

- 4.34 Which shear wall would be considered the least ductile?
- A
 - B
 - C
 - D
- 4.35 A 15-story Office building utilizes steel special concentrically braced frames ($R = 6$) with a fundamental period of 1.2 seconds and effective seismic weight of 12,000 kips. The design acceleration parameters are determined from a ground motion hazard analysis to be $S_{DS} = 0.83$ & $S_{D1} = 0.55$. What is the Equivalent Lateral Force procedure seismic base shear?
- 444 kips
 - 912 kips
 - 1,140 kips
 - 1,660 kips
- 4.36 Given a 3-story light-framed apartment building with wood structural panel shear walls (bearing walls), $S_{DS} = 0.75$, *Seismic Design Category E*, and effective seismic weight of 200 kips. Determine the seismic base shear using the Simplified Design Procedure of *ASCE 7-16*.
- 15 kips
 - 23 kips
 - 28 kips
 - 35 kips
- 4.37 What is the minimum seismic base shear for a *Risk Category IV* structure using steel special moment frames (SMF's) and with $S_1 = 1.10$ & $S_{DS} = 1.33$?
- $0.069 W$
 - $0.088 W$
 - $0.103 W$
 - $0.166 W$
- 4.38 When using the *ASCE 7-16* Equivalent Lateral Force procedure, actual seismic forces from the DBE ground motion (i.e., $2/3 MCE_R$) in relation to *ASCE 7-16* design seismic forces are:
- slightly smaller
 - much smaller
 - equal
 - greater
- 4.39 In the *ASCE 7-16*, the factor Ω_0 represents an/a:
- increase due to actual seismic forces
 - decrease due to actual seismic forces
 - increase of factor of safety for workmanship and materials
 - decrease of factor of safety for workmanship and materials
- 4.40 What is the approximate ratio between the actual DBE seismic base shear and the *ASCE 7-16* Equivalent Lateral Force procedure design seismic base shear?
- 1 to 1
 - $2\frac{1}{2}$ to 1
 - 4 to 1
 - 8 to 1

Problem	Answer	Reference / Solution
		<p>Site Class E & $S_S = 2.13 \rightarrow$ Table 3.1 $\rightarrow S_{DS} = 1.70$ (by interpolation) Site Class E & $S_1 = 0.74 \rightarrow$ Table 3.2 $\rightarrow S_{D1} = 0.99$ (by interpolation) $S_1 = 0.74 < 0.75 \rightarrow$ must use <i>Tables 1613.2.5(1) & (2)</i> to determine <i>SDC</i> $S_{DS} = 1.70$ & $RC = IV \rightarrow$ <i>Table 1613.2.5(1)</i> $\rightarrow SDC = D$ $S_{D1} = 0.99$ & $RC = IV \rightarrow$ <i>Table 1613.2.5(2)</i> $\rightarrow SDC = D$ $\therefore \underline{SDC = D} \leftarrow$</p>
1.32	c	<p>p. 1-104 - Nonbuilding Structure NOT Similar to a Building Cooling tower is part of HVAC system for a <u>Hospital</u> \rightarrow <i>IBC Table 1604.5</i> $\rightarrow RC = IV$ $I_e = 1.5 -$ <i>ASCE 7-16 p. 5 - Table 1.5-2</i> $R = 3.5 -$ <i>ASCE 7-16 p. 148 - Table 15.4-2 – cooling tower (steel)</i> Operating weight, $W = 70,800$ lbs ... ignore the shipping weight $T = 0.12$ sec (given) > 0.06 sec \rightarrow this is <u>NOT</u> a rigid nonbuilding structure $T_s = S_{D1}/S_{DS} = (0.43)/(0.77) = 0.56$ second $T = 0.12$ sec $< T_s = 0.56$ sec \rightarrow <i>ASCE 7 (12.8-2)</i> <u>will</u> govern for C_s $C_s = \frac{S_{DS}}{(R/I_e)} = (0.77)/(3.5/1.5) = 0.33$ <i>ASCE 7 (12.8-2)</i> $V = C_s W$ <i>ASCE 7 (12.8-1)</i> $= 0.33 (70,800 \text{ lbs}) = 23,400$ lbs $\therefore \underline{23,400 \text{ lbs}} \leftarrow$</p>
