Determination of Mechanical strength of Bamboo Reinforced Beam

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Abstract

The indiscriminate construction of facilities contributes to rapid environmental disruption. The energy-intensive steel, cement, synthetic polymers and metal alloys used in building activities are also polluting the atmosphere during its life cycle. It can measure resources and economies through the application of best available technologies such as bamboo for engineering applications. Bamboo is chosen, since it is neither a grass nor plant which is sustainable with a property of high strength and carbon sequestration. In this project an attempt is going to do for predicting the flexural behavior of bamboo reinforced concrete. Bamboo is used as reinforcement in concrete by determining the various physical and mechanical properties of bamboo. The investigations conducted for the tested types of bamboo are evaluated using the same accept criteria as that of steel. This study investigates the flexural strength and load deformation of behavior of BRC by experientially and In addition, bamboo 's strength is as strong as stainless steel and its stiffness is as strong as carbon fiber as concrete reinforcing.The findings of bending testing revealed that the strengthened cement beam in steel has the strongest bending power than others. However, in contrast with the cement framework of simple concrete bamboo reinforced concrete frames (treated and untreated). For lightweight frameworks such as a pillar and slab for the small frame, it may also be suggested to use a bamboo-reinforced concrete framework.

Key Word: concrete,polymers,bamboo,mechanical strength,

I. INTRODUCTION

It is made up of a number of materials, and there are specific structural and mechanical properties of each bamboo species such as trees; teak, oak, or balsa are not alike. Additionally, depending on age and moisture of the bamboo being tested and its roots (sol, height and environment conditions) and part of the tested stem (below, center of the "forest" or the top), one bamboo form may give slightly different results for testing. Another significant explanation for the lack of knowledge is the comparatively uncommon usage of bamboo poles in Europe and North America as building material (partly because temporal bamboo is primarily manufactured in tropical countries). And over the last 30 to 35 years were the mechanical properties of bamboos checked scientifically. In the majority of countries there is no specific bamboo building code, which is hard for those who want to use this material to build. Law confusion occurs in deciding certain properties of bamboo (including fire resistance, strength, longevity etc.), so regulations and requirements are desperately required.

In laboratories around the world, bamboo strength properties have been studied and have obtained excellent performance, which are several times quite superior to traditional building materials. However, requirements for building codes not only require the material's strength properties to be recognized, but they do need to be taken account of the following specific characteristics:

- Toughness
- Fire security
- Environmental impression
- User Security

- Energy productivity

1.1 Reinforced concrete

Reinforced concrete, where concrete is included in steel, these two materials work together to withstand drag. Reinforcement bars, rods or nets absorb tensile, shear, and sometimes compressed pressure in concrete structures.

Figure 1**Reinforced concrete**

1.2Significance of Bamboo Reinforced Concrete

The demand for steel as reinforcing materials increases in most developing countries. In some cases, not enough production could be found to meet steel demand. Therefore, it is necessary to choose a more valuable alternative to steel. It has been found that bamboo is prolific and flexible, so that it can meet the needs is to an appropriate replacement for a steel as a reinforcement material. The bamboo structure gave this property its origin. Hollow tubular structure is characterized by high wind resistance in natural habitats. An innovation that addresses bamboo weaknesses and suggests bamboo as an alternative to structural steel would be a good choice.

1.3Bamboo used as Reinforcement

The materials cast-off as concrete strengtheners must demonstration all the necessary characteristics for structurally active loading of the unit. For steel, we manufacture steel as required and check standard inspection core strength values.

1.4 Bamboo for Reinforced Concrete

Color and Age – Color and use of age clear bamboo brown. This indicates that the bamboo is at least 3 years old.
Diameter - use long, thick legs
Harvest - try to avoid harvesting these bamboo in the spring or summer.
Species –Among the 1500 types of bamboo, the best species must be examined and tested to meet their requirements as booster material.

1.5Material Properties of Bamboo - Reinforced Concrete

The fibers are extremely quality and the cross path is of low intensity. The cellulose fibers are oriented against the length of the composite substance of bamboo. It has dense, dense bamboo fibers, which withstand powerful winds. That is the key explanation of bamboo.

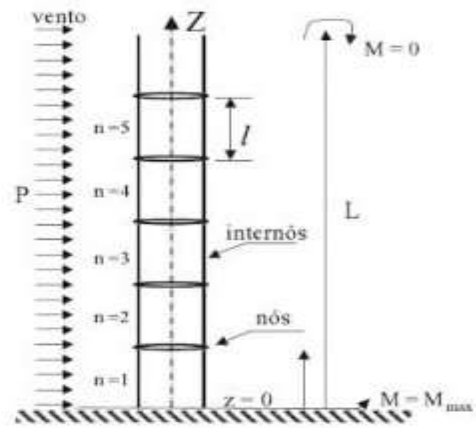

Figure 2 Basic Diagram of a Bamboo

The nodes visible in bamboo are represented by n. The side load "p" it bears produces the maximum moment when supporting. It forms a cantilever structure.

