Cantilever Method

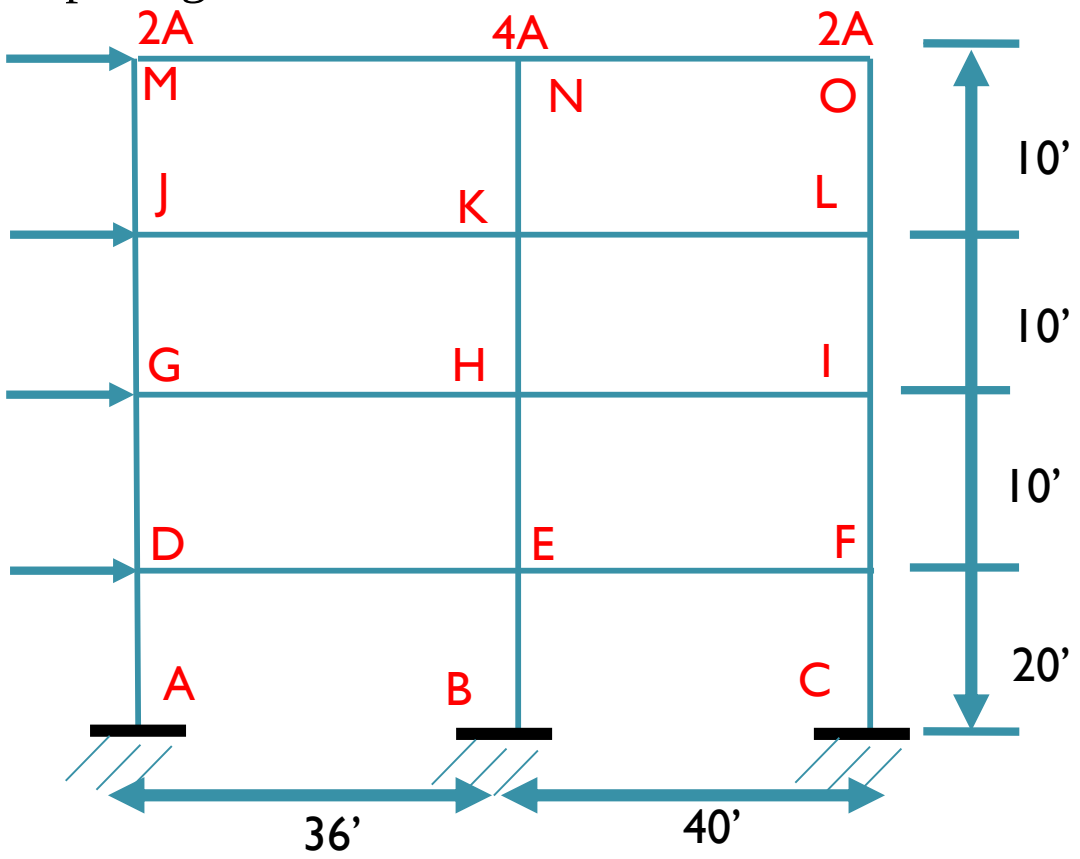
- The results using the Portal Method are reasonable in most cases, the method suffers due to the **lack of consideration** given to the variation of **structural response** due to the difference between sectional properties of various members. The Cantilever Method attempts to rectify this limitation by considering the **cross-sectional areas of columns** in distributing the axial forces in various columns of a story.

Assumption

1. The axial force in each column of a storey is proportional to its horizontal distance from the C.G. of all the columns of the storey.
2. There is a point of inflection at the center of each column.
3. There is a point of inflection at the center of each beam.

Structural Analysis & Design I

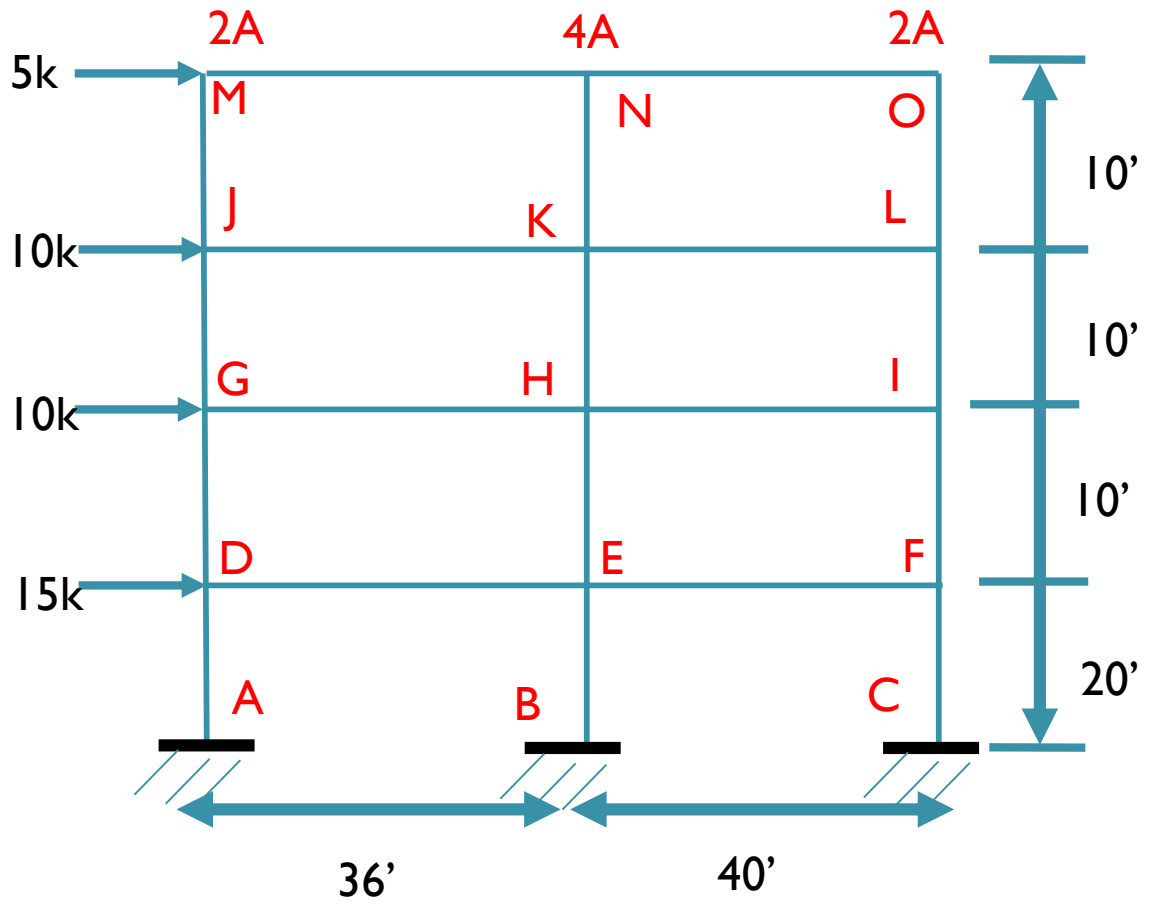
- Use the **Cantilever Method** to draw the axial force, shear force and bending moment diagrams of the four -storied frame structure loaded as shown below : where wind pressure is 40 psf and frame spacing are 25’ C/C.



Structural Analysis & Design I

Sol : D of I

- Wind pressure 40 psf and C/C column spacing 25 ft.
  Load on each column= (40x25)/1000= 1K/ft

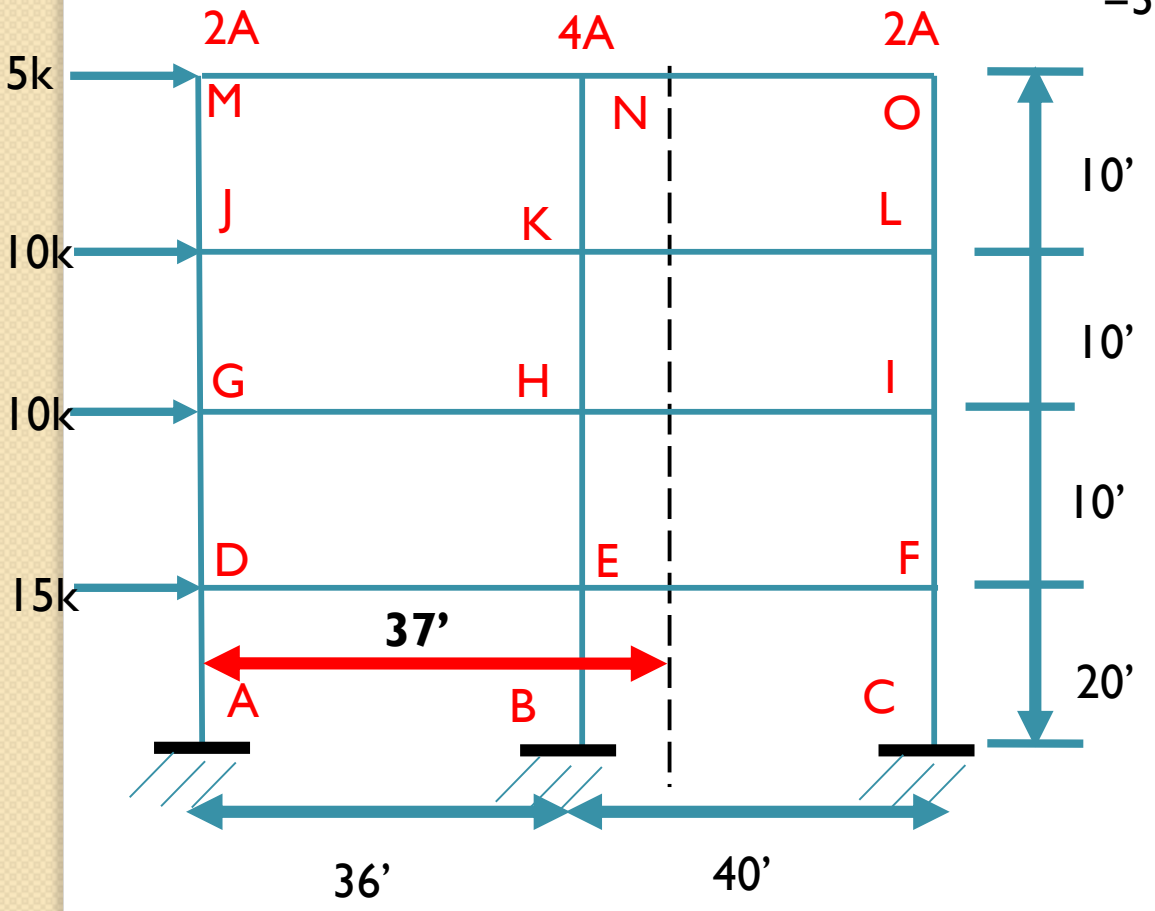


Structural Analysis & Design I

- Determine the distance of c g:

