Seismic Ratings

University of California

Anderson Graduate School of Management

CAANs: 515A, 515B, 515C, 515D, 515E

(Excerpt from 2017 UC Seismic Ratings Document)

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.

9	**CORNELL HALL** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV	1. Moment-Resisting Connections: MF connections cannot develop capacity of frame beams. 2. Compact members: Frame members are not moderately ductile. 3. Openings at Frames: Diaphragm openings at frames > 25%	1. Four-Five Story buildings 2. Representative frames evaluated using Tier 2 Procedures to determine that pre-Northridge connections and non-compact members can resist BSE-1E demands
10	**ENTEP HALL** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV		
11	**GOLD HALL** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV		
14	**ROSNFLD LIBR** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV	1. Moment-Resisting Connections: MF connections cannot develop capacity of frame beams. 2. Compact members: Frame members are not moderately ductile. 3. Openings at Frames: Diaphragm openings at frames > 25%	1. Four-Five Story buildings 2. Representative frames evaluated using Tier 2 Procedures to determine that pre-Northridge connections and non-compact members can resist BSE-1E demands
15	**MULLINS CMNS** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV		
16	**COLLINS CTR** (UCLA Anderson Graduate School of Management)	Complete Set Available	S1	1992	IV		

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
9			0515D	CORNELL HALL
10			0515C	ENTEP HALL
11			0515B	GOLD HALL
	UCLA	90095		
14			0515E	ROSNFLD LIBR
15			0515F	MULLINS CMNS
16			0515A	COLLINS CTR

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”.

4.9 ANDERSON GRADUATE SCHOOL OF MAMGEMENT: Record drawings, titled, "The John E. Anderson Graduate School of Management at UCLA", dated February 14, 1992, prepared by Pei, Cobb, Freed & Partners Architects and Leidenfrost/ Horowitz & Associates Structural Engineers were reviewed for this evaluation. The six buildings located in this complex are:

- Collins Center, formerly known as Executive Education Center.
- Cornell Hall, formerly known as MBA North.
- Entrepreneurs Hall, formerly known as MBA South.
- Gold Hall, formerly known as MBA West.
- Mullin Commons, formerly known as Commons.
- Rosenfeld Library, formerly known as Library.

An aerial View of the complex is shown in Figure 4.9.1.

