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Feasibility of Study on the Use of Bamboo and Admixture with Cement for Construction of some Components of Building

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Abstract: The most popular building material used worldwide is concrete. Excellent compressive strength is found in concrete, but poor tensile strength. Steel is frequently utilized as a reinforcing material to maintain tensile strength. Due to steel's escalating cost, lack of availability, and other issues, it was necessary to use an alternative material as reinforcement. It is seen to be extremely acceptable to employ bamboo, a quickly growing and environmentally beneficial material, for structural applications. Bamboo has a very high tensile strength that can exceed 125 MPa. The use of bamboo as a structural component may help a building consume less material-based energy. The feasibility of using thermal industry waste is investigated in this study.

key words: Bamboo, fly ash, silica fumes ,compressive strength ,tensile strength.

I.INTRODUCTION :

Environmental degradation is occurring quickly as a result of infrastructure growth. Throughout every stage of their existence, the materials used in building, such as steel, cement, synthetic polymers, and metal alloys, pollute the environment. The investigation of non-polluting materials and manufacturing processes has been an obsession in recent years. In the course of this examination, the usage of bamboo, a fast-growing and environmentally benign building material, is considered to be fairly practical, especially in an extremely tropical nation like INDIA. The building supplies needed to construct a bamboo house should be easily accessible. Materials used in construction traditionally are taken into account. It has a quick rotation period and is a renewable plant. Bamboo building materials need to be treated if they're going to last. using energy-intensive materials like cement.

II.REVIEW ON BAMBOO USES AS REINFORCEMENT:

1.Masakazu Terai & Koichi Minami (2012):

Authors looked on how actively manufacturing using natural materials has increased in response to concerns about global warming and a sustainable society. The effect of bamboo corrosion, the binding properties by the surface quality of the bamboo reinforcement, and the flexural behavior of bamboo reinforced concrete slabs by the curing condition are the topics covered in this study. Due to the bamboo's bigger size and faster pace compared to concrete, the bamboo inserted in concrete will experience frequent expansion and contraction. This is thought to be one of the causes for the loss of bond stress. Based on the measured diameter of the test bars, bond stress was computed.

The tensile strength test component has Test samples were remolded for 28, 56, and 84 days before being placed in the lab. The specimen has a water cement ratio of w/c=80% rather than the standard w/c=100%, which is roughly perpendicular to prevent bamboo fiber from splitting. According to test data from lab, the bamboo had a yield strength of 197 MPa. In order to create low strength concrete, low strength concrete mix designs were investigated (fc = 10 MPa at 28 days; 16.2 MPa tested at 62 days; cement content 231 kg/m3; water/cement ratio = 0.88). Putting a waterproof coating on bamboo The use of synthetic rubber and synthetic resin has been contested in place of pricey and specialized materials that are not easily available. The bamboo was strengthened with a lattice design and tied with twisted polypropylene rope (=1.8mm) at the intersection.

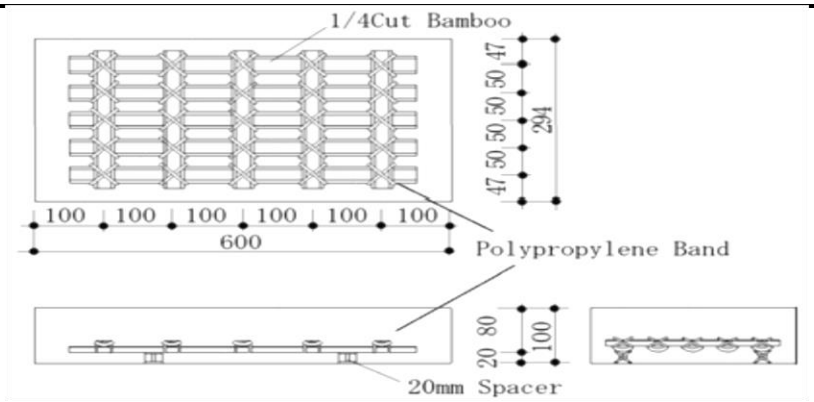

Figure. Details of specimens

2.Abhijeet Dey, Dr. Nayanmoni Chetia, (2012) :

The usage of bamboo-reinforced concrete beams, which are straightforward, effective, and affordable for rural buildings, was examined by the authors. This research compares different frictional qualities of bamboo-reinforced concrete beams. By rolling the bamboo reinforcements with sand, G.I wire, and coir, the frictional properties of bamboo reinforced concrete beams were accomplished. The main component of the web material is steel stirrups, which aid in preventing shearing of bamboo-reinforced concrete beams. The four-point bend test has been used to test these beams until eighteen of them failed. For purposes of comparison, flexural strength at 28, 45, and 60 days has been taken into account. It has been found that beams treated to longer curing times and larger reinforcing sizes perform better at failure.

Bamboo has excellent tensile strength that varies from species to species. The test specimen used in this investigation has an average tensile strength of 250 N/mm2. The test was run on a universal testing apparatus. The test involved a straightforwardly supported beam that was put through a four-point bend test with its middle third piece subjected to maximum uniform bending and zero shear force while presuming that the beam's self-weight was insignificant. The coarse aggregates used to construct the beams were 10 mm and 20 mm, respectively. River sand that has been naturally cleaned and common Portland cement of grade 43 have been used. For M20 grade, the proportion of normal weight concrete has been set at 1:1.5:3, with a water-to-cement ratio of 0.45.

To create bamboo-reinforced concrete beams, the bars are then caged with steel stirrups and cast in a mould with the dimensions 15 cm x 15 cm x 70 cm. The following results have been obtained after testing these beams in the flexure testing device, which operates on the four-point bend test principle. Over the past few decades, concern for the environment and natural resources has increased. It has been realized that misusing or overusing natural resources actually harms the ecosystem. The correct concept of sustainability in architectural design has undergone significant developments recently. A viable choice for the sustainable growth of civil engineering projects is bamboo reinforced concrete.

