Scrutinization of Flexural Practices of Light Weight Concrete by using Sisal Fibres and Bamboo

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Abstract*: Lightweight concrete is the way to reduce the weight as well as deflection in concrete members without affecting its properties. Many of the researches are in progress to find a substitute for this lightweight material. In this project, we would like to take the naturally available fibre named sisal fibre and bamboo as partial replacement material. The influence of sisal fibres on the strength of concrete is taken as the main objective of this experimental study. The addition of natural fibre to the lightweight concrete will enhance the various strength parameters like flexural strength, compressive strength, and increase the ductile behaviour. In the present work, it is aimed to investigate the mechanical properties of lightweight concrete with a replacement of sisal fibre for cement and bamboo as a replacement in coarse aggregate in different percentages. The compressive strength, flexural strength, deflection of the beam is studied with consideration of M25 concrete specimens. Totally 36 number of 500 x 100 x 100mm flexural member cast and tested. It is recommended up to 5% replacement of coarse aggregate with bamboo and 5% addition of sisal fibres with cement provide at M25 grade of concrete gives the optimum increases of strength values. The test results indicated that the sisal fibres were effective in improving the strength of lightweight concrete.

Keywords: Natural fibre, Sisal fibre, light weight concrete, mechanical properties, compressive strength and flexural strength.

I. INTRODUCTION

Lightweight concrete is the type of concrete contains expanded lightweight aggregates which increase the volume of the mixture while giving additional qualities such as lowering the dead weight. Lightweight concrete will have many voids in it and due to this cement layers are not fixed properly. This research article was based on the feat of lightweight concrete using sisal fibre and bamboo. The light-weight concrete is concrete which has a density of 300 to 1850 kg/m3. There are many advantages to having a low density.

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Lightweight concrete has the advantage to reduce the weight of the structure and it leads to an increasing number of floors. In recent years, a huge transaction of curiosity has been fashioned international on the prospective applications of available natural fibre as coarse aggregate and fine aggregates in cement –concrete composites. Sisal fibre is one of the majority extensively worn accepted fibres and is extremely easily refined. Nearly 220.2 thousand tonnes of sisal fibre is produced every year all over the world. Sisal fibre is a rigid fibre prepared from the leaves of the sisal plant. Sisal is mostly had its full-fledged growth in dry and semi-dry regions of Andhra Pradesh, Bihar, Orissa, Karnataka, Maharashtra, and West Bengal. Sisal fibres are extracted from the leaves. The fibre is selected to enhance a variety of strength behaviour properties of the structure to obtain stable and better-quality construction. Bamboo has been one of the widespread resources in pre-industrial construction in the world and engaged as well known structural materials. In reality, at present, there is current research going on bamboo with reflecting of particular treatments is important to elevated toughness, better connectors and numerical modelling for the structural investigation of bamboo as structural elements, along with the entire properties behaviour at different sizes combination like shutter bamboo concrete slabs, utilization of bamboo segments as reinforcement of concrete beams, circular columns.

II. MATERIALS USED

2.1 Cement:

Cement is an obligatory substance in concrete, which holds all other materials to form a dense group. Commonly, Ordinary Portland Cement is worn for all production Construction mechanism. Ordinary Portland cement is available in three grades of 33, 43, 53. In this task, 53 grade ordinary Portland cement is worn for the investigation study. A savings of 8-10% can be achieved with the use of 53 grade Ordinary Portland Cement in place of any other grade.

Table 2.1 Properties of cement

PROPERTIES	VALUE
Fineness modulus	3.5
Specific Gravity	2.9
Consistency	30.2%
Initial Setting Time	30 min
Final Setting Time	1 Hour

2.2 Fine aggregate:

A concrete with enhanced excellence can be made with sand consisting of rounded grains rather than angular grains. River or pit sand must be used and not sea sand as it contains salt other impurities. In this project work, watercourse sand is used as a fine aggregate. By conducting sieve analysis, and compared with the grading table from IS383-1970, it was found that the sand used belongs to the Zone-II.

Table 2.2 Properties of fine aggregate

PROPERTIES	VALUE
Fineness modulus	2.48
Specific gravity	2.75
Size	Passing through 4.75 mm sieve
Water absorption ratio	1%
Grading	Zone II

2.3 Coarse aggregate:

Aggregate must be clean and free from impurities. The coarse aggregate used inside this task is of the size 20mm. Coarse aggregate is also one of the important constituents of conventional concrete. It gives strength to the concrete. The aggregate takes up 70-80 per cent of the volume of the concrete. Aggregate make up some 60-80% of the concrete mix. Aggregate in any particular mix of concrete is selected for their durability, strength, workability, and ability to receive good results.

