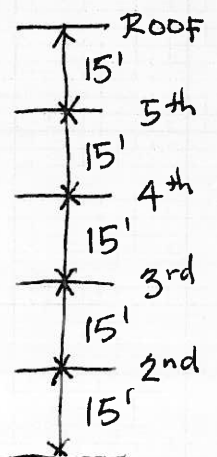Assignment #7
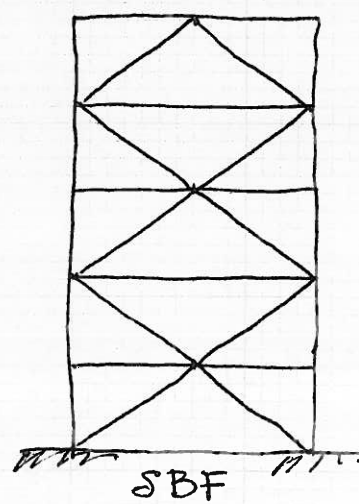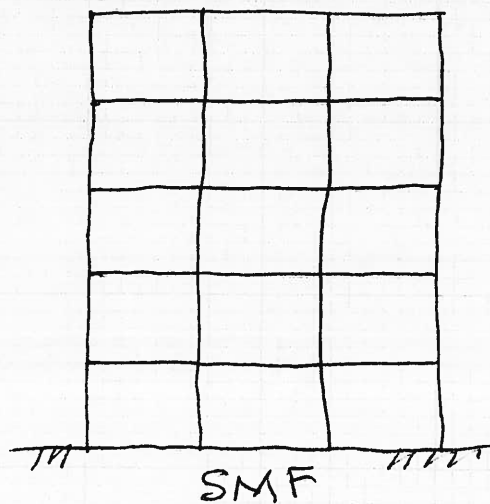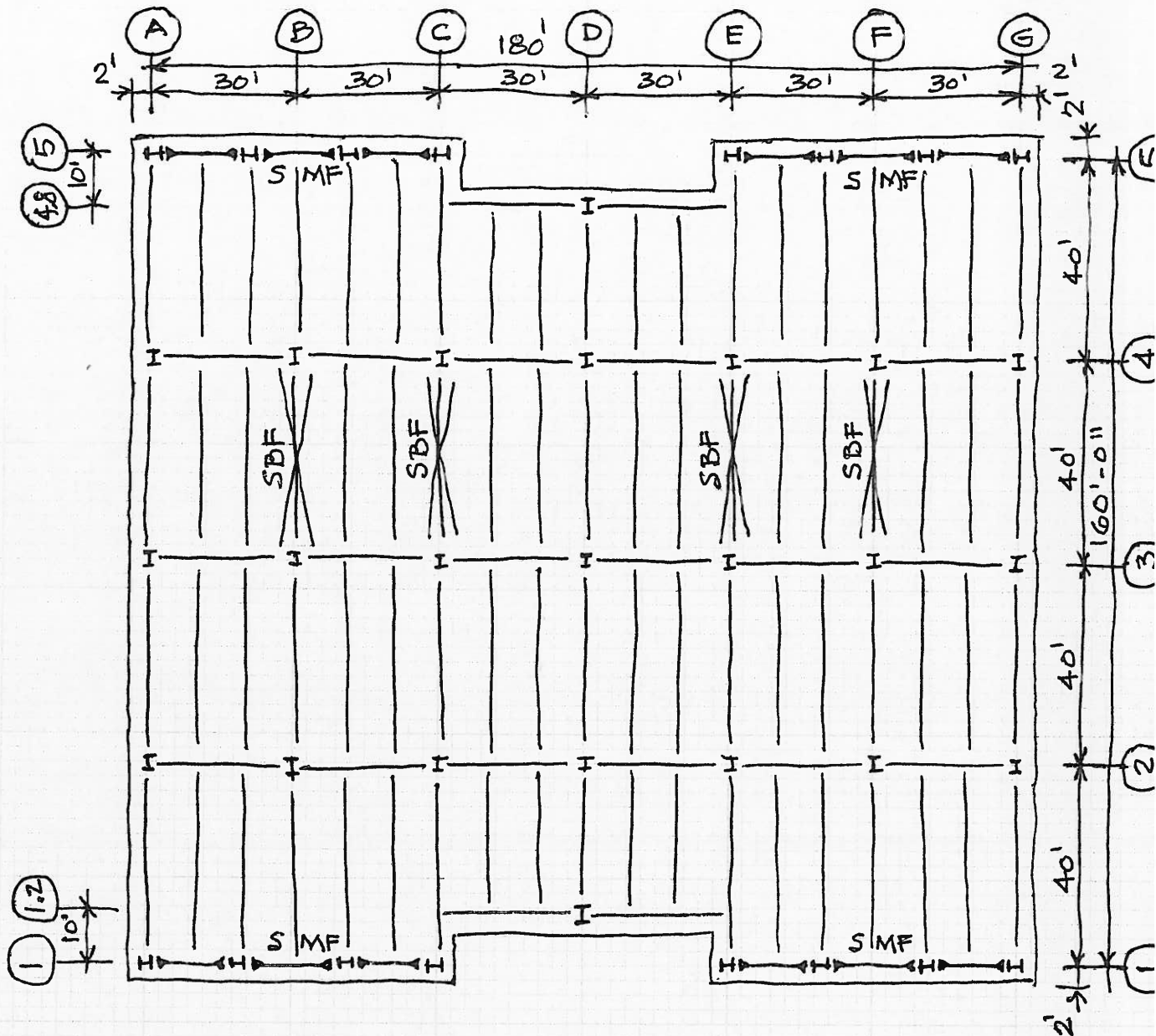
① Determine the column loads and choose column sizes for a typical interior column B-2. (Columns change sizes every 2 stories)

