ARCH 324 - Structures 2, Winter 2009

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**Given:**

- \( b_0 = 80'' \)
- \( w = 1.2 \text{ klf} \)
- \( L_1 = 24 \text{ ksf} \)
- \( F_o' = 1800 \text{ psi} \)
- \( n = 1/8 \)

**Find:**

1. Check the safety
   
   \( F_o' \geq F_o \)
   
   Allowable
   2. Actual

**Step 1: Find \( M_{max} \)**

- Since unsymmetrical loading, must use diag. 3.

\[ \sum M_o = 0 = 16''(5') + 48''(20') - 32''(30') - R_R(40') \]

- \( R_R = 50k \)

\[ \sum F_y = 0 = R_L - 16k - 48k - 32k + 50k \]

- \( R_L = 44k \)

**Shear:** Find \( x \) where \( V = 0 \)

- \( AV = \text{area loading} \)
- \( 24x - 0 = 1.2 \text{ klf} \times (x) \)

- \( x = 20'' \)

From diag:

\[ M_{max} = 455 \text{ kif} \]
**STEP 2:** TRANSFORM TO "HOMOGENEOUS" SECTION.

\[ b_e = 80'' \]

\[ n = \frac{1}{8} \]

**GEOMETRY:**

STEEL - LOOK UP IN TABLES. (P. 347)

For W24 x 68

\[ b = 8.965'' \]

\[ d = 23.78'' \]

\[ A = 20.1 \text{ in}^2 \]

\[ I = 1830 \text{ in}^4 \]

\[ S = 154 \text{ in}^3 \]

CONCRETE - TRANSFORM TO STEEL

Transformed \( b_e = b_e \times n \)

\[ = 80'' \left( \frac{1}{8} \right) = 10'' \]

**STEP 3:** FIND N.A.

\[ \sum A_x = A \bar{x} \quad (p.40) \]

\[ \bar{x} = \frac{\sum A_x \bar{x}}{A} = \frac{464 \text{ in}^3}{70.1 \text{ in}^2} = 6.62 \text{ in} \quad \text{FROM THE TOP} \]

**STEP 4:** FIND IT.R.

\[ I_{tr} = I + A \bar{x}^2 \]

\[ = \frac{b d^3}{12} \quad \text{for beam.} \]

- USE ONLY THE PORTION OF CONCRETE IN COMPRESSION, IGNORE CONC. BELOW N.A. (THIS CASE USE ALL THE CONC.)

\[ C_L \]

\[ I_{tr} = 4905 \text{ in}^4 \]

**REFERENCE:**

Reference point for calculations.
**Step 5:** FIND $F_0$

\[ F_0 = \frac{M_c E_0}{I_T} \leq \text{General Equation} \]

Since working in " Psy " must connect conc. stress,

\[ f_{c,\text{conk}} = \frac{M_c E_0}{I_T} = \frac{455 \times 6 \times (0.62'')(1/8) \times 12''}{4905 \text{ in}^4} = 921 \text{ psi} \]

\[ f_{c,\text{stl}} = \frac{M_c I}{I_T} = \frac{455 \times 6 \times (22.17'' \times 12'')}{4905 \text{ in}^4} = 24.7 \text{ ksi} \]

**Step 6:** CHECK SAFETY

\[ \frac{f_{c,\text{stl}}}{f_{c,\text{actual}}} \Rightarrow 24 \text{ ksi} \neq 24.7 \text{ ksi} \]

N.G. - STEEL FAILS!!

\[ f_{c,\text{conc}} \geq f_{c,\text{actual}} \Rightarrow 1800 \text{ psi} \geq 921 \text{ psi} \text{ V.A.K.} \]

In conclusion, the beam is not adequately designed since steel fails.