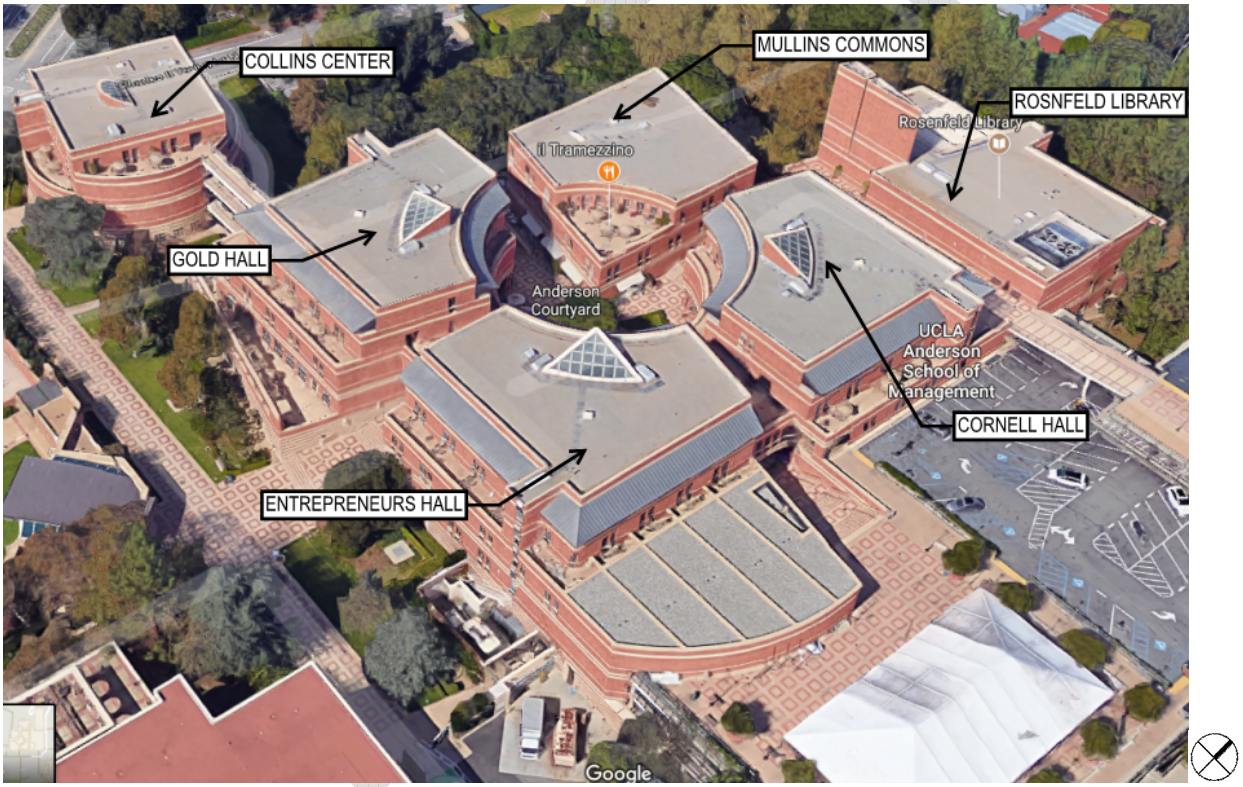

Figure 4.9.1 Anderson School of Management, UCLA (Source: Google Maps)

4.9.1 Building Description and Building Type: All six buildings listed above have a similar construction types and vertical and lateral systems. A key-plan of the building is shown in Figure 4.9.2.

