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DESIGN AND COST ANALYSIS OF BAMBOO PANEL IN LOW COST BUILDING

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Abstract – In India due to economic and environmental need pressure on construction industry is increasing every year. Any concrete building consumes a lot of non-renewable materials such as cement, sand , aggregate which are made from natural sources. Use of renewable materials like bamboo, coconut husk, and etc in replace of concrete are important for sustainability and provide green feature to building. This study has been undertaken to investigate the determinant of bamboo panel and its cost analysis with low cost building. Moisture content test , water absorption test, density test and flexural test is used to check the feasibility of bamboo panel. Thepropertiesofthe panels weretestedaspertheAS/NZS4266:2004IS: 2408-1963andIS 2380– 1997 standards. The cost of preparation of bamboo panel for 1 m2 is calculated. Cost analysis is done with the help of g +1 residential building. Cost comparison is determine by calculating cost of rcc building , rcc + steel building , rcc + bamboo panel building ,steel + bamboo building.

Key Words:Bamboo, Coconut husk , bamboo nail, etc.

1.INTRODUCTION *(Size 11, Times New roman)*

Due to continuously growth in population all over the world , there is increase in demand for building to provide necessary shelter for people. Due to this reason use of number of concrete structure are increasingly rapidly. Use of bamboo panel will help to decreases the pressure over the forests for wood recourses. Bamboo productionsdatedbacktothousandsofyears agoandthustheyarerichwithtraditional elements. Bambooisoftenusedasmaterialsforconstructionorusedastheraw materialsfortheproductionofpapersheet.Messibamboo"isonesp eciesofbamboo. Messibamboowasusedasarawmaterialforproducingpanelsinthi sstudy.

1.1 Problem Statement

Due to rapid growth in development of cities, construction industries also growing in a rapid speed. Therefore use of concrete is also increase in speedy way. Concrete cover cement sand aggregate and admixture which are non-renewable material and manufacture from natural resources. Excessive use of this materials causes shortage in availability and increases the cost of materials. From last few years the cost of this materials increases 30 to 60 % more every year. Continuous use of natural sand, aggregate, cement causes serious damage to environment and indirectly reason for tsunami, flood, and our health. To overcome this problem it is necessary to find a solution as possible as we can. From this research paper we can learn how to replace this non-renewable materials concrete with renewable material like bamboo panel in some portion of building structure like walls and floors in low cost building which will save the cost of construction as well as concrete materials.

1.2 Scope of work

This research paper is limited to study of bamboo panel as renewable materials. It is also including selection and suggestion of renewable and agricultural waste material for replacing the floor and brick wall. Then prepare a panel from the selected waste or renewable material and conduct test on it. Also design of bamboo and wooden composite slab and G+1 building using suggested material.

1.3 Objectives

Followings are the objectives of proposed work.

1. To identify, study and selection of Renewable Materials and Agricultural waste material for construction of floor and wall.
2. To test the bamboo and wooden composites panel.
3. Cost analysis of designed structure.

2 RESEARCH METHODOLOGY

Fig.1Flowchartof methodology

3 PANELMAKINGPROCESS

In this study messi type of bamboo was used.Bamboo is available in the area nearby Tadoba, Chichpalli Chandrapur.In this study, 3 mm plywood sheet is used. The bamboo composite panels are manufactured in wasnik bamboo plant which is at chichpalli tadoba chandrapur. The details about the panel such as bamboo panel's size, process are given in the figure.

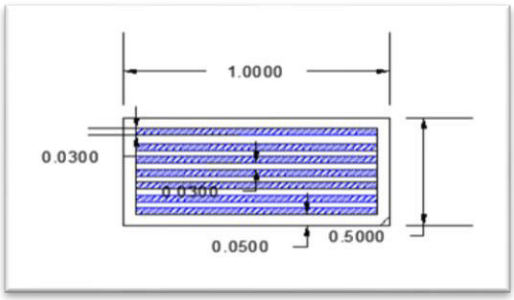

Fig -2 Design of panel size 1 X 0.5 m

Fig -3 Making process of bamboo panel.

