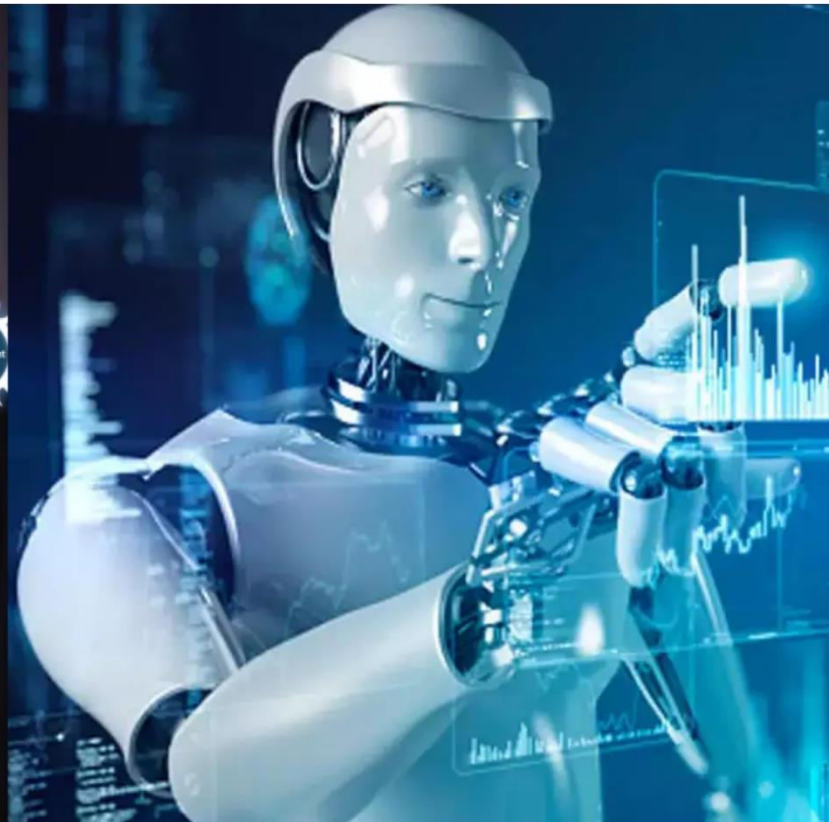




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# Experimental Investigation on Dunite Powder Concrete with Crimped Steel Fibers

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**ABSTRACT:** This experimental investigation evaluates the structural performance and durability of concrete enhanced with dunite powder and crimped steel fibers. Dunite powder is utilized as a partial replacement for fine aggregate to promote sustainable construction practices, while crimped steel fibers are incorporated to mitigate the inherent brittleness of traditional concrete. Standard concrete specimens were cast and subjected to rigorous mechanical testing, including compressive, flexural, and split tensile strength evaluations after 7 and 28 days of water curing. The synergistic effect of the ultra-fine dunite mineral filler and the mechanical anchoring of the wavy steel fibers significantly enhanced the microstructural packing and post-cracking ductility. Experimental results demonstrate a notable increase in energy absorption capacity, tensile resistance, and overall structural integrity compared to conventional control mixes. Ultimately, this study establishes a viable framework for producing high-performance, eco-friendly fiber-reinforced concrete using industrial mineral by-products.

**KEYWORDS:** Dunite Powder, Crimped Steel Fibers, Mechanical Strength, Ductility, Compressive strength and Split tensile strength.

## I. INTRODUCTION

Concrete remains the backbone of modern global infrastructure due to its excellent compressive strength, versatility, and cost-effectiveness. However, the construction industry faces growing pressure to improve its environmental sustainability and mitigate the material's inherent weakness in tension. To address these challenges, researchers are increasingly exploring the integration of industrial mineral by-products and fiber reinforcement. Dunite powder, a magnesium-rich silicate rock byproduct, serves as an eco-friendly micro-filler that optimizes particle packing, fills microscopic voids, and enhances concrete's durability and density. Concurrently, the inclusion of crimped steel fibers addresses the brittleness of the concrete matrix by bridging internal micro-cracks under stress. The unique wavy profile of these fibers provides superior mechanical anchoring, which drastically elevates the concrete's tensile resistance, ductility, and energy absorption capacity. Ultimately, combining dunite powder with crimped steel fibers offers a highly promising pathway toward developing a more sustainable, high-performance, and crack-resistant composite material.

