

# Study on Compressive Strength of Concrete with Dolomite Powder and Crushed Tiles

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**ABSTRACT:** Cement and coarse aggregate are two important constituents of concrete. Several studies were conducted to find an effective replacement for these raw materials of concrete with different goals such as reduced cost and high strength. Replacement of cement with a more environment friendly will help to reduce the emission of carbon dioxide gas into the atmosphere and using a waste material in place of coarse aggregate will help to reduce the environment pollution. This study aims to create a better concrete in low cost and is focused on the compressive strength of the concrete by partially replacing cement with dolomite powder and coarse aggregates with crushed tiles. The obtained results are analysed and the optimum mix with maximum strength is determined.

**KEYWORDS:** Dolomite powder, Crushed tiles, Compressive strength, Replacement, Cement, Coarse aggregates.

## I. INTRODUCTION

Global consumption of concrete has increased with the developments and innovations in the construction industry. Increase in the use of concrete has led to the scarcity of natural aggregates. The demand for aggregates in the construction industry can be met to some extent with the use of construction and demolition wastes. These wastes not only meet the scarcity of aggregates but also help to reduce the solid waste that is dumped into the environment. This paper examines the suitability of crushed pieces of waste ceramic tiles in the concrete mix partially replacing coarse aggregates. Waste ceramic tiles can be obtained free of cost and they are used to partially replace the coarse aggregates.

Cement is another major component of concrete. It is manufactured by calcining calcareous and argillaceous compounds at high temperature. Large amount of carbon dioxide gas is released into the atmosphere by this process. It was found that 0.8 tons of carbon dioxide gas is released into the atmosphere with the manufacture of 1 ton of cement. Dolomite is a carbonate material composed of calcium magnesium carbonate  $\text{CaMg}(\text{CO}_3)_2$ . Dolomite has good weathering resistance and is noted for its remarkable dispersibility and wettability. This paper examines the possibility of using dolomite powder as a partial replacement material to cement in the mix containing optimum amount of ceramic tile replacing coarse aggregates.

## II. RELATED WORK

**Preethi G, Prince Arulraj G (2015)** studied the effect of replacement of cement with dolomite powder on the mechanical properties of concrete. Replacement of cement with dolomite powder is found to improve the strength of concrete.

**Hemanth Kumar Ch, Ananda Ramakrishna K, Sateesh Babu K, Guravaiah T, Naveen N, JaniSk (2015)** studied the effect of waste ceramic tiles in partial replacement of coarse and fine aggregate of concrete. Study found that there are minor increases in workability when crushed tiles are replaced in place of coarse aggregate.

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**Amir Javed, Salman Siddique, Ram Prasad V S (2015)** did investigation on ceramic waste and stone dust as aggregate replacement in concrete. The optimum percentage for replacement of stone dust with fine aggregate along with 20% replacement of coarse aggregate by ceramic waste was found to be 40%.

**Umapathy U, Mala C, SivaK (2014)** did assessment of concrete strength using partial replacement of coarse aggregate for waste tiles and cement for rice husk ash in concrete. Study concluded that waste tiles can be used to replace some of the aggregates in a concrete mixture. This contributes to reducing the unit weight of the concrete. This is useful in applications requiring non-bearing light weight concrete, such as concrete panels used in facades, foot bath.

**S. DeepaBalakrishnan., and K. C. Paulose (2013)** studied the workability and strength characteristics of self-compacting concrete containing fly ash and dolomite powder. It has been observed that the use of fly ash in SCC mixes reduces the possibility of bleeding and segregation, and increases the filling and passing ability of concrete, whereas dolomite powder imparts viscosity to the concrete and improves the segregation resistance of the concrete mix.

### III. SCOPE

- To study the compressive strength development of concrete by replacing cement with dolomite powder and aggregates with crushed tiles.
- To find the optimum mix.
- Provide safeguard to the environment by utilizing waste properly and by reducing the emission of carbon dioxide gas into the atmosphere.

### IV. METHODOLOGY

#### Collection of raw materials

Cement, dolomite, fine aggregate, coarse aggregate, and crushed tiles were collected.

#### Testing of materials

Tests for fineness, consistency, specific gravity, initial and final setting time were conducted for cement and dolomite. Sieve analysis, specific gravity, moisture content and water absorption tests were conducted for fine aggregates. Sieve analysis, specific gravity, moisture content, water absorption, aggregate crushing value test and aggregate impact value test were conducted for coarse aggregates and crushed tiles.

#### Mix design

Mix design for M25 concrete is done and amount of materials needed for casting cubes are calculated. Mix proportion for varying percentages of dolomite and crushed tiles are fixed.

