For a typical frame in the building below:
1. estimate the moment diagram due to gravity loads and compare with RISA
2. estimate the axial forces in the columns due to gravity loads and compare with RISA
3. estimate the moment diagram due to wind loads and compare with RISA
4. estimate the axial forces in the columns due to gravity loads and compare with RISA

DL = 5” slab (normal wt concrete)
LL = 70 psf
WL = 15 psf

Joists: W21x44
Girders: W30x124
Columns: W33x141

Fy = 50 ksi
Frame Analysis

note: apply LL over entire girder

$P_{int} = (62.5 \text{ psf} + 70 \text{ psf}) \times 9' \times 35' + 49 \text{ psf} \times 35' = 43.3 \text{ k}$

$P_{ext} = (62.5 \text{ psf} + 70 \text{ psf}) \times \frac{9'}{2} \times 35' + 49 \text{ psf} \times 35' = 29.4 \text{ k}$

DC = $\frac{5'}{12''/\text{f}}$

DL = 60.25 \text{ psf}

$P_{int} = 64.9 \text{ k}$

$P_{ext} = 519 \text{ k}$

Approx. 1 Ton
Joint 3
\[ M_3 = 64.9 \times 4' = 260' \text{ k.-ft} \]

Joint 4
\[ M_4 = 64.9 \times 4' = 260' \text{ k.-ft} \]

Member 2
\[ \sum M_4 = 0, \quad 260' \text{ k.-ft} - V \times 15' = 0 \]
\[ V = 17.3' \text{ k} \]
\[ M_2 = 17.3' \times 5' = 86.5' \text{ k.-ft} \]

Approx. Max. 4
\[ V = 260' \text{ k.-ft} \]

(drawn on tension)
Solution: LC 1, Gravity Loads
Member z Bending Moments (K-ft)
2. **Gravity**

Assume $R_1 = R_2$

$A_0 = 83.4\, kN$

$A_{\theta} = 83.4\, kN$
Solution: LC 1, Gravity Loads
Member Axial Forces (K)
3. M wL

\[ P_{wL} = 15\text{ psf} \times \frac{20'}{2} \times 35' = 5,250\text{ in} \]

Assume Joints 3 & 4 do not rotate
(C \( \frac{EI_{\text{girder}}}{L} >> \frac{EI_{\text{column}}}{L} \))

\[ \text{rotational stiffness} \]

5.25 in.
\[ k_0 = \frac{3EI}{L^2}, \quad k_2 = \frac{12EI}{L^2} \]

\[ V_1 = \rho w l \frac{k_0}{k_0 + k_2} \]

\[ V_0 = 5.25 k \frac{\frac{3EI}{(20)^3}}{\frac{3EI}{(20)^3} + \frac{12EI}{(20)^3}} = 1.05 k \]

\[ V_2 = \rho w l \frac{k_2}{k_0 + k_2} \]

\[ = 5.25 k \frac{12}{3 + 2} = 4.22 k \]

\[ M_3 = 1.05 k \times 20' = 21.0 k \]

\[ M_4 = 0, \quad M_4 + M_2 = 4.22 k \times 20' \]

Assume \( M_4 = M_2 \),

\( M_4 = M_2 = 412.2 k' \times 20' \)
Approx. \( \frac{M \times w L}{k \cdot ft} \)

\( \text{(drawn on tension side)} \)

\( 4.4 \) \( 5.25 \text{k} \)

\[ \sum M_1 = 0, \quad 5.25 \text{k} \times 20' - 42.2 \text{k} \cdot f' - R_2 \times 36' = 0 \]

\[ R_2 = 1.7 \text{k} \uparrow \]

\[ R_1 = 1.7 \text{k} \downarrow \]
Loads: BLC 2, WL
Solution: LC 2, Wind Load
Member z Bending Moments (K-ft)
Loads: BLC 2, WL
Solution: LC 2, Wind Load
Member Axial Forces (K)

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Frame Example.r3d