Seismic Ratings

University of California

Covel Commons

CAAN: 4302D

(Excerpt from 2017 UC Seismic Studies Report)

Englekirk INSTITUTIONAL

June 30, 2017

Job No. 15-G103A

Seismic Ratings

University of California

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Executive Summary

This report provides Seismic Ratings for all existing buildings listed in the Existing Building Matrix provided below. These buildings are located on various University of California campuses including Berkeley, Irvine, Los Angeles, Riverside, and San Diego.

The Seismic Ratings were based on University of California Seismic Safety Policy, Table A.1. *2016 California Building Code* (CBC) – Part 10 and American Society of Civil Engineers Standard *Seismic Rehabilitation of Existing Buildings*, ASCE 41-13 were used for all building evaluations.

Record drawings were reviewed and Tier 1 and Tier 2 analysis was performed for each building for the BSE-1E level seismic demand for a Life Safety or Damage Control performance objective. Site visits and visual observation was performed for buildings for which record drawings were not available.

The seismic evaluation methodology was based on the ASCE 41-13 Tier 1 Screening and Tier 2 Deficiency Based Evaluation. The Tier 1 Screening consists of checklists, which allow for a rapid evaluation of the existing structure to a desired performance level.

The Basic Performance Objective for Existing Buildings (BPOE) for the buildings depends on their Risk Category as defined in Table 1604.5 of CBC 2016. Most of the buildings under this scope of work belonged to Risk Category III, while some belonged to Risk Categories I and II. For Tier 1 and Tier 2 analysis the BPOE was either Life Safety or Damage Control based on Table 2-1 of ASCE 41-13

Seismic spectral accelerations used in this evaluation for the various campuses were obtained from probabilistic seismic hazard mapping software developed by the Unites States Geological Survey (USGS). Some of the buildings being evaluated were located in the “Zones of Required Investigation”, published in the Regulatory Maps by the California Geological Survey. These maps locate the potential liquefaction and landslide zones in the State of California.

Most of the buildings that have been evaluated were found to qualify for a Seismic Rating of IV i.e. they either meet or exceed the requirements of Part 10 of the 2016 CBC, the *California Existing Building Code*, for Life Safety performance objective for a BSE-1E event that has a 20% probability of occurrence in 50 years. All these buildings belonged to Risk categories I, II or III.

Some of the buildings have been recently retrofitted that helped in increasing their rating from the original construction. These buildings have either been rated III i.e. they meet the structural requirements for a

new building per the 2016 CBC meeting the seismic demands of a BSE-1N event that has a 10% probability of occurrence in 475 years , or they have been rated IV.

Few buildings did not meet the criteria to qualify for a rating of III or IV, and they have been rated V i.e. they meet the Life Safety performance criteria if the seismic demands are reduced to 2/3 of a BSE-1E event.

Two buildings on the UC Berkeley campus, 1601 Allston Way and Cloyne Court are in the seismic "Zone of Required Investigation". One of the buildings is located at the edge of a fault rupture zone and the other is located over a thin fragment of liquefaction zone. Structures located in such regulatory zones run the risk of increased seismic vulnerability due to a fault rupture or differential foundation settlement in case of liquefaction during a seismic event, respectively. It is recommended that the seismic rating of both these structures be confirmed via peer review.

Table shown below summarizes the seismic evaluation results derived from our analysis.

18	**COVEL COMMON** (UCLA North West Housing)	Complete Set Available	C2 - S2 (Vertical Combination)	1989	IV	1. Deflection Compatibility of secondary components: Insufficient ties in reinforced concrete columns 2. Connections in concentric braced frames cannot develop yield cap. of diagonals	1. Four Story building with a mechanical level. 2. Shear wall building with steel truss and braced frames at roof level.

1.0 Introduction

1.1 General

This report provides Seismic Ratings for all existing buildings listed in the Existing Building Matrix provided below. These buildings are located on various University of California campuses including Berkeley, Irvine, Los Angeles, Riverside, and San Diego.

Table 1.1 Existing Building Matrix

Ref #	Campus	Zip	CAAN	Name
	UCLA	90095		
18			4302D	COVEL COMMON

The Seismic Ratings were based on University of California Seismic Safety Policy, Table A.1 shown below. *2016 California Building Code* (CBC) – Part 10 and American Society of Civil Engineers Standard *Seismic Rehabilitation of Existing Buildings*, ASCE 41-13 were used for all building evaluations.

