Lovejeet Gehlot

Combined Stress

Lab Recitation #12
Group #3

April 8 2020
University of Michigan, TCAUP
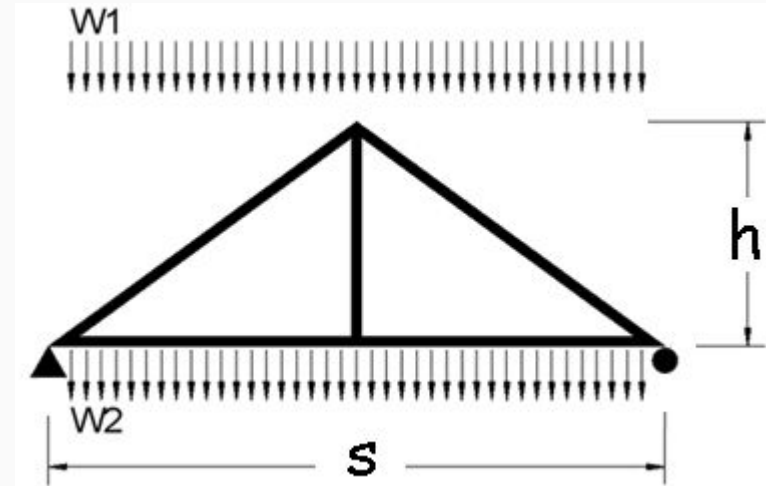
Combined Stress

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	16 FT
Height of truss	4 FT
On Center spacing of trusses	16 IN
Size of bottom chord	2x4
Actual width, b	1.5 IN
Actual depth, d	3.5 IN
Snow Load on roof, w1	40 PSF
Live Load in attic, w2	30 PSF
Factored allowable bending stress, F'b	1265 PSI
Factored allowable tension stress, F't	776 PSI

Q#1 Load on one truss - top chord, w1 (in PLF)

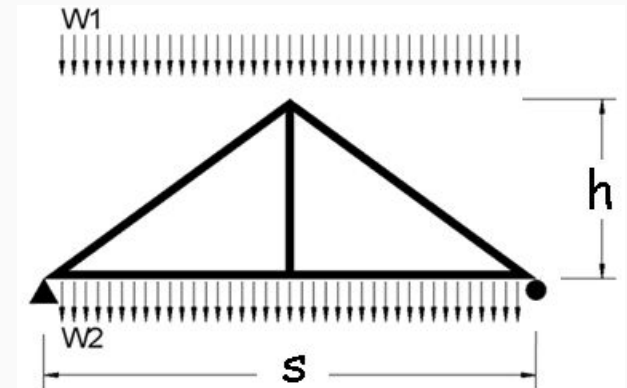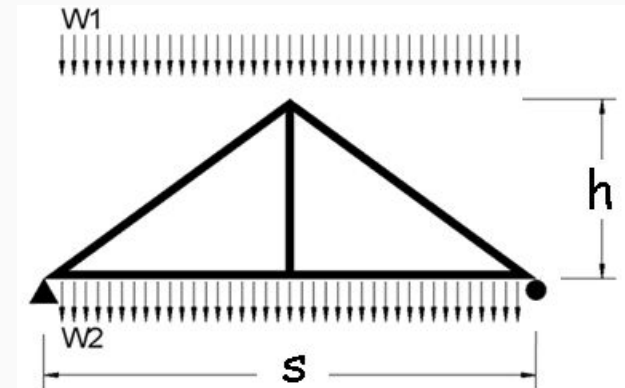**W₁ IN PLF** = O.C. spacing in feet * Snow load, W₁

<div style="text-align:center">(given)   (given)</div>

W₁ IN PLF =   (16/12)   *   40

(O.C. in feet)

W₁ IN PLF =   **53.333 PLF**

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Factored allowable tension stress, F't	776 PSI

W₂ IN PLF = O.C. spacing in feet * Live load, W₂

(given)   (given)

W₂ IN PLF = (16/12)   *   30

(O.C. in feet)

W₂IN PLF =   **40 PLF**

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R1 $= [W_1 * (span/2)] + [W_2 * (span/2)]$

         (Ans1)   (given)   (Ans2)   (given)

