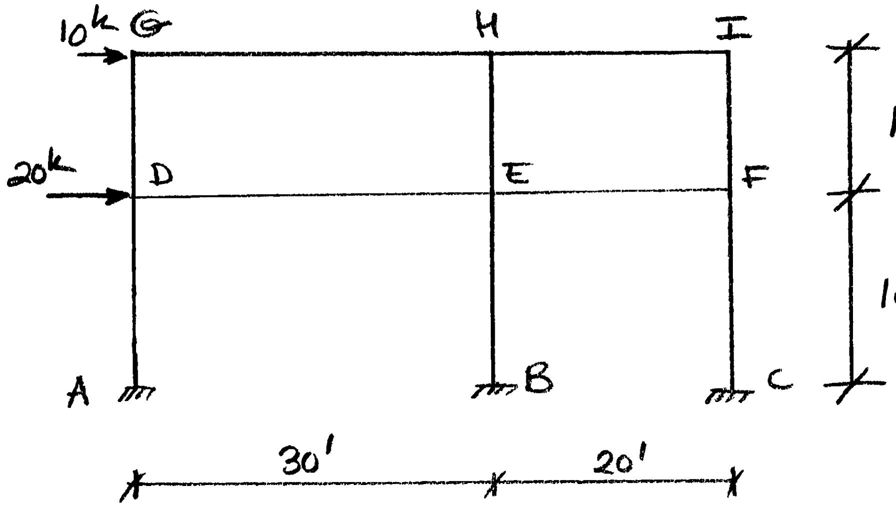
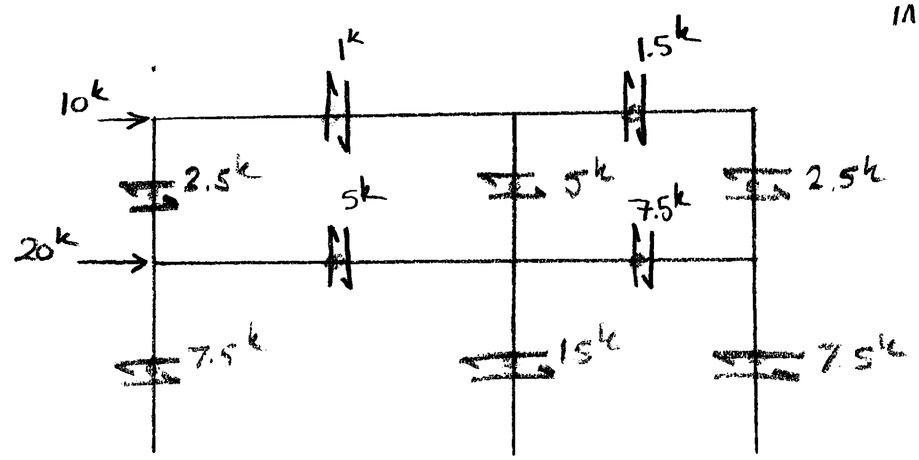
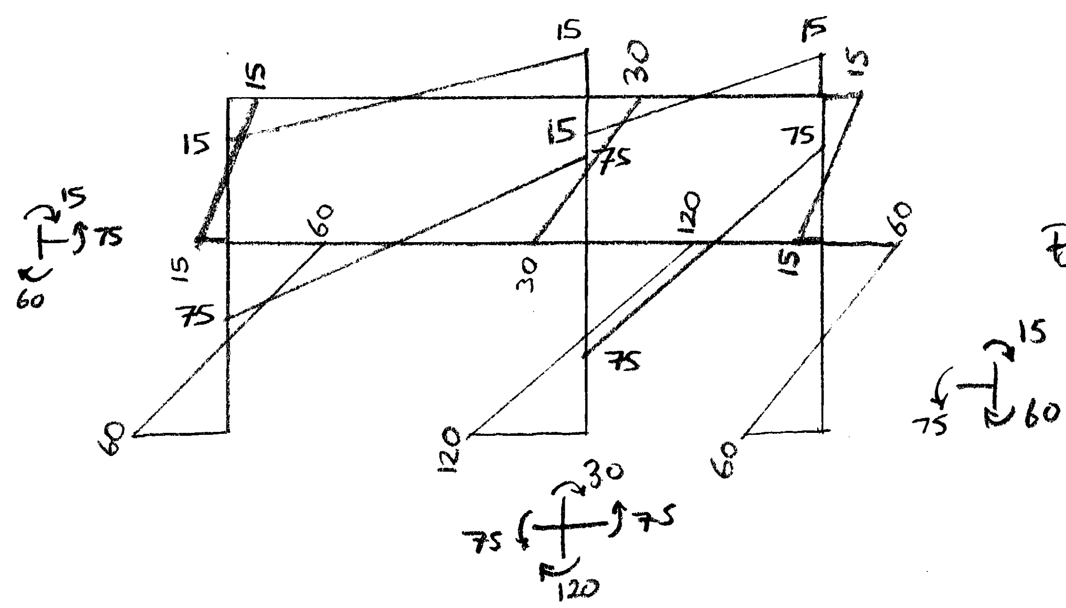
ex: Approx. analysis using portal method



