

Problem R

Bridge With Moving Load

Concrete Material Properties

$E = 5000$ ksi, Poissons Ratio = 0.2

Member Properties

Column

$A = 40$ ft²

$I = 400$ ft³

$AS = 30$ ft²

Girder

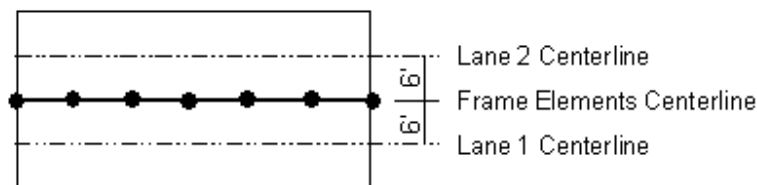
$A = 35$ ft²

$I = 500$ ft³

$AS = 12$ ft²

Moving Load

Number of Lanes = 2

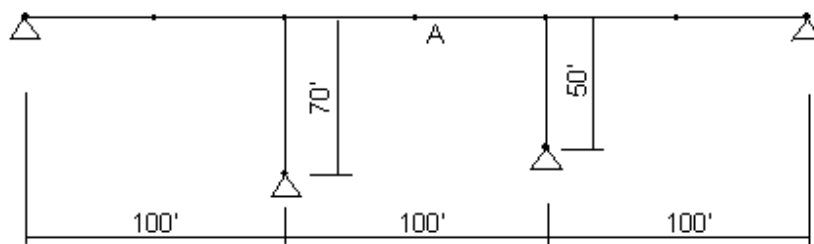


Check for worst case of HS20-44 truck load and HS20-44L lane load applied to each lane simultaneously.

Use the Exact method of calculation.

To Do

Set the number of output segments for girder elements to 2. Review the moving load influence line for vertical displacement at joint A in Lane 1. Review the moving load girder M33 moments in Lane 1. Set the number of output segments for the girder elements to 10. Review the same influence line and moments.

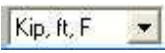


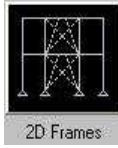
CSI Solution Demonstrates Uses of These features


- Divide Frames
- Bridge Loads
- Output Stations

Problem R Solution

1. Click the **File menu** > **New Model** command to display the **New Model** form.

2. Click the drop-down box to set the units to .



3. Click on the **2D Frame** button  to display the **2D Frames** form. In that form:

- Select *Portal* from the *2D Frames Type* drop-down list.
- Type **1** in the *Number of Stories* edit box.
- Type **3** in the *Number of Bays* edit box.
- Type **70** in the *Story Height* edit box.
- Type **100** in the *Bay Width* edit box.
- Uncheck the *Restraints* check box.
- Click the **OK** button.

4. Click the “X” in the top right-hand corner of the 3-D View window to close it.

5. Click the **Set Display Options** button  (or the **View menu > Set Display Options** command) to display the **Display Options for Active Window** form. In that form:

- Check the *Labels* box in the *Joints* area.
- Check the *Labels* box in the *Frames/Cables/Tendons* area.
- Click the **OK** button.

6. Select line (column) objects 1 and 4. Press the delete key on the keyboard to delete these objects.

7. Select joints 2, 3, 5 and 8.

8. Click the **Assign menu > Joint > Restraints** command to display the **Joint Restraints** form. In that form:

- Verify that the *Translation 1, 2* and *3* check boxes are checked. If they are not checked, check them.
- Click the **OK** button.

9. Select joint 5.

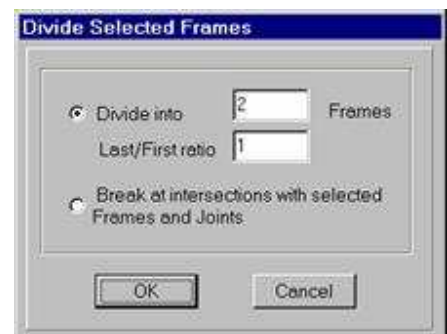
10. Click the **Edit menu > Move** command to display the **Move** form. In that form:


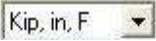
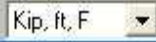
- Type **20** in the *Delta Z* edit box.
- Verify that 0 is entered in the *Delta X* and *Delta Y* edit boxes.
- Click the **OK** button.