R1 $= [53.333 * (16/2)] + [40 * (16/2)]$

R1 $= [53.333 * 8] + [40 * 8]$

R1 $= [426.6664] + [320]$

R1 $= \mathbf{746.664}$

Note that since the truss is symmetrical, R1 = R2 = 746.664 = Half of total load

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W1

h

W2

8'

R1   R2
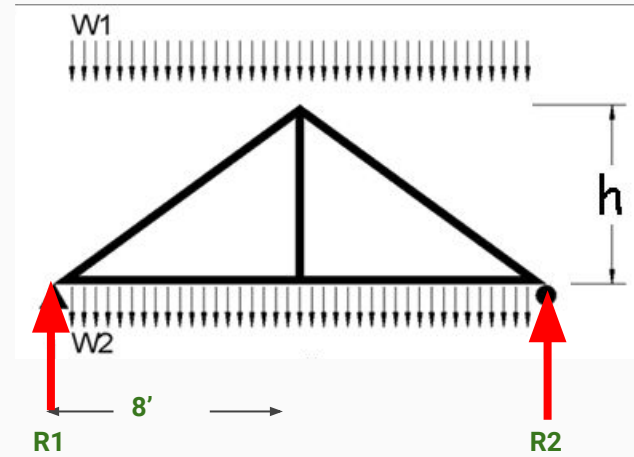
Q#4 Vertical force component in truss top chord (IN LBS)

(Ans1)   (given)

$SL = [W_1 * (span/4)] = 213.332$

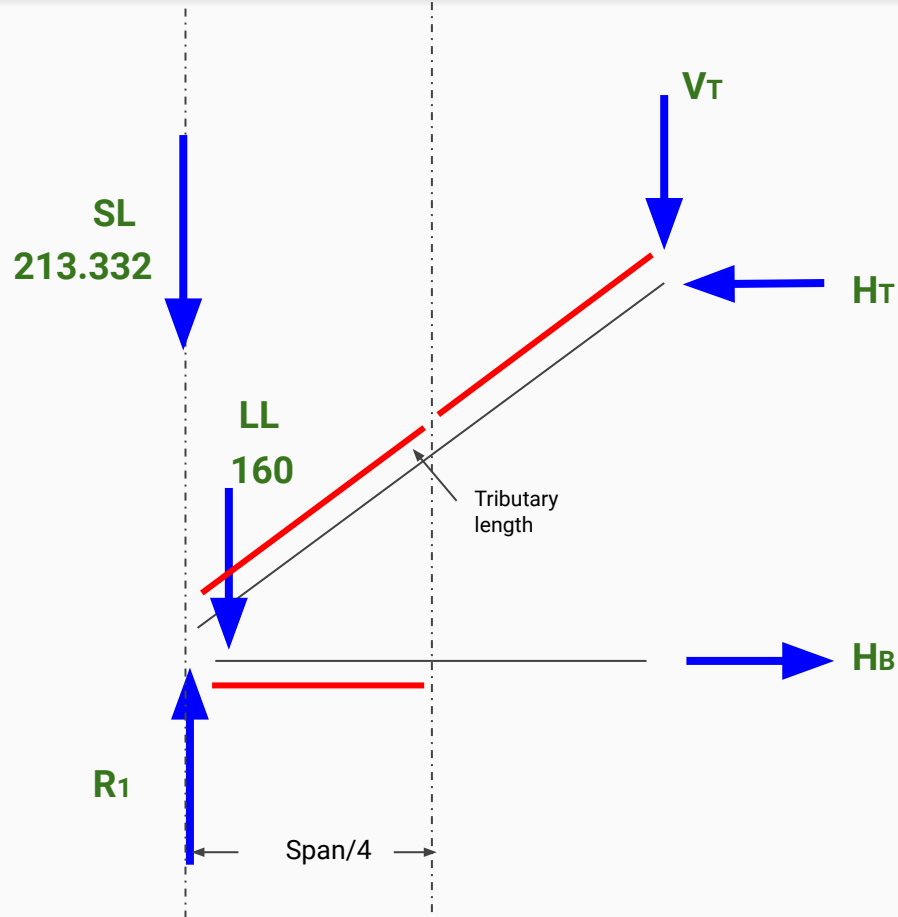$LL = [W_2 * (span/4)] = 160$

(Ans2)   (given)

