Rating form completed by:

RUTHERFORD + CHEKENE
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Evaluator: MN/WAL/BL

Date: 06/28/2019

Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

DATE: 2019-06-28

UC Santa Cruz Building Seismic Ratings

P.E. Fitness Center

CAAN #7726

405 East Field Service Road, Santa Cruz, CA 95064

UCSC Campus: Main Campus

Southeast Corner (Looking Northwest)

Plan

Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating	2019	
Recommended list assignment (UC Santa Cruz category for retrofit)	Priority A	Priority A =Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating[2]	Medium ($50-$200/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	Building was not previously rated
Further evaluation recommended?	Yes	Focus on brace gusset connections, vertical geometric irregularity, and potential torsional irregularity

[1] We translate this Tier 1 evaluation to a Seismic Performance Level rating using professional judgment. Non-compliant items in the Tier 1 evaluation do not automatically put a building into a particular rating category, but we evaluate such items along with the combination of building features and potential deficiencies, focused on the potential for collapse or serious damage to the gravity supporting structure that may threaten occupant safety. See Section III.B of the 19 May 2017 *UC Seismic Safety Policy* and Method B of Section 321 of the 2016 *California Building Code*.

[2] Per Section III.A.4.i of the 26 March 2019 *UC Seismic Program Guidebook, Version 1.3*, the cost includes all construction cost necessitated by the seismic retrofit, including restoration of finishes and any triggered work on utilities or accessibility. It does not include soft costs such as design fees or campus costs. The cost is in 2019 dollars.

Building information used in this evaluation

- Architectural drawings by BOORA Architects, "P.E. Fitness Center, University of California, Santa Cruz," dated 07 August 1998.
- Structural drawings by kpff Consulting Engineers, "P.E. Fitness Center, University of California, Santa Cruz," dated 15 June 1998, Sheets S1-S403 (12 sheets)

Additional building information known to exist

None.

Scope for completing this form

Reviewed structural drawings for original construction, made brief site visit on 16 May 2019, and carried out ASCE 41-17 Tier 1 evaluation.

Brief description of structure

The Fitness Center building was designed in 1998 by BOORA Architects. The structural engineer was kpff Consulting Engineers. The construction completion date is assumed to be 1999.

The building is a two-story structure that contains 13,890 square feet. The building is constructed with concentrically braced frames in the both E-W and N-S directions. At the south and west sides of the building, 10" solid grouted reinforced concrete masonry unit (CMU) walls are provided as retaining walls which extend up to the second floor.

Building condition: In general, the building is in good structural condition. No significant damage in the structural system was observed during the site visit.

Identification of levels: The building has two stories above grade, identified on the original drawings as ground floor and upper floor. They will be termed first floor and second floor for this report.

Foundation system: The site is slightly sloping. The superstructure is founded on shallow spread footings located under the steel pipe columns and strip footings under the CMU walls. The ground floor has a 4" reinforced concrete slab-on-grade.

Structural system for vertical (gravity) load: Both the roof and second floor levels have steel WF beams and girders that span to 6" standard pipe columns which are anchored to the footings or CMU walls. The second floor slab consists of a 3" deep, 20 gauge steel deck with 3-1/2" of concrete fill connected to the framing with shear studs. The roof diaphragm consists of a 1-1/2" thick 18 gauge acoustic metal deck welded to the framing, rigid sheathing boards, insulation layer, and metal roofing on top.

Structural system for lateral forces: The lateral load-resisting system at the second floor consists of two lines of concentrically braced frames (chevron orientation) in both principal directions located at the perimeter of the building. At the first floor, the north and east sides have braced frames, but the south and west sides have CMU shear walls. In each line, a single bay of the frame is braced with TS6"x6"x1/4" steel tubes per Details 1, 4, 6, 7, 10 and 11 on Sheet S201. At the second floor, the braced frames on the south and west side are anchored to the top of the CMU walls which transfer the loads to the foundation per Details 3 and 4 on Sheet S201. The roof diaphragm is flexible; the second floor diaphragm is rigid. Due to the mix of steel braced frames and CMU walls in both directions, we have completed Tier 1 checklists for both Building Type S2 and Building Type RM2.