II.COMPRESSIVE STRENGTH BAMBOO MATERIAL

Curiously, the ISO 22157 standard only describes a test method parallel to the compression strength of the grain, and does not provide a method perpendicular to the pressure strength of the grain.Because of the natural form of the bamboo "forest," it is important to check three separate sections of the stem: bottom, middle, and top. This is important because of the fact that the bamboo leg has no continuous cross section and the structural characteristics vary between the lower section with the greater diameter and the top section with a smaller diameter.
Test cannot have nodes and the findings of such experiments are not identical since the nodes in the bamboo stem are the strongest regions. The segment between the two (inner) nodes must then be taken for the test sample, since it is the weakest portion of the bamboo electrode.

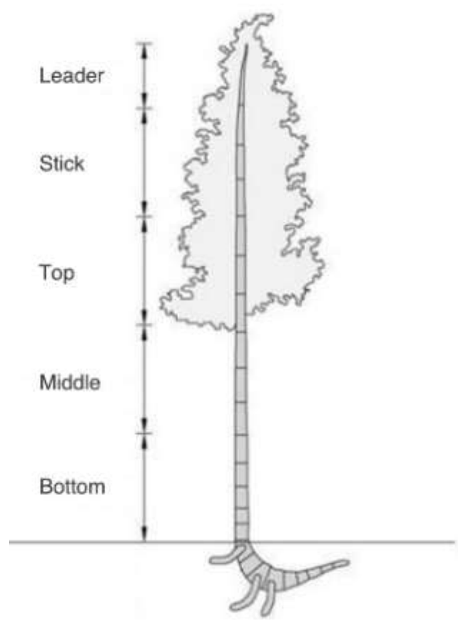

Figure 3 *Stem of Bamboo*

The foundation, center, and top may be used as columns or beams only for building purposes. Because of its limited diameter, 'leading' sections and 'sticky' bamboo poles are not useful in construction.

III. RESEARCH BACKGROUND

1. Bhimarao&Patil (2019) published a paper concentrated mainly on bamboo improvement, double-shear, flexural resistance, friction power, low weight, earthquake protection. They study of the comparison of cost, double shear, flexural strength & tensile strength of bamboo reinforcement with regularly used steel reinforcement. Recently Global warming is the major issue on which we want to focus. Generally in construction steel reinforcement is used but they know that the production of steel is very harmful for nature.
2. Sutharsan et al. (2020) presented a paper the key fields of research were steel strengthening, bamboo, resilience and flexural, "Enhanced substance in concrete" "experimental study of bamboo." The key goal is to replace traditional items such as steel with bamboo sticks which are already usable. Bamboo is ideal for reinforcement as it has very high friction and compressive power. The bending power of the bamboo beam demonstrates greater strength that tends to enhance bamboo use.

3. Viswanathan et al. (2019) This paper compare the strength between steel reinforcement and bamboo reinforcement. The strength of the bamboo reinforcement is improved by wrapping fibers. The replacement of steel reinforced with bamboo reinforced is an important factor as it improves economical aspect as well ecological benefits. To analyses the strength of the bamboo reinforcement beam in the size of 700 x 150 x 150 mm. This paper is designed by using basics of shearing and deflection.
4. Ghante&Shivananda (2019) published a paper "Bamboo reinforced concrete beams experimental research on strength and resilience" primarily based on bamboo reinforced cement frames, bamboo breaks, magnesium sulfate solution, potassium chloride solution, flexural strength , tensile strength. This paper discusses the bending power of BRC beams and the resilience of bamboo as a structural strengthening. The analysis used 1.25 percent and 2.50 percent of standard bamboo and adjusted bamboo as beam reinforcement.

