IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 8, April 2025
Impact Factor: 7.67

Effect of Aggregate Sizes on the Compressive Strength of Concrete – A Case Study

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Abstract: *This paper presents a comparative case study on how aggregate size, shape, and gradation impact the compressive strength of M20 grade concrete. Concrete samples were cast using aggregates collected from three distinct project sites—Borgaon, Sakharale, and Islampur. Both field and laboratory casting methods were used. The samples underwent standard tests such as sieve analysis, silt content, flakiness, elongation, water absorption, and specific gravity evaluation. Additionally, cubes were cast using well-graded aggregates and chemical admixture (Dr. Fixit). Laboratory-prepared cubes consistently yielded higher strength compared to site-casted ones. The study underscores the importance of proper aggregate grading and standardized mixing and curing practices. Practical recommendations and awareness initiatives for local contractors are also proposed.*

Keywords: Concrete, Aggregate Size, Compressive Strength, M20 Grade, Admixture, Workability, Grading

I. INTRODUCTION

Concrete is one of the most widely used construction materials, and its performance is significantly influenced by the properties of its constituents, especially aggregates. Aggregates account for approximately 60–75% of concrete volume, making their shape, size, and grading critical factors in determining concrete strength and durability.

In rural and semi-urban areas, site practices often lack standardization. Improper aggregate selection, unscientific water-cement ratios, and inadequate compaction reduce the compressive strength of concrete, compromising structural safety. This study compares concrete cubes cast on- site with those prepared under standard lab conditions, using the same materials to isolate the influence of casting practices and aggregate quality.

Objectives:

- To study the standard procedure of M20 Grade Concrete Design.
- To investigate the impact of aggregate sizes on the compressive strength of concrete.
- To perform a comparative study between concrete blocks casted on-site and in the laboratory using the same materials.
- To create a detailed awareness video aimed at contractors and site workers about proper cube casting procedures, material selection, and the use of admixtures for better strength.

II. MATERIALS AND METHODS

Materials Used

- **Cement:** OPC 43 Grade
- **Fine Aggregates:** Crush sand (collected from 3 sites)
- **Coarse Aggregates:** 10 mm to 20 mm size range
- **Water:** Clean potable water
- **Admixture:** Dr. Fixit (improves workability and bonding)

DOI: 10.48175/IJARSCT-25555

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Testing of Aggregates

Test	Purpose	Standard
Sieve Analysis	Determine particle size distribution & fineness modulus	IS 383
Silt Content Test	Measure unwanted fines in fine aggregates	IS 2386 Part 2
Flakiness and Elongation	Evaluate shape of coarse aggregate	IS 2386 Part 1
Water Absorption & Gravity	Assess porosity and material density	IS 2386 Part 3

Mix Design and Casting

Mix Ratio: 1:1.5:3 (M20 grade)
Water-Cement Ratio: **0.5**
Cubes: 150 mm x 150 mm x 150 mm
Casting Sites:
Site 1 – Borgaon
Site 2 – Sakharale
Site 3 – Islampur
Samples:
9 site-casted cubes (3 per site)
9 lab-casted cubes (3 per site using same materials)
12 additional cubes for admixture and grading test

Images

Image [1]: Sieve Analysis Setup

Image [2]: Cube Casting at Site

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Image [3]: Cube Casting in Lab

Image [4]: Slump Cone Test

Image [5]: Curing of Specimens

III. RESULTS AND DISCUSSION

Aggregate Property Comparison

Location	FM (CA)	FM (FA)	Silt (%)	Specific Gravity (CA)	Flakiness (%)
Borgaon	2.81	3.97	6.9	2.50	13.75
Sakharale	2.97	3.95	5.7	2.79	9.35
Islampur	2.98	4.85	5.2	2.97	7.85

Interpretation: Islampur had the best-graded, cleanest aggregates with high specific gravity and ideal shape.

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Compressive Strength Comparison

Location	Condition	7-Day (MPa)	14-Day (MPa)	28-Day (MPa)
Borgaon	Site	6.52	8.72	5.01
	Lab	15.84	17.87	20.05
Sakharale	Site	13.04	15.23	18.72
	Lab	14.49	16.35	24.85
Islampur	Site	16.39	17.44	18.31
	Lab	15.26	20.27	20.92

Observation: Site-casted cubes underperformed due to improper compaction and curing. Lab cubes consistently exceeded M20 standards.

Effect of Grading + Admixture

Mix Type	7-Day Avg (MPa)	14-Day Avg (MPa)
Well-Graded (WG)	15.48	17.44
WG + Admixture	23.22	25.29
Normal + Admixture	17.98	23.54

Conclusion: Combining well-graded aggregates with admixtures gives the best strength and workability

IV. CONCLUSION

This research highlights the crucial role that aggregate size, grading, and preparation practices play in determining the compressive strength of concrete. Concrete made with well-graded, clean, and properly shaped aggregates consistently outperformed poorly graded materials.

The following conclusions were drawn:

• Laboratory-casted cubes achieved higher compressive strength than site-casted cubes due to better compaction, water-cement ratio control, and proper curing techniques.

• Islampur aggregates showed the best results in terms of fineness modulus, silt content, and shape—resulting in higher strength values.

• The use of Dr. Fixit admixture with well-graded aggregates significantly increased strength (up to 25.29 MPa at 14 days), showing the benefit of chemical enhancement.

• Borgaon site-casted cubes, which lacked proper handling and used suboptimal materials, failed to meet M20 standards, highlighting the risks of poor site practices.

• The study strongly recommends training programs for contractors and workers, especially in rural and semi-urban areas, to promote IS-code-based practices and improve structural reliability.

• Going forward, more attention should be paid to material selection, quality control, and on- site supervision to ensure that concrete structures meet both safety and durability standards.

ACKNOWLEDGEMENT

We take this opportunity to thank all those who have contributed to the successful completion of this major project work. We sincerely wish to express our gratitude to my major project guides Mr. K. P. Mali, for their full support, expert guidance, encouragement, and kind cooperation throughout the major project work. We are greatly indebted to him for guiding us throughout major project work.

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• Collected Data from Field Sites – Borgaon, Sakharale, Islampur (Experimental Sources).