ISSN: 0974-5823 Vol. 7 No. 1 January, 2022

International Journal of Mechanical Engineering

AN EXPRIMENTAL STUDY OF BAMBOO REINFORCED BEAM-COLUMN JOINT UNDER CYCLIC LOADING

K.Kantharuban *, Dr. R. Venkata Krishnaiah**

***Research scholar, Department of civil engineering, Bharath Institute of Higher Education and Research (BIHER), Chennai-600073, Tamilnadu, India.

**** Professor**, School of civil engineering and Infrastructure, Bharath Institute of Higher Education and **Research** (BIHER), Chennai-600073, Tamilnadu, India.

ABSTRACT

This entire universe requires eco-building materials, because of around 40 % pollution contribution from construction activities only. As part of the above reason, most researchers are focusing on the green building material as much. As part of sustainability this research work also concentrates on natural bamboo reinforcement and the beam-column joints of bamboo reinforcement. The supplementary cementitious materials to building construction are very essential to control pollution. This present report concentrated more on the bamboo reinforced column and beams connection. The beam-column is more responsible to load carrying, earthquake forces, so on. With the step of the first trial, we have taken beam-column joint with different loading systems. This analysis was carried out in the Civil Engineering Structural Laboratory of Bharath Institute of Higher Education University. The resources employed were involuntary bamboo fasten heads finished in 3 dimensions of bamboo columns, BC1, BC2, and BC3. Head region to the bamboo connecting with the scaffolding clamps for BC1, BC2, and BC3 respectively. Were, these three samples of the beam-column combined were experienced utilizing cyclical loading. Deflections for every phase of the loads are plotted, in addition to the association among load & deflection (PΔ & Pε) were distinguished lying on chart document within the appearance of sphere hysteresis. The results point towards that the utmost shear strain attained by the BC1 and BC3 was 17.8 kN. And BC2 had attained 13.76 kN.

1. INTRODUCTION

Construction material using bamboo is not simply renewable other than also plentiful in India and around 1,300 varieties in this universe, among which 26 or 2% originates in India. Bamboo is able to be worn as a substitute intended for steel in reinforced concrete since it has a soaring tensile potency. In adding up, it is rich and extremely cheaper than steel. Also, bamboo is easy to plant and grow up quickly, be able to yield within 3 to 4 years following planting and be capable of yield for a second time the following year.

Numerous classes of bamboo used by the instigator because bamboo bars in concrete, such as 'Indocalamus Wightianus' (Chevani), 'Dendrocalamus Strictus' (Ponmungil), and 'Ochlandra Travancorica' (Kalmungil). Above 3 categories of cane bamboo bars confirm to be particularly appropriate for rienforcement bars in concrete elements. Intended for this learning, the bamboo straps, and the whole bamboo was equipped as follows: 1) The bamboo with the diameter of 10cm to 15 cm and it was cut with the size of 3cm straps and placed for 28 days to get dry; 2) After drying it painted by means of 2 coats of Epoxy to be a water proofer. within the period of one day between all coats; 3) straight away subsequent for the second coat, the newly epoxy coat and bamboo was masked in manufactured sand (M-sand). M-Sand sticks onto the bamboo surfaces and gets better binding with concrete and bamboo, at the same time as soon as the epoxy is dry, it is prepared as bars to reinforcing concrete [2]. the previous investigation by the mastermind [3,4] keen on the expansion of a limited intend for earthquake resistant construction completed with rounded bamboo bars with minimum steel in concrete, carry into individual so as to the majority structural break to the beam-column joints, while, the beams & columns were undamaged apart from a little crack into the parts adjacent to the beam-column joints demonstrating so as to the well service. It was held up through earlier researches in which exterior completed with

rounded bamboo bars has distorted due to cyclical load; the portion of the column was taken to axial loading from a Universal Testing Machine (UTM). The outcome as of axial loading test the controlled columns were able to resist loading between 130 kN and 180 kN. This was go beyond column axial force competence intended for unconventional reinforced concrete columns of 20 kN, which showed that the limited effect worked well and that the bamboo bars still firmly adhered to the concrete. It follows, therefore, that these areas of column joints (reinforced with bamboo bars) require to be strengthened in order to optimize the potency of the entire arrangement. A large amount scrutinize has previously been done into the technicalities of steel bars among others [5, 6, 7, 8], while small or nothing contain been enacted keen on the purpose of bamboo bars in concrete construction.