$$\Sigma F_v = 0$$

$SL \quad + \quad LL \quad + \quad R_1 \quad + V_T = 0$

$213.332 + \quad 160 \quad + (-746.66) + V_T = 0$

$V_T = -373.33$ lbs

Note that the question asks for a signless answer

$V_T = $ **373.33 lbs**

V_T

SL

213.332

H_T

LL

160

Tributary length

H_B

R_1

Span/4

Q#5 Horizontal force component in truss top chord

$V_T / H_T = 4/8$

$373.33 / H_T = 4/8$
(Ans4)

$373.33 / H_T = 4/8$

Note that the question asks for a signless answer

$H_T =$ **746.66**
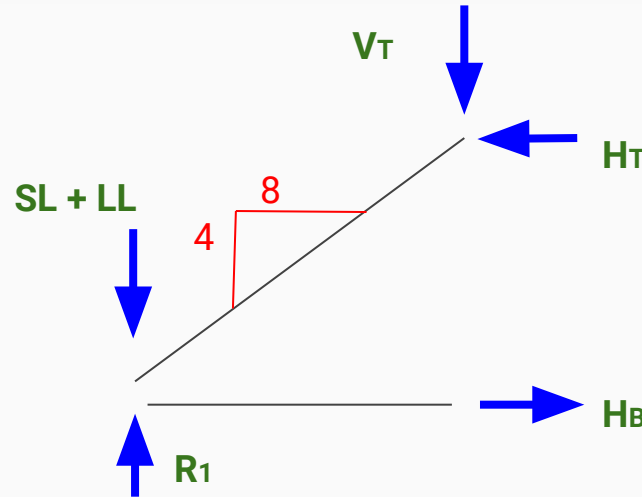
V_T

H_T

SL + LL

8

4

H_B

R_1

DATASET: 1   -2-   -3-

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W1

8

4

4' h

W2

8'
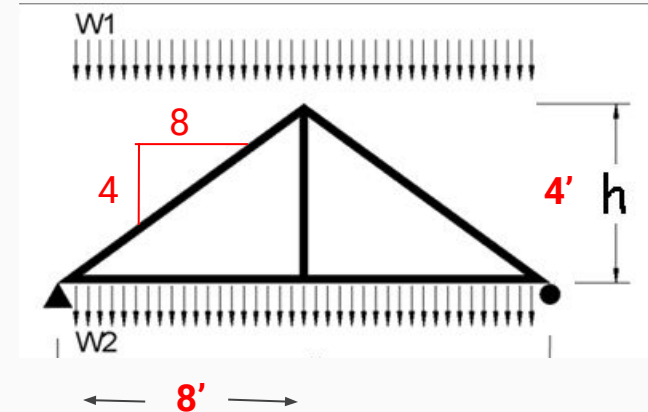
Q#6 Axial force in truss bottom chord

