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EFFECT OF MARBALE DUST IN SELF COMPACTING CONCRETE PROPERTIES

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Abstract: This study investigates the impact of marble dust on the mechanical properties and workability of high-strength self-compacting concrete. An experimental program was conducted to examine the effects of varying marble dust concentrations (20%, 25%, and 30%) on compressive, tensile, and flexural strength under different curing conditions. The results showed significant improvements in strength, despite uneven curing conditions. However, further research is recommended to fully understand the mechanical characteristics of marble dust in self-compacting concrete. The study aims to determine the ideal marble dust concentration for optimal performance.

Index Terms **- Concrete, mix design, marble dust, workability properties, compressive, tensile, and flexural strength.**

1.0INTRODUCTION

Due in significant part to industrial advancement and globalization, India, a growing country, is currently among the nations that produce the most waste worldwide. In order to achieve sustainable development, recycling garbage into useful material is an essential environmentally friendly management strategy. Recycling waste, however, has the potential to cause environmental problems worse than the waste itself if sufficient scientific research and development are not conducted. The cutting, polishing, processing, and grinding of marble in India causes an estimated 6 million tons of trash to flow out each year. The features of self-compacting concrete (SCC) made with leftover marble as a substitute for cement were examined in this study. This method improved the split and flexural tensile strength and produced fresh concrete with acceptable properties.

The study found that the maximum strength was reached at a 25% MD replacement level. According to Brundtland's idea of sustainable development, the utilization of waste products and mineral admixtures has become increasingly important in order to reduce the consumption of natural resources. Nevertheless, it is still necessary to use natural resources in the production of concrete. Furthermore, the needs listed above cannot be met by the extraction of mineral deposits in a narrow surrounding region; hence, it is unsustainable. As a result, the construction sector ought to promote the utilization of leftover materials to make concrete. Alternative, appropriate strategies are intended to be implemented on a national and international scale in order to decrease the usage of mineral resources.

1.2 Objective of present study

Self-compacting concrete, also known as self-consolidating concrete, is a kind of concrete that can flow through a formwork and solidify under its own weight without the requirement for internal or external vibration for compaction. It has enough cohesiveness to fill up gaps of varying sizes and shapes without causing its constituents to separate or bleed. Because of this, SCC is particularly useful for putting members with intensive reinforcement in concrete and members with unique shapes. After placement, the surface is incredibly smooth. To guarantee that newly laid concrete is self-compatible, certain conditions must be met.

1 To determine the workability of marble dust in self-compacted concrete using Slump Cone Test, U Box Test, L Box Test and V Funnel Test.
2 To compare the compressive strength of marble dust in self-compacted concrete with conventional normal concrete.
3 To compare the flexural strength and tensile strength of self-compacted concrete with conventional normal concrete
4 To determine the optimum percentage replacement of cement with marble dust in self-compacted concrete

2.0 NEED OF THE STUDY.

The use of marble dust in self-compacting concrete has garnered significant attention due to its potential to enhance mechanical properties, improve workability, and promote sustainability. However, the effects of marble dust on self-compacting concrete properties are not yet fully understood, necessitating further research. A comprehensive study is needed to investigate the impact of marble dust on compressive strength, tensile strength, flexural strength, and durability, as well as its influence on workability and aesthetic properties. By exploring the optimal dosage and curing conditions for marble dust in self-compacting concrete, researchers can unlock its full potential, leading to the development of innovative, sustainable, and durable construction materials that benefit the environment and the construction industry.

3.0 METHODOLOGY

3.1Material required

a) Cement: The cement used was regular Portland Pozzolana cement, grade Fineness, specific gravity, consistency, cement's initial and final setting, and soundness are among its many physical attributes. ascertained in accordance with is:1489-1991part 1 guidelines.
b) Coarse Aggregate: There are two sizes of course used: one passes through a 12.5 mm sieve, while the other passes through a 20 mm sieve. The characteristics of coarse aggregate were ascertained in accordance with is:2386-1963 guidelines.
c) Fine Aggregate: Material that passes through an IS sieve with a gauge of less than 4.70 mm is referred to be fine aggregate; anything beyond that is not. While fine aggregate creates the filler matrix in between the coarse aggregate, fine aggregate forms the primary matrix of the concrete. Workability and homogeneity in the combination are the two main purposes of the fine aggregate.
d) Marble dust: The majority of the material in marble, a metamorphic rock formed from limestone, is dolomite and calcite. In addition to its numerous other uses, it is frequently employed as a building material for sculpture.

