Determination of Mechanical Properties of Light weight Concrete with Partial Replacement of Cement with Marble powder

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Abstract

Concrete is a composite material famous for construction of building across the world. Concrete is brittle and tough, when reinforced with iron will have tensile strength which resists the bending forces. This concrete was being researched by replacing the regular materials with some eco-friendly materials like rice husk, sawdust, coconut shell, marble powder, quarry dust and other materials that are dumped as solid waste. In this research work cement is partially replaced with marble powder and coarse aggregate was replaced with coconut shell, with addition of coconut fiber. Marble powder is partially replaced in the percentage ranges of 2.5-10 and coconut shell is fully replaced in addition to arrest the micro cracks fiber is added in range of 1% - 3%. Here, in this research work mechanical properties are tested and compared with Conventional concrete and Coconut shell concrete. The optimum compressive strength is obtained at 5% replacement of marble powder in conventional concrete and as well as in coconut shell concrete. To this optimum percentage fiber was added and it is observed that at 3% of addition in conventional concrete and at 2% of addition in coconut shell concrete. This optimum is considered to test tensile, flexure and impact specimens have improved results.

Key words: Coconut shell concrete, marble powder, coconut fiber, compressive strength

Introduction

The rapid development of infrastructure in the world has created improved demand for the construction materials. Concrete is the important civil engineering material, but the demand for materials is not up to mark. To overcome many researches have been made by replacing the ingredients like cement, sand and coarse aggregate. Also, production of cement from the manufacturing plants is producing 7% of CO_2 into environment. To control pollution an ideal material should be selected to replace it, material should have similarity with cement. In search for it marble powder with same chemical composition of calcium is found to be the perfect replacement.

The other environmental issue is over dumping of coconut shell from oil manufacturing industries; this will decrease the living land. Many researches have been done lightweight

concrete by replacing coarse aggregate with coconut shell. In India and other agricultural countries the waste is produced in the form of coconut shell and husk. Concrete is having a structural problem is formation of micro cracks will become larger cracks by rapid application of loading on the material. To arrest the propagation crack a brittle material to be added such that it should hold the materials within the concrete. For this coconut fibre is been used and implemented

In this research work the materials repalced were cement with marble powder, coarse aggregate with coconut shell and addition of fibre. Marble powder is replaced at 2.5%, 5%, 7.5% and 10% , the optimum percentage is taken and added with addition of fibre at 1%, 2% and 3%. This optimum addition of fibre is considered and the tensile, flexure and impact test is casted and tested.

Materials

Cement, sand, coarse aggregate are the regular materials used in the concrete which no need any detailed explanation or about their properties. The replacing materials marble powder and coconut shell concrete are explained as follows:

Marble powder

Marble powder is a source obtained from the Quarry, where the quarry is blasted and turned into heavy rock mass. this process will produce heavy rock mass. this process the rock mass is allowed to cutting in the industry, this process will produce powder. This powder is allowed for dry; it is collected and used for replacement of cement in concrete. This marble powder has following properties in table 1

Table 1 Properties of marble powder

State	Fine powder
Odour	Odourless
Appearance	Free flowing
Colour	Natural pure white
Specific gravity	2.6
Moisture	Below
Particle size	325 Mesh

Coconut shell

Coconut shell is the waste obtained from the coconut oil manufacturing industries. This is collected and crushed into small pieces, sieving should be done such that the crushed material should be passed from12.5mm sieve is to be used. The surface should be cleaned, smooth inner side and rough outer side. the coconut shell has high water absorption capacity due to its porosity, to overcome this problem coconut shell is soaked in water for 24 hours before its use. In this project coconut shell is fully replaced to coarse aggregate. The properties are in table 2

Table 2 Properties of Cococnut shell

S. No.	Description	Value
1	Max. size used (mm)	12.5
2	Water absorption(%)	25
3	Sp. Gravity	1.2
4	Fineness Modulus	6.28
5	Crushing Value (%)	2.60
6	Shell Thickness (mm)	2-8

Coconut fibre

It is obtained from the husk of the coconut shell which is left as waste from Coconut Oil Production Company. It is used in the production of mats, brushes, door mats and mattresses due to its brittle nature it has attracted the concrete research where the problem of micro cracks worrying the concrete. The fibre has the diameter of 0.2-0.5 mm, it was cut into 4mm size in length. Thus cut fibre is added to concrete at 1%, 2% and 3% by volume of concrete.