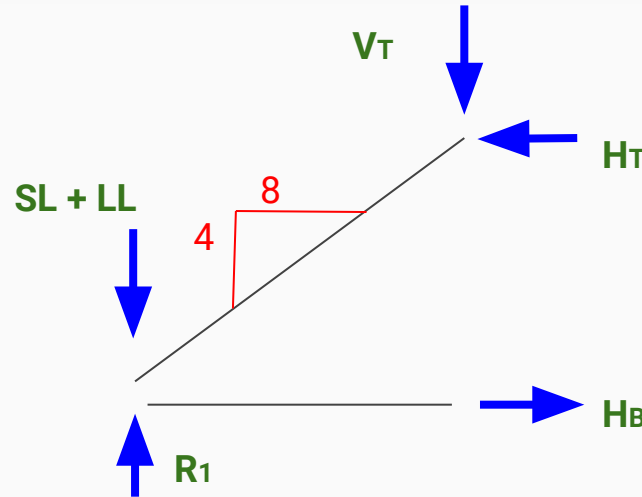$$\Sigma F_H = 0$$

$H_T + H_B = 0$

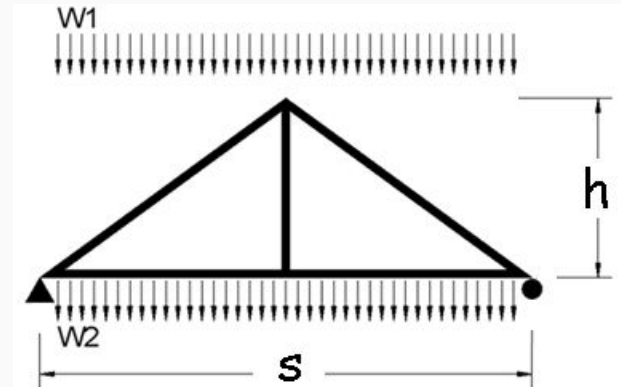$H_B = - H_T$

(Ans5)

$H_B = - 746.66$

*Note that H_B is pulling away, hence us under compression.
The questions asks to use a (-ve) sign if it is under compression.*

But, since it is under Tension,

$H_B = $ **746.66**

V_T

H_T

SL + LL

8

4

H_B

R_1

DATASET: 1   -2-   -3-

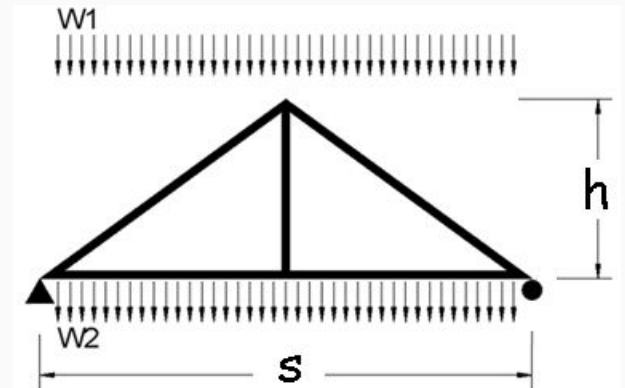|	
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W1

h

W2

s

b x d = 1.5 x 3.5 = **5.25**

(given) (given)

DATASET: 1   -2-   -3-

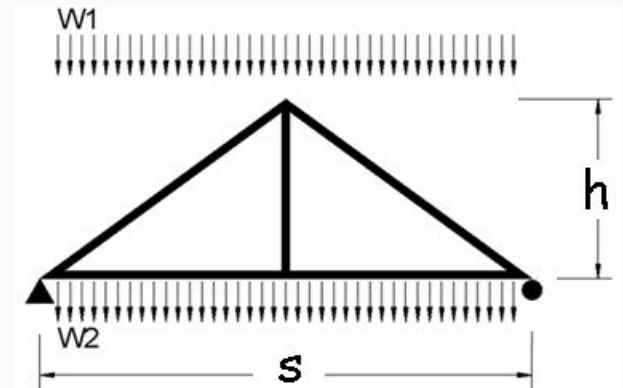|	
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Q#8 Axial stress in the bottom chord

$$F_T = H_B \ / \ \text{Area}$$
$$\qquad \text{(Ans6)} \qquad \text{(Ans7)}$$

$$F_T = 746.66 \ / \ 5.25$$

$$F_T = \textbf{142.22}$$

DATASET: 1   -2-   -3-

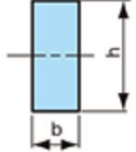|	
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M = $WL^2/8$

(Ans2) (Span/2)

M = 40 * (8*8) /8

M = **320**

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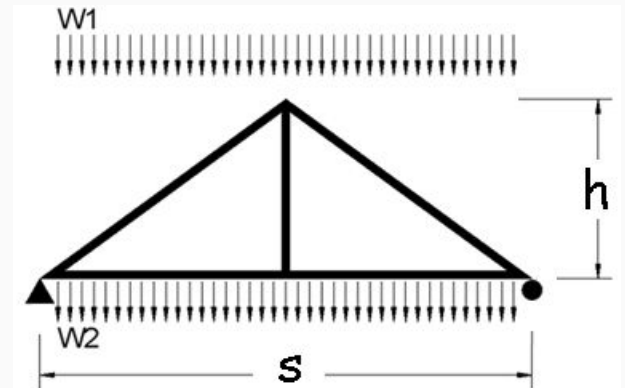
S_x = (b * h * h) / 6