② Determine the seismic forces in each direction for the 5-story building. Note that there are 4 Special Moment Frames (SMF) in the E-W direction and 4 Special Braced Frames (SBF) in the N-S direction

   Site = Middle of Dodger Stadium
   Site class "D"
   See Attached

• Calculate the building period T_a in each direction. Assume $C_u = 1.4$ for SMF and $C_u = 1.0$ for SBF

• Determine the forces on each SMF and SBF including accidental torsion. Assume ρ, the redundancy factor is 1.0 in each direction.

(see sample spread sheet)

Grid lines (top): A — 30' — B — 30' — C — 30' — D — 30' — E — 30' — F — 30' — G, with 2' overhangs at each end, total 180'

Grid lines (right/side): 5 — 40' — 4 — 40' — 3 — 40' — 2 — 40' — 1, total 160'-0", with 2' overhangs

(5), (4.8) 10'
(1.2), (1) 10'

S MF

SBF

I

SMF

SBF

ROOF
15'
5th
15'
4th
15'
3rd
15'
2nd
15'

SMF

SBF

Assignment #7

① Column Loads B-2

Story	H	DL	LL	At	ΣAt	P_{DL}	P_{LL}	$ΣP_D$	$ΣP_L$	R	$P(D+L)$	$P_u(D+L)$
Roof	15	82	20	1200	1200	98.4	24	98.4	24	0.6	112.8	141.1
5$\frac{th}{}$	15	91	50	1200	1200	109.2	60	207.6	84	0.47	248	312.3
4$\frac{th}{}$	15	91	50	1200	2400	109.2	60	316.8	144	0.4	374.4	472.3
3$\frac{rd}{}$	15	91	50	1200	3600	109.2	60	426	204	0.4	507.6	641.8
2$\frac{nd}{}$	15	91	50	1200	4800	109.2	60	535.2	264	0.4	640.8	811.2

$A_t = 30 \times 40 = 1200 \ ft^2 \quad K_{LL}=4$

Roof $\quad R = 0.6 \quad A_t > 600$

5$\frac{th}{}$ $\quad R = 0.25 + \dfrac{15}{\sqrt{4 \times 1200}} = 0.47 > 0.40$

4$\frac{th}{}$ $\quad R = 0.25 + \dfrac{15}{\sqrt{4 \times 2400}} = 0.40$

3$\frac{rd}{}$ & 2$\frac{nd}{}$ $\quad R = 0.40$

$P(D+L) = ΣP_D + R \, ΣP_L$

$P_u(D+L) = 1.2 \, ΣP_D + 1.6 \, R \, ΣP_L$

Story	Column	$φP_n$
Roof	W12×40	281
5$\frac{th}{}$	W12×40	281
4$\frac{th}{}$	W12×53	478
3$\frac{rd}{}$	W12×53	478
2nd.	W12×87	

8%

← W12×40

← W12×53

← W12×87

Foundation designed for $P_{D+L} = 640.8^k$

Unit Loads for Seismic Design

Roof

2 ½ " Conc. (HR) over 3" – 20 ga. Metal Deck	51 psf
Mechanical, electrical, plumbing	10 psf
Roofing	6 psf
Roof Mounted Equipment	5 psf
Partitions	5 psf
Steel beams, columns and LFRS	15 psf
	--------
	92 psf

