Recitation 13

Combined Stress

Homework problem

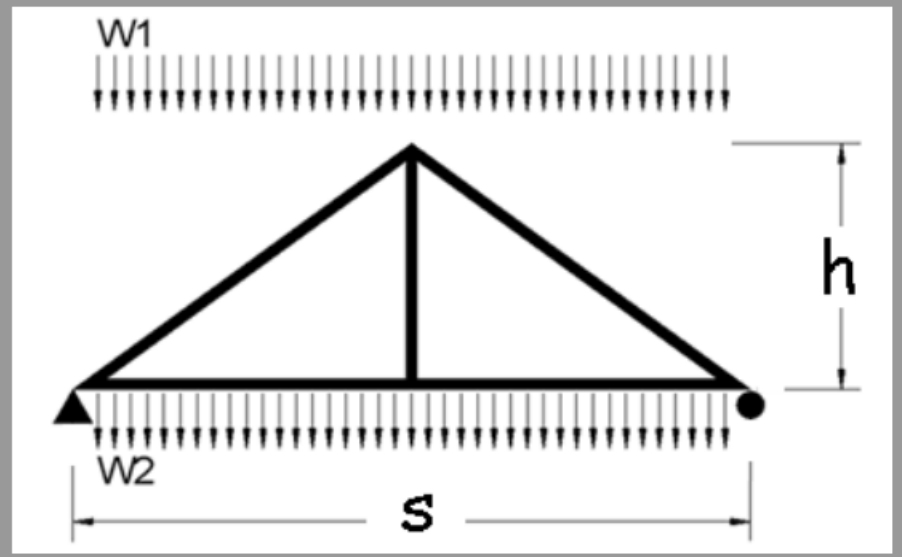
Combined Stress

12. Combined Stress

The given roof truss carries both an exterior snow load and an interior (attic) floor load. Determine the member forces and stresses and calculate the combined stress levels (top and bottom) for the lower chord member using the NDS combined stress equations. Consider all joints pinned, with simple (joint to joint) members. The given allowable stresses (F't and F'b) are for southern pine with all adjustment factors already applied.

DATASET: 1 -2- -3-

Full span of truss	26 FT
Height of truss	9 FT
On Center spacing of trusses	16 IN
Size of bottom chord	4x6
Actual width, b	3.5 IN
Actual depth, d	5.5 IN
Snow Load on roof, w1	20 PSF
Live Load in attic, w2	60 PSF
Factored allowable bending stress, F'b	1150 PSI
Factored allowable tension stress, F't	690 PSI



Q1) Load on one truss - top chord (w1) :-

From w1 (PLF) = w1 (PSF) × O.C. spacing

$$= 20 \frac{lb}{ft} \times 16in \times \frac{1ft}{12in}$$

$$= 26.667 \ lb/ft$$

Q2) Load on one truss - bottom chord (w2) :-

from w_2 (PLF) = w_2 (PSF) × O.C spacy.

$$= 60 \frac{lb}{ft} \times 16in \times \frac{1ft}{12in}$$

$$= 80 \ lb/ft$$

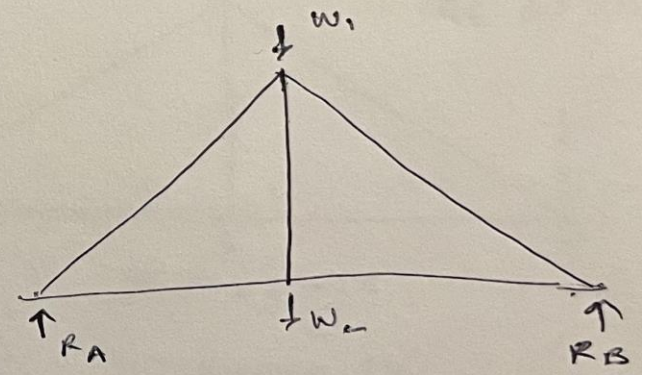
Q3) Total left reaction due to w_1 and w_2 :-

Point load (W_1) :-

$= W_1$ (PLF) × S (full span of truss)