(given)

S_x = (1.5 * 3.5 * 3.5) / 6

S_x = **3.0625**

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Cross Section	Section Modulus Z
	$\frac{1}{6} bh^2$

$F_B = M/S_x$

(Ans 9)   (Ans 10)

$F_B = (320 * 12) /3.0625$

(convert to inches)

$F_B =$ **1253.877**

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$$(f_t \div Ft') + (f_b \div Fb')$$

$$(142.22 \div 776) + (1253.88 \div 1265)$$

=0.1832 + 0.9912

1.174

$\dfrac{f_t}{F_t'} + \dfrac{f_b}{F_b^*} \le 1.0$ TENSION CRIT.   (3.9-1)

and

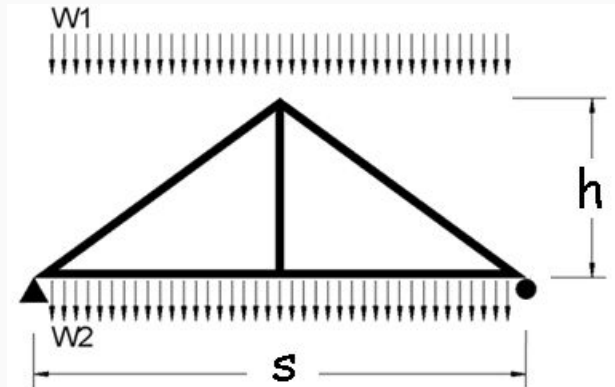$\dfrac{f_b - f_t}{F_b^{**}} \le 1.0$ FLEXURE CRIT.   (3.9-2)

where:

F_b^* = reference bending design value multiplied by all applicable adjustment factors except C_L

F_b^{**} = reference bending design value multiplied by all applicable adjustment factors except C_v

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W1

W2

h

s

$(fb - ft) / Fb$

$(1253.88 - 142.22) / 1265$

=1111.66 / 1265

0.87878

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$\dfrac{f_t}{F_t'} + \dfrac{f_b}{F_b^*} \leq 1.0$ TENSION CRIT.   (3.9-1)

and

$\dfrac{f_b - f_t}{F_b^{**}} \leq 1.0$ FLEXURE CRIT.   (3.9-2)

where:

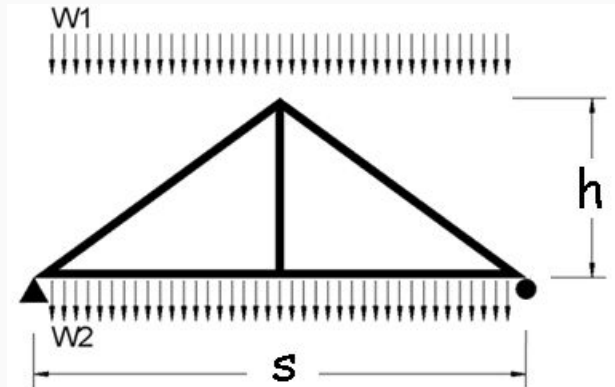F_b^* = reference bending design value multiplied by all applicable adjustment factors except C_L

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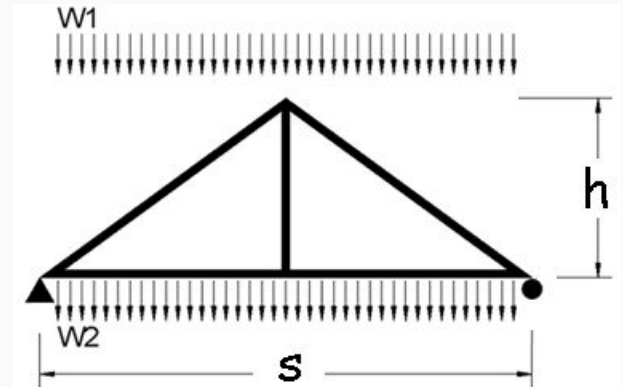
W1

W2

h

s

Q#14 Does member pass?

Note that for the member to pass, both answers 12 and 13 should be less than or equal to 1

Since Ans12 > 1

The member failed

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Any Questions?

Contact: gehlot@umich.edu