Recitation 004

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GSI Info

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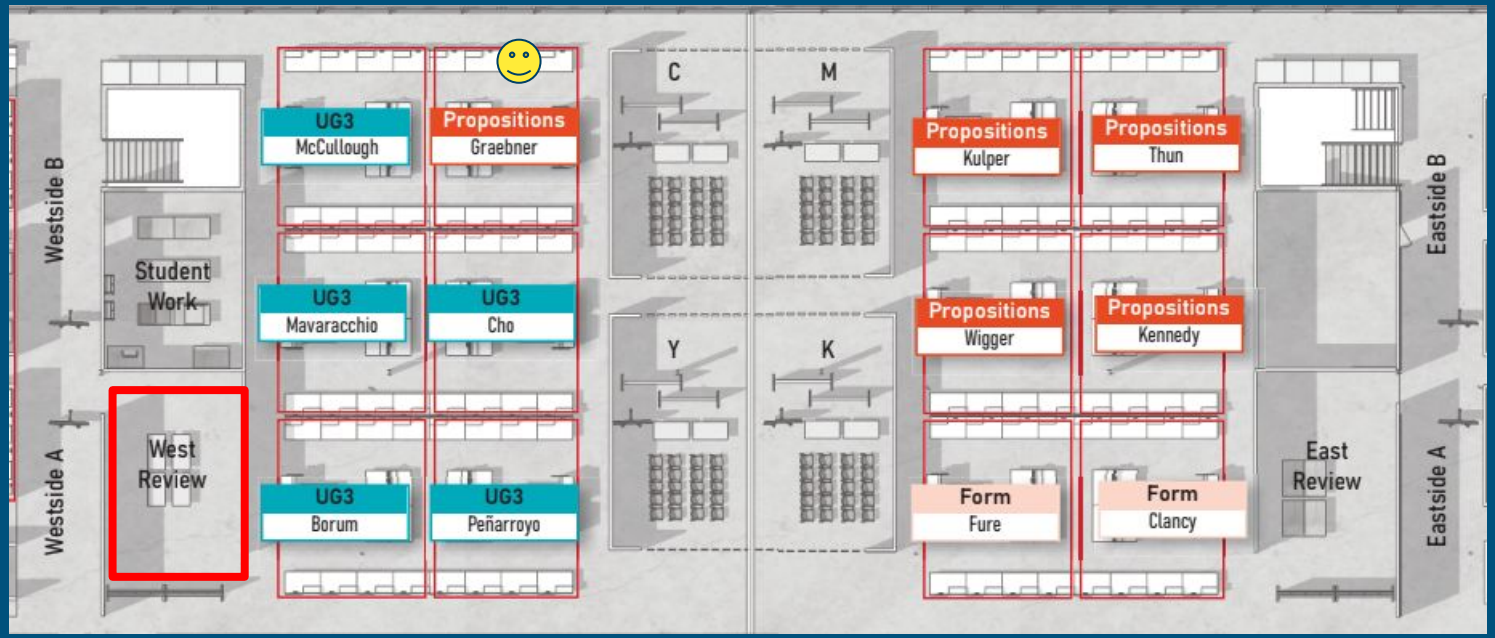