$= 26.667 \times 26$

$= 693.342$ lbs



Pointed Load (W_2) = W_2 (PLF) × S (full span of truss)

= 80 × 26

= 2080 lbs

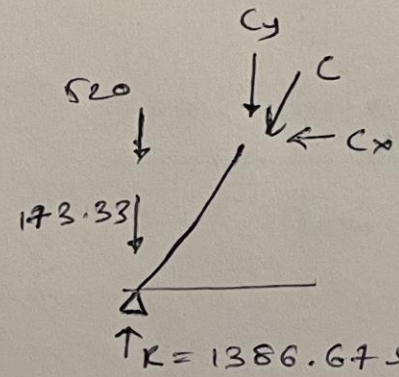
$R_A = R_B$

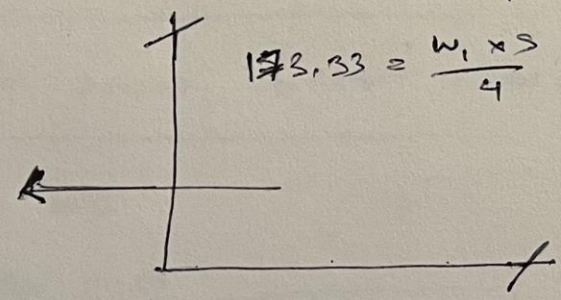
$R_A + R_B = W_1 + W_2$

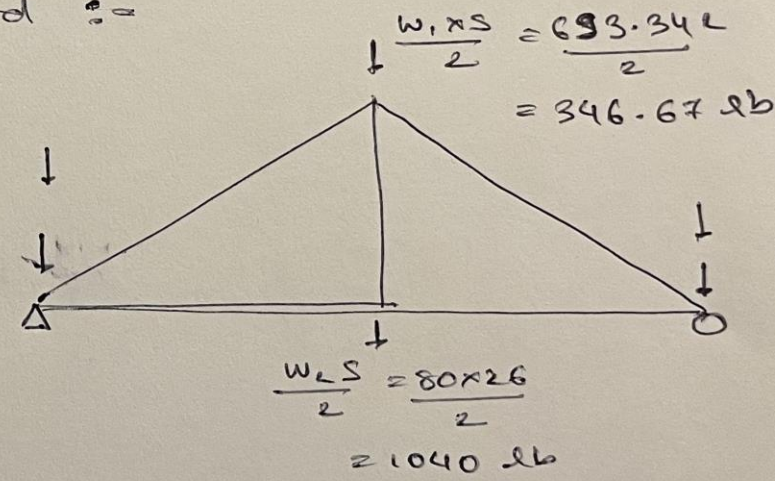
$R_A = \frac{W_1 + W_2}{2} = \frac{693.342 + 2080}{2}$

$R_A = R_B = 1386.671$ lbs → RS

94) Vertical force component in truss top chord :=



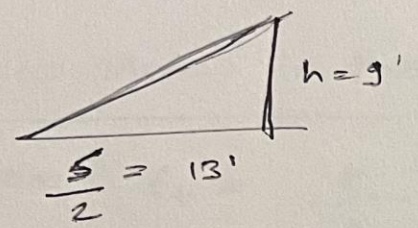


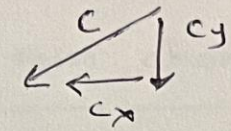


From $\Sigma F_y = 0$ → $1386.67 - 520 - 173.33 - C_y = 0$

$$\therefore \boxed{C_y = 693.34 \text{ lb}}$$

25) Horizontal force component in truss top chord :-





$$\frac{C_y}{C_x} = \frac{h}{S/2}$$

$$\frac{693.34}{C_x} = \frac{9}{13}$$

$$\boxed{C_x = 1001.49 \text{ lb}}$$

26) Axial force in the truss bottom chord :-

From $\Sigma F_x = 0$

$$T - C_x = 0$$

$$\boxed{T = 1001.49 \text{ lb}}$$

Q7) Area of the bottom chord member :-

from Area = b * d

= 3.5 × 5.5

∴ Area = 19.25 in^2

Q8) Axial stress in the bottom chord :-

from $f_t = \frac{P}{A}$ ← (Q6)