Brief description of seismic deficiencies and expected seismic performance including mechanism of nonlinear response and structural behavior modes

Identified seismic deficiencies of the building include the following:

- The braced frame connections were not built as shown on the structural drawings. The 5/16 double fillet from the gusset to the top flange of the beam was missing on both sides of the corner column at one location we observed (see photo in Appendix A). This severely limits the capacity of the braced frames.
- At the second floor, in 5C-6C grid, the seismic force-resisting system changes from a one-bay braced frame to 10" x 71.5 ft CMU wall. This occurs at B.2-C also. Per ASCE 41-17, geometric irregularities can affect the dynamic

response of the structure and may lead to unexpected higher mode effects and concentrations of demand. A dynamic analysis should be performed to more accurately calculate the distribution of seismic forces.

- The lateral load-resisting system is not redundant, since only one bay is braced in each braced line. Per ASCE 41-17, an analysis that demonstrates the adequacy of the seismic force-resisting elements is required.
- There is a large diaphragm opening adjacent to the braced frames between Gridlines 1A and 1B and Gridlines 1A and 2A at the second floor. The opening can significantly limit the ability of the diaphragm to transfer seismic forces to the braced frames.
- Torsion is likely at the first story as the CMU walls on the south side will much stiffer than the braced frames on the north side.
- The braced elements do not meet the width-thickness requirements for a moderately ductile member.
- The end connections are not adequate to resist the develop the yield strength of the braces.
- Beams intersecting braces do not have the adequate flexural strength to resist the unbalanced vertical load generated by the braces.
- Columns of the braced frames which are subjected to overturning carry a substantial amount of gravity load and may have limited additional capacity to resist seismic forces. The columns may buckle under induced seismic loads because of excessive axial compression.

Braces are expected to experience overall buckling in compression and yielding in tension. The lack of welds from the gusset plates to the beam severely limits the connection capacities. Because of their width-thickness ratio, braces are not anticipated to sustain many inelastic cycles of axial deformation. Braces may fracture prematurely. If braces are able to resist many inelastic cycles, brace end connections may fracture at their net sections. If that does not occur, the gusset connection with a discontinuous load path may tear apart from the column. Assuming none of the preceding occurs and the braces develop large unbalanced vertical loads, then beams intersecting braces may yield in flexure and undergo very large deformations. If braces are able to develop their tension strength, there are two frame columns which resist loads from orthogonal directions which may need to resist compressive load in excess of their strength. If that occurs, loss of vertical load-carrying support over a limited area may be a possibility.

Structural deficiency	Affects rating?	Structural deficiency	Affects rating?
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	Y	Openings at shear walls (concrete or masonry)	N
Load path	Y	Liquefaction	N
Adjacent buildings	N	Slope failure	N
Weak story	N	Surface fault rupture	N
Soft story	N	Masonry or concrete wall anchorage at flexible diaphragm	N
Geometry (vertical irregularities)	Y	URM wall height-to-thickness ratio	N
Torsion	Y	URM parapets or cornices	N
Mass – vertical irregularity	N	URM chimney	N
Cripple walls	N	Heavy partitions braced by ceilings	N
Wood sills (bolting)	N	Appendages	N
Diaphragm continuity	Y		

Summary of review of nonstructural life-safety concerns, including at exit routes.[3]

The building has full height glazing adjacent to and above the Wellness Center entrance. We recommend verifying that the glazing consists of tempered glass or the like.

[3] For these Tier 1 evaluations, we do not visit all spaces of the building; we rely on campus staff to report to us their understanding of if and where nonstructural hazards may occur.

UCOP nonstructural checklist item	Life safety hazard?	UCOP nonstructural checklist item	Life safety hazard?
Heavy ceilings, feature or ornamentation above large lecture halls, auditoriums, lobbies or other areas where large numbers of people congregate	None observed	Unrestrained hazardous materials storage	Unknown
Heavy masonry or stone veneer above exit ways and public access areas	None observed	Masonry chimneys	None observed
Unbraced masonry parapets, cornices or other ornamentation above exit ways and public access areas	None observed	Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.	None observed

Basis of rating

A Seismic Performance Level rating of V is assigned to this building because (1) its energy dissipating element (the HSS braces) have width-thickness ratios which limit their ductility, (2) the gusset end connections are not designed to develop the tension yield strength of the braces, (3) the gusset connections are not detailed for ductile behavior, (4) there is a load-path discontinuity at some gusset connections, (5) the beams intersected by HSS braces are not designed to resist the vertical unbalanced load of the braces, and (6) there are two frame columns which resist loads from orthogonal braced frames for which they do not appear to be adequately designed. We consider this to be at the very low (poor) end of the Level V rating.