3.2 Mix Design

The design of an M30 grade self-compacting concrete mix requires precise proportioning of ingredients to achieve the desired workability, strength, and durability properties, ultimately yielding a compressive strength of 30 MPa after both 7 and 28 days of curing. This mix design procedure must be tailored to meet specific project requirements, taking into account regional norms, resource availability, and particular project needs, which may necessitate adjustments to the mix design. To ensure a successful M30 grade self-compacting concrete mix, it is crucial to consult relevant codes and guidelines, as well as seek expert advice from knowledgeable concrete technologists, to guarantee the production of a high-quality mix that meets the required standards.

Table 3.1: Mix design for M30

Material	CNC	SCC	SCC (20%)	SCC (25%)	SCC (30%)
Cement (Kg.)	412	400	400	400	400
Marble dust (Kg.)	00	00	80	100	120
Coarse aggregate (Kg.)	856	900	900	900	900
Fine aggregate (Kg.)	1023	900	900	900	900
Water(L)	197	184	192	200	200

3.3 Casting Quantity

The casting quantity and testing schedule for the concrete mixes are as follows: For each mix type, three cubes, beams, and cylinders were cast. The mix types included conventional normal concrete, self-compacting concrete (SCC) with 20% marble dust, SCC with 25% marble dust, and SCC with 30% marble dust. The testing schedule consisted of testing three cubes at 7 days and three cubes at 28 days for each mix type. This testing schedule allowed for a comprehensive evaluation of the compressive strength, flexural strength, and durability of each mix type at different ages.

4.0 Laboratory Experiments:

4.1 Test on fresh concrete

a) Slump Flow Test: The Slump Flow test measures the spread and flow of self-compacting concrete. It uses a slump cone and flow table to assess the concrete's ability to flow and fill a mold. The test measures the time it takes for the concrete to flow to a 50-centimeter diameter (T50 time) and the final diameter of the concrete.
b) L-Box Test; The L-Box test evaluates the ratio of concrete levels at each end of the box after the test. It measures the blocking value, which indicates the concrete's ability to flow and fill the box. The test uses an L-box with two sections: the trough and chimney.
c)U-Box Test: The U-Box test assesses the filling ability of self-compacting concrete. It uses a U-shaped box with two compartments separated by a wall. The test measures the height of the concrete in each section after it has flowed through the gate.
d)V-Funnel Test: The V-Funnel test evaluates the concrete's filling ability with a maximum aggregate size of 12-20 mm. It measures the time it takes for the concrete to pass through the funnel (flow time). The test can be repeated after five minutes to assess segregation.

4.2 Test on hardened concrete

Tests on hardened concrete include compressive strength, split tensile strength, and flexural strength. The compressive strength test determines the concrete's ability to withstand compressive forces, providing a measure of its overall strength and durability. The split tensile strength test assesses the concrete's resistance to cracking and tensile forces, providing insight into its ability to withstand stresses. The flexural strength test measures the concrete's ability to resist bending and flexural stresses, evaluating its performance in structural applications. These tests provide a comprehensive understanding of the concrete's mechanical properties, allowing for the evaluation of its suitability for various construction projects and ensuring the safety and longevity of structures.

4.2.1 compressive test procedure:

The compressive strength test was conducted in accordance with IS 516:1979 guidelines. Concrete specimens were cast in 150 x 150 x 150 mm steel molds and cured for 7 and 28 days. After curing, the specimens were removed, cleaned, and their weight and dimensions recorded. The compressive strength test was performed using a universal testing machine, which applied increasing load until the specimen failed. The compressive strength (fc) was calculated by dividing the maximum load supported by the specimen (Pmax) by the cross-sectional area of the cube (A), using the formula: $F_c = P_{max} / A$. This calculation provides a measure of the concrete's ability to withstand compressive forces, which is essential for evaluating its structural integrity and durability.

