Practice Exam 1, Problem 4

Test Bank Question preview

Question

A 155 ft (47 m) steel building in Los Angeles will be braced laterally by a steel eccentrically braced frame structure. The structure will be utilized as a communication center that can respond in emergencies. The geotechnical engineer estimates the S_1 and S_S values are 0.2 and 0.5, respectively. The design base shear using the equivalent lateral-force procedure is most nearly

Answers

(A) 0.42W

(B) 0.044W

(C) 0.057W

(D) 0.088W

The answer is (A).

Solution

SI Solution

The mapped acceleration parameters are given in the problem statement as 0.2 and 0.5. The site class is not given, therefore, it is assumed to be site class D according to ASCE/SEI7 Sec. 11.4.3.

To obtain the site coefficients and the risk-targeted maximum considered earthquake (MCE_R) spectral response acceleration parameters, use ASCE/SEI7 Sec. 11.4.4. For S_S = 0.5 and site class D, the site coefficient, F_a, is 1.4 [ASCE/SEI7 Table 11.4-1]. For S_1 = 0.2 and site class D, the site coefficient, F_v, is 2.2 [ASCE/SEI7 Table 11.4-2].

The MCE_R spectral response acceleration for short periods, S_{MS}, and a 1 s period, S_{M1}, is given by ASCE/SEI7 Eq. 11.4-1 and Eq. 11.4-2.

$$S_{MS} = F_a S_S = (1.4)(0.5) = 0.7$$
$$S_{M1} = F_v S_1 = (2.2)(0.2) = 0.44$$

QUESTION DATA

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DISCIPLINES

CA Civil Seismi (/admin/questio sfield=discipline Civil Seismic)

SE Lateral Forc Vertical Forces (/admin/questio

The design spectral acceleration parameters are given by ASCE/SEI7 Eq. 11.4-3 and Eq. 11.4-4.

$$S_{DS} = \tfrac{2}{3} S_{MS} = \left(\frac{2}{3}\right)(0.7) = 0.47$$
$$S_{D1} = \tfrac{2}{3} S_{M1} = \left(\frac{2}{3}\right)(0.44) = 0.29$$

Determine the risk category for the building based on ASCE/SEI7 Table 1.5-1. For this building, the risk category is IV.

From ASCE/SEI7 Sec. 11.5.1 and Table 1.5-2, the importance factor, I_e, is 1.5. From ASCE/SEI7 Table 12.2-1, the response modification factor, R, is 8.

Determine the building's time period based on ASCE/SEI7 Sec. 12.8.2. From ASCE/SEI7 Table 12.8-2, $C_t = 0.0731$ and $x = 0.75$.

$$T_a = C_t h_n^x = (0.0731)(47 \text{ m})^{0.75} = 1.312 \text{ s}$$

ASCE/SEI7 Sec. 12.8 states the procedure for the equivalent lateral force method.

$$\begin{aligned} C_s &= \frac{S_{DS}}{\frac{R}{I_e}} = \frac{0.47}{\frac{8}{1.5}} \\ &= 0.088 \qquad [\text{ASCE/SEI7 Eq. 12.8-2}] \\ C_{s,\max} &= \frac{S_{D1}}{T_a\left(\frac{R}{I_e}\right)} = \frac{0.29}{(1.312 \text{ s})\left(\frac{8}{1.5}\right)} \\ &= 0.42 \qquad [\text{ASCE/SEI7 Eq. 12.8-3}] \end{aligned}$$

ASCE/SEI7 Eq. 12.8-3 is valid for $T \leq T_L$. (In California, T_L is either 8 s or 12 s, so ASCE/SEI7 Eq. 12.8-4 will not be valid.)

$$\begin{aligned} C_s &= 0.044 S_{DS} I_e \geq 0.01 \quad [\text{ASCE/SEI7 Eq. 12.8-5}] \\ &= (0.044)(0.47)(1.5) \\ &= 0.031 \quad [\geq 0.01, \text{OK}] \\ C_{s,\text{gov}} &= 0.031 \end{aligned}$$

Per ASCE/SEI7 Eq. 12.8-1, the base shear is

$$V = C_s W = 0.42 W$$

Customary U.S. Solution

sfield=discipline Lateral Forces Vertical Forces)

KNOWLEDGE AREAS

Seismic Forces Structures (/admin/questio sfield=area&ste Forces: Building Structures)

Seismic static f procedures (/admin/questio sfield=area&ste static force proc

PRODUCTS USED IN
SEIS2EX

The mapped acceleration parameters are given in the problem statement as 0.2 and 0.5. The site class is not given, therefore, it is assumed to be site class D according to ASCE/SEI7 Sec. 11.4.3.