Figure.2 Bamboo bars with various frictional properties

3.Prem Kumar.V and Vasugi. (2014):

Researchers studies that Bamboo has been in wide usage as a vital material for construction due to its low cost, high strength, flexibility, light weight, earthquake resistance, etc. This study explores the feasibility of usage of bamboo as reinforcement in concrete beams for rural construction. The untreated and treated bamboo reinforced concrete beams are casted with different stirrup materials. The shear link materials used were bamboo and Thermo Mechanically Treated (TMT) rods. Bamboo has been treated with a thin layer of epoxy to the surface followed by a coating of fine sand. Conventional steel reinforced concrete beam is tested for its flexural strength, modulus of elasticity, deflection and crack pattern. Same tests were carried out for the treated and untreated bamboo reinforced beams with TMT

Finally, using the results of the experiments, comparison and analysis are done between the conventional steel reinforced concrete beam and the treated and untreated bamboo reinforced concrete beams. For this experimental inquiry, the traditional beam is a cast steel reinforced beam. The test specimen has the following qualities. The stirrup and spacing are 8mm diameter bars at 100mm center-to-center, while the longitudinal tension bar has a diameter of 12mm. The beam's clear cover is 30mm thick. Beams made of untreated bamboo that have been strengthened are cast utilizing various stirrup materials. Bamboo and Thermo Mechanically Treated (TMT) rods are the materials utilized to make the stirrups. W = Weight, L = Beam Length, = = Deflection, and I = Moment of Inertia. Similarly, the treated and untreated

The treated and untreated bamboo reinforced beams as well as the standard steel beam were all cast and allowed to cure for roughly 28 days. The specimen is then examined for its flexural strength, elastic modulus, deflection, and crack pattern. The standard steel reinforced concrete beam is compared to both treated and untreated bamboo reinforced concrete beams for comparison and analysis. The nearby value among the bamboo-reinforced beams that is closer to the value of the conventional beam is taken into consideration from the experimental values acquired and is described for its durability, affordability, and sustainability.

4. Jigar K. Sevalia, Nirav B. Siddhpura, Chetan S. Agrawal, Deep B. Shah and Jai V.Kapadia (2013):

Machine TUN 600, the specimen's ends were roughed up on both ends. Bamboo's flexural strength will be evaluated. cement reinforced concrete,This study examines the use of bamboo as a building material going back in time. Both technical and non-technical applications are made of the bamboo. Due to the benefits of bamboo, research on its usage as a structural component and concrete reinforcement has been conducted in recent years. Lack of knowledge regarding bamboo's interactions with concrete, strength, and durability is the main barrier to its use as reinforcement.

The practicality of using bamboo as reinforcement in concrete members is evaluated in this study. Without any treatment or stirrups, bamboo was used as a reinforcing material in this investigation. Giant grasses in the Bambusoideae family include bamboos. The bamboo underwent a tensile test because it will be utilized to support tensile loads in flexural elements. The bamboo strip had a length of 520 mm and an average thickness of 10 mm. Such requirements were developed as specimens. In order to have a better hold on the specimen in the Universal Testing Machine.

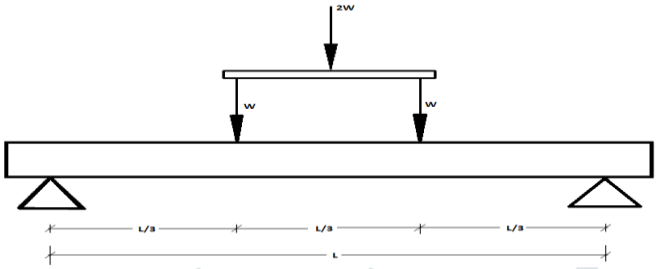

Fig: Two Point Loading System

5. Yanuar Haryanto, Nanang Gunawan Wariyatno, Hsuan-Teh Hu, Ay Lie Han andBanu Ardi Hidayat (2021):

The structural behavior of concrete slabs reinforced with bamboo that are utilized as footplate foundations and are subject to concentrated loads was studied by the authors. Four distinct reinforced concrete slab panels were created and studied for this purpose. By measuring the load-deflection properties, the ultimate load, the stiffness, the ductility, the cracking pattern, and the energy absorption capacity of concrete slabs, the effect of using bamboo instead of steel for reinforcement was evaluated. According to the findings, bamboo-reinforced concrete slabs can achieve a strength of 82% compared to steel-reinforced concrete slabs. Additionally, the ductility displayed by the two types of specimens was nearly equal, or up to 93%. They showed that the structural performance displayed by bamboo reinforced slabs is pretty equal.

As a result, bamboo has promise as a steel alternative for concrete reinforcement. Future research may look into this possibility in more detail. The average tensile strength of bamboo strips was 138 MPa. They underwent a two-day soak at 27 ℃ as part of the first procedure, and to reach a suitable level of dryness, they were then exposed to the sun for roughly thirty days. Before utilizing bamboo, it is vital to take some steps to prevent any fungal development, porosity, decay, flaws, or degeneration. Before casting slab specimens, bamboo strips were properly lubricated. It strengthens the connection to the concrete matrix and stops moisture absorption. A grade of concrete (M18) was utilized because it is frequently used in this investigation.

The mix design and testing of concrete specimens were done in accordance with the SNI 1974: 2011 (BSN 2011) recommendations. Coarse aggregates in the sizes 10 mm and 20 mm were combined for the mixed design. So that the concrete mass with aggregate size of 10 mm can easily accommodate in semi-circular groove, these were mixed in a ratio of 30:70. The interlocking of bamboo and concrete is established in this manner. The square was created with slab specimens of SRC8, BRC8, BRC10, and BRC12 in order to conduct research. The illustration shows the reinforcing cage created for the control and BRC specimens. The cage was then evenly placed inside the mold , with covers on all four sides and 20 mm from the bottom. In

The specific measurements of the slab samples. They were each 600 x 60 x 70 mm in dimension. The bamboo strip's cross-section in the BRC8 slab specimen was 8 mm by 8 mm, and the spacing was 75 mm center-to-center. The bamboo strip's cross-section for the BRC10 slab specimen was 10 mm x 10 mm, and the spacing was 100 mm c/c. Last but not least, the bamboo reinforcement employed in the BRC12 slab specimen had a cross-section of 12 mm x 12 mm and a spacing of 150 mm c/c. Each bamboo used had a total length of 360 mm in the main slab specimen directions. The ability to absorb energy is a crucial characteristic for the study of how the overall structure may fracture.