#### Specimen preparation

Cubes of size 150 x 150 x 150 mm were prepared and are placed in the curing tank for tests to be conducted after 7 and 28 days.

#### Testing of specimens

Cured specimens are tested for calculating compressive strength.

#### Data analysis and evaluation

From the values obtained from the tests, the optimum value of dolomite and crushed tiles that gave maximum strength is determined and the maximum value of compressive strength is noted.

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Table 1. Selected mix designs

Mix design	Description
M <sub>1</sub>	Conventional mix
M <sub>2</sub>	Concrete mix with 10% replacement of coarse aggregate with crushed ceramic tiles
M <sub>3</sub>	Concrete mix with 20% replacement of coarse aggregate with crushed ceramic tiles
M <sub>4</sub>	Concrete mix with 30% replacement of coarse aggregate with crushed ceramic tiles
M <sub>5</sub>	Concrete mix with 40% replacement of coarse aggregate with crushed ceramic tiles
M <sub>6</sub>	Concrete mix with optimum replacement of coarse aggregate with crushed ceramic tiles and addition of 5% dolomite replacing cement
M <sub>7</sub>	Concrete mix with optimum replacement of coarse aggregate with crushed ceramic tiles and addition of 10% dolomite replacing cement
M <sub>8</sub>	Concrete mix with optimum replacement of coarse aggregate with crushed ceramic tiles and addition of 15% dolomite replacing cement
M <sub>9</sub>	Concrete mix with optimum replacement of coarse aggregate with crushed ceramic tiles and addition of 20% dolomite replacing cement

M1 is the normal mix. M2, M3, M4 and M5 are the mixes containing crushed tiles. M6, M7, M8 and M9 are the mixes containing dolomite replacing cement in the optimum mix of tiles.

## V. MATERIAL PROPERTIES

Table 2. Material properties of cement used

Sl No:	Property	Value
1	Specific gravity	3.15
2	Fineness modulus	2%
3	Initial setting time	33 min.
4	Final setting time	360 min.
5	Consistency	30%

Specific gravity is defined as the “ratio between the weight of a given volume of cement and weight of an equal volume of water”. Specific gravity test is done with Le Chateliers flask. Fineness of cement is obtained by sieving it on standard sieve. Consistency, initial and final setting time of the cement is determined by using the Vicat apparatus.

Material properties of the fine aggregate are tabulated in Table 3. Fineness modulus is calculated from the sieve analysis, and specific gravity from the Pycnometer test. Moisture content is obtained by drying it in oven and water absorption is obtained by saturating it in water for 24 hours.

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Table 3. Material properties of fine aggregate used

SI No:	Property	Value
1	Fineness modulus	2.475
2	Specific gravity	2.5
3	Moisture content (%)	2.4
4	Water absorption (%)	2

Table 4. Material properties of coarse aggregate used

SI No:	Property	Value
1	Fineness modulus	4.76
2	Specific gravity	2.71
3	Moisture content (%)	0.23
4	Water absorption (%)	0.5
5	Crushing value (%)	33.14
6	Impact value (%)	20.58

Fineness modulus of coarse aggregates is calculated from the sieve analysis. Specific gravity test is done with a wire basket. Moisture content and water absorption test was done similar to fine aggregate. Crushing test was done on compression testing machine and impact value was determined by testing in an impact testing machine.

Table 5. Material properties of dolomite

SI No:	Property	Value
1	Specific gravity	2.65
2	Fineness modulus	6%
3	Initial setting time	5 min.
4	Consistency	28%

Table 6. Material properties of broken tiles

SI No:	Property	Value
1	Fineness modulus	3.94
2	Specific gravity	2.5
3	Water absorption (%)	0.7
4	Crushing value (%)	20.3
5	Impact value (%)	27.8

Table 5 and Table 6 shows the test results of dolomite and broken tiles. Tests on dolomite are similar to the tests on cement and tests conducted on broken tiles are same as the tests conducted on natural coarse aggregates.

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## VI. EXPERIMENTAL RESULTS

Compression tests were conducted on the M25 concrete cube specimens of size 150mm containing varying percentage crushed/broken tiles replacing coarse aggregate.

Table 7. Compressive strength values with crushed tiles

Mix	Compressive Strength (N/mm <sup>2</sup> )	
	7 day	28 day
M <sub>1</sub>	17.15	24.20
M <sub>2</sub>	19.40	26
M <sub>3</sub>	21.20	28.4
M <sub>4</sub>	25	33.50
M <sub>5</sub>	22.30	29.2

7 day and 28 day compressive strength of the specimens containing 0%, 10%, 20%, 30% and 40% of crushed tiles are shown in the Table 7. M1, M2, M3 and M4 indicates the mixes containing 0%, 10%, 20%, 30% and 40% crushed tiles replacing natural coarse aggregates.