1.33	b	<p>p. 1-44 - Bearing Wall System <u>Shear walls</u> which resist lateral loads <u>and</u> support vertical gravity loads. \therefore <u>Shear walls that resist lateral (wind and seismic) loads and also support a major portion of the vertical (gravity) loads from roofs and floors</u> \leftarrow</p>
1.34	a	<p>p. 1-119 - Chord Force N-S: $w_s = f_{px} = F_{px}/L = 25$ kips / 100' = 250 plf $CF_{N-S} = w_s L^2 / 8d = 250 \text{ plf} (100')^2 / (8)(50') = 6,250$ lbs E-W: $w_s = f_{px} = F_{px}/L = 25$ kips / 50' = 500 plf $CF_{E-W} = w_s L^2 / 8d = 500 \text{ plf} (50')^2 / (8)(100') = 1,563$ lbs $CF_{N-S} / CF_{E-W} = (6,250 \text{ lbs}) / (1,563 \text{ lbs}) = 4.0$ $\therefore \underline{CF_{N-S} = 4} (CF_{E-W}) \leftarrow$</p>
1.35	b	<p>p. 1-104 - Rigid Nonbuilding Structures & <i>ASCE 7-16 p. 149 - §15.4.2</i> Wastewater treatment facilities \rightarrow <i>IBC Table 1064.5</i> $\rightarrow RC = III$ $I_e = 1.25 -$ <i>ASCE 7-16 p. 5 - Table 1.5-2</i> $W = 45$ kips $S_{DS} = 0.87$ $T = 0.05$ second < 0.06 second \rightarrow <u>Rigid</u> nonbuilding structure $V = 0.30 S_{DS} W I_e$ <i>ASCE 7 (15.4-5)</i> $= 0.30(0.87)(45 \text{ kips})(1.25) = 14.7$ kips $\therefore \underline{15 \text{ kips}} \leftarrow$</p>

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		$\sum_{i=1}^n w_i h_i = w_1 h_1 + w_2 h_2 + w_3 h_3$ $= (90 \text{ kips})(12') + (80 \text{ kips})(22') + (65 \text{ kips})(32') = 4,920 \text{ kip-ft}$ $C_{v1} = \frac{w_1 h_1^1}{\sum_{i=1}^n w_i h_i^1} = (90 \text{ kips})(12') / (4,920 \text{ kip-ft}) = \underline{0.220}$ $C_{v2} = \frac{w_2 h_2^1}{\sum_{i=1}^n w_i h_i^1} = (80 \text{ kips})(22') / (4,920 \text{ kip-ft}) = 0.357$ $C_{v3} = \frac{w_3 h_3^1}{\sum_{i=1}^n w_i h_i^1} = (65 \text{ kips})(32') / (4,920 \text{ kip-ft}) = 0.423$ $F_1 = C_{v1} V = 0.220(24 \text{ kips}) = \underline{5.28 \text{ kips}}$ $F_2 = C_{v2} V = 0.357(24 \text{ kips}) = 8.57 \text{ kips}$ $F_3 = C_{v3} V = 0.423(24 \text{ kips}) = 10.15 \text{ kips}$ $F_1 + F_2 + F_3 = 5.28 + 8.57 + 10.15 = 24.0 \text{ kips} = V \text{ OK}$ $\therefore \text{lateral force @ 2}^{\text{nd}} \text{ floor} = F_1 = \underline{5.3 \text{ kips}} \leftarrow$
