Solution:

Office building = *Risk Category* II → *2015 IBC Table 1604.5*

$S_{DS} = 0.95$ → given

$I_e = 1.0$ → *ASCE 7 – Table 1.5-2*: *Risk Category* II

$R = 5½$ → *ASCE 7 – Table 12.2-1, item B.16*: Building Frame System – special reinforced masonry shear walls

NOTE: by observation, for a single story building … $T < T_S$ → ∴ *ASCE 7 (12.8-2)* will govern C_S

Seismic Response Coefficient, C_S

$$C_S = \frac{S_{DS}}{(R/I_e)} = \frac{(0.95)}{(5.5/1.0)} = \underline{0.173} \qquad \textit{ASCE 7 (12.8-2)}$$

Seismic Base Shear, *V*

$$V = C_S W \qquad \textit{ASCE 7 (12.8-1)}$$

$= \underline{0.173\ W}$ ← use for shear wall design

Diaphragm Design Force at Roof, F_{px}

$$F_{px} = \frac{\sum_{i=x}^{n} F_i}{\sum_{i=x}^{n} w_i} w_{px} \qquad \textit{ASCE 7 (12.10-1)}$$

For a single-story building (i.e., $F_1 = V$):

$$F_{p1} = \frac{C_S W}{W} w_{p1} = C_S\, w_{p1} = 0.173\, w_{p1}$$

$F_{p1} \le 0.4\, S_{DS}\, I_e\, w_{p1} = 0.4\,(0.95)(1.0)\, w_{p1} = 0.380\, w_{p1}$ maximum

$F_{p1} \ge 0.2\, S_{DS}\, I_e\, w_{p1} = 0.2\,(0.95)(1.0)\, w_{p1} = \underline{0.190}\, w_{p1}$ minimum ← use for roof diaphragm design

A.) N-S DIRECTION: $L = 70'$, $d = 40'$

1. Design Seismic Force to Diaphragm, $w_s = f_{p1} = F_{p1} / L$

roof DL + 20% snow; North & South exterior walls

$w_{p1} = (16\text{ psf} + 20\% \cdot 100\text{ psf})(40')(70') + (85\text{ psf})(14'/2 + 2')(2\text{ walls})(70')$
$= 100{,}800\text{ lbs} + 107{,}100\text{ lbs} = 207{,}900\text{ lbs}$

$F_{p1} = 0.190\, w_{p1} = 0.190\,(207{,}900\text{ lbs}) = 39{,}501\text{ lbs}$

$w_s = f_{p1} = F_{p1} / L = (39{,}501\text{ lbs}) / (70') = \boxed{564\text{ plf}}$

2. Unit Roof Shear on lines A & B, v_r

$V_A = V_B = w_s L / 2 = (564\text{ plf})(70'/2) = \underline{19{,}740\text{ lbs}}$

Unit roof shear, $v_A = v_B = V_A / d = (19{,}740\text{ lbs}) / 40' = \boxed{494\text{ plf}}$ (SD/LRFD force level)

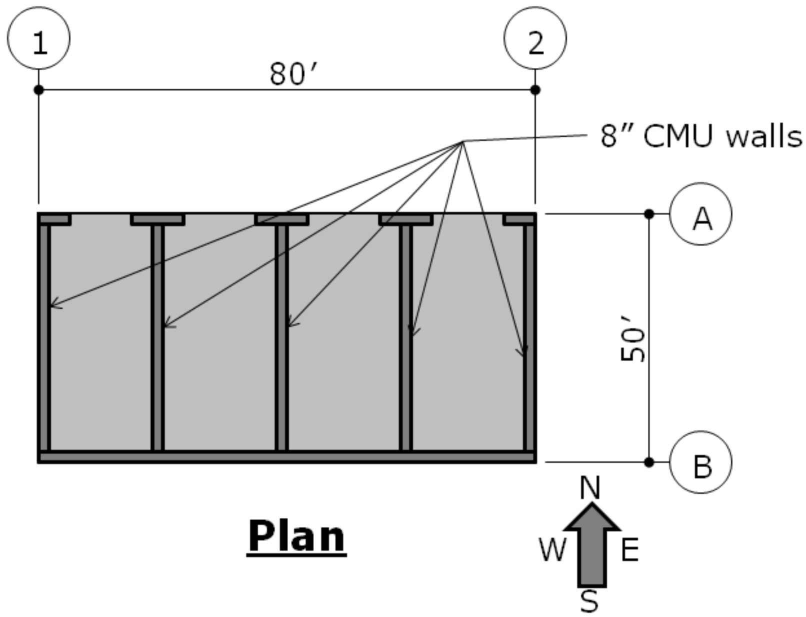
3. Maximum Chord Force on lines 1 & 2, *CF*

