Lesson Plan: Review of Influence Lines For Determinate Structures

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Lesson: Review of Influence Lines for Determinate Structures.

Timeframe: 75 minutes.

Target Audience: upper division undergraduate engineering students in the Structural Mechanics I (CE 3600) course.

Materials needed: laptop, projector, PowerPoint slides, and handout of sample review problems (Activity #1 and #2)

Objectives:

Basic:

1. Understand the concept of influence lines.

2. Use the "Statics" to construct influence lines.

3. Utilize the influence lines for analyzing structures with moving loads.

Advanced:

1. Learn the Muller-Breslau to graphically (qualitatively) construct influences.

2. Learn to position moving loads to maximum the influence of moving loads.

3. Construct influence lines for various types of structures, such as bridges, trusses, and frames.

Background: Students who take this course are required to perform structural analysis for a variety of loads without considering how the position of loading was established. This lesson is for students in structural mechanics course to analyze structures other than dead load, which is fixed in position. For example, the live load or moving load, e.g. vehicle load which can change position at all times. This lesson is a review and summary of the sessions on the influence lines.

Introduction to Lesson [4 minutes]:

Write the agenda on the board:

1. Review the theory of influence lines
2. Discuss how to construct influence lines using basic concept with statics
3. Discuss an alternative way ,i.e. Muller-Breslau principle to construct influence lines
4. Apply two methods discussed above to construct influence lines for two types of structures (Activity #1 and #2)

Procedure [two weeks]:

Pre-Class Individual Space Activities and Resources:

Steps	Purpose	Estimated Time	Learning Objective
Step 1: Review the Chapter 8 of the textbook: Live Load forces – Influence Lines for Determinate Structures.	**Review the material**	**One week**	**Basic:#1-#3**
Step 2: Complete the homework assignments for Chapter 8.	**Understand the material**	**Two weeks**	**Basic:#1-#3 and Advanced: #1-#3**
Step 3:			
Step 4:			
Step 5:			

Procedures [66 minutes]:

In-Class Group Space Activities and Resources:

Steps	Purpose	Estimated Time	Learning Objective
Step 1: What is influence line? It is a diagram depicting variation of structural responses (such as support reaction, shear forces, and bending moments, etc.) with position of load along span of the structure. Influence lines are used to (1) determine where to place live load on a structure to maximize the responses (reaction, shear, and moment, etc.) for which the influence line is drawn, and (2) evaluate the magnitude of the forces (represented by the influences line) produced by the live load. There are two methods in constructing an influence line, namely (1) use the basic concept together with statics [Slide 3], and (2) establish the shape of the influence line for structural response such as support reactions and internal forces in a beam. [Slide 4]	**Defining the Influence lines and explaining how to construct it. [Slides 1-4]**	**8 minutes**	**Basic: #1-#3**
Step 2: Let us study the two methods of instructing influence lines we just introduced. In group of four [Slide 6], share what you have noticed about procedures and differences between these two methods. [Student with each group takes turns for **two minutes** to share what they noticed, allow students to discuss the methodology as a group for **two minutes.** Then each group provides summary of their discussion on the board.] Using information provided by all groups, allow students from whole class to discuss the methods toward a greater understanding of how these two methods based and their differences in application for **four minutes**.	**Applying Understanding**	**8 minutes**	**Advanced: #1-#3**

Step 3: Now, we are getting into learning and practicing methods. For the sake of learning method, we'll choose one type of structure, i.e. continuous beam to work with as a group. Because I want you have enough time in class to go through this process on your own, I'm only acting as a facilitator. Each group has its own assignment as indicated in #1 of the Activity #1 [Slide 7]. The group leader, captain shall coordinate their group member with the selection of a specific method for a response given within each group. The student will come up with their solutions for the assigned problem. Then, the student will discuss his/her solution with other group members until consensus solutions are made and a summary of approaches are developed. After individual group discussion has completed, the students from each group will come up to the board to present what they have developed in their group work. A question and answer from whole class and the facilitator conclude the practicing Activity #1.	**Learning how to construct influence lines using two methods: Practice as a group for Activity #1 [Slide 7]**	**25 minutes**	**Basic and Advanced #1-#3**
Step 4: Now, we have a chance to learn to apply the methods to a different structure, e.g. truss. Again, as shown in [Slide 7], each group gets a different assignment for the same structure. Before starting the practice of the methods, I want you to consider the characteristics of the truss so that we'll address the solutions via two methods we had learned before, i.e. method of joints and method of sections. The group practice for Activity #2 follows the same process as indicated in Step 3 above.	**Learning how to construct influence lines using two methods: Practice as a group for Activity #2 [Slide 7]**	**25 minutes**	**Basic and Advanced #1-#3**