## II. OBJECTIVES

1. To evaluate the effect of varying percentages of dunite powder as a partial fine aggregate replacement on the workability and mechanical strength properties (compressive, flexural, and split tensile) of concrete.
2. To investigate the synergistic impact of incorporating crimped steel fibers on the post-cracking behavior, ductility, and energy absorption capacity of the dunite-modified concrete matrix.

### III. MATERIALS

- **Cement:** A finely ground hydraulic mineral powder that acts as the primary binding agent in construction. When mixed with water, it undergoes a chemical hydration process to glue all the aggregate components into a solid, rock-like mass.
- **Fine Aggregate:** Small mineral particles, typically consisting of natural sand or crushed stone, that measure less than 4.75 mm in size. Their primary role is to fill the microscopic voids between larger stones, ensuring a dense and cohesive concrete mix.
- **Coarse Aggregate:** Larger structural components of concrete, such as gravel or crushed rock, that are generally greater than 4.75 mm in size. They form the robust skeleton of the mix, providing the fundamental bulk strength, stability, and wear resistance.
- **Water:** The crucial liquid chemical catalyst required to initiate and sustain the hydration process of the cement binder. It also provides the fluid workability necessary to properly mix, place, and compact the fresh concrete.
- **Dunite Powder:** An ultra-fine, magnesium-rich silicate rock powder used as a sustainable alternative or micro-filler in concrete. It optimizes particle packing at a microscopic level, densifying the internal matrix and enhancing overall durability.
- **Crimped Steel Fibers:** Short, wavy-profiled strands of high-tensile steel uniformly distributed throughout the concrete mixture. Their unique crimped shape provides mechanical anchoring within the hardened matrix, significantly increasing tensile strength, ductility, and crack resistance.

### IV. RESULTS AND DISCUSSIONS

a. **Compressive strength test:** 150 x 150 x 150 mm cube specimens were cast, and for varying concrete mix proportions, they were tested in a compression testing equipment for 7 and 28 days of curing time.

**Table 1:- Compressive Strength result of concrete with Dunite Powder with partial replacement of cement.**

S.No	% of Dunite Powder	Compressive Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	26.24	39.46
2	10%	27.28	40.25
3	20%	27.64	40.59
4	30%	29.49	42.19
5	40%	29.87	42.62
6	50%	28.16	40.82

**Table 2:- Compressive Strength result of Crimped Steel fibres in addition of concrete .**

S.No	% of Crimped Steel Fibres	Compressive Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	26.24	39.46
2	1%	26.57	40.03
3	2%	27.35	40.71
4	3%	28.95	41.43
5	4%	28.21	40.93

**Table 3:- Compressive Strength result of Crimped Steel fibres and Dunite Powder .**

S.No	Combined Replacment(s)	Compressive Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	26.24	39.46
2	40% DP+3%CSF	30.54	43.58

**b. Split tensile strength:** In this procedure, a standard cylindrical specimen measuring 300 mm in length and 150 mm in diameter is positioned horizontally between the loading platens of a Compression Testing Machine (CTM). A compressive load is applied diametrically and uniformly across the cylinder's length until it fails along its vertical diameter at 7 and 28 days.

