Tensile Strength of Chandrapur Type Indian Bamboo

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ABSTRACT-In this paper we had studied the mechanical properties of bamboo reinforced in slab, column & beams. Tensile strength of bamboo is good and can be used as reinforcement in RC structure for low cost housing project. Tensile strength of round bamboo ranges from 135.92 to 349.69 Mpa. As bamboo is weak in shear it cannot be used as shear reinforcement in RC structure. According to study by researchers in world, in next 60 years steel production will be reduce hence a utilization of natural and eco-friendly options like bamboo should be used[1]. Bamboo is weak in bond stress hence it should be treated by epoxy coating, tar coating etc. Bamboo is weak at node section major failure in bamboo occurs at node[2]. In this experimental study it is concluded that tensile strength of bamboo is approximately one half that of mild steel.

Key Words: Mechanical properties, Tensile strength, Tensile reinforcement, Shear reinforcement, Eco-friendly, Bond Stress.

I. MECHANICAL PROPERTIES

Bamboo is one material, which will have a tremendous economic advantage, as it reaches its full growth in just a few months and reaches its maximum mechanical resistance in just few years. Moreover, it exists in abundance in tropical and subtropical regions of the globe.[4] The mechanical properties of bamboo is specifically pertaining to bamboo in concrete. To find mechanical properties of bamboo proper treatments that should be applied to bamboo, and the methods that should be employed when utilizing bamboo as concrete reinforcement. Bamboo reinforcement in concrete considerably increased the load carrying capacity of members over that of members without reinforcement.[10] In this paper we experimented bamboo for determining the tensile strength. To determine the mechanical properties of bamboo following tests are conducted. With the help of that test result bamboo can be used as construction reinforcement.

II. TENSILE STRENGTH PARALLEL TO GRAIN

Specimens for tensile strength test shall be taken from the undamaged ends of specimens used in static bending tests.[11] The test specimens shall be with one node in the center. The general direction of the fibers shall be parallel to the longitudinal axis of the test specimen. The length of the specimen shall be 60 mm and the width shall be 10 to 20 mm, so that the test specimen is more or less flat. The thickness of the specimen shall be that of the wall thickness or less, depending on the diameter of the culm. All the dimensions shall be measured to an accuracy of 0.1 mm, it shall be permitted to use test pieces with laminated ends for better grip.

Procedure:-

The grips shall press the test specimen perpendicular to the fibers and in radial direction. The load shall be applied continuously and the movable head of the testing machine shall travel at a constant rate of 0.01 mm/s. The maximum load shall be recorded..

Fig -1: Bamboo with node specimens

Fig -2: Bamboo with node specimens

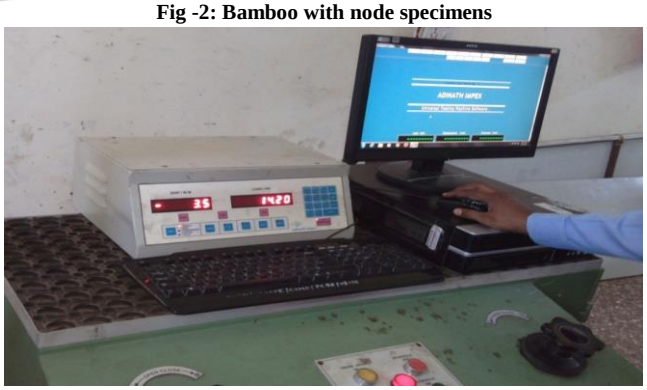


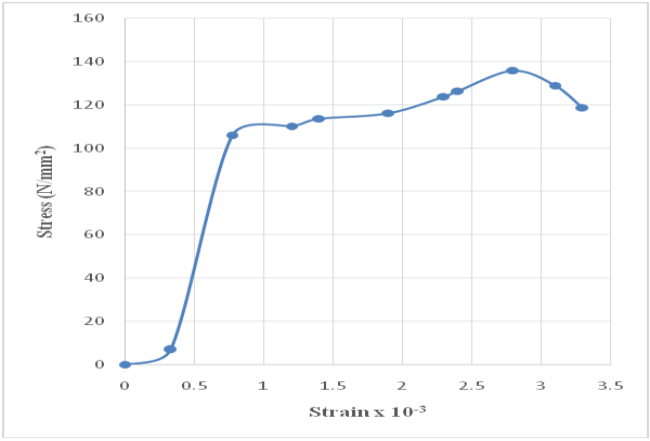
Fig -3: Tensile test readings taken with the help of computer system.

