Homework Tutorial Session 3: Statically Indeterminate Beams

Mentor Guide Knowledge & Skills Question

1.3 State or derive the algebraic relations between beam rotation, transverse displacement and bending moment (θ, y and M).

Numerical Questions

1) A beam is encastre (built-in) at the left hand end, but simply supported at the right hand end. A uniformly distributed load is applied along its length. Derive the shearing force and bending moment diagrams.

[Hint: the reaction forces at the two ends will be different, and all four beam equations are required].

What is the maximum bending moment giving tension on the top surface, and where is it located?

What is the maximum bending moment giving tension on the bottom surface, and where is it located?

How does the maximum bending stress compare with, (a)a beam simply supported at both ends, and, (b)a beam encastre at both ends?

Plant Example

2) The superheater tailpipes at ****** convey the steam from the main boilers to the superheater penetrations, where it egresses the reactor. The terminal weld of the tailpipe is called the tailpipe-pintle weld. Many of these welds have been found to develop creep-fatigue cracks in service and have required repair. The tailpipe may be approximated as a straight pipe of length L which is encastre at the pintle and simply supported (pin-jointed) at the other end. In service the pintle rotates by an angle θ_a due to various thermal expansion effects, but its translational movement may be approximated to zero. Find an expression for the maximum bending stress in the tailpipe due to this loading in terms of L and the outer radius, R_o, of the tailpipe.

[Hint: Use all four beam equations, and note that there are four known boundary conditions: one in terms of a moment, two in terms of displacements, and finally the applied rotation].

Why does the maximum bending stress not depend upon the section second moment of area (I)?

If the tailpipe OD is 66.7mm, L = 1.67m and E = 160 GPa, evaluate the maximum bending stress if the applied rotation is 1.5^o. (Hint: It should be consistent with the thin end of the pintle, as per Session #1 homework).