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Research Paper

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Experimental Study of Partial Replacement of Coarse Aggregate by Marble Chips

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Abstract—A considerable amount of trash is produced throughout the processing and mining steps of creating marble tiles. This garbage is thrown to the ground., generating a slew of environmental problems. The principal reason for this study was to check whether marble trash could be utilized in concrete as a halfway substitution for regular coarse total. Utilizing trial draws near, the practicality of involving marble flotsam and jetsam as a coarse total in concrete was considered. The results of the experiment indicate that discarded marble chips can be used to partially replace coarse aggregate in M25 concrete. The marble shards are being utilized to substitute coarse aggregate in concrete. 25%, 50%, and 75% of the typical coarse aggregate are replaced, respectively, by weight. Employing experimental approaches, the feasibility of using marble debris as a coarse aggregate in concrete was studied. On the 7th and 28th days, compressive and rigidity are estimated. Marble totals can be utilized in substantial blends to supplant coarse totals.

Keywords— waste marble chips, coarse aggregate, compressive and tensile strength**.**

I. INTRODUCTION

Concrete is a very versatile development material in view of its capacity to endure perilous circumstances while keeping sufficient solidness and strength. The increased rate of production is harmful to the environment, and the excessive use of concrete materials causes a sense of dread. However, the waste we have in our position has an impact on the biological cycle, and amid all mechanical rubbish, there is a significant quantity of waste that will have an impact on the world. Concrete and total, which are the most key parts utilized in substantial assembling, are expected by the development area. This probably generated a lifetime interest in the natural materials used to create them. In addition to the requirement to use natural resources, there is increasing need to safeguard the environment and conserve natural resources, such as aggregate, by using alternative materials that are either reused or discarded. Most of development and destruction squander in the United States isn't reused, and on second thought winds up in landfills, where it takes up significant land and costs cash to fill. However, construction garbage is generated by a large portion of India's construction industry, which contributes significantly to solid waste. Solid waste material, such as stone, wood, iron, cement, and other waste materials, is typically created as a result of construction waste or remaining results from a building's rehabilitation.

The production of the marble business is currently dumped as rubbish that has not yet been recycled. The most common coarse aggregates used in concrete production are gravel, crushed stone, granite, and limestone. Marble chips, as well as blocks and material tiles, are widely utilized in the production of divider and floor tiles. Clean marble, like all marble goods, is created from common materials including lime, silica, alumina, and magnesium carbonate. As the end user of all ceramic materials, the development industry is prepared to cope with this fundamental difficulty, which is in some respects unique to it. Some transportation issues are also addressed by using waste products in concrete temperate. Pounded marble chips aggregate can be used to create lightweight, yet robust concrete. Because of the construction industry's high reliance on raw materials, there is a constant scarcity of building materials, which has a negative influence on the environment. Throughout the past ten years, different examinations on the utilization of waste materials in concrete have been directed in the development business to lessen the utilization of normal assets.

II. OBJECTIVE

1. To find out the suitability of using marble as a partial replacement for coarse aggregate in concrete.
2. The Optimum percentage of replacement is found out by casting cubes for different percentages for replacement and finding out their compressive strength.
3. Compare the compressive strength and split tensile strength between conventional and partial replaced with marbles concrete.

III. LITERATURE REVIEW

Jay P. Chotaliya et al (2016) has studied it may be inferred that discarded marble chips can be used as a coarse aggregate in concrete manufacturing and can completely replace natural aggregate. According to the results of the cost research, marble concrete is 7.44 percent more cost effective than concrete built with standard coarse aggregate. Because marble chips are used in concrete, they lower the amount of natural aggregate utilized, which reduces the amount of natural aggregate mined, resulting in less environmental damage. It assists with diminishing the utilization of ordinary coarse totals in the climate while additionally considering the development of Green Concrete. As a result of this research, a revolutionary construction material is created.

Sudarshan D. Kore and A.K. Vyas (2016) According to the research, the workability of all concrete mixes improves as the amount of natural coarse aggregate replaced with marble aggregates increases. Until 80% marble is utilized as coarse total in concrete, the substantial's compressive strength shows a vertical pattern. The penetrability of the substantial increments as the level of normal coarse total supplanted by marble total expands, attributable to the presence of pores in the substantial. When presented to acids, the compressive strength of control concrete is diminished by 61%, while the compressive strength of marble total cement is decreased by 65%. As a result, when compared to control concrete, acids had less of a detrimental effect on marble aggregate concrete. The results of the Los Angeles Abrasion test are within the BIS: 2386 (part IV)-1963 limitations. As a result, marble aggregates can be used in the construction of concrete pavements. According to the findings of this study, marble aggregate can be used to improve the mechanical qualities of typical concrete mixtures. In Rajasthan, India, there is an abundance of marble trash. This trash can be used as aggregates in the creation of concrete mixtures, which is both cost-effective and environmentally friendly. Nonetheless, more examination into the toughness of involving this loss as a total in substantial blends is required.

