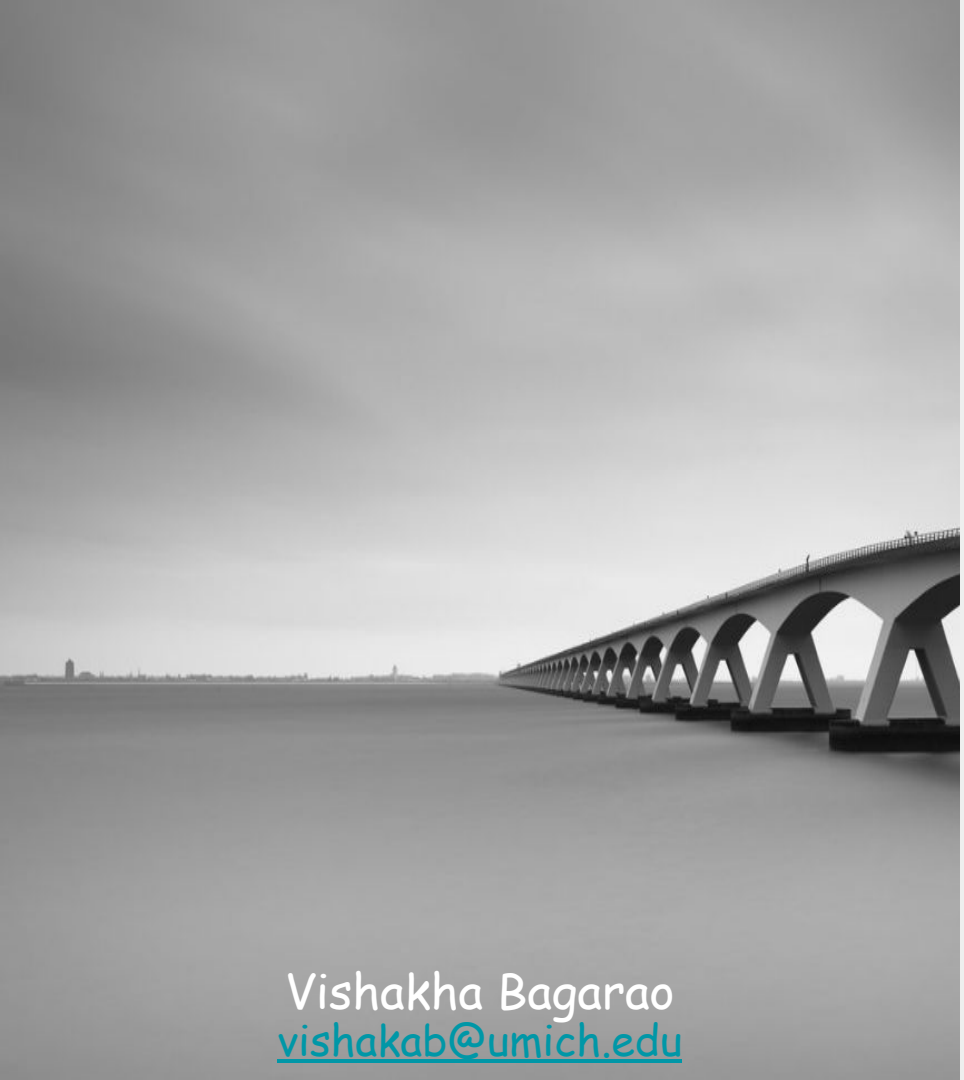
Arch 314- Structures I

Recitation 006

Vishakha Bagarao

6th Oct 2024



Contents

- Truss
- Problem Set 07

Vishakha Bagarao
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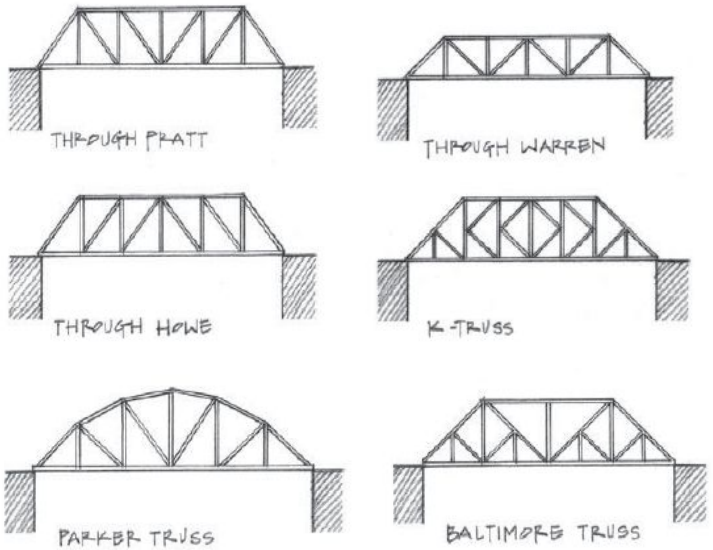
Truss: A truss represents a structural system that distributes loads to supports through a linear arrangement of various-sized members in patterns of planar triangles.

- A Rigid Structure made up of collection of straight members, where all joints are pinned.
- Since all joints are pinned, the members cannot carry bending moments, they can only carry axial loads.
- Each member has to be in equilibrium, Forces acting at each end of the member must be equal and opposite.
- Each member is either in tension or compression.



Example of Bridge Truss

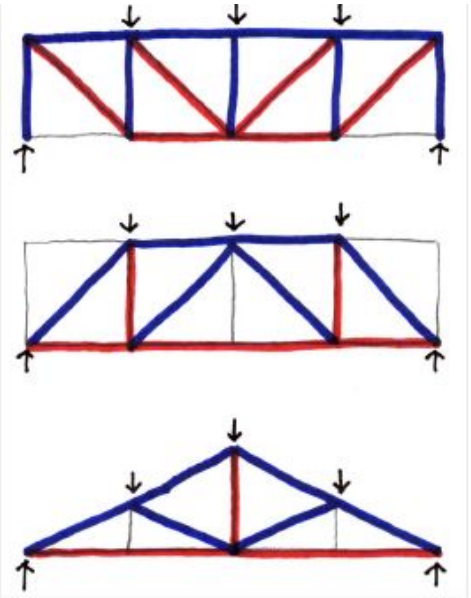
For typical gravity loading:
(tension=red compression=blue)

Top chords are in compression

Bottom chords are in tension

Diagonals down toward center are in tension (usually)

Diagonals up toward center are in compression (usually)



Formulas:

- End Reactions:
  - $\sum M = 0$
  - $\sum Fy = 0$

- Horizontal and vertical forces in members:
  - $\sum Fx = 0$
  - $\sum Fy = 0$
  - Slope is proportional to the forces;
  - $Cv/Ch = G/E$

- Total axial force in member:
  - $F = \sqrt{Fx^2 + Fy^2}$

- Signs:
  - Top Chords are in compression
  - Bottom Chords are in Tension
  - Usually, Diagonals down towards center are in tension
  - Diagonals up towards center are in compression

Example:

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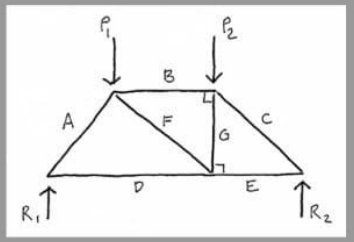