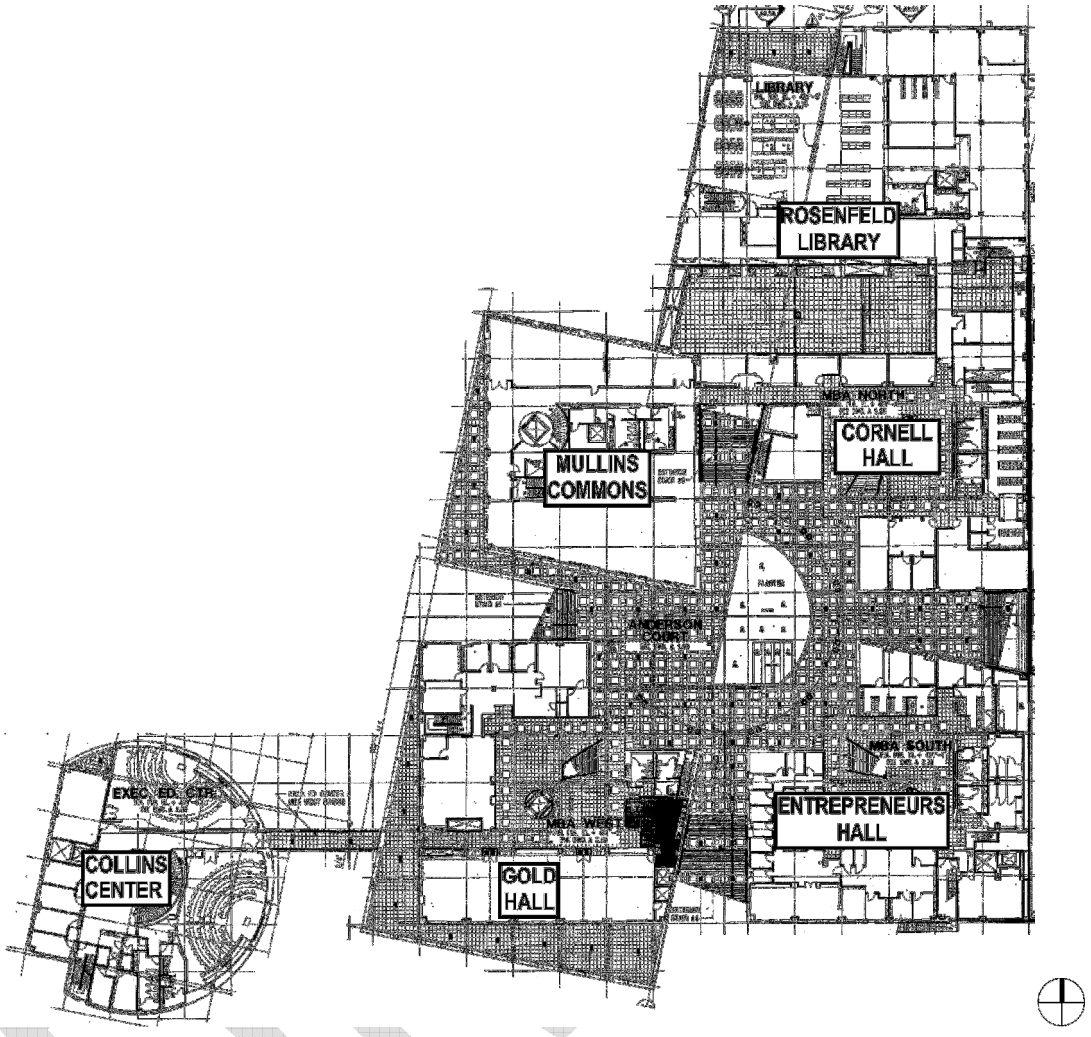

Figure 4.9.2 Anderson School of Management – Key Plan

4.9.1.1 Cornell Hall is a five story steel building with a fairly rectangular plan with approximately 14,000 sq. ft. area and a total height of about seventy feet.

4.9.1.2 Entrepreneurs Hall is a five-story steel building with a fairly rectangular plan shape with approximately 15,000 sq. ft., and a total height of about seventy feet. A partial demolition of an adjacent parking structure was carried out to build the Entrepreneurs Hall. Part of the older parking structure has been incorporated into the new building.

4.9.1.3 Gold Hall is a five-story steel building with a fairly rectangular plan with approximately 12,000 sq. ft. area, and a total height of about seventy feet.

4.9.1.4 Rosenfeld Library is a four-story steel building with a rectangular plan approximately 12,000 sq. ft. in plan, and a total height of about sixty feet.

4.9.1.5 Mullin Commons is a four story steel building with a rectangular plan approximately 10,000 sq. ft. in area, and a total height of about sixty feet.

4.9.1.6 Collins Center is a four story steel building with a circular plan approximately 9,200 sq. ft. plan area, with a total height of about sixty feet.

Cornell Hall, Entrepreneurs Hall, Gold Hall, and Mullin Commons share a common podium at Level 2. Exterior stairs surrounding the buildings are separated by seismic joints and supported at either Level 2 or the Ground Level.

Gold Hall, Entrepreneurs Hall and Cornell Hall are connected at Levels 3 and 4 by bridges that are not separated by a seismic joint.

The typical floor system of these buildings is composed of concrete filled metal deck spanning between wide flange steel beams supported by steel girders and steel columns. Some of the columns are built-up box sections.

Columns are supported by either spreads or piles.

Steel moment frames form the lateral force resisting system of all these buildings. Columns of the moment frames are supported on pile foundations ties together by grade beams. Most of the steel moment frames are located at the perimeter of the building and have pre-Northridge beam-column connections.

Per ASCE 41-13, these buildings are classified as S1.

4.9.2 Seismic Rating: Due to similar construction the Tier 1 non-compliances are similar for all buildings, they are as follows:

- Moment resisting connections: Moment connections in the steel moment frames appear to be typical welded flange-bolted web Pre-Northridge connections. This type of connection is identified as non-compliant per ASCE 41-13 Tier 1 checks, and further analysis is required to determine the adequacy of the connections.
- Compact members: Some moment frames possess built-up box column sections that do not comply with section requirements for moderately ductile members per AISC 341.
- Vertical irregularities: Discontinuous moment frames exist throughout the compound. However, analysis shows that the capacity of the columns below the frames is sufficient to resist the axial demand associated with the shear shear of the moment frame columns above.
- Geometry: The moment frame bays reduce along the height of the building changing more than 30% in horizontal dimension, due to reduction in moment frame bays, progressing up the building.