3.1 Flow chart of panel making process

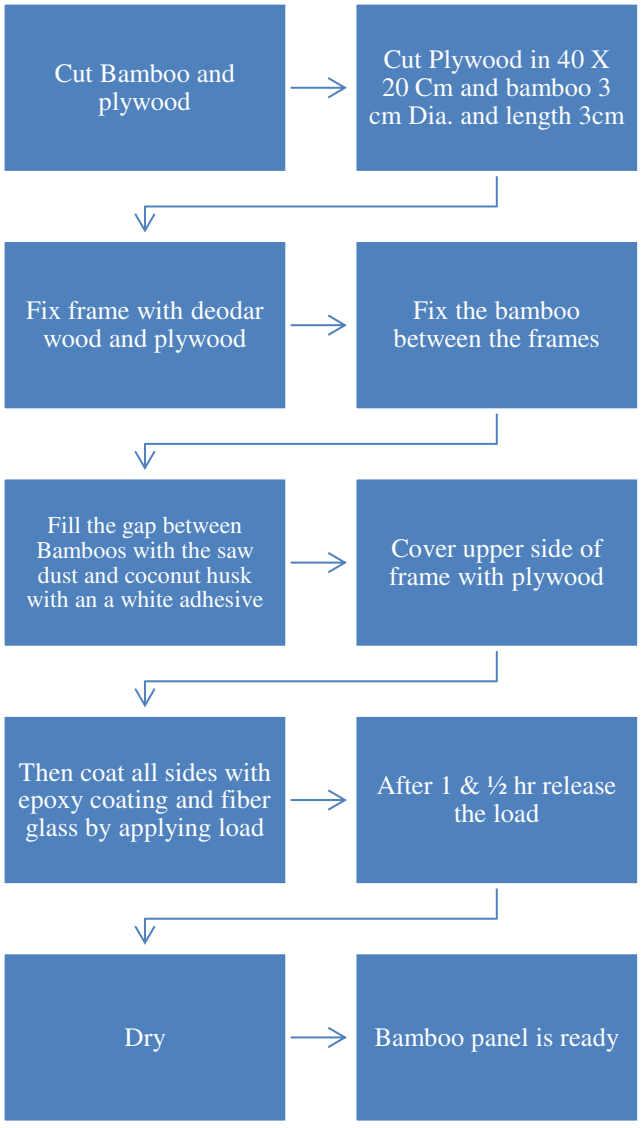

Fig-4 Flow chart of bamboo panel process

4 TESTING OF BAMBOO PANEL

The different IS codes and New Zealand preferred codes have been referred in this take a look at procedure.

(AS/NZS 4266-2004, IS: 2408-1963 and IS 2380 – 1997)

Following tests were conducted on bamboo composite panels.

Water Absorption – IS 2380 part 16:1977
Density of Panel – IS 2380 part 3:1977
Moisture Content – IS 2380 Part 3: 1977
Modulus of Rupture and Modulus of Elasticity - IS 2380 part 4: 1977

4.1Water absorption test on panel IS 2380 part16:1977

Water Absorption test was conducted on bamboo composite panel. The test results of panels are compared with particle boards and red clay brick from papers and codes. For testing purpose, I cut the panel sample in size of 40 X 20 X3 cm. With the help of clean and fresh water tank is used for panel Deeping Process. After the 24 hours we observed that following results

Table -1: Water absorption for 24 Hrs. in %

Sample	Panel 1	Panel 2	Panel 3	Formula for water absorption in % = $\frac{W0-W1}{W0}$ X 100 %
Size of panel (cm)	40X20 X3	40X2 0X3	40X2 0X3	
Original weight (W_0) Kg	1.6	1.59	1.62	
Wet weight (W_1) Kg	1.82	1.78	1.83	
Water absorption in %	13.75	11.94	12.93	
Average in %	12.88			

Fig No. 5 Water absorption for 24 Hrs

4.2 Moisture content test on panel IS 2380 Part 3: 1977 and AS/ NZS 4266 part 3: 2004

Moisture content test was conducted on bamboo composite panels. Sample size is same as the water absorption test sample. The Procedure is follow by the given in IS code 2380 Part3.All three samples are dry in 103^0c for 24 hours by using electrical oven. After drying 24 hours sample following results are obtained from the test.