inf. pts. @ mid-story ht in cols and mid-span in beams

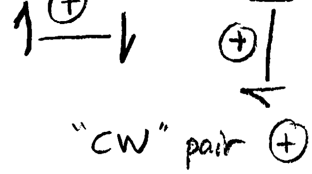


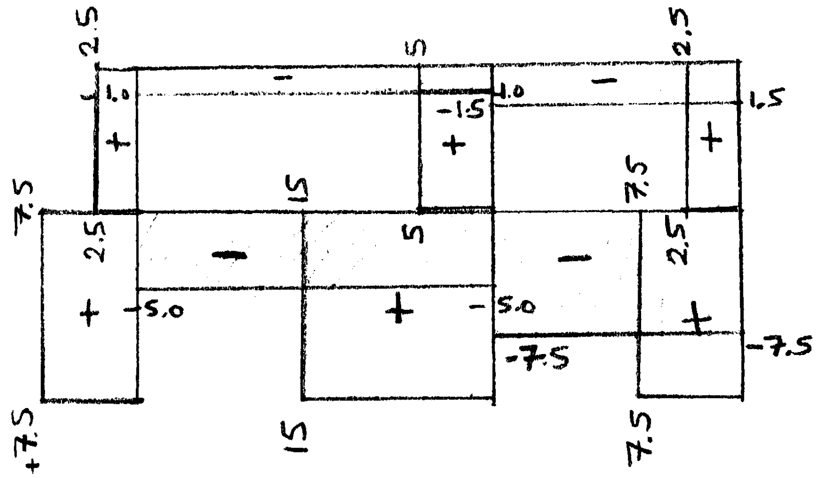
Shear force in columns & beams



Bending moment

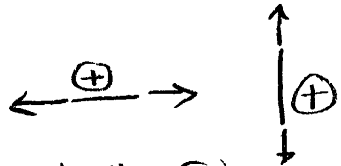
[M]

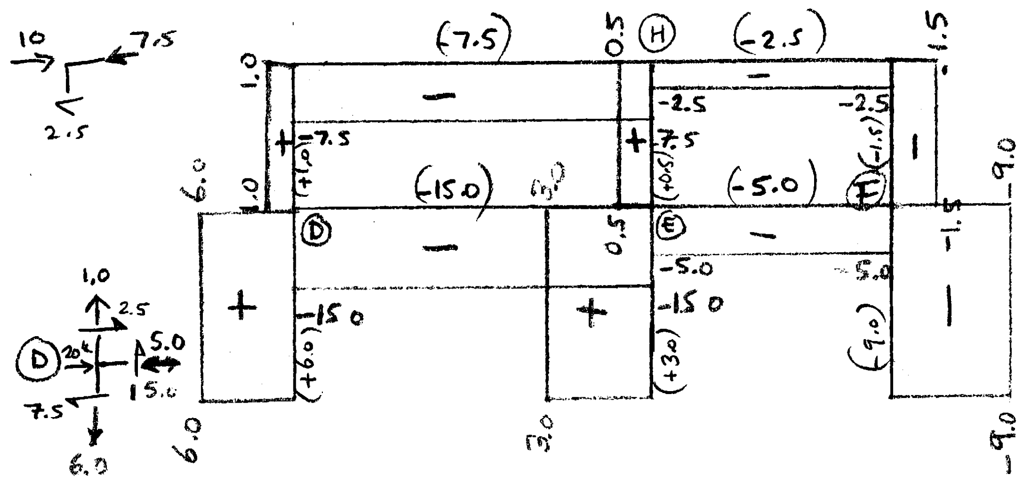




Shear force

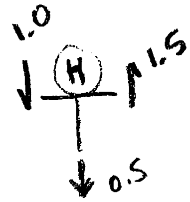
[V]