7. Truss Systems

Find the internal forces in members: A, B, C, D, E, F and G.

DATASET: 1 -2- -3-

Length B	8 FT
Length D	14 FT
Length E	6 FT
Length G	6 FT
Load P1	500 LBS
Load P2	150 LBS



#	Question	Your Response	Correct Answer	Score
1	End reaction R1 (positive is upward)	395 LBS	395 LBS	5
2	End reaction R2 (positive is upward)	255 LBS	255 LBS	5
3	Horizontal component of force in member A (absolute value)	395 LBS	395 LBS	5
4	Vertical component of force in member A (absolute value)	395 LBS	395 LBS	5
5	Total axial force in member A (absolute value)	558.61 LBS	558.614 LBS	5
6	Sign for member A (1 for tension or -1 for compression)	-1 (1 or - 1)	-1 (1 or - 1)	5
7	Total axial force in member B (absolute value)	255 LBS	255 LBS	5
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12	Sign for member C (1 for tension or -1 for compression)	-1 (1 or - 1)	-1 (1 or - 1)	5
13	Total axial force in member D (absolute value)	395 LBS	395 LBS	5
14	Sign for member D (1 for tension or -1 for compression)	1 (1 or - 1)	1 (1 or - 1)	5
15	Total axial force in member E (absolute value)	255 LBS	255 LBS	5
16	Sign for member E (1 for tension or -1 for compression)	1 (1 or - 1)	1 (1 or - 1)	5
17	Horizontal component of force in member F (absolute value)	140 LBS	140 LBS	5
18	Vertical component of force in member F (absolute value)	105 LBS	105 LBS	5
19	Total axial force in member F (absolute value)	175 LBS	175 LBS	5
20	Sign for member F (1 for tension or -1 for compression)	-1 (1 or - 1)	-1 (1 or - 1)	5
21	Total axial force in member G (absolute value)	105 LBS	105 LBS	5
22	Sign for member G (1 for tension or -1 for compression)	1 (1 or - 1)	1 (1 or - 1)	5