The intend of this study was to investigate the uniqueness of beam-column joints in a variety of uses through contradictory sized bamboo with clamp-headed bars, qualified experimentally in the laboratory by making use of cyclical load to engage in recreation part of the property of seismic activity. The distinctiveness of the beam-column joints examines are represented in charts of the correlation of the combined shear-force dislocation (PΔ) and charts shows the connection among shear-force strain (Pε) and the prototype of fracture in the Bamboo Strap reinforced concrete has, in addition, to use on behalf of top frame structure. Various revise has been completed (S.M. Dewi [5]), the current explore beginning to employ the light-weight aggregate for concrete to decrease the heaviness of pre-cast structure, and utilize a few pegs captivated to the joints of Structures.

2. DETAILS OF BAMBOO REINFORCED BEAM-COLUMN JOINT

In this study, four bamboo associations were equipped and experienced according to the experiment pattern shown in Fig. 1. The metaphors of these union examples, as well as the quantity of reiteration, are summarized in Table 1. The corresponding load-to-grain relations or extend beyond combined were collected of 3 bamboo components, at the same time as the right angles load-to-grain relations consisted of one major associate and 4 side bamboo.

Table 1. Description of bamboo connection specimens

Joint	Connection	Direction	Samples	Diameter (mm)
BC1	Inserted	Parallel	3	70
BC2	Tie with Nylon rope	Parallel	3	72
BC3	Connected with Clip	Parallel	3	75

Figure 1. Bamboo Beam-Column Joint Pattern

To control the beam-column joint of bamboo reinforcement it should be very well confined. For making the integrity of the beam-column joint by metal anchors with bolts are used. To make a proper connection of beam-column joint is made by making dowel bars with 90-degree bend and connected with beam and column as shown in fig 2 and fig 3.