5. Mishra et al. (2019) published an article was emphasized mainly . The emphasis of this inquiry was on the usage of bamboo as an alternate beam joint strengthening material. The comparison research is performed with and without water repellent treating bamboo-reinforced beam-column joints with steel-reinforced beam-column joints. The bamboo-reinforced beam-column joints had the overall load-bearing capability considerably higher than that of joints without waterproof care.
6. Karthik et al. (2017) published a paper "Strength properties of bamboo and steel reinforced concrete containing manufactured sand and mineral admixtures" Mainly based on, steel strengthening, bending power, GGBS, fly ash and energy. In this analysis, bamboo strips were used to strengthen concrete, made of additional cement materials and partial removal of the river sand (M-sand). Cement has been partly supplemented by 25% of the mixture of fly-ash and ground-granulated blast-furnace-slag (GGBS).
7. Dewi&Nuralinah (2017) published a paper "Strength properties of bamboo and steel reinforced concrete containing manufactured sand and mineral admixtures", they focused mainly bamboo reinforced. The usage, more easily applied and added benefit in cost and environmental protection of bamboo for environmentally-friendly building materials is very important to research further.The application of the pins along the beam will improve the potential for tensile load bearing. Additional strengthening raises the successful tension from 45 MPa to 90 MPa. A strong radiation-column relation would be possible with the use of fittings for reinforcement including hooks on steel reinforcement. For the next test, another form of pins was important. For precast buildings and earthquake-resistant systems the usage of lightweight materials is very beneficial. In spite of the socially sustainable application of building and manufacturing waste.

8. Siddique et al. (2017) they focused mainly Bamboo reinforcement, Flexure test, and Composite beam. This paper emphasis of behavior of a Composite material that is Bamboo as a Replacement for Reinforcement in concrete. Mechanical properties of Bamboo are studied and basic testing like Water Absorption tests using two different coating, Compression test of bamboo are carried out.

IV. TEST EXPERIMENT FORCEMENT AND BAMBOO

4.1 Cement

Cement is a material, generally in powder from,that can be made into a paste usually by addition of water and, when poured,set into a solid mass. Numerous organic compounds used for adhering, or fastening materials, are called cements.Cement, when mixed with coarse aggregate, fine aggregate and water it made concrete. The function of cement is first of all to bind the sand and stone together and second to fill up the voids in between sand and stone particles to form a compact mass. In the building and manufacturing industry, even in addressing specific technical problems, we have a broad range of cements. These cements may have very different chemical compositions, but

Portland cements manufacture the largest volumes of concrete nowadays. The manufacture of Portland cement is very easy in nature and relies on the usage of plenty of raw materials. Intimate mixture, normally of calcareous and clay, is heated to 1400 to 1600 ° C, the temperature range beyond which the two compounds chemically combine in order to form calcium silicates. High quality cements need appropriate pure and stable raw materials. Calcium carbonate (calcium carbonate) is the most common calcium oxide source, but other forms of calcium carbonate are used (usually the iron-bearing alumino-sillicates are used as a main source of silique, while clay or silts are preferred as they are already in a thinly divided state.The most widely used cement is Portland cement. Portland cement is manufactured by grinding together calcareous (limestone, chalk, marl, etc.) and argillaceous (shale or clay) materials in approximate proportion of 2:1 and other silica, alumina or iron oxide bearing materials. The most important type of cement is Portland concrete known as (Ordinary Portland Cement). The OPC is graded in three grades: 33, 43, and 53 based on the 28-day intensity.

Figure 4 Cement

Name of Compound	Formula	Abbreviated Formula	% Content
Tricalcium Silicate	$3CaO.SiO_2$	C_3S	40-55
Diacalcium Silicate	$2CaO.SiO_2$	C_2S	15-30
Tricalcium aluminate	$3CaOAl2O_3$	C_3A	8-11
Tetracalciumaluminoferrite	$4CaOAl_2O3Fe2O_3$	C_4AF	13-17

Figure 4 (a)Typical composition of OPC

Cement is the most important ingredient and act as a binding material. OPC is used for casting concrete. The cement was of uniform grey color and free from any hard lumps and was bought from a local vendor. In this research we use Ordinary Portland Cement (OPC) of 43 grade of brand Ambuja Cements form single batch through the investigation was used.

Lime (CaO)	60 to 67%
Silica (SiO2)	17 to 25%
Alumina (Al2O3)	3 to 8%
Iron oxide (Fe2O3)	0.5 to 6%
Magnesia (MgO)	0.1 to 4%
Sulphur trioxide (SO3)	1 to 3%
Soda and/or Potash (Na2O+K2O)	0.5 to 1.3%

Figure 4 (b)The chief chemical constituents of Portland cement

Portland Cement	Normal	Rapid hardening	Low heat
(a) Composition: Percent			
Lime	63.1	64.5	60
Silica	20.6	20.7	22.5
Alumina	6.3	5.2	5.2
Iron Oxide	3.6	2.9	4.6

Figure 4(c) Composition and compound content of Portland cement

4.1.1Tests on Cement
Apparatus

Vicat's apparatus with mould, Plunger, Balance, Measuring cylinder, Non-porous plate.