Tier 2 checks were performed for the deficiencies listed above, and the non-compliant members and connections were found to satisfy the requirements associated with a BSE-1E seismic event.

As a result, these buildings qualify for a Seismic Rating of IV, as defined in Table 1.2.

APPENDIX A

Tier 1 Checklists

16.1.2LS Life Safety Basic Configuration Checklist

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 BUILDING. The clear distance between the building being evaluated and any adjacent building is greater than 4% 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. 5.4.2.1)
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 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 granular soils that could jeopardize the building's seismic performance shall not exist in the foundation soils at depths within 50 ft. under the building. (Commentary: Sec. A.6.1.1. Tier 2: Sec. 5.4.3.1)

C NC U NA	SLOPE FAILURE. The building site 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. Tier 2: Sec. 5.4.3.1)
C NC U NA	SURFACE FAULT RUPTURE. Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: Sec. 5.4.3.1)

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 $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)
C NC U NA	THIS 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)

16.4LS Life Safety Structural Checklist for Building Types S1: Steel Moment Frames with Stiff Diaphragms and S1A: Steel Moment Frames with Flexible Diaphragms

Low Seismicity

SEISMIC-FORCE-RESISTING SYSTEM	
C NC U NA	DRIFT CHECK. The drift ratio of the steel moment frames, calculated using the Quick Check procedure of Section 4.5.3.1, is less than 0.025. (Commentary: Sec. A.3.1.3.1. Tier 2: Sec. 5.5.2.1.2)
C NC U NA	COLUMN AXIAL STRESS CHECK. The axial stress due to gravity loads in columns subjected to overturning forces is less than $0.10F_y$. Alternatively, the axial stress due to overturning forces alone, calculated using the Quick Check procedure of Section 4.5.3.6, is less than $0.30F_y$. (Commentary: Sec. A3.1.3.2. Tier 2: Sec. 5.5.2.1.3)
C NC U NA	FLEXURAL STRESS CHECK. The average flexural stress in the moment frame columns and beams, calculated using the Quick Check procedure of Section 4.5.3.9 is less than F_y. Columns need not be checked if the strong column–weak beam checklist item is compliant. (Commentary: Sec. A.3.1.3.3. Tier 2: Sec. 5.5.2.1.2)
CONNECTIONS	
C NC U NA	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 U NA	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 U NA	REDUNDANCY. The number of lines of moment frames in each principal direction is greater than or equal to 2. The number of bays of moment frames in each line is greater than or equal to 2. (Commentary. Sec. A.3.1.1.1. Tier 2: Sec. 5.5.1.1)
C NC U NA	INTERFERING WALLS. All concrete and masonry infill walls placed in moment frames are isolated from structural elements. (Commentary: Sec. A.3.1.2.1. Tier 2: Sec. 5.5.2.1.1)
C NC U NA	MOMENT-RESISTING CONNECTIONS. All moment connections are able to develop the strength of the adjoining members based on the specified minimum yield stress of steel. (Commentary: Sec. A.3.1.3.4. Tier 2: Sec. 5.5.2.2.1). Note: more restrictive requirements for High Seismicity.

