4.34 Which shear wall would be considered the least ductile?

a. A
b. B
c. C
d. 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?

a. 444 kips
b. 912 kips
c. 1,140 kips
d. 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*.

a. 15 kips
b. 23 kips
c. 28 kips
d. 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?

a. 0.069 W
b. 0.088 W
c. 0.103 W
d. 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:

a. slightly smaller
b. much smaller
c. equal
d. greater

4.39 In the *ASCE 7-16*, the factor Ω_0 represents an/a:

a. increase due to actual seismic forces
b. decrease due to actual seismic forces
c. increase of factor of safety for workmanship and materials
d. 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?

a. 1 to 1
b. 2½ to 1
c. 4 to 1
d. 8 to 1

Problem	Answer	Reference / Solution
		Site Class E & S_S = 2.13 → Table 3.1 → S_{DS} = 1.70 (by interpolation) *Site Class* E & S_1 = 0.74 → Table 3.2 → S_{D1} = 0.99 (by interpolation) $S_1 = 0.74 < 0.75$ → must use *Tables 1613.2.5(1)* & *(2)* to determine *SDC* S_{DS} = 1.70 & *RC* = IV → *Table 1613.2.5(1)* → *SDC* = D S_{D1} = 0.99 & *RC* = IV → *Table 1613.2.5(2)* → *SDC* = D ∴ <u>*SDC* = D</u> ←
1.32	c	p. 1-104 - Nonbuilding Structure NOT Similar to a Building Cooling tower is part of HVAC system for a <u>Hospital</u> → *IBC Table 1604.5* → *RC* = IV I_e = 1.5 – *ASCE 7-16* p. 5 - *Table 1.5-2* *R* = 3.5 – *ASCE 7-16* p. 148 - *Table 15.4-2* – cooling tower (steel) Operating weight, *W* = 70,800 lbs … ignore the shipping weight *T* = 0.12 sec (given) > 0.06 sec → 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 → *ASCE 7 (12.8-2)* <u>will</u> govern for C_s $C_S = \dfrac{S_{DS}}{(R/I_e)}$ = (0.77) / (3.5 / 1.5) = 0.33 *ASCE 7 (12.8-2)* $V = C_s W$ *ASCE 7 (12.8-1)* = 0.33 (70,800 lbs) = 23,400 lbs ∴ <u>23,400 lbs</u> ←
1.33	b	p. 1-44 - Bearing Wall System *Shear walls* which resist lateral loads <u>and</u> support vertical gravity loads. ∴ <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> ←
1.34	a	p. 1-119 - Chord Force N-S: $w_s = f_{px} = F_{px} / L$ = 25 kips / 100′ = 250 plf $CF_{\text{N-S}} = w_s L^2 / 8d$ = 250 plf $(100')^2$ / (8)(50′) = 6,250 lbs E-W: $w_s = f_{px} = F_{px} / L$ = 25 kips / 50′ = 500 plf $CF_{\text{E-W}} = w_s L^2 / 8d$ = 500 plf $(50')^2$ / (8)(100′) = 1,563 lbs $CF_{\text{N-S}} / CF_{\text{E-W}}$ = (6,250 lbs) / (1563 lbs) = 4.0 ∴ $CF_{\text{N-S}}$ = <u>4</u> ($CF_{\text{E-W}}$) ←
1.35	b	p. 1-104 - Rigid Nonbuilding Structures & *ASCE 7-16* p. 149 - *§15.4.2* Wastewater treatment facilities → *IBC Table 1064.5* → *RC* = III I_e = 1.25 – *ASCE 7-16* p. 5 - *Table 1.5-2* *W* = 45 kips S_{DS} = 0.87 *T* = 0.05 second < 0.06 second → <u>Rigid</u> nonbuilding structure $V = 0.30 S_{DS} W I_e$ *ASCE 7 (15.4-5)* = 0.30(0.87)(45 kips)(1.25) = 14.7 kips ∴ <u>15 kips</u> ←

