# Utilization of Waste Marble Dust and Granite Dust for Manufacture of Sustainable Concrete

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***Abstract*— The basic objective of this research was to identify alternative source of good quality aggregates. Marble and Granite are important materials used in construction industry. Marble dust is produced from processing plants during sawing and polishing of marble blocks and about 20-25% processed marble is turned into powered form. Granite dust is the stone waste generated from granite stone industries. Disposal of these wastes from the industries is one of the major environmental concerns worldwide. The present investigation was undertaken to study the effect of Marble dust and Granite dust on the mechanical properties of concrete. The main parameter investigated was the cube compressive strength. In this research, M-25 grade concrete mix was prepared using IS method of mix design. Cubic specimens of dimension (150 x 150 x 150) mm were casted for compressive strength test. Total of 24 cubes were casted, 6 specimens of nominal mix, 6 specimens with 20% marble inclusion, 6 specimens with 20% granite inclusion and 6 specimens with 10%-10% both marble and granite inclusion. Cubes were tested for 7 days and 28 days.**

***Keywords*—Marble dust, Granite dust, Cube Compressive Strength, Mix design, Compressive strength test.**

## I. INTRODUCTION

Rapid urbanization in developing countries such as India is creating a shortage of adequate housing in cities. Using artificial aggregates for quality concrete is a natural step to mitigate this problem. To overcome the stress and demand for river fine aggregate, research sand practitioners in the construction industries have identified some alternative materials such as fly ash, slag, limestone powder and siliceous stone powder. In India attempts have been made to replace river sand with Marble dust and Granite dust.
The successful utilization of Marble and Granite dust as fine aggregate would turn this waste materials that causes disposal problem into a valuable resource. This utilization will also reduce the strain on supply of natural fine aggregate, which will also reduce the cost of concrete. The main objective of this investigation was to evaluate the possibilities of using Marble and Granite dust as a replacement of fine aggregate. Present investigation was aimed to study the partial replacement of traditional Sand with Marble dust, Granite dust and both. Compressive strengths were found after 7 days and 28 days of curing.

## II. LITERATURE REVIEW

- Sakalkale et al. (2014) and Reddy et al. (2015) conducted strength tests by substituting Marble Dust indifferent proportions by weight of Sand (25%,50%, 75%,100%).The compressive strength of concrete was increased with addition of waste marble powder upto 50% and any further addition of waste marble powder decreases the compressive strength.
- Kalchuri et al. (2015) and Anwar et al. (2015) obtained the strength characteristics of concrete with and without Marble Dust in different proportions (0%, 10%, 20%, 30%, and 40%).The compressive strength of concrete is increased with addition of waste marble powder upto 20% by replacing Sand. Waste Marble Dust has cementitious properties and thus it can be used as a filler material. Sharma and Kumar (2015)
- Deepankar et al. (2013) used marble dust in M-30 concrete by partially replacing natural sand and cement in different proportions (0%, 10%, 15%, 20%, and 30%). Replacement of Sand by MD upto 15% increases Compressive strength but replacement of Cement by MD upto 15% decreases the strength. Durability of mix increases with reference to the control mix.
- Kumar and Rao (2017) used marble dust in M-25 concrete by partially replacing natural sand (0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, and 40%).They concluded that Sand can be replaced by MD upto 40% without affecting the target strength.
- Arivumangai et al. (2014) conducted a detailed experimental study on compressive strength by replacing sand by granite powder in 0, 25 and 50% and cement with silica fume, fly ash, slag and super plasticizer. He observed that granite powder concrete enhances the resistance and thus could improve the chemical resistance of concrete.
- Shehdeh et al. (2016) conducted an experimental investigation to explore the possibility of using the granite powder and iron powder as a partial replacement of sand in concrete. He concluded that granite powder and iron powder as partial replacement of sand showed good workability and fluidity similar to normal concrete mixes.

## III. PROPERTIES OF MATERIAL USED

### *A. Cement:*

Pozzolona Portland cement with conforming to BIS (IS: 455-1989) of grade 43 was used in the entire experimental study.

TABLE I
PHYSICAL PROPERTIES OF CEMENT

| Properties | Test Method | Results | IS code limits |
|---|---|---|---|
| Standard Consistency | Vicat Apparatus(IS:4031 Part 4) | 35% | |
| Soundness | Le-Chatlier method(IS:4031 Part 3) | 3mm | <10 mm |
| Initial Setting time | Vicat Apparatus(IS:4031 Part 5) | 32 min. | >30 minutes |
| Fineness | Sieve Test(IS:4031 Part 2) | 1.38% | <10% |

*B. Coarse Aggregate:*

Coarse Aggregate from Crushed Basalt rock confirming to BIS (IS 383:1970) was used in this experiment. The fractions from 20 mm to 10 mm were used.