Because bamboo has a higher flexibility coefficient and modular ratio than concrete, a lower young modulus than concrete, and significantly less stiffness than concrete, bamboo reinforced slabs have less energy absorption than concrete-only slabs.This study looked at the structural behavior of BRC slabs under heavy loads. Experiments have been conducted to examine the function of bamboo strips from G. apusas reinforcement material in concrete slabs. The following conclusions can be made in light of the findings: The BRC slabs behave exactly like the SRC slabs when subjected to focused load. The BRC slabs may achieve strength of 82% when compared to SRC slabs. The two types of specimens examined in this study's ductility.

a) SRC specimens b) BRC specimens

FIGURE 1. Arrangement of reinforcement

6.Atul Agarwal and Damodar Maity (2011):

According to this analysis, the rapid environmental degradation is being caused by indiscriminate infrastructure growth. Metal alloys, steel, cement, synthetic polymers, and other materials used in building require a lot of energy and pollute the environment over the course of their whole lives. In recent years, research on non-polluting components and production techniques has been pursued to solve this problem. The usage of bamboo, a quickly growing and environmentally beneficial material, for structural applications is seen to be highly suited in this situation. Bamboo has a comparatively high tensile strength that can exceed 370 MPa. Because of this, bamboo is a desirable substitute for steel in applications involving tensile loading. Concrete, steel, and wood can be replaced with bamboo concrete composite materials in housing.

Furthermore, this is due to the fact that bamboo has a tensile strength to specific weight ratio that is six times higher than steel's. Therefore, it has been tried to create engineered bamboo structural components for usage in rural houses in this work. The use of bamboo slats made from bamboo poles to create the necessary structural bonding and strength is explored in this research. A number of tests on bamboo-reinforced concrete components have been carried out in reference to the aforementioned goals.

According to previous studies, the failure of bamboo-reinforced concrete members was mostly caused by a poor connection between the bamboo and concrete. Various adhesives have been used to strengthen the binding at the bamboo concrete composite's interface.

II.MANY TESTES CONDUCTED ON BAMBOO AS WELL AS FINDINGSAND DISCUSSION:

1. M.R. Wakchaure and S.Y. Kute, (2012):

According to the author of this study, the moisture content of bamboo fluctuates with height and seasoning, which has an impact on all of its mechanical and physical qualities. It is among the crucial elements in determining the lifespan of bamboo. This study evaluated the Dendrocalamus strictus species of bamboo's physical and mechanical characteristics as well as its potential for use as a building material, either whole or in split form.In the current investigation, it is determined the moisture content, specific gravity, water absorption, dimensional changes, tensile strength, and compressive strength at various height locations. When bamboo is still green or at any point after harvest, the moisture content fluctuates along the height.

It controls mechanical characteristics and is crucial in determining the lifespan of bamboo. Green bamboo typically has a moisture content ranging from 60 to 75%, depending on the age, season, region, species, and watering techniques. Insect assaults are strongly correlated with the starch and humidity levels in bamboo culms. For a variety of reasons, drying bamboo is essential to its protection. Bamboos are dried by air while being held vertically. At all phases of seasoning, bamboo's moisture content decreases from bottom to top for both green and bamboo. the variance in moisture content along a typical bamboo's height. Low humidity makes bamboo less vulnerable to mold infestations, especially when the humidity concentration is under 15%. mechanical and physical

At different stages of seasoning, the top of the bamboo exhibited the maximum compressive stress. The difference between the bottom and center portions was insignificant. The lowest compressive stress was found in one-month-seasoned bamboo, which averaged 47.12 MPa at the bottom segment for specimens including nodes. The top segment from the internode zone of one-year-seasoned bamboo exhibited an average compressive stress of 69.89 MPa, which was the highest. For one-month-seasoned bamboo at the bottom, the modulus of elasticity in compression (Ec) is at its lowest value of 4266 MPa, while for one-year-seasoned bamboo at the center, it reaches its highest value of 4638 MPa. At any level of seasoning, bamboo's moisture content for both green and mature bamboo decreases from bottom to top.

2.Pankaj R. Mali, D. Datta, (2018):

According to research, static gravity loads are the main factor that affects reinforced concrete structural members. To give concrete members more tensile strength and energy absorption capability, conventional steel reinforcing is applied. However, traditional M.S. (Mild steel) or HYSD (High Yielding Strength Deformed) bars are expensive, unrenewable, and environmentally unfriendly. In the current work, bamboo has been employed as an eco-friendly, renewable, and sustainable material in place of steel in an effort to allay this worry. Pull-out tests were first used to examine bond behavior. An examination into bond strength led to the development of a special bamboo strip profile and surface treatment, the combination of which demonstrated the highest bond strength under uniaxial loading. Additionally, this new bamboo strip serves as the primary reinforcement.

In terms of load-deformation properties, energy absorption capacity, crack patterns, and failure mechanisms, the impact of completely replacing the primary steel reinforcement with bamboo has been investigated. The results of the tests indicate that using the proposed bamboo strip as reinforcement in concrete slab panels improves the load carrying and deformation capacity when compared to using PCC (Plain Cement Concrete) and RCC (Reinforced Cement Concrete) slabs. It's interesting to note that the structural behavior of slabs employing newly created bamboo reinforcement has significantly improved flexural performance and was only slightly worse than the RC slabs having M.S. bars as the main reinforcement. strengthening of the connection at the bamboo-concrete interface. RC slab panels with newly created bamboo reinforcement.

The PCC slabs displayed linear elastic behavior up to a first crack load of 35 KN at an average displacement of 2.2 mm. The slabs failed abruptly after the initial crack, exhibiting a brittle mode of failure, as seen by the crack pattern. A maximum load of 37 KN at an average displacement of 2.35 mm was supported by PCC slabs. The absence of any reinforcing material in concrete is the primary cause of the brittle mode of collapse. According to results, PCC slabs have the lowest levels of ductility and energy absorption. The traditional RCC slabs have supported an average ultimate load of 70.9 KN with steel bars of 6 mm diameter in both primary directions.