Closure/Evaluation [5 minutes]:
Now that you have had a chance to go through this process, let's debrief. What worked? What did not? What would you change about this process? [Ask all students to contribute. If practical and/or necessary, write the responses on the board and address student concerns after all students have contributed- you will want to make sure that students understand that this is a process that they go through in order to develop critical thinking skills in the application of constructing influence lines, for example. This takes energy and can feel tedious at times, but the payoff is that they will have a deeper understanding of a complex subject in the course.

Analysis:
This is a great activity for students to work on together to generate ideas for constructing influence lines. Because students often feel stuck at the initial stage of developing solutions, working with others to discuss topics can help them to generate their own ideas. Also, the process asks students to consider different ways to examine the problems. This lesson gets students to examine the intuitive solutions rather definite answers and develop more complex query and organization skills for the course.

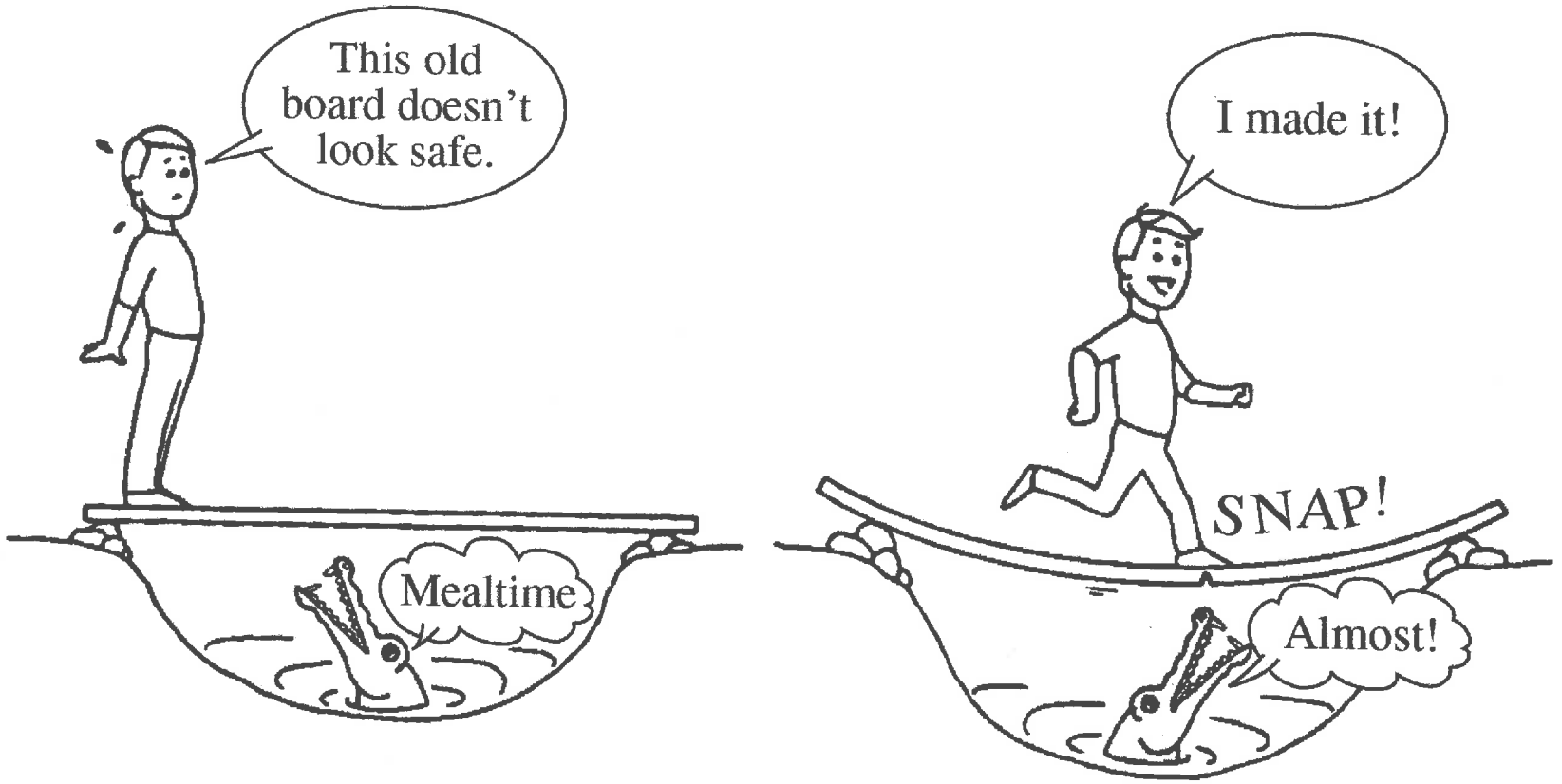
A limitation or weakness is that this process can feel tedious or repetitive. Some students may be put off by this and want to jump ahead to the end point. Therefore, it is important to remind students that this is a PROCESS and that should trust it (at least for this one time).