$$x = \frac{(2A*0+4A*36+2A*76)}{(2A+4A+2A)}$$

$$= 37'$$



From assumption-1
Stress proportional to distance of column to cg

$6 \propto y$

$=> 6 = k*y = (M*y)/I$

Structural Analysis & Design I

$I = \sum A d^2$

$= 2 * A * 37^2 + 4A * (37 - 36)^2 + 2A * (37 - 76)^2$

$= 5784 * A$

$6 \propto y$

$\Rightarrow 6 = k * y = (M * y)/I$

Left column $= \frac{M * 37 * 2A}{5784A}$

$= 0.0128M$ (**LC**)

Middle column $= \frac{M * (37 - 36) * 4A}{I}$

$= 0.000692M$ (**MC**)

Right column $= \frac{M * (37 - 76) * 2A}{I}$

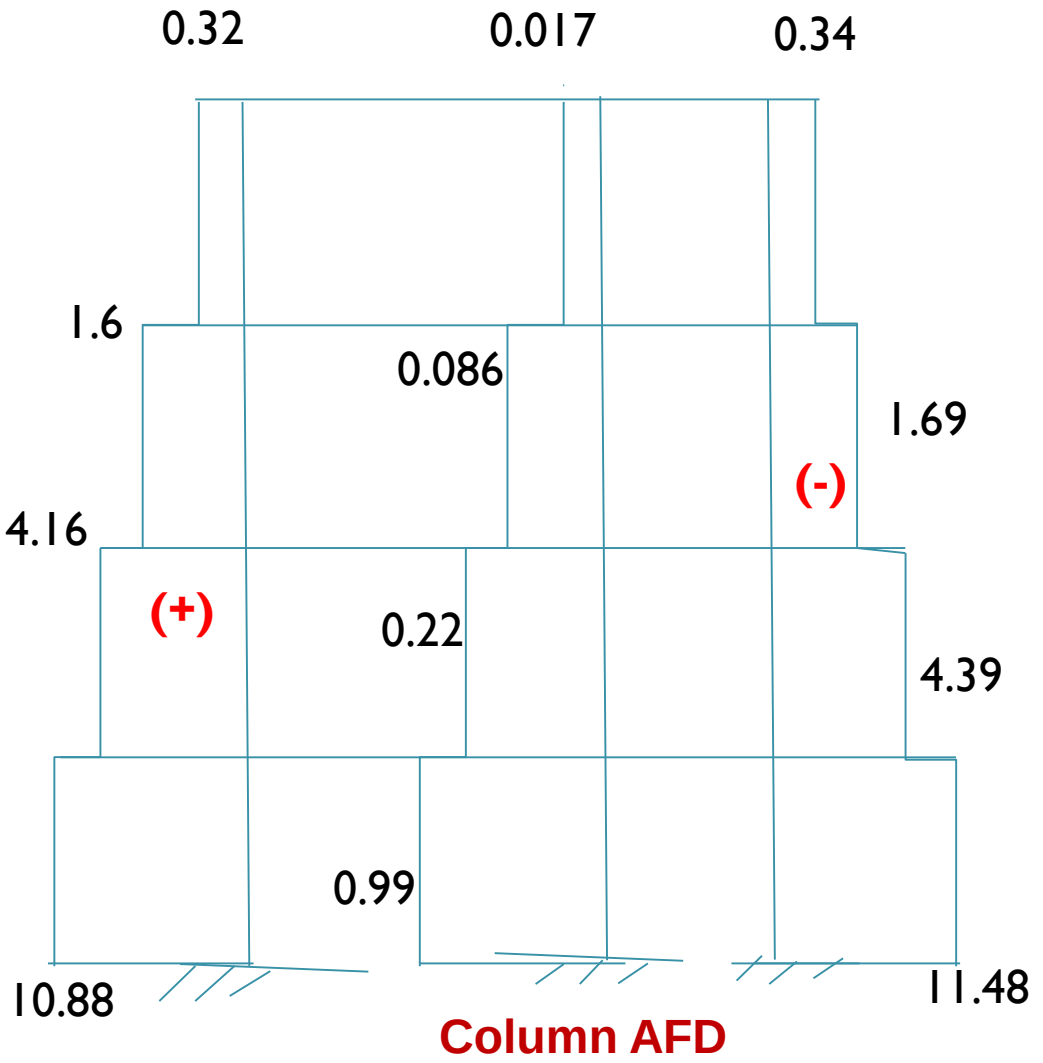
$= -0.0135M$ (**RC**)

Structural Analysis & Design I

Floor	Moment (k-ft)	AF (kip)		
		LC	MC	RC
3rd	5*5=25	0.32	0.017	-0.34
2nd	5*15+10*5 =125	1.6	0.086	-1.69
1st	5*25+10*15 +10*5=325	4.16	0.22	-4.39
GF	5*40+10*30 +10*20+15 *10=850	10.88	0.59	-11.48

