

# CONSTRUCTION OF COMPOSITE STEEL AND BAMBOO REINFORCEMENT

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## Abstract-

*This paper scrutinizes the Design and analysis of Quality Control Lab and Office Building by insinuating Bamboo Reinforced Concrete (BRC). BRC structure are currently developing and using alternate material to reduce the usage of steel, where the necessity of Reinforcement Steel is Notable needed we can use Selective Bamboos as Replacement of Steel Reinforcement. Increasing the BRC for constructions have shown that it's comparatively shows Close results to the steel reinforcement in the Tension Zone. Bamboo is botanically belongs to family "poaceae", the crop growth within 3 years period. In comparison between the steel and Bamboo, the load carrying capacity is low when it is fully replaced. When it comes to Partial Replacement of bamboo is shown comparatively good result in the mechanical properties with SRC and the cost of the steel is high than compared to bamboo and it has good tensile strength and compression strength in this paper we introduced partial replacement of src with brc in construction.*

**Key Words:** BRC, SRC, POACEAE, TENSILE STRENGTH, COMPRESSION STRENGTH

## 1. INTRODUCTION

The building sector in India is increasing at a rapid pace and contributing immensely to the growth of the national economy, in general steel and bamboo are structural materials with different engineering qualities used for the construction of buildings and other engineering construction related purposes, steel reinforced concrete is mostly used for construction of high load bearing structures, however factors such as high cost and non renewability are the major concerns of the current construction industry. Though the tensile strength of steel is 2.5-3.0 times higher than bamboo, the specific gravity 6-8 times that of bamboo, but counting their tensile strength strength/unit weight (bamboo vs. Steel), the tensile strength of bamboo is 34 times that of steel, therefore it is essential to understand and compare the seismic behavior of the bamboo reinforced concrete and steel reinforced concrete structural members.

### 1.1 Objective:

- To plan a quality control lab
- Partial replacement of BRC with SRC for a cost control project
- To design the BRC structure based on Indian standard code book
- To analyses the structure using staad pro software

## 2. SELECTION OF BAMBOO:

- The following factors should be considered for the selection bamboo
- The bamboo should be in brown color it will indicate the bamboo is at least 3 years old
- Select longest length of Clumps
- Avoid the Clumps which are in green color
- Avoid bamboo cutting in spring or early summer because the clump may contain moisture content

**2.1 MATERIALS:**

- Bamboo:- bamboos Tulda
- Steel:- Fe500 Grade of Steel
- Cement: Ordinary Portland Cement, Grade: 53 grade.
- Coarse Aggregate
- Fine Aggregate
- Water
- Anti terminator is applied for Bamboo to make it Pest Free.
- Water repellents : For not absorbing the water and for not swelling while get in contact with water and for good bonding with concrete sikadhur 32 gel
- Galvanized iron wire: To provide frictional grip between concrete and Bamboo.

**3. Preparation of bamboo:**

The bamboo clumps are taken which are brownish in color that indicates the age for bamboo is 3 years and select the longest clump and cut into splints and they are dried for 20 days to remove the moisture content and the splints are treated for not absorbing the water and they coated with water repellent(sikadhur 32 gel) and applying of fine sand of 90 microns for increasing adhesive properties between concrete and splints and for a good friction we used galvanized iron wire (gi wire) of 1mm thick with spacing of 10mm and the moulds of (700x150x150) has taken for the preparation of beams and columns for the testing the mechanical properties.

**4. MIX DESIGN Proportion (as per is 10262: 2009)**

Mix design is the process to find the mix proportion cement, coarse aggregate, fine aggregate, and water for good and to find the accurate strength of the structure.

