Problem H

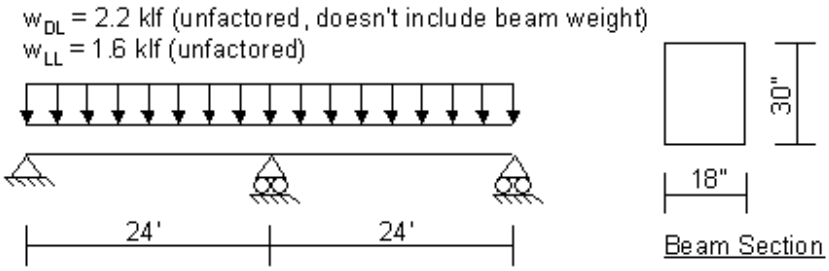
Reinforced Concrete Beam

Concrete

E =3600 ksi, Poissons Ratio = 0.2
f'c = 4 ksi
fy = 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

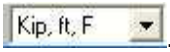
Determine required longitudinal reinforcing steel and required shear stirrups based on ACI 318-95



CSI Solution Demonstrates Use of These Features

- Concrete Design
- New Model From Template

Problem H 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 

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3. Click the **Beam** button 

to display the ***Beam*** form. In that form:
    - Accept all of the default values.
    - 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 **Define menu > Materials** command to display the ***Define Materials*** form. In that form:

- 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. In that form:
    - Verify *0.15* is entered in the *Weight per Unit Volume* edit box.
    - Click the **OK** buttons on the ***Material Property Data*** and ***Define Materials*** forms to close all forms.

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

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7. Click the **Define menu > Materials** command to display the ***Define Materials*** form.
8. 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. In that form:
    - Verify *3600* is entered in the *Modulus of Elasticity* edit box.
    - Verify 0.*2* is entered in the *Poisson's Ratio* edit box.
    - Verify *4* is entered in the *Specified Conc Comp Strength, f'c* edit box.
    - Verify *60* is entered in the *Bending Reinf. Yield Stress, fy* edit box.
    - Type **60** in the *Shear Reinf. Yield Stress, fys* edit box.
    - Accept the other default values.
    - Click the **OK** buttons on the ***Material Property Data*** and ***Define Materials*** forms to close all forms.
9. Click the **Define menu > Frame Sections** command to display the ***Frame Properties*** form. In that form:
    - Click the drop-down box that reads *Add I/Wide Flange* and then click on the *Add Rectangular* item.
    - Click the **Add New Property** button to display the ***Rectangular Section*** form. In that form:
        - Type **CONBEAM** in the *Section Name* edit 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 **Concrete Reinforcement** button to display the *Reinforcement Data* form. In that form:
            - In the *Design Type* 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** buttons on the ***Reinforcement Data***, ***Rectangular Section***, and ***Frame Properties*** forms to close all forms.
10. Click the **Select All** button 

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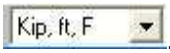
11. Click the **Assign menu > Frame/Cable/Tendon > Frame Sections** command to display the ***Frame Properties*** form. In that form:
    - Click on CONBEAM in the *Properties* area to highlight it.
    - Click the **OK** button.
12. Click the drop-down box in the status bar to change the units to 

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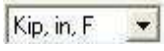
13. Click the **Define menu > Load Cases** command to display the ***Define Loads*** form. In that form:
    - Type **LIVE** in the *Load Name* edit box.
    - Select *LIVE* from the *Type* drop-down box.
    - Verify 0 is entered in the *Self Weight Multiplier* edit box.
    - Click the **Add New Load** button.
    - Click the **OK** button.
14. Select the two line (frame) objects.
15. Click the **Assign menu > Frame/Cable/Tendon Loads > Distributed** command to display the ***Frame Distributed Loads*** form. In that form:
    - Verify that the *Load Case Name* is *DEAD*.
    - In the *Load Type and Direction* area, verify that the *Forces* option is selected and that the *Gravity* direction is selected.
    - In the *Uniform Load* area, type **2.2** in the *Load* edit box.
    - Click the **OK** button.
16. Select the two line (frame) objects.
17. Click the **Assign menu > Frame/Cable/Tendon Loads > Distributed** command to display the ***Frame Distributed Loads*** form. In that form:
    - Select *LIVE* from the *Load Case Name* drop-down box.
    - In the *Uniform Load* area, type **1.6** in the *Load* edit box.
    - Click the **OK** button.
18. 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.
19. Click the **Options menu > Preferences > Concrete Frame Design** command to display the ***Concrete Frame Design Preferences*** form. In that form:
    - Verify *ACI 318-99* is entered in the *Design Code* drop-down list.

- Verify that the Strength Reduction (Phi) Factors are 0.9, 0.7, 0.75 and 0.85 for *Bending Tension, Compression Tied, Compression Spiral* and *Shear* respectively.
- Click the **OK** button.

20. 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 analysis case is set to *Run* in the *Action* list.
    - Verify that the LIVE analysis case is set to *Run* in the *Action* list.
    - Click the **Run Now** button to run the analysis.
21. 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.
22. Verify that the **Design menu > Concrete Frame Design** command is active (it is active if it is not grayed out).
23. Click the **Design menu > Concrete Frame Design > Select Design Combos** command to display the ***Design Load Combinations Selection*** form. In that form:
    - 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 ***Response Combination Data*** form. In that form:
        - Note the definition of the load combination in the *Define Combination* area. It should be 1.4DEAD.
        - Click the **Cancel** button to return to the ***Design Load Combinations Selection*** form.
        - Highlight DCON2 and click the **Show** button to display the ***Response Combination Data*** form. In that form:
            - Note the definition of the load combination in the *Define Combination* area. It should be 1.4DEAD + 1.7LIVE.
            - Click the **Cancel** button on the ***Response Combination Data*** form and the **OK** button on the ***Design Load Combinations Selection*** form to close all forms.
24. Click the **Design menu > Concrete Frame Design > Start Design/Check of Structure** command to run the design check.
25. When the design is finished, the area of longitudinal bar required is displayed on the screen. Note that the current units are kips and feet.
26. Click the drop-down box in the status bar to change the units to 

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

27. Click the **Design menu > Concrete Frame Design > Display Design Info** command to display the ***Display Concrete Design Results*** form. In that form:

- 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: 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.

28. Right click on the left beam to display the ***Concrete Beam Design Information*** form. In that form:
    - 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 **Flex. Details** button to display flexural design details for the highlighted design load combination and output station location. The ***Concrete Design Information ACI 318-99*** form is displayed.
    - When finished viewing the detailed information, click the "X" in the upper right-hand corner of the ***Concrete Design Information ACI 318-99*** form to close it.
    - Click the **OK** button to close the ***Concrete Beam Design Information*** form.