Table 1.2 Seismic Ratings and Expected Seismic performance Level

Table A.1. Determination of Expected Seismic Performance Level[1] Based on the Edition, California Code of Regulations, Part 10, California Building Code (CBC) (current edition)

Definitions based upon California Building Code (CBC) requirements for seismic evaluation of buildings using Risk Categories of CBC Table 1604A.5, depending on which applies, and performance criteria in CBC Table 317.5[2]	**Expected Seismic Performance Level [1]**
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria with BSE-1N and BSE-2N hazard levels replacing BSE-R and BSE-C as given in Chapter 3.	I
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category IV performance criteria.	II
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria with BSE- 1N and BSE-2N hazard levels replacing BSE-R and BSE-C respectively as given in Chapter 3; alternatively, a building meeting CBC requirements for a new building.	III
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria.	IV
A building evaluated as meeting or exceeding the requirements of CBC Part 10 Chapter 3 for Risk Category I-III performance criteria only if the BSE-R and BSE-C values are reduced to 2/3 of those specified for the site.	V
A building evaluated as not meeting the minimum requirements for Level V designation and not requiring a Level VII designation.	VI
A building evaluated as posing an immediate life-safety hazard to its occupants under gravity loads. The building should be evacuated and posted as dangerous until remedial actions are taken to assure the building can support CBC prescribed dead and live loads.	VII

Notes:

1. Expected seismic performance levels are indicated by Roman numerals I through VII. Assignments are to be made following a professional assessment of the building's expected seismic performance as measured by a CSE's experience or referenced technical standard and earthquake ground motions. Equivalent Arabic numerals, fractional values, or plus or minus values are not to be used. These assignments were prepared by a task force of state agency technical personnel, including the California State University, the University of California, the California Department of General Services, the Division of the State Architect, and the Administrative Office of the Courts. The levels apply to structural and non-structural elements of the building as contained in Chapter 3, CBC Part 10 requirements. These definitions replace those previously used by these agencies.

2. Chapter 3 of the California Building Code Part 10, current edition, regulates existing buildings. It uses and references the American Society of Civil Engineers Standard *Seismic Rehabilitation of Existing Buildings, ASCE-41-13*. All earthquake ground motion criteria are specific to the site of the evaluated building. The CBC definitions for earthquake ground motions to be assessed are paraphrased below for convenience:

3. BSE-2N, the 2,475-year return period earthquake ground motion, or 150% of the Maximum Considered Earthquake ground motion for the site.

   BSE-C, the 975-year return period earthquake ground motion.

   BSE-1N, two-thirds of the BSE-2N, nominally, the 475-year return period earthquake ground motion. BSE-R, the 225-year return period earthquake ground motion.

   Risk Category is defined in the CBC Table 1604A.5. The risk category sets the level of required seismic building performance under the CBC. Risk Category IV includes acute care hospitals, fire, rescue and police stations and emergency vehicle garages, designated emergency shelters, emergency operations centers, and structures containing highly toxic materials where the quantities exceed the maximum allowed quantities, among others. Risk categories I-III includes all other building uses that include most state-owned buildings.

1.2 Tasks Performed

The following Tasks were performed for providing Seismic ratings for all buildings:

1. Review of existing drawings and other available documentation as provided by the various University campuses.
2. Site visits were performed for the following buildings because no record drawings could be obtained from the University archives:
3. Consistent with the requirements of ASCE 41-13 and the Seismic Performance Level, seismic ground motion parameters were obtained from the probabilistic seismic hazard mapping software developed by the United States geological Survey (USGS).

4. Review of fault locations in the vicinity of the buildings based on the maps published by the California Geological Survey.
5. Identification of the seismic force resisting system for the building based on record drawings or visual observation followed by the qualitative review of the lateral elements based on Tier 1 checklists for various Building Types included in ASCE 41-13. All Tier 1 checklists have been provided in Appendix A.
6. Tier 2 evaluations, per ASCE 41-13, for the deficiencies observed in the Tier 1 checklists. All Tier 2 calculations have been provided in Appendix B.
7. Seismic Ratings were assigned for all buildings included in the Existing Building Matrix based on the results of the Tier 1 and Tier 2 evaluations.

