Assignment #8

1. Design Beams for SMF in Assignment #7
   (Beams must satisfy "Highly Ductile", Table 1-3
2. Design Columns for "Strong Column - Weak Beam"
3. Apply loads to a frame model and check story drift.

Notes ~

Assume RBS Connection

$$\text{Req'd } Z_b = 1.5 \frac{M_u}{\phi F_y}$$

$$\text{Req'd } Z_c = 1.9\, Z_b$$

From Assignment #7

Story	W_x	F_x/SMF*	V_x/SMF*
R.	2824	129.5	129.5
5	2734	96.1	225.6
4	2734	68.2	293.8
3	2734	42.0	335.8
2	2734	18.4	354.2

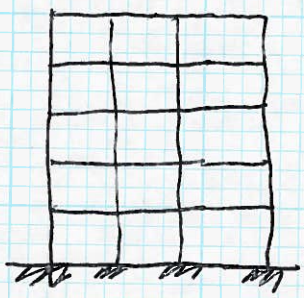
* Direct + Torsion. $= 0.55V / 2$ Frames $= 0.275V$

4. Calculate Building Period T and compare to $T = C_u T_a$

Frame Design

5 Stories - 3 Bays

h = 15' all stories



STRY	F_x	V_x
R	129.5	129.5
5	96.1	225.6
4	68.2	293.8
3	42.0	335.8
2	18.4	354.2

ROOF

$$M_E = \frac{V_R h}{4N} = \frac{129.5 \times 15'}{4 \times 3} = 162'^k$$

$w_D = 1760\#/'$ (Assignment #1)

$A_t = 20' \times 22'$ $\quad L_r = 20(1.2 - 0.001 \times 440) \times 1.0 = 15.2 \sim 16$ psf.

$w_L = 16 \text{ psf} \times 22' = 352\#/'$

$M_L = .352 \times 20^2/12 = 11.7'^k$ $\quad M_D = 1.760 \times 20^2/12 = 58.7'^k$

$M_U = 1.55(58.7) + 1.0(162) + 0.5(11.7) = 259'^k$

$$\text{Req'd } Z_b = 1.5 \frac{M_{U_b}}{\phi F_y} = 1.5 \frac{259 \times 12}{0.9 \times 50} = 104 \text{ in}^3$$

W24×55 $\quad Z_b = 134 \text{ in}^3$ $\quad I = 1350 \text{ in}^4$

Req'd $Z_c = 1.9 \times 134 = 256$

W14×145 $\quad Z_c = 260 \text{ in}^3$ $\quad A = 42.7 \text{ in}^2$ $\quad I = 1710 \text{ in}^4$

5th Floor

$$M_E = \frac{V_5 h}{2N} = \frac{225 \times 15'}{2 \times 3} = 563'^k$$

$M_U = 1.55(65.3) + 1.0(563) + 0.5(27.9) = 678'^k$

$$\text{Req'd } Z_b = 1.5 \frac{678 \times 12}{0.9 \times 50} = 271.2 \text{ in}^3$$

W27×94 $\quad Z_b = 278 \text{ in}^3$ $\quad I = 3270 \text{ in}^4$

4th Floor

$$M_E = \frac{293.8 \times 15'}{2 \times 3} = 735'^k$$

$M_U = 1.55(65.3) + 1.0(735) + 0.5(27.9) = 850'^k$

$$\text{Req'd } Z_b = \frac{850 \times 12}{0.9 \times 50} \times 1.5 = 340 \text{ in}^3$$

W30×108 $\quad Z_b = 346$ $\quad I = 4470$

Req'd $Z_c = 1.9 \times 346 = 657\ in^3$

W14×342 $Z = 672\ in^3$ $A = 101\ in^2$ $I = 4900\ in^3$

3rd Floor

$M_E = \frac{335.8 \times 15}{2 \times 3} = 840^{1k}$

$M_u = 1.55(65.3) + 1.0(840) + 0.5(27.9) = 955^{1k}$

Req'd $Z_b = 1.5 \times \frac{955 \times 12}{0.9 \times 50} = 382\ in^3$

W30×124 $Z = 408$ $I = 5360\ in^4$

2nd Floor

$M_E = \frac{354.2 \times 15}{2 \times 3} = 886^{1k}$

$M_u = 1.55(65.3) + 1.0(886) + 0.5(27.9) = 1001^{1k}$

Req'd $Z_b = 1.5 \times \frac{1001 \times 12}{0.9 \times 50} = 400^{in^3}$

W30×124 $Z = 408$ $I = 5360\ in^4$

Req'd $Z_c = 1.9 \times 408 = 775\ in^3$

W14×398 $Z = 801\ in^3$ $A = 117\ in^2$ $I = 6000\ in^4$

Check Drift $\delta_x = \frac{C_d \delta_E}{I} = \frac{5.5 \delta_E}{1.0} = 5.5 \delta_E$