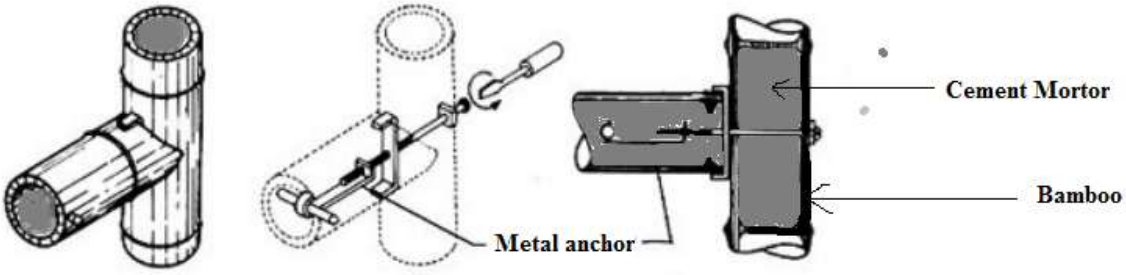

Fig 2.Bamboo Beam Column joint metal anchors with bolts

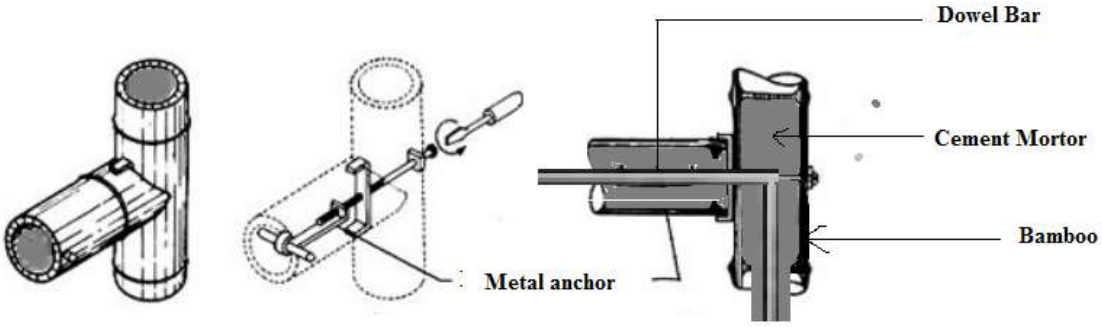

Fig 3. Bamboo Beam Column joint metal anchors and dowel bars with bolts

In this research bamboo beam and column connection were made by 4 different methods and it experimented by various tests. Within a conventional way, construction completed since bamboo use ordinary fiber "Nylon" rope by the region of their bond as shown in Fig. 4. The involuntary attribute of this jointing technique entirely relies on the covering rigidity of the "Nylon" rope, which almost immediately loses its potency outstanding to permanent shrinkage-swelling behavior of bamboo. New improvement set up fastens in bamboo associations [2, 5-7]. It is innermost to make a note so as to in the associations by means of dowel-type tie such as bolt shared; tensile stress perpendicular-to-grain with the intention of try to divide the bamboo constituent come into view as a effect of twisting bend of the pin. Within this lessons, fiber toughened synthetic (FTS) obtainable in the shape of a leaf is worn to envelop the bamboo correlation. FTS fabric at the start was functional in concrete construction intended for increase fractured beams, column and plates as fit. This lesson in universal scrutinize the applicability of FTS as combined strengthening and the conversation resolve the alert resting on cooperative tangential load capability, ductility and slip modulus.

Fig 4. Bamboo joint used ordinary fiber "Nylon" rope by the region of their bond

3. PREPARATION OF SPECIMENS

3.1 Specimens for Test:

The samples are experimentally experienced were 3 concrete beam-column commonly reinforced by means of bamboo bars. Their qualifications and fractious section sizes are shown in the below figures. Vertical column sizes were 200mm x 250mm, and horizontal beam member sizes are 200mm x 250mm. Actual compression potency was 30 MPa. The bamboos hallow and strap bars are made from Indocalamus Wightianus bamboo and engaged as main bars gauge 35mm x 25mm. While, for the stirrup bars completed as of normal steel of 8mm diameter, capitulate strength was 730MPa. Within categorize to fasten the locale of the beam-column joints, 3 variety of perfunctory bamboo fix were worn. Relation of the top region to the bar region of involuntary bamboo fasten were 2.18, 2.98, and 2.99 for BC 1, BC 2, and BC 3 correspondingly. The 3 samples get together the necessities of conversion Beam column joint.

3.2 Loading Sequence and Test Setup:

The wide-ranging collection of the investigational arrangement is exposed in Fig. 5. Each and everyone sample were tested to 5 series functional by gradually transferring the column's end free according to the load present shown in below. The displacement of the peaks in the load times went by 4.28 kN, 8.62 kN, 12.36 kN, and 16.78 kN. Individual dislocation series was carried out for each loading system. Rejection of axial load was functional to the beam columns of the sample.

All the associations used bamboo straps Indocalamus Wightianus (humidity content, 15%; specific gravity, 0.65) and a warped steel rod 10mm in diameter (circuitous yield stress, 626 MPa) plus normal bolt-nut and washer. The combined glide or comparative dislocation stuck between the bamboo chief constituent and face part was attained by regular slip dimension data of 2 Liner Variable Differential Transformer (LVDT) shown in Fig 5. Different loads were functional below quasi-static and the examinations were finished at what time breakdown of the bond was observed.

3.3 Experimental Results:

After Casting of beam column joint, it is allowed for curing for 28 days. Then bamboo beam column joint arranged in above mentioned typical loading frame for the purpose of applying cyclic load for average of 3 cyclic 1, 2 and 3. The de-moulded specimens were shown in fig 6.