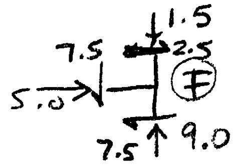


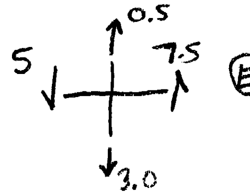
Axial force

[N]

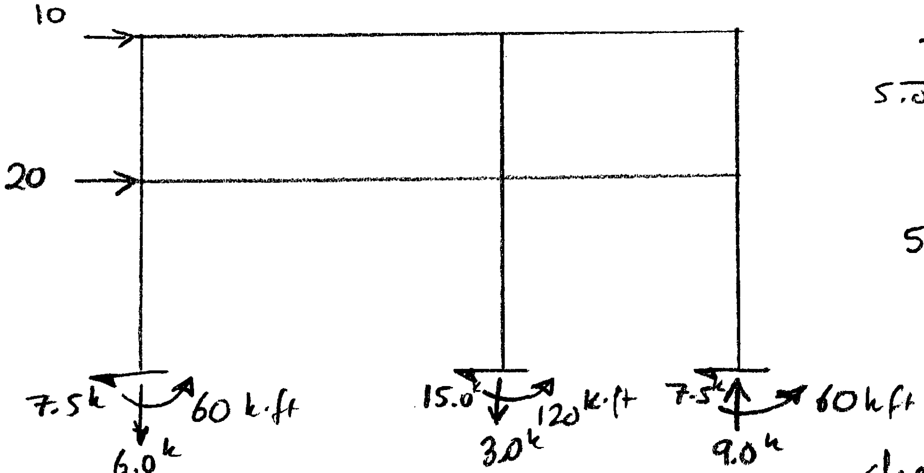


Jnt. H





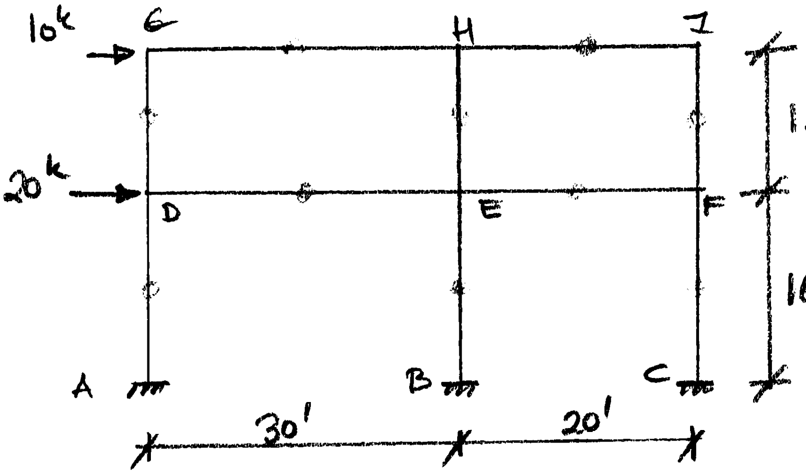
Reactions



check equilibrium

Satisfied!

ex: Approx. analysis using cantilever method



• assumed locations of inflection pnts

need to identify where the "neutral axis" is.
Assuming that the columns in a given story have the same cross-sectional area A_c

@ 2^{nd} story, @ the inf. pnt level (i.e., mid-story ht) there is an overturning moment of $10^k \times 6^{ft} = 60$ k·ft that needs to be resisted by columns thru axial forces

@ 1^{st}/ground story mid-story ht, the overturning moment is $10^k \times (12' + 8') + 20^k \times 8' = 360$ k·ft

The stress in each column is proportional to the distance from the centroid of the cross-sectional area of the column to the centroid of the cross-sectional areas of the columns at a given floor level.

location of the centroid of the cross-sectional areas of the columns at a given floor level from column line ADG