UC Seismic Safety Policy Section III, Sub-section C, Footnote 2, states " For purposes of seismic performance levels, falling hazards are interior and exterior building elements that may fall or slide during an earthquake, including parapets, ornamentation, chimneys, walls and partitions, but excluding equipment, fixtures, ceilings, furniture, furnishings, and other contents. The excluded elements should not be considered in the determination of the seismic performance rating of a facility." The relevant nonstructural elements that affect the seismic rating were detailed on the record drawings; as a result Tier 1 non-structural checklists had no bearing on the Seismic Rating of the buildings.

2.0 Seismic Evaluation Methodology

The seismic evaluation methodology is based on the ASCE 41-13 Tier 1 Screening and Tier 2 Deficiency Based Evaluation. The Tier 1 Screening consists of checklists, which allow for a rapid evaluation of the existing structure to desired performance level.

The Basic Performance Objective for Existing Buildings (BPOE) for the buildings depends on their Risk Category as defined in Table 1604.5 of CBC 2016. Most of the buildings under this scope of work belonged to Risk Category III, while some belonged to Risk Categories I and II. For Tier 1 and Tier 2 analysis the BPOE was either life Safety or Damage Control based on Table 2-1 of ASCE 41-13 as shown below:

Table 2.1 Basic Performance Objective for Existing Buildings (BPOE)
(Ref. ASCE 41-13 Table 2-1)

	Tier 1	Tier 2
Risk Category	**BSE-1E**	**BSE-1E**
I & II	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)	Life Safety Structural Performance Life Safety Nonstructural Performance (3-C)
III	See Note 1 for Structural Performance Position Retention Nonstructural Performance (2B)	Damage Control Sturtcural Performance Position Retention Nonstructural Performance (2-B)
IV	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)	Immediate Occupancy Structural Performance Position Retention Nonstructural Performance (1-B)

Note 1: For Risk category III, Tier I Screening Checklists shall be based on Life Safety Performance Level (S-3), except that checklists statements using Quick Check procedures of Section 4.5.3 shall be based on Ms-factors and other limits that are an average of the values for Life Safety and Immediate Occupancy.

The Tier 1 checklists were completed with each checklist item marked as any of the following: Compliant, Non-Compliant, Unknown or Not Applicable. Following the completion of the Tier 1 phase, Deficiency

based Tier 2 checks were performed. The scope of the tier 2 checks was limited to items marked as Non-Compliant per the Tier 1 Checklists.

Following the completion of Tier 2 Evaluation, we assigned a Seismic Rating to each building.

Figure 3.1.1 Zone of Require Investigation

3.3 University of California, Los Angeles

Site Latitude: 34.07407°N

Site Longitude: 118.44323°W

Site Class: D

Period (sec)	Spectral Accelerations for BSE-1E	Site Coefficients from ASCE 41-13 Tables 2-3,2-4	Design values per ASCE 41-13 Eqs. 2-4, 2-5
0.2	$S_{S,\ 20\%/50}$ = 0.793g	Fa = 1.183	$S_{XS,\ 20\%/50}$ = 0.938g
1.0	$S_{1,\ 20\%/50}$ = 0.284g	Fv = 1.831	$S_{X1,\ 20\%/50}$ = 0.521g

Based on the 0.2 second and 1.0 second spectral accelerations, in accordance with ASCE 41-13 Table 2-4, the level of seismicity at this site is defined as High.

The buildings being investigated are not located in a “Zone of Required Investigation”.

- Shear stress check in concrete shear walls: The shear stress in concrete shear walls is higher than the Tier 1 limit of 100 psi or 2 √f'c.
- Deflection Compatibility: secondary components due to insufficient ties in concrete columns.
- The steel penthouses and the steel elevator tower also demonstrate deficiencies such as: Inadequate moment frame connections, panel zones, and brace connections.

Tier 2 checks were performed for the deficiencies identified above and the results were found to be acceptable, for a BSE-1E level seismic event therefore, the building qualifies for a Seismic Rating of IV, as defined in Table 1.2.

4.13 COVEL COMMONS: Located at the UC Los Angeles campus, this building was built in 1989. Record drawings titled, "UCLA Northwest Housing/Parking Commons Building D", dated, November 20, 1989, and prepared by John A. Martin & Associates Structural Engineers and Gensler and Associates Architects were reviewed for this evaluation. An aerial view of the building is shown in Figure 4.18.1.