The ultimate load that UTBRC slabs could withstand before failing was 60.6 KN, with an average displacement of 5.48 mm. In comparison to PCC slabs, this ultimate load was 51% higher. Comparing UTBRC slabs to PCC slabs, there was an improvement in ductility and energy absorption capability. This demonstrates the effectiveness of bamboo strip reinforcement, which enhanced slab strength in comparison to PCC while being untreated. As can be observed, slabs at first exhibit linear elastic behavior up until the point of failure, at which time the curve begins to quickly degrade. Only a handful of the diagonal tension cracks in the observed fracture pattern migrate normally toward the slab's four edges.

This shows that the suggested surface treatment enhanced bond strength at the bamboo-concrete interface, which increased the action of the bamboo concrete composite. Additionally, these grooved slab panels (GTBRC) are made from these treated plain bamboos. In comparison to PCC, RCC, UTBRC, and PTBRC slab panels, the ultimate load increased by 92.5%, 8.7%, 27.2%, and 10% for GTBRC slabs, respectively. These slabs were found to exhibit linear elastic behavior prior to failure. These slabs had a better energy absorption capacity than other BRC slabs, and they were only 8.6% less efficient than RCC slabs.

The adequate bonding between bamboo and concrete was the main source of the significant increase in load carrying capability. The action of the bamboo concrete composite has been greatly enhanced by the improvement in the bamboo-concrete bond. The increased bond strength was produced by the simultaneous chemical activity of surface treatment and mechanical action of concrete interlocking grooves. As a result, slab panels with bamboo reinforcement that were treated and grooved in accordance with the suggested approach had higher flexural strength. The crack pattern was used to evaluate the failure of the GTBRC slab specimen. The rectangular loading plunger's periphery on the tension side is where the cracks in this instance started, and they spread diagonally towards each corner, indicating a ductile mode of failure.

3. Yashdeep, Deepak Kumar and Sitender,(2015):

This study describes the use of bamboo as reinforcement in cement concrete and tests the specimens for tensile and flexural strength. Insects and fungi should be kept away from the bamboo. Bamboo poles may not last more than two years if left untreated. The following techniques can be used to cure bamboo poles: Bamboo poles that have just been cut are submerged in water for four to twelve weeks. Insects inside the poles lose their food source during this period. Ponds or streams are suitable. Ponds should have a water circulation system. Saltwater immersion is not a good technique. An effective method of preservation is with a borate solution. The process entails pressure-feeding the borate/borax salt solution into the pole until it is visible at the opposite end of the pole.

Various Bamboo reinforced concrete beam specimens were created in order to understand how bamboo behaves in concrete. The initial crack in the plain beam test specimen was a flexure crack that appeared vertically from the point of force application and widened. Then, concrete crushing during point load application was seen. The beam finally collapsed under the maximum load of 11.65 kN. A simple concrete beam specimen abruptly cracked and demonstrated brittle failure. A single reinforced concrete beam made of cement with two untreated bamboo strips at the bottom and 20 mm clear coverings. The specimens of beams lack stirrups. In a single reinforced concrete beam, a fracture first appeared vertically in the middle third.

The fissures formed quite gradually. The fissures took the shape of triangles. A node failure occurred during the failure, which affected the Bamboo at the bottom. At the node, the higher Bamboo also failed. Node split failure is the sort of failure. The beam broke at a 15 kN load. There was a lack of grip between the bamboo and the concrete. The readings are also obtained, and the load vs deflection graph is examined. According to an experimental investigation, a doubly reinforced beam has an elasticity modulus that is more than twice as high as a single reinforced beam. A comparison is made. The Singly Reinforced Beam's elastic modulus is 3,762.94 N/mm2. The Doubly Reinforced Beam has an elastic modulus of 14,597.70 N/mm2. Doubly Reinforced Beam has performed more elastically than Singly Reinforced Beam while performing flexural tests. Load carrying capacity in Doubly Reinforced Beam increased by 29.31 % as compared to Singly Reinforced Beam. Vertical cracks are developed, on failure of the beam, within middle third region of the beam. This type of failure is a proof existence of pure moment without any shear. Modulus of Elasticity of the Doubly Reinforced Beam is more than twice of Modulus of Elasticity of the Singly Reinforced Beam as it can be seen.

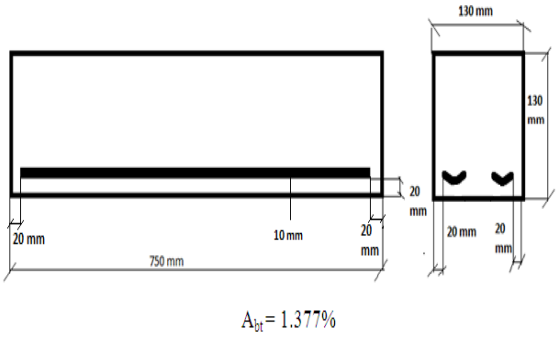

Fig.1: Singly Reinforced Concrete beam

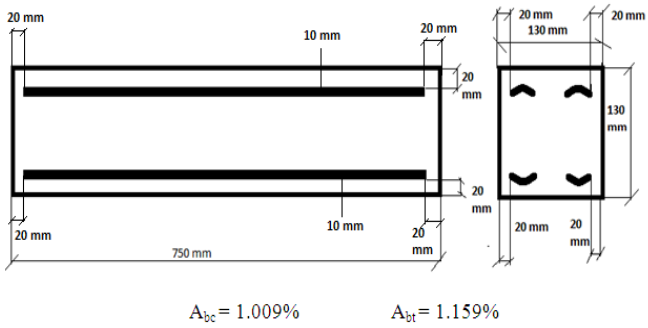

Fig.2: Doubly Reinforced Concrete beam

4.B.Benitta PaulinMary and Dr. D.Tensing,(2013):