Anther limitation is that students are not well prepared on their pre-class assignment, thus it is very difficult to start off the process; or simply they were just tag along without involvement to the process. Therefore, there will be no benefit for their learning.

Post-Class Individual Space Activities:
A midterm will be held after this lesson to evaluate the students' understanding of the topic.

Connections to Future Lesson Plan(s):
This lesson is an experimental one along with other lessons taught in conventional way for this course offered in summer 2017. More lesson plans will be developed in connection of this experiment one in the near future so that the full course can be instructed with flipped lessons.

§8.2 Influence Lines



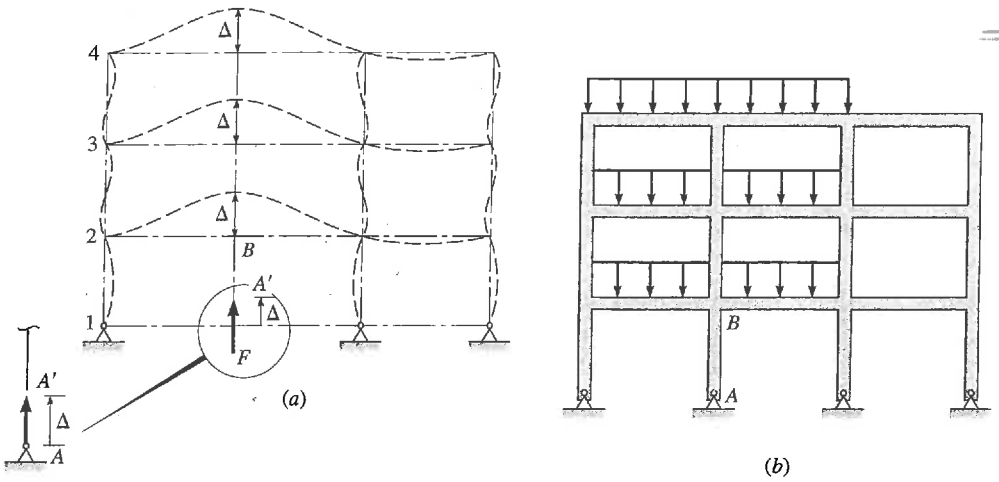
No bending at midspan, load at support

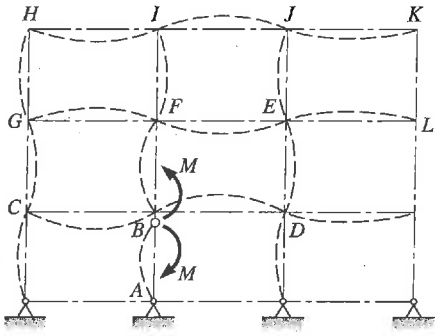
Maximum bending and deflection, load at midspan

