Evaluators Handout

EcoShield

Team 10126

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1 Force Analysis

1.1 Force Acting on the Brace Members

The 26.9 cm diagonal is Member 1, and the 30.6 cm diagonal is Member 2.

The axial force acting on the diagonals =

$$F = \frac{P}{2\sin(\theta)}$$

Where

P = 2 kg × 9.8 N = 19.6 N

θ = 45° For Member 1, and 38.3° For Member 2

by substituting

For Member 1: $F = \frac{19.6N}{2\sin(45°)} = 13.86N$

For Member 2: $F = \frac{19.6N}{2\sin(38.3°)} = 15.87N$

1.2 The Stress on The Brace Members

The axial Stress acting on the diagonals =

$$\sigma = \frac{F}{A}$$

Where

$F = 13.86N$ For Member 1, And $F = 15.87N$ For Member 2.

A (cross-sectional area) = 40 mm × 40 mm = 1600 mm^2

by substituting

For Member 1: $\sigma = \frac{13.86\ N}{1600\ \mathrm{mm2}} = 0.00866\ N/mm2$

For Member 2: $\sigma = \frac{15.87\ N}{1600\ mm2} = 0.00986\ N/mm2$

Table 1: Mechanical testing for casuarina

Property	Casuarina	
	Glauca	Cunn.
Compressive strength parallel to the grain (N/mm^2)	32.2	11.4
Compressive strength perpendicular to the grain (N/mm^2)	7.4	4.9
Bending strength (N/mm^2)	62.1	32.4
Tensile strength parallel to the grain (N/mm^2)	163.0	-
Tensile strength perpendicular to the grain (N/mm2)	5.9	-
Specific Gravity	0.63	0.50

The applied stress on the brace members is much lower than the compressive and tensile strength of the structural material (casuarina wood), as shown in **Table 1.**

2 Thermal conductivity properties

2.1 Calculating thermal Resistance for each material

The prototype wall consists of two layers: an external bamboo layer (Layer 1) and an internal rice-straw insulation layer (Layer 2).

The thermal resistance of each wall layer is calculated using the equation:

$$R = \frac{L}{k}$$

Where

The material thickness for Layer 1 is L = 0.01 m, and for Layer 2, L = 0.04 m.

The material thermal conductivity for the Layer 1 is K = 0.149 W/m·K and for Layer 2 = 0.05 W/m·K

By substituting

For Layer 1:

$$R = \frac{0.01}{0.149}$$

So, the thermal resistance for the bamboo layer is 0.0667 m^2·K/W.

For Layer 2:

$$R = \frac{0.04}{0.05}$$

So, the thermal resistance for the Rice straw layer is 0.80 m^2·K/W.

2.2 Total Thermal Resistance of the Wall

The total thermal resistance of the composite wall is equal to the sum of the thermal resistances of the individual layers:

R-total = R-bamboo + R-straw

By substituting:

R-total = 0.067 + 0.80 = 0.87 m²·K/W

2.3 Overall Heat-Transfer Coefficient (U value)

The overall heat-transfer coefficient (U value) (W/m²·K). =

$$U = \frac{1}{R_{\text{total}}}$$

By substituting:

$$U = \frac{1}{0.87}$$

So, the U value for the walls is 1.15 W/m²·K

The calculated U-value indicates that the composite bamboo and rice-straw wall have high thermal resistance and low heat-transfer capability. In comparison, the U-value of conventional brick walls is approximately 2 W/m²·K, which highlights that the proposed wall system demonstrates significantly better thermal performance. This reduced heat-transfer rate limits the amount of heat transmitted into the interior space, a result that was further confirmed through experimental testing.