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ANALYSIS OF WASTE MARBLE POWDER AND STEEL FIBRE IN CEMENT CONCRETE

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ABSTRACT: Concrete is currently one of the most widely used construction material. One of the recent advancement in construction industry is replacement of materials in concrete. It has been estimated that several million tons of MDP are produced during quarrying worldwide. Hence utilization of marble powder has become an important alternative materials towards the efficient utilization in concrete for improved harden properties of concrete. Marble is a metamorphic rock resulting from the transformation of a pure limestone. There are several reuse and recycling solutions for this industrial by-product, both at an experimental phase and in practical applications. However the concrete produced from the waste composition can be produced more durable by the application of steel wires for enhancing the tensile properties of concrete. To counter the tensile limitation, concrete is ordinarily assorted with steel reinforcement. The tensile reinforcement compensates for the lack of tensile ability, increased brittleness and decreased strain capacity. To achieve this objective we are partially replacing the cement with waste marble powder as partial replacement of cement incorporating with steel fibers. In this research, steel binding wires were used as steel fibers which are locally available at very cheap cost. Steel fibers were added in different percentage i.e. 0.5 %, 1 %, 1.5 % and 2 % along with control samples (0% Fibers) with addition with waste marble powder. For this purpose cubes, cylinders and short beams were casted and checked under Universal Testing Machine for compressive and tensile strength. The research showed that there was slight increase in the strength due to addition of steel fibers.

Keywords: Concrete, Waste Materials, Marble powder, Steel Wires, Durability, Mechanical Properties.

I. INTRODUCTION

The environmental impact of concrete is a complex mixture of not entirely negative effects; while concrete is a major contributor to greenhouse gas emissions, recycling of concrete is increasingly common in structures that have reached the end of their life. Structures made of concrete can have a long service life. As concrete has a high thermal mass and very low permeability, it can make for energy efficient housing.

Concrete is a composite construction material composed primarily of aggregate, cement and water. There are many formulations that have varied properties. The aggregate is generally coarse gravel or crushed rocks as limestone, or granite, along with a fine aggregate such as sand. The cement, commonly Portland cement and other cementitious materials such as fly ash and slag cement serve as a binder for the aggregate. Various chemical admixtures are also added to achieve varied properties. Water is then mixed with this dry composite which enables it to be shaped (typically poured) and then solidified and hardened into rock-hard strength through a chemical process known as hydration. The water reacts with the cement which bonds the other components together, eventually creating a robust stone like material. Concrete has relatively high compressive strength. For this reason is usually reinforced with materials that are strong in tension (often steel). Concrete can be damaged by many processes, such as the freezing of trapped water.

II. WASTE MARBLE POWDER

Marble powder is one of the waste produces in marble industry. It is obtained during the processes of sawing and shaping. It is collected as slurry near the dumpsite of the industry. It mixes with the water and makes it unfit for reuse. Due to the presence of heavy metals it affects the environment and also the human health. Marble as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete.

III. FIBERS IN CONCRETE

Fibers can be defined as a small piece of reinforcing material possessing certain dimensional characteristics. The most significant parameter describing a fiber is its Aspect ratio. “Aspect ratio” is the span of fiber divided by an equivalent diameter of the fiber. The properties of fiber reinforced concrete are very much affected by the type of fiber. Fibers are secondary reinforcement material and acts as crack arrester. Prevention of dissemination of cracks originating from internal flaws can result in improvements in static and dynamic properties of the medium. The concept that post cracking of concrete can be improved by the inclusion of fiber. There has been a wave of interest in fiber reinforced concrete and several interesting experiments have been carried out. Fibers are taken as a new form of binder that combines Portland cement in the bonding with cement matrices. Fibers are generally discontinuous, indiscriminately distributed throughout the cements matrices. numerous kinds of fibers such as steel, fibrillated polypropylene, nylon asbestos, coir, jute, sisal, glass, and carbon have been tried and these are available in a variety of shapes, sizes

EXPERIMENTAL PROGRAMME

The aim of the paper is to study the variation in strength characteristics of concrete, for this proportion of M 20 grade

is designed. In each mixes containing different percentages of steel fibre with rice husk ash is replaced by different % in cement as compared to normal concrete, i.e. controlled The number of specimens casted for each case is as follows.
1. Workability of concrete test like slump cone test.
2. Engineering properties like Compressive, Split tensile and Flexural strength Test.

MATERIALS
The aim of studying of various properties of material is used to check the appearance with codal requirements and to enable an engineer to design a concrete mix for a particular strength.
The physical properties of the cement as determined from various tests conforming to Indian Standard IS: 8112:1989. The various tests conducted on cement are initial and final setting time, specific gravity, fineness and compressive strength. The results of above said tests are given below in Table 3.1.