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

Problem	Answer	Reference / Solution
		$F_{px} = \dfrac{\sum_{i=x}^{n} F_i}{\sum_{i=x}^{n} w_i} w_{px}$ *ASCE 7 (12.10-1)* 3[rd] 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 $w_{p2} = w_2$ $F_{p2} = (\Sigma F_i)(w_{p2}) / (\Sigma w_i)$ $= (185$ kips$)(425$ kips$) / (1{,}575$ kips$) = 49.9$ kips min. $F_{px} \geq 0.2 S_{DS} I_e w_{px}$ *ASCE 7 (12.10-2)* $= 0.2\,(1.37)(1.0)(425$ kips$) =$ <u>116 kips</u> > 49.9 kips ∴ <u>116 kips</u> ←
2.39	b	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>: $H_1 / D_1 = 7.33' / 2.67' = 2.75$ → Table D2 (p. 5-23) → $R_{F1} = 0.344$ <u>Pier 2</u>: $H_2 / D_2 = 4.0' / 2.67' = 1.50$ → Table D2 (p. 5-23) → $R_{F2} = 1.270$ <u>Pier 3 & 4</u>: $R_{F3} = R_{F4} = R_{F2} = 1.270$ $\Sigma R = R_{F1} + R_{F2} + R_{F3} + R_{F4} = 0.344 + 3\,(1.270) = 4.154$ $V_1 = F\,(R_{F1}) / \Sigma R = 25$ kips $(0.344) / (4.154) = 2.07$ kips ∴ <u>2.1 kips</u> ←
2.40	c	p. 1-130 to 131 - *Y*-Direction: Torsional Irregularity Check From the figure: $\overline{X}_{CM} = 120' / 2 = 60'$ & $\overline{Y}_{CM} = 100' / 2 = 50'$ $\overline{X}_{CR} = 72'$ & $\overline{Y}_{CR} = 66.67'$ Calculated (inherent) eccentricity $e_x = \overline{X}_{CR} - \overline{X}_{CM} = 72' - 60' = 12'$ 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 *CM* is moved nearest to line 1 where the maximum <u>additive</u> torsional shear will occur: $e_{x1} = 12' + 6' = 18'$ $M_{T1} = V \cdot e_{x1} = 192$ kips $(18') = 3{,}456$ kip-ft $\sum Rd^2 = R_{1A} d_{1A}^2 + R_{1B} d_{1B}^2 + R_2 d_2^2 + R_A d_A^2 + R_B d_B^2$ $= 1\,(72')^2 + 1\,(72')^2 + 3\,(48')^2 + 4\,(33.33')^2 + 2\,(66.67')^2 = 30{,}613$ ft^2 max. $F_{1A} = V \dfrac{R_{1A}}{R_{1A} + R_{1B} + R_2} + \dfrac{M_{T1} R_{1A} d_{1A}}{\sum Rd^2}$ $= 192$ kips $(1) / (1 + 1 + 3) + 3{,}456$ kip-ft $(1)(72$ ft$) / 30{,}613$ ft^2 $= 38.4$ kips $+ 8.1$ kips $= 46.5$ kips ∴ <u>47 kips</u> ←

<table>
<tr><th>Problem</th><th>Answer</th><th>Reference / Solution</th></tr>
<tr><td>2.41</td><td>c</td><td>
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 kips + 50 kips = 500 kips
Weight of tank to total weight = W_p / W = 450 kips / 500 kips = 90% > 25%
& period of tank = 0.04 sec < 0.06 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)
$T_S = S_{D1}/S_{DS} = (0.56)/(0.75) = 0.75$ second
$T = 0.55$ sec (given) < $T_s = 0.75$ sec → ASCE 7 (12.8-2) <u>will</u> govern for C_S
$C_S = \dfrac{S_{DS}}{(R/I_e)}$ ASCE 7 (12.8-2)
$= \dfrac{0.75}{(6/1.5)} = 0.188$
$V = C_S W$ ASCE 7 (12.8-1)
$= 0.188$ (500 kips) = 94 kips
∴ <u>94 kips</u> ←
</td></tr>
<tr><td>2.42</td><td>c</td><td>
p. 1-124 - Center of Mass, CM
<u>By inspection</u>: $\overline{X}_{CM}$ should be slightly <u>greater than</u> 120′ / 2 = 60′ and $\overline{Y}_{CM}$ 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 kips (given for 5 walls)
Roof weight W_1 = (120′)(80′ – 20′)(80 psf) = 576 kips
Roof weight $W_2 = W_3$ = (40′)(20′)(80 psf) = 64 kips
ΣW = 5 walls (20 kips) + 576 kips + 2 (64 kips) = 804 kips
$\overline{X}_{CM} = \dfrac{\sum W\,\overline{x}}{\sum W}$
$= \dfrac{20^K(0'+20'+100'+100'+120')+576^K(60')+64^K(20'+100')}{804^K} = 61.0'$
$\overline{Y}_{CM} = \dfrac{\sum W\,\overline{y}}{\sum W}$
$= \dfrac{20^K(0'+20'+20'+80'+80')+576^K(30')+64^K(70'+70')}{804^K} = 37.6'$
∴ <u>(61.0′, 37.6′)</u> ←
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