Mrs.Anwaya.N.S, et al (2017) The influence of marble aggregate on the qualities of concrete was explored, and it was established that, as the percentage level of natural aggregate replacement by marble aggregates grew, the workability of all concrete mixes including marble aggregate increased. All concrete mixes including marble aggregate show an increased trend in compressive strength until they reach 80 percent replacement level. It is concluded that marble aggregates can be used to substitute natural aggregates in concrete mixes. As a result, rather of being discarded as garbage, marble waste can be utilized as aggregates.

Sarath Sunil and Nisha Varghese (2020) The physical features of marble (specific gravity, water absorption, and so on) have been studied and found to meet the IS code standards for coarse aggregates. As a result, marble can be utilized in concrete as a coarse aggregate. Hardened qualities such as compressive strength, split tensile strength, and flexural strength improve with an increase in marble content of up to 50%, then decline. The concrete mix containing 50 percent WMCA has a higher compressive strength than the control mix. Because of the discoveries, the best rate substitution of marble squander as coarse total in concrete is half.

Athul Krishna K R (2017) The addition of marble wastes increases the physical and mechanical qualities, according to the results of the experiments. These findings are critical since this type of revolutionary concrete necessitates a huge volume of small particles. Due to the fineness of the marble dust, it proved to be quite successful in ensuring excellent concrete cohesion. According to the findings of the research, marble dust can be used as a fine aggregate alternative. The use of 50% marble chips in place of coarse aggregate (Green concrete) produces an exceptional outcome in terms of strength and quality. The MC-50 blend produced better compressive strength, according to the findings. The workability improves as the marble chip content rises.

IV. MATERIALS USED

A) Cement

Cement The current experimental examination used Portland cement of Grade 43 that complied with IS 8112 - 1989. It is unique.3.15 is the gravity. The cement was put to the test in accordance with the guidelines. IS 4031-1988 is an Indian standard.

Fig 4.1 Cement

B) Fine Aggregate

M sand that met IS 2116 – 1980's Zone II requirements was employed. The fine aggregate has a specific gravity of 2.79 and a fineness modulus of 2.64.

Fig 4.2 Fine Aggregate

C) Coarse Aggregate

Aggregate is an important part of concrete. They add body to concrete, minimise shrinkage, and help you save money. Because aggregates make up 70-80% of the volume of concrete, their influence on a variety of concrete characteristics and features is undeniable. The natural coarse aggregate used in this study was subjected to two tests: specific gravity and sieve analysis for gradation.

Fig 4.3 Coarse Aggregate

D) Marble Aggregate

The marble waste used in this study originated from a Jain temple in Puzhal that is now under construction. The specific gravity of marble aggregates and water absorption are studied. The most extreme ostensible size of the marble total utilized is 20 mm. Marble aggregate absorbs around 10% of the water that natural conventional aggregate does, as can be shown. The molecule size dissemination of marble total exhibits that it needs better divisions when contrasted with regular total.

Fig 4.4 Marble

V. MATERIALS TESTING

5.1 Specific gravity of aggregate

A total's particular gravity is utilized to decide the material's solidarity or quality. Stones with a low unambiguous gravity are frequently more vulnerable than stones with a higher explicit gravity. The coarse aggregate specific gravity test calculates the weight of a given volume of aggregate divided by the weight of an identical volume of water to find the specific gravity of a coarse aggregate sample.

Fig 5.1. Specific gravity test for marble chips(aggregate)

5.2 Water absorption

The porosity and absorption of aggregate will alter the water/cement ratio, and thus the workability of concrete. As a result, water absorption in the aggregate is determined.

Fig 5.2. Water Absorption Test for Marble

5.3 Fresh Concrete

Substantial that is still in its adaptable shape is alluded to as new concrete. New concrete might be shaped into a dependable underlying part in no time. Because simple materials are easily available, it may be manufactured on the spot and has a wide range of properties.