Table No.2- Moisture Content in %

Sample	Panel 1	Panel 2	Panel 3	Formula for water absorption in % = $\frac{W2-W1}{W2}$ X 100 %
Size of panel (cm)	40X20 X3	40X2 0X3	40X2 0X3	
Original weight (W_1) Kg	1.6	1.59	1.62	
Dry weight (W_2) Kg	1.45	1.42	1.46	
Water absorption in %	10.35	11.98	10.96	
Average in %	11.097 %			

Panel before and after test

Fig No. 6- Moisture content Test

4.3 Density test on panel IS 2380 part 3:1977

Table No. 3 - Density of the panels

Sample	Panel 1	Panel 2	Panel 3	Average	Formula for Density = $\frac{Mass}{Volume}$
Size (cm)	40X20X3	40X20X3	40X20X3		
Weight	1.6	1.59	1.62		
In Kg/m3	0.00067	0.0006625	0.000675	669.167	
In Kg/cm3	666.66667	662.5	675.00	0.000669	
In g/cm3	0.66667	0.6625	0.675	0.66916	

4.4 Flexural strength test (Bending test) on panel IS 2380 part 4: 1977:-

By using flexural strength test we can calculate the modulus of rupture (R) and modulus of elasticity (young's modulus E). The three point flexural tests of composites are carried out using Universal Testing Machine as per the IS 2380 part 4: 1977 standards under displacement control mode at crosshead speed 2 mm/min. All tests were performed at room temperature and results were taken as the average value of four samples. The sample of rectangular cross section 40 x 20 cm rests on two supports and is loaded by means of a loading nose midway between the anchors. The flexural modulus is calculated from the slope of the initial portion of the load deflection curve. The flexural strength and Young's modulus of elasticity of the composite were calculated using Equation

$$R \text{ or } \sigma_{max} = \frac{3PmaxL}{2bh\hat{}2} \& \; E = \frac{L\hat{}3P}{4bh\hat{}3\Delta}$$

Where, σ_{max} is flexural strength, E is Young's modulus of elasticity, P_{max} is the maximum load, L is specimen span, b is specimen width, h is specimen thickness and (P/Δ) is the slope of the linear region of the obtained load deformation relationship.

Table -4: Bending test on panel

	Unit	Sample 1	Sample 2	Sample 3	Sample4	Average
Modulus of Rupture	kg/cm^2	390	416	387	413.4	401.6
	N/mm^2	39.44	41.79	38.42	40.55	40.05
Modulus of elasticity	kg/cm^2	55050	55050	55050	55050	55050
	N/mm^2	5435.35	5435.35	5435.35	5435.35	5435.35

Fig No 7 Flexural Test

5. Cost Analysis

RCC building is considered in local area of 1018 square feet in ramnagar chandrapur for calculating the estimated cost of RCC building , RCC + Steel building , RCC + Bamboo panel building. This building is done for low income group and also for middle class group. Following are the calculated values:

5.1 Cost of RCC building :

Table No. **5**Cost of RCC Building

Item no	Particular of item and Details of work	Quantity	Per Unit	Rate Rs.	Labour Rate	Amount Rs.
	Earthwork in excavation in foundation	9.24	Cum	110	50	1016.4+462=1478.4
	……					
	Total					**12,20,260 rs**
	Sundries (including mixer, transportation) 7.5 %					91,519
	Water charges 1.5 %					18,304
	Contractor profits 15 %					1,83,039
	Total =					**Rs.15, 13,121**

