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Partially Replacement of Broken Roof Tiles As Coarse Aggregate and Bamboo as Reinforcement in RC Beam

Priyanka S , D H Yashasvini, Sudhakar H V

Abstract: ***Steel is commonly used as reinforcement, the cost of the steel is increases day by day, during the fabrication of steel emits the*** Co_2 ***and it consumes high energy, for this reason bamboo is substituent material for the reinforcement. Scarcity of aggregate due banned quarries, the industries waste like broken roof tiles cause the environmental pollution, so it can be replaced as a coarse aggregate. In this paper aptness of bamboo used as reinforcement in RC beam with different percentage of roof tiles are replaced as a coarse aggregate. For the bamboo compressive strength, tensile strength and different treatment are performed. The beams are having size 2mx230mmx300mm, strength parameters are compared with conventional beams the roof tiles are replaced 0%, 20% ,40% , 60% and cost comparison are done.***

Index Terms: Bamboo reinforcement, compressive strength, tensile strength, flexural strength, deflection, young's modulus.

I. INTRODUCTION

Cement motor and Concrete are commonly used as a Construction Material, Re-in forced cement concrete which includes steel bars as reinforcement and cement concrete. The cement concrete made of different ingredients such as cement, fine aggregate, coarse aggregate and water. The cement gives to concrete cementious property when water is hydrated.

The cost of the steel is increase day by day, steel is non-renewable source, Steel release the carbine dioxide during fabrication and its consume high energy. For the safety of Environment, Global concern for the development countries, due to all the reason Bamboo is one of the substituent materials for the replacement for reinforcement. Bamboo consumes less energy, low cost, fast growing, light weight, and Environmental friendly.

In the world bamboo is fast growing plant, some species grow up to 0.25-1m within 24 hours period and depends on species, climatic and soil condition. Bamboo is widely available material, having flexible nature to resist the seismic action. Bamboo needs treatment due to rich in mineral and vitamins content. Its good in compression strength and tensile strength, the tensile strength attains up to 350 N/mm^2 during 3-4th year of its life span. From the environment Bamboo absorbs lot of carbine dioxide, and release the oxygen to atmosphere.The rapid development of infrastructure growing, the demand of the raw materials increases, the aggregates gets scarcity due to banned the quarries. From lost few decades the Environmental load is day by day increases building industries are causing environmental damage. Due all these reason one of the direct solution is looking for new materials. The industries waste like broken roof tiles produces the large quantities it cause the environmental pollution so for that it need safety disposal. The broken roof tiles process the potential characteristics, it can be used as various uses and it can be partially replaced as coarse aggregate and solved the disposal problem. The roof tiles can be make into a coarse aggregate in simplest manner, removing contaminated particles surrounding the aggregate and broken the less than 20mm size as per IS 383-1970.

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***** Correspondence Author

PRIYANKA S*, Asstiatnt Professor, Civil Engineering Department, Sri Venkateshwara college of Engineering, Bangalore, Karnataka, India,

D H YASHASVINI, Asstiatnt Professor, Civil Engineering Department, Sri Venkateshwara college of Engineering, Bangalore, Karnataka, India,

SUDHAKAR H V, Asstiatnt Professor, Civil Engineering Department, Alpha college of Engineering, Bangalore, Karnataka, India,

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II. MATERIALS AND ITS PROPERTIES

A. Cement

OPC 53 grade Cement was used for the M20 mix proportion

Table 1: Properties Of Cement

Sl.No	Description	Results	Requirement as per IS:81121989
1	Consistency	29%	Not specified
2	Initial setting time	166 minute	>30 minutes
3	Final setting time	450 minute	>600 minutes
4	Compressive strength 72±1h 168±2h 672±4h	31.Mpa 42.0 Mpa 58.oMpa	>27 Mpa >37 Mpa >53 Mpa
5	Specific gravity	3.14	3.15
6	Fines modulus	1.22	10% (maximum)

B. Fine aggregate

Laically available sand as used as a fine aggregate, fines modulus performed as per IS 389-1970 and specific gravity, water absorption is followed as per IS 2386(part -3)1963.