TABLE III
PHYSICAL PROPERTIES OF COARSE AGGREGATE

| Properties | Test Method | Results | IS code limits |
|---|---|---|---|
| Fineness Modulus | Sieve Analysis (IS: 2386 Part 1) | 3.74% | 3.5% - 6.5% for all in aggregate |
| Aggregate Impact Value | Aggregate Impact Test (IS: 2386 Part 4) | 17.28% | <30% for wearing surfaces and < 45% for other than wearing surface |
| Aggregate Crushing Value | Aggregate Crushing Test (IS: 2386 Part 4) | 33.6% | <30% for wearing surfaces and <45% for other than wearing surface |
| Flakiness Index | Flakiness Index Test (IS: 2386 Part 1) | 3.47% | <30% |
| Elongation Index | Elongation Index Test ( IS: 2386 Part 1) | 13.21% | < 45% |

*C. Fine Aggregate:*

River Sand and Crushed sand were used in combination as fine aggregate confirming to BIS (IS 383:1970). The fractions from 4.75 mm to 150 micron were used.

*D. Marble Dust:*

India is the third top most exporter of marble in the world. Every year million tons of marble waste from processing plants are released during sawing and polishing of marble blocks and about 20-25% processed marble is turned into powered form. Locally available marble dust from Ashoka Marble Pvt. Ltd, Vishwakarma Industrial Area, Jaipur and M/S Khaitan Tiles Pvt. Ltd, Vishwakarma Industrial Area, Jaipur was used in this research project.

*E. Granite Dust:*

Indian Granite Stone industry produces around 17.8 million tons of solid granite wastes in form of cuttings, trimmings and granite slurry from processing and polishing units. Locally available marble dust from Ashoka Marble Pvt. Ltd, Vishwakarma Industrial Area, Jaipur and M/S Khaitan Tiles Pvt. Ltd, Vishwakarma Industrial Area, Jaipur was used in this research project.

*F. Admixture:*

Super plasticizer, *BS Futura PCX 107* was used in this project. It is a light brown liquid in ready to use form. It has to be introduced in the concrete mix along with the dosing water. It was obtained from Techno trade Associates, Lalkothi, Jaipur, Rajasthan.

TABLE VI
MIX PROPORTIONING OF DIFFERENT INGREDIENTS

| Parameter | Mix 0 (Conventional concrete) | Mix 1 (20% Marble Dust) | Mix 2 (20% Granite Dust) | Mix 3 (10% MD + 10% GD) |
|---|---|---|---|---|
| Cement (kg) | 7.4 | 7.4 | 7.4 | 7.4 |
| Sand (kg) | 18.2 | 14.6 | 14.6 | 14.6 |
| Aggregate (kg) | 22.3 | 22.3 | 22.3 | 22.3 |
| Water (kg) | 4.1 | 4.1 | 4.1 | 4.1 |
| w/c ratio | 0.5 | 0.5 | 0.5 | 0.5 |
| Admixture (g) | 59.2 | 59.2 | 59.2 | 59.2 |
| Marble dust (kg) | -- | 3.6 | -- | 1.8 |
| Granite Dust (kg) | -- | -- | 3.6 | 1.8 |

## IV. Test Performed on Concrete

Two tests were performed on the four types of concrete mix. Slump test was conducted for measurement of workability of concrete and compressive strength test was performed to determine compressive strength of the concrete mix.

### *A. Slump test:*

Slump test is used to determine the workability of fresh concrete as per BIS (IS: 1199).

TABLE VII
SLUMP VALUE

| Concrete Mix | Slump value (in mm) |
|---|---|
| Mix 0 (Conventional Mix) | 165 |
| Mix 1 (20% Marble Dust) | 60 |
| Mix 2 (20% Granite Dust) | 50 |
| Mix 3 (10% MD+10% GD) | 45 |