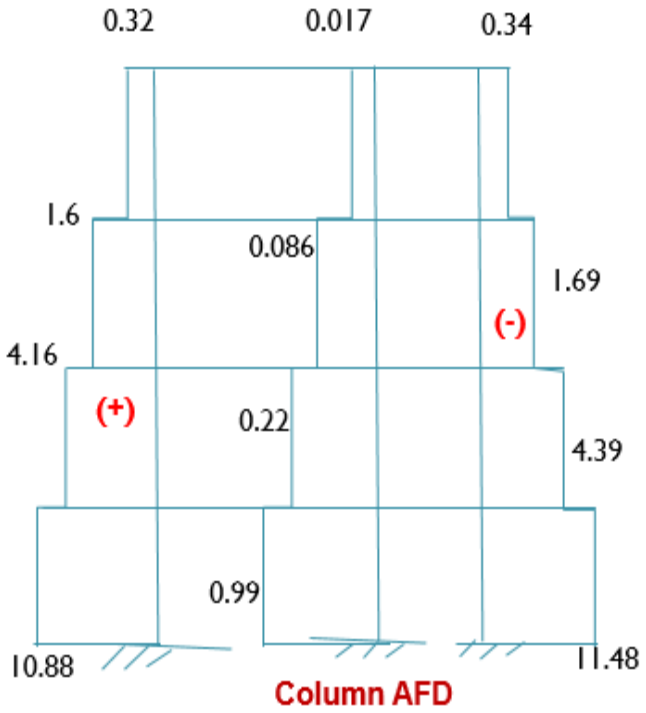
Structural Analysis & Design I

	AF	
LC	MC	RC
0.320	0.017	-0.34
1.6	0.086	-1.69
4.16	0.22	-4.39
10.88	0.59	-11.48

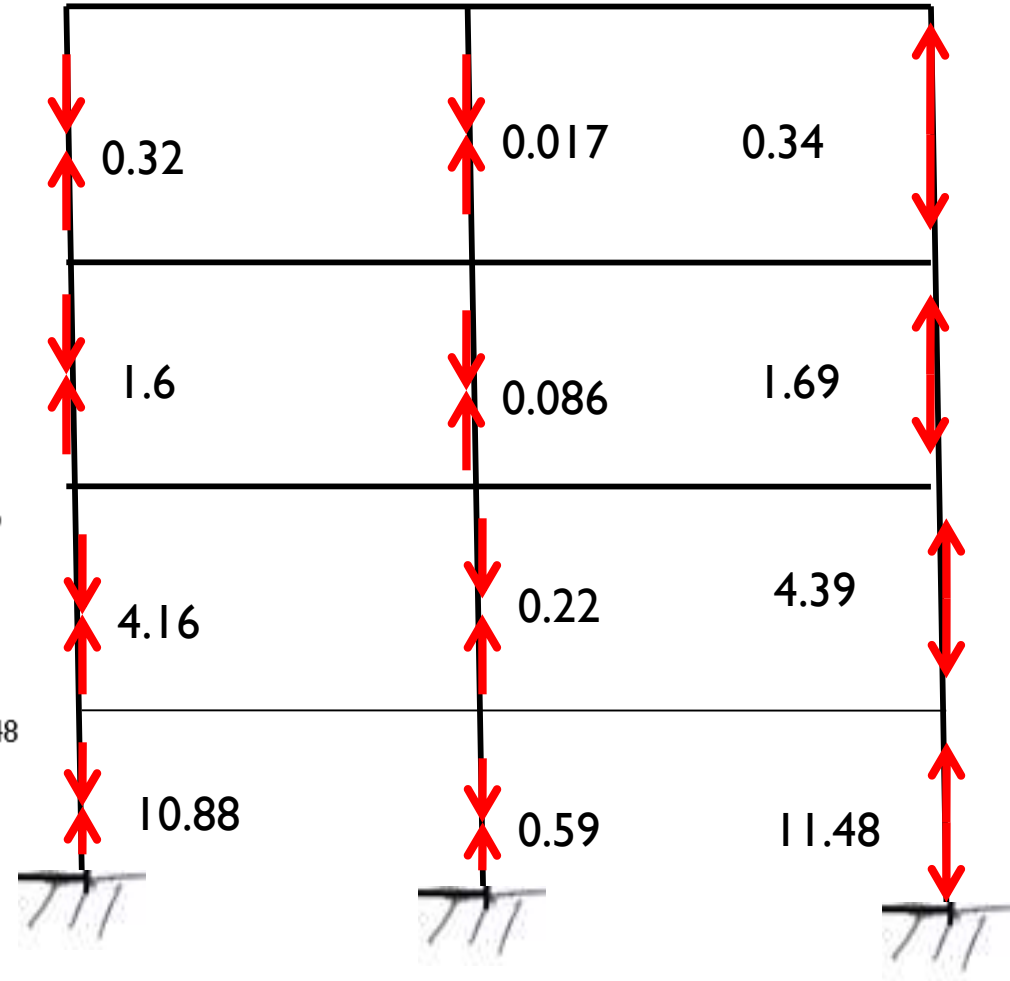


Column AFD

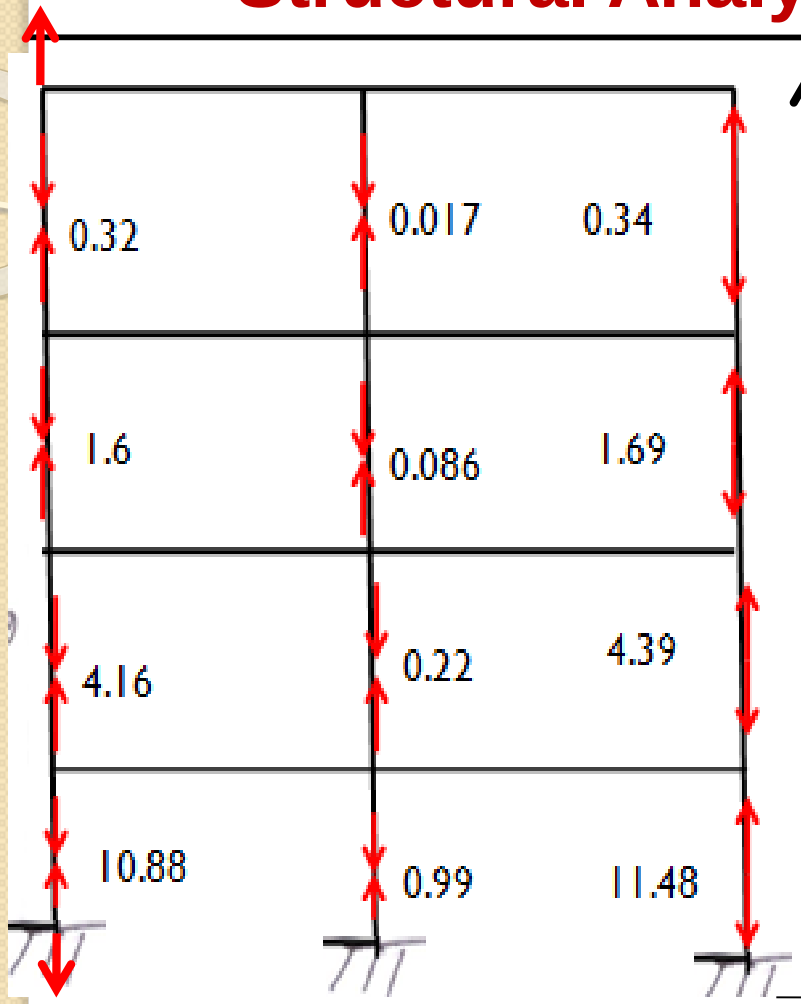
Structural Analysis & Design I

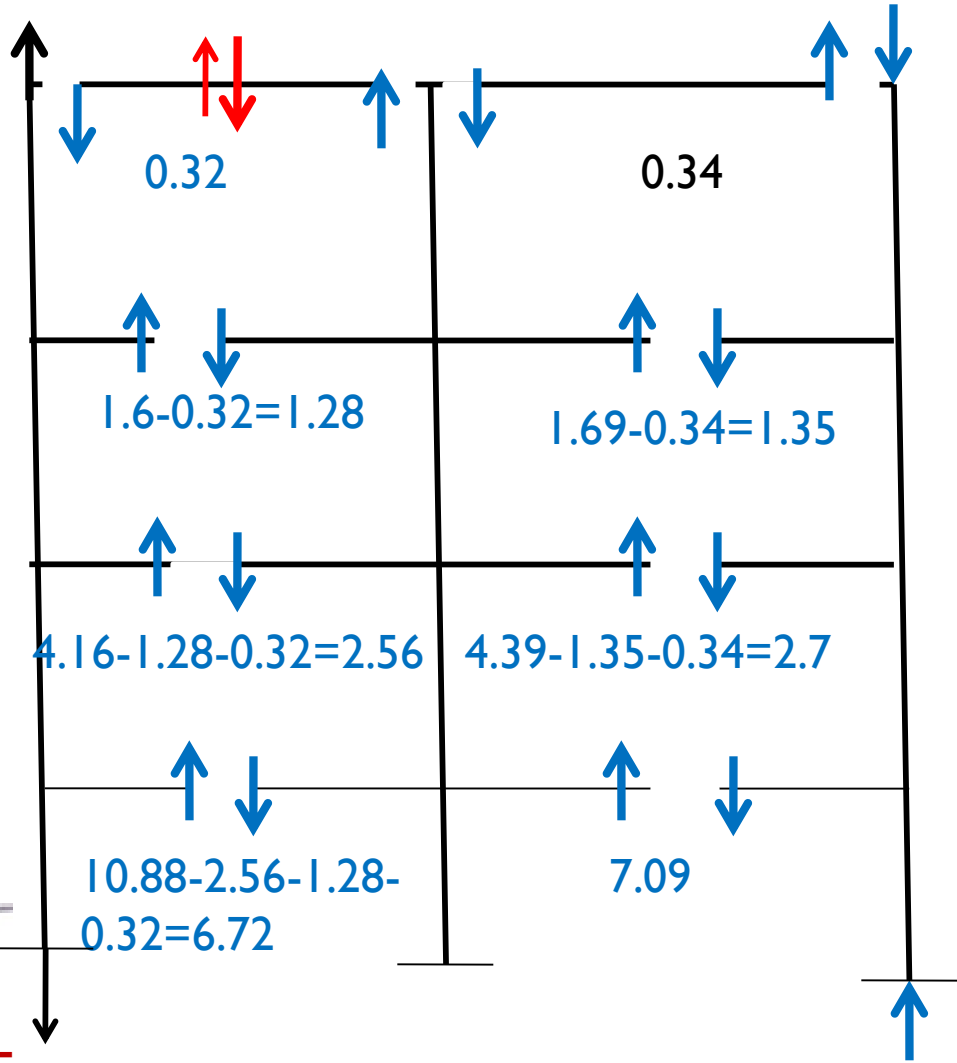


Column AFD



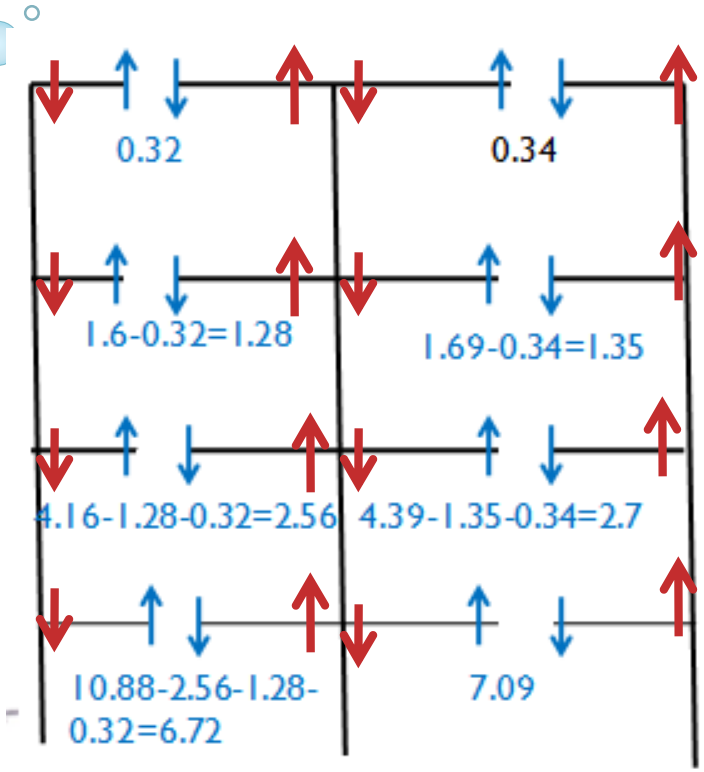
Structural Analysis & Design I