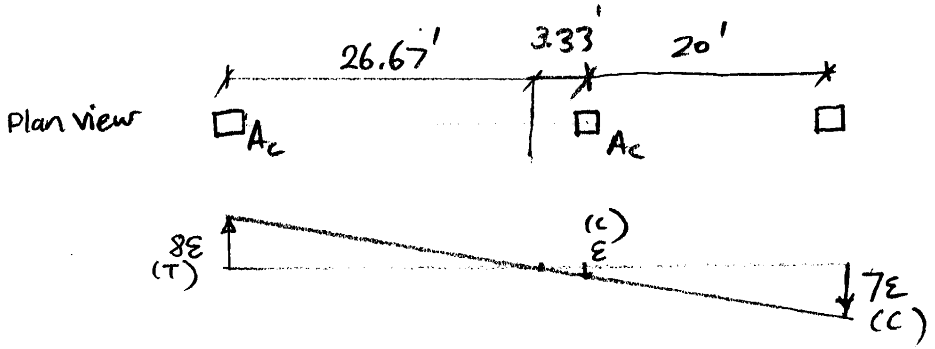
$$\bar{x} = \frac{A_c \cdot 0' + A_c \cdot 30' + A_c \cdot 50'}{\Sigma A_c} = \frac{80A_c}{3A_c} = 26.67'$$

$$I = (I_c + A_c \times 26.67^2) + (I_c + A_c \times 3.33^2) + (I_c + A_c \times 23.33^2)$$

$$I = \cancel{3I_c} + 1266.67\, A_c$$

negligible compared to $\Sigma A \cdot d_i^2$

$2' \times 2' \rightarrow I_c = \frac{1}{12} \cdot 2^4 =$
$\Rightarrow I_c = \frac{1}{3} A_c$



$$\varphi = \frac{M}{EI}$$

$$\varepsilon = \varphi \cdot y = \frac{M}{EI} y$$

$$\sigma = \varepsilon E = \frac{M}{I} y$$

$$F = \sigma \cdot A_c$$

$$\sigma_{DG} = \frac{M}{I} \times 26.67' = \frac{M}{1267 A_c} \times 26.67' = 8\sigma \ (T)$$

$$\sigma_{EH} = \frac{M}{I} \times 3.33' = \frac{M}{1267 A_c} \times 3.33' = \sigma \ (c)$$

$$\sigma_{FI} = \frac{M}{I} \times 23.33' = \frac{M}{1267 A_c} \times 23.33' = 7\sigma \ (c)$$

$$M_{overturning} = M_{resistance} = (8\sigma A_c)\, 26.67' + (\sigma \cdot A_c)\, 3.33' + (7\sigma \cdot A_c)\, 23.33'$$

