

# Flexural Strength Improvement of M35 Grade Concrete Using 20% and 30% Partial Replacement of Fine Aggregate with Stone Crusher Dust

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**Abstract** - Concrete is widely used due to its strength and durability. Excessive extraction of river sand has led to environmental degradation and increased costs. This study investigates the flexural strength improvement of M35 grade concrete by partially replacing fine aggregate with 20% and 30% Stone Crusher Dust (SCD). Beam specimens were tested at 14 and 28 days. Results showed that 20% SCD replacement achieved the highest flexural strength of 5.07 N/mm<sup>2</sup> at 28 days, demonstrating improved mechanical performance and sustainability benefits.

**Keywords:** M35 Concrete, Stone Crusher Dust (SCD), Flexural Strength, Sustainable Construction, Partial Replacement

## 1. INTRODUCTION

Concrete is the most widely used construction material in the world. It mainly consists of cement, coarse aggregate, fine aggregate, and water. River sand is commonly used as fine aggregate but its excessive use causes scarcity and environmental damage. To overcome this issue, alternative materials are being explored. Stone Crusher Dust (SCD) is a by-product obtained during the crushing of stones in quarries. It has similar particle size properties to natural sand and can be used as a partial replacement. Replacing sand with SCD also helps in utilizing waste material effectively. M35 grade concrete is widely used in structural works like beams, slabs, and pavements. Flexural strength is a key property of concrete as it determines its performance in bending. This project studies the improvement in flexural strength of M35 concrete when 0%, 20%, and 30% of sand is replaced with stone crusher dust.

## 2. OBJECTIVES-

- To find the perfect amount of SCD that makes the concrete the strongest.
- To find properties of various ingredients to determine flexural strength of M35 grade of concrete
- To test the flexural strength of these concrete mixes after 14 and 28 days.

## Material Collection-

- **Cement:** Ordinary Portland Cement (OPC) 53 Grade, conforming to IS 12269:2013, used for high early strength.
- **Fine Aggregate (Sand):** Natural River sand passing through a 4.75 mm IS sieve.
- **Coarse Aggregate:** Crushed basalt stone of 20 mm nominal size, conforming to IS 383:2016.
- **Stone Crusher Dust (SCD):** Quarry waste by-product used as a partial replacement for fine aggregate.

## 3. TESTING -

Testing: The flexural strength (modulus of rupture) was tested using a Universal Testing Machine (UTM) via a 3-point loading setup. Load was applied gradually at a rate of 140 kg/sq.cm/min until failure.

## 4. PREPARATION AND TESTING-

### A. Preparation of Concrete (M35 Grade)

For this experiment, concrete of M35 grade was prepared by partially replacing fine aggregate (sand) with Stone Crusher Dust (SCD) at 20% and 30% levels.

Concrete beams of size 100 mm × 100 mm × 500 mm were cast for flexural strength testing.

Mix Proportion (M35 Grade – Nominal Design Example)  
 (Actual design may vary as per IS 10262)

Table 1.

Sr. No	Material	Quantity	Unit
1	Cement	14	kg/m <sup>3</sup>
2	Sand	22	kg/m <sup>3</sup>
3	Aggregate	36	kg/m <sup>3</sup>
4	Water	6	Liter
5	Stone Crusher Dust	16	kg/m <sup>3</sup>

### B. Casting Procedure

1. Materials were weighed accurately.
2. Dry mixing of cement, sand, stone crusher dust, and coarse aggregate was done.
3. Water was added gradually and mixed thoroughly.
4. Concrete was placed into beam moulds in three layers.
5. Each layer was compacted using a tamping rod or vibrating table.
6. Specimens were kept undisturbed for 24 hours.
7. After demoulding, beams were cured in water for 7 and 28 days.

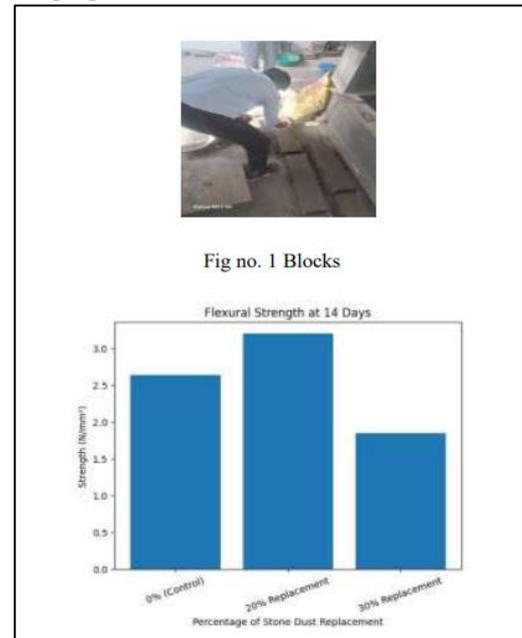
### Observation / Result –

The casted beams were tested, and the flexural strength was calculated based on the maximum load sustained before failure