4.2.1 Flexural test procedure:

The tensile strength of concrete is often neglected in structural design, but it's crucial to evaluate cracking under stress. Concrete structures must remain continuous to prevent corrosion and maintain aesthetics. Tensile strains can occur due to temperature, shrinkage, and flexural tension in unreinforced surfaces like roads and pavements.

The flexural tension test measures the tensile strength of plain concrete. It involves applying two-point loading to a beam, with equal weights at one-third of the distance from each support. This creates pure bending in the central one-third section, without inducing shear force. The modulus of rupture (flexural strength) is the maximum tensile stress reached at fracture, calculated using:

Flexural Stress = WL/ BD^2

Were,

W = load applied

B = Width of the beam

D = beam depth

L= beam length.

4.2.2 Split tensile test procedure:

The split tension test determines the tensile strength of concrete. A cylindrical specimen is compressed between two opposing generators until it cracks in diameter. Following IS 516:1979 guidelines, specimens were cast in 150 mm diameter and 300 mm height steel molds, cured for 7 and 28 days, and their weight and measurements recorded. The specimens were then placed horizontally on a 200-ton hydraulic compression testing machine and loaded until failure. The splitting tensile strength (T) was calculated using:

$T = 2P / (\pi LD)$

where:

T = Split tensile strength (MPa)

P = Maximum applied load (indicated by the testing machine)

D = Specimen diameter (mm)

L = Specimen length (mm)

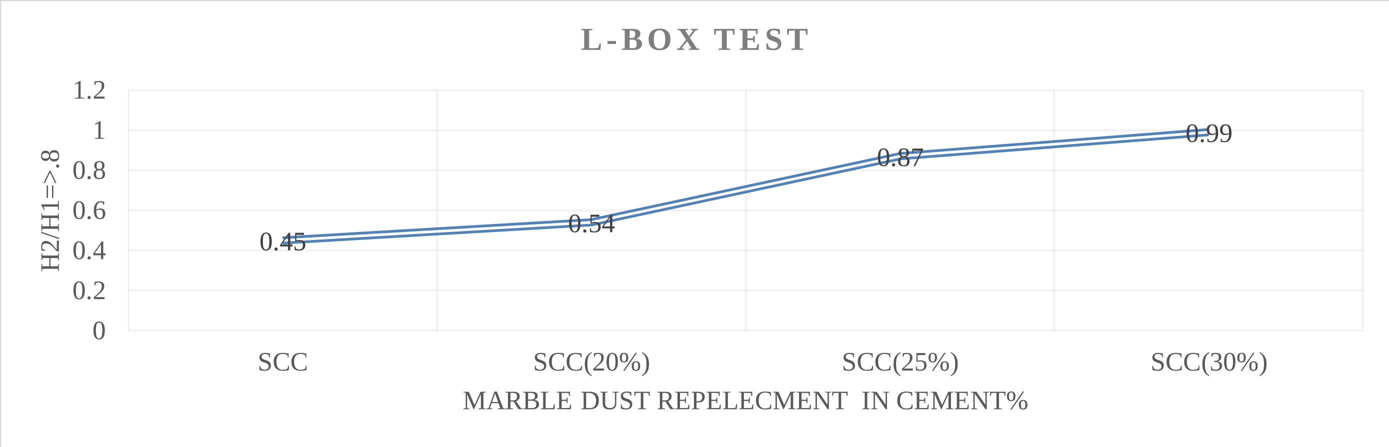
5.0 Results and discussion:

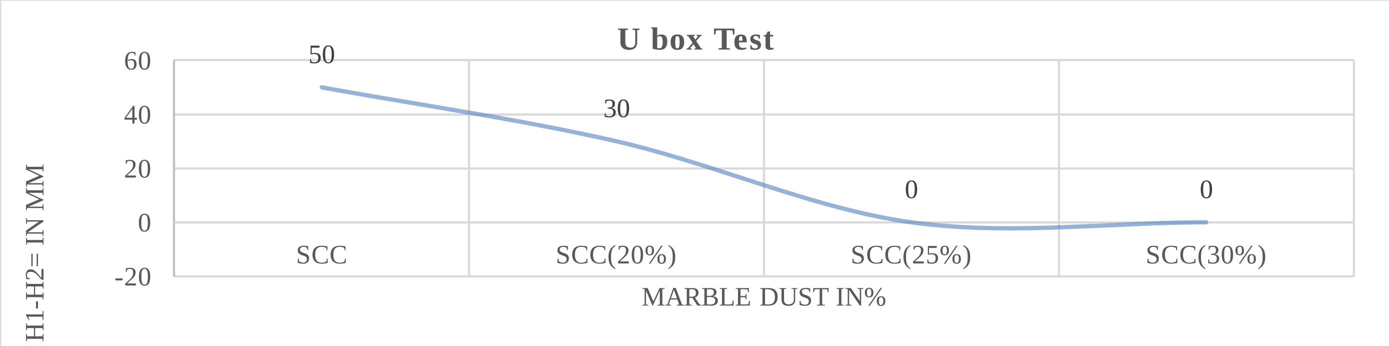
5.1 Test on fresh concrete:

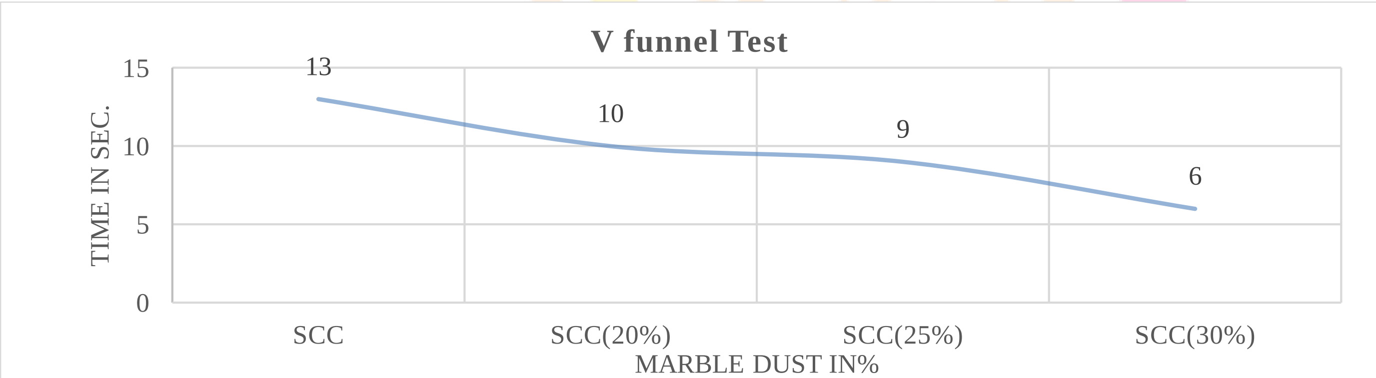
Table 5.1 Result of Workability Test

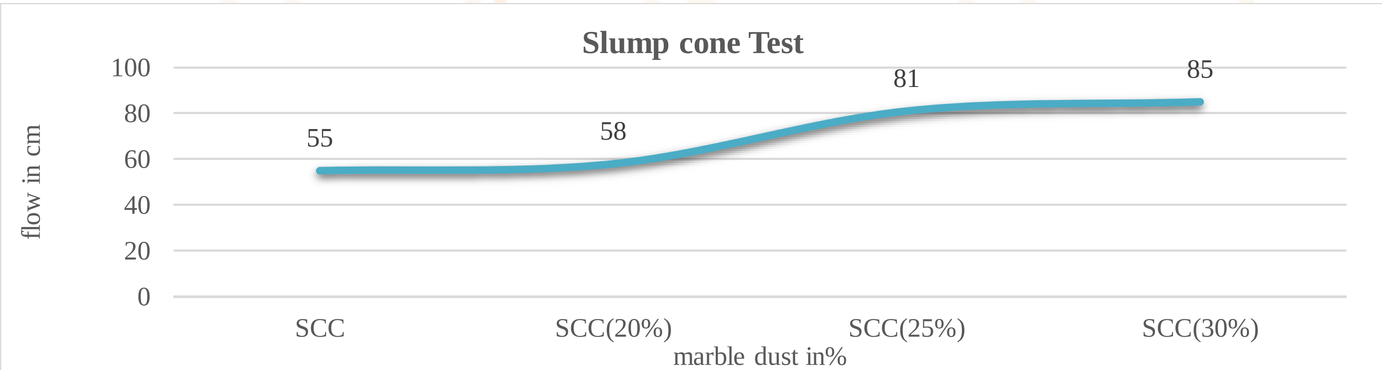
TEST	STANDARDS VALUS	SCC	SCC20%	SCC25%	SCC30%
L BOX	H2/H1>0.8	0.45	0.54	0.8	0.99
U BOX	H1-H2=0	50mm	30mm	0	0
V FUNNEL	8<TIME<12S	13S	10S	9S	7S
SLUMP FLOW IN CM.	66-85cm.	55	58	71	85