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

SEISMIC-FORCE-RESISTING SYSTEM	
C NC U NA	MOMENT-RESISTING CONNECTIONS. All moment connections are able to develop the strength of the adjoining members or panel zones based on 110% of the expected yield stress of the steel per AISC 341, Section A3.2. (Commentary: Sec. A.3.1.3.4. Tier 2: Sec. 5.5.2.2.1)

C NC U NA	PANEL ZONES. All panel zones have the shear capacity to resist the shear demand required to develop 0.8 times the sum of the flexural strengths of the girders framing in at the face of the column. (Commentary: Sec. A.3.1.3.5. Tier 2: Sec. 5.5.2.2.2)
C NC U NA	COLUMN SPLICES. All column splice details located in moment-resisting frames include connection of both flanges and the web. (Commentary: Sec. A. 3.1.3.6. Tier 2: Sec. 5.5.2.2.3)
C NC U NA	STRONG COLUMN–WEAK BEAM. The percentage of strong column–weak beam joints in each story of each line of moment frame is greater than 50%. (Commentary: Sec. A.3.1.3.7. Tier 2: Sec. 5.5.2.1.5)
C NC U NA	COMPACT MEMBERS. All frame elements meet section requirements set forth by AISC 341, Table D1.1, for moderately ductile members. (Commentary: Sec. A.3.1.3.8. Tier 2: Sec. 5.5.2.2.4)
DIAPHRAGMS (STIFF OF FLEXIBLE)	
C NC U NA	OPENINGS AT FRAMES. Diaphragm openings immediately adjacent to the moment frames extend less than 25% of the total frame length. (Commentary: Sec. A.4.1.5. 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 rations less than 2-to1 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 ft. consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2)
C NC U NA	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 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)

APPENDIX B

Tier 2 Analysis

UCLA AGSM

Tier 2 Calculations

A Tier 2 evaluation have been performed to determine the adequacy of the non-compliances presented before. Non-compact members have been evaluated against the actual demand under the BSE-1E level and all the limit states for the Pre-Northridge moment resisting connections have been checked to determine that the building can perform at a Life Safety level under the BSE-1E hazard.

ASCE 41-13 classifies actions as deformation controlled or force controlled. Where actions are considered deformation controlled, ASCE 41-13 allow the use of a component capacity modification factor "*m*" to account for the expected ductility associated with this action at the selected Performance Level, the demand should be compared with the component expected strength calculated per regular structural engineering procedures (i.e. AISC 360-10 for steel elements) with a phi equal to unity.

Where actions are considered force controlled, the demands should be compared with the lower bound strength calculated per regular structural engineering procedures with a phi equal to unity.

Gold Hall's Frame #4 is presented below showing seismic forces applied and a table with demand/capacity ratios for columns, where a couple of non-compact members are used, with acceptable ratios less than or equal to one. Demands at a BSE-1E level including gravitational loading are compared against the section capacities considering the appropriate *m-factor* to determine the adequacy of the structure.