Tests results and discussion

The aim of this research work is to find the mechanical properties of concrete grade of M30. The tests will determine the properties of conventional concrete and coconut shell concrete by replacing cement with marble powder with addition of coconut fibre. The test results will determine to make lightweight concrete and the use of natural by-products.

Compression test

Compressive strength is the internal resistance of a body or a material toward the application of loads on to it. To test this the concrete specimens used were of size 100mm×100mm×100mm cubes. These casted specimens are allowed for water curing and tested at the age of 3days, 7days and 28days. The content of marble powder was replaced in 2.5%, 5%, 7.5% and 10% in both conventional and coconut shell concrete to cement. The test results were as followed in table 3

Table 3 Compressive strength values

Compressive Strength Test (Mpa)				
Mix	**Marble Powder (%)**	**3rd day**	**7th day**	**28th day**
Conventional Concrete with Marble powder	0	16.23	21.56	34.69
	2.5	18.31	22.12	33.75
	5	19.97	25.52	36.74
	7.5	17.19	24.09	31.98
	10	15.58	18.69	29.69
Coconut shell concrete with Marble powder	0	15.96	19.95	32.78
	2.5	17.16	21.06	31.89
	5	19.45	23.19	33.72

	7.5	15.87	18.79	30.26
	10	12.94	17.27	28.37

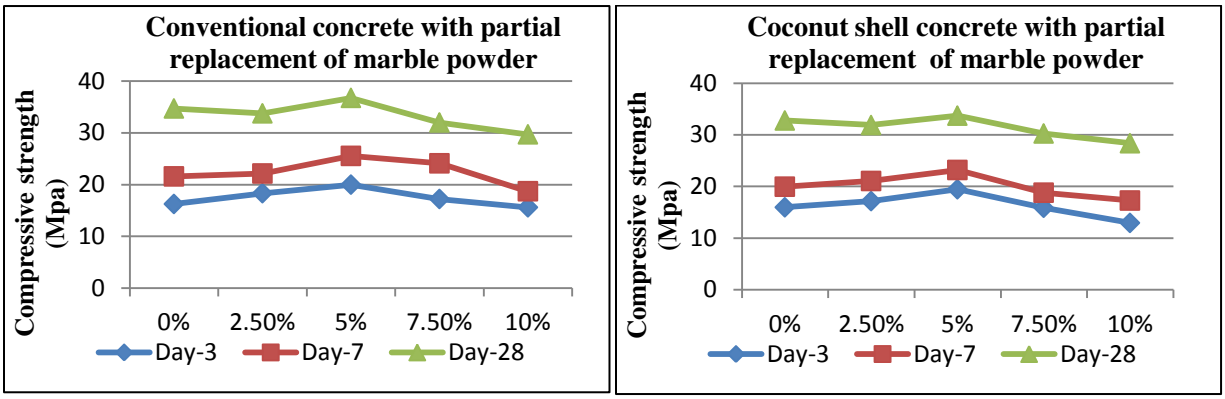

Figure 1 Graphical representation of Compressive test values

From the above compressive test results it is clear that at 5% replacement of marble powder to cement is having highest compressive strength. This is because even though marble powder is calcareous material, the excess amount will lead to reduction in strength. This 5% replacement is now added with fibre at 1%, 2% and 3%.