The following results, which were tested over, workability test is L Box, U box, V funnel, slump flow. marble dust at the suggested replacement levels of 20%, 25%, and 30% for M30 grade concrete









Self-Consolidating Concrete (SCC) with a 25% mix design exhibited:

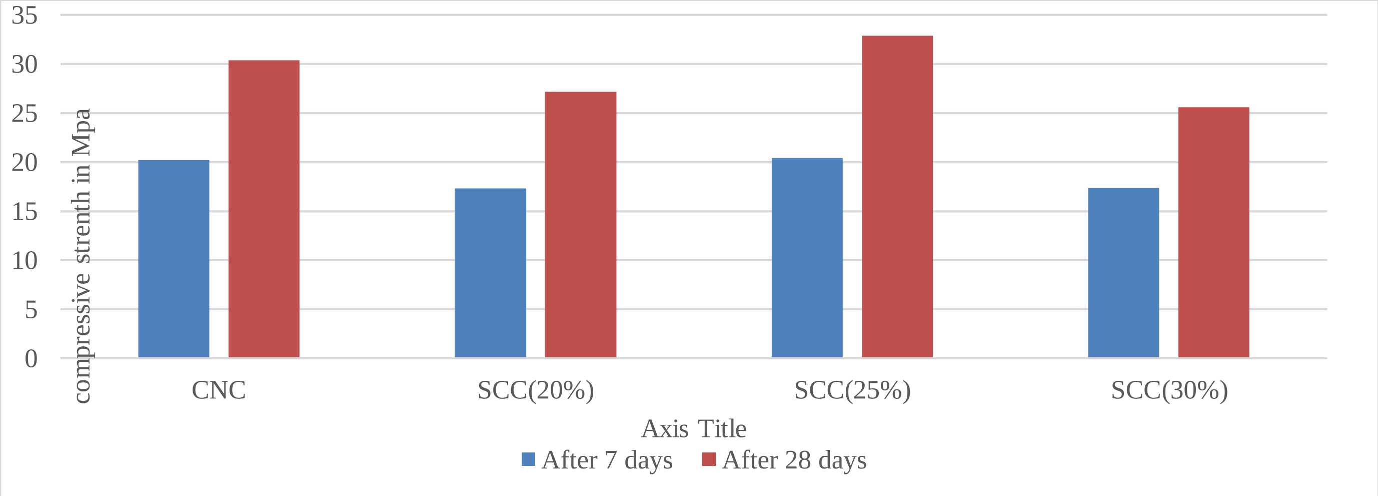
- Good flowability: Slump flow test showed a diameter of 710 mm, within the target range of 650-800 mm.
- Adequate flow time: V-funnel test indicated a flow time of 9 seconds, within the target range of 6-12 seconds.
- Excellent passing ability:
- U-box test showed no blockage, with a height ratio of 0.
- L-box test showed a height ratio of 0.87, within the target range of 0.8-1.0.