Mix design M<sub>25</sub> ratio of 1:1.5:3

Per m<sup>3</sup> = 191.6 lit of water

383 kg cement

574.5 kg fine aggregate

1149 kg coarse aggregate

**5. TEST**

The test for the beam and column sample are conducted by using the certified UTM(universal testing machine) the three point loading test is carried out under UTM by making 350mm foe center point load 100mm markings are drawn at the both ends for supporting beam by two rollers from the test we observed load-deflection curve and calculated the flexural strength by using the formula  $F_b = 3PL/2BD^2$  and for the columns the test piece is placed on UTM and a base block and moving down the central grip to apply load  $l_e/d = 700/150 < 12$   $5 < 12$  the graph plotted between stress strain curves are plotted and young's modulus represented for different zones by using MATLAB software.

**Table – 1: Column Displacement**

Columns	Displacement(mm)	Ultimate Load(kN)
C-1	13.86	3.9177
C-2	14.9	2.326
C-3	9.22	3.389

**Table - 2:** Beam Displacement

Beams	Deflection(mm)	Flexural Strength(Mpa)
B-1	21.34	2.00
B-2	21.05	0.435
B-3	15.51	1.495

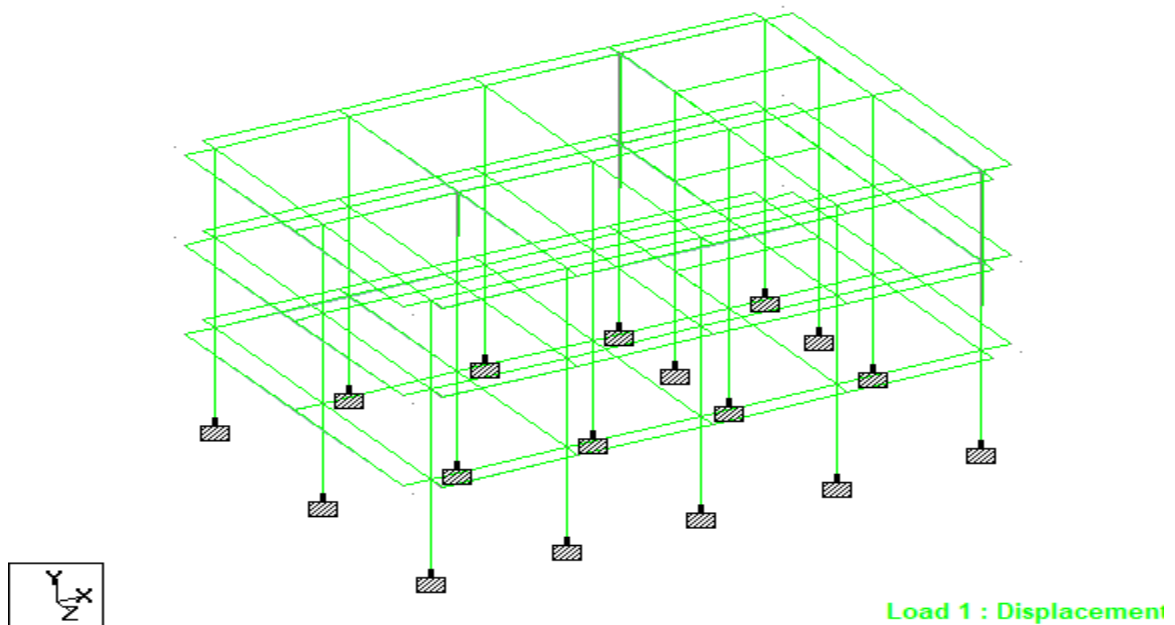
**Table - 3:** Comparison of flexural strength for beams and young's modulus for columns

Columns	Displacement(mm)	Young's modulus(Mpa)	Beams	Deflection(mm)	Flexural Strength(Mpa)
C-1	13.86	16.18	B-1	21.34	2.00
C-2	14.9	8.50	B-2	21.05	0.435
C-3	9.22	13.08	B-3	15.51	1.495