Testing is done with help of Universal testing machine (UTM). The load vs. deformation of bamboo strips is given by UTM. Figure shows fixing of with node bamboo sample in the jaws of

UTM. For the reading purpose computer system is attached to the UTM. These reading are directly stored in the computer system.
For sample with node
Initial width= 18mm
Initial thickness= 6.5mm

Table -1: Observation for tensile strength for sample T1

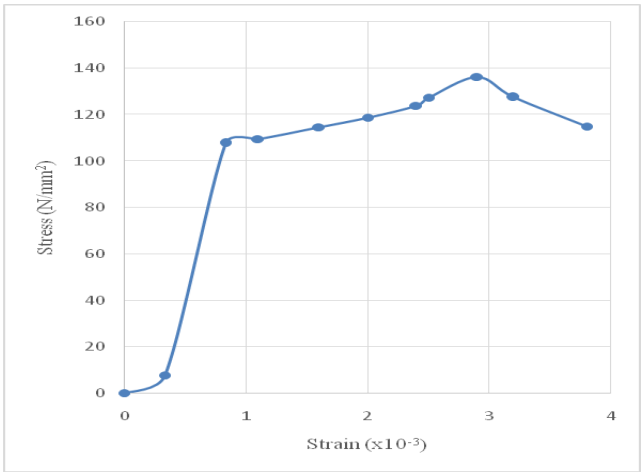
Obs.No.	Load (kN)	Elongation (mm)	Strain ($x10^{-3}$)	Stress (N/mm^2)
1	0	0	0	0
2	0.8	0.1	0.33	6.84
3	12.4	0.23	0.77	105.98
4	12.9	0.35	1.2	110.26
5	13.3	0.42	1.4	113.66
6	13.6	0.57	1.9	116.24
7	14.5	0.68	2.3	123.93
8	14.8	0.71	2.4	126.5
9	15.9	0.84	2.8	135.92
10	15.1	0.92	3.1	129.06
11	13.9	1.00	3.3	118.8



Graph -1: Stress vs. strain of sample T1.

Table -2: Observation for tensile strength for sample T2

Obs.No.	Load (kN)	Elongation (mm)	Strain ($x10^{-3}$)	Stress (N/mm^2)
1	0	0	0	0
2	0.9	0.1	0.33	7.69
3	12.6	0.25	0.83	107.69
4	12.8	0.34	1.1	109.40
5	13.4	0.48	1.6	114.53
6	13.9	0.60	2.0	118.80
7	14.5	0.71	2.4	123.93
8	14.9	0.76	2.5	127.35
9	15.95	0.87	2.9	136.32
10	14.90	0.96	3.2	127.52
11	13.45	1.15	3.8	114.96



Graph-2: Stress vs. strain of sample T2.

The maximum tensile strength σ_{ult}. in N/mm^2, shall be determined as follows:

$$\sigma_{ult} = \frac{F_{ult}}{A}$$

$$= \frac{15.9 \times 10^3}{18 \times 6.5}$$

$$= 135.92\ N/mm^2$$

Where

F_{ult} = maximum load, in N.

A = area of cross section of test specimen, in mm^2

σ_{ult} = maximum tensile strength in N/mm^2

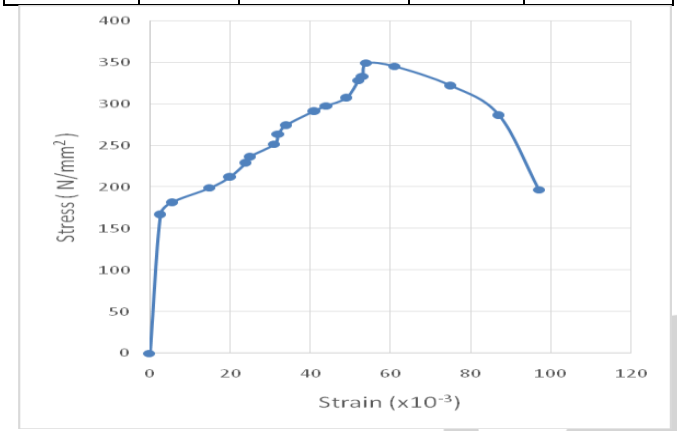
For sample without node
Initial width = 10mm, Initial thickness = 5mm

Fig -4: Bamboo without node specimen

Table -3: Observation for tensile strength for sample T3

Obs.No.	Load (kN)	Elongation (mm)	Strain ($x10^{-3}$)	Stress (N/mm^2)
1	0	0	0	0
2	13.7	0.16	2.6	167.28
3	14.9	0.33	5.6	181.93
4	16.3	0.94	15	199.02
5	17.4	1.21	20	212.45
6	18.8	1.43	24	229.55
7	19.4	1.52	25	236.87
8	20.6	1.83	31	251.53
9	21.6	1.91	32	263.74
10	22.5	2.05	34	274.73
11	23.9	2.48	41	291.82
12	24.4	2.61	44	297.92

