

# Problem H

## Reinforced Concrete Beam

### Concrete

$E = 3600$  ksi, Poissons Ratio = 0.2

$f'c = 4$  ksi

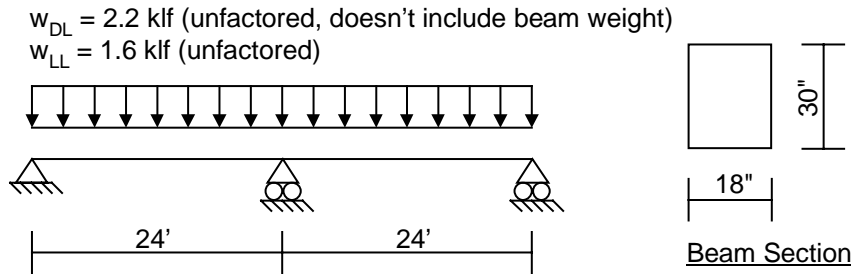
$f_y = 60$  ksi

Concrete cover to longitudinal rebar center at top of beam = 3.5 in

Concrete cover to longitudinal rebar center at bottom of beam = 2.5 in


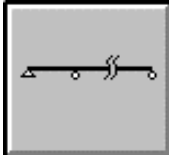

### To Do


Determine required longitudinal reinforcing steel and required shear stirrups based on ACI 318-95

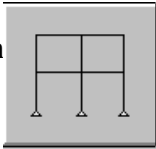



Note: Our intent is that you try this problem on your own first. After you have solved it on your own, you can step through our solution if desired. If you have problems trying to create the model, then follow the steps in our solution.


## Problem H Solution

1. Click the drop down box in the status bar to change the units to kip-ft. 
2. From the **File** menu select **New Model From Template...** This displays the Model Templates dialog box.
3. In this dialog box click on the **Beam** template  button to display the Beam dialog box.
4. In this dialog box:
  - Accept all of the default values.
  - Click the **OK** button.
5. Click the “X” in the top right-hand corner of the 3-D View window to close it.
6. From the **Define** menu select **Materials...** to display the Define Materials dialog box.
7. Click on CONC in the Materials area to highlight (select) it, and then click the **Modify/Show Material** button. The Material Property Data dialog box is displayed.
8. In this dialog box:
  - Verify 0.15 is entered in the Weight per Unit Volume edit box.
  - Click the **OK** button twice to exit all dialog boxes.
9. Click the drop down box in the status bar to change the units to kip-in. 
10. From the **Define** menu select **Materials...** to display the Define Materials dialog box.
11. Click on CONC in the Materials area to highlight (select) it, and then click the **Modify/Show Material** button. The Material Property Data dialog box is displayed.
12. In this dialog box:
  - Verify 3600 is entered in the Modulus of Elasticity edit box.
  - Verify .2 is entered in the Poisson’s Ratio edit box.
  - Verify 60 is entered in the Reinforcing Yield Stress, fy edit box.
  - Verify 4 is entered in the Concrete Strength, fc edit box.
  - Type **60** in the Shear steel Yield Stress, fys edit box.

- Verify 4 is entered in the Concrete Shear Strength, fcs edit box.
  - Accept the other default values.
  - Click the **OK** button twice to exit all dialog boxes.
13. From the **Define** menu select **Frame Sections...** to display the Define Frame Sections dialog box.
14. In this dialog box:
- With the default section, FSEC1, highlighted, click the **Modify/Show Section** button to display the Rectangular Section dialog box.
  - In this dialog box:
    - Select CONC from the Material drop-down box.
    - Type **30** in the Depth (t3) edit box.
    - Type **18** in the Width (t2) edit box.
    - Click the **Reinforcement** button to display the Reinforcement Data dialog box.
    - In this dialog box:
      - ✓ In the Element Class area select the Beam option.
      - ✓ In the Concrete Cover To Rebar Center area type **3.5** in the Top edit box.
      - ✓ In the Concrete Cover To Rebar Center area type **2.5** in the Bottom edit box.
      - ✓ Click the **OK** button three times to exit all dialog boxes.
15. Click the drop down box in the status bar to change the units to kip-ft. 
16. From the **Define** menu select **Static Load Cases...** This will display the Define Static Load Case Names dialog box.
17. In this dialog box:
- Type **DL** in the Load edit box.
  - Click the **Change Load** button
  - Type **LL** in the Load edit box.
  - Select LIVE from the Type drop-down box.

