Written Report 7

Introduction: A cantilever is constructed from several pieces of wood held together with glue or nails. In this report, three pieces of wood are built into an I-beam. Two designs, one with glue and one with nails, are compared to determine which is better.

Given:

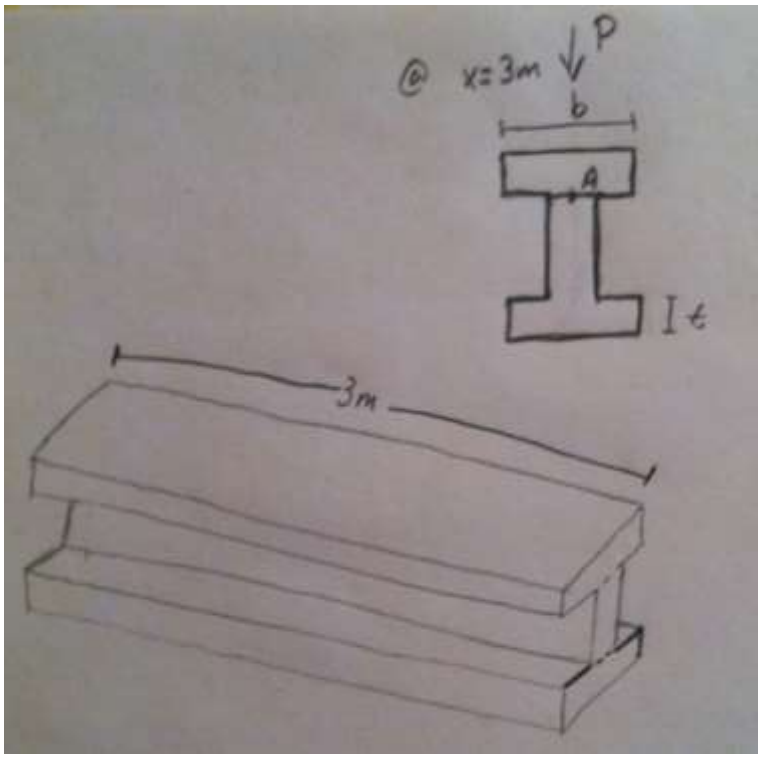
t = 0.06m
b = 0.24m
L = 3m
P = 12,000N

Wood:
$\tau_{all} = 1.5MPa$
$\sigma_{all} = 9MPa$

Glue:
$\tau_{max} = 1.5MPa$

Nails (100):
$F_n = 2.0kN$

Free Body Diagrams (FBD):



Find: Evaluate two cantilever designs to determine which is feasible.

Solve:

Assumptions:

Nail diameter = 0.5cm = 0.005m

Calculations:

$$I_c = \frac{tb^3}{12} + 2\left(\frac{bt^3}{12} + (bt)\left(\frac{b+t}{2}\right)^2\right) = 7.26x10^{-4}m^4$$

$$Q = Ay = (bt)\left(\frac{b+t}{2}\right) = 0.0026m^3$$

$$M = 3(12000) = 36{,}000$$

$$\sigma = \frac{My}{I} = 5.95\ MPa$$

$$\tau = \frac{VQ}{It} = 0.595\ MPa$$

Where $\sigma < \sigma_{all}$ and $\tau < \tau\_all$, thus this design is sturdy.

There are 100 nails, so 50 will be used on each side and are divided into two rows.

$$s = \frac{3}{25} = 0.012m$$

$$\tau = \frac{qs}{2\frac{\pi d^2}{4}} = \frac{2VQs}{I\pi d^2} = 109MPa$$

$$F_b = \tau A_b = 109\left(\frac{\pi d^2}{4}\right) = 2.1kN$$

$F_b > F_{b_{all}}$, thus, this is not a feasible design.

Conclusion:

The first design, and I-bean held together with glue, is a feasible design because both σ and τ are less than the allowable stresses for both the wood and glue. However, there are not enough nails to use to hold the I-beam together as a cantilever. Thus, the better of the two designs is the I-beam with the glue.