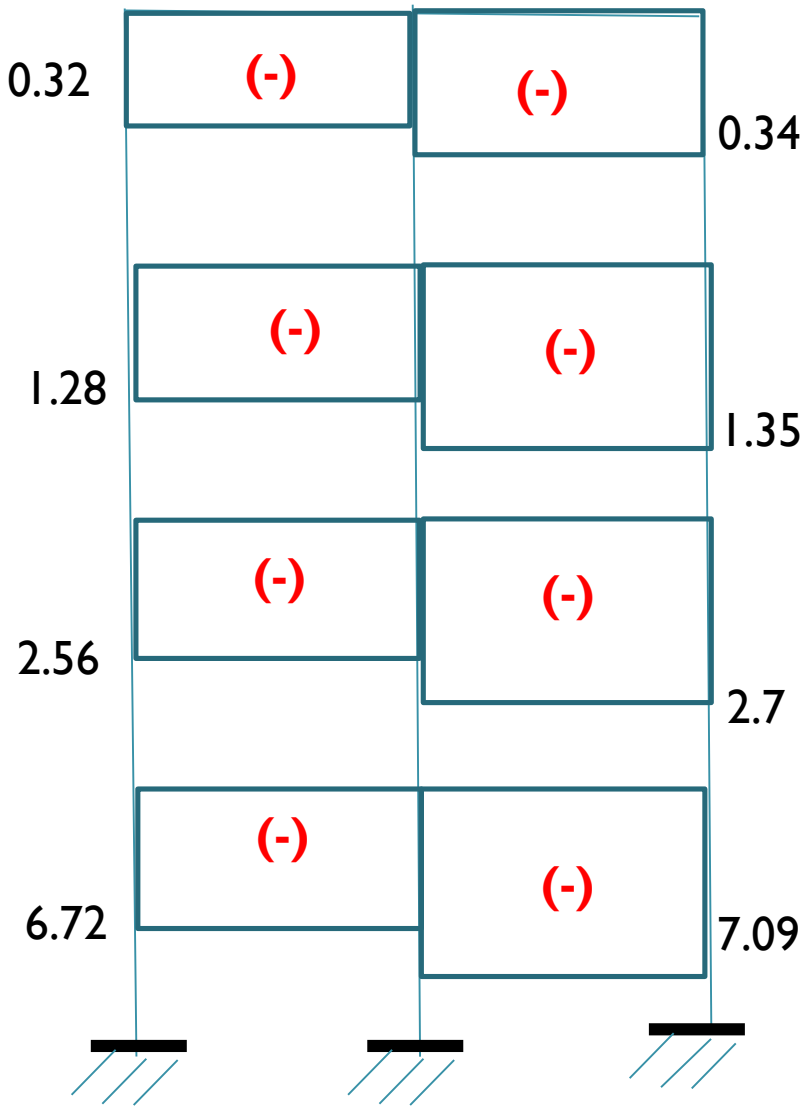




Beam SF

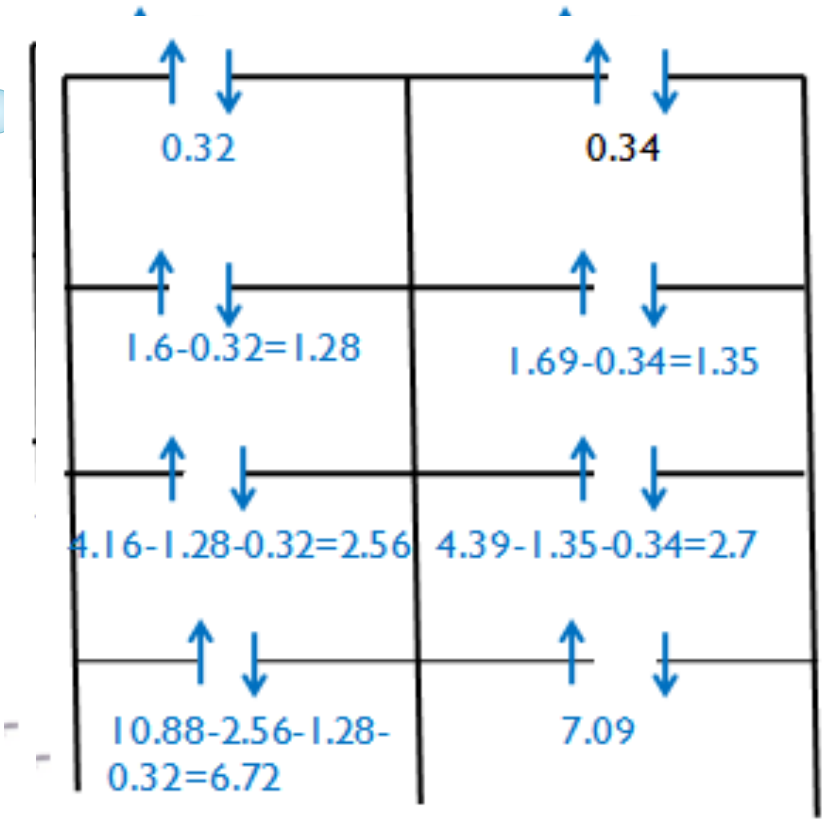
Structural Analysis & Design I





Beam SFD

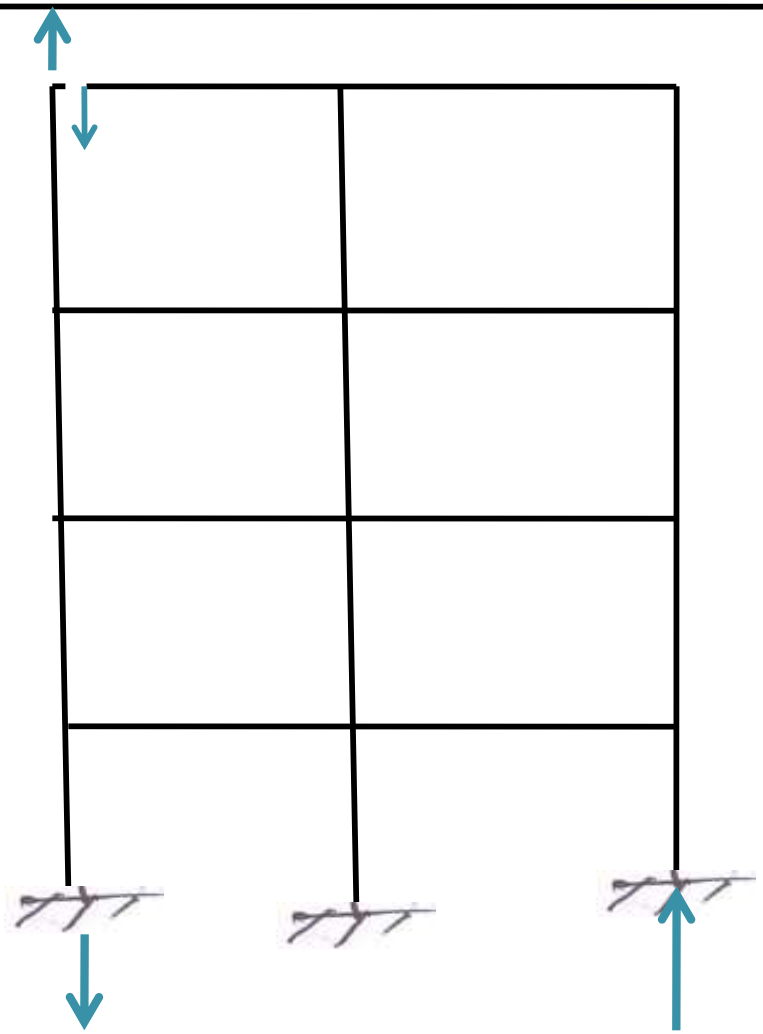
Structural Analysis & Design I



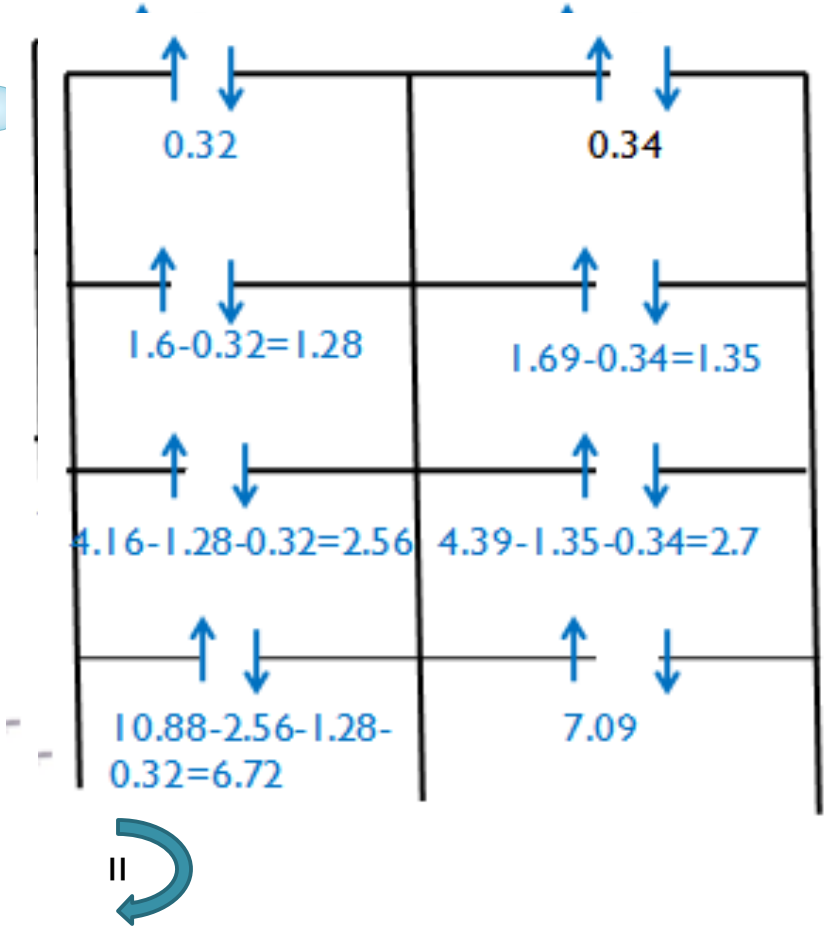
+

Mm -0.32x18=0

Mm= 5.76

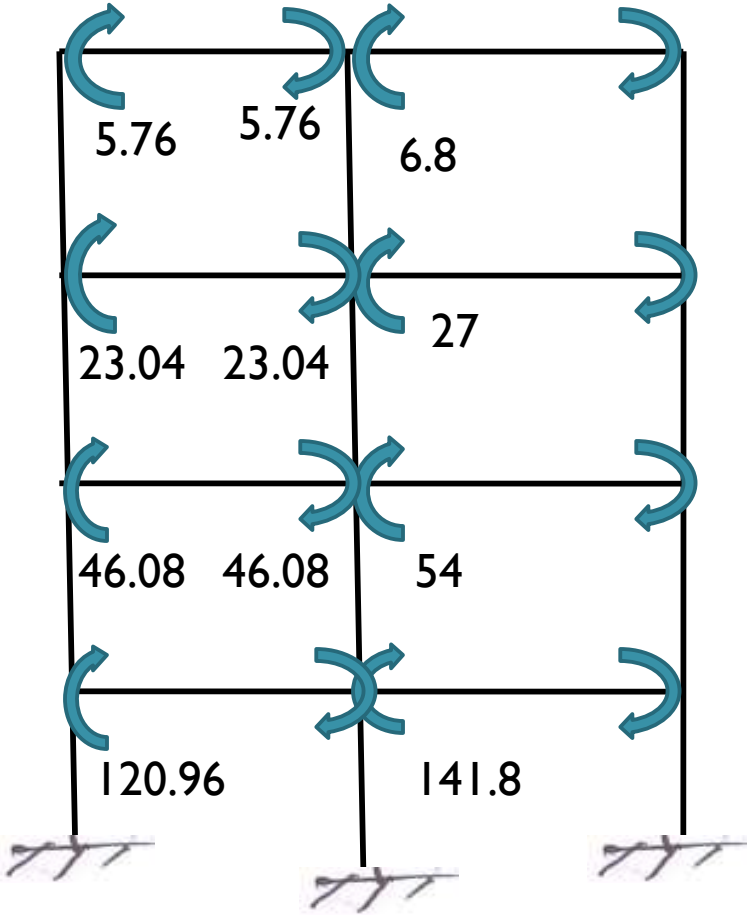


Structural Analysis & Design I



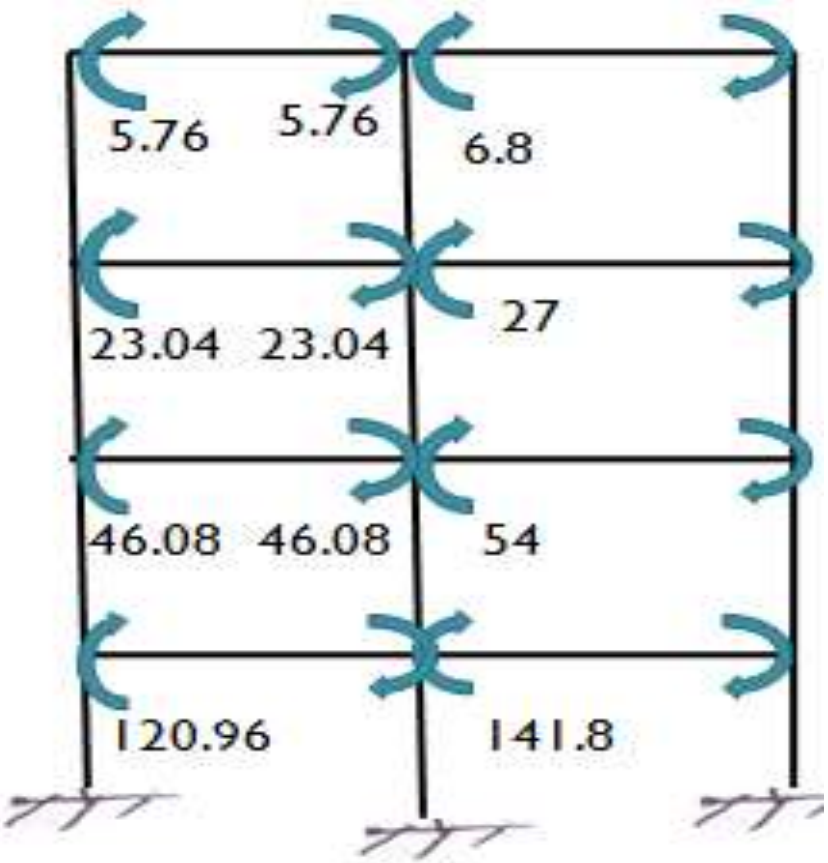