- Type **0** in the Self weight Multiplier box.
  - Click the **Add New Load** button.
  - Click the **OK** button.
18. Select the two frame elements.
19. From the **Assign** menu select **Frame Static Loads...** and then **Point and Uniform...** from the submenu to display the Point and Uniform Span Loads dialog box.
20. In this dialog box:
- Verify that the Load Case Name is DL.
  - In the Load Type and Direction area verify that the Forces option is selected and that the Global Z direction is selected.
  - In the Uniform Load area type **-2.2**.
  - Click the **OK** button.
21. Select the two frame elements.
22. From the **Assign** menu select **Frame Static Loads...** and then **Point and Uniform...** from the submenu to display the Point and Uniform Span Loads dialog box.
23. In this dialog box:
- Select LL from the Load Case Name drop-down box.
  - In the Uniform Load area type **-1.6**.
  - Click the **OK** button.
24. From the **Analyze** menu select **Set Options...** to display the Analysis Options dialog box.
- In this dialog box click the **Plane Frame XZ Plane** button  to set the available degrees of freedom.
  - Click the **OK** button.
25. From the **Options** menu select **Preferences...** to display the Preferences dialog box.
26. In this dialog box:
- Select the CONC Tab.

- Select ACI 318-95 from the Concrete Design Code drop-down box.
  - Verify that the Strength Reduction Factors are 0.9, 0.85, 0.7 and 0.75 for Bending/Tension, Shear, Compression (T) and Compression respectively.
  - Click the **OK** button.
27. Click the **Run Analysis** button  to run the analysis.
  28. When the analysis is complete check the messages in the Analysis window (there should be no warnings or errors) and then click the **OK** button to close the Analysis window.
  29. On the **Design** menu verify that the **Concrete Design** feature is active. There should be a check mark next **Concrete Design** if it is active.
  30. From the **Design** menu click Select Design Combos... to display the Design Load Combinations Selection dialog box.
  31. In this dialog box:
    - Verify that the default combinations for concrete design, DCON1 and DCON2 are included in the Design Combos list box.
    - Highlight DCON1 and click the **Show** button to display the Load Combination Data dialog box.
    - In this dialog box:
      - Note the definition of the load combination in the Define Combination area. It should be 1.4DL.
      - Click the **OK** button to return to the Design Load Combinations Selection dialog box.
    - Highlight DCON2 and click the **Show** button to display the Load Combination Data dialog box.
    - In this dialog box:
      - Note the definition of the load combination in the Define Combination area. It should be 1.4DL + 1.7LL.
      - Click the **OK** button twice to exit all dialog boxes.
  32. From the **Design** menu select **Start Design/Check of Structure** to run the design check.
  33. When the design is done the area of longitudinal bar required is displayed on the screen. Note that the current units are kips and feet.

34. Click the drop down box in the status bar to change the units to kip-in. 

*Note that the values for the area of longitudinal reinforcing steel are now in units of square inches.*

35. From the **Design** menu select **Display Design Info...** to display the Display Design Results dialog box.

36. In this dialog box:

- Verify that the Design Output option is selected.
- Select Shear Reinforcing from the Design Output drop-down box.
- Click the **OK** button. The required shear reinforcing is displayed on the screen.

*Note that the values for the shear reinforcing steel are reported as an area per unit length of element. Since the current units are kips and inches, the shear reinforcing reported is in square inches per inch.*

37. Right click on the left beam to display the Concrete Design Information dialog box.

38. In this dialog box:

- Note that the required top and bottom longitudinal steel and the required shear steel is reported for each design load combination at each output segment along the beam.
- Click the **Details** button to see design details for the highlighted design load combination and output station location. The Concrete Design Information ACI 318-95 dialog box is displayed.
- When finished viewing the detailed information click the “X” in the upper right-hand corner of the Concrete Design Information ACI 318-95 dialog box to close it.
- Click **OK** to close the Concrete Design Information dialog box.