Procedure
A paste of weighed cement content must be prepared for a weighted quantity of drinking water (measuring time not lower than 3 minutes and not higher than 5 minutes). Note the time to measure when water is added to dry cement until the mold is filled. Fill the Vicat'smould with the paste, smoothen and level it to the top of the mould.

Place the test block and the mould together with a non-porous resting plate under the plunger
Lower the plunger gently to touch the surface of test block and quickly release, allowing it to sink into the paste.
Prepare trial pastes with various % of water and carry out tests as above until the amount of water necessary for penetration of the Vicat's plunger to 5mm to 7mm from the bottom is determined.

Results
Express the amount of water as % by weight of dry cement.
Initial and Final Setting Time

Apparatus
Vicat's apparatus with mould and non-porous plate, Initial setting time 1 sq. mm Needle, Final setting time 1 sq. mm Needle with enlarged base, Balance, Measuring cylinder, Stopwatch, Thermometer.

Samples
Cement, Potable water.

Procedure
Weigh about 300gm. of neat cement
Time will be recorded with stopwatch from the time the water is added. Standard needle will be placed on the test block and time will be observed when the needle fails to pierce the block beyond 5.0 +/- 0.5 mm (measured from the bottom of the mould) The time difference between the starting time when water is added to cement to the time mentioned in (v) above will be noted as initial setting time.
The needle with annular attachment will be used for determining final setting time.
The cement shall be considered as finally set when upon applying the needle gently to the surface of the block, the needle makes an impression thereon, while the attachment fails to do so.

Figure 5 Vicat'sApparatus

V.METHODOLOGY & TESTS OF BAMBOO

5.1 Test Experiment for Bamboo

Tests were performed: bamboo tension pressure checks, bamboo stress tests and bending beam tests. Universal control machine (UTM) with a capacity of 2 tons, used for stress checking for bamboo. Tests conducted with hydraulic jackets for the bending power of the concrete filling system.

S. No.	Type of Testing	Specimens
1	Compressive Test of Bamboo	One
2	Tensile Test of Bamboo	One
3	Beam Bending Test	M-25

Figure 6 Test Experiment for Bamboo

VI. RESULTS AND DISCUSSION

6.1 Flexural strength

Bamboo beams (BRC), treated beam reinforced bamboo (TBRC) and steel reinforced concrete (SRC) beams were tested for all sizes of flexural intensity (150x150x700 mm and 150 x 200 x 700 mm), and the experiments were conducted on single concrete beams (PCC) (BRC). The charges of the beam and the degree of loss were measured during the experimental study. There have been reported cumulative failure loads. At the same time, the beams under load is discharged by means of the dial indicator, which was used in experimental implementation. In this load deflection curve, maximal bending moment was plotted.The bending power of TBRC was greater than the flexing force of BRC, according to the experimental findings for both bamboo beams. That may be because the bamboo is durable by putting a paint on its surface and because of sand binding on the back of the bamboo. This has increasing the bonding potential.

Table 1 Flexure test results of PCC1, BRC1, TBRC1 and SRC1 beams at 7, 14&28 days

Beam designation	**Avg. Flexural**	**Percentage variation in**	**Avg. Flexural**	**Percentage variation in**	**Avg. Flexural**	**Percentage variation in**
for beam of size	**strength at 7**	**flexural strength with respect to PCC1 beam**	**strength at 14**	**flexural strength with respect to PCC1 beam**	**strength at 28**	**flexural strength with respect to PCC1 beam**
150 x 150 x 700	**days (N/mm2**		**days (N/mm2**		**days (N/mm2)**	
mm						
PCC1 beam	**2.68**	**0%**	**3.01**	**0.00%**	**3.88**	**0%**
BRC1 beam	**3.57**	**38.88%**	**4.10**	**36.32%**	**5.99**	**57.23%**
TBRC1 beam	**4.89**	**56.33%**	**6.10**	**48.80%**	**6.59**	**69.73%**
SRC1 beam	**10.9**	**293.91%**	**13.46**	**221.65%**	**14.84**	**278.80%**