To obtain the site coefficients and the risk-targeted maximum considered earthquake (MCE_R) spectral response acceleration parameters, use ASCE/SEI7 Sec. 11.4.4. For $S_S = 0.5$ and site class D, the site coefficient, F_a, is 1.4 [ASCE/SEI7 Table 11.4-1]. For $S_1 = 0.2$ and site class D, the site coefficient, F_v, is 2.2 [ASCE/SEI7 Table 11.4-2].

The MCE_R spectral response acceleration for short periods, S_{MS}, and a 1 sec period, S_{M1}, is given by ASCE/SEI7 Eq. 11.4-1 and Eq. 11.4-2.

$$\begin{aligned} S_{MS} &= F_a S_S = (1.4)(0.5) = 0.7 \\ S_{M1} &= F_v S_1 = (2.2)(0.44) = 0.44 \end{aligned}$$

The design spectral acceleration parameters are given by ASCE/SEI7 Eq. 11.4-3 and Eq. 11.4-4.

$$\begin{aligned} S_{DS} &= \tfrac{2}{3} S_{MS} = \left(\frac{2}{3}\right)(0.7) = 0.47 \\ S_{D1} &= \tfrac{2}{3} S_{M1} = \left(\frac{2}{3}\right)(0.44) = 0.29 \end{aligned}$$

Determine the risk category for the building based on ASCE/SEI7 Table 1.5-1. For this building, the risk category is IV.

From ASCE/SEI7 Sec. 11.5.1 and Table 1.5-2, the importance factor, I_e, is 1.5. From ASCE/SEI7 Table 12.2-1, the response modification factor, R, is 8.

Determine the time period of the building based on ASCE/SEI7 Sec. 12.8.2. From ASCE/SEI7 Table 12.8-2, $C_t = 0.03$ and $x = 0.75$.

$$T_a = C_t h_n^x = (0.03)(155 \text{ ft})^{0.75} = 1.318 \text{ sec}$$

ASCE/SEI7 Sec. 12.8 states the procedure for the equivalent lateral force method.

$$\begin{aligned} C_s &= \frac{S_{DS}}{\frac{R}{I_e}} = \frac{0.47}{\frac{8}{1.5}} \\ &= 0.088 \quad [\text{ASCE/SEI7 Eq. 12.8-2}] \\ C_{s,\max} &= \frac{S_{D1}}{T_a\left(\frac{R}{I_e}\right)} = \frac{0.29}{(1.318 \text{ sec})\left(\frac{8}{1.5}\right)} \\ &= 0.42 \quad [\text{ASCE/SEI7 Eq. 12.8-3}] \end{aligned}$$

ASCE/SEI7 Eq. 12.8-3 is valid for $T \leq T_L$. (In California, T_L is either 8 sec or 12 sec, so ASCE/SEI7 Eq. 12.8-4 will not be valid.)

$$\begin{aligned} C_{s,\min} &= 0.044 S_{DS} I_e \geq 0.01 \quad [\text{ASCE/SEI7 Eq. 12.8-5}] \\ &= (0.044)(0.47)(1.5) \\ &= 0.031 \quad [\geq 0.01, \text{OK}] \\ C_{s,\text{gov}} &= 0.031 \end{aligned}$$

Per ASCE/SEI7 Eq. 12.8-1, the base shear is

$$V = C_s W = \sout{0.42} W$$

steel bracing or unreinforced masonry infill walls can be modified by removing the bracing or the infill walls and installing eccentric bracing or reinforced concrete shear walls.

The answer is (A).

27. *SI Solution*

$$\begin{aligned} b &= 4.6 \text{ m} + 7.6 \text{ m} \\ &= 12.2 \text{ m} \\ V &= \left(7300 \ \frac{\text{N}}{\text{m}}\right)(12.2 \text{ m}) \\ &= 89\,060 \text{ N} \end{aligned}$$

Alternatively,

$$\begin{aligned} V_{\text{panel I}} &= \left(7300 \ \frac{\text{N}}{\text{m}}\right)(4.6 \text{ m}) \\ &= 33\,580 \text{ N} \\ V_{\text{panel II}} &= \left(7300 \ \frac{\text{N}}{\text{m}}\right)(7.6 \text{ m}) \\ &= 55\,480 \text{ N} \end{aligned}$$

$$\begin{aligned} V &= V_{\text{panel I}} + V_{\text{panel II}} \\ &= 33\,580 \text{ N} + 55\,480 \text{ N} \\ &= 89\,060 \text{ N} \quad (89\,000 \text{ N}) \end{aligned}$$

The answer is (B).