C. Coarse aggregate and roof tiles

NCA &RT of Physical properties are performed as per IS 2386-1963

Fig 1: CA and RT

Table 2: Properties of CA & RT

Sl.No	Characteristics	RT	NCA
1	BULK DENSITY	1148 Kg/m^3	1400Kg/m^3
2	MOISTURE CONTENT	0.82%	0.3%
3	WATER OBSERPTION	2%	0.6%
4	FINENESS MODULOSE	2.72	18%-35%
5	IMPACT VALUE	26.47%	18%-35%
6	CRUSHING VALUE	28.88%	18%-35%
7	SPECIFIC GRAVITY	2.4	2.6- 2.9
8	FLAKIENESS INDEX	34.23%	18%-35%

D. Bamboo

The bamboo was brought from bamboo market at Bangalore the bamboo species is "Guadua Anustifolia" the bamboo clubs are available in form of cylindrical plants. As per require dimension the bamboo was cut into sticks forms, having a size10mm thick, 25mm width, and 2m length with five nodes bamboo sticks are used.

Fig 2: Bamboo sticks

Selection Criteria for Bamboo Clubs Are Used As Reinforcement

1. The Bamboo should be seasoned bamboo (seasoned means at least three –four years old)
2. The diameter, thickness of bamboo uniform and length of bamboo should be narrow.
3. The Bamboo color should be yellow or brown color it shows seasoned bamboo. Bamboo can cut in rainy season but should not in summer season since bamboo weak due to increase fiber moisture content.

III. SAMPLE PREPARATION

1. Preparation bamboo sticks as a Reinforcement

10mm thickness, 25mm width, 2000mm long size of bamboo stick is used as reinforcement.

Fig 3: Bamboo reinforcement

The 3-10mm steel rod with bamboo is reinforced intension zone and only 2-number bamboo is reinforced in compresion zone.

2. Mix Propotion

M20 mix propotion was followed as per IS 383-1970 less than 20mm size of aggregates are used

Table 3: Mix proportion

Cement	351 kg/m^3
Super plasticizers	158 kg/m^3
Fine aggregate	763 kg/m^3
Coarse aggregate	1186 kg/m^3
Water cement ratio	0.45

3. Workability of concrete

For finding workability of concrete we adopted slump cone test

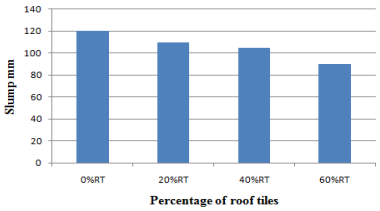

Fig 4: workability of different concrete

4. Compressive strength of concrete

As per IS 516-1959 was followed for the casting cubes and testing. The prism having a size 150x150x150mm.after casting the specimens are kept in 24 hours the de-molded specimens are kept in water curing up to 28 days.

Fig 5: prisms setting and curing

5. Beam specimen The beam having size 2000x230x300mm, for all the beams the bamboo reinforcement same all the beams but variation in percentage of roof tiles, 25mm cover is provided, after completion of casting, the specimens are done gunny bags curing.

Fig 6: beams curing

IV. RESULTS AND DISCUSIONS

1. Compressive Strength

The compression testing machine was used for finding compressive strength of prisms, as per the code provision 7,14,28 days curing specimens are performed, the cubes are casted 0%,20%,40%,60%, from these 40% roof tiles can be replaced as coarse aggregate in concrete.

2. Flexural test of beam

The loading frame was used to find the fleural stregth of beam. LVDT was used for finding deflection. The placed on loading flatform, and two point loading condition prepared to get the pure bending

