Lesson 2: Strength of Materials Review – Direct and Bending Stresses

Wednesday, August 31, 2016

Lesson Objectives

1. Define Normal and Shear stress, list example occurrences, and state the applicable formulae.
2. Compute internal normal force P, bending moment M, and shear force V, normal stress $\sigma$, and shear stress $\tau$ in determinate structures by cutting and applying equilibrium.
3. Compute the moment of inertia of a composite section (such as an I-shape or the open-web example in class).
4. Compute the extreme fiber stress $\sigma$ for a member subjected to combined bending and axial effects.

Reading: Segui Chapter 1

Reference:
Today is a review of Strength of Materials. You are expected to be able to demonstrate the objectives above on an exam and you will probably need to refer to your Strength of Materials notes and textbook (and perhaps Statics). Some examples are not covered in today’s lesson (e.g., V and M diagrams, shear stresses on beams). The course website contains Strength of Materials Final Exams from recent years, along with solutions; students are strongly encouraged to study these.

The reading will also refer you to Table 1-1 in the AISC Manual of Steel Construction

In Class Problems

1. Given: Pinned foundations at A and F. Pinned connection at D. C is midway between B and D, at the top fiber of the open-web member. The open web member consists of two main tubes that are 4”x4” hollow squares with a ½” wall thickness, spaced 10” apart, on-center, as shown. The frame is loaded with a center-point load of 10 kips and a horizontal loading of 0.1 kip/ft.

   Problem: Determine the normal stress at Point C (top surface – “extreme fiber”)

   ![Frame Diagram](image)

2. Given: 1” diameter punch punches through a ½” thick plate. The punch punches a 1” diameter hole in 1/2” thick steel. The ½” thick steel plate is punched when its average shear stress is 40 ksi.

   Problem: Determine P and M on the Cross-section a-a.

   ![Punch Diagram](image)
**HOMEWORK** - Due Friday. Standard homework assignment (presentation counts). Hand in Problems 1 through 4. Report 3 significant digits in the final answer, unless noted otherwise. Carry 4 significant digits in intermediate steps, unless noted otherwise.

0. (do not hand in). Based on the reading, while also referring to the AISC Manual of Steel Construction – Part One, be able to sketch or describe W, S, C, L, Double-L, WT, ST, MT, and HSS shapes. Be able to specify the meanings of “W18x50”, “C9x20”, and “L6x4x5/8”, etc. Be able to locate the key properties of Area $A$, Moment of Inertia $I$ (for both x and y axes).

1. Do Problem 1.5-2 in the Segui text.

2. Compute the normal stress at Point A and Point B, clearly indicating whether the stress is compressive or tensile.

3. The angle bracket shown is subjected to $P=1300$ lbs. The bracket has a rectangular cross section with a width of $b=3.00$” and a thickness $t=0.375$”. If the tensile normal stress must be limited to 24000 psi at section a-a, what is the maximum offset distance $y$ that can be used?

3. **Given**: 1” diameter punch punches through steel plates that fail at a shear stress of 40 ksi. The punching device is made of cast iron, which will fail if either the tensile stress exceeds 10 ksi at cross-section a-a or the compressive stress exceeds 25 ksi at cross-section a-a. **Determine** the thickest steel plate that the punching device can handle without failing at cross-section a-a.