Figure 4.13.1 Covel Commons, UCLA (Source: Google Maps)

4.13.1 Building Description and Building Type: The UCLA Covel Commons is a five-story reinforced concrete shear wall building with a steel framed roof. The building has a rectangular plan with a semi-

circular extension at the east end, and an area of approximately 24,500 sq. ft. The building is located on a sloping site and is about 87' tall above the lowest grade elevation. The average inter-story height is 12'.

The floors are framed with 8" thick concrete flat slabs spanning between concrete columns with drops panels, and walls, all supported on piles. The roof and the upper roof levels are framed with un-topped metal deck spanning between steel beams, supported on steel girders and columns. These levels are laterally braced with steel braced frames. A large two-story space exists at the eastern semi-circular end of the building at Level 1. A typical floor framing plan is shown in figure 4.18.2.

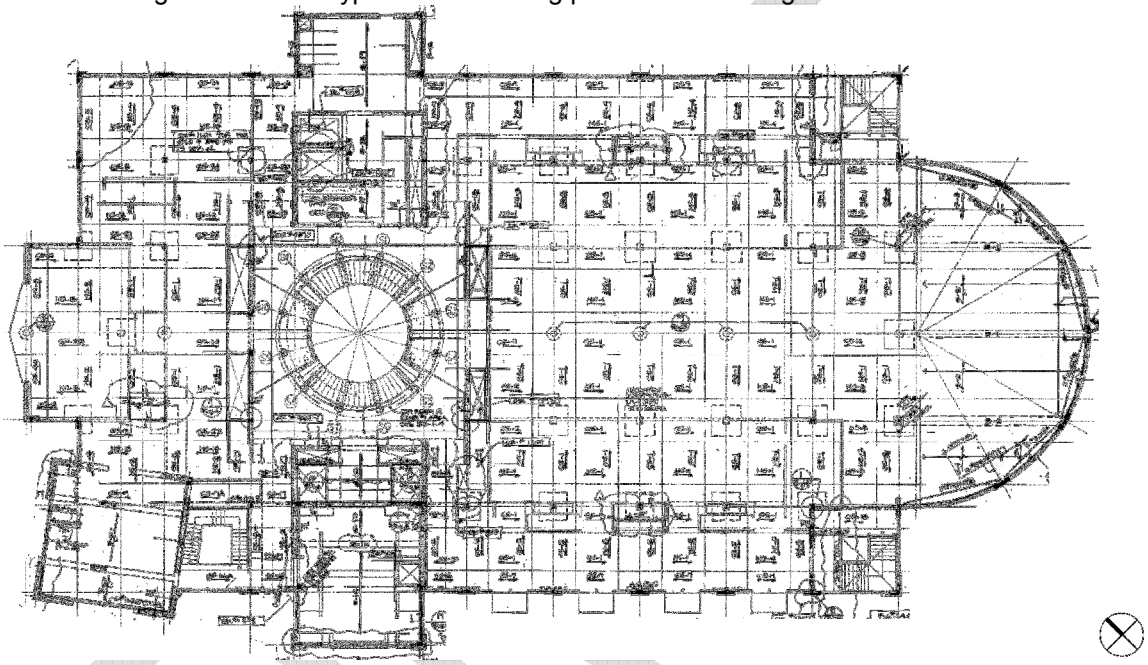

Figure 4.13.2 Typical Floor Framing Plan

Per ASCE 41-13, the building is classified as Building Type C2 and S2 in a vertical combination.

4.13.2 Seismic Rating: The following Tier 1 deficiencies were observed:

- Deflection Compatibility of secondary components due to insufficient concrete column ties.
- Connection of steel braced frames cannot develop yield capacity of diagonals.

Tier 2 checks were performed for the observed deficiencies and acceptable results were obtained for a BSE-1E level seismic event, therefore the building qualifies for a Seismic Rating of IV, as defined in Table 1.2.

