical properties are shown below [8].

Table 4 Physical properties of Coarse Aggregate

Characteristics	Obtained Value
Specific Gravity	2.7
Water Absorption	0.19%
Fineness Modulus	6.39
Surface Moisture	Nil

D. Marble Dust

It is waste dust obtained in marble industries and marble stone quarry. Physical properties like specific gravity 2.7 and Fineness 10%,pale white fine powdered appearance. Chemical properties obtained of marble dust are shown below.

Table 5 Chemical properties of Marble Dust

Test conducted	Test Results
Silica SiO ₂ (% by mass)	9.04
Alumina Al ₂ O ₃ (% by mass)	0.88
Iron oxide Fe ₂ O ₃ (% by mass)	0.86
Calcium oxide Cao(% by mass)	49.77
Magnesium by mass(% by mass)	0.71

E. Comparison of chemical properties of Pozzalona Portland cement and marble dust

The comparison between PPC and Marble Dust is shown in table below.

Table 6 Comparison of chemical properties of PPC and Marble Dust

Components	Cement	Marble Dust
Silica SiO ₂	17-25%	9.04
Alumina Al ₂ O ₂	4-8%	0.88
Iron OxideFe ₂ O ₃	0.5-0.6%	0.86
Calcium oxide Cao	61-63%	49.77
Magnesium	0.1-4.0%	0.71

F. Mix proportion

Mix design of concrete is done as per IS 10262:2009, shown in table 6. [7] [8] [11].

TABLE 7 MIX PROPORTION

Grade	Cement (kg/m ³)	Fine Aggregate (kg/m ³)	Coarse Aggregate (kg/m ³)	Water (lit./m ³)
M30	492.5	598.34	1103.8	197

G. Types of mixes

Table 8 Type of Mixes

Type of Mix	Description
CC	Conventional Concrete
MD1	Marble Dust 5%
MD2	Marble Dust 10%
MD3	Marble Dust 15%
MD4	Marble Dust 20%

V. TESTS CONDUCTED ON SPECIMENS

The testing will be done as per I.S Specifications.

- Compression Tests
- Split Tensile Tests
- Flexural Tests

The above tests are done for knowing the strength characteristics of concrete after 7 days and 28days. The table below shows results of 7days 28 days strength of specimens.

Table 9 Compressive strength of specimens

Type of Mix	7Days(N/MM ²)	28Days(N/MM ²)
Conventional Mix	30.9	42.5
Marble Dust (5%)	31.6	43.5
Marble Dust (10%)	34.9	46.22
Marble Dust (15%)	32.1	44
Marble Dust (20%)	27.1	35.46

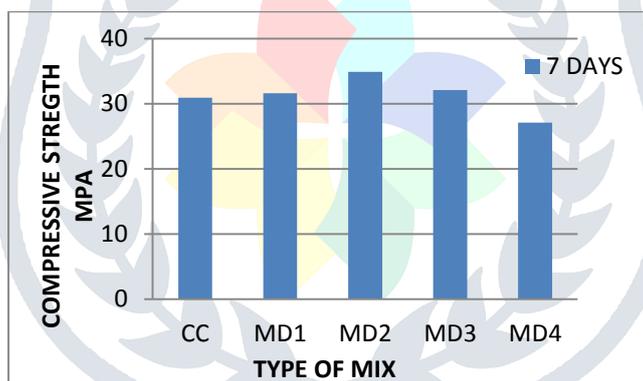


Fig 2 Compressive Strength for 7 days curing

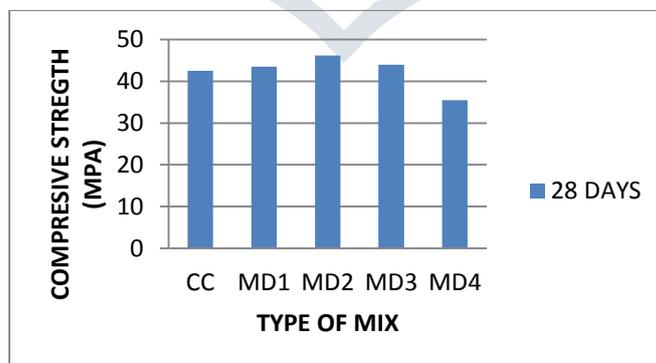


Fig 3 Split tensile strength for 28 days curing

The concrete mix is prepared for M30 grade and cement is replaced by marble dust as certain percentage. These are the graphs which shows the 7 days and 28days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete. However there is a decrease in compressive strength value concrete mix when 20% marble dust is used as compared with that of 15% marble dust.