Figure 8.1 Variation of bending with position of load

Slide 1

slide 2





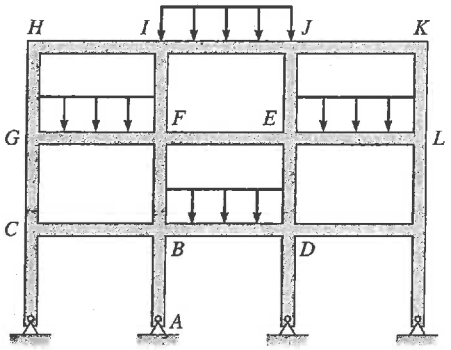
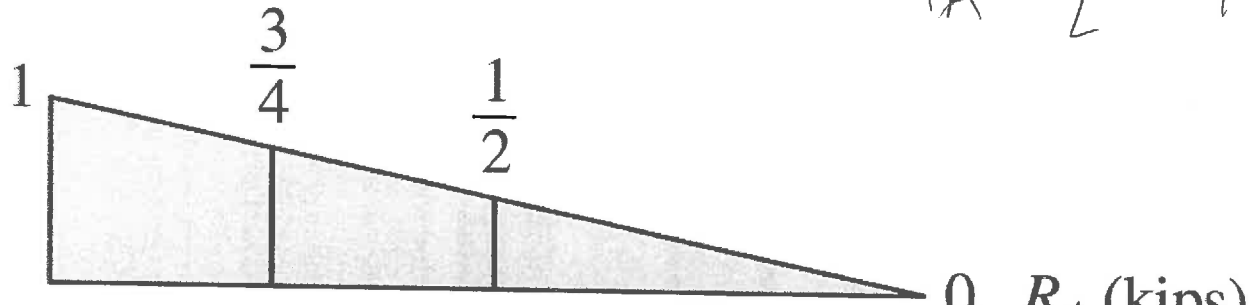


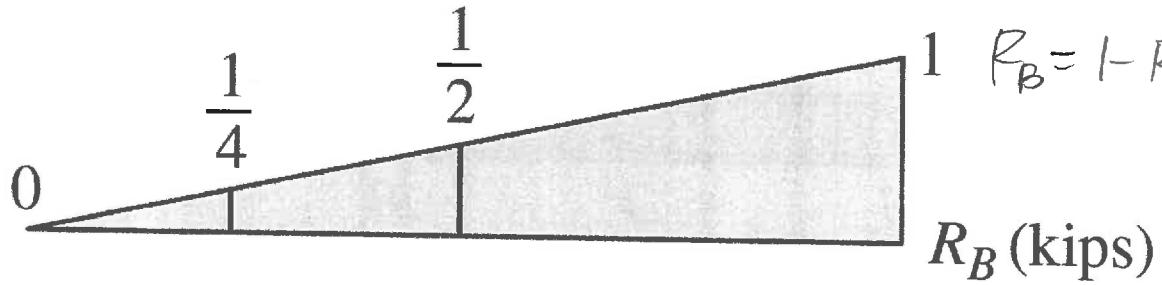
Figure 14.9: Pattern loading to maximize forces in columns: (*a*) influence line for axial load in column *AB*; (*b*) live load pattern to maximize axial force in column *AB*; (*c*) influence line for moment in column *AB*; (*d*) position of live load to maximize moment in column *AB*, and the axial force associated with maximum moment is approximately one-half that shown in (*b*) since a checkerboard pattern of loading is required.

§8.3 Construction of an Influence Line

$R_A = \frac{L-x}{L} = 1 - \frac{x}{L} \quad 0 \le x \le L$



Influence line for R_A



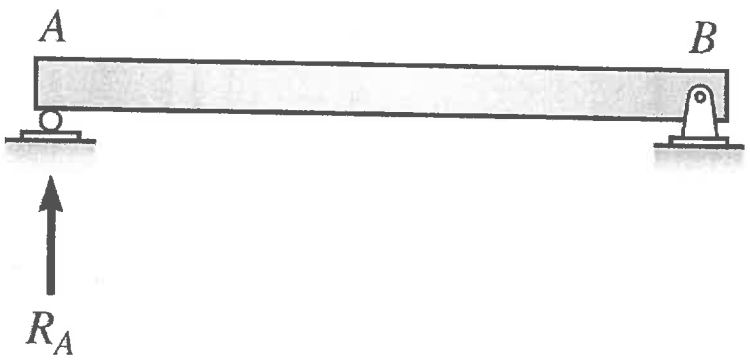
$R_B = 1 - R_A = \frac{x}{L} \quad 0 \le x \le L$