Typical Floors

2 ½ " Conc. (HR) over 3" – 22 ga. Metal Deck	51 psf
Mechanical, electrical, plumbing	10 psf
Partitions	10 psf
Steel beams, columns and LFRS	15 psf
	--------
	86 psf

Exterior Building Skin (50% insulating glass 6.5 psf + 50% 4 inch precast concrete)
  =0.50 x 6.5 psf + 0.5 x 4/12 x 150 pcf = 28.25 psf use 30 psf
4 foot high parapet above Roof

≥USGS Design Maps Summary Report
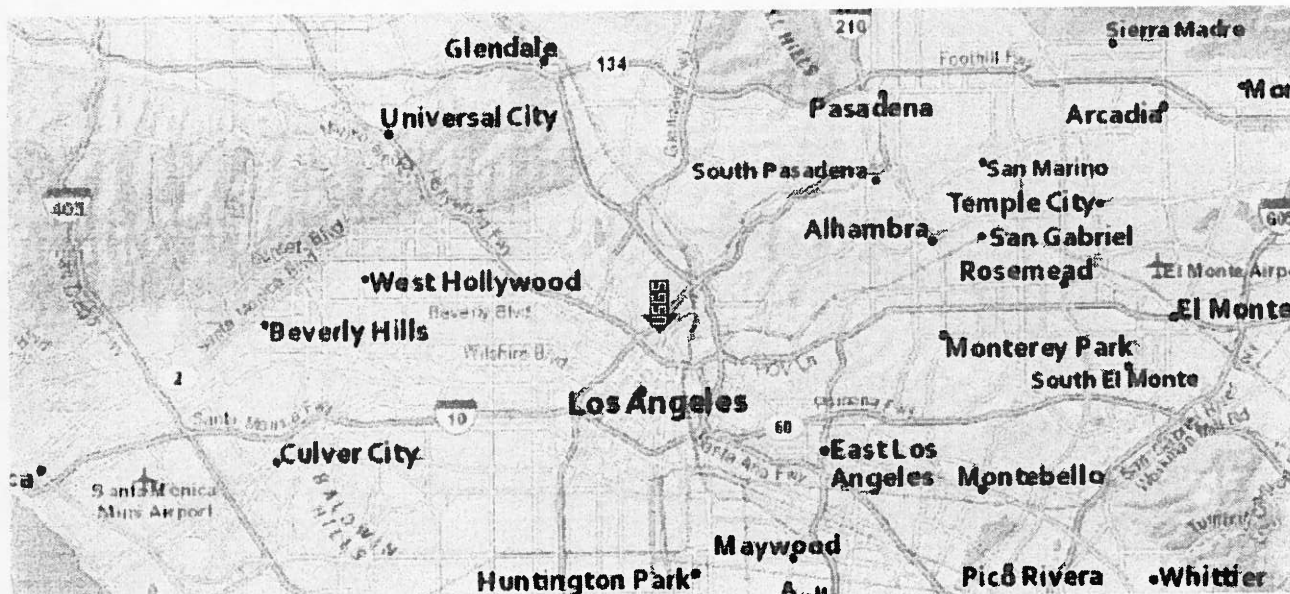
User—Specified Input

Report Title Homework
Wed February 17, 2016 19:09:56 UTC

Building Code Reference Document ASCE 7-10 Standard
(which utilizes USGS hazard data available in 2008)

Site Coordinates 34.074°N, 118.24°W

Site Soil Classification Site Class D – "Stiff Soil"

Risk Category I/II/III

USGS—Provided Output

S_s = 2.637 g	S_{MS} = 2.637 g	S_{DS} = 1.758 g
S_1 = 0.928 g	S_{M1} = 1.392 g	S_{D1} = 0.928 g

For information on how the SS and S1 values above have been calculated from probabilistic (risk-targeted) and deterministic ground motions in the direction of maximum horizontal response, please return to the application and select the "2009 NEHRP" building code reference document.