Table 4 Compressive strength test values (Fiber)

Compressive Strength Test (Mpa)				
Mix	**Fibre (%)**	**3rd day**	**7th day**	**28th day**
Conventional Concrete with addition fibre	0	14.23	21.89	36.74
	1	16.21	22.53	36.96
	2	17.45	23.12	37.71
	3	17.91	23.67	38.98
Coconut shell concrete with addition of fibre	0	13.24	18.19	33.72
	1	13.69	19.56	34.28
	2	14.57	21.32	36.29
	3	12.63	18.87	31.01

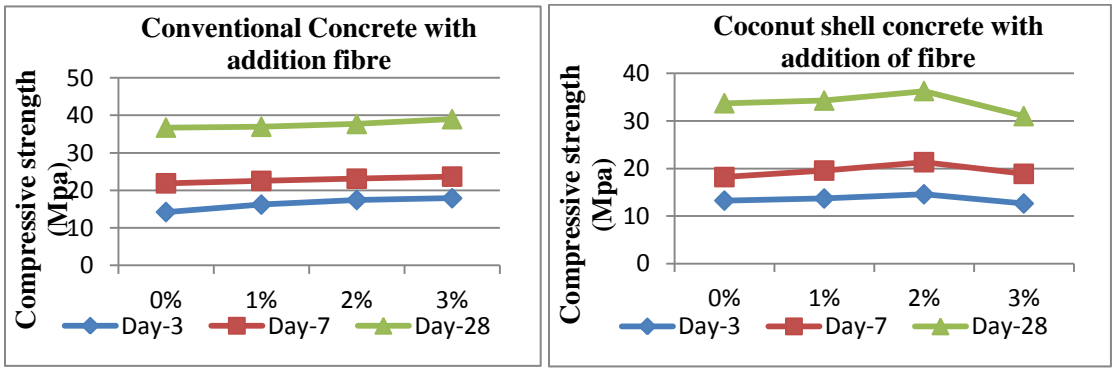

Figure 2 Graphical representation of compression values with addition of fibres

In the above Tabulated test values at 3% addition of fibre concrete has gained high strength when compared to control concrete and conventional concrete with 5% replacement of marble powder. At 2% addition of fibre in coconut shell concrete with replacement of marble powder has also given better result when with coconut shell concrete. This percentage optimum is used to cast the specimens for tensile, flexure and impact tests.

Split tensile strength test

This test will be performed on cylinders of size 100mm×200mm specimens. The test is performed by applying the load on the cylinder, placing the cylinder horizontally between the loading plates. The load is applied till a vertical crack to develop along the diameter. The value of tensile strength by doing in this way will be 0.05 – 0.12 greater than the direct tensile strength. The specimens were tested for concrete with 5% replacement of marble powder at 3% addition of fibre in Conventional and at 2% of fibre in coconut shell.

Table 5 Split tensile strength test values

Split tensile strength (Mpa)				
M30	**Fibre (%)**	**3rd day**	**7th day**	**28th day**
CC	0	2.38	3.91	4.15
CCMC	3	2.83	4.31	4.69
CSC	0	1.63	2.27	2.97
CSMC	2	2.09	3.24	3.81

