

CLASS # 18 - COMPOSITE BEAMS

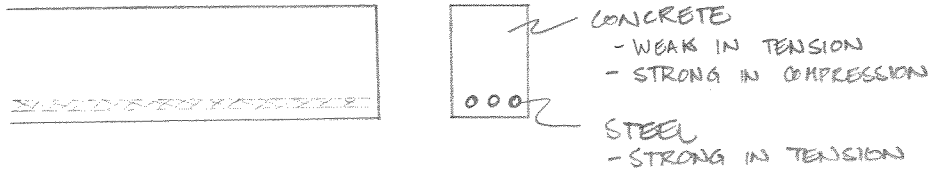
- OBJECTIVES:
- ① BEHAVIOR of COMPOSITE BEAMS
 - ② COMPOSITE BEAM EXAMPLE - R/C

(SECTION 6.8 OUT)

① COMPOSITE BEAMS

COMPOSITE BEAM - BEAM CONSTRUCTED OF TWO OR MORE MATERIALS

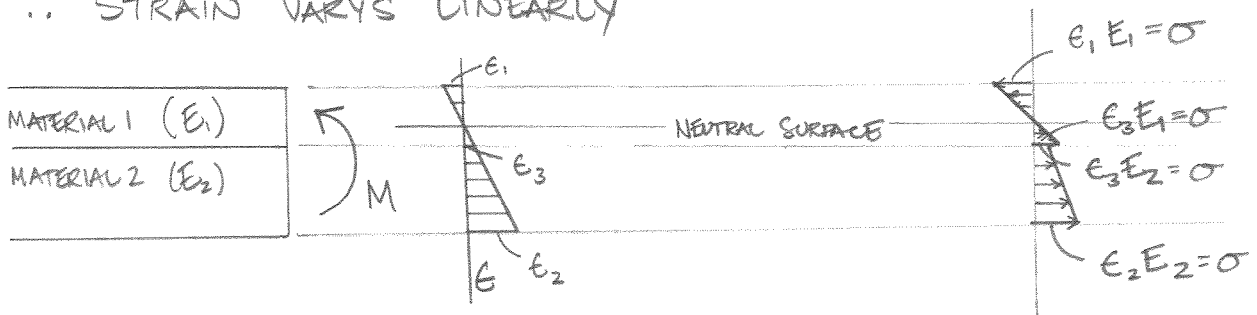
e.g. CONCRETE BEAM WITH STEEL REINFORCEMENT



FLEXURE FORMULA WAS DEVELOPED FOR HOMOGENEOUS BEAMS
NOT APPLICABLE DIRECTLY FOR COMPOSITE BEAMS

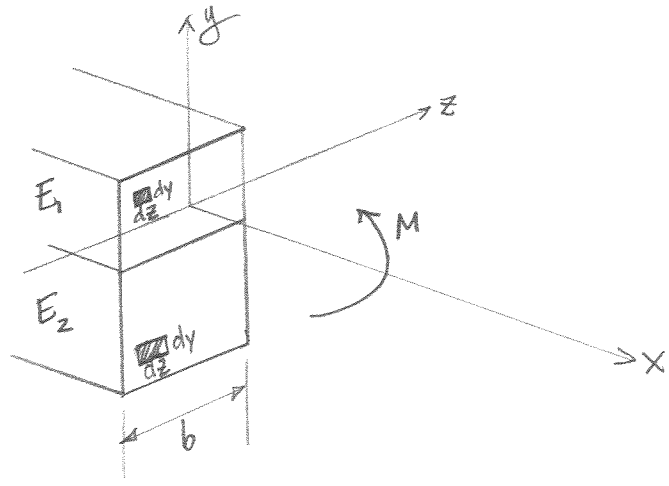
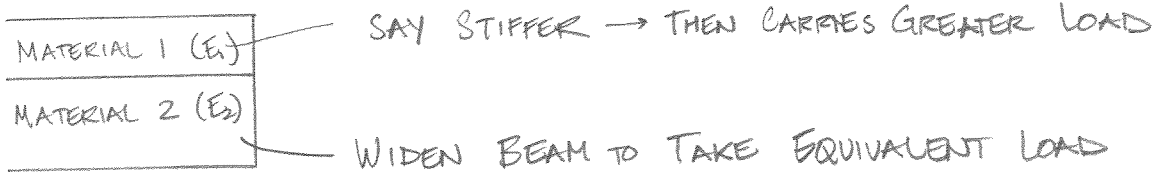
TRANSFORMED SECTION METHOD

WHEN BENDING, PLANE SECTIONS REMAIN PLANE
 \therefore STRAIN VARIES LINEARLY



INTEGRATE STRESS DISTRIBUTION
TO FIND N.S.

EASIER TO TRANSFORM SECTION TO ONE EQUIVALENT MATERIAL AND USE FLEXURE FORMULA



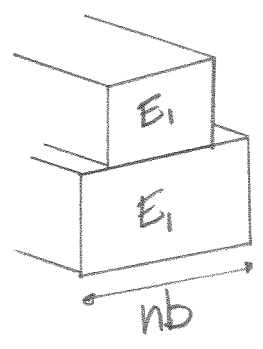
$$dF_1 = \sigma dA = (E_1 \epsilon) dz dy$$