Customary U.S. Solution

$$\begin{aligned} b &= 15 \text{ ft} + 25 \text{ ft} \\ &= 40 \text{ ft} \\ V &= \left(500 \ \frac{\text{lbf}}{\text{ft}}\right)(40 \text{ ft}) \\ &= 20{,}000 \text{ lbf} \end{aligned}$$

Alternatively,

$$\begin{aligned} V_{\text{panel I}} &= \left(500 \ \frac{\text{lbf}}{\text{ft}}\right)(15 \text{ ft}) \\ &= 7500 \text{ lbf} \\ V_{\text{panel II}} &= \left(500 \ \frac{\text{lbf}}{\text{ft}}\right)(25 \text{ ft}) \\ &= 12{,}500 \text{ lbf} \\ V &= V_{\text{panel I}} + V_{\text{panel II}} \\ &= 7500 \text{ lbf} + 12{,}500 \text{ lbf} \\ &= 20{,}000 \text{ lbf} \end{aligned}$$

The answer is (B).

28. The provision "Practice within Area of Competence," Sec. 415 of the Rules of the Board, specifies that a professional registered engineer can practice and perform engineering work only in the field(s) in which the engineer is educated and/or experienced and is fully competent and proficient.

The Rules prohibit a professional highway engineer from being in responsible charge in areas other than those in which the engineer is qualified. Therefore, the engineer cannot design high-rises, hospitals, or highway bridge structures unless the engineer is fully competent in those areas. (Competency and proficiency in highway and transportation design do not qualify a civil PE to be in responsible charge of the design of a highway bridge structure.) The responsible charge for designing hospitals in California is restricted to licensed structural engineers [Health and Safety Code, Sec. 129805(a)]. In some areas of California, the design of high-rises is also restricted to licensed structural engineers. Where these restrictions apply, a professional highway engineer can perform engineering design work only under the direction of the licensed structural engineer who is responsible for signing final plans.

The answer is (B).

29. The NEHRP publication, *Recommended Provisions for Seismic Regulations for New Buildings and Other Structures*, states that the primary goal of seismic design is

1. to provide minimum design criteria for structures appropriate to their primary function and use considering the need to protect the health, safety, and welfare of the general public by minimizing the earthquake-related risk to life

2. to improve the capability of essential facilities and structures containing substantial quantities of hazardous materials to function during and after design earthquakes

Damage control (i.e., preventing structure failures or preserving property) is not the primary focus of seismic design.

The answer is ~~(A)~~.

30. Ductility is the ability of a material to yield without collapse. The structure response modification factor, R, is a measure of inherent overstrength and global ductility and is determined from the type of structural system selected. It is defined for buildings in ASCE/SEI7 Table 12.2-1 and for nonbuilding structures in ASCE/SEI7 Table 15.4-1 and Table 15.4-2.

48. ASCE/SEI7 Sec. 12.2.2 allows different response modification factor, R, values for the x- and y-directions of a structure. ASCE/SEI7 Sec. 12.2.3.1 explains how to determine the R value if two different systems are used for different levels of a structure in the same direction (e.g., the y-direction). When the upper system has a lower value of R, this lower value should be used for the entire height of the structure. For the two steel systems shown, ASCE/SEI7 Table 12.2-1 lists an R value of 6 for the steel special concentrically braced frame (the upper system), and a value of 8 for the steel special moment resisting frame, (the lower system). Use the lower value of 6 for R in the y-direction.

The answer is (B).

49. Based on IBC Table 2306.3(1), a maximum allowable shear stress of 315 lbf/ft (4600 N/m) will be achieved when the staple spacing at the wood structural panel edges is 3 in (76 mm).

The answer is (B).

50. According to IBC Sec. 202 (Definitions), an approved agency is approved by the local building official or authority having jurisdiction for the purpose of conducting materials testing or inspection of civil engineering projects.

IBC Sec. 202 also states that an inspection certificate is applied on a product or material to indicate that it has been inspected and evaluated by an approved agency. An inspection certificate cannot be applied to an entire building.

According to IBC Sec. 202 (Definitions), continuous special inspection must be performed by a special inspector who is present when and where the work to be inspected is being done. A continuous special inspection may be performed by ~~a part-time~~ inspector as long as he or she fulfills this requirement.