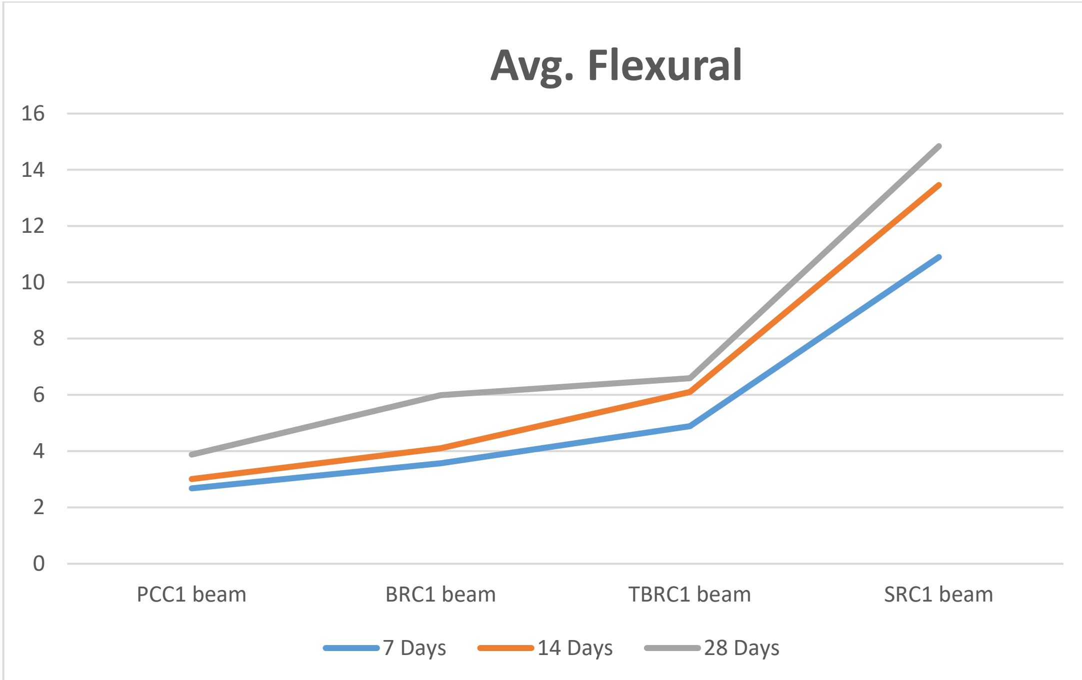

Figure 7 Figure shows that the avg. flexural strength in 7 ,14 and 28 days

Fig above, the flexural strength of PCC1 beam with respect to other BRC1, TBRC1 and SRC1 beams at 7, 14 and 28 days are found 5.99 N/mm2, 6.59 N/mm2 and 14.84 N/mm2 respectively.

Table 1Flexure test results of PCC2, BRC2, TBRC2 and SRC2 beams at 7 & 28 days

Beam designation	**Avg. Flexural**	**Percentage variation in**	**Avg. Flexural**	**Percentage variation in**	**Avg. Flexural**	**Percentage variation in**
for beam of size 150 x 200 x 700 mm	**strength at 7**	**flexural strength with**	**strength at 28**	**flexural strength with**	**strength at 28**	**flexural strength with**
	days (N/mm2	**respect to PCC2 beam**	**days (N/mm2**	**respect to PCC2 beam**	**days (N/mm2)**	**respect to PCC2 beam**
PCC2 beam	**2.98**	**0%**	**3.59**	**0%**	**4.18**	**0%**
BRC2 beam	**3.88**	**30.20%**	**5.09**	**41.00%**	**6.27**	**50%**
TBRC2 beam	**4.48**	**50.34%**	**5.60**	**55.98%**	**6.76**	**64.12%**
SRC2 beam	**10.92**	**266.44%**	**12.55**	**249.58%**	**14.89**	**258.13%**