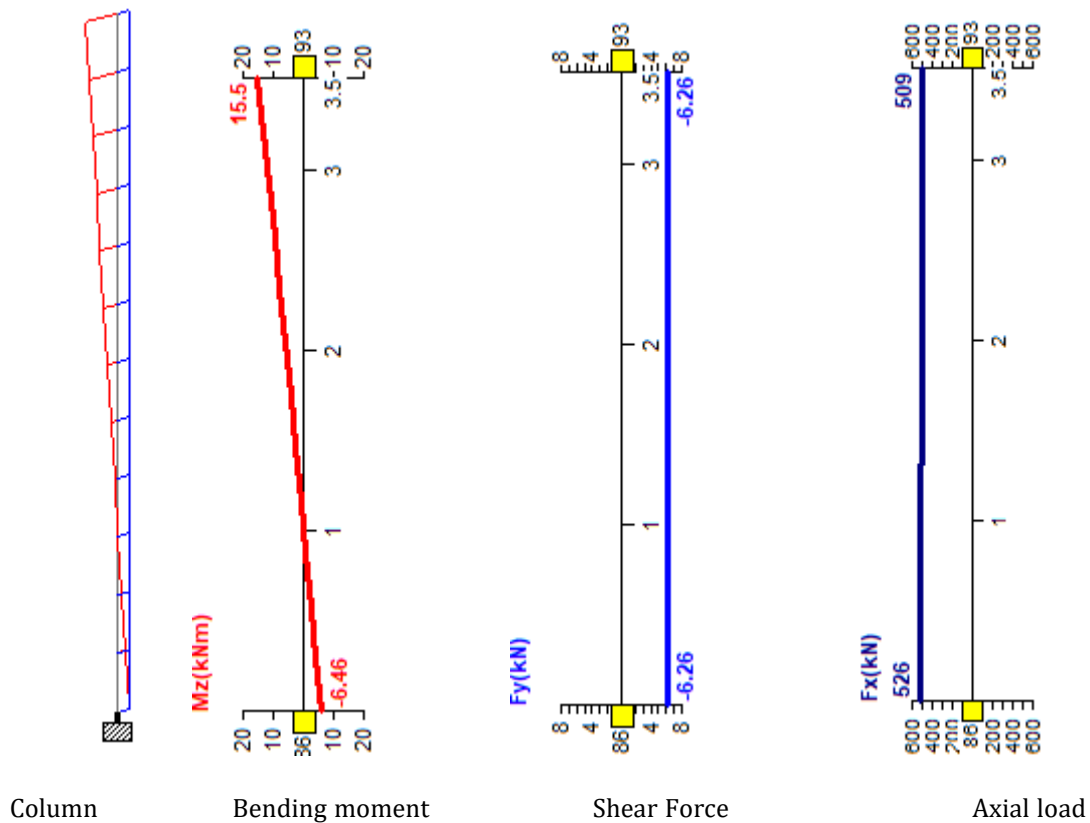
**Table - 4:** Comparison of cost for steel and bamboo reinforcement

Type	Steel reinforcement(RS)	Bamboo reinforcement(RS)	Steel reinforcement(RS)	Bamboo reinforcement(RS)
1 Bar/Splint + 1Stirrup	52+9=61	40+14=54	(52+40)+9=101	
4bars/splints + 5stirrups	(4x52)+(5x9)=253	(4x40)+(5x14)=230	-	
2bars+2splints +5stirrups	-	-	(2x52)+(2x40)+(5x9)=229	

## 6. Staad pro results



**FIG - 1:** Isolated view of the structure



### 7. Methodology:

1. Planning of g+2 laboratory building
2. Design and analysis using staad pro
3. Designing the partial brc structure using Indian standards
4. Optimizing the structure
5. Result and Discussion

### 8. Structure profile:

- Type of building : laboratory
- Construction area : Nandyala
- Build up area : 372 sq m
- Structure dimension :27.26m@3.5m height of each floor
- Total height of building : 10.5m

Wind load:

According to IS 456: part 3 the wind load calculations are calculated

- Wind zone : zone III , $v_b=46\text{m/s}$
- $K_1:1, k_2:1, k_3:1, k_4:1$

- $V_z = v_b * K_1 * k_2 * k_3 * k_4$
- $P_z = 0.6 v_z^2$
- $P_d = p_z * k_a * k_d * k_c$
- $F = (c_p e - c_{pi}) * A * P_d$