5.5 Slump- cone test

Before new substantial fixes, the substantial rut test is finished to check its consistency. It's utilized to evaluate the usefulness of newly blended concrete and, subsequently, its flowability. It can likewise be utilized to distinguish on the off chance that a bunch has been spoiled. Substantial usefulness alludes to how effectively recently blended cement might be poured, established, and wrapped up with least loss of homogeneity. The concrete to water proportion, by and large, decides the ease of a substantial blend.

Subsequent to washing the shape, apply oil to the inside surface. Put the shape on a non-permeable level base plate that is level. Empty the pre-arranged substantial blend into the shape in four genuinely equivalent thicknesses. Pack each layer with a normal example of 25 strokes of the adjusted finish of the packing bar across the cross segment of the shape. The basic layer ought to be packed through for the progressive layers. Eliminate any overabundance concrete and level the surface utilizing a scoop. Any mortar or water that has gotten between the form and the base plate ought to be eliminated. Raise the shape from the substantial as fast as conceivable in an upward bearing.

Table 5.5 Workability of concrete

Degree of workability	Slump	
	mm	Inches
Very Low	0-25	0-1
Low	25-50	1-2
Medium	50-100	2-4
High	100-175	4-7

Table 5.5.1 Slump Value

	Trial no	Slump in mm	Average slump value in mm	Types of slump
conventional concrete	1	142	140	True / high slump
	2	138		
25 % replacement	1	132	136	
	2	140		
50 % Replacement	1	140	137	
	2	134		
75% Replacement	1	135	140	
	2	145		

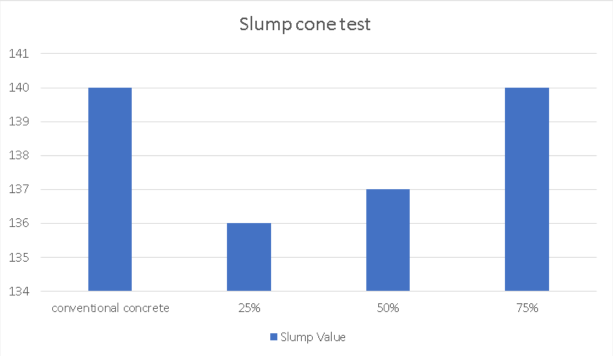

Chart 5.2 Slump cone test value


Fig 5.5 Slump Cone

VI. THE EXPERIMENTAL STUDY

The distinction between the form's level and the level purpose in the example being analyzed is utilized to figure the hang. The experiment's goals were to make M25 concrete with varying amounts of marble aggregates as a coarse aggregate substitute and to test the concrete's compressive strength. The mix ratio for the M25 mix was determined to be 1: 1.6: 2.5:0.45 in compliance with IS 10262:2009. The required elements were weighed, and the concrete was hand-mixed. Cube specimens of 150 mm x 150 mm x 150 mm are casted.The specimens are de moulded and cured in a tank for 7, 14, and 28 days after casting. 130-150 millimetres (about 5.1-5.9 inches) As a result, the slump value is set in the mix design and should be verified for your specific region. Compressive strength of cement is characterized as the compressive strength of cement communicated as far as the trademark compressive strength of 150mm size blocks assessed at 28 days, as per Indian standards (fck). The ordinary strength of cement is characterized as the strength beneath which something like 5% of the experimental outcomes ought to fall.

VII. RESULT & DISCUSSION

7.1 Compressive strength

The test findings are also presented in a table, which shows that when the marble aggregate is increased, the tensile strength of concrete increases with each curing age. In addition, marble aggregate concrete mixtures had a 5–10% greater mean strength than the control concrete. At the point when 25% marble total is added to the substantial blend, nonetheless, the rigidity of the substantial blend diminishes marginally when contrasted with the other substantial blends.

Table 7.1 Compressive strength

Curing Days	Trials	Conventional Concrete		Replacement Concrete 25%	
		Compressive Strength in N/mm²	Average N/mm²	Compressive Strength in N/mm²	Average N/mm²
7	1	19.55	19.55	19.22	19.09
	2	19.77		19.44	
	3	19.33		19	
14	1	27.67	27.67	26	26.63
	2	27.89		26.4	
	3	27.44		26.2	
28	1	30.77	30.36	29.6	29.88
	2	30		29.11	
	3	30.33		29.8	