Current Score: 110 / 110

Problem Set 07

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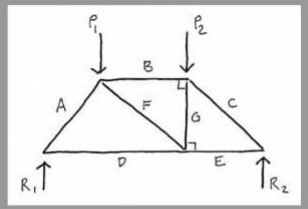
7. Truss Systems

Find the internal forces in members: A, B, C, D, E, F and G.



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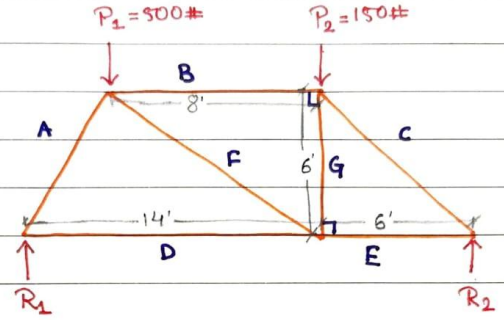
Current Score: 110 / 110

Problem Menu

Logout



#1-2. End reaction R_1 & R_2

$$\Sigma M_{R_1} = P_1(D-B) + P_2(D) - R_2(D+E)$$

$$0 = 500(14-8) + 150(14) - R_2(14+6)$$

$$R_2 = \frac{500(6) + 150(14)}{20} = 255\ \#$$

$\therefore$ End reaction $R_2 = 255$ LBS. //

$$\Sigma F_y = R_1 - P_1 - P_2 + R_2$$

$$0 = R_1 - 500 - 150 + 255$$

$$R_1 = 395\ \#$$

$\therefore$ End reaction $R_1 = 395$ LBS. //

MATRIKAS

Problem Set 07

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7. Truss Systems

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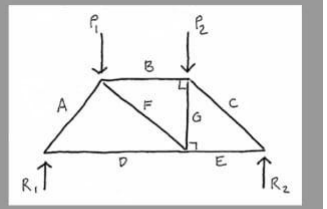

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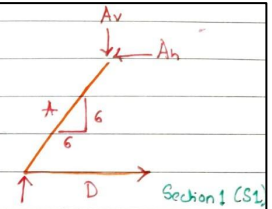
14	Sign for member D (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5
15	Total axial force in member E (absolute value)	255 LBS	255 LBS	5
16	Sign for member E (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5
17	Horizontal component of force in member F (absolute value)	140 LBS	140 LBS	5
18	Vertical component of force in member F (absolute value)	105 LBS	105 LBS	5
19	Total axial force in member F (absolute value)	175 LBS	175 LBS	5
20	Sign for member F (1 for tension or -1 for compression)	-1 (1 or -1)	-1 (1 or -1)	5
21	Total axial force in member G (absolute value)	105 LBS	105 LBS	5
22	Sign for member G (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5

Current Score: 110 / 110

Problem Menu

Logout

#3-5. Member A.



4. $\Sigma F_V = -A_V + R_1 = 0$

$A_V = R_1$

$\therefore A_V = 395\ \#$

Section 1 (S1)

∴ Vertical component of force in member A is 395 LBS.

3. $\frac{A_V}{A_h} = \frac{6}{6}$

$A_h = \frac{395 \times 6}{6} = 395\ \#$

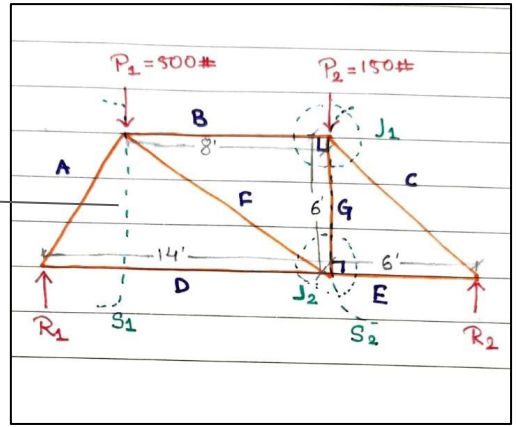
∴ Horizontal component of force in member A is 395 LBS.