This paper provides an overview of the experimental work that has been done in the research on bamboo reinforced concrete. The ultimate load carrying capability of the precast concrete elements with bamboo reinforcing was calculated using ultimate strength design methodologies adapted to account for the properties of the bamboo reinforcement.It is a good construction material because of some advantages like a lightweight design, improved flexibility, toughness because of its thin walls with discretely distributed nodes, and great strength. Bamboo is a strong, flexible, lightweight, and reasonably priced building material that is utilized as the structural support for scaffolding at construction sites in China, India, and other nations. The qualities of Bamboo exhibits behavior similar to steel in that its compressive and tensile strengths are approximately equal. Compared to HYSD steel bars, bamboo has a much lower bond stress with concrete because of its flat surface. Bamboo has a very high water absorption rate, hence waterproofing agent is advised.Five samples of finished bamboo were evaluated with GI wire spirals at the ends to improve grip, whereas three samples of finished bamboo were tested in their original state (untreated). investigated the use of bamboo as a viable reinforcement in the concrete beam to make up for the concrete's low tensile strength. According to experimental tests, bamboo that has been damaged by G.I. wire has a uniform tensile strength and a failure pattern.

According to the study's findings, ductility was relatively low, especially for the column reinforced by 1.6% of bamboo without surface treatment, even though its strength capacity was sufficient to withstand the maximum axial force allowed by ACI318-05. This resulted from concrete and bamboo losing some of their bonding strength due to water absorption. Before concrete was poured, reinforcement bamboo was treated with Sikadur-31CFN to make it water-repellent. These treated reinforcement bamboo columns outperformed untreated reinforcement bamboo in terms of strength and ductility.Concrete reinforced with bamboo has a higher load-bearing capability. Compared to steel, bamboo has a lower elasticity modulus. Therefore, it cannot stop concrete from breaking under maximum stress. The test findings demonstrated that bamboo has a high tensile strength.

Fig . GI Spiral around the ends of bamboo specimen

5.Dr.M.Usha Rani and J.Martina Jenifer,(2017) : The purpose of the research was to determine whether bamboo could be used as a flexural reinforcement material in reinforced concrete members. Strength tests were done on reinforced-concrete beams containing bamboo in place of all rebars, including the primary rebar and the stirrups. Nine beams, each measuring 150x150x750 mm, were cast as part of the current investigation to examine the flexural strength. With the aid of a hydraulic jack, beams were put to the test in flexure under two equal focused loads that were each placed at the one-third point of the beam. According to the results of these experimental studies, bamboo can be employed as a non-structural component in low-cost building.Cement, aggregates, water, and other readily accessible ingredients are mixed to create concrete. Common Portland cement, 43 were used.

Three of the nine 750x150x150 mm beams that were cast for this study's flexural strength analysis were employed as plain concrete beams. Concrete that was double reinforced was cast. A nominal cover of 30mm serves as reinforcement on either side of the beam. As demonstrated, steel and bamboo reinforced beams both require steel stirrups. The bamboo that was chosen for reinforcing had a 12mm average diameter. Three reinforced steel beams and three reinforced bamboo beams were cast. The reinforced concrete beam designated as RCB, the plain concrete beam designated as PCB, and the bamboo reinforced concrete beam designated as BRCB. The laboratory experiments to ascertain the tensile strength of bamboo, the compressive strength of concrete, and the flexural strength of three test results' averages were kept track of with the aid of a hydraulic jack, concrete beams were put to the test in flexure under two equal focused loads that were each placed at the one-third point of the beam. Beams strengthened with steel and bamboo underwent separate testing. Periodically, the displacement was measured. The displacement was recorded as the load was continuously raised.

The deflection of the beam is measured by a strain gauge. The deflection value increases together with the application of load. As a result of applying load, cracks begin to develop in the beam. For concrete of the M-235 grade, the mix percentage of

various elements (namely, cement, sand, aggregate, and water) is determined in line with the design obtained in accordance with code IS-10262.According to IS 516-1959, the flexural strength was estimated. Bamboo reinforced beams have a flexural strength that is 28% higher than plain concrete beams and 55% lower than the reinforced concrete beams that are depicted. The bamboo reinforced beam has a center deflection that is 50% higher than that of reinforced concrete and 60% lower than that of plain concrete. Compared to reinforced concrete beams and bamboo reinforced beams, the ultimate load carrying capacity of bamboo reinforced beams is 29% higher superior to the simple concrete beam. This study shows that the flexural strength of a bamboo-reinforced concrete beam is calculated to be 50% of a steel-reinforced concrete beam's flexural strength. While cracks formed in steel reinforced concrete beams at the site of loading, or L/3 distance from the edges, in the beam.

While the deflection curve of a bamboo reinforced beam initially develops gradually, and then increases sharply after a certain load, the deflection curve of a steel reinforced beam increases continuously as a function of the application of stress. In a tension test, the steel failure profile happens in the middle, but the bamboo failure profile happens at the very end. Bamboo has a tensile strength that is exactly half that of steel. Bamboo is a sustainable material that can be used in minor structural components to minimize carbon dioxide emissions by about 25%.

6. Gunalaan Vasudevan,(2017):

In a mixed Portland cement, the study examines the mechanical and physical characteristics of bamboo fiber powder. With consideration for its applicability in concrete, the structural value of the bamboo fiber powder in a blended Portland cement was assessed. Bamboo fiber powder (BFP) was added in varying amounts to concrete mixtures of 1:2:4 at 0%, 5%, 10%, 15%, and 20%. Slump was used to gauge the mix's workability, and the cement underwent the usual consistency test. Concrete cubes measuring 150 x 150 x 150 mm that had been hardened and cured were evaluated for compressive strength after 7, 14, and 28 days. Bamboo's density can be determined using specific gravity.