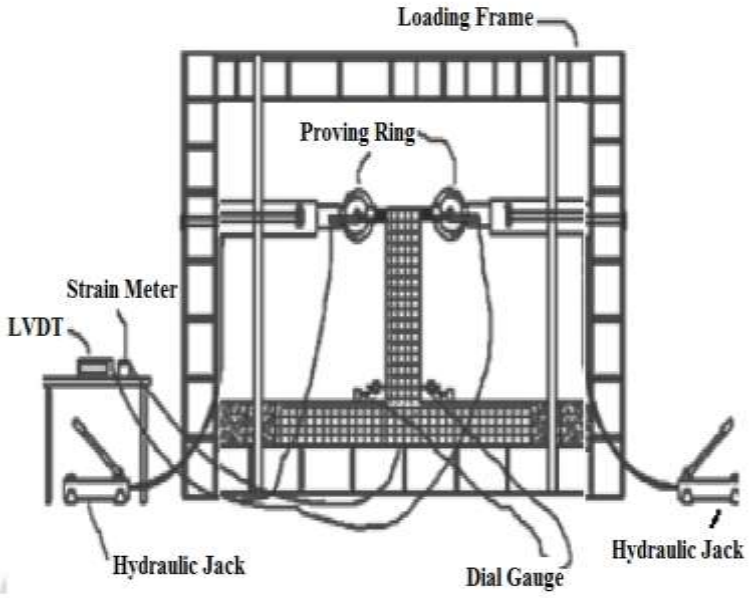

Fig 5. Loading Frame Setup for Beam Column Joint Analysis

Fig 6. Sample specimen for bamboo beam - column Joint

Table 2. Maximum lateral load capacity and maximum lateral displacement

Sample	Max Load (kN)	Lateral Displacement (mm)	Energy Dissipation (kN mm)
BC 1	16.34	51.21	460.7
BC 2	12.86	40.66	780.36
BC 3	16.68	51.22	650.12

Based on the utmost lateral loads in Table, two samples it highest shear-force, that is, 16 kN in BC 1 and BC 3. By calculation of the whole region of curvature of connection load-displacement for every sample, the sum quantity of liveliness self-indulgent (E) from the beam-column combined can be find, specifically, 460.7 kNmm, 780.36 kNmm, and 650.12 kNmm, for BC 1, BC 2, and BC 3, correspondingly. Subsequently the amount of quake, for unfathomable or intermediate measures, mB (extended period body wave magnitude) can be obtained using equation Log E = 5.8 + 2.4 mB (Gutenberg and Richter, 1956), anywhere “E” indicates force during ergs.

3.3 Relationship of Load Vs Strain:

By means of the loading frame setup the cyclic load was given to the beam-column joint of bamboo reinforced. During direct calculation of strain on top of the head bar, a strain measuring strain gauge setup was positioned resting on their feet. The quantity of strain for each load phase was conspiring on top of the load and the strain association chart below.

The beam-column joints BC 1 to BC 3 Beam has exposed in Chart. Load with strain relationship for every samples are shown in Figures 7 to 9 given bellow.