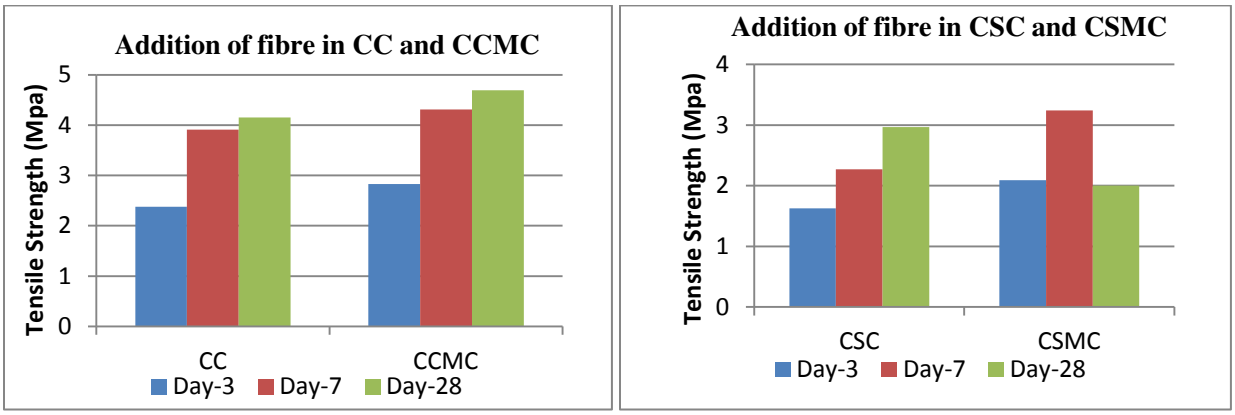

Figure 3 Graphical representation of split tensile strength

Flexure test

This test is carried out on beams of size 100mm×100mm×500mm; the test performed is three point loading. The loading will make the beam to fail at the mid span, the main thing is the ability to resist the failure, fibre is used to improve this ability.

Table 6 Flexural strength values

Flexure strength (Mpa)				
M30	**Fibre (%)**	**3rd day**	**7th day**	**28th day**
CC	0	2.16	3.73	4.69
CCMC	3	2.79	4.61	5.23
CSC	0	2.11	2.91	3.75
CSMC	2	2.64	3.14	4.34

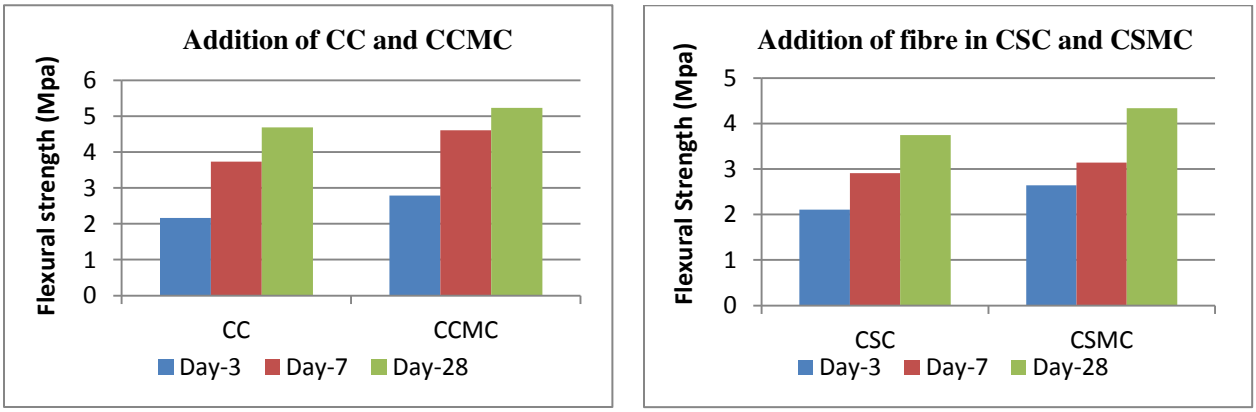

Figure 4 Graphical representation of flexural strength test values

Impact test

The sudden shock to the material in the form of load is termed to be impact. Concrete will have to face many impact loads during construction and after construction, to resist the impact loads the fibre usage to be tested and the test results are as in table 7. The specimen sizes 150mm×65mm.

Table 7 Impact test values

Impact strength (Mpa)			
Mix	**Fibre %**	**No. of blows at the age of 28**	
		Initial crack	**Final crack**
CCMC	3	169	183
CSMC	2	109	128

Conclusion

1. Compression: At 5% replacement of marble powder and at addition of 3% of fibre the compressive strength is like 38.98 Mpa in conventional concrete. For coconut shell concrete with 5% replacement of marble powder and at 2% addition of fibre is 36.29Mpa.
2. Tension: The cylinders were casted at the same percentage quantities at optimum percentages for cubes. The values are obtained as 4.69Mpa in conventional concrete, 3.81 for coconut shell concrete.
3. Flexure: The fibre is having the capacity to resist the failure, the values are 5.23Mpa for conventional and 4.34Mpa for coconut shell concrete.
4. Impact: fibres are capable of resisting the impact force, the impact values have shown the better results than normal concrete.

The above values shows that fibre usage is better suited to resist the micro cracks and bear the impact loads. So the fibre is well suited and this usage can reduce the solid waste and use of marble powder will decrease the environmental damage due to Co_2.

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