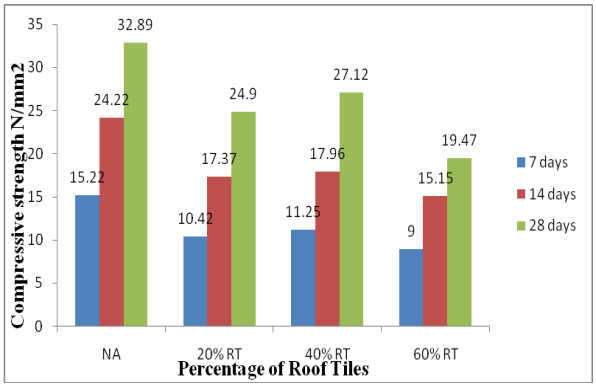

Fig 7: compression stregth of different concrete

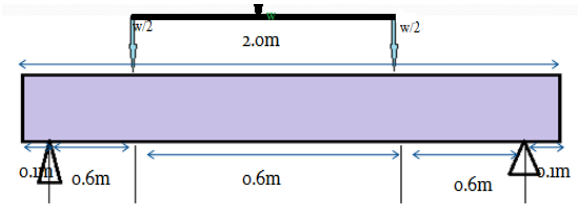

Fig 8: load arrengement diagram

Fig 9: setting and arrengement in loading frame

a. Convesional beam

The convesional beam having steel reinforcement with natural aggregate, ultimate load is taken before failure is 241.2KN under the deflection is 11mm, flexural strength is 41 N/mm^2

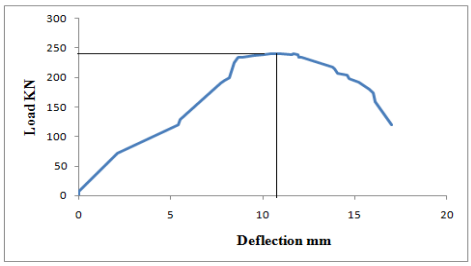

Fig 10: load v/s deflection diagram for convensional beam

From the Stress- Strain curve Modulus of Elasticity is 13490.57 N/mm^2.

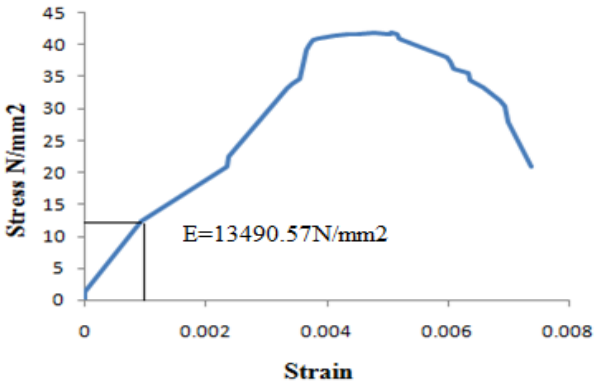

Fig 11: stress v/s strain diagram for convensional beam

b. Bamboo reinforced with natural aggregate (0% RT)

In this beam Bamboo is replaced as reinforcement and natural aggregates are used. The maximum load is taken 176.1 KN under 18mm deflection, flexural strength is 46 N/mm^2.

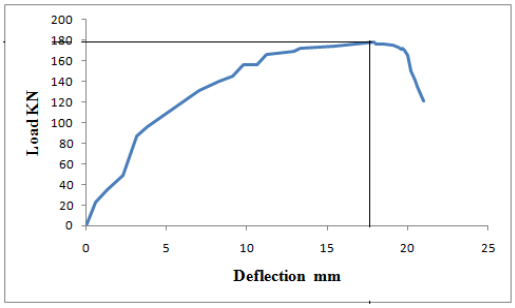

Fig 12: load v/s deflection diagram for 0% RT Beam

From the stress- strain curve E was obtained 15266.66N/mm^2

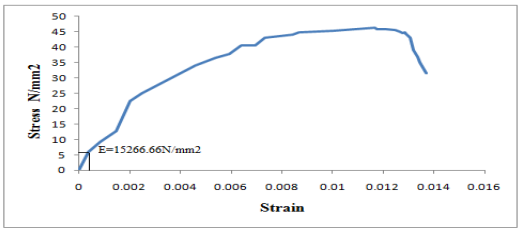

Fig 13: stress v/s strain diagram for 0% RT Beam

c. Bamboo reinforced with 20% Roof Tiles

20% of the roof tiles are replaced in this beam it's taken max load is 143.33KN under 16mm deflection, the flexural strength was 25 N/mm^2.

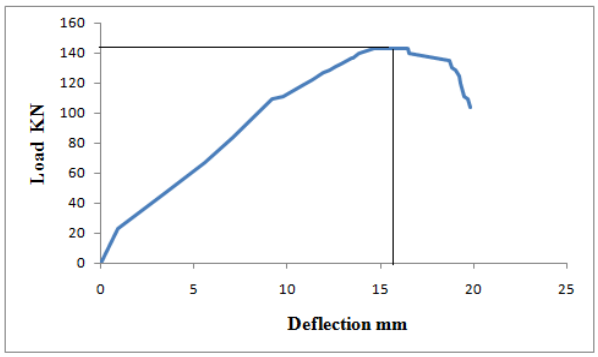

Fig 14: load v/s deflection diagram for 20% RT Beam

Moduluse of elascity was obtained from stress strain curve that is 10285.71N/mm^2.