Curing Days	Trials	Replacement Concrete 50%		Replacement Concrete 75%	
		Compressive Strength in N/mm²	Average N/mm²	Compressive Strength in N/mm²	Average N/mm²
7	1	19.1	19.30	20.11	20.41
	2	19.33		20.8	
	3	19.48		20.33	
14	1	27	27.14	28.3	28.62
	2	27.3		28.75	
	3	27.11		28.8	
28	1	30.45	30.40	31.5	31.17
	2	30		31	
	3	30.77		31.02	

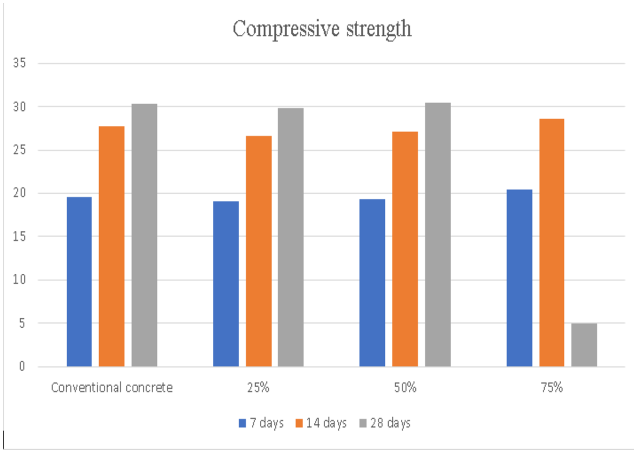

Chart 7.1 Compressive strength

Fig 7.1 Compression Testing Machine

7.2 Tensile strength

The test discoveries are likewise introduced in a table, which shows that when the marble total is expanded, the rigidity of substantial increments with each relieving age. In addition, marble aggregate concrete mixtures had a 5–10% greater mean strength than the control concrete. At the point when 25% marble total is added to the substantial blend, notwithstanding, the rigidity of the substantial blend diminishes somewhat when contrasted with the other substantial blends.

Table 7.2 Tensile strength

Curing Days	Trials	Conventional Concrete		Replacement Concrete 25%	
		Tensile Strength N/mm²	Average N/mm²	Tensile Strength N/mm²	Average N/mm²
7	1	3.98	3.38	3.26	3.6
	2	3.05		3.33	
	3	3.12		3.48	
14	1	3.68	3.66	3.83	3.64
	2	3.75		3.97	
	3	3.54		3.11	
28	1	4.97	4.64	4.18	4.18
	2	4.04		4.25	
	3	4.90		4.11	

Curing Days	Trials	Replacement Concrete 50%		Replacement Concrete 75%	
		Tensile Strength N/mm²	Average N/mm²	Tensile Strength N/mm²	Average N/mm²
7	1	3.55	3.62	3.12	3.19
	2	3.69		3.19	
	3	3.62		3.26	
14	1	3.25	3.25	3.68	3.66
	2	3.32		3.61	
	3	3.18		3.68	
28	1	4.40	4.4	4.82	4.85
	2	4.47		4.9	
	3	4.32		4.82	

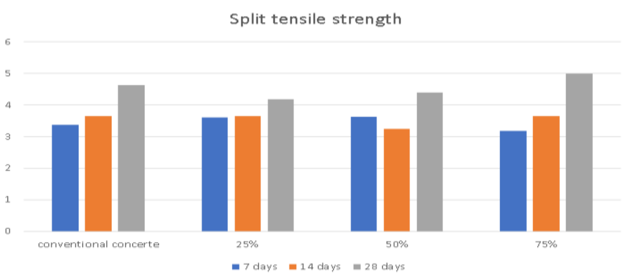

Chart 7.2 Tensile strength

VIII. CONCLUSION

Following the experimental inquiry and debate, it was decided that using leftover marble chips is cost-effective, widely available, and environmentally preferable, resulting in less construction waste.

- According to the results of the tests, partial replacement of marble chips as coarse aggregate is more successful than complete replacement. It starts to decline when replacement strength reaches 25%.
- At the point when marble chips are supplanted by 25%, compressive strength increments, and when the rate is diminished, compressive strength drops, subsequently 25% substitution is the ideal rate.
- The compressive strength of customary cement was 19.55 N/mm2 following 28 days of relieving, while the improved strength of subbed concrete was 29.88 N/mm2.
- The split elasticity of the ordinary chamber is 3.6 N/mm2, though the substitution cement's expanded strength of 25% was 4.18 N/mm2 following 28 days of restoring.
- Without a doubt, the use of discarded marble chips is a low-cost material that saves money in civil construction while also reducing waste generated during construction or demolition.

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