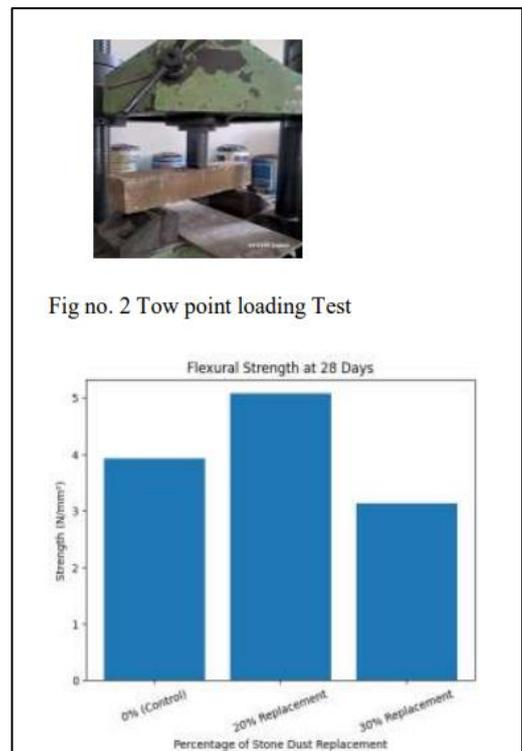
### Flexural Strength Test Results

% of Stone Dust Replacement	14 Days Strength (N/mm <sup>2</sup> )	28 Days Strength (N/mm <sup>2</sup> )
Control Mix (0%)	2.64	3.92
20% Replacement	3.20	5.07
30% Replacement	1.85	3.13

### Strength archive after 14 days curing of blocks for show in bellow graph –



### Strength archive after 28 days curing of blocks for show in bellow graph –



## 6.COST COMPARISON

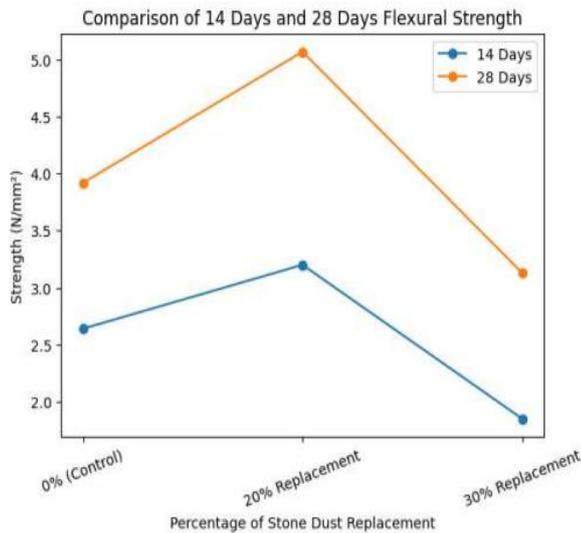


Fig no. 5 Result Comparison Graph

Figure 3. Result Comparison Graph

### Cost Comparison Result

Mix Type	Percentage Replacement	Cost (₹ / m³)
Control Mix	0% (Normal Concrete)	₹ 7800 /m³
Mix 1	20% Stone Dust	₹ 7500 /m³
Mix 2	30% Stone Dust	₹ 7300 /m³

### Observation:

#### Flexural Strength Observation (14 Days & 28 Days)

- Flexural strength increases from 14 days to 28 days for all mixes due to proper hydration of cement.
- The 20% stone dust replacement mix shows the highest flexural strength at both 14 and 28 days.
- The control mix (0%) gives moderate strength compared to replaced mixes.
- At 30% replacement, strength decreases compared to 20%, but it is still comparable to or slightly higher than control at 28 days.
- 20% replacement provides better particle packing and bonding between aggregates and cement paste.
- Excess replacement (30%) slightly reduces strength due to increased fines and reduced workability.