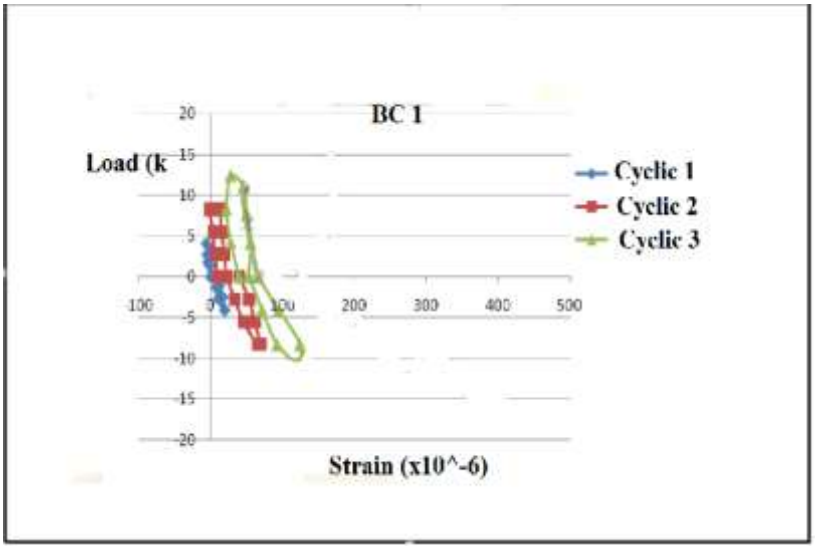

Fig 7. Load Vs Strain of Sample BC 1

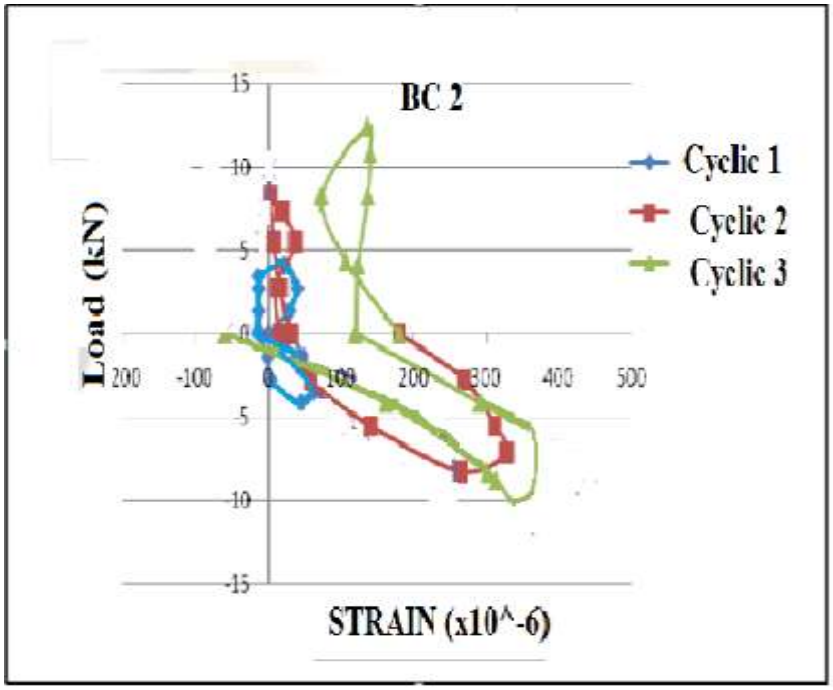

Fig 8. Load Vs Strain of Sample BC 2

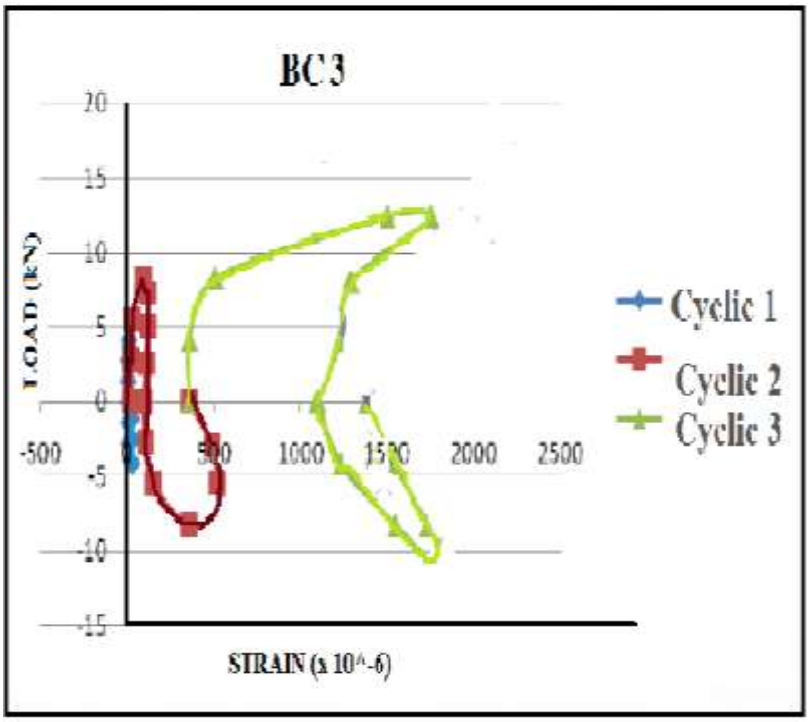

Fig 9. Load Vs Strain of Sample BC 3

3.4 Relationship of Load vs Displacement:

The association among load Vs creative column dislocation next to an elevation of 50 cm over the beam surface as exposed in Figures 10 to 12 given below.