**Table 4:- Split tensile Strength result of concrete with Dunite Powder with partial replacement of cement.**

S.No	% of Dunite Powder	Split tensile Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	2.52	3.84
2	10%	2.63	3.96
3	20%	2.71	4.01
4	30%	2.84	4.17
5	40%	3.07	4.33
6	50%	2.83	4.05

**Table 5:- Split tensile Strength result of Crimped Steel fibres in addition of concrete.**

S.No	% of Crimped Steel Fibres	Split tensile Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	2.52	3.84
2	1%	2.57	3.92
3	2%	2.62	3.99
4	3%	2.73	4.11
5	4%	2.66	4.05

**Table 6:- Split tensile Strength result of Crimped Steel fibres and Dunite Powder**

S.No	Combined Replacment(s)	Split tensile Strength Results, N/mm <sup>2</sup>	
		7 days	28 days
1	0%	2.52	3.84
2	40% DP+3%CSF	3.02	4.36

**C. Ultrasonic pulse velocity:** The testing apparatus consists of an electrical pulse generator, an amplifier, and a pair of transducers—a transmitter and a receiver—that are typically applied to opposite faces of a member for the most accurate "direct" transmission results. If only one face is accessible, indirect or surface transmission can be used, though it requires specific calibration.

**Table 7:- Ultra pulse velocity result of concrete with Dunite Powder with partial replacement of cement.**

S.No	% of Dunite Powder	Ultra pulse velocity Results m/s	
		28 days	Quality of concrete
1	0%	4132	Good
2	10%	4233	Good
3	20%	4296	Good
4	30%	4441	Good
5	40%	4514	Excellent
6	50%	4379	Good

**Table 8:- Ultra Pulse Velocity result of Crimped Steel fibres in addition of concrete.**

S.No	% of Crimped Steel Fibres	Ultra Pulse Velocity Results, m/s	
		28 days	Quality of Concrete
1	0%	4132	Good
2	1%	4286	Good
3	2%	4448	Good
4	3%	4528	Excellent
5	4%	4363	Good

**Table 9:- Ultra Pulse Velocity result of Crimped Steel fibres and Dunite Powder**

S.No	Combined Replacment(s)	Ultra Pulse Velocity Results, N/mm <sup>2</sup>	
		28 days	Quality of Concrete
1	0%	4132	Good
2	40% DP+3%CSF	4536	Excellent

### V. CONCLUSION

1. The achieved Normal Concrete Compressive strength result for 7 and 28 days is 26.24 and 39.46 N/mm<sup>2</sup>.
2. At 40% Dunite powder the Compressive strength result for 7 and 28 days is 29.87 and 42.62 N/mm<sup>2</sup>.
3. Addition of 3% Crimped steel fibre then the Compressive strength result for 7 and 28 days is 28.95 and 41.43 N/mm<sup>2</sup>.
4. By constant maintaining of 40% replacement of Dunite powder in cement and 3% added of crimped steel fibres the maximum compressive strength result for 7 and 28 days is 30.54 and 43.58N/mm<sup>2</sup>.
5. The achieved Normal Concrete Split tensile strength result for 7 and 28 days is 2.52 and 3.84 N/mm<sup>2</sup>.
6. At 40% Dunite powder the Split tensile strength result for 7 and 28 days is 3.07 and 4.33 N/mm<sup>2</sup>.
7. Addition of 3% Crimped steel fibre then the Split tensile strength result for 7 and 28 days is 2.73 and 4.11 N/mm<sup>2</sup>.
8. By constant maintaining of 40% replacement of Dunite powder in cement and 3% added of crimped steel fibres the maximum Split tensile strength result for 7 and 28 days is 3.02 and 4.36 N/mm<sup>2</sup>.
9. The achieved Normal Concrete ultrasonic pulse velocity result for 28 days is 4132 m/s.
10. At 40% Dunite powder the ultrasonic pulse velocity result for 28 days is 4514 m/s.
11. Addition of 3% Crimped steel fibre then the ultrasonic pulse velocity result for 28 days is 4528 m/s.
12. By constant maintaining of 40% replacement of Dunite powder in cement and 3% added of crimped steel fibres the maximum ultrasonic pulse velocity result for 28 days is 4536m/s.

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