CE 120 Structural Engineering
Examination #1

Solution 1

a) Cutting though C and between D and G: unknowns = U=6 (3 reactions, 2 internal forces at C and force in DG); Equations =E= 2x3 =6 for 2 FBD's

n=U-E=0; Statically determinate and stable (reactions are not parallel or intersecting).

If member DG is absent, it is unstable as n=-1.

b)

<table>
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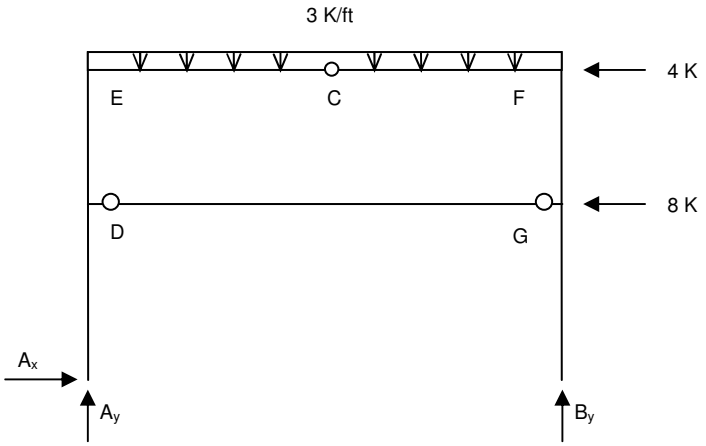
<td> 
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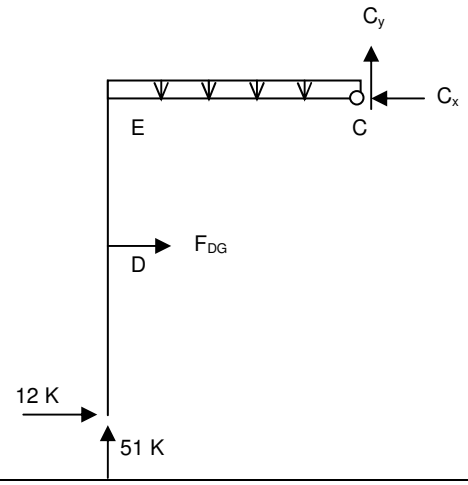
<td> 
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<tr>
<td>$\sum M_A = 0$
$\Rightarrow B_y = 39$ K

$\sum F_y = 0$
$\Rightarrow A_y = 51$ K

$\sum F_x = 0$
$\Rightarrow A_x = 12$ K</td>
<td>$\sum M_C = 0$
$\Rightarrow 9\ F_{DG} + (12)(21) + (45)(7.5) - (51)(15) = 0$
$\Rightarrow F_{DG} = 19.5$ K