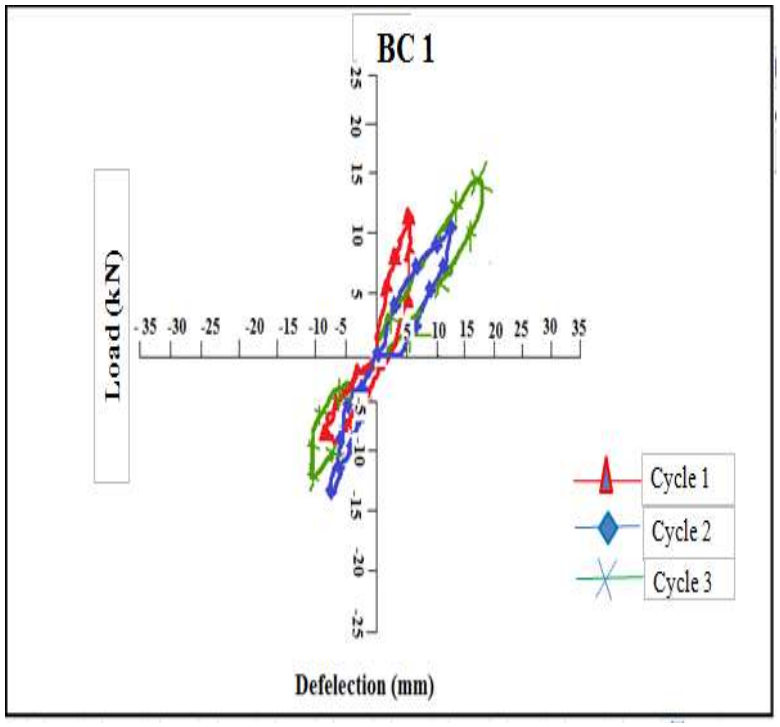

Fig 10. Load Vs Displacement of Sample BC 1

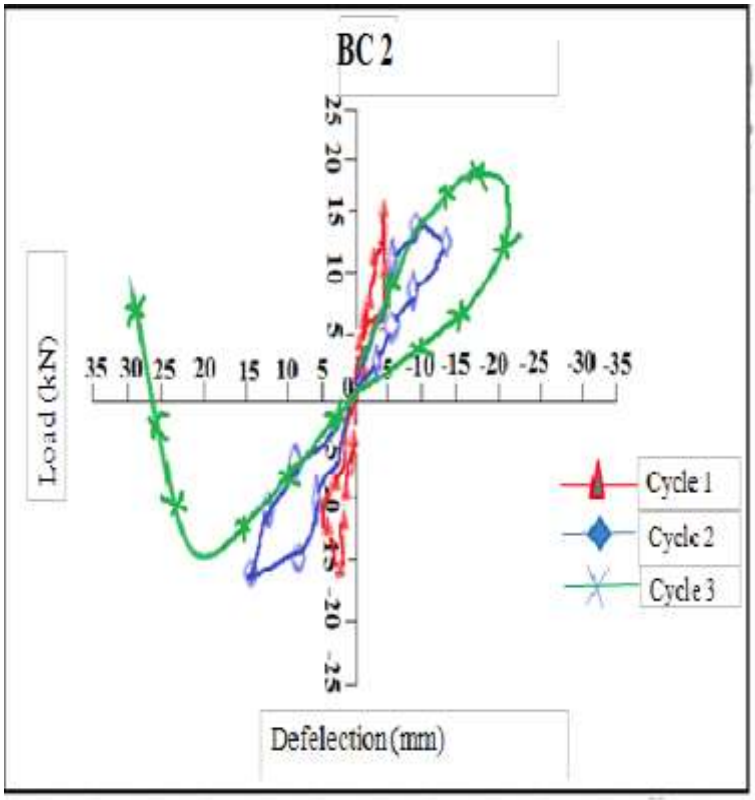

Fig 11. Load Vs Displacement of Sample BC 2

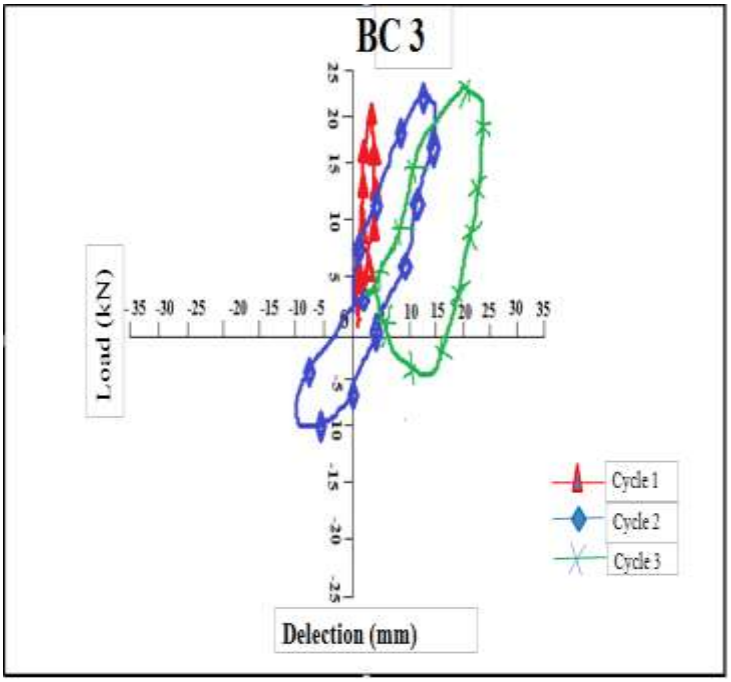

Fig 12. Load Vs Displacement of Sample BC 3

3.5 Patterns of Crack in tested samples:

Fracture outline in 3 samples experienced are shown, taken pictures as shown below in fig 13. The Figures explain with the purpose of flexure fracture happen inside all 3 samples within the column section. This point out with the intention of flexure breakdown occurred earlier than shear collapse into the beam-column joint region. It represents that the all samples carry out

fighting fit in seismic stress. The major split within every sample was originated within the critical part of the beam-column joints, i.e., the part wherever the columns attach among the beams.

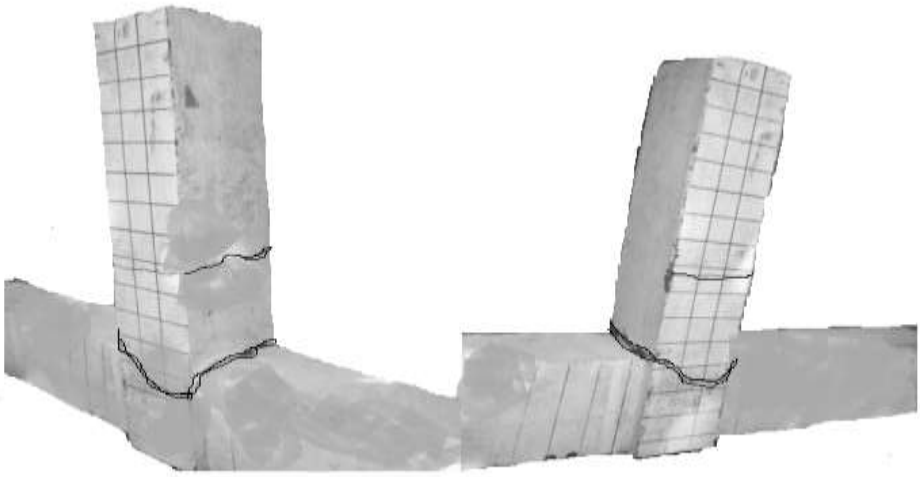

Fig 13. Tested sample Crack Patterns of Beam Column-Joint

4. CONCLUSION :

- With the evidence of above experimental study it is proved Beam-Column joint 1 that is bamboo inserted by horizontally and vertically and also bamboo Beam-Column joint 3 connected with clamp screw by bolt and nut got very good load resisting and energy dissipation.

- As of the above result, it know how to accomplished with the purpose of the reaction bamboo fasten is to resist the cyclical masses tremendously and therefore extremely right for employ in reaction anchor, their potency individual equivalent to or better than to facilitate the steel (during the additional element of involuntary anchor revise behavior by the biographer) and be able to, place to seismic distress enhanced.

- It was confirm from the detail to facilitate flexure breakdown take place sooner than shear combined malfunction in all 3 samples. In the mechanical properties of bamboo anchors, is supreme shear strength was attain by the slighter thick anchors, BC 1 and BC 3 (of 10mm and 14mm thickness correspondingly).

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