

3-Hinged Arches

Description

This project finds the reactions and moments of a three-hinged arches.

Goals

To observe the end thrust behavior of a three-hinged arch.

To calculate the end reactions of the arch.

To calculate the moment at the knee.

To find the geometry of a catenary arch.

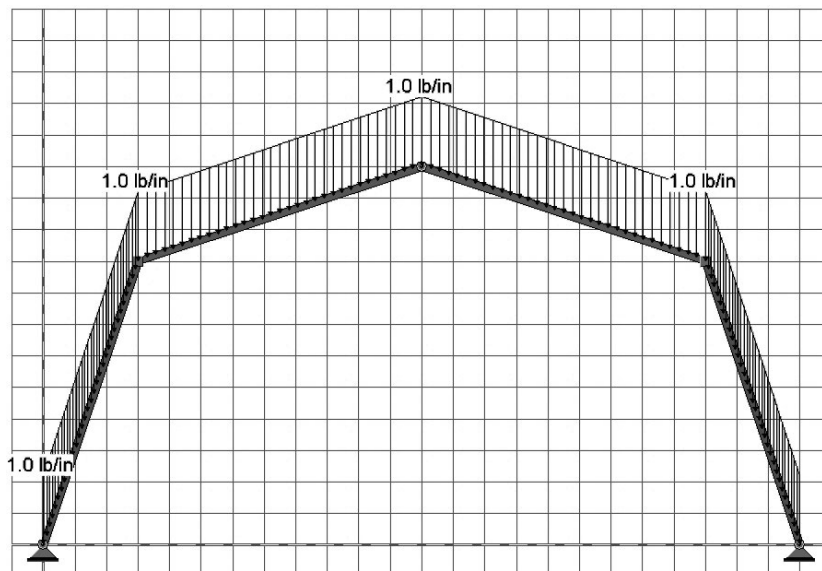
Procedure

Part 1

1. Adjust the 3-hinged arch model on graph paper to have a 9" span.
2. Copy the geometry onto graph paper to determine the dimensions – the member lengths should be about 4" each.
3. Assume a uniform vertical load of 1 pound / inch on the length of each member (like a selfweight). Find and locate the resultant forces on your drawing.
4. Calculate the end reactions.
5. Calculate the peak moment at the knee.