Influence line for R_B

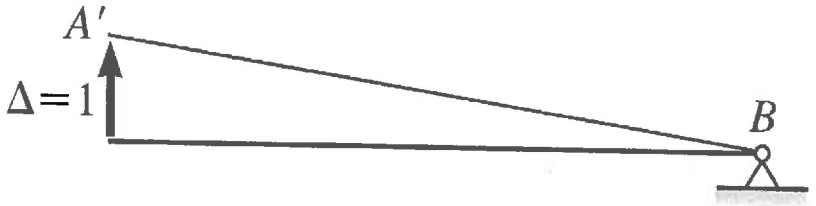
Figure 8.2 Influence lines for reactions at *A* and *B* (continued)

Slide 3

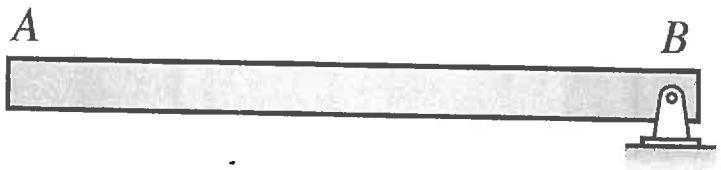
§8.4 The Müller–Breslau Principle



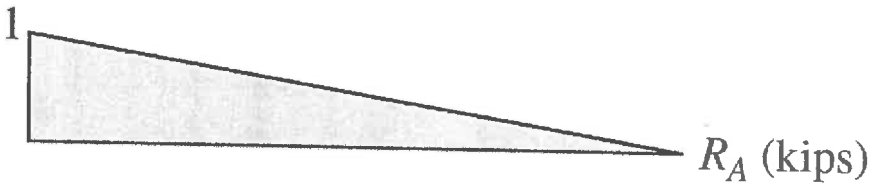
Simply supported beam



Displacement introduced that corresponds to reaction at *A*



The *released* structure



The influence line for R_A

Figure 8.9 Construction of the influence line for R_A by the Müller–Breslau principle

Slide 4

4/3/2017
7/12/2017

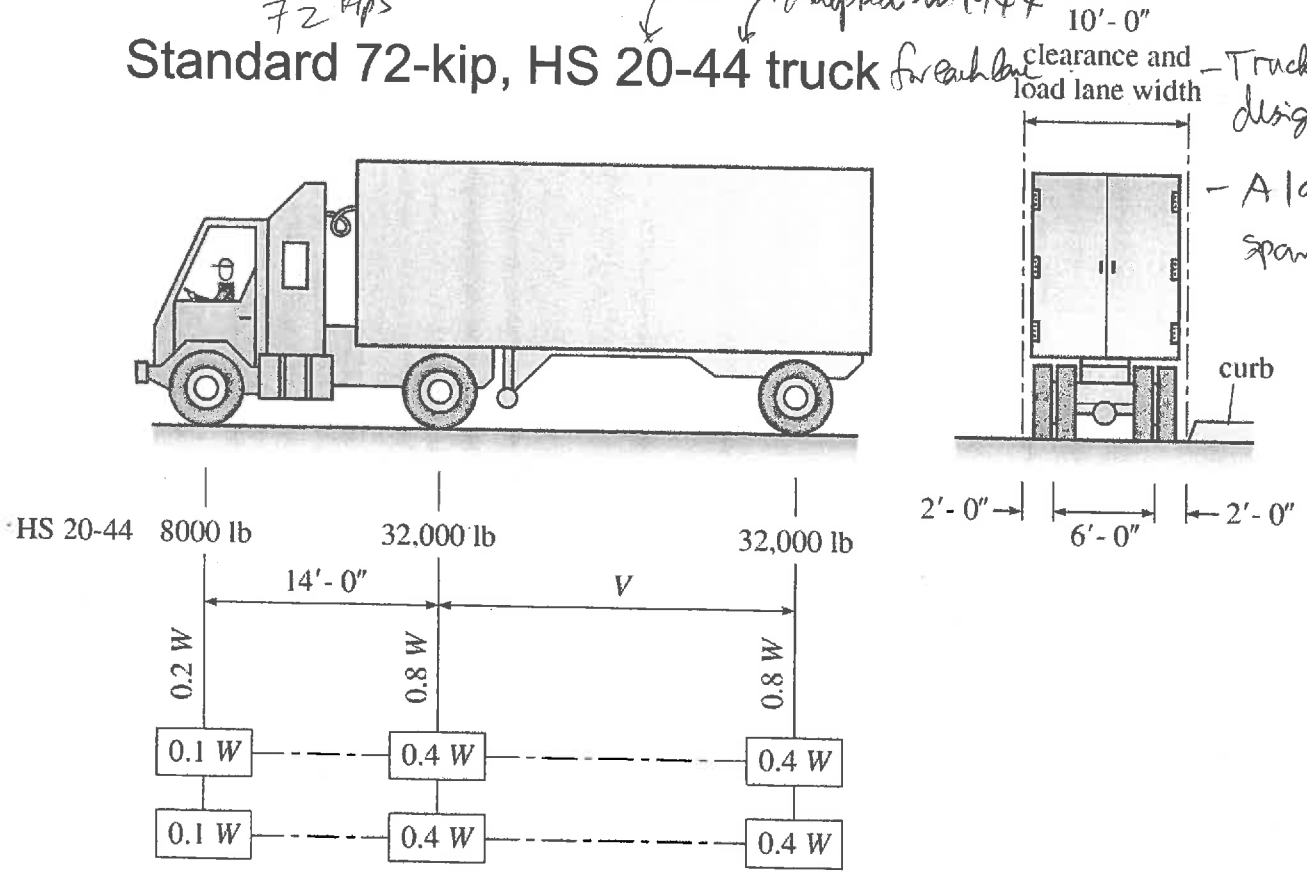
§8.8 Live Loads for Highway and Railroad Bridges