$= \frac{1001.49 \text{ lb}}{19.25 \text{ } in^2}$

$f_t = 52.025 \text{ lb/in}^2$

Q9) Maximum bending moment in the bottom chord :-

from $M_{max} = \frac{Wl^2}{8} = \frac{w_2 (s/2)^2}{8}$

$= \frac{80 \times 13^2}{8}$ = 1690 lb.ft

Q10) section modulus of bottom chord member (S_x) :-

From $S_x = \frac{I}{c} = \frac{\frac{1}{12} bd^3}{d/2}$

$= \frac{bd^2}{6}$

$S_x = \frac{3.5 \times 5.5^2}{6} = 17.646 \text{ in}^3$

Q11) Maximum bending stress in the bottom chord member :-

From $f_b = \frac{M}{S_x} = \frac{1690 \text{ lb.ft}}{17.646 \text{ in}^3} \times \frac{12 \text{ in}}{1 \text{ ft}}$

$\therefore f_b = 1149.27 \text{ lb/in}^2$

Q12) Combined stress using NDS equation 3.9-1 :-

from 3.9.1 (f_t ← Q8, f_b ← Q11)

$\frac{f_t}{F_t'} + \frac{f_b}{F_b^*} = \frac{52.025}{690} + \frac{1149.27}{1150}$

$= 1.075$ ← (4) write the value as answer for Q12

1.075 > 1.0 ∴ fail.

Q13) Combined stress using NSD equation 3.9-2 :-

$$\frac{f_b - f_t}{F_b'} = \frac{1149.27 - 52.025}{1150}$$

$$= 0.954$$

$0.954 < 1.0$ ∴ pass

Q14) Does member pass or fail?

since 3.9-1 equation value is greater than 1.0

∴ member fails = 0

Structures II

Arch 324

Name 1 _____

Name 2 _____

Name 3 _____

Combined Stress

Description

This project uses observation of a physical trial to see the effects of flexure combined with tension or compression.

Goals

To observe the behavior of tension + flexure
To observe the behavior of compression + flexure
To estimate the addition of combined stress profiles
To observe results of P + delta loading

Procedure

1. Load the 12 inch wood stick with 4 washers at midspan as shown below. The stick is 1/16"x1/2" A=0.03125 in^2 Sy=0.0003255 in^3 4 washers = 0.15 lbs.
2. Note the deflection caused by the load. Calculate the flexure stress.
3. Next apply an additional axial tension force to the stick of approximately 10 lb (pull on it) and note the change in deflection. Calculate the additional axial stress.
4. Make a sketch showing the addition of the stress profiles of flexure + tension.
5. Now apply (or try) an axial compression load of approximately 10 lb to the stick and again note the change in deflection. Again calculate the axial stress.
6. Make a sketch showing the addition of the stress profiles of flexure + compression.
7. What additional load and stress is being neglected in the case of compression + flexure?

$$M = \frac{P\,L}{4} \qquad f_b = \frac{M}{S_y} \qquad f_t = \frac{P}{A} \qquad f_c = \frac{P}{A} \qquad f_{comb} = \pm\frac{M}{S_y} \pm \frac{P}{A}$$