Questions

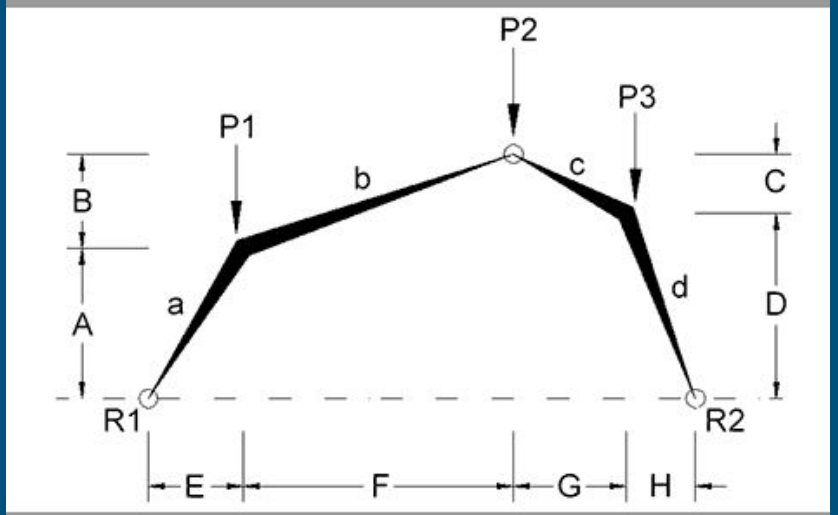
HW #8

8. Three Hinged Arches

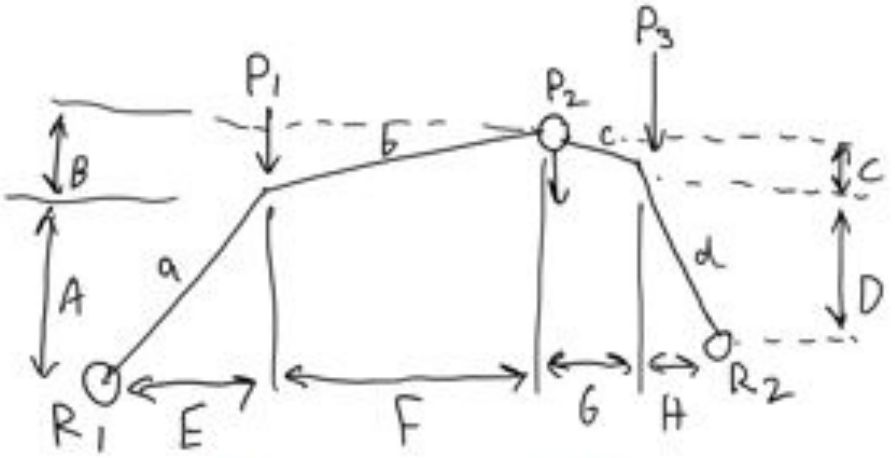
For the three-hinged arch shown, determine horizontal and vertical components of each reaction, and the moments at the knees.

DATASET: 1 -2- -3-

Height A	15 FT
Height B	3 FT
Height C	9 FT
Height D	9 FT
Length E	4 FT
Length F	14 FT
Length G	14 FT
Length H	4 FT
Force P1	6 KIPS
Force P2	19 KIPS
Force P3	10 KIPS



#	Question
1	HORIZONTAL component of R1 (+ = to the right)
2	VERTICAL component of R1 (+ = upward)
3	HORIZONTAL component of R2 (+ = to the right)
4	VERTICAL component of R2 (+ = upward)
5	Moment at M1 (+ = tension inside)
6	Moment at M2 (+ = tension inside)
7	Axial force in member "a" (+ is compression)
8	Axial force in member "b" (+ is compression)
9	Axial force in member "c" (+ is compression)
10	Axial force in member "d" (+ is compression)