11. Select line (frame) objects 5, 6 and 7.

12. Click the **Edit menu > Divide Frames** command to display the **Divide Selected Frames** form.

13. Verify that the form appears as shown in the figure and click the **OK** button.




14. Select line objects 8 through 13 (i.e., the girder objects).
15. Click the **Assign menu > Frame/Cable/Tendons > Output Stations** command to display the **Assign Output Station Spacing** form. In that form:
 - Type **3** in the *Min Number Stations* edit box (this gives 2 segments).
 - Click the **OK** button.
16. Click the **Show Undeformed Shape** button  to remove the displayed output stations assignments and clarify the view of the line object labels.
17. Click the drop-down box in the status bar to change the units to .
18. Click the **Define menu > Materials** command to display the **Define Materials** form.
19. Click on CONC in the *Materials* area to highlight it (select it), and then click the **Modify/Show Material** button to display the **Material Property Data** form is displayed. In that form:
 - Type **5000** in the *Modulus of Elasticity* edit box.
 - Type **.2** in the *Poisson's Ratio* edit box, if it is not already entered.
 - Click the **OK** buttons on the **Material Property Data** and **Define Materials** forms to exit all forms.
20. Click the drop-down box in the status bar to change the units to .
21. Click the **Define menu > Frame Sections** command to display the **Frame Properties** form.
22. In the *Choose Property Type to Add* area, click the drop-down box that reads *Add I/Wide Flange* and then click on the *Add General* item. Click the **Add New Property** button to display the **Property Data** form. In that form:
 - Type **40** in the *Cross Sectional (Axial) Area* edit box.
 - Type **400** in the *Moment of Inertia About 3 Axis* edit box.
 - Type **30** in the *Shear Area in 2 Direction* edit box.
 - Click the **OK** button to display the **General Section** form. In that form:
 - Type **COLUMN** in the *Section Name* edit box.
 - Select CONC from the *Material* drop-down box.
 - Click the **OK** button to return to the *Frame Properties* form.
23. In the *Choose Property Type to Add* area, click the drop-down box that reads *Add General* and then click on the *Add General* item. Click the **Add New Property** button to display the **Property Data** form. In that form:
 - Type **35** in the *Cross Sectional (Axial) Area* edit box.
 - Type **500** in the *Moment of Inertia About 3 Axis* edit box.
 - Type **12** in the *Shear Area in 2 Direction* edit box.
 - Click the **OK** button to display the **General Section** form. In that form:
 - Type **GIRDER** in the *Section Name* edit box.
 - Select CONC from the *Material* drop-down box.

- Click the **OK** buttons on the **General Section** and **Frame Properties** forms to exit all forms.
24. Select line objects 8 through 13 (girders).
25. Click the **Assign menu > Frame/Cable/Tendons > Frame Sections** command to display the **Frame Properties** form. In that form:
- Click on GIRDER in the *Properties* area to highlight it.
 - Click the **OK** button.
26. Select the two column objects.
27. Click the **Assign menu > Frame/Cable/Tendons > Frame Sections** command to display the **Frame Properties** form. In that form:
- Click on COLUMN in the *Properties* area to highlight it.
 - Click the **OK** button.
28. Click the **Show Undeformed Shape** button  to remove the displayed frame section assignments to clarify the display of the frame object labels.
29. Click the **Define menu > Bridge Loads > Lanes** command to display the **Define Lanes** form. In that form:
- Click the **Add New Lane Defined From Frames** button to display the **Lane Data** form. In that form:
 - Accept the default *Lane Name*, LANE1.
 - Type **8** in the *Frame* edit box.
 - Type **-6** in the *Centerline Offset* edit box.
 - Click the **Add** button.
 - Type **9** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **10** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **11** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **12** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **13** in the *Frame* edit box.
 - Click the **Add** button.
 - Click the **OK** button to return to the **Define Bridge Lanes** form.
30. In the **Define Lanes** form:
- Click the **Add New Lane Defined From Frames** button to display the **Lane Data** form. In that form:
 - Accept the default *Lane Name*, LANE2.

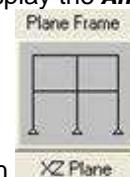
- Type **8** in the *Frame* edit box.
 - Type **6** in the *Centerline Offset* edit box.
 - Click the **Add** button.
 - Type **9** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **10** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **11** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **12** in the *Frame* edit box.
 - Click the **Add** button.
 - Type **13** in the *Frame* edit box.
 - Click the **Add** button.
 - Click the **OK** buttons on the **Lane Data** and **Define Lanes** forms to exit all forms.
31. Click the **Define menu > Bridge Loads > Vehicles** command to display the **Define Vehicles** form. In that form:
- In the *Choose Vehicle Type to Add* area, click the drop-down list and select *Add Standard Vehicle*. Click the **Add Vehicle** button to display the **Standard Vehicle Data** form. In that form:
 - In the *Data Definition* area, select HSn-44 in the *Vehicle Type* drop-down list.
 - Type **20** in the *Scale Factor* edit box if it is not already entered.
 - Click the **OK** button to return to the **Define Vehicles** form.
 - Click the **Add Vehicle** button to display the **Standard Vehicle Data** form. In that form:
 - In the *Data Definition* area, select HSn-44L in the *Vehicle Type* drop-down box.
 - Type **20** in the *Scale Factor* edit box if it is not already entered.
 - Click the **OK** buttons on the **Standard Vehicle Data** and **Define Vehicles** forms to exit all forms.
32. Click the **Define menu > Bridge Loads > Vehicle Classes** command to display the **Define Vehicle Classes** form. In that form:
- Click the **Add New Class** button to display the **Vehicle Class Data** form. In that form:
 - Accept the default *Vehicle Class Name*, *VECL1*
 - Verify that HSn-44-1 is in the *Vehicle Name* drop-down list.
 - Type **1** in the *Scale Factor* edit box if it is not already entered.
 - Click the **Add** button.