A comparison of bamboo's density to that of water yields its specific gravity. The anatomical anatomy causes the range to be between 0.4 and 0.8. Moving both horizontally from the outer layer to the inner layers and vertically from the bottom to the top portions is the dampness material. Bamboo may contain a lot of moisture. On an oven-dry weight basis, green bamboo may have a 100% percent wetness. The deepest strata can have up to 155% and the outer layers can have 70%. Comparatively less vertical diversity is seen from the top (82%) to the bottom (110%) of the scale. The fiber saturation point for bamboo is approximately 20–22%. Unlike wood, bamboo does not have secondary growth. Once all gains have grown to their full height, all gains are

The compressive stress of bamboo that is one year old is 16.1 MPa. The largest compressive stress is present in bamboo that is five years old. The longitudinal direction is equivalent to the compression qualities. Bamboo is well known for being a lightweight and durable material. It is stable in the meantime because its cavities are airy and elastic. The technical characteristics and original texture of bamboo are comparable to that of wood. Wood is weaker in the outer and inner regions due to its harder center. Bamboo's chemical makeup is exactly comparable to that of wood. They are mostly made of cellulose, hemicellulose, and lignin. Over 90% of the mass is made up of the composition.

Resins, tannins, waxes, and inorganic salts are the minor components. As a result, compared to wood, bamboo has higher concentrations of ash, silica, and alkaline extracts. Bamboo also has some organic material in it aside from that. Bamboo has 2% deoxidized saccharide, 2% fat, 0.8-6% protein, and 2-6% starch. The bamboo's strength and lifespan are influenced by its carbohydrate content. Bamboo is dependent on the climate for its natural durability. The structure of starch can also shield against fungal attack. Additionally, bamboo has inorganic minerals in its ash, including silica, calcium, and potassium. By creating concrete cube samples and testing them to get some of the fundamental engineering qualities, the goal of this research is to ascertain the performance of concrete that contains bamboo fiber powder.

Using a methodical study, the proportions of the ingredients are chosen for the concrete mix to create a cost-effective concrete that will have the necessary strength when the cube hardens. The water cement ratio, maximum aggregate size, aggregate grading, and additive application are all controllable variables. the outcomes of tests done using 0–20% bamboo fiber powder for 7, 14, and 28 days on cemented concrete. According to figure 2, the results demonstrate that compressive strength rises as curing time increases. Comparing the compressive strength of concrete with 15% replacement of bamboo fiber powder to control concrete for 7 days, 14 days, and 28 days, it appears that the average value was attained.This increase in the positive number demonstrates that adding bamboo fiber powder to concrete will enable it to reach its early strength ratios within 14 days.

The impact of substituting bamboo fiber powder for cement for 7, 14, and 28 days on the flexural strength of concrete. It appears that after 7 days, 14 days, and 28 days, respectively, the flexural strength of concrete with 15% of the cement replaced by bamboo fiber powder showed an average higher value compared to control concrete. Strength increases up to 10% when more cement is replaced with bamboo fiber powder, after which it starts to decline by 20%.The pozzolanic reaction of bamboo may be the cause of the strength improvement of up to 15% when bamboo fiber powder is used in place of cement.

The SEM can identify the geometric characteristics of objects in the microstructure, such as the tiny concrete cracks that Wood's metal can represent. Although slightly weaker in strength when performing a compression test, the strength is still considered good just because it is too weak in workability, according to the results of the laboratory experiment, the effect of bamboo ash powder in concrete mix does not give a positive optimism. This might be because bamboo ash powder can make concrete less workable by increasing water absorption. The conclusion that can be drawn from the results of the slump test and the compaction factor test is that the more bamboo ash powder is used to replace fresh concrete, the less workable the concrete will be.

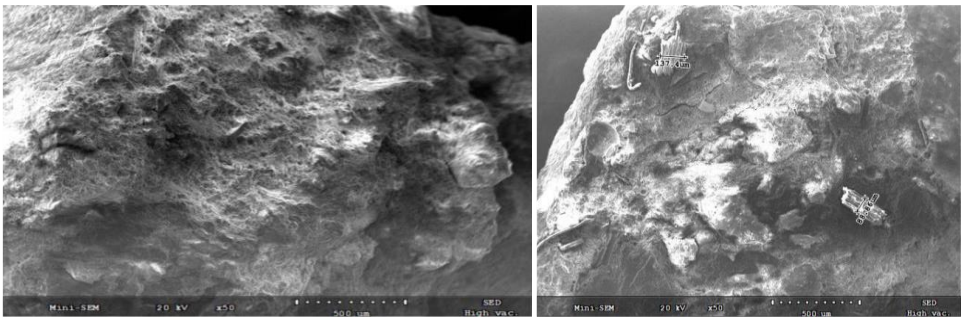

Fig . SEM test for control mix concrete and bamboo fiber powder concrete

7. Ajinkya Kaware, Prof. U.R.Awari, Prof. M.R.Wakchaure, (2013):

According to the author, bamboo is a grass and, as such, is a member of the "Poaceae" family of plants. Within months, it has finished growing, and it takes three years to reach maturity. Its popular name in Maharashtra is "velu". Bamboo species vary according on geography and climate factors. It has strong compression and tensile strength. According to a review, the bamboo species dendrocalamus strictus and bambusa vulgaris schard have the highest tensile and compression strengths. Water absorption and moisture content are issues with bamboo as a building material. Bamboo should receive the right seasoning or treatment to prevent these issues. This study reviews test results on the mechanical and physical characteristics of bamboo-reinforced columns and beams.

Only the most environmentally friendly structural forms have survived, making the structures in nature excellent teaching tools for humans. The remarkable ability of a natural form to react to various climatic and environmental forces makes it an excellent model for many structural design sectors. Bamboo is a natural product that is readily accessible and simple to use in rural parts of developing nations. Although a few species of bamboo can be found in temperate regions, bamboos are primarily found in tropical and subtropical regions, from sea level to snow-capped mountain peaks. Construction and dwelling are bamboo's two main uses. According to a survey, one billion people worldwide are thought to reside in bamboo homes. Considering that bamboo has historically been used in construction,

To address the deformation issues in embankments, bamboos are planted in soft clay and linked together to provide grid reinforcement. Bamboo is mostly used in rural India as reinforcement for mud walls. Bamboo is a great material for engineering projects and may be used to build inexpensive homes. It can primarily be utilized to strengthen the construction. Bamboo's water absorption and moisture content qualities are a drawback when used as a building material. Its strength is mostly impacted by this. Before utilizing bamboo as reinforcement, it should be properly coated and season to lessen this effect.