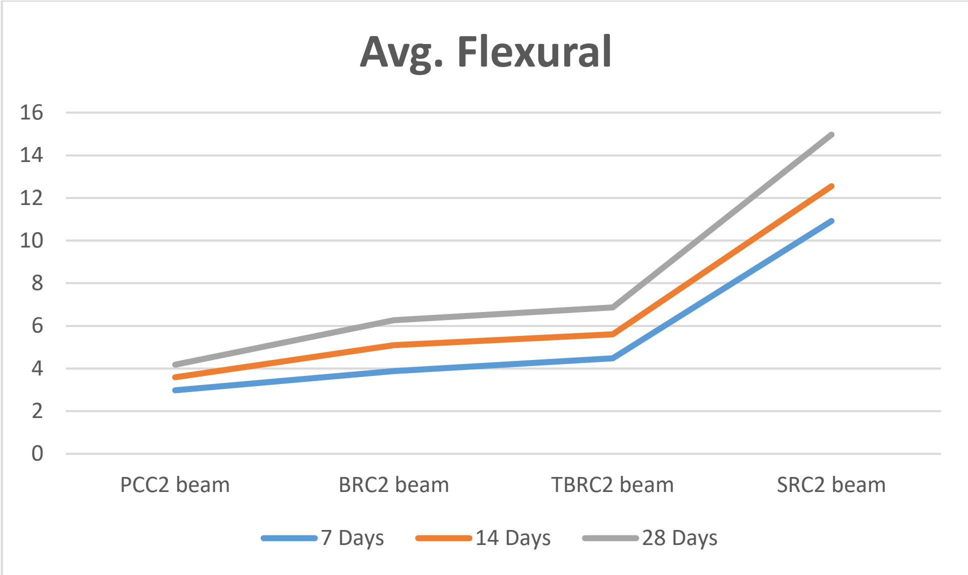

Figure 8 Figure shows that the avg. flexural strength in 7 ,14 and 28 days

Fig above the flexural strength of PCC2 beam with respect to other BRC2, TBRC2 and SRC2 beams at 7, 14 and 28 days are found 6.27 N/mm2, 6.76 N/mm2 and 14.89 N/mm2 respectively.

Specimen No.	Avg. Area (mm2)	Failure Load (kN)	Stress at Failure (MPa)	Failure type
1	195	17.9	85.9	Splitting and failure at grip
2	183	19.5	107.6	Failure at node
3	150	24.5	154.5	Splitting and failure at grip

Figure 9 Tension Test for Bamboo Reinforcement

The study shows that the bamboo specimen's failures trend is standard division without grasp. The separation becomes similar to the grain and extends around the knot until gradually more than one position exists. It can be seen from these findings that the tensile strength is almost universal and the failure trend for specimens of bamboo where failure in grip was avoided is identical. The tensile strength of bamboo specimens with prepared ends is often greater (to resist grip failure) than the respective bamboo specimens without prepared ends (grip failure).

Table 3 Max Deflection (mm) and Ultimate load (kN) (Specimen-1)

Max Deflection (mm)	Ultimate load (kN)
8	1
15	3
23	4
33	6
42	10
57	16
64	18
77	22
83	34
88	40
90	50

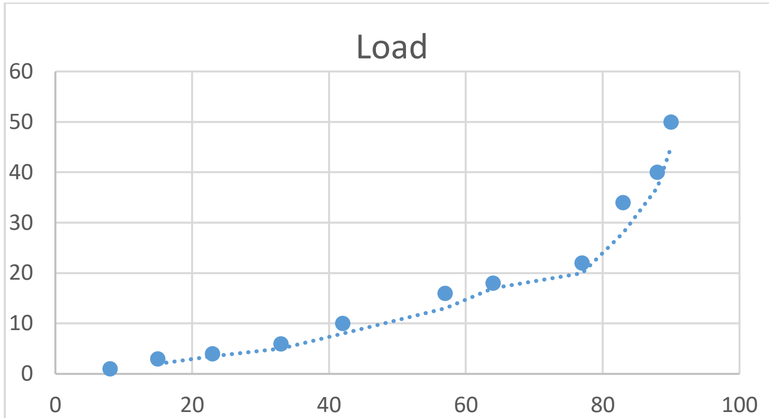

Figure 10 Max Deflection (mm) vs. Load Ultimate load (kN) specimen -1

Table 4 Strain and Stress (N/mm) (Specimen-1)

Strain	Stress (N/mm)
0.3	0.005
0.6	0.01
1.05	0.015
1.5	0.02
1.90	0.024
2.50	0.028
2.75	0.037
3.5	0.048
3.65	0.06
3.80	0.78
4.0	0.1

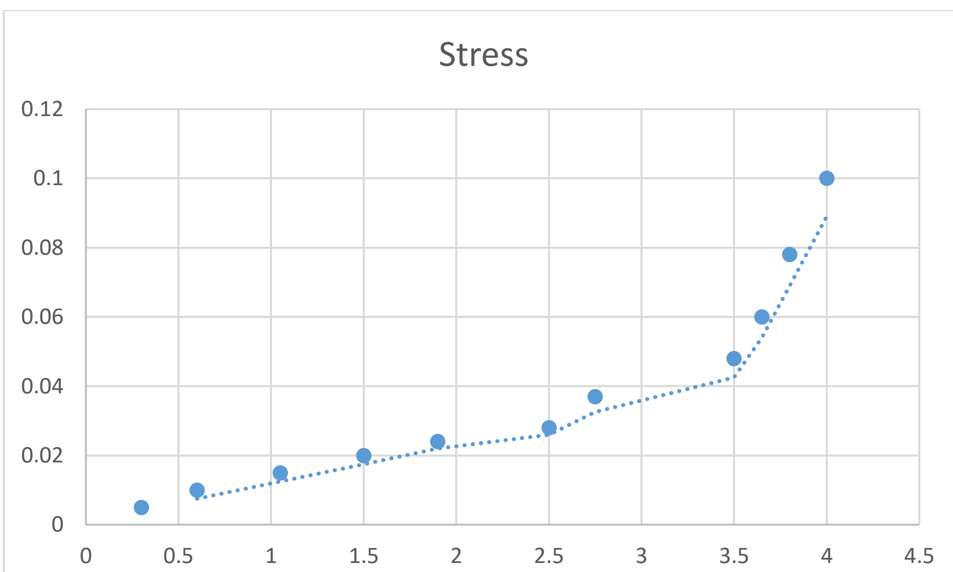

Figure 11 Strain vs. Stress (specimen -1)