APPENDIX A

Tier 1 Checklists

Chapter 16.0 Tier 1 Checklist

16.1 Basic Checklists
This Very Low Seismicity Checklist shall be completed for all building types in levels of very low seismicity being evaluated to the Life Safety Performance Level only. Tier 1 evaluation shall include on-site investigation and condition assessment as required by Section 4.2.1.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Noncompliant (NC), Unknown (U), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while noncompliant and unknown statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant and unknown evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C16.1.1 Very Low Seismicity Checklist
The evaluation statements provided represent all of the required statements for buildings in areas of very low seismicity being evaluated for Life Safety, including structural and nonstructural. The statements in the Very Low Seismicity Checklist section need not be completed for buildings in low, moderate, and high seismicity and for buildings in very low seismicity being evaluated for Immediate Occupancy Performance Level since those statements are repeated where appropriate in the Basic Configuration checklist, the building type checklists, and the nonstructural checklists.

The section numbers in parentheses following each evaluation statement refer to the commentary in Appendix A regarding the statement's purpose and the corresponding Tier 2 Evaluation procedures. If additional information on the evaluation statement is
required, refer to the commentary in the Tier 2 procedure for that evaluation statement.

C = Compliant
NC = Non-compliant
U = Unknown or not investigated
NA = Not applicable to this building

STRUCTURAL COMPONENTS	
C NC U NA	LOAD PATH. The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)
C NC U NA	WALL ANCHORAGE. Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1)

16.1.2LS Life Safety Basic Configuration Checklist
This Basic Configuration Checklist shall be completed for all building types, except buildings in very low seismicity, being evaluated to the Life Safety Performance Level. Once this checklist has been completed, complete the appropriate building type checklist for the desired seismic performance level as shown in Table 4-7. Tier 1 evaluation shall include on-site investigation and condition assessment as required by Section 4.2.1.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Noncompliant (NC), Unknown (U), or Not Applicable (N/A) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while noncompliant and unknown statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant and unknown evaluation statements,

the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C16.1.2LS Basic Configuration Checklist
For buildings in low, moderate, and high seismicity the following evaluation statements represent general configuration issues applicable for most building based on observed earthquake structural damage during actual earthquakes. This checklist should be completed for all buildings in low, moderate, and high seismicity for Life Safety Performance Level.

The section numbers in parentheses following each evaluation statement refer to the commentary in Appendix A regarding the statement's purpose and the corresponding Tier 2 Evaluation procedures. If additional information on the evaluation statement is
required, refer to the commentary in the Tier 2 procedure for that evaluation statement.

Low Seismicity

Building System

GENERAL	
C NC U NA	LOAD PATH. The structure shall contain a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1)
C NC U NA	ADJACENT BUILDINGS. The clear distance between the building being evaluated and any adjacent building is greater than 4 percent of the height of the shorter building. This statement shall not apply for the following building types: W1, W1A, and W2. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2)
C NC U NA	MEZZANINES. Interior mezzanine levels are braced independently from the main structure, or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)
BUILDING CONFIGURATION	
C NC U NA	WEAK STORY. The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A.2.2.2. Tier 2: Sec. 5.4.2.1and)
C NC U NA	SOFT STORY. The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2)
C NC U NA	VERTICAL IRREGULARITIES. All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3)
C NC U NA	GEOMETRY. There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4)
C NC U NA	MASS. There is no change in effective mass more than 50% from one story to the next. Light roofs, penthouses and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5)
C NC U NA	TORSION. The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6)

Moderate Seismicity (Complete the following items in addition to the items for Low Seismicity)

GEOLOGIC SITE HAZARDS	
C NC U NA	LIQUEFACTION. Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 feet under the building. (Commentary: Sec. A.6.1.1)
C NC U NA	SLOPE FAILURE. The building site is sufficiently remote from potential earthquake-induced slope failures or rockfalls to be unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2)
C NC U NA	SURFACE FAULT RUPTURE. Surface fault rupture and surface displacement at the building site is not anticipated. (Commentary: Sec. A.6.1.3)

High Seismicity (Complete the following items in addition to the items for Low and Moderate Seismicity)

FOUNDATION CONFIGURATION	
C NC U NA	OVERTURNING. The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than 0.6Sa. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)
C NC U NA	TIES BETWEEN FOUNDATION ELEMENTS. The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4)

16.10LS Life Safety Structural Checklist for Building Type C2: Concrete Shear Walls with Diaphragms, Type C2A: Concrete Shear Walls with Flexible Diaphragms

This Life Safety Structural Checklist shall be completed where required by Table 4-7 and where the building configuration complies with the description of C2 or C2A building type defined in Table 3-1. Tier 1 evaluation shall include on-site investigation and condition assessment as required by Section 4.2.1.