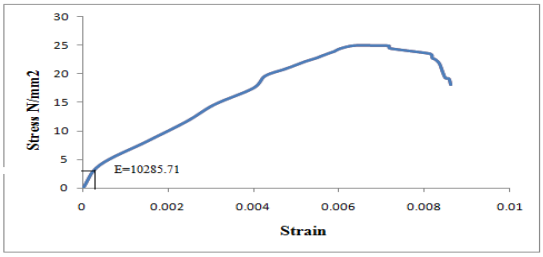

Fig 15: stress v/s strain diagram for 20% RT beam

d. Bamboo reinforcement with 40% Roof Tiles

Along the bamboo broken roof tiles replaced up to 40% in this beam, the ultimate load is 167.8 KN, 15.4 is the deflection. The flexural strength was obtained 29 N/mm^2.

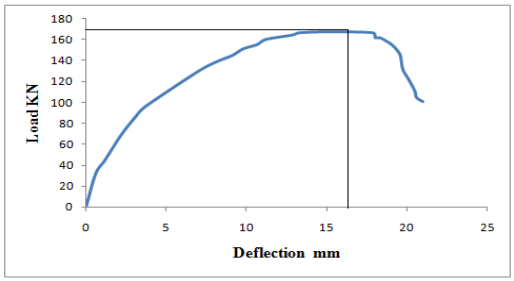

Fig 16: load v/s deflection diagram for 40% RT Beam

From the stress –strain curve the modulus elasticity is 14677.51 N/mm^2.

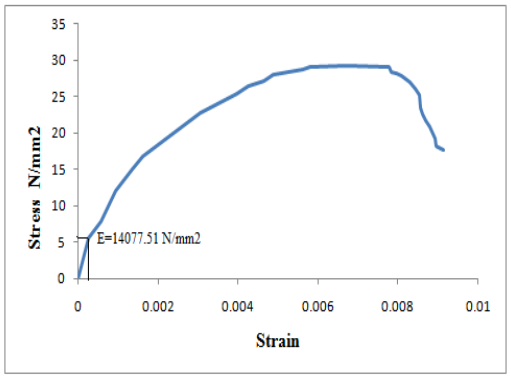

Fig 17: stress v/s strain diagram for 40% RT beam

e. Bamboo reinforced with 60% of roof tiles

In this beam 60% roof tiles are replaced along the bamboo as reinforcement, the ultimate load is taken 115.11KN, under the 15.62mm deflection. The flexural stregth was obtained 32 N/mm^2.

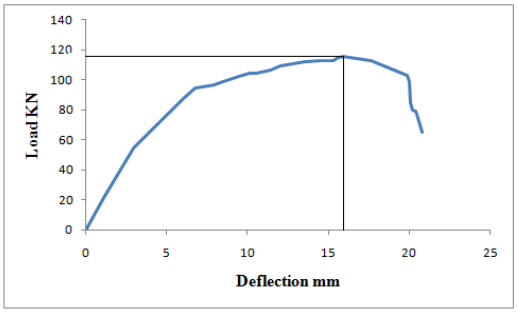

Fig 18: load v/s deflection diagram for 60% RT Beam

The modulus of elasticity was obtained from stress strain curve 7430.508 N/mm^2

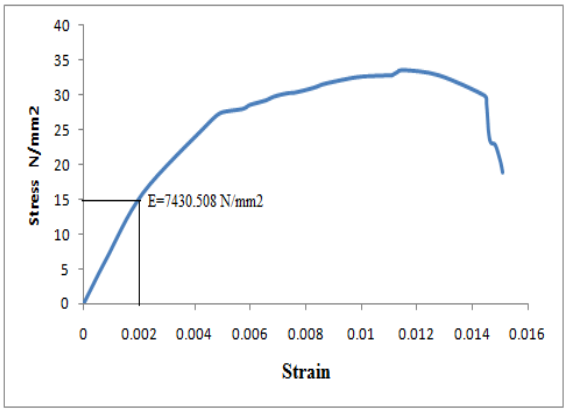

Fig 19: stress v/s strain diagram for 60% RT beam

V. COMPARISION STUDY

a. Cost comparison

The cost of the steel is high, by the replacement of roof tiles the cost of beam can be reduces up to 30%.