III.INEXPENSIVE BUILDING:

1. Md. Abdullah Al Mamun and Md. Abu Bakar Siddique :

Conducted a study on the effectiveness of using bamboo as reinforcement in low-cost constructions. The physical and mechanical characteristics of bamboo reinforcements were examined in this study. Different reinforcing ratios were evaluated on bamboo-reinforced concrete beam specimens while observing the load capacity, deflection, and failure patterns. Flexural strength of a bamboo-reinforced column was found to be considerably greater than that of a plain cement column and comparable to that of steel-reinforced concrete beams. The ultimate compressive strength and failure pattern of bamboo-reinforced concrete columns with varying reinforcing ratios were also tested and examined. It was discovered that concrete crushing caused all columns to break in a consistent fashion. Cost research reveals that bamboo-reinforced beams and columns with The following variables were examined: the density, tensile strength, and elastic modulus of bamboo reinforcements; the flexural performance of bamboo reinforced beams; the patterns of cracks and deflection after loading; the compressive properties of bamboo reinforced columns; and the strength-to-cost ratio of bamboo reinforced construction. In this study, Bambusa balcooa, also known as "Borak Bash" in Bangladesh, was utilized to examine the effectiveness of reinforcing material.

Dry bamboos that were three to four years old and effect-free were chosen for testing. Initially, bamboos were divided into a number of 14 mm diameter, straight sticks that ranged in length from 1 to 1.5 meters. then rounded with a smooth 12 mm diameter. Steel reinforcements with a 12 mm diameter 40 Grade bar were also tested for comparison. The tensile strength characteristics of samples with a 12 mm diameter and 0.3 m length were assessed. GI wires (1 mm diameter) were spirally joined at both ends of the specimen in order to alleviate the gripping issue in tensile strength testing of specimens using UTM. To determine the yield strength and elastic modulus of bamboo reinforcements, three specimens were evaluated. The outcomes for Sample Bamboos 1 through 3 (Bamboos 1). To test their flexural strength, plain cement concrete beams, bamboo-reinforced concrete beams, and steel-reinforced concrete beams were cast. Each type of beam's reinforcements were bound together as stirrups using mild steel wires with a 2 mm diameter and a 150 mm spacing. After It is described how to prepare the reinforcement for the beam and column specimens. The simple cement concrete beam can only support a load of up to 25 KN at its center, and failure occurs at a deflection of 1.9 mm at the specimen's center, according to the findings of flexural tests. However, under the same conditions, the beam strengthened with two 12 mm diameter bamboo reinforcements gained 32% more strength, and failure occurred at 3.5 mm of deflection. Three bamboo reinforcements increased the flexural strength by 80%. According to prior research, the cost of a bamboo-reinforced beam is quite low when compared to a plain cement concrete beam with a limited span, given the same strength requirements. Although steel reinforced concrete beams are stronger than other types when it comes to durability and cost,

Bamboo has a strength-to-cost ratio that is more than nine times greater than steel's. These recommendations by researchers make it obvious that bamboo reinforced structures are secure and reasonably priced for construction of moderate strength. The biggest issue with using bamboo as reinforcement in concrete structures is bamboo's high water absorption rate, hence waterproofing chemical is advised to reduce continuous water absorption. After absorbing water from the concrete, which gradually reduced bond strength, the bamboo's volume increased. In actuality, bamboo reinforcements' binding strength with

concrete is far weaker than that of mild steel reinforcements. As a result, it cannot be employed in high-rise buildings with severe imposed loads. The bamboo house system has a relatively low resistance to seismic pressures when compared to As a result, bamboo reinforced concrete has a substantially shorter design life than steel reinforced concrete. Bamboo reinforcements can be employed by putting some concrete-bonding waterproofing paint on them to lessen the amount of water absorption. Researchers have previously suggested using steel wire to improve binding strength. For seasoning purposes, bamboo requires around 3–4 weeks of drying time after cutting, which makes it difficult to always avoid building delays. If seasoning was improperly carried out, the structure will be less strong. Although bamboo is susceptible to deterioration of the environment and attacks from insects and mold. The vulnerability of bamboo reinforcements to fire is a serious drawback. As a result, bamboo reinforced concrete components are appropriate for low-rise commercial projects.

2. Vijay R Wairagade, Ishwar P Sonar :

The authors of this study found that adopting an alternate material as reinforcement for affordable housing has become required due to the rising cost, unavailability, and other limitations of steel. Due to its environmentally friendly, beneficial, affordable, and adaptable qualities, bamboo, a renewable resource that is widely available, has been utilized as a building material since ancient times. For low-cost projects, it can be used as reinforcement in cement concrete due to its good bending and stress capabilities. As a step towards sustainable development, this study attempted to investigate the structural behavior and potential uses of a bamboo-reinforced beam for low cast housing, ideally in rural locations where bamboo is abundantly accessible. In this investigation, plant-based products with fibers were the comparatively low elasticity modulus might lead to issues with deflection and cracking: A steel reinforced element of equal section will deflect and crack by about 50% less than a bamboo reinforced element. Dendrocalmus strictus is the bamboo species, and it is mainly found in India. The bamboo is 3 to 4 years old, has a brownish look, and samples are harvested in the winter. Bamboos can be 6 mm to 20 mm thick and 30 mm to 50 mm in diameter. These bamboo culms were prepared for testing, and the bamboo splints of the necessary size were cut from them. Bamboo splints are painted with oil paint (a coating material) and liberally dusted with sand to increase the bond strength.The several testing carried out.

The 400KN UTM is used to test the BRC beams after which a built-up portion is fabricated to sustain a 2.4 meter long beam in the right arrangement. Under the expert's guidance, tests are also conducted on the BRC beam that has strain gauges mounted. On bamboo-reinforced beams, a two-point loading test is conducted to examine the failure load and pattern. The fluctuation of Mr with bamboo % has only been depicted for M30 because that is the concrete grade we have chosen to utilize for casting the final beams. The graph makes it very evident that having a maximum of 4.36 percent of bamboo as a reinforcement is preferable. In response, I cast a couple additional beams with 1.96%, 2.93%, and a maximum of 3.91 percent of bamboo splints.