- Select HSn-44L-1 in the *Vehicle Name* drop-down box.
 - Click the **Add** button.
 - Click the **OK** buttons on the **Vehicle Class Data** and **Define Vehicle Classes** forms to exit all forms.
33. Click the **Define menu > Bridge Loads > Bridge Responses** command to display the **Bridge Response Requests** form. In that form:
- Verify that the *Exact* option is selected in the *Method of Calculation* area.
 - Click the **OK** button.
34. Click the **Define menu > Analysis Cases** command to display the **Analysis Cases** form. In that form:
- Click the **Add New Case** button to display the **Analysis Case Data** form. In that form:
 - Type **MOVE1** in the *Analysis Case Name* edit box.
 - Select *Moving Load* from the *Analysis Case Type* drop-down box.
 - In the *Loads Applied* area verify that VECL1 shows in the *Vehicle Class* drop-down list and click the **Add** button.
 - Click the **OK** buttons on the **Analysis Case Data** and **Analysis Cases** forms to exit all forms.

Note: The joint labeled A in the problem statement is labeled 10 on the screen.


35. Click the **Set Display Options** button  (or the **View menu > Set Display Options** command) to display the **Display Options for Active Window** form. In that form:
- Uncheck the *Labels* box in the *Joints* area.
 - Uncheck the *Labels* box in the *Frames/Cables/Tendons* area.
 - Click the **OK** button.

36. Click the **Analyze menu > Set Analysis Options** command to display the **Analysis**



Options form. In that form click the **Plane Frame XZ Plane** button to set the available degrees of freedom.

- Click the **OK** button.




38. Click the **Run Analysis** button  to display the **Set Analysis Cases to Run** form. In that form:
- Highlight (select) MODAL in the *Case Name* list and click the **Run/Do Not Run Case** button.
 - Verify that the DEAD and MOVE1 analysis cases are set to *Run* in the *Action* list.
 - Click the **Run Now** button to run the analysis.

38. When the analysis is complete, check the messages in the SAP Analysis Monitor window (there should be no warnings or errors) and then click the **OK** button to close the window.
39. Click the **Display menu > Show Influence Lines** command to display the **Show Influence Line** form. In that form:
- In the *Plot Influence Line for This Element Type* area, select the *Joint* option.
 - Select LANE1 from the *Select One or More Lanes* list.
 - Select the *Plot Along Lane Center Line* option in the *Plot Parameters* area of the form.
 - Type **10** in the *Joint Label* edit box in the *Plot Influence Line for this Object* area on the right half of the form.
 - In the *Joint Result Type* area, select the *Displacement* option if it is not already selected.
 - In the *Component* area, select the *U3* option (vertical displacement).
 - Click the **OK** button to display the influence line.

Note: This influence line is constructed with three output stations specified for the girder objects. Points for the influence line are calculated at each output station. These points are then connected by straight lines.

40. Click the **Display menu > Show Forces/Stresses > Frames/Cables/Tendons** command to display the **Member Force Diagram For Frames** form. In that form:
- Select *MOVE1* from the *Case/Combo Name* drop-down box.
 - In the *Component* area select the *Moment 3-3* option.
 - Uncheck the *Fill Diagram* check box.
 - Check the *Show Values On Diagram* check box.
 - Click the **OK** button to display the moment diagram.

Note: This moment diagram is constructed with two output segments specified for the girder objects. Points for the moment diagram are calculated at each output station. These points are then connected by straight lines. The segments are clearly displayed in the moment diagram.

41. Click the **Lock/Unlock Model** button  and click the resulting **OK** button to unlock the model.
42. Select line objects 8 through 13 (i.e., the girder objects).
43. Click the **Assign menu > Frame/Cable/Tendons > Output Stations** command to display the **Assign Output Station Spacing** form. In that form:
- Type **11** in the *Min Number Stations* edit box.
 - Click the **OK** button.
44. Click the **Show Undeformed Shape** button  to remove the displayed output station assignments.
45. Click the **Run Analysis** button  to display the **Set Analysis Cases to Run** form. In that form:

- Click the **Run Now** button to run the analysis.
47. When the analysis is complete, check the messages in the **SAP Analysis Monitor** window (there should be no warnings or errors) and then click the **OK** button to close the window.
 48. Click the **Display menu > Show Influence Lines** command to display the **Show Influence Line** form. In that form, ensure that the *Plot Along Lane Center Line* option is selected and click the **OK** button to display the influence line.

Note: This influence line is much smoother than the previous one.

48. Click the **Display menu > Show Forces/Stresses > Frames/Cables/Tendons** command to display the **Member Force Diagram For Frames** form. In that form, click the **OK** button to display the moment diagram.

Note: This moment diagram is much smoother than the previous one.