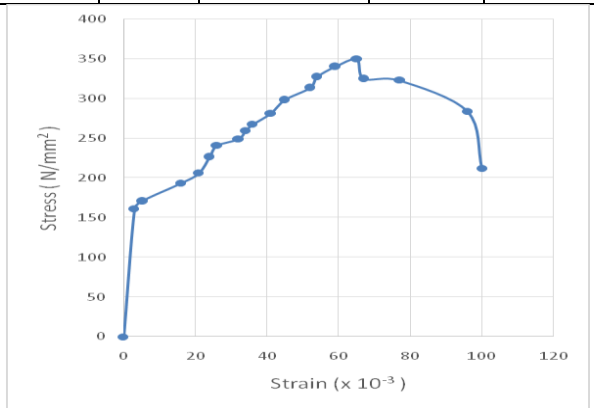
13	25.2	2.96	49	307.69
14	26.9	3.11	52	328.45
15	27.3	3.17	53	333.33
16	28.6	3.25	54	349.21
17	28.3	3.7	61	345.54
18	26.4	4.5	75	322.34
19	23.5	5.2	87	286.93
20	16.1	5.8	97	196.58



Graph-3: Stress vs. strain of sample T3.

Table -4: Observation for tensile strength for sample T4

Obs.No.	Load (kN)	Elongation (mm)	Strain ($x10^{-3}$)	Stress (N/mm^2)
1	0	0	0	0
2	13.9	0.18	3	160.95
3	14.8	0.32	5.3	171.38
4	16.7	0.98	16	193.38
5	17.8	1.23	21	206.11
6	19.6	1.47	24	226.96
7	20.8	1.55	26	240.85
8	21.5	1.89	32	248.95
9	22.4	2.02	34	259.38
10	23.1	2.15	36	267.48
11	24.3	2.48	41	281.38
12	25.8	2.71	45	298.75
13	27.1	3.09	52	313.8
14	28.3	3.23	54	327.7
15	29.4	3.56	59	340.44
16	30.2	3.91	65	349.69
17	28.1	4.03	67	325.38
18	27.9	4.61	77	323.07
19	24.5	5.73	96	283.7
20	18.3	6.07	100	211.9



Graph-4: Stress vs. strain of sample T4.

The maximum tensile strength σult. in N/mm^2, shall be determined as follows:

$$\sigma_{ult} = \frac{F_{ult}}{A}$$

$$= \frac{30.2 \times 10^3}{12.7 \times 6.8}$$

$$= 349.69\ N/mm^2$$

Where

F_{ult} = maximum load, in N.

A = area of cross section of test specimen, in mm^2

σ_{ult} = maximum tensile strength in N/mm^2

Table -5: Ultimate stress, strain value of bamboo

Sample No.	Type of Sample	Strain	Stress (N/mm^2)
T1	With Node	0.0028	135.92
T2	With Node	0.0029	136.32
T3	Without node	0.054	349.21
T4	Without node	0.065	349.69

III. RESULT AND DISCUSSION

In this experimental study we got following results.

- Tensile strength of with node bamboo strip is 135.92 N/mm^2.
- Tensile strength of without node bamboo strip is 349.69 N/mm^2.
- Bamboo having 0.7 times less load carrying capacity than steel.
- Bamboo having good physical and mechanical properties as compared to steel and also easily available in nearby locality. It reduces construction material cost up to 40 to 50 % than steel.
- Bamboo is an eco-friendly replenish able agricultural resource material which is abundantly available in our country. Thus it would be expected that bamboo can be used as a low cost constructional material.
- In this experimental study it is found that tensile strength of bamboo is approximately one half that of mild steel.

Bamboo gives more strength along fiber, and less across the fiber. Bamboo is weak at nodes.

IV. CONCLUSION

The bamboo Culm, in general, is a cylindrical shell, which is divided by transversal diaphragms at the nodes. Bamboo shells are orthotropic materials with high strength in the direction parallel to the fibers and low strength perpendicular to the fibers. The thickness and strength of bamboo, however, decreases from the base to the top of the bamboo shell.

In this paper work attempt is made to find out tensile strength of Chandrapur bamboo over steel. Tensile strength of bamboo with node is 135.92 N/mm^2 and bamboo without node is 349.21N/mm^2. Bamboo gives more strength along fiber, and less across the fiber. Bamboo is weak at nodes.

From above experimental study we can say that, bamboo can used as a main reinforcement in concrete structures like slab, beam, and column etc. because bamboo takes tensile load safely and gives sufficient warning before failure.

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