Two beams have gauges positioned differently on bamboo splints and the concrete surface. A total of 33 beams were cast, of which the test results of 12 shortlisted beams are taken into account. To determine the failure load and pattern of bamboo-reinforced beams with dimensions of 1200 mm X 150 mm X 250 mm, two point loading tests are conducted. The ultimate testing load exceeded the estimated load for all the beams (RC & BRC). Additionally, all other beams exhibit better load carrying capacity at a permitted deflection of 3mm (span/350) aside from 1.96% reinforced BRC beams. If the allowed deflection for BRC could be increased to 4.2mm (span/250), all beams would demonstrate substantially safer loads than their intended loads.

3. Mritunjay Kumar Singh, Shiv Pratap Singh, Kaisar Jamal and Piyush Verma,(2020):

According to the research, the construction industry is a crucial component of human civilization and is essential to everyone's personal growth in the world of development. Therefore, in order to save costs, we have substituted bamboo for steel bars in the reinforcement process. The main difference between the two is bamboo's higher tensile strength. The project report serves as a theoretical illustration of bamboo's extensive application in concrete construction as a reinforcing material and its replacement of steel as reinforcement in concrete load-bearing components. This article discusses the construction concepts involved in creating bamboo reinforced members and structures, using bamboo as a substitute for steel. The results of several studies and research projects will be used to deduce the optimum procedure for using bamboo as a substitute for steel or other reinforcing materials in the proper quantity, proportion, and location. The report must demonstrate a technique that would not jeopardize the structure's safety. We are attempting to concentrate on a particularly unique kind of engineering reinforcing material in this study, such as bamboo. We will be familiar with their land in the coming years, although it is not currently being used to its full potential. Bamboo does have some beneficial qualities, such as the ability to absorb CO2 and reduce environmental pollution.

Ordinary Portland cement is used as a binder in concrete. This cement has the desired characteristics and comes in 53 grades that are compliant with IS 456-2000. By using a standard operating process, the characteristics of cement were ascertained. The following table lists the properties. The primary fundamental properties that were established include normal consistency, start and final setting times, specific gravity, and fineness. M-sand is a fine aggregate used. Fine aggregates were subjected to laboratory testing to ascertain their various physical characteristics in accordance with IS 2386 (part3)1963(Reaffirmed2002).The sieve analysis is used to determine fineness, and the outcome is such that the fine aggregate complies with IS 383 - 1970.The specific gravity of fine aggregate is 2.65, the fineness modulus is 5.41, and the water absorption rate is 1.7%.

Crushed stone was used as the project's coarse aggregate. Aggregate with an angular shape and a minimum size of 20 mm. Coarse aggregate is defined as that which passes through a sieve with a 75mm opening and retains 4.75mm. The grading of coarse aggregates should adhere to IS 383-1970 requirements. The fineness is calculated by sieve analysis, and the outcome complies with IS requirements. A crucial component of concrete is water. It makes cement stronger and makes concrete more workable. For casting and curing, potable water is required.

According to research, some species of bamboo have an ultimate tensile strength that is equal to mild steel at the yield point. Experimental research has revealed that bamboo's ultimate tensile strength ranges from 140 N/mm2 to 280 N/mm2, making it similar to mild steel. Because of its excellent strength to weight ratio, ease of workability, and availability, bamboo is a material with many uses. Bamboo's limited natural durability necessitates chemical treatment. It can be used to create bamboo trusses, roofs, skeletons, walls and ceilings, doors and windows, flooring, scaffoldings, and more. It has been discovered that bamboo behaves very well in buckling, however due to lower stresses than steel and since it is not straight, it buckles more slowly.

Bamboo's primary constituent, cellulose, is also the source of its mechanical qualities. The design, mix ratio, and construction methods utilized for steel reinforced concrete also apply to bamboo reinforced concrete. Bamboo reinforcement shares many of the same characteristics as steel reinforcement. In building construction, bamboo has been utilized for numerous things, including stands to support formwork and scaffolding. Only medium-sized to large projects can use these. Although bamboo has been around for generations, using it as a reinforcement material is a new development in the world of civil engineering building. Bamboo is both renewable and biodegradable. Because it is natural and environmentally friendly, it is energy efficient.

IV.CONCLUDING REMARK:

1. The strength of bamboo reinforcement concrete members the cross sectional size of bamboo is not constant therefore strength changes
2. The high tensile strength of bamboo is 250 N/MM2 or higher, depending on the species and cross-sectional area of cultivation with places.
3. The seasoning period, height, and location all affect the moisture content of the bamboo, which in turn affects all of its mechanical and physical attributes.
4. Acquiring more strength at a lower cost For moderately loaded structures, bamboo reinforce concrete is superior to others at the same conditions and is more affordable.
5. BAMBOO Reinforcement has a lower elasticity modulus and is roughly one third as strong as steel.
6. Pull-out test results with bamboo behaved nearly identically to those with simple steel bars, but the bond strength with bamboo was greater.
7. It is reasonable to assume that the bond strength covering after thorough treatment demonstrates the high value.
8. When fly ash is substituted for cement in high concrete grades, the grades' compressive and early strength are reduced.
9. Fly ash can be a cost-effective alternative that provides greater 28-day strength by mixing a little amount of high fly ash percentage rather than a large amount of poor graded concrete with low ash percentage.

IV.ACKNOWLEDGEMENT:

With great pleasure, we provide this study paper on the "Feasibility of Study on the Use of Bamboo and Admixture with Cement for Construction of Some Components of Building." I would like to take this occasion to express my profound gratitude to my adviser, Prof. S. D. Malkhede, for his continued support of my academic and research pursuits as well as for his tolerance, inspiration, and enormous knowledge. In order to perform my research and complete this thesis, I found his advice to be of great assistance. I'd also like to express my gratitude to Dr. N. W. Ingole for his steadfast support.

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