Table 2.3 Properties of coarse aggregate

PROPERTIES	VALUE
Fineness modulus	7.88
Specific gravity	2.6
Size	20mm
Water absorption ratio	1.2%

2.4 Coarse aggregate bamboo:

The fresh and debris bamboo is collected locally and then broken into a piece of requires sizes related to coarse aggregate and sieved through 4.75mm sieve to remove the finer particles. The use of bamboo as a structural module is provoked by its extensive availability in the tropical and subtropical climatic regions, its quick enlargement in growth, and the amalgamation of eminent mechanical strength and little specific weight

Table 2.4 Properties of coarse aggregate bamboo

PROPERTIES	VALUE
Fineness modulus	8.95
Specific gravity	0.6
Size	20mm
Water absorption ratio	21%

Figure 1) Bamboo

2.5. Sisal Fibre:

Sisal fibre is one of the major natural fibres and is very easily cultivated with less amount of water requirement. It has short regeneration times and grows naturally in the cultivable and non-cultivable lands of fields like hedges and railway tracks. Nearly 360 metric tons of sisal fibre is manufactured in the world. In recent years, German-funded project focusing on enhancing the commercial opportunities for sisal fibre in Haiti, Mozambique and Tanzania. The project will assess the possible way to commercialize sisal fibre, expand industry models which recognize strategy and actions to be carried out to understand the strength of the fibre. Though native to hot and semi-hot countries, sisal plant is now widely grown in tropical countries of Africa and the West Indies. Sisal fibres are extracted from the leaves

Table 2.5 Physical Properties of Sisal Fibre

PROPERTIES	VALUE
Average length (mm)	300
Average diameter (mm)	0.12
Average Tensile strength (N/mm^2)	1090
Elongation (%)	18.2
Water absorption (%)	76.7%

2.6. Water:

Water used for mixing and curing was potable water, which was free from any amounts of oils, acids, alkalis, sugar, salts, and organic materials or other substances that may be deleterious to concrete or steel. The pH significance is supposed to not be less than 6.

3. Preparation and testing of specimen:

The experimental program was designed to study the mechanical properties like flexural behaviour of concrete with 5% of replacement of coarse aggregate by bamboo and 2.5%, 5%, 7.5% of sisal fibres with the weight of cement for M25 grade of concrete along with 0.1% of replacement of water with super plasticizer due to addition of sisal fibres in concrete. The flexural behaviour of the beam after replacing super plasticizer, bamboo & sisal fibres the flexural strength is checked for 7, 14, 28 days.

For the test specimens, 53 grade Ordinary Portland Cement, natural river sand, coarse aggregate, bamboo, super plasticizer, sisal fibres are being utilized.

The highest size of the coarse aggregate was restricted to 20mm. the concrete mix proportions of M25 with the water-cement ratio of 0.40 were used. The concrete mix design was proposed to achieve the flexural strength of 25MPa after 28 days curing in the case of beams. The concrete beams (500mm × 100mm × 100mm) for conventional as well as other mixes were cast. Each layer was compacted with 25 blows using a 16mm diameter rod.

Figure 3) Test specimens

3.1. Sample Specimen Details

Si.No	Specimens	Details
1	Sample 1	2.5% sisal for cement and 5% bamboo for coarse aggregate
2	Sample 2	5% sisal for cement and 5% bamboo for coarse aggregate
3	Sample 3	7.5% sisal for cement and 5% bamboo for coarse aggregate
4	Conventional concrete	M_{25} grade of light weight concrete

3.1 Flexural strength Test

The sample stored in water shall be weathered immediately on the removal of water and at the same time as they are still in the wet condition. Exterior water and dust shall be wiped off from the specimens and any projecting fins are detached. Sample, when received dry shall be taken for testing. The bearing surface of the testing machine shall be wiped clean and any loose sand or other material removed from the surface of the specimen which is to be in contact with the compression platens. The concrete beam shall be placed in the machine in such a manner the load shall be applied on the curved surface of the beam as cast. The load shall be applied without shock and increase at a constant rate until the resistance of the specimen to the increasing loads breaks down the no greater load can be sustained. The maximum load applied to the specimen shall be recorded and the appearance of any unusual cracks shall be noted. The specimens are tested to find out the mechanical properties. The measured strength of the specimen shall be calculated by using the formula $Fb = PL / (b \times d^2)$.