## 9. LITERATURE REVIEW:

Extraction and preparation of Bamboo Reinforced Composites by Zakikhani et al<sup>1</sup>. says that Bamboo is a Ductile Reinforcing material having some appreciable tensile strength which makes as a suitable for steel due to strong bonding nature gives an excellent material for compression and bending mechanism. Performance of bamboo and steel reinforced concrete by P E H Ab.Rahman, N J A Malek<sup>2</sup> says that the flexural capacity of bamboo reinforced concrete covering slab are 3.02N/mm<sup>2</sup> and 4.39N/mm<sup>2</sup> respectively the result of comparison of flexural strength between steel reinforcement and bamboo meshing shows that the percentage of bamboo are 40.95% and 62.37% lower than steel and he concludes through his experiment that bamboo reinforced covering slab is stiffer than steel reinforcement. Seismic Performance of Bamboo Structure by Bhavana Sharma<sup>3</sup> says that vernacular bamboo construction methods may be formalized into a performance based design framework and understanding both the materials and structural behavior an appreciation of the social and engineering context in which the structure is built the several studies were completed and pushover, dynamic analyses provided information on the capacity and demand on the structure the performance points were obtained and are clearly located within the serviceability limits. A Review on Comparative Study on the Seismic Behaviour of RCC Composite Structures Anuj Kumar Sharma, B.S Tyagi<sup>4</sup> says that the dead weight of the composite structure is less as compared to the RCC structure, so that the seismic forces are not harmful for this type of composite structures the displacement and story drift in RCC structure is less than the composite structures but it is in permissible limit. And flexibility than RCC structure the composite structure gives lateral stiffness and more ductility and the RCC has more weight compared to composite so that the shear is more in RCC than composite structure and maximum bending moment in beams of composite structure is slightly on higher side in some stories than RCC structure and maximum bending moment in columns of composite structure. Experimental investigation on chemically treated bamboo reinforced concrete beams and columns by Atul Agarwal<sup>5</sup> says the feasibility use of bamboo reinforcement is increasing and no of experimental investigations are done the tensile strength and engineering properties of bamboo are good compared to SRC variety of adhesives have been used for the treatment of bamboo for effective bond strength and the most suitable adhesive has selected for casting of bamboo reinforcement and the axial compression and transverse loading tests are performed to check the carrying capacity and lateral deflection and test done for studying of mechanical properties by this we conclude that the proper treatment of bamboo has the potential to partially replace of steel as reinforcement in beams and column member. Experimental Study on the use of Bamboo as structural Reinforcements in RCC structures by Pushpanjali verma<sup>6</sup> says that experimental analysis is done for compressive strength of bamboo specimen and splints with nodes have great strength than that of without nodes this could be because of additional cross section and water absorption is high and better to use some water repellents but the splints can withstand the sufficient tensile loads in a concrete flexural element and the ultimate moment is good for short buildings.

## 10. Conclusion

From the above table and graph it clearly represents that SRC and BRC beam have almost same deflection at point of failure where BRC has 21.7% of strength in SRC beam when steel Bamboo reinforced concrete beam compared with SRC beam the deflection was significantly low at point of failure simultaneously strength of SBRC is increased which is 75% of SRC beam BRC column shows lower young's modulus compared with SRC and SBRC columns. When steel bamboo reinforced concrete

column compared with SRC column the young's modulus is 80% of SRC column where it results in higher stiffness. In addition the SBRC column shows 87% of strength in SRC column and it can also resist the wind forces. From overall discussion we understood that SBRC is suitable for column than beam and the cost is also less than SRC members.