5.2 Compressive test results:

Table 5.2 Compressive test result

Sr. No.	Type of concrete	7days (N/mm^2)	7days avg.(N/mm^2)	28days (N/mm^2)	28days avg.(N/mm^2)
1	CNC	20.00	20.22	30.66	30.35
2		19.90		30.12	
3		20.76		30.28	
1	SCC (20%)	17.50	17.31	26.20	27.14
2		16.90		26.90	
3		17.50		28.36	
1	SCC (25%)	20.21	20.41	33.68	32.87
2		21.09		32.46	
3		19.95		32.49	
1	SCC (30%)	17.69	17.36	25.69	25.61
2		17.50		24.80	
3		16.90		26.36	

The following results, which were tested over, show the compressive strength of concrete containing marble dust at the suggested replacement levels of 20%, 25%, and 30% for M30 grade concrete



From the table 5.2 it is observed that the compression test at 7 & 28 days result 20.22 N/mm2 & 30.35 N/mm2 respectively 25 percentage inclusion of marble dust which is greater than 2% for 7 days & 8% for 28 days compare to all mix ratio of concrete.

5.3 Flexural test results:

Table 5.3 Flexural test on beam

Sr. No.	Type of concrete	Load carried (KN)	28days Map.	28days avg. Mpa
1	CNC	8.90	1.78	1.59
2		9.78	1.51	
3		9.90	1.58	
1	SCC (20%)	6.42	1.28	1.28
2		6.63	1.19	
3		7.33	1.39	
1	SCC (25%)	8.74	1.74	1.74
2		9.33	1.55	
3		9.78	1.95	

1	SCC (30%)	6.63	1.19	1.27
2		7.68	1.30	
3		7.28	1.34	

The addition of marble dust has a significant impact on the flexural strength of concrete, as evident from the 28-day flexural test results.

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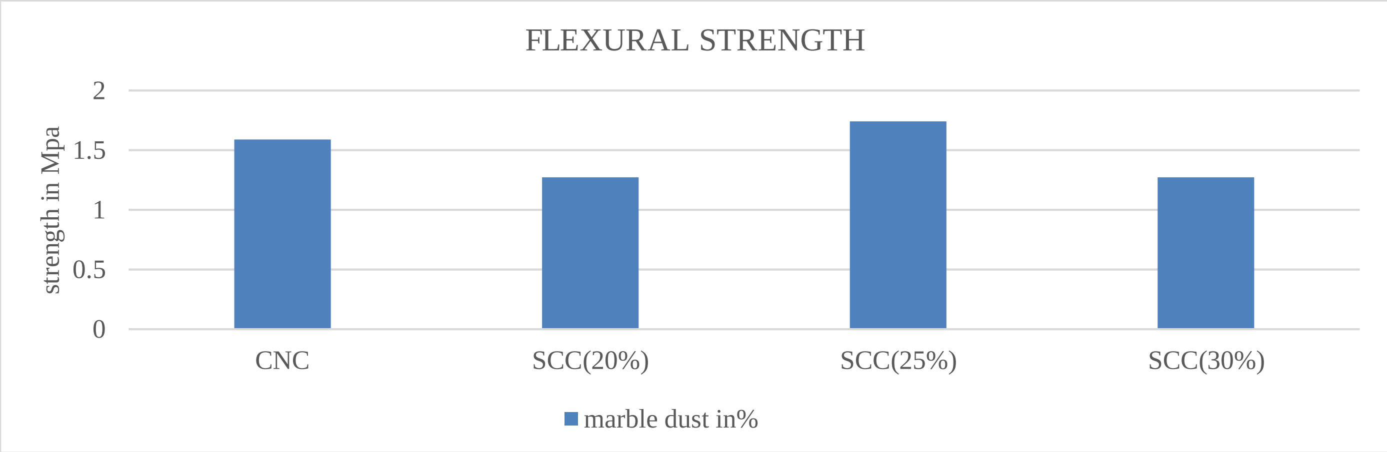