Mm -0.32x18=0

Mm= 5.76

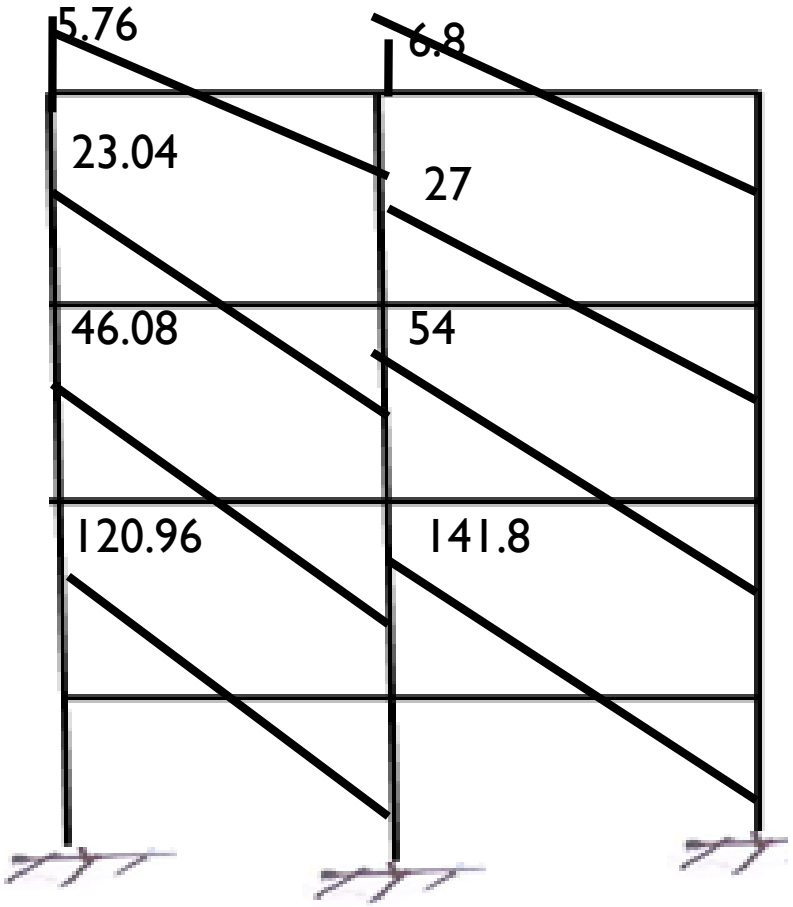


Beam Moment

Structural Analysis & Design I

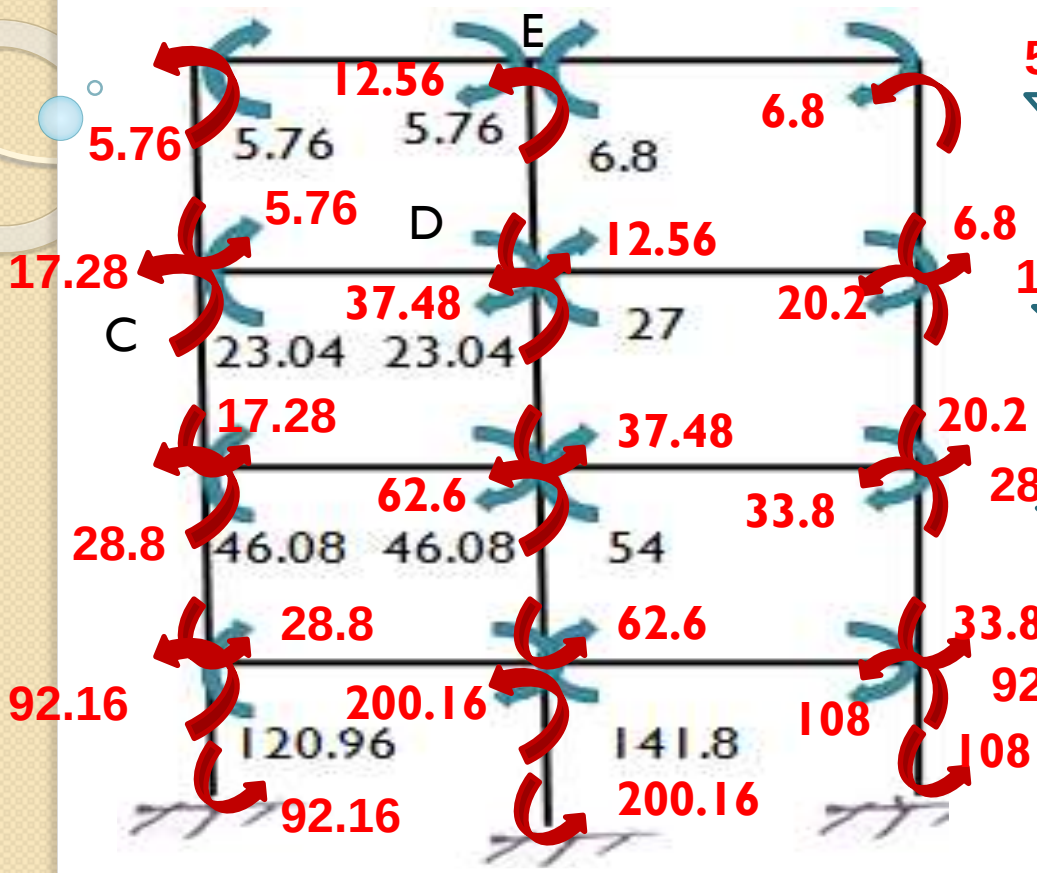


Beam Moment

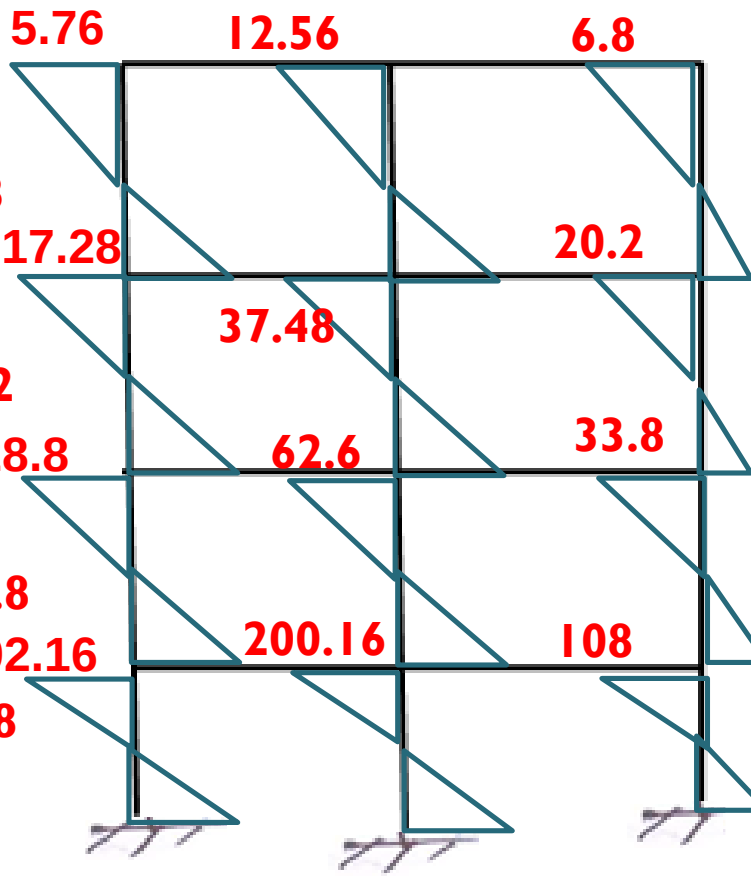


Beam BMD

Structural Analysis & Design I



Column BM

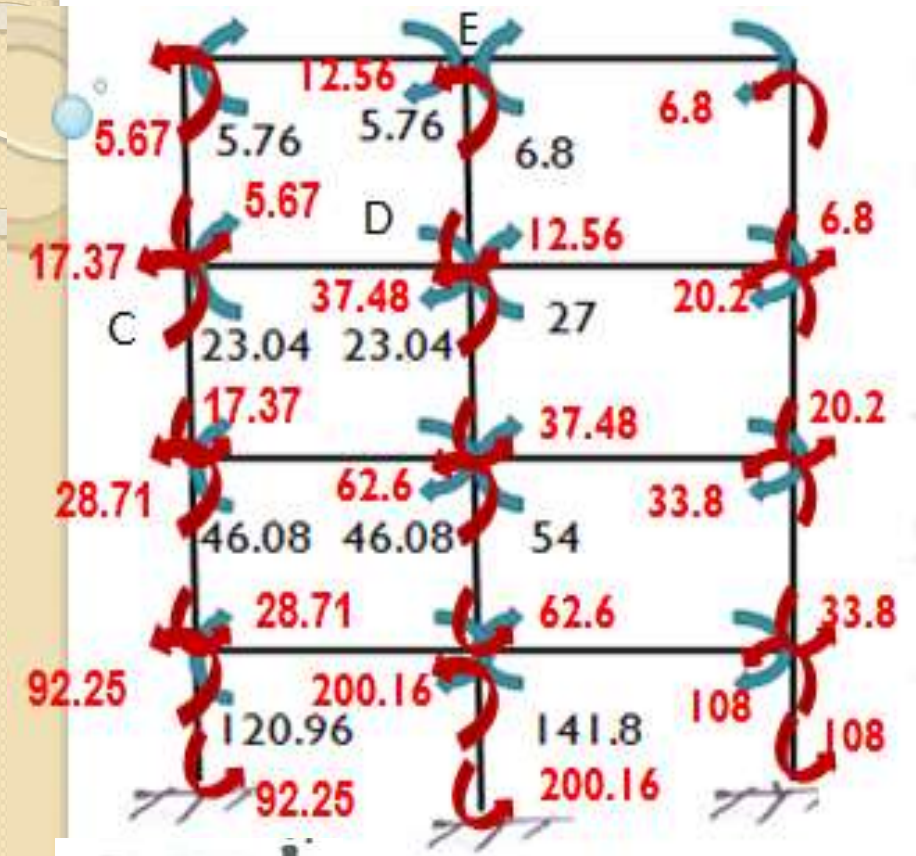


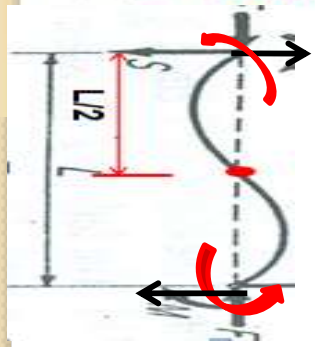
Column BMD

MC=23.04-5.56=17.37, ME =5.76+6.8=12.56