5.2 Cost of Steel and Concrete building

- ISMB= 300 =3126.75 kg = Rs. 1,21,943
- ISMB =250 =1193.17 kg= Rs. 46,534
- Cost up to plinth level= Rs. 41,457
- 1st class brick work in 1:6 cement mortar = Rs.2, 24,056
- Half brick masonry = Rs. 2,470
- RCC work 1:1.5:3 in staircase = Rs. 23,503
- RCC work 1:1.5:3 in slab = Rs. 1, 16,085
- Mild steel including bending in reinforcement in RCC works RCC roof slab @0.8%= Rs. 38,337
- Mild steel including bending in reinforcement in RCC works RCC staircase @ 0.5% = Rs. 4,329
- Providing and laying Rough Shahabad Stone Flooring 25mm to 30mm thick = Rs. 38,800
- Total = Rs. 657514= **Rs. 7,23,265**
- Labour charges 15% = **Rs. 98627**
- Sundries 7.5% = **Rs.49314**
- Contractor profit 15% **= Rs. 98627**
- Total Cost of steel and concrete building = **Rs. 9,04,082**

5.3 Cost of RCC and Bamboo Panel building

Table No. **6**Cost of RCC and bamboo panel Building

Item no	Particular of item and Details of work	Quantity	Per Unit	Rate Rs.	Labour Rate	Amount Rs.
	Earthwork in excavation in foundation	9.24	Cum	110	50	1016.4+462=1478.4
	Wall bamboo panel 1.5X1m	63	No.	1403		88389
	Wall bamboo panel 1X0.5m	43	No.	468		20124
	……					

	Total	**Rs.8,81,482**
	Sundries (including mixer, transportation) 7.5 %	66,111
	Water charges 1.5 %	6,611
	Contractor profits 15 %	1,32,222
	Total =	**Rs. 10,86,427**

5.4 Cost of bamboo panel for 1 m2

Table No. 7 Bamboo panel

Materials	Cost
Bamboo (Rs.20/m)	Rs.280
Plywood 3mm (Rs.13/sq.ft.)	Rs.279.76
Saw Dust (Rs.125/Bag)	Rs.7.5
Adhesive (Rs.100/ litter)	Rs.125
Fiber Glass (Rs.150/kg)	Rs.24.75
Deodar Wood (Rs.31/kg)	Rs.66
Total	Rs.935

6. Result & Discussion

6.1 Test on Panel

- For Water absorption Test

  From table no 1 it can be calculated that the average water absorption of the panels is 12.88% for 24 Hrs.Total three samples are tested for this procedure. According to research paper red burned clay brick and particle board water absorption capacity is up to 20%.The maximum water absorption capacity of the any type of the particle board is equal to 20% and not more than 20%.
  Thus the water absorption of the bamboo composite panels is sufficient and it is accepted.

- For Moisture content test

  From table no 2 it can be concluded that the common moisture content of the bamboo composite panel via checking out three samples is 11.097 %. According to IS codes and Research paper average value of moisture content of particle board is between 10-15 percent and this is accepted

- For Density Test

  From table 3, it can be concluded that the common density of the bamboo composite panel by testing three samples is 669.167 Kg/m3.As per the medium density particle boards, the density is in between 500 kg/m3 and 1,000 kg/m^3.

- For Flexural test

  From table no 4, it can be calculated that the common modulus of rupture and modulus of elasticity of the panels is 401.6 kg/cm2 (40.05 N/mm2) and 55050 kg/cm2 (5435.35 N/mm2).
  As in contrast to wood composite board the cost of modulus of rupture and modulus of elasticity is 16.6 N/mm2 and 2800 N/mm2 .
  Total 4 samples are tested for this Procedure.
  The modulus of rupture and modulus of elasticity is larger than the wooden composite boards.

6.2 Cost analysis.

- From this research it is concluded thatCost of steel building by using bamboo panels is less than the 56% cost of RCC building and 26% costs are less than the combination of steel and concrete building. Cost of RCC building by using bamboo panel is less than the 28% cost of RCC building.
- Weight of steel building by using bamboo panels is 30.012 KN (3060.37 Kg)and using combination of steel and concrete building is 42.364 KN (4319.92Kg). Using bamboo panel's weight of steel building reduces 29%.

7. CONCLUSIONS

From this research paper following points are concluded:

- Bamboo, coconut husk and saw dust are renewable material selected for the panel preparation, because it is available in local area near by Chandrapur city and cost is very cheap.
- All material is green construction material.
- The various tests were performed to check the suitability of Bamboo composite panel as a wall and floor construction.
- The experimental results it was found that the panel is suitable for wall and floor construction and hence it needs to be safe.

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