③

MCE$_R$ Response Spectrum

Sa (g) vs Period, T (sec)

Design Response Spectrum

Sa (g) vs Period, T (sec)
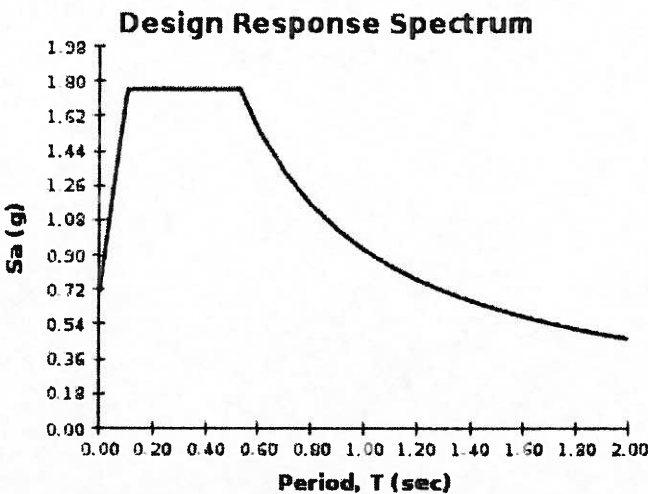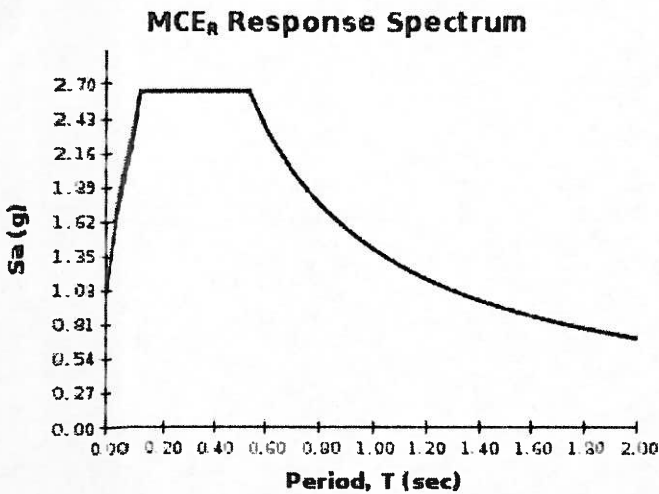
For PGA$_M$, T$_L$, C$_{RS}$, and C$_{R1}$ values, please view the detailed report.

Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

Floor & Roof Area = $184' \times 164' - 56 \times 10 \times 4 = 27,936$ sq. ft.

Building Perimeter = $184' \times 2 + 164' \times 2 + 10' \times 4 = 736$ ft.

Floor Weight — Typical Floor

$$W_5 = 86 \text{psf} \times 27,936 + 30 \text{psf} \times 736' \times \left(\frac{15}{2} + \frac{15}{2}\right) = 2734^k$$

$$W_4 = W_3 = W_2 = 2734^k$$

Roof Weight

$$W_R = 92 \text{ psf} \times 27936 + 30 \text{ psf} \times 736' \left(\frac{15}{2} + 4\right) = 2824^k$$

Building Weight

$$W = \Sigma W_i = W_2 + W_3 + W_4 + W_5 + W_R$$
$$= 4(2734) + 2824$$
$$= 13,760^k$$

Torsion

SBF
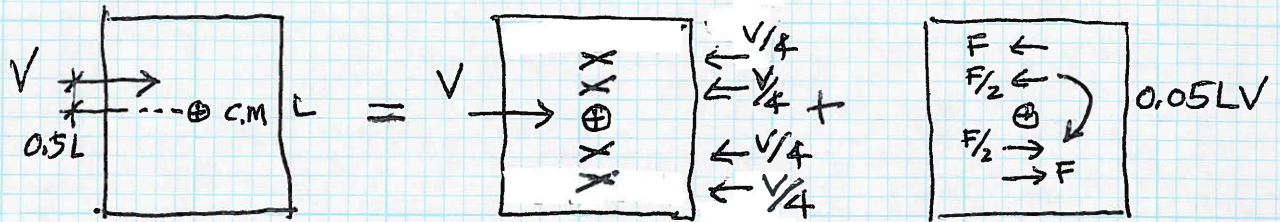
$$0.05 \times 180\,V = 2 \times 30 \times \frac{F}{2} + 2 \times 60 \times F$$