Figure 4) Flexural test of specimen

Table 3.1 Flexural strength test result for 7 days curing

Si. No	Type of Sample	Set 1	Set 2	Set 3			
		KN	M Pa	KN	M Pa	KN	M Pa
1	Conventional concrete	4.6	2.3	5.0	2.5	4.8	2.4
2	Sample 1	4.9	2.45	5.1	2.55	5	2.5
3	Sample 2	5.2	2.6	5.3	2.65	5.2	2.6
4	Sample 3	5.1	2.55	5.2	2.6	5.1	2.55

Figure 5) Graphical representation of flexural strength test at 7 days

Table 3.2 Flexural strength test result fo 14 days curing

Si. No	Type of Sample	Set 1		Set 2		Set 3	
		KN	M Pa	KN	MPa	KN	MPa
1	Conventional concrete	6.9	3.45	7.0	3.5	7.2	3.6
2	Sample 1	7.1	3.55	7.2	3.6	7.3	3.65
3	Sample 2	7.3	3.65	7.4	3.7	7.5	3.75
4	Sample 3	7.2	3.6	7.3	3.65	7.4	3.7

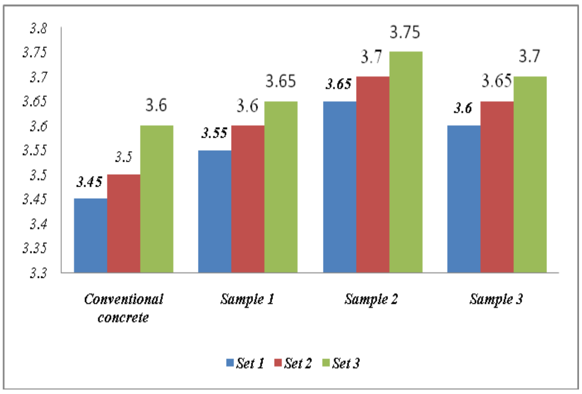

Fig., 6) Graphical representation of flexural strength test at 14 days

Table 3.3 Flexural strength test result for 28 days curing

Si. No	Type of Sample	Set 1		Set 2		Set 3	
		KN	M Pa	KN	MPa	KN	MPa
1	Conventional concrete	8.3	4.15	8.4	4.2	8.3	4.15
2	Sample 1	8.4	4.2	8.5	4.25	8.4	4.2
3	Sample 2	8.8	4.4	8.9	4.45	9.6	4.8
4	Sample 3	8.7	4.35	8.8	4.40	8.6	4.3

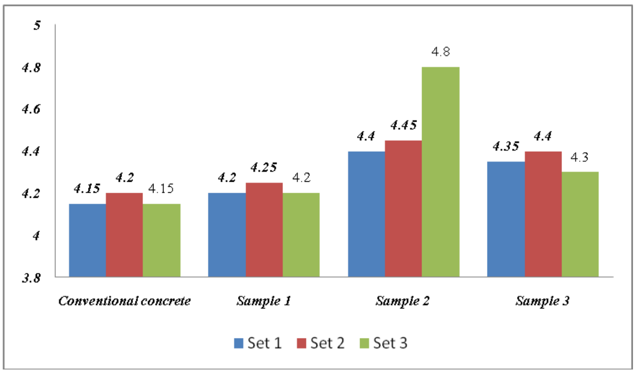

Figure 7) Graphical representation of flexural strength test at 28 days

III. RESULT DISCUSSION AND CONCLUSION

CONCLUSION

1. The experimental results of adding Sisal fibre and Bamboo as an admixture in concrete is presented in the work. The comparison of mechanical properties among the ordinary concrete and admixture added concrete is discussed. The fresh and hardened concrete properties are analysed and compared for all the trials.
2. We found that the use of Sisal fibre increases the flexural strength of the concrete. Thus, the construction work with Bamboo concrete becomes environmentally safe and also economical.
3. Sisal fibre can be used as a substitute for cement which will reduce the cost of cement in concrete and also reduce the consumption of cement. Therefore, it is safe to replace the cement with 5% Sisal fibre considering the strength. It also enhances the workability of fresh concrete.
4. It is proved that the flexural strength is increased up to the optimum level of replacement of Sisal fibre and Bamboo. The optimum percentage of replacement Sisal fibre by cement is 5% and Bamboo by coarse aggregate is 5%.
5. Modification of mix design due to a reduction in water content results in the reduction of cement and coarse aggregate
6. Reduction in cement content did not cause any aggressive effect in strength parameters.
7. 7 days, 14days & 28 days flexural strength is more than the conventional light concrete. From the result, it is observed that the concrete with Sisal fibre and Bamboo is showing improvement of all type of strength characteristics.
8. The Sisal fibre and Bamboo at the optimum level in concrete work, it is seen that all the strength character is increasing than in the conventional concrete. Particularly, this meets the sustainability conditions and saves natural resources.

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