Each of the evaluation statements on this checklist shall be marked Compliant (C), Noncompliant (NC), Not Applicable (N/A), or Unknown (U) for a Tier 1 Evaluation. Compliant statements identify issues that are acceptable according to the criteria of this standard, while noncompliant and unknown statements identify issues that require further investigation. Certain statements may not apply to the buildings being evaluated. For non-compliant and unknown evaluation statements, the design professional may choose to conduct further investigation using the corresponding Tier 2 Evaluation procedure; corresponding section numbers are in parentheses following each evaluation statement.

C16. 10LS Life Safety Structural Checklist for Building Type C2 and C2A

Building Type C2

These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Floors are supported on steel beams and columns or on concrete beams and columns or bearing walls. Seismic forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of concrete slabs and are stiff relative to the walls. Foundations consist of concrete spread footings, mat foundations, or deep foundations.

Building Type C2A

These buildings are similar to C2 except that the diaphragms consist of wood sheathing, untopped metal deck; or metal deck with lightweight insulating concrete, poured gypsum, or similar nonstructural topping or have large aspect ratios, and are flexible relative to the walls.

Refer to Sections A.3.2.1 and A3.2.2 for additional commentary related to concrete shear walls.

C = Compliant
NC = Non-compliant
U = Unknown or not investigated
NA = Not applicable to this building

Low and Moderate Seismicity

SEISMIC-FORCE-RESISTING SYSTEM	
C NC U NA	COMPLETE FRAMES. Steel or concrete frames classified as secondary components form a complete vertical-load-carrying system. (Commentary: Sec. A.3.1.6.1. Tier 2: Sec. 5.5)
C NC U NA	REDUNDANCY. The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.1.1)
C NC U NA	SHEAR STRESS CHECK. The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.5.3.3, is less than the greater of 100 psi or 2sqrt(f'c). (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1)
C NC U NA	REINFORCING STEEL. The ratio of reinforcing steel area to gross concrete area is not less than 0.0012 in the vertical direction and 0.0020 in the horizontal direction. (Commentary: Sec. A.3.2.2.2. Tier 2: Sec. 5.5.3.1.3)

CONNECTIONS	
C NC U NA	WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS. Exterior concrete or masonry walls that are dependent on flexible diaphragms for lateral support are anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 4.5.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1)
C NC U NA	TRANSFER TO SHEAR WALLS. Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)
C NC U NA	FOUNDATION DOWELS. Wall reinforcement is doweled into the foundation with vertical bars equal in size and spacing to the vertical wall reinforcing immediately above the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)

High Seismicity (Complete the following items in addition to the items for Low and Moderate Seismicity)

SEISMIC-FORCE-RESISTING SYSTEM	
C NC U NA	DEFLECTION COMPABILITY. Secondary components have the shear capacity to develop the flexural strength of the components. (Commentary: Sec. A.3.1.6.2. Tier 2: Sec. 5.5.2.5.2)
C NC U NA	FLAT SLABS. Flat slabs/plates not part of seismic-force-resisting system have continuous bottom steel through the column joints. (Commentary: Sec. A.3.1.6.3. Tier 2: Sec. 5.5.2.5.3)
C NC U NA	COUPLING BEAMS. The stirrups in coupling beams over means of egress are spaced at or less than d/2 and are anchored into the confined core of the beam with hooks of 135 or more. The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads due to overturning. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1)
CONNECTIONS	
C NC U NA	UPLIFT AT PILE CAPS. Pile caps have top reinforcement and piles are anchored to the pile caps. (Commentary: Sec. A.5.3.8. Tier 2: Sec. 5.7.3.5)
DIAPHRAGMS (FLEXIBLE OR STIFF)	
C NC U NA	DIAPHRAGM CONTINUITY. The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1)
C NC U NA	OPENING AT SHEAR WALLS. Diaphragm openings immediately adjacent to the shear walls are less than 25 percent of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)
FLEXIBLE DIAPHRAGMS	
C NC U NA	CROSS TIES. There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)
C NC U NA	STRAIGHT SHEATHING. All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)

C NC U NA	SPANS. All wood diaphragms with spans greater than 24 feet consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)
C NC U NA	UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 feet and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)
C NC U NA	OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)

Project: Steel CBF @ Storefront (North-West Corner) Location: UCLA Covel Commons

Completed by: Date:

16.5LS LIFE SAFETY STRUCTURAL CHECKLIST FOR BUILDING TYPES S2: STEEL BRACED FRAMES WITH STIFF DIAPHRAGMS AND S2A: STEEL BRACED FRAMES WITH FLEXIBLE DIAPHRAGMS

Low Seismicity

Seismic-Force-Resisting System

C NC N/A U COLUMN AXIAL STRESS CHECK: The axial stress caused by gravity loads in columns subjected to overturning forces is less than $0.10F_y$. Alternatively, the axial stress caused by overturning forces alone, calculated using the Quick Check procedure of Section 4.5.3.6, is less than $0.30F_y$. (Commentary: Sec. A.3.1.3.2. Tier 2: Sec. 5.5.2.1.3)

C NC N/A U BRACE AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 4.5.3.4, is less than $0.50F_y$. (Commentary: Sec. A.3.3.1.2. Tier 2: Sec. 5.5.4.1)

Connections

C NC N/A U TRANSFER TO STEEL FRAMES: Diaphragms are connected for transfer of seismic forces to the steel frames. (Commentary: Sec. A.5.2.2. Tier 2: Sec. 5.7.2)

C NC N/A U STEEL COLUMNS: The columns in seismic-force-resisting frames are anchored to the building foundation. (Commentary: Sec. A.5.3.1. Tier 2: Sec. 5.7.3.1)

Moderate Seismicity: Complete the Following Items in Addition to the Items for Low Seismicity.

Seismic-Force-Resisting System

C NC N/A U REDUNDANCY: The number of lines of braced frames in each principal direction is greater than or equal to 2. The number of braced bays in each line is greater than 2. (Commentary: Sec. A.3.3.1.1. Tier 2: Sec. 5.5.1.1)

C NC N/A U CONNECTION STRENGTH: All the brace connections develop the buckling capacity of the diagonals. (Commentary: Sec. A.3.3.1.5. Tier 2: Sec. 5.5.4.4)

C NC N/A U COMPACT MEMBERS: All brace elements meet compact section requirements set forth by AISC 360, Table B4.1. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec. 5.5.4)

C NC N/A U K-BRACING: The bracing system does not include K-braced bays. (Commentary: Sec. A.3.3.2.1. Tier 2: Sec. 5.5.4.6)

High Seismicity: Complete the Following Items in Addition to the Items for Low and Moderate Seismicity.

Seismic-Force-Resisting System

C NC N/A U COLUMN SPLICES: All column splice details located in braced frames develop 50% of the tensile strength of the column. (Commentary: Sec. A.3.3.1.3. Tier 2: Sec. 5.5.4.2)

C NC N/A U SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression have Kl/r ratios less than 200. (Commentary: Sec. A.3.3.1.4. Tier 2: Sec. 5.5.4.3)

C NC N/A U CONNECTION STRENGTH: All the brace connections develop the yield capacity of the diagonals. (Commentary: Sec. A.3.3.1.5. Tier 2: Sec. 5.5.4.4)

C NC N/A U COMPACT MEMBERS: All brace elements meet section requirements set forth by AISC 341, Table D1.1, for moderately ductile members. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec. 5.5.4)

C NC N/A U CHEVRON BRACING: Beams in chevron, or V-braced, bays are capable of resisting the vertical load resulting from the simultaneous yielding and buckling of the brace pairs. (Commentary: Sec. A.3.3.2.3. Tier 2: Sec. 5.5.4.6)

C NC N/A U CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces shall frame into the beam–column joints concentrically. (Commentary: Sec. A.3.3.2.4. Tier 2: Sec. 5.5.4.8)

Diaphragms (Stiff or Flexible)

C NC N/A U OPENINGS AT FRAMES: Diaphragm openings immediately adjacent to the braced frames extend less than 25% of the frame length. (Commentary: Sec. A.4.1.5. Tier 2: Sec. 5.6.1.3)

Flexible Diaphragms

C NC N/A U CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)

C NC N/A U STRAIGHT SHEATHING: All straight sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2)

C NC N/A U SPANS: All wood diaphragms with spans greater than 24 ft consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)

C NC N/A U DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2)

C NC N/A U OTHER DIAPHRAGMS: The diaphragm does not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Commentary: Sec. A.4.7.1. Tier 2: Sec. 5.6.5)