6.2 Experimental result for specimen -2(convention bamboo reinforced)

Table 5. Max Deflection (mm) and Ultimate load (KN) (Specimen-2)

Max Deflection (mm)	Ultimate load (kN)
1	5
3	12
5	24
6	32
10	42
15	55
18	62
25	75
30	80
40	88
50	92

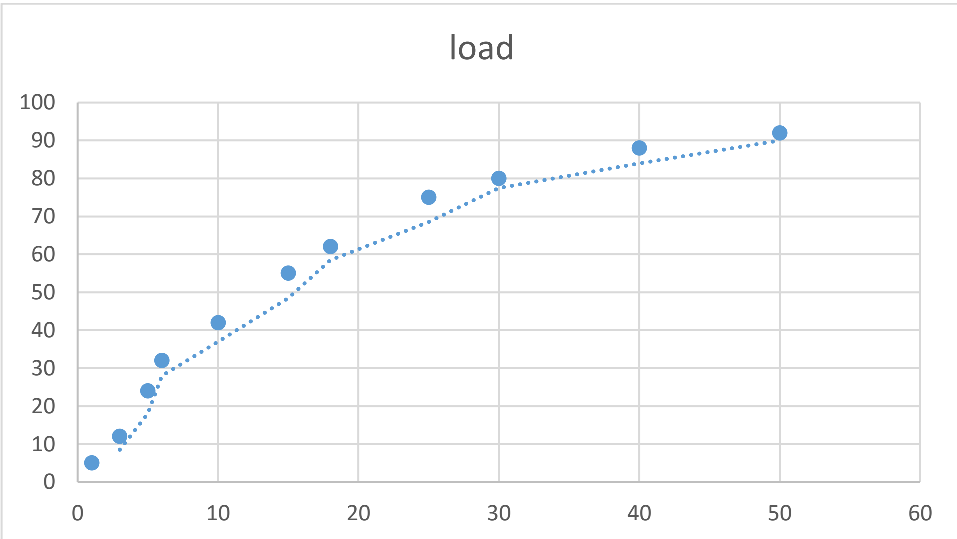

Figure 12 load vs. deflection specimen -2

Table 6 Strain and Stress (N/mm) (Specimen-2)

Strain	Stress (N/mm)
0.005	0.1
0.015	0.5
0.02	1
0.021	1.5
0.025	1.9
0.03	2.5
0.04	2.75
0.048	3.3
0.06	3.7
0.08	3.9
0.1	4

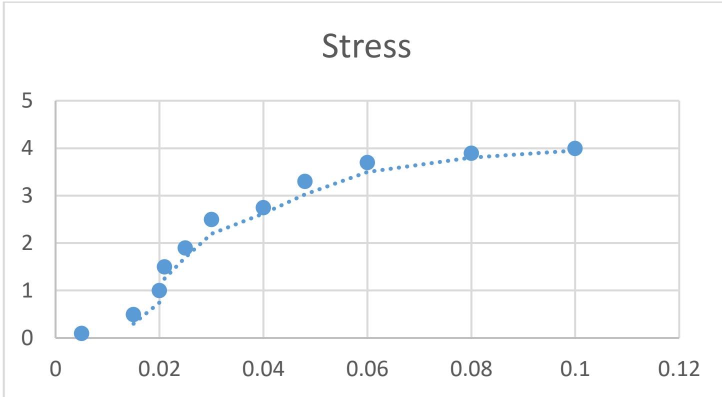

Figure 13 stress vs. strain specimen -2

Table7 Max Deflection (mm) and Ultimate load (KN) (Specimen-3)

Max Deflection (mm)	Ultimate load (kN)
0	0
0.5	2.5
0.6	5
1	6
2	7.5
4	10
9	15
12	16
20	22
30	25
40	27
50	28
60	28