## 7.APPENDIX-

The materials used in this project were OPC 53 grade cement, natural river sand (Zone II), 20 mm coarse aggregate, stone crusher dust, and clean potable water.

Concrete of M35 grade was prepared for experimental study. Fine aggregate (sand) was partially replaced with stone crusher dust at 20% and 30%.

Concrete beams of size 100 mm × 100 mm × 500 mm were cast for flexural strength testing. Three specimens were prepared for each replacement level, including the control mix (0%), making a total of nine beams.

All specimens were cured in clean water for 14 days and 28 days before testing. Flexural strength was determined using a two-point loading test on a Universal Testing Machine (UTM) as per standard procedures.

The experimental results showed that flexural strength increased at 20% replacement and slightly decreased at 30% replacement compared to 20%, but remained comparable to the control mix.

### 8.CONFLICT OF INTEREST-

The authors declare that there is no conflict of interest regarding the publication of this project work.

The materials used in this study were collected from local sources, and no financial or commercial support influenced the experimental results.

All tests were conducted in the laboratory environment, and the conclusions are based purely on experimental observations and analysis.

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## 10. AUTHORS' BIOGRAPHY-

Professor, Mr. A. M. Kadam Department of Civil Engineering works as a faculty member in the Department of Civil Engineering. He or she has expertise in concrete technology, construction materials, and structural engineering. She has guided several undergraduate research and capstone projects and has a strong interest in sustainable and eco-friendly construction practices.

Rohan S. Kale is a student of Civil Engineering. His interests include concrete technology, sustainable construction materials, and environmental engineering. In this project, he actively contributed to mix design, specimen preparation, flexural strength testing, and data analysis for M35 grade concrete with stone crusher dust replacement.

Shreyash M. Patil is a student in Civil Engineering. His academic interests include structural engineering and innovative construction materials. He was involved in collecting materials, casting concrete cubes, the curing process, and laboratory testing during the project work.

Samruddhi S. Jadhav is a Civil Engineering student with a strong interest in sustainable construction and waste management. In this project, he contributed to experimental work, comparing results for 15%, 25%, and 35% replacement levels, and preparing technical documentation.

Omsuryoday S. Jangam is a student of Civil Engineering. His interests include building materials and construction technology. He participated in laboratory experiments, recording data, analyzing compressive strength results, and preparing reports for the project.

## 11. REFERENCES

References within Main Content of the Research Paper-

- [1] Sahu, A. K., Kumar, S., and Sachan, A. K. (2003). *Crushed Stone Waste as Fine Aggregate for Concrete*. Indian Concrete Journal. This study investigates the use of crusher dust as partial replacement of sand and reports improvement in strength due to better particle packing.
- [2] Ilangoana, R., Mahendrana, N., and Nagamanib, K. (2008). *Strength and Durability Properties of Concrete Containing Quarry Rock Dust as Fine Aggregate*. ARPN Journal of Engineering and Applied Sciences. This paper examines concrete with quarry dust replacement (10–40%) and shows improvement in compressive and flexural strength at optimum levels.
- [3] Hmaid Mir, A. (2015). *Improved Concrete Properties Using Quarry Dust as Replacement for Natural Sand*. International Journal of Civil Engineering and Technology. The research highlights improved mechanical properties including flexural strength when quarry dust replaces fine aggregate partially.
- [4] Lohani, T. K., Padhi, M., Dash, K. P., and Jena, S. (2012). *Optimum Utilization of Quarry Dust as Partial Replacement of Sand in Concrete*. International Journal of Applied Sciences and Engineering Research.
- [5] Shetty, M. S. (2012). *Concrete Technology – Theory and Practice*. S. Chand Publishing. This book provides detailed information about mix design, strength properties, and testing methods of concrete including flexural strength as per IS codes.
- [6] Bureau of Indian Standards (2000). *IS 456: Plain and Reinforced Concrete – Code of Practice*. BIS, New Delhi. This standard provides guidelines for concrete mix design, strength requirements, and durability criteria.
- [7] Bureau of Indian Standards (1959). *IS 516: Methods of Tests for Strength of Concrete*. BIS, New Delhi. This code specifies procedures for flexural strength testing using two-point loading method.
- [8] Karthick, R., and Prakash, M. (2017). *Experimental Study on Partial Replacement of Fine Aggregate with Stone Dust in Concrete*. International Journal of Research in Engineering and Technology. The study reports improved compressive and flexural strength at 20% stone dust replacement level.