SAY, WE WIDEN E_2 TO TAKE SAME LOAD

$$dF_1 = \sigma dA = (E_2 \epsilon) \underbrace{dz(n)}_{\text{widened element}} dy$$

$$\therefore E_1 \epsilon \frac{dz}{dy} = E_2 \epsilon n \frac{dz}{dy}$$

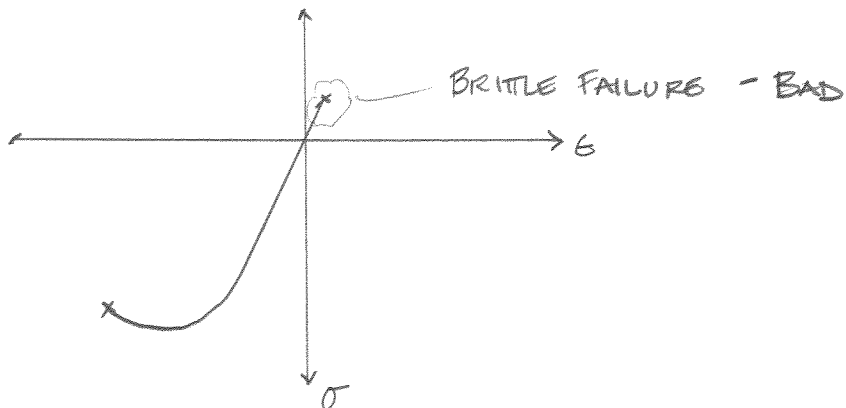
$$n = \frac{E_1}{E_2}$$



APPLY FLEXURE FORMULA AS ONE MATERIAL IF

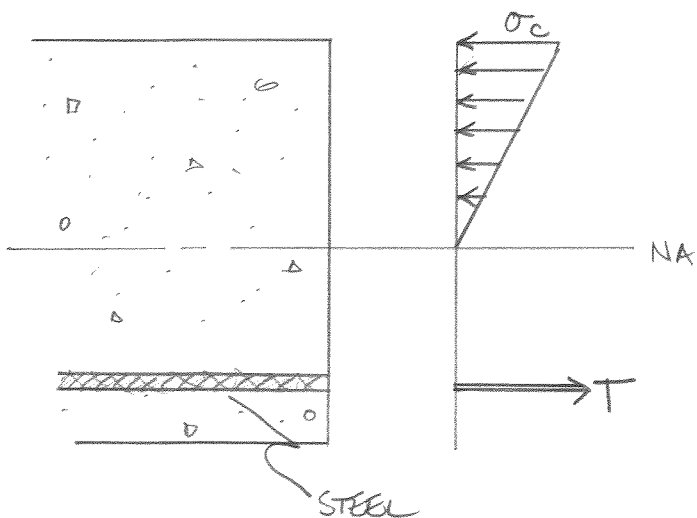
CONCRETE

① CAN TAKE ALMOST NO TENSION

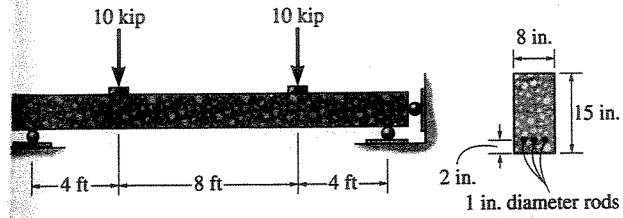


② OUTSTANDING IN COMPRESSION

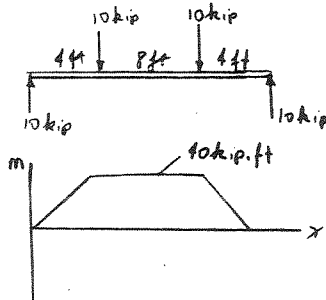
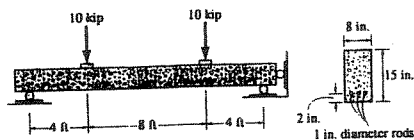
③ EMBED STEEL FOR TENSION



6-126. The reinforced concrete beam is used to support the loading shown. Determine the absolute maximum normal stress in each of the A-36 steel reinforcing rods and the absolute maximum compressive stress in the concrete. Assume the concrete has a high strength in compression and yet neglect its strength in supporting tension.



6-426 The reinforced concrete beam is used to support the loading shown. Determine the absolute maximum normal stress in each of the A-36 steel reinforcing rods and the absolute maximum compressive stress in the concrete. Assume the concrete has a high strength in compression and neglect its strength in supporting tension.



$$M_{\max} = (10 \text{ kip})(4 \text{ ft}) = 40 \text{ kip} \cdot \text{ft}$$

$$A_{s1} = 3(\pi)(0.5)^2 = 2.3562 \text{ in}^2$$

$$E_{st} = 29.0(10^3) \text{ ksi}$$

$$E_{con} = 4.20(10^3) \text{ ksi}$$

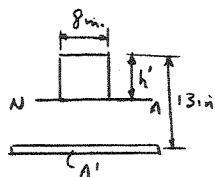
$$A' = nA_{s1} = \frac{29.0(10^3)}{4.20(10^3)}(2.3562) = 16.2690 \text{ in}^2$$

$$\Sigma \bar{y}A = 0; \quad 8(h')\left(\frac{h'}{2}\right) - 16.2690(13 - h') = 0$$

$$h^2 + 4.06724h - 52.8741 = 0$$

Solving for the positive root:

$$h' = 5.517 \text{ in.}$$



$$I = \left[\frac{1}{12}(8)(5.517)^3 + 8(5.517)(5.517/2)^2 \right] + 16.2690(13 - 5.517)^2 = 1358.781 \text{ in}^4$$

$$(\sigma_{con})_{\max} = \frac{My}{I} = \frac{40(12)(5.517)}{1358.781} = 1.95 \text{ ksi} \quad \text{Ans}$$

$$(\sigma_{st})_{\max} = n\left(\frac{My}{I}\right) = \left(\frac{29.0(10^3)}{4.20(10^3)}\right)\left(\frac{40(12)(13 - 5.517)}{1358.781}\right) = 18.3 \text{ ksi} \quad \text{Ans}$$