$$M_{overturning} = 380\, \sigma A_c$$

@ 2^{nd} story $\quad 60\ k\cdot ft = 380\ \sigma A_c$

$$\sigma = \frac{0.158}{A_c}$$

$\sigma_{EH} = \dfrac{0.158}{A_c} \longrightarrow N_{EH} = 0.158\ k \quad (c)$

$\sigma_{FI} = \dfrac{1.105}{A_c} \longrightarrow N_{FI} = 1.105\ k \quad (c)$

$\sigma_{DG} = \dfrac{1.263}{A_c} \longrightarrow N_{DG} = 1.263\ k \quad (T)$

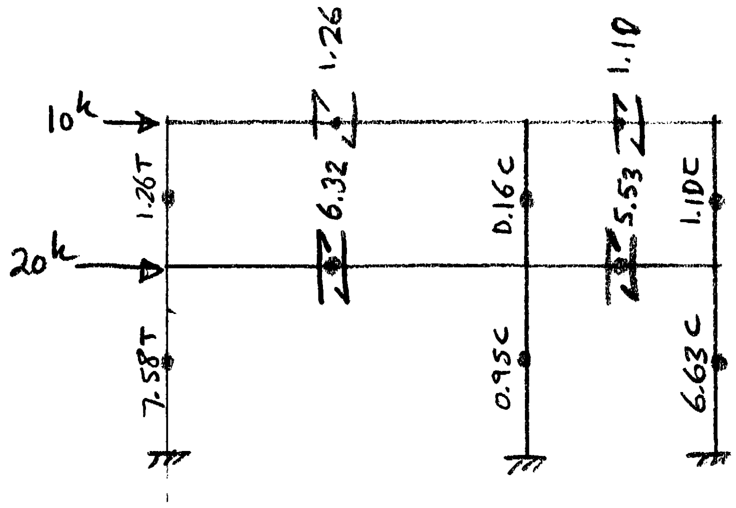
see net axial force is <u>Zero</u>

@ 1^{st} story $\quad 360\ k\cdot ft = 380\ \sigma A_c$

$\sigma_{BE} = \dfrac{0.158}{A_c} \times 6 = \dfrac{0.947}{A_c} \rightarrow N_{BE} = 0.947^k \quad (c)$

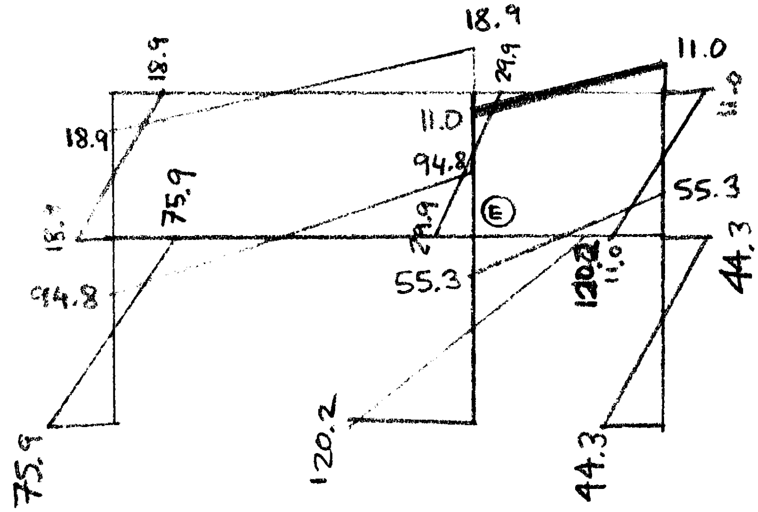
$\sigma_{CF} = \dfrac{1.105}{A_c} \times 6 = \dfrac{6.632}{A_c} \rightarrow N_{CF} = 6.632^k \quad (c)$

$\sigma_{AD} = \dfrac{1.263}{A_c} \times 6 = \dfrac{7.579}{A_c} \rightarrow N_{AD} = 7.579^k \quad (T)$

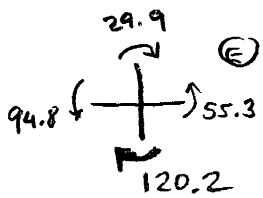


10k
20k
1.26T
7.58T
6.32
1.26
0.16C
0.95C
5.53
1.10
1.10C
6.63C

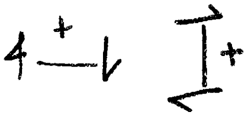
[M]