Sr. No.	Characteristics	Values Obtained Experimentally	Values Specified By IS 8112:1989
1.	Specific Gravity	3.12	-
2.	Standard Consistency, percent	29	-
3.	Initial Setting Time, minutes	147	30 (minimum)
4.	Final Setting Time, minutes	305	600 (maximum)
5.	Compressive Strength 3 days 7 days 28 days	 24.7 N/mm^2 37.4 N/mm^2 47.5 N/mm^2	 23 N/mm^2(minimum) 33 N/mm^2(minimum) 43 N/mm^2(minimum)

CALCULATION OF FIBRE TO BE ADDED IN THE MIX
The fibre content is taken as 0.5 percent by volume of concrete mix.
Therefore 0.5% by volume
= (0.005×unit weight of fibre/ 0.995×unit weight of concrete)×100= % by weight
We have, Unit weight of fibre = 7860 kg/m^3
Unit weight of concrete = 2300 kg/m^3
0.5% by volume
= (0.005×7860/ 0.995×2300) × 100 = 1.7173% by weight
0.5% fibre by volume
= (% by weight/100) ×unit weight of concrete in kg/m^3
0.5% fibre by volume
= (1.173/100) ×2300= = 39.4979 kg/m^3 = 40 kg/m^3 (approx.)
For 0.5 % Fibre content = 40 kg/m^3
For 1.0 % Fibre content = 80 kg/m^3
For 1.5 % Fibre content = 120 kg/m^3
For 2.0 % Fibre content = 160 kg/m^3
The mix was prepared as nominal mix in a ratio of 1:1.5:3. The desired characteristic strength of 20 N/mm^2 at 28 days was used in this study. Concrete were prepared for this study in five sets. All set were prepared in control mix in w/c = 0.45. The mix proportions obtained for the various mixes cast are tabulated in Table below.

Mix Designation (M20)	Water (W), ltr	Cement (C), kg	Fine Aggregates (FA), kg	Marble powder, kg	Coarse Aggregates (CA), kg
00 %	0.642	1.47	2.205	00	4.41
05 %	0.642	1.38	2.205	0.073	4.41
10%	0.642	1.31	2.205	0.146	4.41
15%	0.642	1.23	2.205	0.221	4.41
20%	0.642	1.16	2.205	0.293	4.41

IV. RESULT ANALYSIS

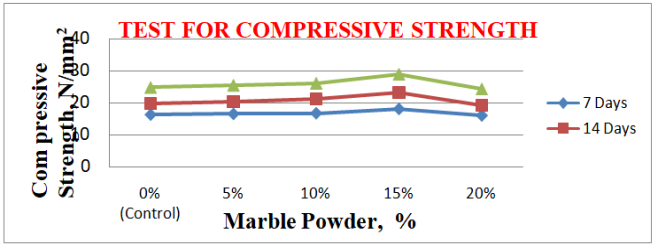
The experimental program included the following:

- Testing of properties of materials used for making concrete.
- Design of mixes for modified concrete and steel fibre reinforced concrete by making trials.
- Casting and curing of specimens.
- Tests to determine the compressive strength, split tensile and flexural strength of high strength steel fibre reinforced concrete.

TEST PROCEDURE AND RESULTS
Test specimens of size 150×150×150 mm were prepared for testing the compressive strength of both controlled as well as marble dust-steel fibre reinforced concrete. The modified concrete mixtures with varying percentages of steel fibres and partial replacement of cement with marble dust were prepared and cast into cubes. In this study, the mix was done by manually. The cement and fine aggregate were first mixed dry to uniform color and then coarse aggregate was added and mixed with the mixture of cement and fine aggregates. Water was then added and the whole mass mixed. In the case of marble dust, cement in different percentages was replaced with marble dust and added before adding water. Simultaneously, the fibres were added just before adding water and mixed dry thoroughly. The interior surface of the moulds and the base plate were oiled before concrete was placed. After 24 hours the specimens were removed from the moulds and placed in clean fresh water at a temperature of 270 $\pm 2^0$C for 28 days curing. For testing in compression, no cushioning material was placed between the specimen and the plates of the machine. The load was applied axially without shock till the specimen was crushed. Test results of compressive strength test at the age of 28 days are given in the Table 4.2 and 4.3. The cube strength results of concrete mix are also shown graphically.