8.63	b	<p>p. 1-64 - Story Shear & ASCE 7-16 p. 102 to 103 - §12.8.4</p> $V_x = \sum_{i=x}^n F_i \quad \text{ASCE 7 (12.8-13)}$ <p>Using the lateral forces (i.e., F_x) from Problem 8.62: $F_1 = 5.28 \text{ kips}$ $F_2 = 8.57 \text{ kips}$ $F_3 = 10.15 \text{ kips}$</p> <p>2nd story shear (V_2) is the total shear in the story <u>below</u> level 2 (i.e., 3rd floor) $\therefore V_2 = F_3 + F_2 = 10.15 \text{ kips} + 8.57 \text{ kips} = \underline{18.7 \text{ kips}} \leftarrow$</p>
8.64	c	<p>p. 1-111 - Diaphragm Design Force & ASCE 7-16 p. 106 - §12.10.1.1</p> $F_{px} = \frac{\sum_{i=x}^n F_i}{\sum_{i=x}^n w_i} w_{px} \quad \text{ASCE 7 (12.10-1)}$ $\text{minimum } F_{px} \geq 0.2 S_{DS} I_e w_{px} \quad \text{ASCE 7 (12.10-2)}$ $= 0.2(0.60)(1.0) w_{px} = 0.12 w_{px}$ $\text{maximum } F_{px} \leq 0.4 S_{DS} I_e w_{px} \quad \text{ASCE 7 (12.10-3)}$ $= 0.4(0.60)(1.0) w_{px} = 0.24 w_{px}$ <p>Using the lateral forces (i.e., F_x) from Problem 8.60: $F_1 = 5.28 \text{ kips}$ $F_2 = 8.57 \text{ kips}$ $F_3 = 10.15 \text{ kips}$</p> <p style="text-align: right;"><i>(continued)</i></p>

Problem	Answer	Reference / Solution
		$F_{px} = \frac{\sum_{i=x}^n F_i}{\sum_{i=x}^n w_i} w_{px}$ <p style="text-align: right;"><i>ASCE 7 (12.10-1)</i></p> <p>3rd floor = Level 2, $i = 2$: $\Sigma F_i = F_2 + F_3 + F_4 + F_5 = 30 + 45 + 60 + 50 = 185$ kips $\Sigma w_i = w_2 + w_3 + w_4 + w_5 = 3(425) + 300 = 1,575$ kips Assume $w_{p2} = w_2$ $F_{p2} = (\Sigma F_i)(w_{p2}) / (\Sigma w_i)$ $= (185 \text{ kips})(425 \text{ kips}) / (1,575 \text{ kips}) = 49.9$ kips</p> $\text{min. } F_{px} \geq 0.2 S_{DS} I_e w_{px}$ <p style="text-align: right;"><i>ASCE 7 (12.10-2)</i></p> $= 0.2 (1.37)(1.0)(425 \text{ kips}) = \underline{116 \text{ kips}} > 49.9 \text{ kips}$ <p>$\therefore \underline{116 \text{ kips}} \leftarrow$</p>
2.39	b	<p>p. 1-122 - Shear Wall with Openings & Figure 8.15 Given four piers (shown lightly shaded) fixed from rotation at the top <u>and</u> bottom of the piers ... use Relative Rigidity of Fixed Piers (Table D2). <u>Pier 1</u>: $H_1 / D_1 = 7.33' / 2.67' = 2.75 \rightarrow$ Table D2 (p. 5-23) $\rightarrow R_{F1} = 0.344$ <u>Pier 2</u>: $H_2 / D_2 = 4.0' / 2.67' = \mathbf{1.50} \rightarrow$ Table D2 (p. 5-23) $\rightarrow R_{F2} = 1.270$ <u>Pier 3 & 4</u>: $R_{F3} = R_{F4} = R_{F2} = 1.270$ $\Sigma R = R_{F1} + R_{F2} + R_{F3} + R_{F4} = 0.344 + 3(1.270) = 4.154$ $V_1 = F(R_{F1}) / \Sigma R = 25 \text{ kips} (0.344) / (4.154) = 2.07$ kips $\therefore \underline{2.1 \text{ kips}} \leftarrow$</p>
2.40	c	<p>p. 1-130 to 131 - Y-Direction: Torsional Irregularity Check From the figure: $\bar{X}_{CM} = 120' / 2 = 60'$ & $\bar{Y}_{CM} = 100' / 2 = 50'$ $\bar{X}_{CR} = 72'$ & $\bar{Y}_{CR} = 66.67'$ Calculated (inherent) eccentricity $e_x = \bar{X}_{CR} - \bar{X}_{CM} = 72' - 60' = 12'$ accidental eccentricity $e_x = \pm 5\% L_x = 5\% (120') = \pm 6'$ The governing (i.e., maximum) force to the shear walls on line 1 will occur when the <i>CM</i> is moved nearest to