$A = 15'$ $E = 4'$ $P_1 = 6$ kips

$B = 3'$ $F = 14'$ $P_2 = 19$ kips

$C = 9'$ $G = 14'$ $P_3 = 10$ kips

$D = 9'$ $H = 4'$

1.) Find Vertical Components

$$\Sigma M @ R_2 = 0 = P_3(H) + P_2(G+H) + P_1(F+G+H) - R_{1y}(E+F+G+H)$$

$$R_{1y} = \frac{\bar{P}_3(H) + P_2(G+H) + P_1(F+G+H)}{E+F+G+H}$$

$$R_{1y} = \frac{10_k(4') + 19_k(14'+4') + 6_k(14'+14'+4')}{4'+14'+14'+4'}$$

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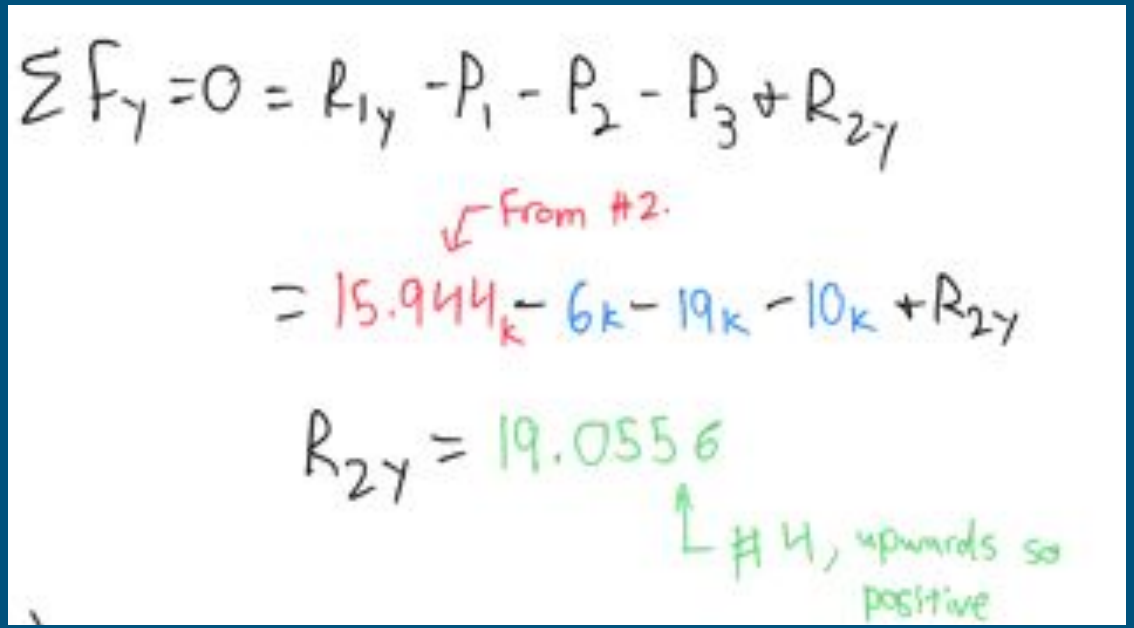
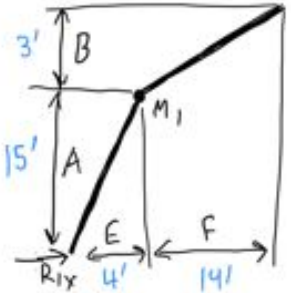
$$R1_y = 15.944 \text{ kips}$$

↑ #2, upwards so positive


$\Sigma F_y = 0 = R_{1y} - P_1 - P_2 - P_3 + R_{2y}$
From #2.
$= 15.944_k - 6_k - 19_k - 10_k + R_{2y}$
$R_{2y} = 19.0556$
#4, upwards so positive

2.) Solve for horizontal components



$$\Sigma M = 0 = R_{1y}(E+F) - R_{1x}(A+B) - P_1(F)$$

$$R_{1x} = \frac{P_1(F) - R_{1y}(E+F)}{(A+B)}$$

From #2

$$= \frac{6_k(14') - 15.94(4' + 14')}{(15' + 3')}$$

$$R_{1x} = 11.2778 \text{ kips}$$

#1, to the right so positive

$$\Sigma F_x = 0 = R_{1x} + R_{2x}$$

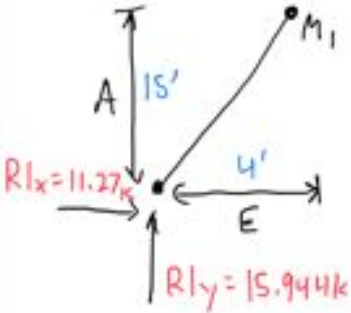
from #1.