max. $M = w_s L^2 / 8 = (564\text{ plf})(70')^2 / 8 = 345{,}450$ lb-ft

max. $CF = (345{,}450\text{ lb-ft}) / 40' = \boxed{8{,}636\text{ lbs}}$ (SD/LRFD force level)

53. The figure below shows a 1-story Storage building with 8" nominal reinforced concrete masonry (CMU) walls and a flexible metal deck roof diaphragm. For the North-South load direction, the lateral loads will be resisted by 2 exterior masonry shear wall lines (1 & 2) and 3 interior masonry shear wall lines. For the East-West direction, lateral loads will be resisted by the 2 exterior masonry shear wall lines (A & B). Determine the unit roof shear on lines A & B for East-West seismic loads. Given:

- CMU wall weight = 75 psf
- Roof dead load weight = 15 psf
- Wall height (to roof) = 12 feet ... no parapet
- $V = C_S W = 0.158 W$



a. 105 plf
b. 170 plf
c. 210 plf
d. 240 plf

54. A light-framed shear wall is framed with 2x6 Douglas Fir studs at 16" on center and sheathed with 15/32" APA rated plywood sheathing attached to the 2x studs and 2x blocking with 8d common nails at 4" on center at panel edges and 12" on center at intermediate framing members. If the shear wall is 20 feet long and 16 feet tall, what is the LRFD and ASD unit shear capacity for resisting seismic forces?

a. 690 plf LRFD & 430 plf ASD
b. 860 plf LRFD & 430 plf ASD
c. 610 plf LRFD & 380 plf ASD
d. 760 plf LRFD & 380 plf ASD

55. Nonstructural components that require design in accordance with *ASCE 7-10 – Chapter 13* and for which the component importance factor is greater than 1.0 are known as:

a. Seismic force-resisting systems
b. Life-safety systems
c. Essential systems
d. Designated seismic systems

Problem	Answer	Reference / Solution
		▪ Pump building of wastewater treatment plant → RC = III ∴ Community college classroom building w/ occupant load = 475 ←
8	c	p. 1-118 - Center of Rigidity, *CR* By observation, the *CR* will be located in the center of the 125 foot building dimension (in the X-direction) because the total rigidity on the left wall line is equal to the total rigidity on the right wall line (i.e., ΣR = ¾ + ¾ = 1½). $\overline{X}_{CR} = \frac{\sum R_y \overline{x}}{\sum R_y}$ = 125′ / 2 = 62.5′ (by observation) $\overline{Y}_{CR} = \frac{\sum R_x \overline{y}}{\sum R_x} = \frac{1.25(0)+1.25(25')+(1.25+1.25)(75')}{4(1.25)} = 43.8'$ ∴ (62.5′, 43.8′) ←
9	b	p. 1-185 - Liquefaction Shallow saturated cohesionless silty sand ←
10	a	p. 1-151 & *ASCE 7-10* p. 76 - *§12.11.2.2.1* max. L/d = 2.5 to 1 for subdiaphragms (*SDC* = C to F) min. $d = L / 2.5$ = (20′) / 2.5 = 8.0′ ∴ 8'-0" ←
11	c	p. 1-42 - Response Modification Coefficient, *R* The *R* coefficient is representative of the … global ductility of a seismic force-resisting system (SFRS). ∴ Response modification coefficient ←
12	a	p. 1-179 - Flat Slab (or Lift Slab) Concrete Buildings Partial or total collapse of roof and/or floor slabs due to inadequate slab shear strength at the slab-column joints (i.e., *punching shear* failure). ∴ Punching shear failure of slabs at columns ←
13	c	p. 1-59 - Overturning Moment & *ASCE 7-10* p. 73 - *§12.8.5* $OTM_{base} = F_1 h_1 + F_2 h_2 + F_3 h_3$ = 15 kips (16′) + 25 kips (30′) + 20 kips (44′) = 1870 kip-ft ←
14	d	p. 1-195 - UNSAFE (red) placard ∴ Unsafe - do not enter or occupy ←
15	c	p. 1-56 & *ASCE 7-10* p. 72 - *§12.8.2.1* $T_a = C_t h_n^x$ *ASCE 7 (12.8-7)* C_t = 0.03 & x = 0.75 → *ASCE 7-10* p. 72 - *Table 12.8-2* (steel BRBF) $T_a = 0.03\,(140')^{0.75}$ = 1.22 sec Or using Table C1 (p. 5-18) → Steel BRBF & h_n = 140′ → T_a = 1.22 sec ∴ T_a = 1.2 second ←