IBC Sec. 202 (Definitions) explicitly does not permit structural observation to include or waive the responsibility for work performed by a qualified inspector.

The answer is (C).

51. IBC Sec. 1705.4.2 states that special inspections are required for vertical masonry foundation elements. IBC Table 1705.3 states that special inspections are required for anchors cast in concrete. IBC 1705.2.2 states that special inspections are required for cold-formed steel decks. Therefore, all three types of construction would require special inspection.

The answer is (D).

52. A diaphragm anchor resists an out-of-plane seismic load by connecting the structural wall to the roof diaphragm. The in-plane shear flow loads are not relevant. The design force on individual anchors is calculated in accordance with ASCE/SEI7 Sec. 12.11 and requires knowing the weight of the tributary portion of the wall. The redundancy factor is not needed to calculate the anchor design force.

The answer is (A).

53. ASCE/SEI7 Table 12.3-2 defines both weak and soft stories as types of vertical irregularities. Soft-story irregularity is related to story stiffness, and is not related to story strength (i.e., load-carrying ability). According to items 5a and 5b of ASCE/SEI7 Table 12.3-2, weak stories must be checked against the lateral strength of the story directly above it. Per item 5a of ASCE/SEI7 Table 12.3-2, a weak story exists if the lateral strength of a story is greater than 66% but less than 80% of the strength of the story directly above it. Under item 5b of ASCE/SEI7 Table 12.3-2, an extreme weak story exists if the lateral strength of the story is less than 65% of the strength of the story directly above it.

SI Solution

The first level of the building is the potential soft story. This first level must be checked against the story directly above it. The 80% and 65% limit values for the lateral strength of the lower story are

$$V_{\text{weak}} = (0.80)(1100\ \text{kN}) = 880\ \text{kN}$$
$$V_{\text{ext-weak}} = (0.65)(1100\ \text{kN}) = 715\ \text{kN}$$

Since the lower story strength of 800 kN is less than the 80% limit of 880 kN, but more than the 65% limit of 715 kN, the building is defined as a weak story irregularity.

The answer is (C).

Customary U.S. Solution

The first level of the building is the potential soft story. This first level must be checked against the story directly above it. The 80% and 65% limit values for the lateral strength of the lower story are

$$V_{\text{weak}} = (0.80)(250\ \text{kips}) = 200\ \text{kips}$$
$$V_{\text{ext-weak}} = (0.65)(250\ \text{kips}) = 163\ \text{kips}$$

Since the lower story lateral strength of 180 kips is less than the 80% limit of 200 kips but more than the 65% limit of 163 kips, the building has a weak story irregularity.

The answer is (C).

54. ASCE/SEI7 Sec. 12.2 describes eight major types of structural systems (bearing wall, building frame, moment-resisting frame, dual systems with special moment-resisting frames, dual systems with intermediate moment-resisting frames, shear wall-frame, cantilevered column, and steel systems without seismic detailing). The factors used to determine a structural system's base shear are the response modification factor, R, the overstrength factor, Ω_O, and the deflection

Practice Exam 1, Problem 98

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Test Bank Question preview

Question

A geotechnical engineering report finds an existing foundation with deficient piles/drilled piers. The capacity of the piles or drilled-piers foundation can be ~~increased~~ by

I. removing the existing pile caps, driving additional piles, and providing new pile caps of larger size

II. reducing loads on the piles or piers

III. adding tie beams between pile caps

Answers

(A) I only

(B) I and II only

(C) II and III only

(D) I, II, and III

The answer is (D).

Solution

Foundations with piles or drilled piers that lack lateral force capacity to adequately transfer the seismic shears from the pile caps and the piles to the soil (ground) can be improved by

- removing the existing pile caps, driving additional piles, and providing new pile caps of larger size.
- reducing loads on the piles or piers. This can be done by providing supplemental vertical-resisting elements (i.e., shear walls or braced frames) and transferring forces to other foundation members with reserve capacity.
- adding tie beams to adjacent pile caps. This measure causes the loads on pile caps to be reduced and distributed.

IBC Chap. 18 contains additional information about foundations.

QUESTION DATA

Vendor

0000005303

Solving Time

Difficulty

easy

Quantitative?

No

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OTHER VERSIONS

DISCIPLINES

CA Civil Seismic (/admin/questions/i sfield=discipline&st Civil Seismic)

SE Lateral Forces Vertical Forces (/admin/questions/i sfield=discipline&st Lateral Forces and Vertical Forces)

KNOWLEDGE AREAS

Seismic Characteri Engineered Systen (/admin/questions/i sfield=area&stext=