$$R_{2x} = -R_{1x} = -11.2778 \text{ kips}$$

$$R_{2x} = -11.2778 \text{ kips}$$

#3) to the left so negative

3.) Calculate Moments @ knees



$\Sigma M_{@knee} = 0 = -R1_y(E) + R1_x(A) + M_1$

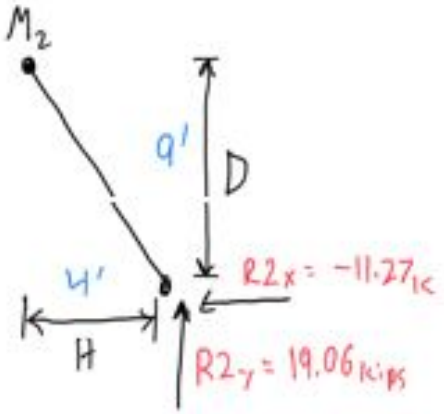
$M_1 = R1_y(E) - R1_x(A)$

$= 15.944(4') - 11.277(15')$

↑ From #2 ↑ From #1.

$M_1 = 105.3774$ kips

↑ #5. tension inside so positive



$\Sigma M_{@\ knee} = 0 = -R2_y(H) + R2_x(D) + M_2$

$M_2 = R2_y(H) - R2_x(D)$

$= 19.06(4') - 11.277(9')$

From #4 ↑ ↑ From #3

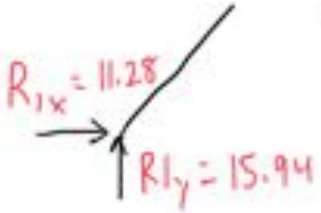
$M_2 = -25.2778$ kips

↑ #6. No tension inside, so negative

Moment diagram is drawn on the tension side, opposite of the conventions for beams

4.) Determine Axial Forces

member a



$a = \sqrt{11.28^2 + 15.94^2} = 19.53$ kips

11.28 from #1

15.94 from #2

#7, forces are pointed to the joint so it is in compression

member b

From $R1_y$

From $R1_x$

$$\Sigma F_x = 0 = a_x - b_x$$

$$b_x = 11.28$$

$$\Sigma F_y = 0 = a_y - P_1 - b_y$$

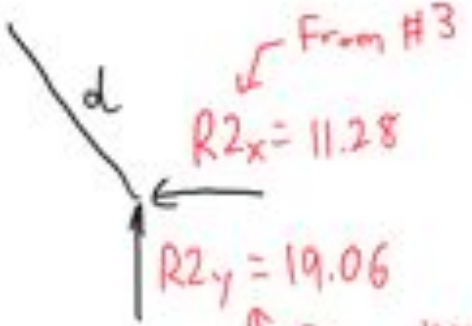
$$b_y = 15.94_k - 6_k$$

$$b_y = 9.94_k$$

$$b = \sqrt{11.28^2 + 9.94^2} = 15.036 \text{ kips}$$

8, forces are towards joint so it is in compression

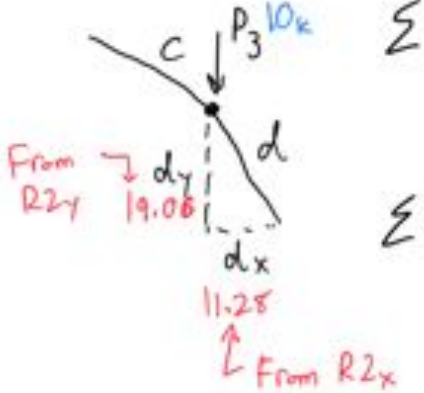
Member d



$d = \sqrt{11.28^2 + 19.06^2} = 22.15$ kips

#10, forces are towards joint so it is in compression

Member C



$\Sigma F_x = 0 = d_x - C_x$

$C_x = 11.28$

$\Sigma F_y = 0 = d_y - P_3 - C_y$

$C_y = 19.06_k - 10_k$

$C_y = 9.06_k$

$C = \sqrt{11.28^2 + 9.06^2} = 14.466$ kips

#9, Forces are towards joint so it is in compression

LAB