MD=23.04+27-12.56=37.48

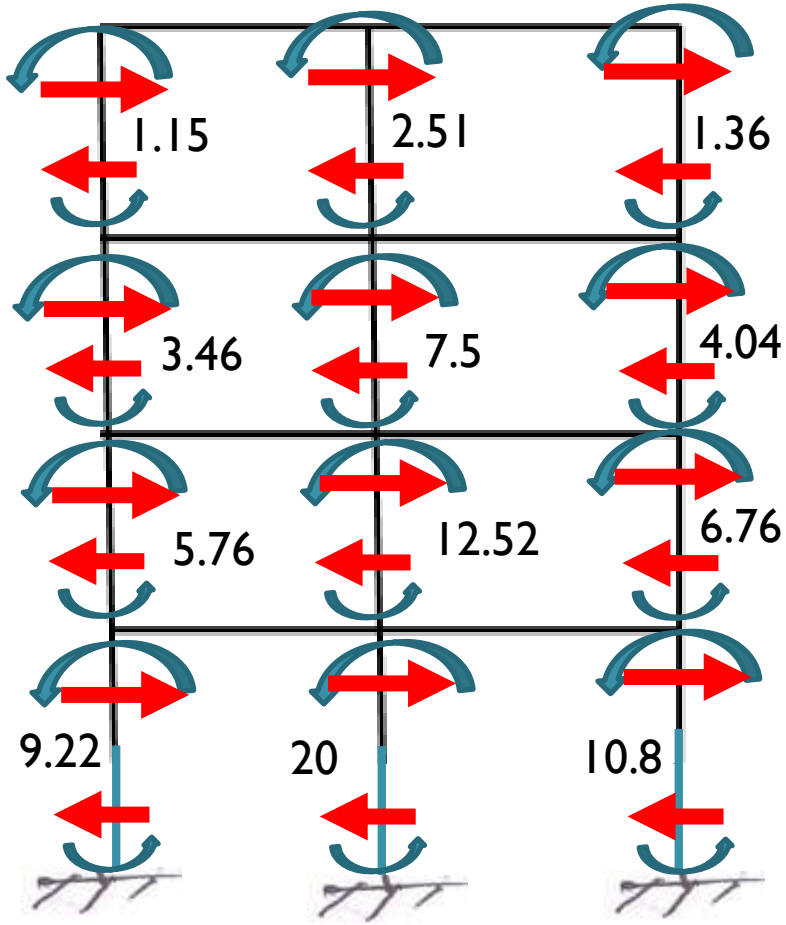
Structural Analysis & Design I





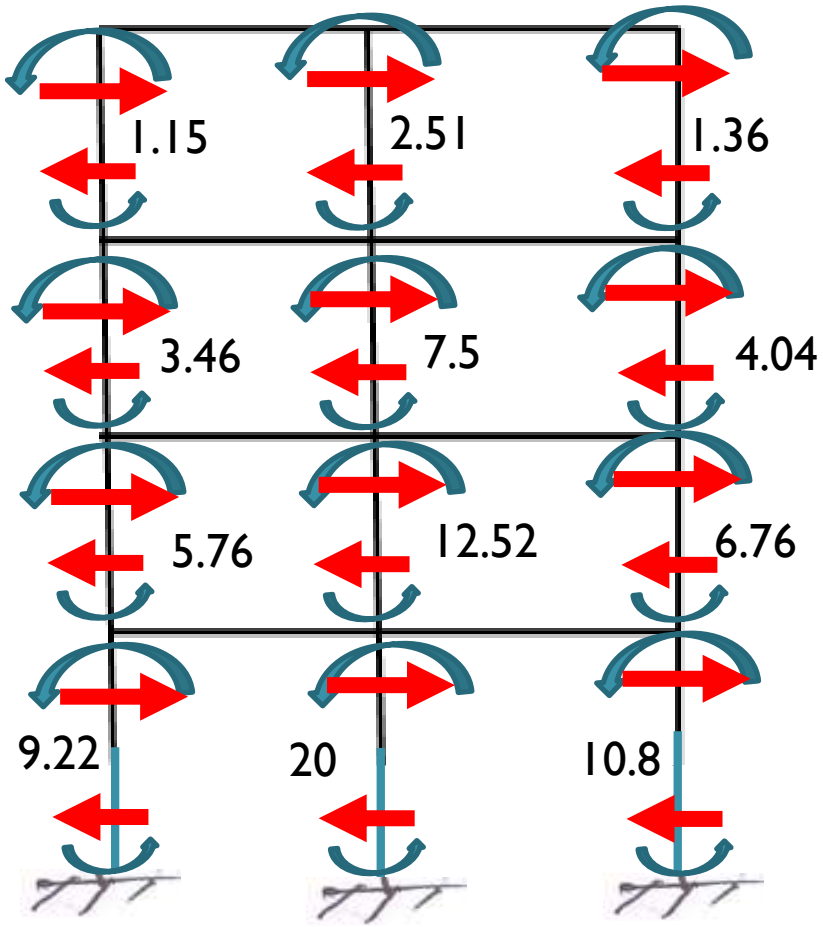
Column BM

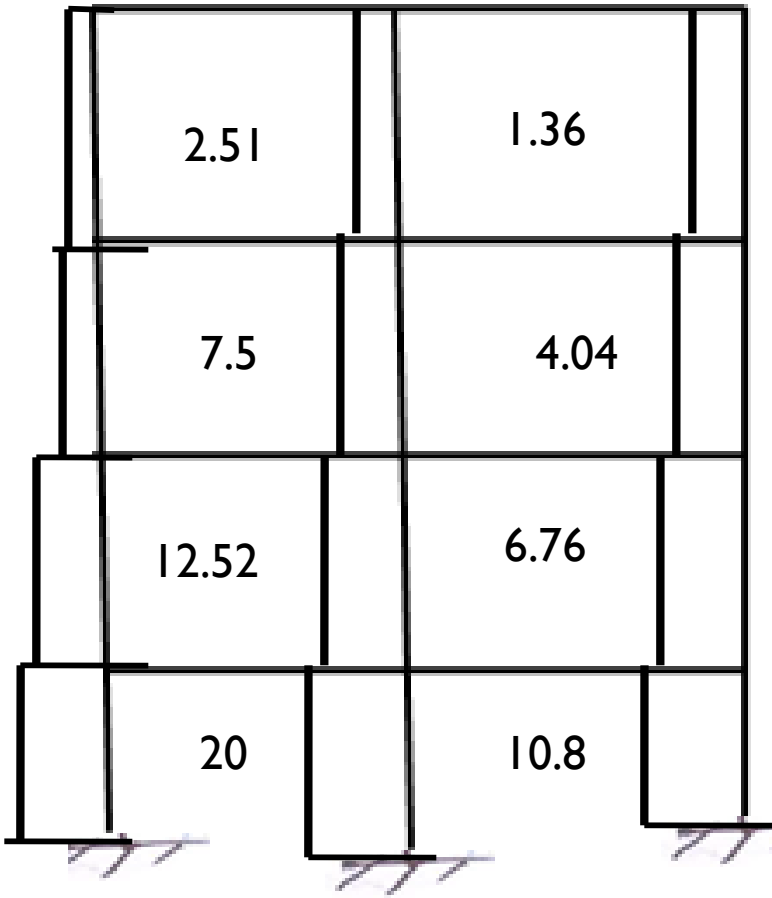
S=2*5.67/10= 1.15



Column SF

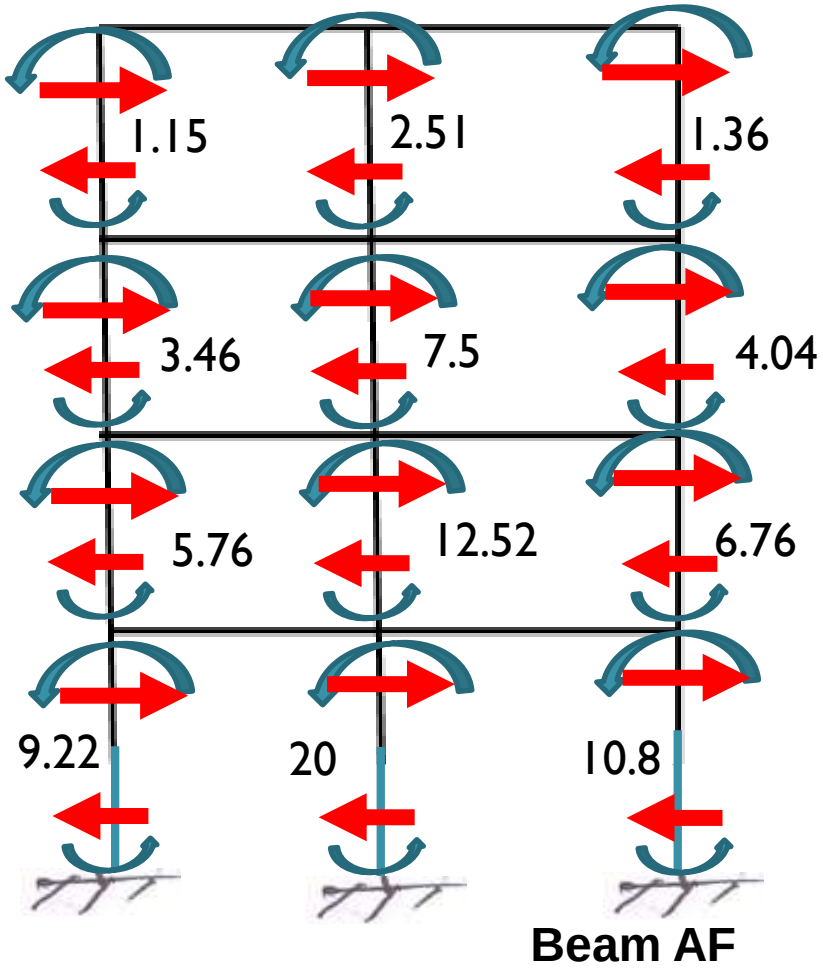
Structural Analysis & Design I



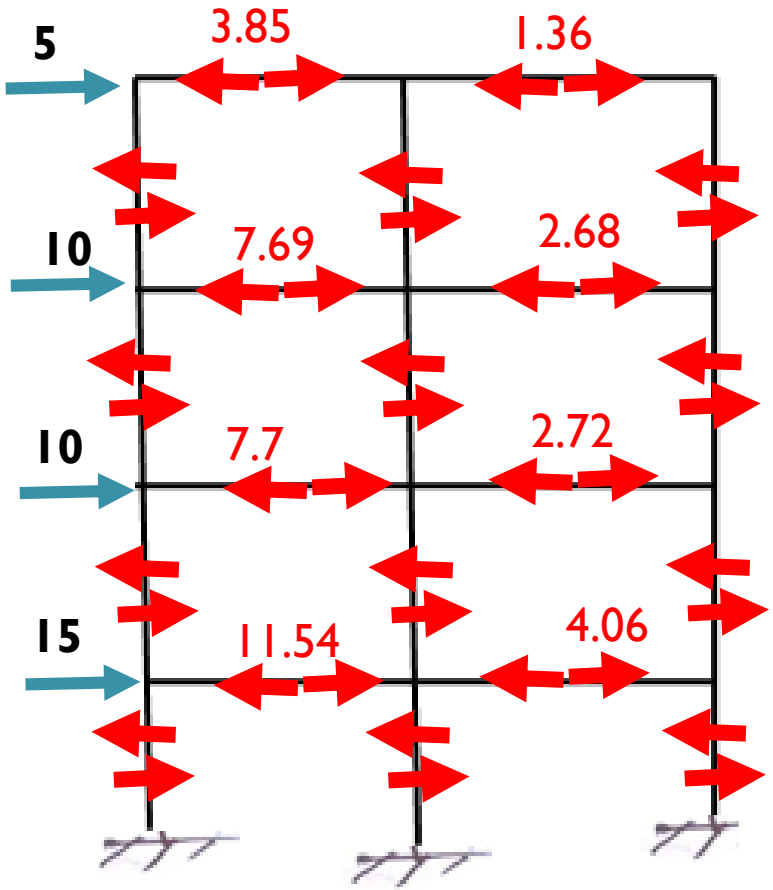


Column SFD

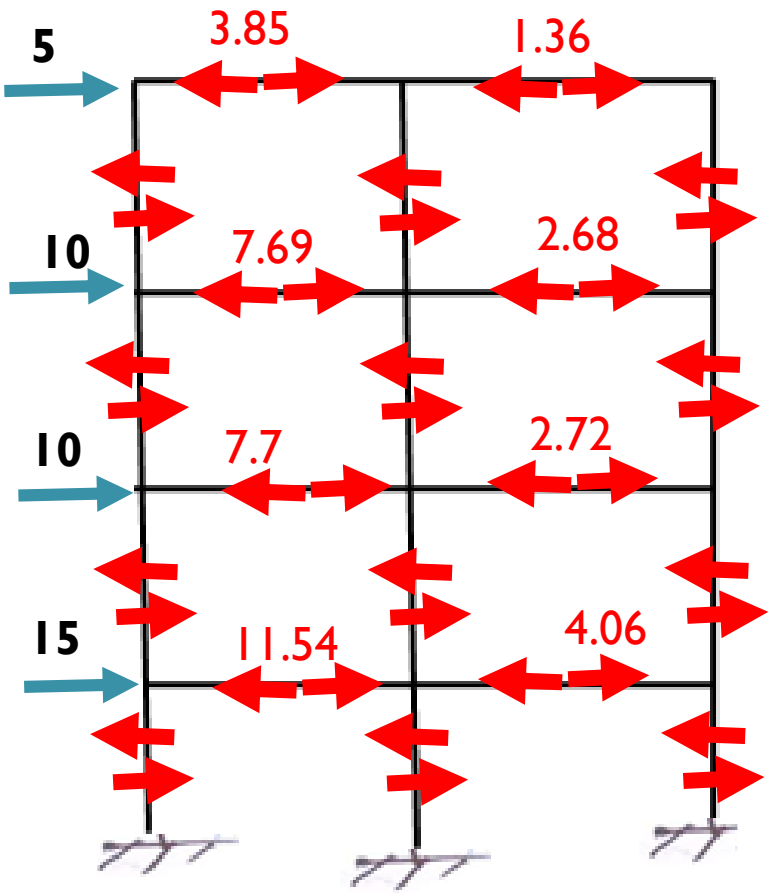