S.No	Cube Sample name	Marble powder, %	7 Days strength, N/mm²	14 Days strength, N/mm²	28 Days strength, N/mm²
			Average of 3 samples		
1	C 0	0	16.17	19.75	24.80
2	C 5	5	16.40	20.25	25.45
3	C 10	10	16.60	21.20	26.10
4	**C 15**	**15**	**17.95**	**23.15**	**28.95**
5	C 20	20	15.90	19.25	24.30

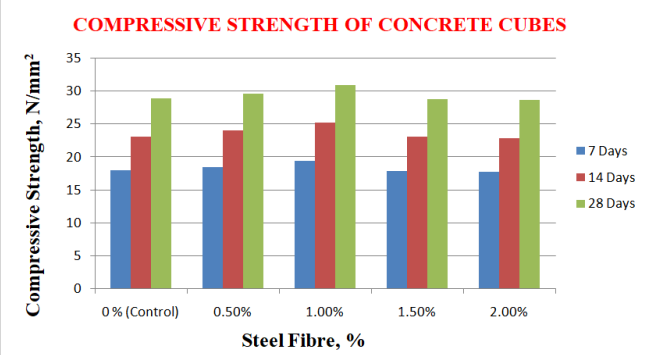
Table 4.2: Details of Compressive Strength test with various % of marble dust.



Graph 4.2: Compressive Strength testing of concrete with various % marble dusts.

S.No	Marble powder (15%) + Steel Fiber %	Average Compressive Strength (N/mm²)		
		7 days	14 days	28 days
1	0 % (Control)	17.95	23.15	28.95
2	0.5%	18.45	24.10	29.65
3	1.0%	19.35	25.25	30.90
4	1.5%	17.90	23.05	28.80
5	2.0%	17.75	22.90	28.65

Table 4.3: Test results of compressive strength of different mix with different percentage of 15% marble powder & Steel fibre.



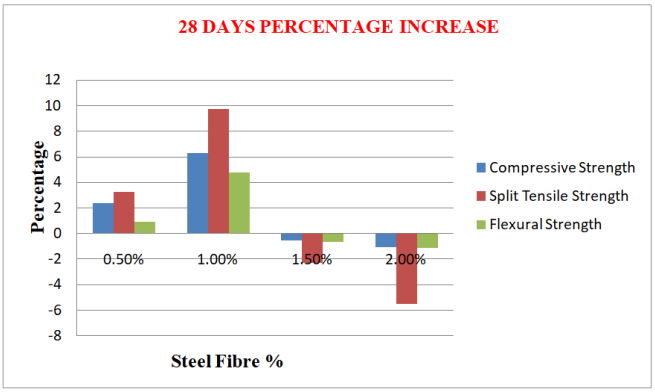
Graph 4.3: Compressive Strength variation of each mix with 15 % of marble powder & different % of Steel fibre.

CALCULATION OF OPTIMUM FIBRE CONTENT

From the test result conducted in different days with the different percentage of marble powder-Steel fibre, it is observed that the optimum content of fibre in concrete mixes is 1%. The variation of compressive, split tensile and flexural strength with the different percentage of marble powder-Steel fibre can be concluded from the curve shown in graph 4.3, 4.5 and 4.7. However at the same percentage of marble powder-Steel fibre in the mix the percentage increase difference in between compressive, split tensile and flexural strength, the flexural strength improvement is comparatively more. The 28 days percentage increase variation is described below:

S.No	Marble powder (15%) + Steel Fiber %	Average		
		Compressive Strength, %	Split Tensile Strength, %	Flexural Strength,%
1	0.5%	2.36	3.23	0.93
2	1.0%	6.31	9.73	4.79
3	1.5%	-0.52	-2.28	-0.63
4	2.0%	-1.04	-5.49	-1.11

Table 4.8: 28 Days percentage increase of strength with different percentage of marble powder & Steel fibre %.



Graph 4.8: 28 Days percentage increase of strength with 15% of marble powder & different % of Steel fibre.

WORKABILITY

- Test results shows that the workability increases when percentage of waste marble powder for M20 grade of concrete increased up to 20% replacement by cement. The workability increase due to greater surface area contact, smooth texture of marble powder, and spherical shape of marble powder particles.
- After addition of steel fibre into the concrete, it significantly decreases the workability due to the reinforcing effects of steel fibres which makes better bond between concrete substrates.

STRENGTH CHARACTERISTICS

- The enhancement in different strengths is observed with the addition of marble powder and Steel fibres in the plain concrete. However, maximum gain in strength of concrete is depending upon the amount of fibre content to be mixed.
- The research is done first on the marble powder incorporation in replacement with cement, so it was observed that 15 % marble powder is optimum for replacement.
- On the basis of those result second lot was prepared adding different percentage of steel fibres, so from this results obtained shows that 1% steel fibre in addition with 15 % marble powder shows better results in all the aspects.
- Concrete mix with 15 percent marble dust as

replacement of cement is the optimum level as it has been observed to show a significant increase in compressive strength at 28 days when compared with nominal mix.

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