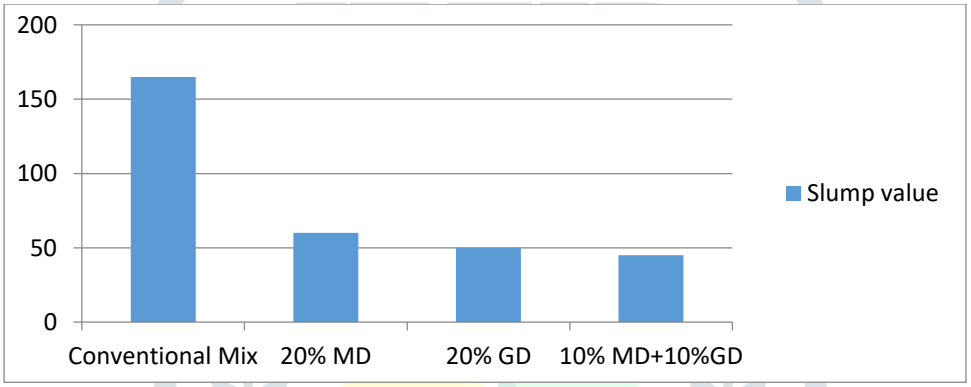


Fig. IBar Graph for Slump Value

### *B. Compressive Strength Test*

Compressive strength of concrete cube test provides an idea about all the characteristics of concrete in accordance with BIS (IS: 516).

TABLE VIII
COMPRESSIVE STRENGTH TEST RESULTS

| Concrete Mix | Average Compressive Strength (in N/mm$^2$) | |
|---|---|---|
| | 7 days | 28 days |
| Mix 0 (Conventional Mix) | 17.92 | 26.88 |
| Mix 1 (20% Marble Dust) | 20.59 | 30.36 |
| Mix 2 (20% Granite Dust) | 8.59 | 20.14 |
| Mix 3 (10% Marble Dust+10% Granite Dust) | 11.77 | 20.29 |

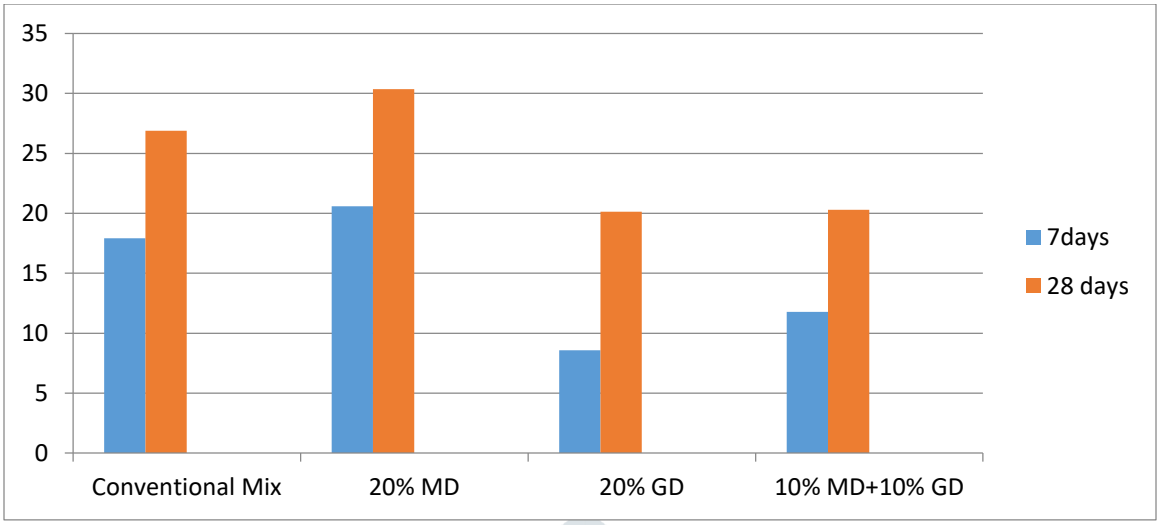


Fig. II Bar Graph for Compressive strength test results

## V. CONCLUSION

- In case of marble dust replacement, from the above investigation we conclude that at 20% inclusion of marble dust compressive strength of replaced concrete increases by 14.8 % at 7 day curing and 12.9% at 28 day curing.
- In case of granite dust replacement, from the above investigation we conclude that at 20% inclusion of granite dust compressive strength of replaced concrete decreases by 52% at 7 day curing and 25% at 28 day curing.
- In case of both marble and granite dust replacement, from the above investigation we conclude that at 10%+10% inclusion of both marble and granite dust compressive strength of replaced concrete decreases by 34.3% at 7 day curing and 24.5 % at 28 day curing.
- For granite dust replacement, from literature review we conclude that granite dust offers a considerable amount of increase in compressive strength when cement is also partially replaced with along with granite replacement. Only Granite replacement offers no such benefits.
- **The compressive strength of concrete increases when natural river sand is replaced with 20% Marble dust powder.**

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