PROBLEM 5.11-6 TWO WOOD BOX BEAMS (BEAM A AND B) HAVE THE SAME OUTSIDE DIMENSIONS (200mm x 360mm) AND THE SAME THICKNESS (t = 20mm) THROUGHOUT, AS SHOWN IN THE FIGURE. BOTH BEAMS ARE FORMED BY NAILING, WITH EACH NAIL HAVING AN ALLOWABLE SHEAR LOAD OF 250N. THE BEAMS ARE DESIGNED FOR A SHEAR FORCE V = 3.2 kN. (a) WHAT IS THE MAXIMUM LONGITUDINAL SPACING s_A FOR THE NAILS IN BEAM A? (b) WHAT IS THE MAXIMUM LONGITUDINAL SPACING s_B FOR THE NAILS IN B? (c) WHICH BEAM IS MORE EFFICIENT IN RESISTING THE SHEAR FORCE?

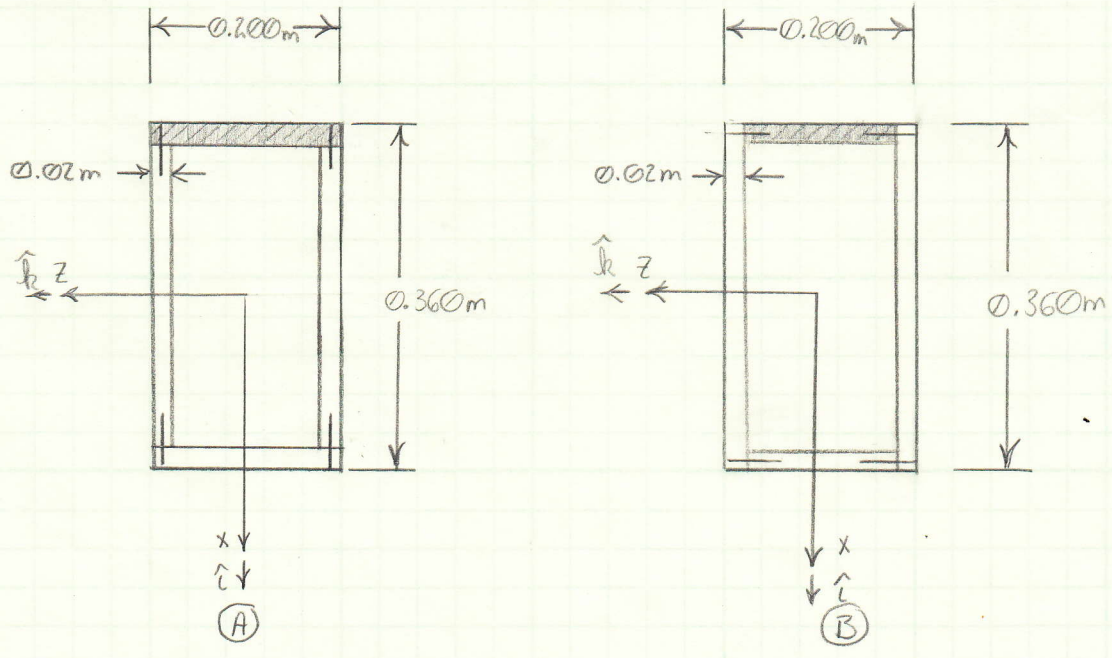
GIVEN:

CONSTRAINTS
1) 200 mm x 360mm BOX BEAMS MADE OF 20mm THICK BOARDS
2) ALLOWABLE SHEAR LOAD OF 250N
3) SHEAR FORCE 3.2 kN
4) NAIL FASTNERS

ASSUMPTIONS
1) SMALL DEFLECTIONS
2) LINEAR ELASTIC RESPONSE
3) NO FRICTION IN JOINTS, FASTNERS TRANSFER ALL LOAD

FIND:
1) MAXIMUM LONGITUDINAL SPACING FOR NAILS IN BEAM A
2) MAXIMUM LONGITUDINAL SPACING FOR NAILS IN BEAM B
3) DETERMINE WHICH BEAM IS MORE EFFICIENT IN RESISTING SHEAR LOADS

DIAGRAM:



MECHANICS:

THE SHEAR FLOW THROUGH THESE TWO SECTIONS NEEDS TO BE CONSIDERED. FOR BOTH CROSS SECTIONS THE SHEAR FORCE IS 3.2 kN AND THE MOMENT OF INERTIA IS GIVEN BY

$$I = \frac{1}{12}(0.2m)(0.36m)^3 - \frac{1}{12}(0.16m)(0.32m)^3 = 340.7(10^{-6})m^4 \quad (1)$$

THE SHEAR FLOW THROUGH THE SHADED SECTION OF (A) IS

$$q = \frac{VQ}{I} = \frac{3.2(10^3)N \cdot 0.17m \cdot .2m \cdot .02m}{340.7(10^{-6})m^4} = 6.387(10^3)\ N/m \quad (2)$$

THE SHEAR FLOW IS SHARED BY BOTH NAILS, THUS HALF GOES THROUGH ON NAIL AND THE REST THROUGH THE OTHER. THUS THE NAIL SPACING IS COMPUTED

$$S_A = \frac{2 \cdot 250N}{6.387(10^3)\ N/m} = \boxed{0.07829m} \quad (3)$$

THE SHEAR FLOW THROUGH THE SHADED SECTION OF (B) IS

$$q = \frac{VQ}{I} = \frac{3.2(10^3)\ N \cdot 0.17m \cdot 0.16m \cdot 0.02m}{340.7(10^{-6})m^4} = 5.109(10^3)\frac{N}{m} \quad (4)$$

THUS THE SHEAR SPACING IS

$$S_B = \frac{2 \cdot 250N}{5.109(10^3)\ N/m} = \boxed{0.09786m} \quad (5)$$

BEAM (B) IS MORE EFFICIENT SINCE FEWER NAILS WILL BE REQUIRED TO SAFELY SUPPORT THE DESIGNATED LOAD.

SUMMARY:

THIS SOLUTION IS VERY CONSERVATIVE IN THAT FRICTION IN THE JOINTS IS IGNORED. FRICTION WILL ASSIST THE NAILS IN TRANSFERING LOAD FROM ONE SECTION OF THE BEAM TO THE OTHER. THIS WILL CAUSE THE NAIL SPACING TO INCREASE