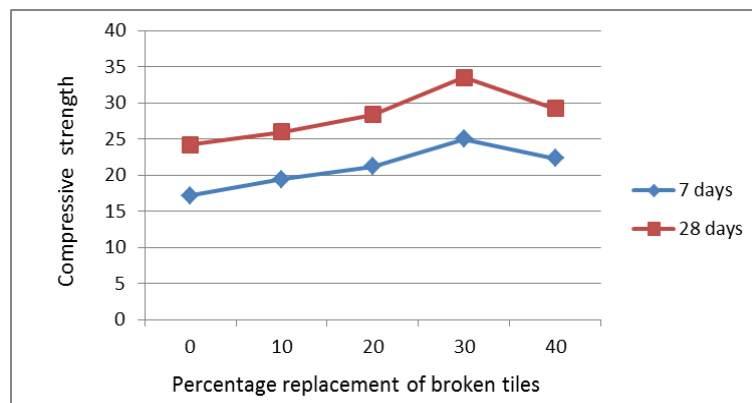


Fig 1. Compressive strength of broken tiles replacing coarse aggregates

From the results obtained it was found that the maximum value of strength was obtained for 30% tile replacing coarse aggregates (mix M<sub>4</sub>). In the mix M<sub>4</sub> cement was replaced with dolomite by 5%, 10%, 15%, and 20%. Table 8 shows the compressive strength of concrete with varying percentage of dolomite.

Table 8. Compressive strength

Mix	Compressive Strength (N/mm <sup>2</sup> )	
	7 day	28 day
M <sub>6</sub>	26.4	34.3
M <sub>7</sub>	27.54	35.0
M <sub>8</sub>	25.15	33.20
M <sub>9</sub>	22.6	30.50

7 day and 28 day compressive strength of the specimens containing 5%, 10%, 15% and 20% dolomite replacing cement are shown in the Table 8. M6, M7, M8 and M9 indicates the mixes containing 5%, 10%, 15%, and 20% of dolomite powder replacing cement in the M4 mix.

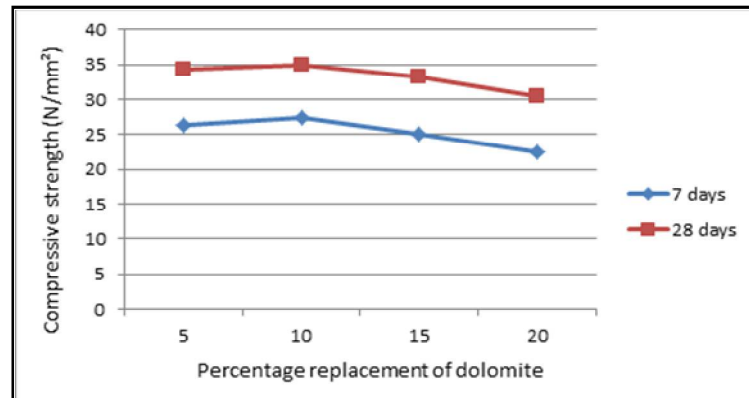


Fig 2. Compressive strength of dolomite replacing cement

From the Fig 2 it is clear that M7 mix containing 30% tile aggregate and 10 % dolomite gives greater strength as compared to other mixes. The maximum compressive strength of concrete containing 30% of tile aggregate and 10 % of dolomite was found to be 35 N/mm<sup>2</sup>.



Fig 3. Compression testing of cube specimen

## VII. CONCLUSION

- Replacement of cement with dolomite powder and coarse aggregate with crushed tiles improved the strength of concrete.
- The compressive strength of M25 grade concrete increased with the replacement of coarse aggregates with crushed tiles. The maximum strength is obtained with 30% crushed tile replacing coarse aggregates. The compressive strength is 33.50N/mm<sup>2</sup>.
- The cement in the mix containing 30% broken tiles was replaced with dolomite powder and the maximum strengths were obtained at 10% dolomite in place of cement. The 28 day compressive strength is 35 N/mm<sup>2</sup>.
- Low cost concrete is developed using waste ceramic tiles (obtained free of cost) and dolomite powder, which is obtained at half the price as that of cement.

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- With the reduction in the use of cement, the emission of greenhouse gas into the atmosphere from concrete can be reduced. Utilization of waste tiles reduces environmental pollution. Scarcity of the aggregates for construction can also be met by the use of waste tiles.

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