18.9
18.9
18.9
11.0
29.9
11.0
94.8
75.9
55.3
55.3
94.8
120.2
44.3
75.9
120.2
44.3
E

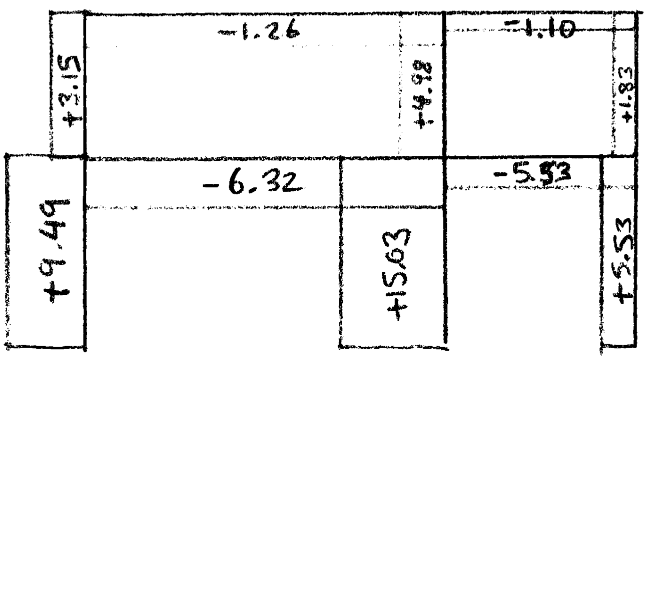


29.9
E
94.8
55.3
120.2



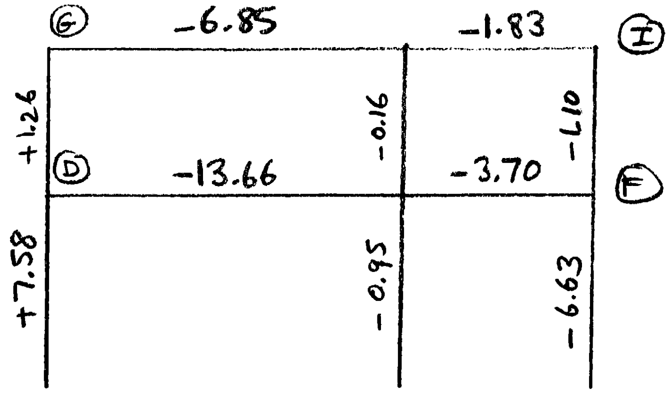
+
+

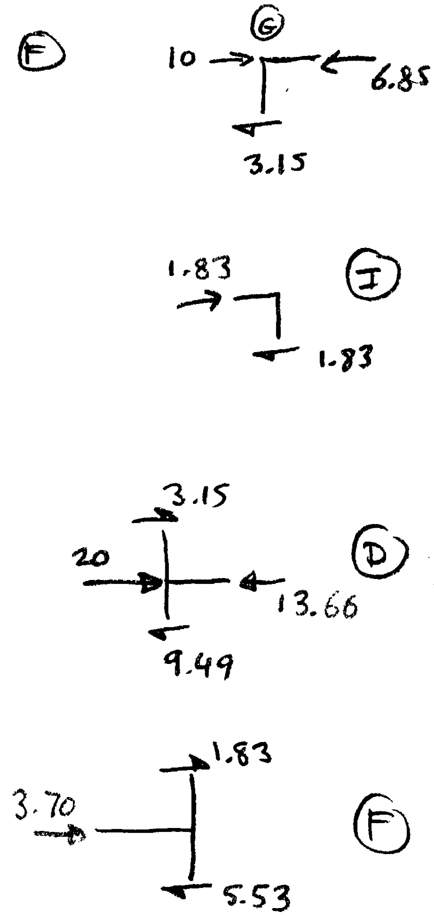
[V]



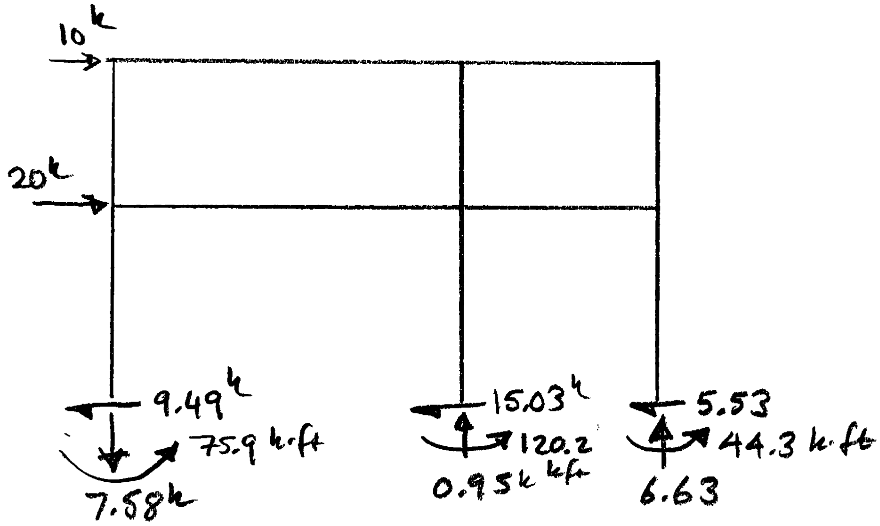
-1.26
-1.10
+3.15
+4.98
+1.83
-6.32
-5.53
+9.49
+15.63
+5.53

[N]





Reactions



check equilibrium.
satisfied! (within tolerance of numerical errors)