Problem	Answer	Reference / Solution
27	d	p. 1-110 - Vertical Flexible Diaphragm Analysis NOTE: this is a flexible diaphragm and you do not distribute the story shear (or base shear for a 1-story building) based on the shear wall rigidities provided. The rigidities are ignored to determine V_1 & V_2 (i.e., use tributary area). $\therefore\ V_1 = V_2 = V / 2 = 116 \text{ kips} / 2 = \underline{58 \text{ kips}} \leftarrow$
28	a	*ASCE 7-10* p. 63 - *§12.2.5.2* – Cantilever Column Systems *ASCE 7-10 – Table 12.2-1, Type G* refers to *ASCE 7-10 – §12.2.5.2* - " … shall not exceed 15% of the available axial strength, …" ∴ 15% ←
29	d	p. 1-117 to 122 From the figure: $\overline{X}_{CM} = 150' / 2 = 75'$ & $\overline{Y}_{CM} = 100' / 2 = 50'$ $\overline{X}_{CR} = 60'$ & $\overline{Y}_{CR} = 50'$ calculated/inherent eccentricity $e_x = \overline{X}_{CM} - \overline{X}_{CR} = 75' - 60' = 15'$ accidental eccentricity $e_x = \pm 5\%\ L_x = 5\%\ (150') = \pm 7.5'$ The governing (i.e., maximum) force to the shear wall on line 2 will occur when the *CM* is moved nearest to line 2 where the maximum additive torsional shear will occur: $e_{x1} = 15' + 7.5' = 22.5'$ $M_{T1} = V \cdot e_{x1} = 155 \text{ kips } (22.5') = 3488 \text{ kip-ft}$ $\sum Rd^2 = R_1 d_1^2 + R_2 d_2^2 + R_A d_A^2 + R_B d_B^2$ $= 3\ (60')^2 + 2\ (90')^2 + 1.5\ (50')^2 + 1.5\ (5')^2 = 34{,}500 \text{ ft}^2$ max. $F_2 = V \dfrac{R_2}{R_1 + R_2} + \dfrac{M_{T1} R_2 d_2}{\sum Rd^2}$ $= 155 \text{ kips } (2) / (2 + 3) + 3488 \text{ kip-ft } (2)(90 \text{ ft}) / 34{,}500 \text{ ft}^2$ $= 62 \text{ kips} + 18 \text{ kips} = \underline{80 \text{ kips}} \leftarrow$
30	b	p. 1-72 - Redundancy Factor, ρ Redundancy is a characteristic of structures in which multiple paths of resistance to loads are provided. ∴ Redundancy ←
31	b	p. 1-33 to 35 & *2015 IBC* p. 398 - *Tables 1613.3.5(1)* & *1613.3.5(2)* Office building w/ fire station in 1st story → *IBC Table 1604.5* → *RC* = IV Site Class E & $S_S = 2.13$ → *Table 3.2* → $S_{DS} = 1.28$ Site Class E & $S_1 = 0.74$ → *Table 3.3* → $S_{D1} = 1.18$ $S_1 = 0.74 < 0.75$ → must use *Tables 1613.3.5(1) & (2)* to determine *SDC* $S_{DS} = 1.28$ & *RC* = IV → *Table 1613.3.5(1)* → *SDC* = D $S_{D1} = 1.18$ & *RC* = IV → *Table 1613.3.5(2)* → *SDC* = D ∴ *SDC* = D ←