Recommendations for further evaluation or retrofit

This building continuously serves students. We did verify that the posted occupant load is less than 300; as a result, the building need not be classified as Risk Category III. Given the continuous use of the building by students, we recommend that advanced Tier 2 or Tier 3 analyses be conducted to more carefully ascertain its seismic risk. More advanced analyses will also help identify the magnitude of retrofit required to bring into compliance the detailing and strength deficiencies identified.

Peer review of rating

This seismic evaluation was discussed in a peer review meeting on 28 May 2019. Reviewers present were Joe Maffei of Maffei Structural Engineering and Holly Razzano and Jay Yin of Degenkolb Engineers. Comments from the reviewers have been incorporated into this report. The reviewers agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	36.9936362	
Longitude	-122.0545746	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	2	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	13,890	From UCSC facilities database
Risk Category per 2016 CBC Table 1604.5	II	

Building structural height, h_n	26 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Estimated using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Estimated using ASCE 41-17 equation 4-4 and 7-18
Estimated fundamental period	0.23 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975-year hazard parameters S_s, S_1	1.284, 0.486	From SEAOC/OSHPD website
Site class	D	
Site class basis	Geotech[4]	See footnote below
Site parameters F_a, F_v	1.0, 1.814	From SEAOC/OSHPD website
Ground motion parameters S_{cs}, S_{c1}	1.284, 0.882	From SEAOC/OSHPD website
S_a at building period	1.28	
Site V_{s30}	900 ft/s	
V_{s30} basis	Estimated	Estimated based on site classification of D.
Liquefaction potential	Low	
Liquefaction assessment basis	County map	See footnote below
Landslide potential	Low	
Landslide assessment basis	County map	See footnote below
Active fault rupture identified at site	No	
Fault rupture assessment basis	County map	See footnote below
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 1999 Code: 1995 CBC	Per structural drawings, Sheet S1
Applicable code for partial retrofit	None	No partial retrofit
Applicable code for full retrofit	None	No full retrofit
Model building data		
Model building type 1	S2 –Braced Steel Frame	S2 at second floor; S2 and RM2 at first floor
Model building type 2	RM2 –CMU with Rigid Diaphragm	S2 at second floor; S2 and RM2 at first floor
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.

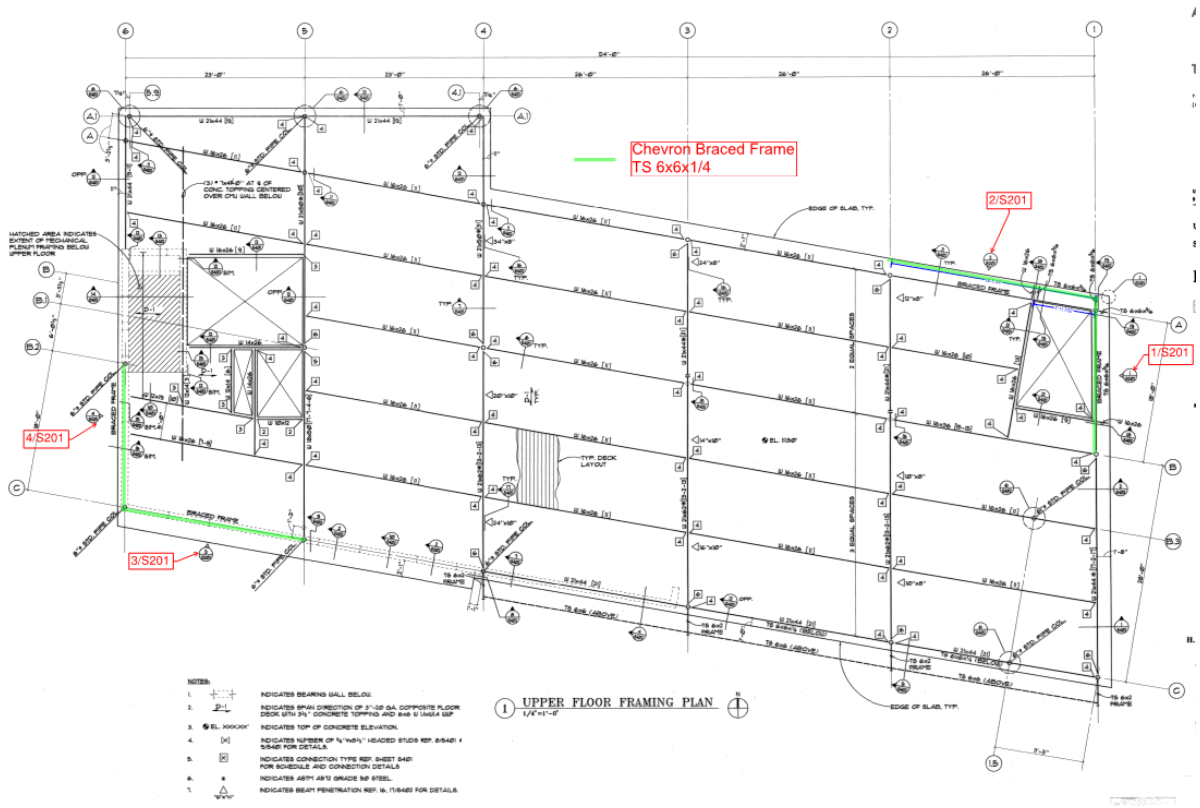
[4] Determination of site class and assessment of geotechnical hazards are based on correspondence with Pacific Crest Geotechnical Engineers and Nolan, Zinn, and Associates Geologists. [*Revised Geology and Geologic Hazards, Santa Cruz Campus, University of California*, Job # 04003-SC 13 May 2005]. Site class is taken as D throughout the main campus of UC Santa Cruz. The following links provide hazard maps for liquefaction, landslide, and fault rupture:
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LiquifactionMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LandslideMap2009.pdf
https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/FaultZoneMap2009.pdf