LAB

$$M_A = \frac{PL}{4}$$

$$M = \frac{0.15(12)}{4}$$

$$= 0.45 \text{ inch pound.} \quad \text{(1)}$$

$$f_b = M / S_y$$

$$= \frac{0.45}{0.0003255}$$

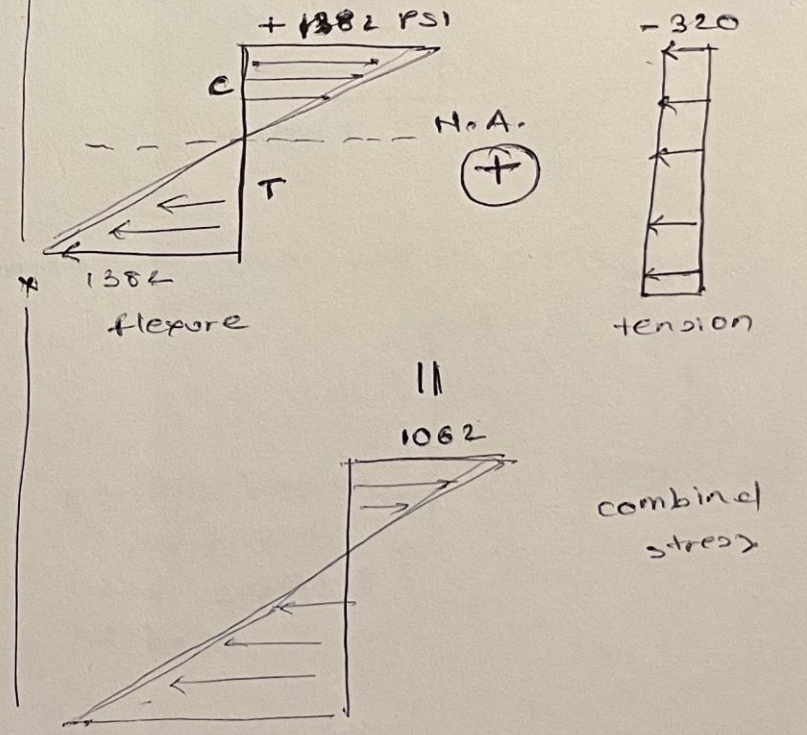
$$= 1382 \text{ psi} \quad \text{(2)}$$

$$f_t = \frac{10}{0.03125} \leftarrow \text{axial tension force}$$

$$= 320 \text{ psi} \quad \text{(3)}$$

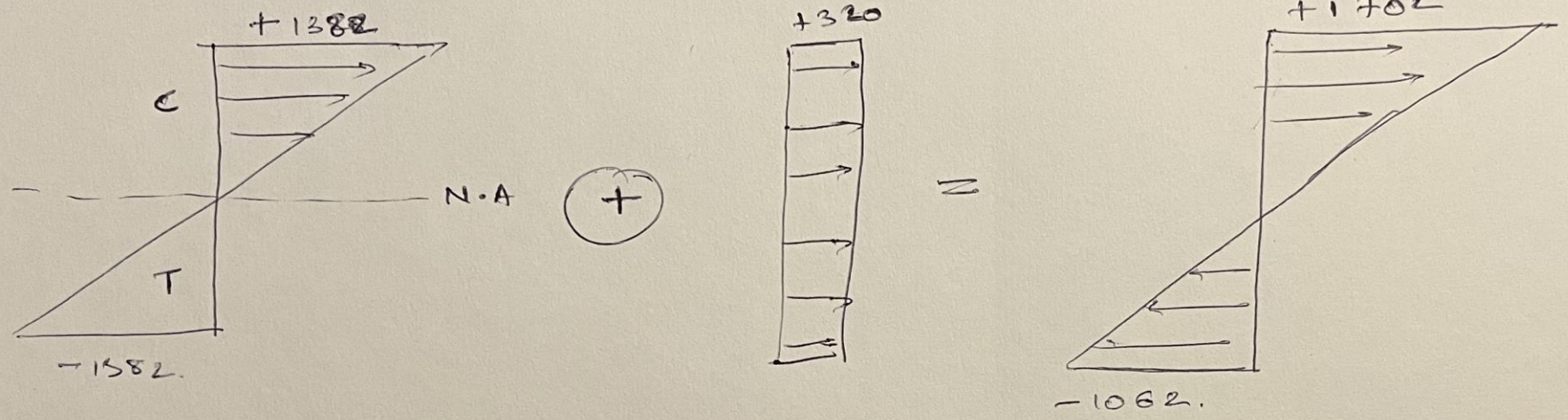
(4) ↓

Graph for bending stress and tensile stress :- (and two together) :-



$f_c = \frac{10}{0.03125}$

$= 320$ psi ——— (5)



(7) Additional stress caused by ΔP moment over weak axis.

$M_{\Delta P}$ = P * deflection

= 10 × (1) = 10
(2) = 20
(3) = 30
(4) = 40

quickly becomes more than the capacity of beam

$\frac{l}{r} = 192 > 50$

very slender.

Thankyou !!!