Structural Analysis & Design I

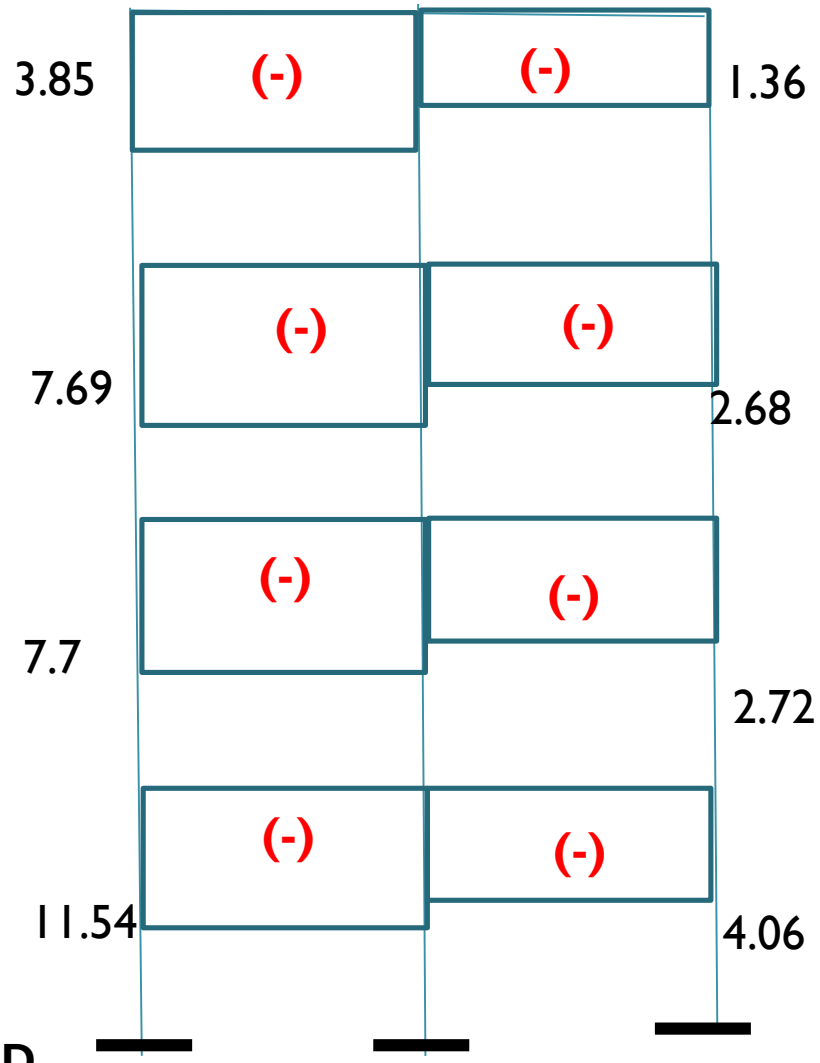


Beam AF



Structural Analysis & Design I





Beam AFD

Structural Analysis & Design I

Order of analysis

Column A.F.D (From Assumption)

↓

Beam S.F.D

↓

Beam B.M.D

↓

Column BMD

↓

Column S.F.D

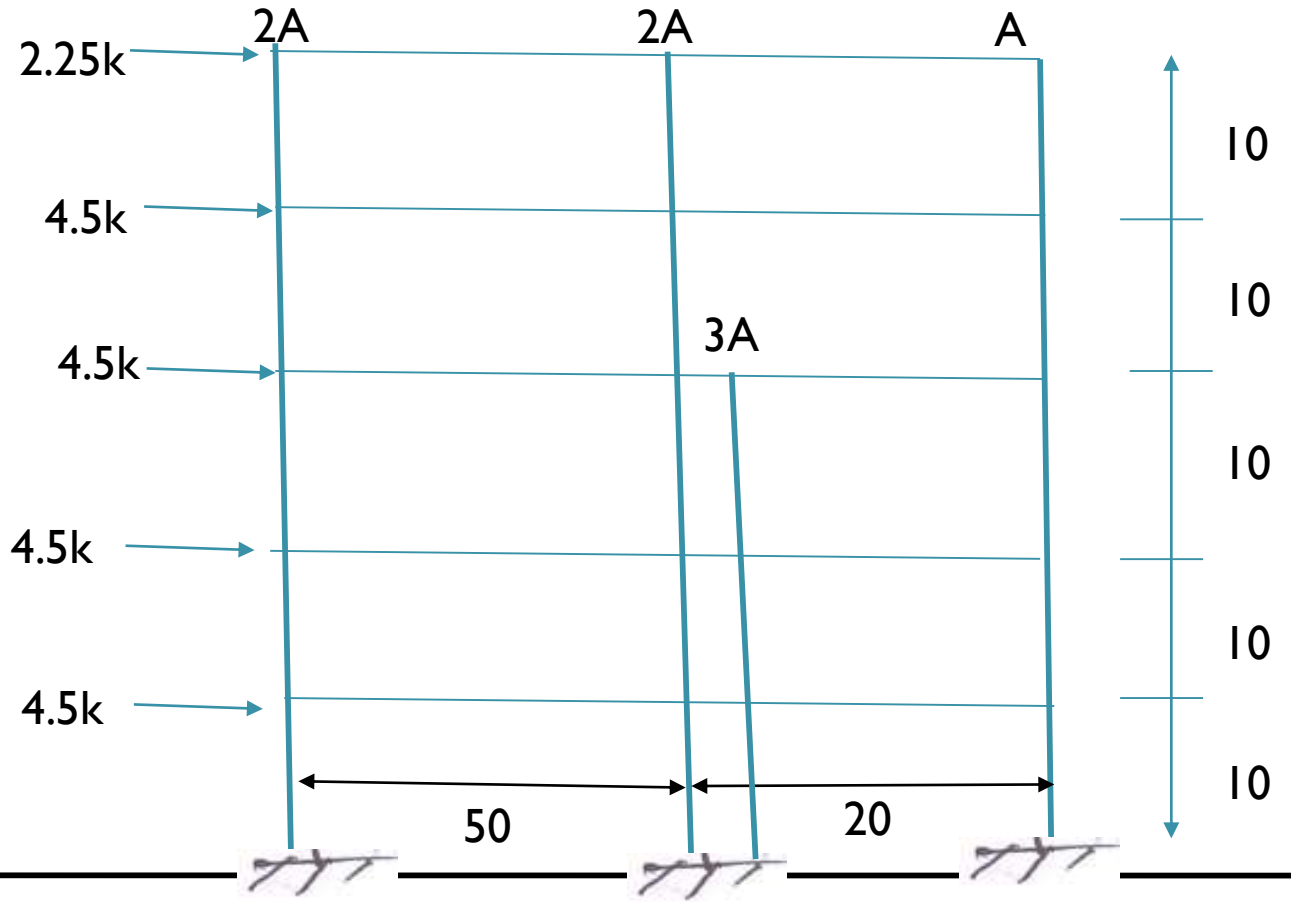
↓

Beam A.F.D

Free body diagram

Structural Analysis & Design I