5. $F_A = \sqrt{A_h^2 + A_V^2}$

$= \sqrt{395^2 + 395^2}$

$\therefore F_A = 558.61\ \#$

∴ Total axial force in member A is 558.61 LBS.



#13. Member D.

13. $\Sigma F_h = -A_h + D = 0$

$\therefore D = A_h = 395\ \#$

∴ Total axial force in member D = 395 LBS.

Problem Set 07

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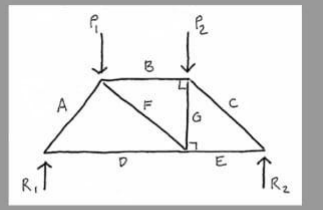
7. Truss Systems

Find the internal forces in members: A, B, C, D, E, F and G.



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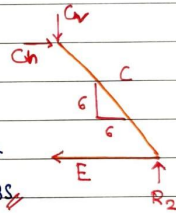
13	Total axial force in member D (absolute value)	395 LBS	395 LBS	5
14	Sign for member D (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5
15	Total axial force in member E (absolute value)	255 LBS	255 LBS	5
16	Sign for member E (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5
17	Horizontal component of force in member F (absolute value)	140 LBS	140 LBS	5
18	Vertical component of force in member F (absolute value)	105 LBS	105 LBS	5
19	Total axial force in member F (absolute value)	175 LBS	175 LBS	5
20	Sign for member F (1 for tension or -1 for compression)	-1 (1 or -1)	-1 (1 or -1)	5
21	Total axial force in member G (absolute value)	105 LBS	105 LBS	5
22	Sign for member G (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5

Current Score: 110 / 110

Problem Menu

Logout

9-11. Member C.



10. $\Sigma F_V = R_2 - C_V = 0$

$\therefore C_V = R_2 = 255\ \#$

$\therefore$ ~~Plotted~~ Vertical component in member C is 255 LBS.

Section 2 (S2)

9. $\frac{C_V}{C_H} = \frac{6}{6}$

$C_H = \frac{C_V \times 6}{6} = \frac{255 \times 6}{6}$

$\therefore C_H = 255\ \#$

$\therefore$ Horizontal component of force in member C is 255 LBS.

11. $F_C = \sqrt{C_V^2 + C_H^2}$

$= \sqrt{255^2 + 255^2}$

$\therefore F_C = 360.62\ \#$

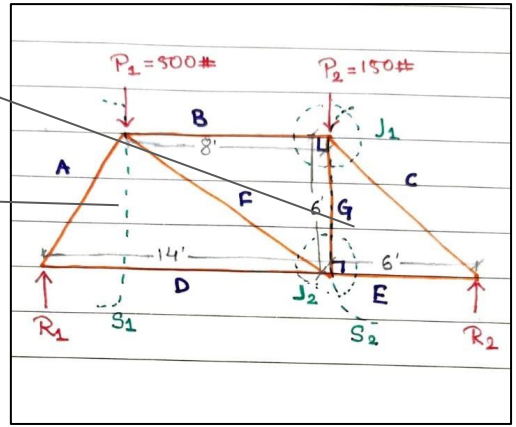
$\therefore$ Total axial force in member C is 360.62 LBS

15. Member E.

15. $\Sigma F_H = C_H - 6 = 0$

$E = C_H = 255\ \#$

$\therefore$ Total axial force in member E is 255 LBS



Problem Set 07

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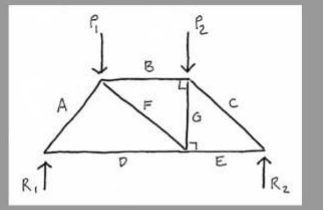
7. Truss Systems

Find the internal forces in members: A, B, C, D, E, F and G.