	δ_E	δ_x	Δ
R	3.27	17.99	4.07
5	2.53	13.92	3.58
4	1.88	10.34	3.96
3	1.16	6.38	3.79
2	0.47	2.59	2.59

$\Delta = \delta_{xi} - \delta_{x\,i-1}$

$\Delta_{max} = 0.020\, h_{sx}$

$= 0.020 \times 15' \times 12$

$= 3.6"$

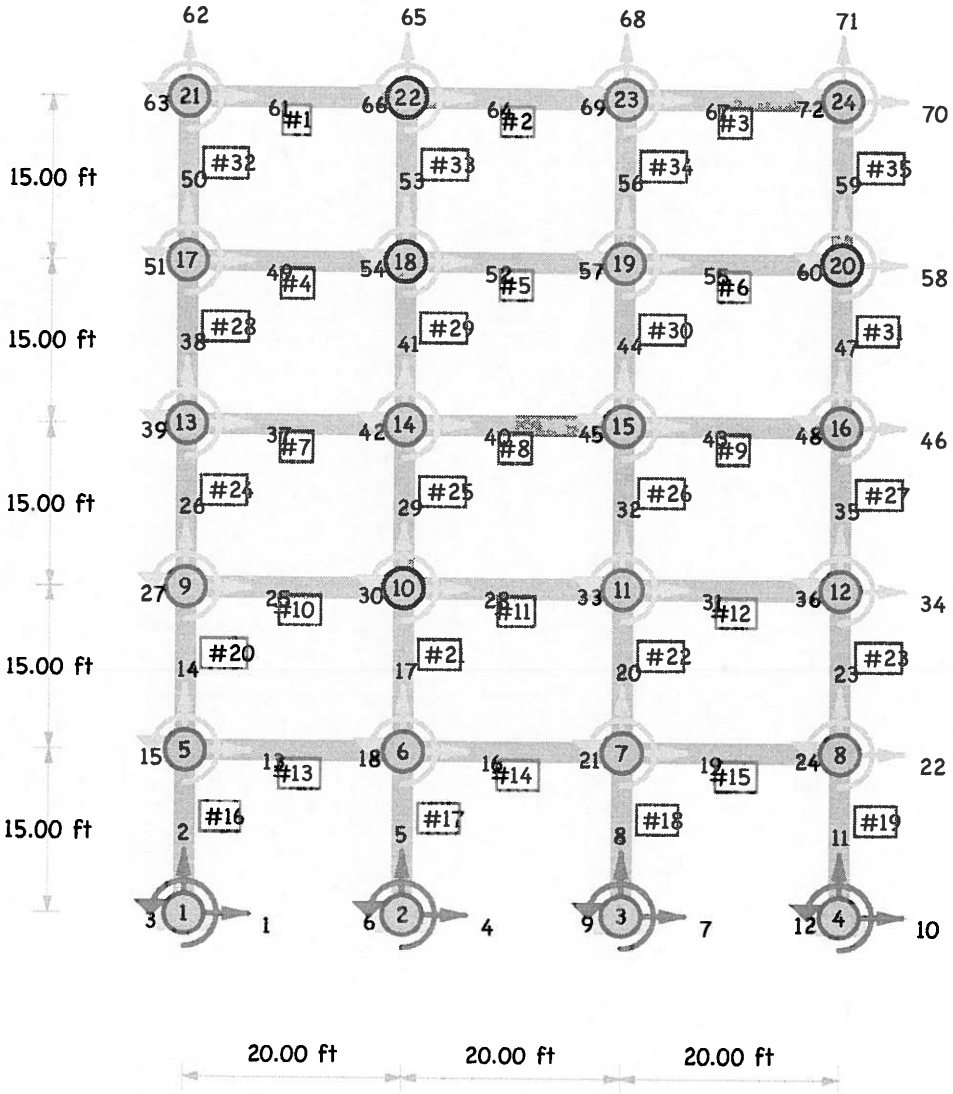
For RBS

$\Delta_{max} = 0.020\, h_{sx} \times 0.90$

$= 0.020 \times 15 \times 12 \times 0.9$

$= 3.24"$

Global DOF



(4) Calculate T using Rayleigh Procedure

Story	w_x	δ_E	δ_E without torsion	$w_x \delta^2$	F_x	$F_x \delta$
R	2824	3.27	2.97	24910	470.8	1398
5	2734	2.53	2.30	14463	349.3	804
4	2734	1.88	1.71	7994	247.8	424
3	2734	1.16	1.05	3014	152.8	160
2	2734	0.47	0.43	506	66.8	29
				$\Sigma = 50\,887$		$\Sigma = 2815$

$$T = 0.132\sqrt{\frac{\Sigma w_i \delta_i^2}{\Sigma f_i \delta_i}}$$

$$= 0.132\sqrt{\frac{50\,887}{2815}}$$

$$T = 1.36 \text{ sec} > T_a \times C_u = 0.886 \times 1.4 = 1.24 \text{ sec}$$