- **Assignment (Cantilever) 1 Example 7.11 Norris & Wilbur**
- **Assignment (Cantilever) 2 Example 7.8 Hibbler**
- **Assignment (Cantilever) 3**

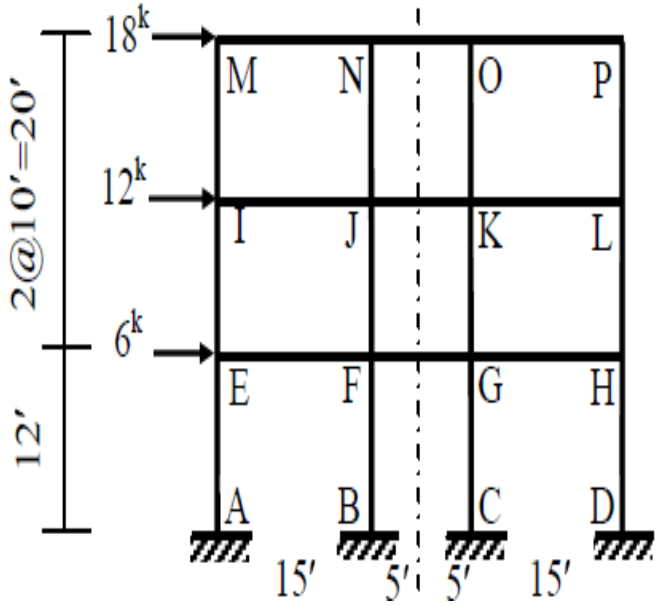


Structural Analysis & Design I

Assignment 4

Example

Use the Cantilever Method to draw the axial force, shear force and bending moment diagrams of the three - storied frame structure loaded as shown below



Structural Analysis & Design I