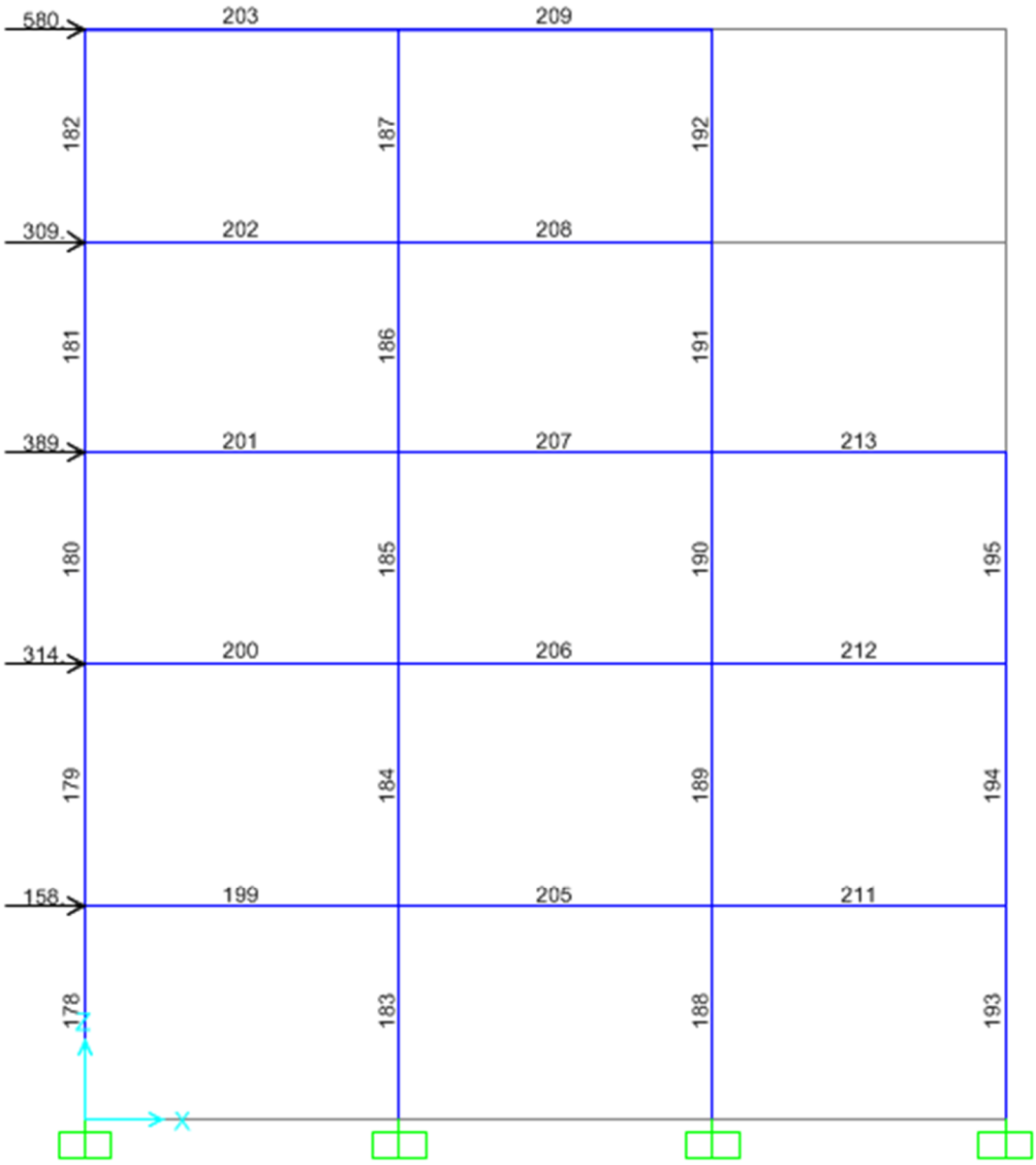

Figure 2 – Gold Hall's Frame #4 – Element numbers and applied seismic forces (kips).

Table 1: Gold Hall's Frame #4 columns Demand/Capacity Ratios

Element #	Section Type	Section	D/C
178	I/Wide Flange	W24X229	0.91
179	I/Wide Flange	W24X229	0.63
180	I/Wide Flange	W24X229	0.38
181	I/Wide Flange	W24X146	0.21
182	I/Wide Flange	W24X146	0.13
183	I/Wide Flange	W24X229	0.90
184	I/Wide Flange	W24X229	0.83
185	I/Wide Flange	W24X229	0.57
186	I/Wide Flange	W24X162	0.23
187	I/Wide Flange	W24X162	0.17
188	I/Wide Flange	W24X229	0.91
189	I/Wide Flange	W24X229	0.85
190	I/Wide Flange	W24X229	0.62
191	I/Wide Flange	W24X146	0.25
192	I/Wide Flange	W24X146	0.13
193	Tube	T20X258	0.38
194	Tube	T20X258	0.29
195	Tube	T20X258	0.23

Similarly, moment frame connections are checked with the appropriate *m-factors* to determine their demand/capacity ratios for the different limit states. Results for the connections on the frame presented before are shown next, with acceptable demand/capacity ratios less than or equal to one.

Table 2: Gold Hall's Frame #4 moment resisting connections Demand/Capacity Ratios

Story	Beam	m-factor	D/C
2	W33X152	1.00	0.92
3	W30X124	1.15	1.00
4	W27X114	1.30	0.64
5	W27X114	1.30	0.58