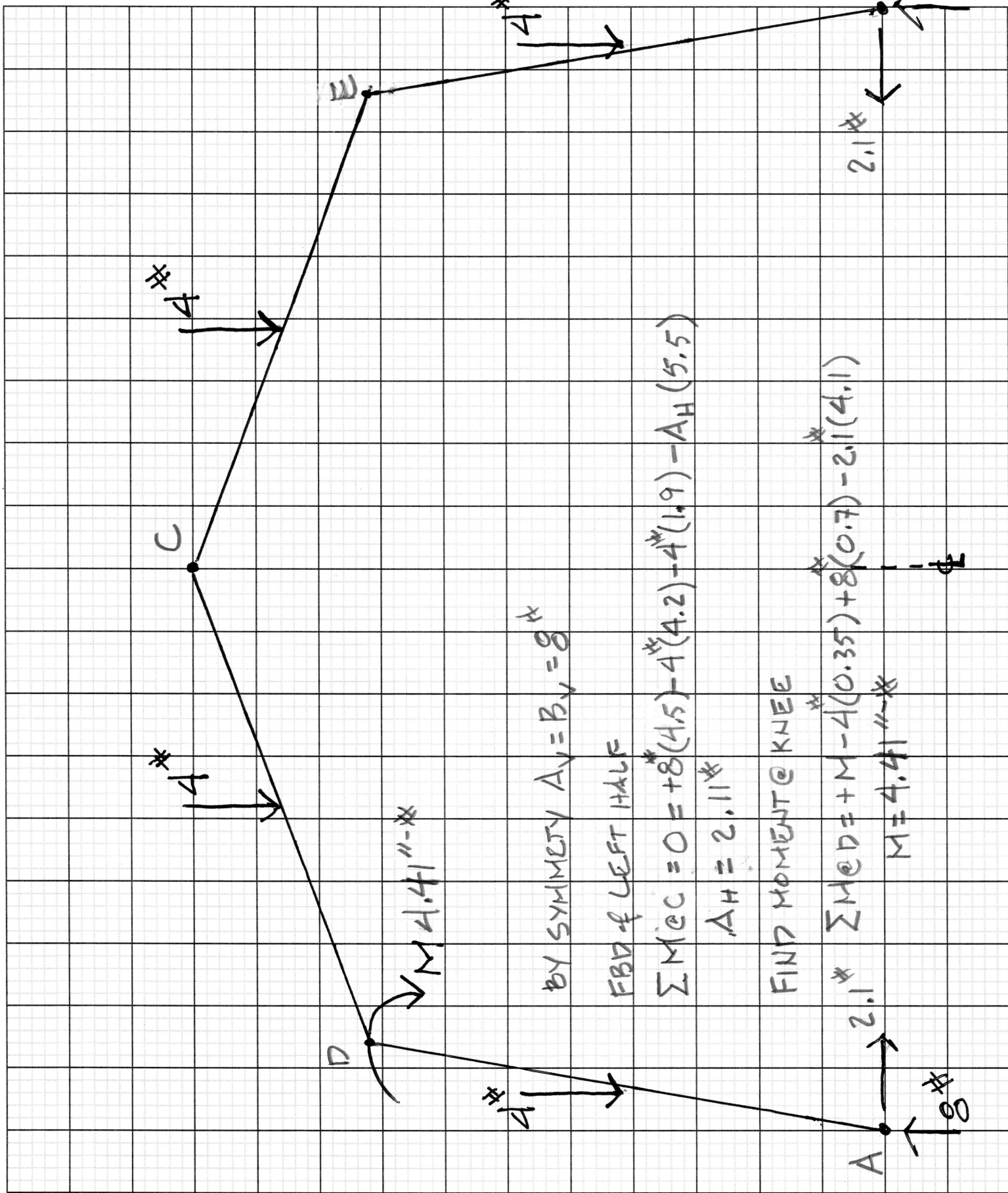
Part 2

6. Next use the string to find a funicular shape with the same span.
7. Copy the new geometry onto the graph paper (overlaid on the original arch) to determine the dimensions.
8. Segment the arch into four symmetric sections.
9. Calculate the end reactions.
10. Calculate the peak moment at the knee.



Due

During recitation



4 k

4 k

4 k

2.1 k

C

D

A

B

$M = 4.41 \text{ k-ft}$

BY SYMMETRY $A_y = B_y = 8 \text{ k}$

FBD of LEFT HALF

$\sum M_c = 0 = +8(4.5) - 4(4.2) - 4(1.9) - A_h(5.5)$

$A_h = 2.11 \text{ k}$

FIND MOMENT @ KNEE

$\sum M_d = +M - 4(0.35) + 8(0.7) - 2.1(4.1)$

$M = 4.41 \text{ k-ft}$

PART 1

VERTICAL REACTIONS - BY SYMMETRY

$$\sum F_V = 16 - R_1 - R_2 = 0$$

$$R_1 = R_2 = \boxed{8^*}$$

FBD LEFT SIDE

$$\sum M_k = 0 = 8(4.5) - H(5.5) - 4(4.2) - 4(1.9)$$

$$H = \boxed{2.1^*}$$

RIGHT SIDE BY SYMMETRY

$$M_{@KNEE} = 8(0.7) - 2.1(4.1) - 4(0.35) + M = 0$$

$$M = \boxed{4.41''^*}$$

PART 2

AGAIN VERTICAL REACTIONS BY SYMMETRY

$$R_V = \boxed{8^*}$$

FBD LEFT SIDE

$$\sum M_k = 0 = 8(4.5) - 5(3.5) - 3(1.2) - H(6.3)$$

$$H = \boxed{2.3^*}$$

$$M_{@KNEE} = 8(2) - 2.37(4.6) - 5(1) - M = 0$$

$$M = \boxed{0.1 \approx 0}$$