line 1 where the maximum <u>additive</u> torsional shear will occur: $e_{x1} = 12' + 6' = 18'$ $M_{T1} = V \cdot e_{x1} = 192 \text{ kips} (18') = 3,456 \text{ kip-ft}$ $\Sigma R d^2 = R_{1A} d_{1A}^2 + R_{1B} d_{1B}^2 + R_2 d_2^2 + R_A d_A^2 + R_B d_B^2$ $= 1(72')^2 + 1(72')^2 + 3(48')^2 + 4(33.33')^2 + 2(66.67')^2 = 30,613 \text{ ft}^2$ $\text{max. } F_{1A} = V \frac{R_{1A}}{R_{1A} + R_{1B} + R_2} + \frac{M_{T1} R_{1A} d_{1A}}{\Sigma R d^2}$ $= 192 \text{ kips} (1) / (1 + 1 + 3) + 3,456 \text{ kip-ft} (1)(72 \text{ ft}) / 30,613 \text{ ft}^2$ $= 38.4 \text{ kips} + 8.1 \text{ kips} = 46.5 \text{ kips}$ $\therefore \underline{47 \text{ kips}} \leftarrow$</p>

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2.41	c	<p>p. 1-102 - Nonbuilding Structures Supported by Other Structures & ASCE 7-16 p. 146 - §15.3 Water storage tank required to maintain water pressure for fire suppression → IBC Table 1604.5 → RC = IV $I_e = 1.5$ – ASCE 7-16 p. 5 - Table 1.5-2 for RC = IV Total effective seismic weight, $W = 450 \text{ kips} + 50 \text{ kips} = 500 \text{ kips}$ Weight of tank to total weight = $W_p / W = 450 \text{ kips} / 500 \text{ kips} = 90\% > 25\%$ & period of tank = $0.04 \text{ sec} < 0.06 \text{ sec}$ → use §15.3.2, item 1 Steel special concentrically braced frames → ASCE 7-16 – Table 12.2-1, Type B.2 → $R = 6$ Site Class D & $S_S = 1.04$ → Table 3.1 → $S_{DS} = 0.75$ (by interpolation) Site Class D & $S_1 = 0.45$ → Table 3.2 → $S_{D1} = 0.56$ (by interpolation) $T_s = S_{D1} / S_{DS} = (0.56) / (0.75) = 0.75 \text{ second}$ $T = 0.55 \text{ sec (given)} < T_s = 0.75 \text{ sec}$ → ASCE 7 (12.8-2) <u>will</u> govern for C_s $C_s = \frac{S_{DS}}{(R/I_e)} \quad \text{ASCE 7 (12.8-2)}$ $= \frac{0.75}{(6/1.5)} = 0.188$ $V = C_s W \quad \text{ASCE 7 (12.8-1)}$ $= 0.188 (500 \text{ kips}) = 94 \text{ kips}$ ∴ <u>94 kips</u> ←</p>
2.42	c	<p>p. 1-124 - Center of Mass, CM <u>By inspection:</u> \bar{X}_{CM} should be slightly <u>greater than</u> $120' / 2 = 60'$ and \bar{Y}_{CM} should be slightly <u>less than</u> $80' / 2 = 40'$... which eliminates choices a, b & d (i.e., c must be the correct answer) <u>OR by calculation:</u> Wall weights $W_w = 20 \text{ kips}$ (given for 5 walls) Roof weight $W_1 = (120')(80' - 20')(80 \text{ psf}) = 576 \text{ kips}$ Roof weight $W_2 = W_3 = (40')(20')(80 \text{ psf}) = 64 \text{ kips}$ $\sum W = 5 \text{ walls} (20 \text{ kips}) + 576 \text{ kips} + 2 (64 \text{ kips}) = 804 \text{ kips}$ $\bar{X}_{CM} = \frac{\sum W \bar{x}}{\sum W}$ $= \frac{20^K (0' + 20' + 100' + 100' + 120') + 576^K (60') + 64^K (20' + 100')}{804^K} = 61.0'$ $\bar{Y}_{CM} = \frac{\sum W \bar{y}}{\sum W}$ $= \frac{20^K (0' + 20' + 20' + 80' + 80') + 576^K (30') + 64^K (70' + 70')}{804^K} = 37.6'$ ∴ <u>(61.0', 37.6')</u> ←</p>