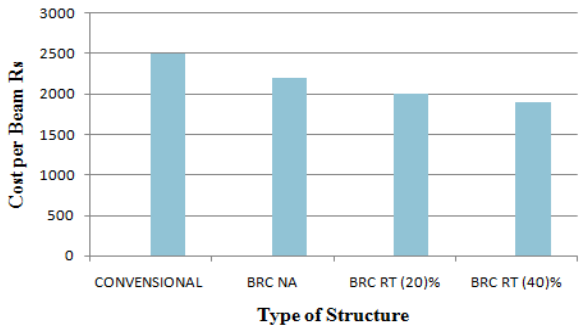

Fig 20: cost comparison diagram

b. Strength comparison

By the replacement of rooftiles upto 40% got good compressive strength.

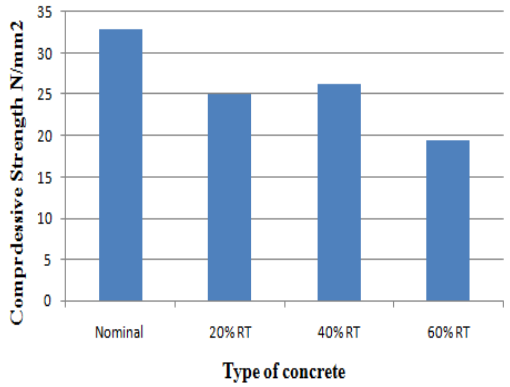

Fig 21: Compressive stregth comparison diagram

c. Load and Deflection comparison

Load 40% replaced roof tiles beam as taken more load comparatively, deflection is almost same as all the beams.

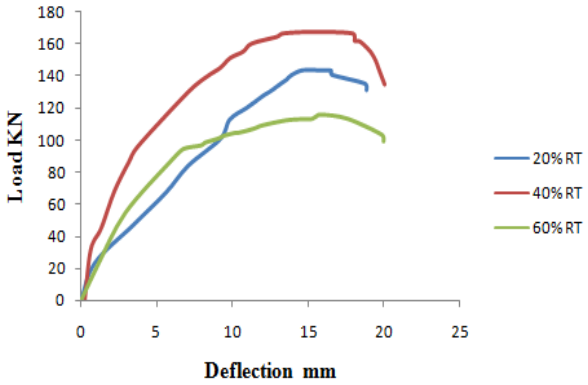

Fig 22 : load and deflection comprison

VI. CONCLUSION

- It has been concluded that using the bamboo with roof tiles as aggregate to achieve both economy and sustainability.
- It has been concluded along the bamboo with roof tiles as coarse aggregate can be replaced up to 40%.
- It has been concluded Roof tiles concrete is reduce the dead load of concrete whose density of 40% replaced aggregate is 2200 kg/m^3. So it reduces the dead load of concrete.
- It has been concluded Polyester Resign coating is good method to control water absorption, compare to other method.

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CODE OF PRACTICE

1. IS 2386-Part 1 1963 Guidelines for Aggregate Testing.
2. IS 516-1959 for compressive strength and flexural strength
3. IS 456-2000 code for practiced Plain and Reinforced Concrete
4. IS 383-1970(Specifications for coarse aggregate and Fine aggregate)
5. IS 8242:1976 Method of tests for split bamboo
6. IS 10262 (2009): Guidelines for concrete mix design proportioning
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AUTHORS PROFILE

PRIYANKA S , BE, M.Tech, Working as Assistant Professor at SVCE Bengaluru. 15Scopus and Non scopus papers published in both National and International Journals.

D H YASHASVINI, , M.Tech, Working as Assistant Professor at SVCE Bengaluru. Ten Scopus and Non scopus papers published in both National and International Journals.

SUDHAKAR H V,BE , M.Tech, Working as Assistant Professor at SVCE Bengaluru. Ten Scopus and Non scopus papers published in both National and International Journals.