$\sum F_y = 0$
$\Rightarrow C_y = -6$ K

$\sum F_x = 0$
$\Rightarrow C_x = 31.5$ K</td>
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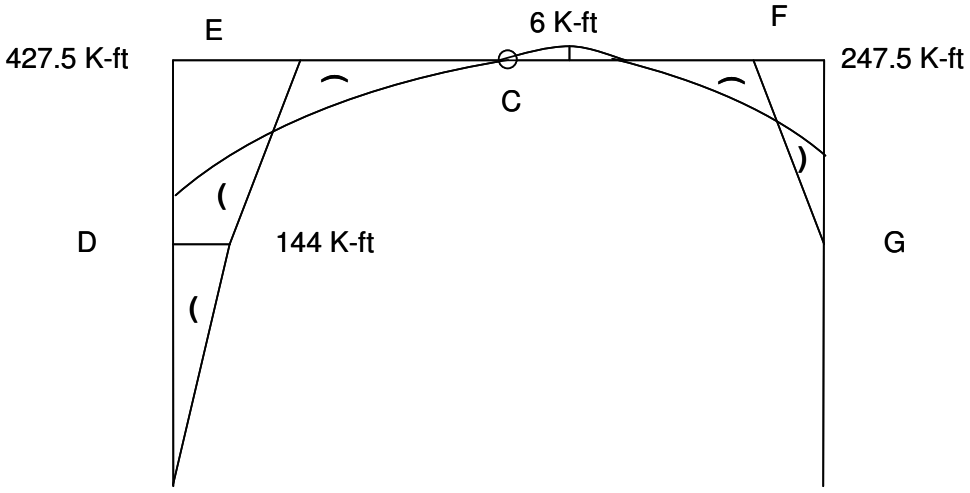
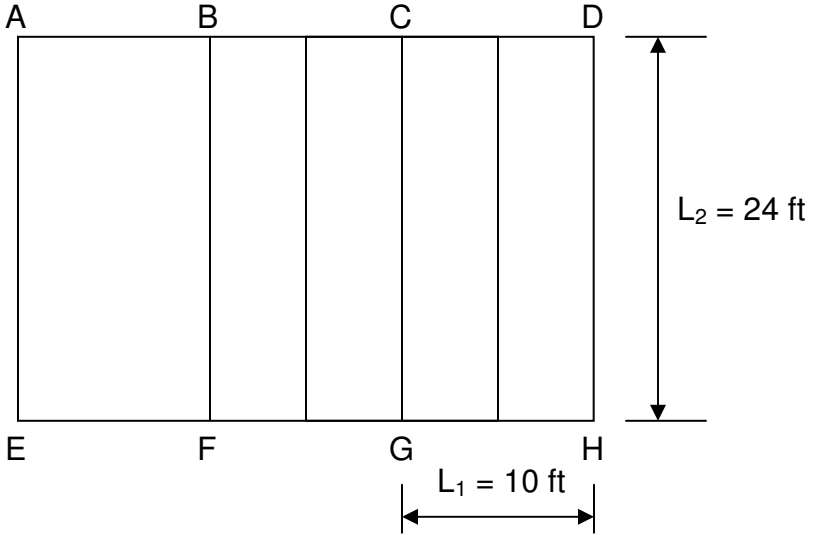
</table>

Bending Moment Diagram:



Solution 2



$\gamma_{concrete}$ = 150 lb/ft^3

γ_{steel} = 490 lb/ft^3

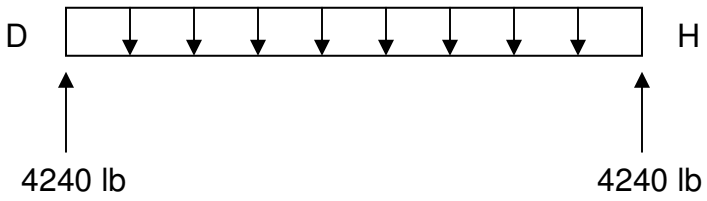
a) Beam DH:

Dead load from the slab = (150)(5/12)(5) = 312.5 lb/ft

Area of cross section of the beam = [(2)(4)(1)+(8)(0.5)]/144 = 1/12 ft^2

Self weight of the beam = 490/12 = 40.83 lb/ft

312.5 + 40.83 = 353.33 lb/ft



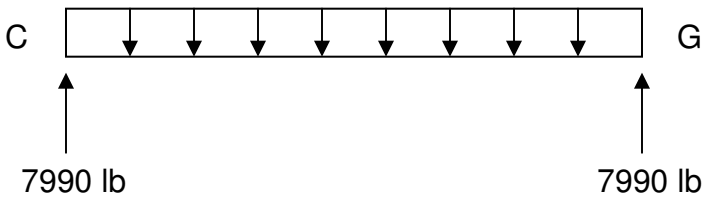
Beam CG:

Dead load from the slab = (150)(5/12)(10) = 625 lb/ft

Area of cross section of the beam = [(2)(4)(1)+(8)(0.5)]/144 = 1/12 ft^2

Self weight of the beam = 490/12 = 40.83 lb/ft

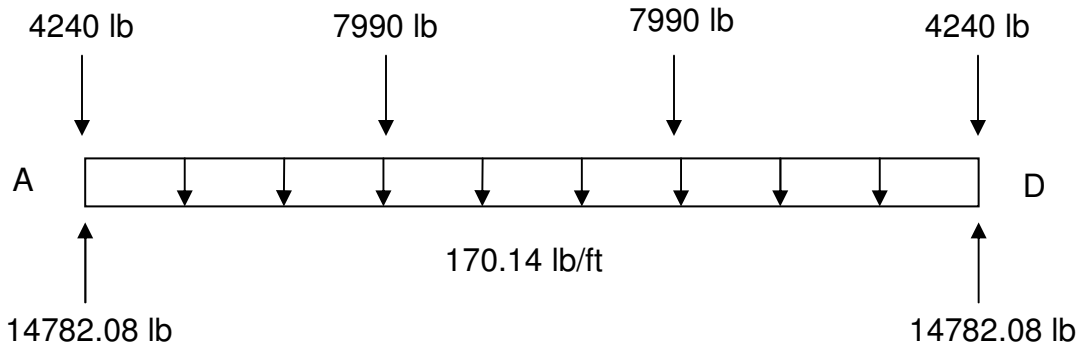
625 + 40.83 = 665.83 lb/ft



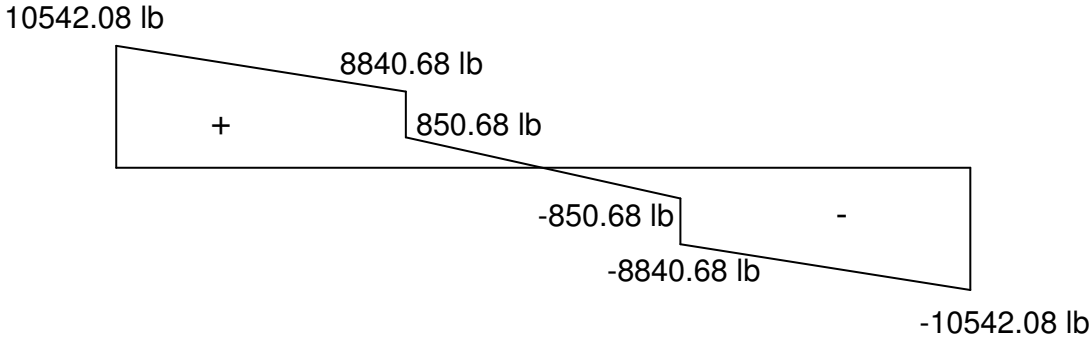
Girder ABCD:

Area of cross section of the beam = [(2)(8)(2)+(12)(1.5)]/144 = 0.347 ft^2

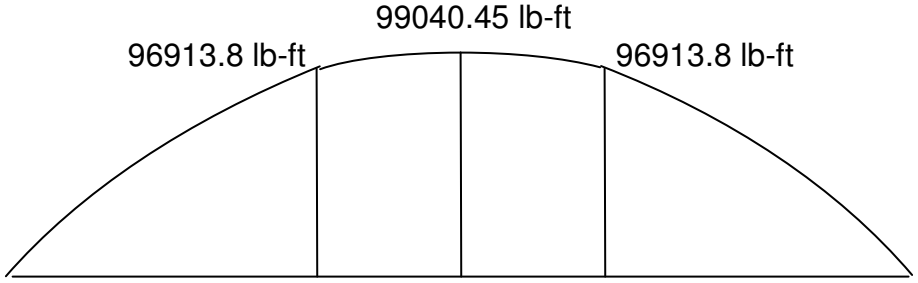
Self weight of the beam = 170.14 lb/ft



Shear Force Diagram:



Moment Diagram:



$I = 2[(1/12)(8)(2^3) + (16)(7^2)] + (1/12)(1.5)(12^3) = 1794.67 \text{ in}^4$

Maximum bending moment is in the center of the girder ABCD. It is 99.04 K-ft.

$\sigma = Mc/I = (99.04)(12)(8) / (1794.67) = 5.3$ ksi

Maximum shear is at the ends = 10.54 K, $v = VQ / Ib$

Shear stress at the joint (inside the flange): $v = (10.54)(16)(7)/(1794.67)(8) = 82.1$ psi

Shear stress at the joint (inside the web): $v = (10.54)(16)(7)/(1794.67)(1.5) = 438.5$ psi

Shear stress in center of web: $v = (10.54)[(16)(7)+(6)(1.5)(3)]/(1794.67)(1.5) = 544.2$ psi