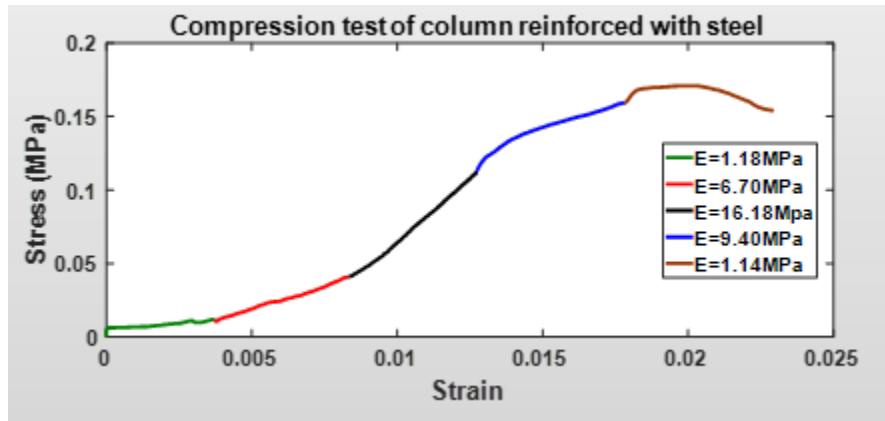


Chart - 1: test of column reinforced with steel

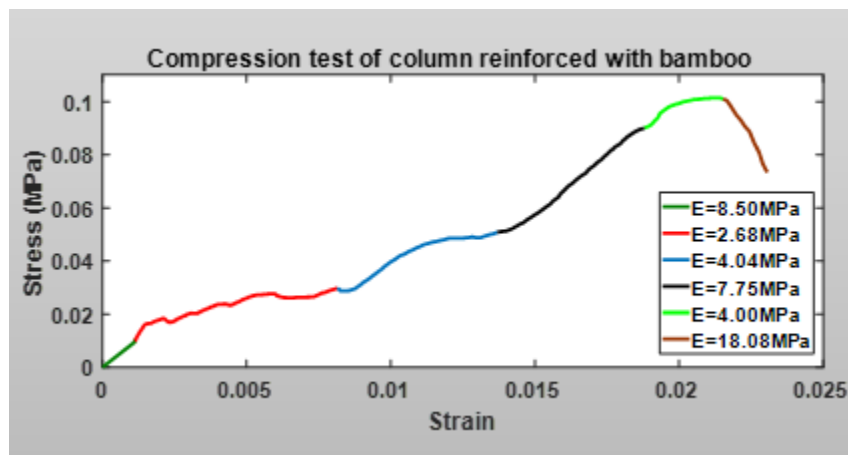


Chart - 2: Compression test of column reinforced with bamboo

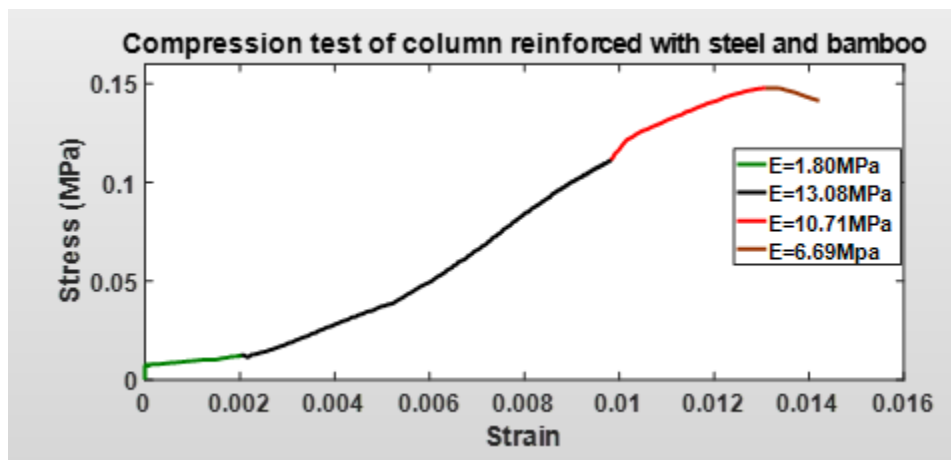


Chart - 3: Compression test of column reinforced with steel and bamboo

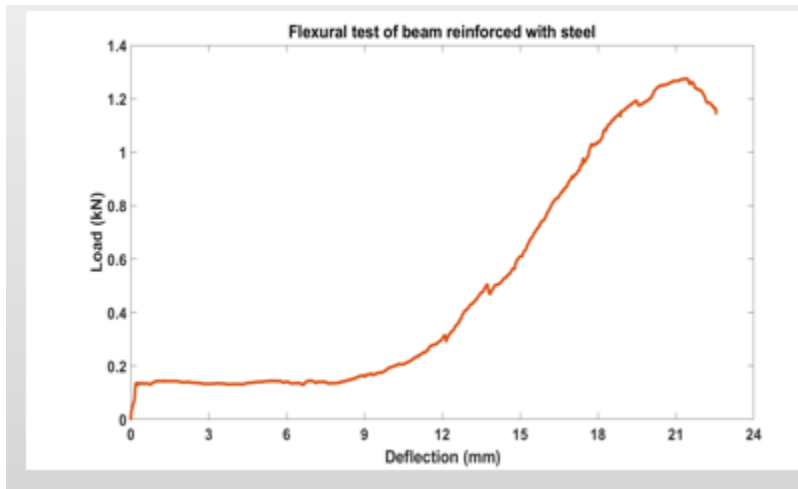


Chart - 4: Flexural test of beam reinforced with steel

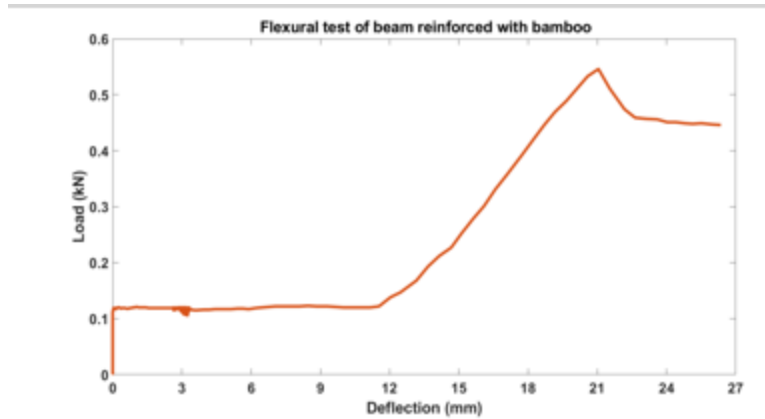


Chart - 5: Flexural test of beam reinforced with bamboo

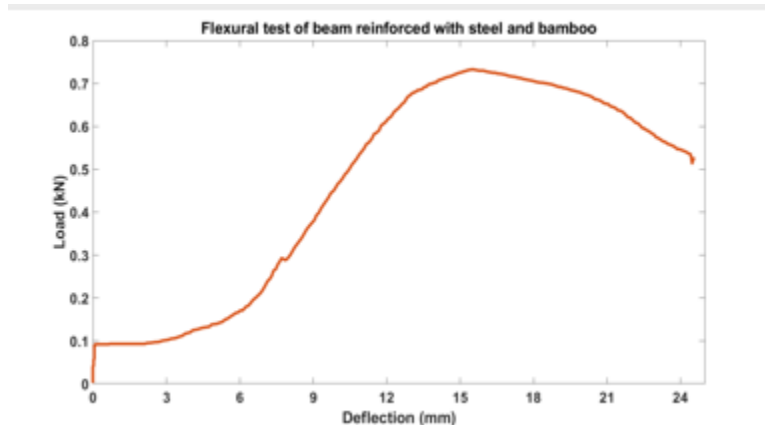


Chart - 6: Flexural test of beam reinforced with steel and bamboo

## 11. Future Scope:

Bamboo is a natural material and has high strength and easy availability and workability. The analysis of the replacement of the Steel with bamboo as reinforcement and the bamboo reinforcement is cheap than the steel reinforcement the advantages of Bamboo is supporting its environment friendly nature and also some disadvantages like absorption of water and smooth wall of the bamboo clump and there is development of a simple design code for the application of bamboo as a construction material. Several researches are on going to overcome these problems many new techniques are being developed which may make bamboo the best constructional material in future and has a wide scope in low cost construction.

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