$$9\,V = 150\,F$$

$$F = 0.06\,V$$

$$V/_{SBF} = 0.25\,V + 0.06\,V = \underline{0.31\,V}\,/_{SBF}$$

SMF
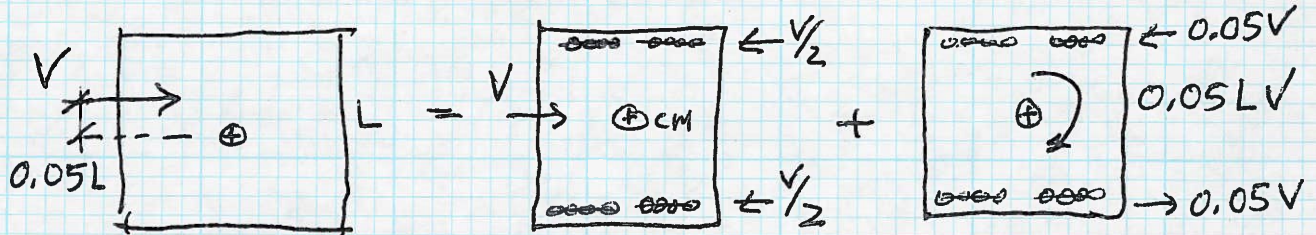
$$V/_{SMF} = \frac{0.50\,V + 0.05\,V}{2\,SMF} = \frac{0.55\,V}{2\,SMF} = \underline{0.275\,V}/_{SMF}$$

Determine Earthquake Forces Multi-Story Building   Steel Special Braced Frames - Assignment #7 - 2017

Ss =	2.637	
S1 =	0.928	
Fa =	1.000	
Fv =	1.500	
SMs =	2.637	
SM1 =	1.392	
Sds =	1.758	
Sd1 =	0.928	

Risk Category   =   II
Seismic Design Category D
Building Period Ta = Ct hn^x

Ct = 0.020
hn (ft) = 75.00
x = 0.75
Ta (sec) = 0.510
k = 1.005

Cu =	1	T (sec) = 0.510
R =	6	ρ = 1
I =	1	

Cs = Sds/(R/I) = 0.2930 Eq. 12.8-2
Cs (max) = Sd1/T/(R/I) = 0.3034 Eq. 12.2-3
Cs(min)=0.5Sd1/(R/I) = 0.0773 Eq. 12.8-6 IF S1>=0.6
Cs = 0.2930
V (kips) = 4031.7

Fx/LFRS = 0.31

Story	hx	Wx	wxhx^k	Fx	Vx	Seismic Coef.	Fx/LFRS	Vx/LFRS
Roof	75	2824	216288	1375.6	1375.6	0.4871	426.5	426.5
5th Floor	60	2734	167335	1064.3	2439.9	0.3893	329.9	756.4
4th Floor	45	2734	125326	797.1	3237.0	0.2916	247.1	1003.5
3rd Floor	30	2734	83386	530.4	3767.4	0.1940	164.4	1167.9
2nd Floor	15	2734	41553	264.3	4031.7	0.0967	81.9	1249.8
		13760	633887	4031.7				

Determine Earthquake Forces Multi-Story Building   Steel Special Moment Frames - Assignment #7 - 2017

S_s =	2.637	Risk Category	II	C_u =	1.4	T (sec) =	1.240
S_1 =	0.928	Seismic Design Category	D	R =	8	ρ =	1
F_a =	1.000	Building Period $T_a = C_t h_n{}^x$		I =	1		
F_v =	1.500	C_t =	0.028	$C_s = S_{DS}/(R/I)$ =	0.2198	Eq. 12.8-2
S_{MS} =	2.637	h_n (ft) =	75.00	C_s (max) = $S_{D1}/T/(R/I)$ =	0.0936	Eq. 12.2-3
S_{M1} =	1.392	x =	0.80	$C_s(min)=0.5S_{D1}/(R/I)$ =	0.0580	Eq. 12.8-6 IF S_1>=0.6
S_{DS} =	1.758	T_a (sec) =	0.886	C_s =	0.0936	
S_{D1} =	0.928	k =	1.193	V (kips) =	1287.5	

Story	h_x	W_x	$w_x h_x{}^k$	F_x	V_x	Seismic Coef.	F_x/LFRS =	V_x/LFRS
							0.55	
Roof	75	2824	486832	470.8	470.8	0.1667	258.9	258.9
5th Floor	60	2734	361179	349.3	820.0	0.1277	192.1	451.0
4th Floor	45	2734	256271	247.8	1067.9	0.0906	136.3	587.3
3rd Floor	30	2734	158002	152.8	1220.6	0.0559	84.0	671.4
2nd Floor	15	2734	69120	66.8	1287.5	0.0244	36.8	708.1
		13760	1331403	1287.5				

	F_x / SMF		V_x / SMF
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