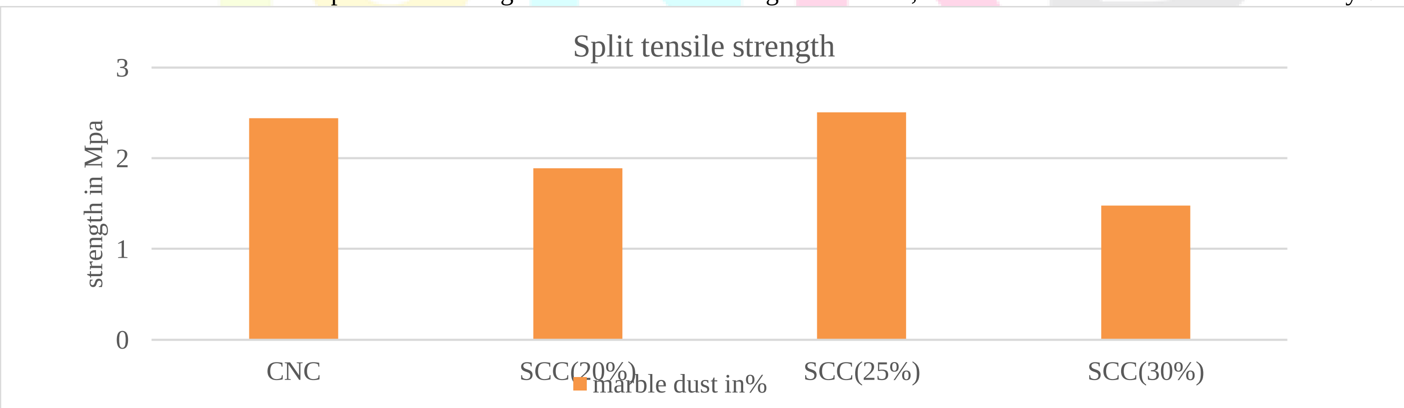
This indicates that the addition of 25% marble dust has significantly improved the flexural strength of the concrete at 28 days, outperforming all other mix ratios by a margin of 10%

5.4 Split tensile test results:

Table 5.4 Tensile strength test on beam

Sr. No.	Type of concrete	28days (N/mm^2)	28days avg.(N/mm^2)
1	CNC	2.35	2.44
2		2.57	
3		2.41	
1	SCC (20%)	1.96	1.89
2		1.88	
3		1.84	
1	SCC (25%)	2.35	2.51
2		2.70	
3		2.49	
1	SCC (30%)	1.23	1.48
2		1.56	
3		1.66	

The data below illustrates the split tensile strength of concrete containing marble dust, evaluated at various intervals of 28 days.



From the table 5.4 it is observed that the split tensile test at 28 days is 2.44 N/ mm2 at 25 percentage inclusion of marble dust which is greater than 3% compare to all mix ratio of concrete.

6.0 Conclusion

The physical characteristics of marble dust and the workability of SCC were investigated in this study utilizing the Slump Cone, U Tube, L Box, and V Funnel tests. contrasting self-compacted concrete's tensile, flexural, and compressive strengths with those of regular concrete. Determine the ideal percentage for replacing cement in self-compacted concrete with marble dust

1. The various tests on Self-Consolidating Concrete (SCC) with a 25% mix design - Good flowability, as shown by the slump flow test (710 mm diameter, within the target range of 650-800 mm) Adequate flow time, as indicated by the V-funnel test (9 seconds, within the target range of 6-12 seconds) Excellent passing ability, as demonstrated by the U-box test (height ratio of 0, indicating no blockage) and L-box test (height ratio of 0.87, within the target range of 0.8-1.0).
2. The average compressive strength of SCC (25%) at 7 days and 28 days (20.41 N/mm²) and (32.87 N/mm²) is higher than that of the CNC (20.22 N/mm²) and (30.35 N/mm²), indicating improved strength with the use of marble dust.
3.Overall, the results suggest that the replacement of cement with marble dust up to 25% improves the flexural and tensile strength of concrete, while higher replacement percentages SCC (30%) and law replacement percentages SCC (20%) lead to reduced strength. SCC (25%) exhibits the best performance in both tests.
4. The results indicate that the optimum percentage replacement of cement with marble dust is 25%, as it exhibits good flowability, passing ability, and hardened properties. SCC (25%) shows improved compressive strength, flexural strength, and split tensile strength compared to other mixes.

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