Front + Back Axels weigh 20 ton = 40 kips
= 32 kips
Trailer wt
72 kips

American Association of State Hwy & Transportation Offic (AASHTO)

Ton ↙ ↘ Adopted in 1944

Standard 72-kip, HS 20-44 truck for each lane



- Truckload governs the design for bridge span < 145 ft
- A lane loading governs for span > 145 ft

W = Combined weight on the first two axles, which is the same as for the corresponding H truck
V = Variable spacing – 14 ft to 30 ft inclusive. Spacing to be used is that which produces maximum stresses.

Slide 5

Figure 8.25 Lane loads used to design highway bridges

Slide 6

Group A:
Elise Bare – Captain
Minoo
Joshua
Abdullah
John Triantafyllos
~~Meshal Alamri~~

Group B:
Jose. Nieto – Captain
James Tuazon
Calvin Miguel
Jose Velasquez
Meshal Alamri

Group C:
Julio peralta – Captain
Menghua Zhuang
Chen Pin Chan
Ahmad Alrefai

Group D:
Ryan Yip – Captain
Yee Hang Xiao
Rodolfo A. Gonzalez Escudero
Danna Shelleh

Slide 7

CE 3600: Structural Mechanics I, Summer 2017

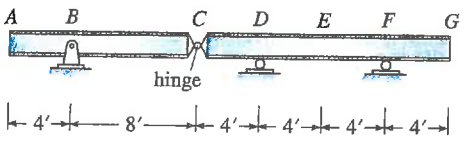
Dr. Jing Wen Jaw **NAME:**_____ _____

Review of Influence Lines For Determinate Structures

Activity #1:

1.) Draw the influence lines for the reactions and internal forces noted as follows. (a) Use the basic concept together with statics or alternatively, (b) Using Muller-Breslau Principle.
Group A: R_B, V_E Group B: R_D, M_E Group C: R_F, M_B Group D: V_C, M_F

2.) Assuming the span can be loaded with a 1.2 kips/ft uniform load of variable length, determine the maximum positive and negative moment at E. (All Groups)



Activity #2:

1.) (a) Draw the influence lines for the bar forces of the truss shown below. The load moves along the bottom chord of the truss;
Group A: Bar HB Group B: Bar CD Group C: Bar HG Group D: Bar HC

2.) Compute the forces in members as indicated below if panel points B, C, and D are each loaded by a concentrated vertical load of 12 kips.
Group A: Bar HB Group B: Bar CD Group C: Bar HG Group D: Bar HC