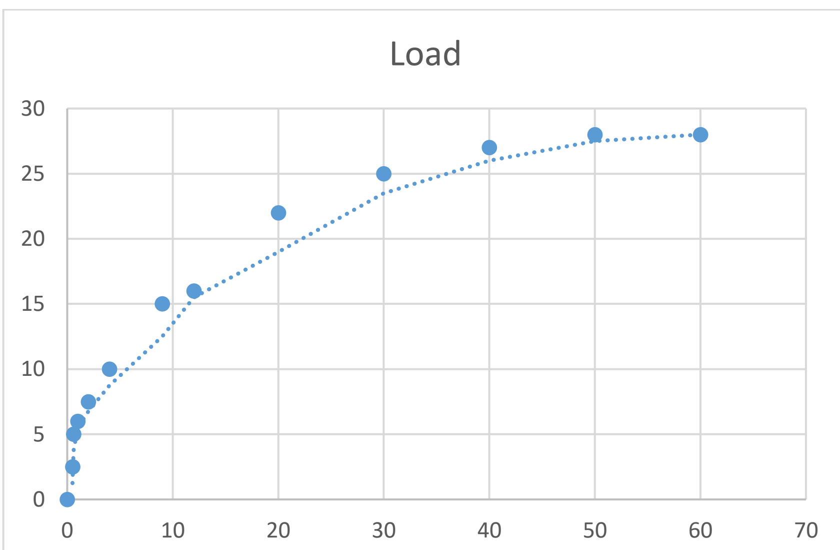

Figure 14 load vs. deflection specimen -3

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Table 8 Strain and Stress (N/mm) (Specimen-3)

Strain	Stress (N/mm)
0	0
1000	0.005
1100	0.01
3000	0.02
8000	0.03
10000	0.031
15000	0.035
20000	0.04
25000	0.048
30000	0.05
40000	0.52
50000	0.55
60000	0.54
70000	0.54

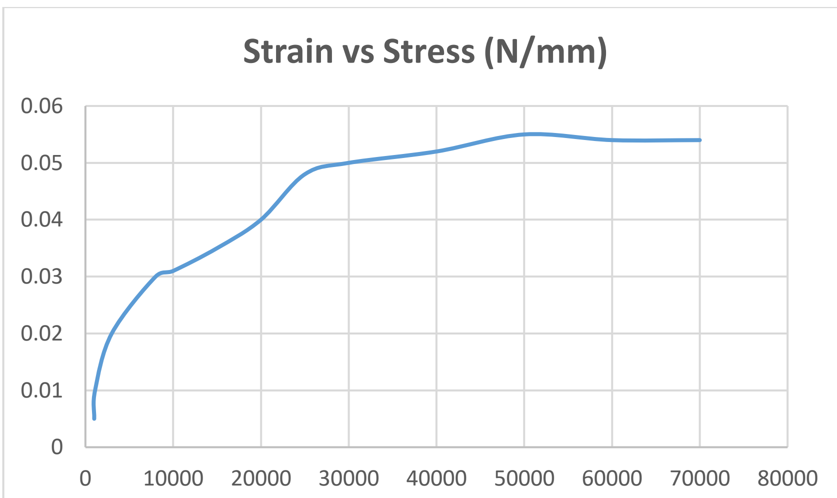

Figure 15. stress vs. strain specimen -3

VII. CONCLUSION & FUTURE SCOPE

The discoveries of bowing testing uncovered that the reinforced concrete pillar in steel has the most grounded twisting force than others. In any case, interestingly with the concrete structure of basic solid bamboo fortified solid edges (treated and untreated). For lightweight systems, for example, a column and chunk for the little edge, it might likewise be recommended to utilize a bamboo-strengthened solid structure. The outer edge may likewise be utilized. Beton and steel are maybe the world's most generally delivered development items. The quality of steel comparative with concrete is extremely solid, anyway different issues exist. Any of these issues include a huge expense of yield, a solid power utilization during improvement, a non-sustainable asset, and a high level of carbon contamination. The desire not to endanger the elasticity of fortified cement has driven numerous researchers and specialists to scan for neighborhood materials to supplant customary steel reinforcing. Bamboo is, truth be told, one of the most appropriate items for the utilization of concrete as strengthening square. The appropriateness of bamboo as solid fortification was tried in the stage. Beton and steel are perhaps the world's most commonly produced construction products. The strength of steel relative to concrete is very strong, however other issues exist. Any of these issues involve a large cost of output, a strong electricity usage during development, a non-renewable resource, and a high degree of carbon pollution. The urge not to jeopardize the tensile strength of reinforced concrete has led many scientists and engineers to search for local materials to replace traditional steel strengthening. Bamboo is, in fact, one of the most suitable products for the use of concrete as reinforcing block. The suitability of bamboo as concrete reinforcement was tested in the phase. The outcome shows that the bamboo Significantly fundamentally affected the existing structure.

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