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13	Total axial force in member D (absolute value)	395 LBS	395 LBS	5
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15	Total axial force in member E (absolute value)	255 LBS	255 LBS	5
16	Sign for member E (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5
17	Horizontal component of force in member F (absolute value)	140 LBS	140 LBS	5
18	Vertical component of force in member F (absolute value)	105 LBS	105 LBS	5
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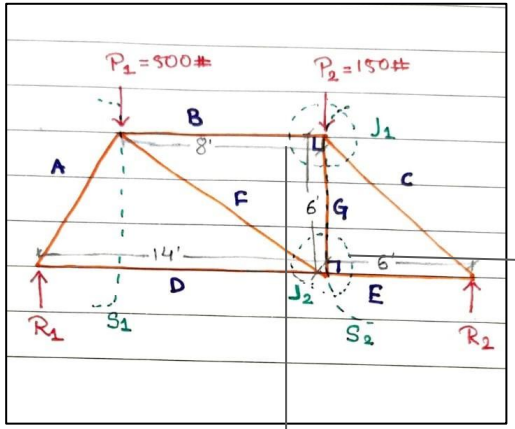
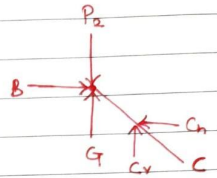
Current Score: 110 / 110

Problem Menu

Logout



#7, 21. Member B & G



$\Sigma F_V = -P_2 + G + C_V$

$0 = -150 + G + 255$

$\therefore G = -105\ \#$

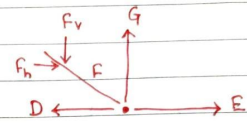
∴ Total axial force in member G is 105 LBS. // (Joint 1 (J_1))

$\Sigma F_H = B - C_H = 0$

$B = C_H = 255\ \#$

∴ Total axial force in member B is 255 LBS. //

#17-19. Member F.



$\Sigma F_V = G - F_V = 0$

$F_V = G$

$\therefore F_V = 105\ \#$ (Joint 2 (J_2))

∴ Vertical component of force in member F is 105 LBS. //

$\Sigma F_H = -D + E - F_H$

$0 = -395 + 255 - F_H$

$\therefore F_H = -140\ \#$

∴ Horizontal component of force in member F is 140 LBS. //

$F_F = \sqrt{F_V^2 + F_H^2}$

$= \sqrt{105^2 + 140^2}$

$\therefore F_F = 175\ \#$

∴ Total axial force in member F is 175 LBS. //

Problem Set 07

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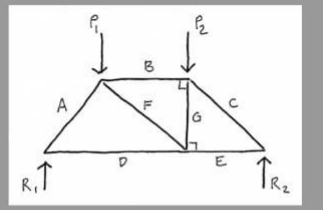

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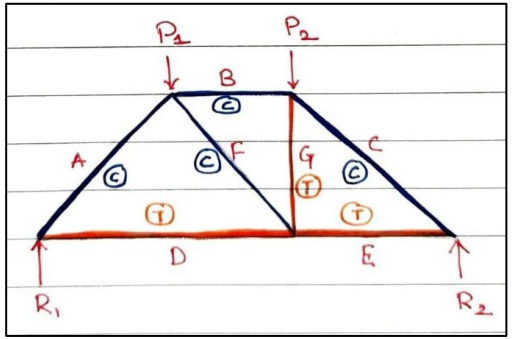
20	Sign for member F (1 for tension or -1 for compression)	-1 (1 or -1)	-1 (1 or -1)	5
21	Total axial force in member G (absolute value)	105 LBS	105 LBS	5
22	Sign for member G (1 for tension or -1 for compression)	1 (1 or -1)	1 (1 or -1)	5

Current Score: 110 / 110

Problem Menu

Logout



#20, 22. Signs for diagonal chords (F, G).

G was considered diagonally up → compression but value of G → -ve (G = -105).

∵ G → -ve ∴

∴ G ≠ diagonals down towards center are in tension

∴ Signs for member G → 1 (tension). //

Similarly,

Signs for member F → -1 (compression). //

Signs for members

Top chords are in compression;

Bottom chords are in tension;

Usually, Diagonals down towards center are in tension

Diagonals up towards center are in compression.

#6, 8, 12. Signs for top chords (A, B, C)

Signs for members A, B, C (top chords).

= -1 (compression).

#14, 16. Signs for bottom chords (D, E).

Signs for members D, E (bottom chords).

= 1 (tension).