Table 10 Split tensile test result of specimens

Type of Mix	7Days(N/MM ²)	28Days(N/MM ²)
Conventional Mix	2.54	3.43
Marble Dust (5%)	3.01	4.45
Marble Dust (10%)	3.11	4.74
Marble Dust (15%)	3.15	3.96
Marble Dust (20%)	2.64	2.83

The concrete mix is prepared for M30 grade and cement is replaced by marble dust as certain percentage. These are the graphs which shows the 7 days and 28 days strength of the concrete mix, graph also says, there is increase in strength as compared to conventional concrete. However there is a decrease in split tensile strength value concrete mix when 20% marble dust is used as compared with that of 15% marble dust.

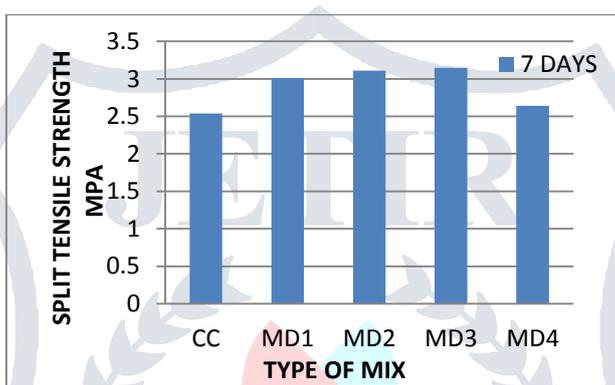


Fig 4 Split tensile strength for 7 days curing

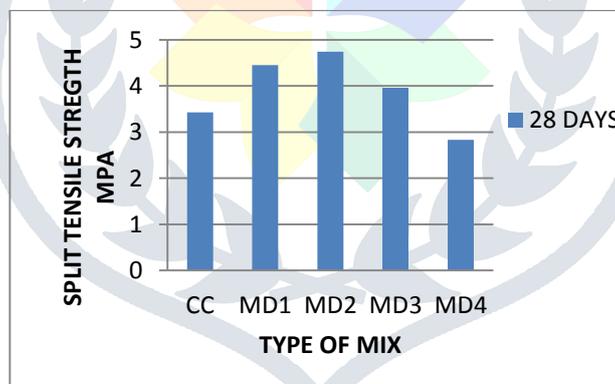


Fig 5 Split tensile strength for 28 days curing

Table 11 Flexural Stregth test results of specimens for 28 days curing

Type of mix	28 Days(N/MM ²)
Conventional Mix	3.60
Marble Dust (5%)	4.79
Marble Dust (10%)	5.18
Marble Dust (15%)	5.40
Marble Dust (20%)	4.70

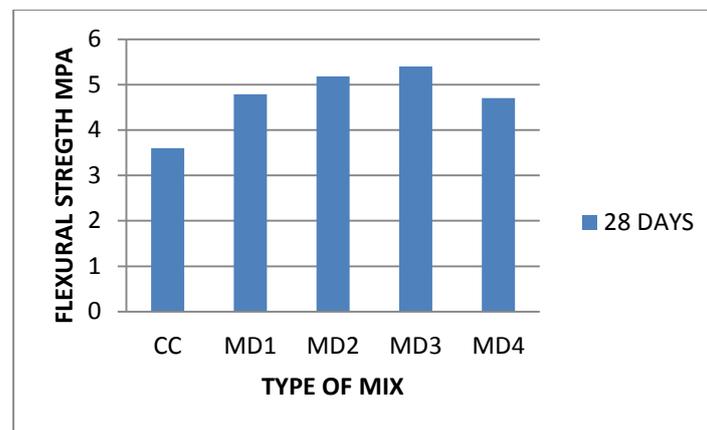


Fig 6 Flexural Strength of specimens for 28 days

VI. CONCLUSION

- In this study compressive strength of specimens is increased with addition of marble dust compared to conventional concrete up to 15%, and there is a sudden decrease in strength for 20% addition.
- The study says split tensile strength of specimens is increased with addition of marble dust compared to conventional concrete up to 15%, and there is a sudden decrease in strength for 20% addition.
- Flexural strength of specimens is increased with addition of marble dust up to 15%, as compared with conventional concrete and there is sudden decrease in strength after addition of 20% marble dust.
- However there is slight decrease in compressive and split tensile strength value concrete mix when 20% marble dust is used as compared with that of 15% marble dust.
- Thus we found out the optimum percentage for replacement of marble dust with cement is almost 15% of the total cement for cubes, beams and cylinders.
- We have put a simple step to minimize the costs for construction with use of waste material, which is freely and cheaply available.
- This study also has an aim of controlling the environmental pollution.

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