Previous ratings		
Most recent rating	-	Not evaluated before
Date of most recent rating	-	Indicated on spreadsheet
2nd most recent rating	-	
Date of 2nd most recent rating	-	
3rd most recent rating	-	
Date of 3rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file

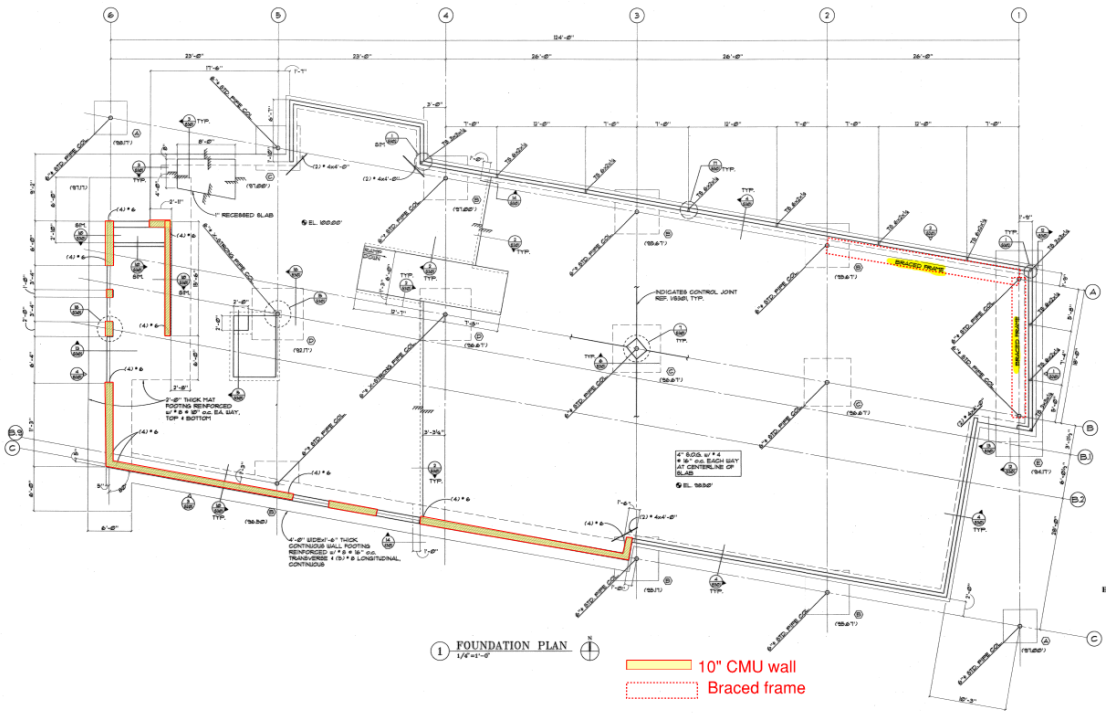
Color Coded Floor Plan:

Second Floor Architectural Plan

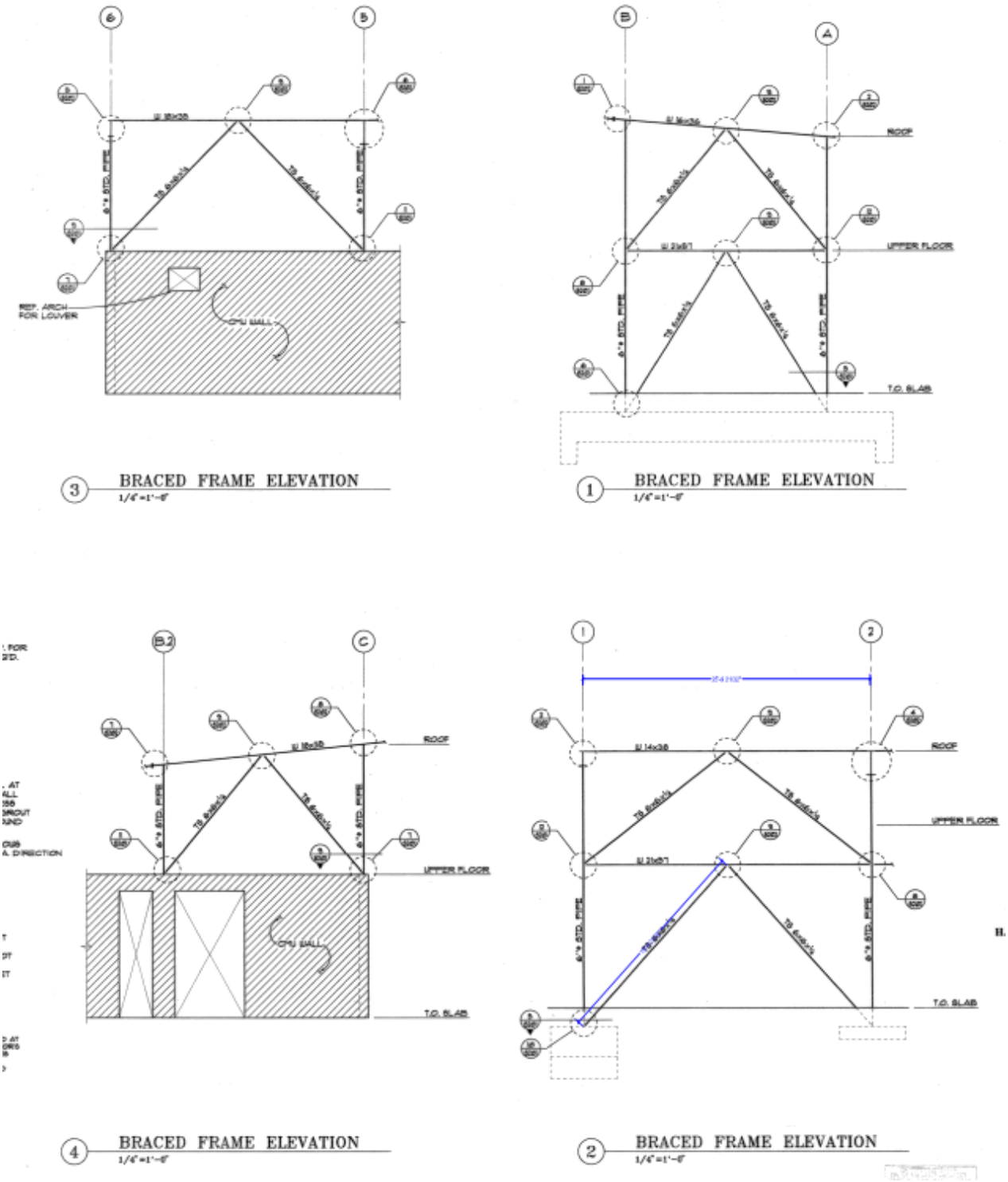
First Floor Architectural Plan



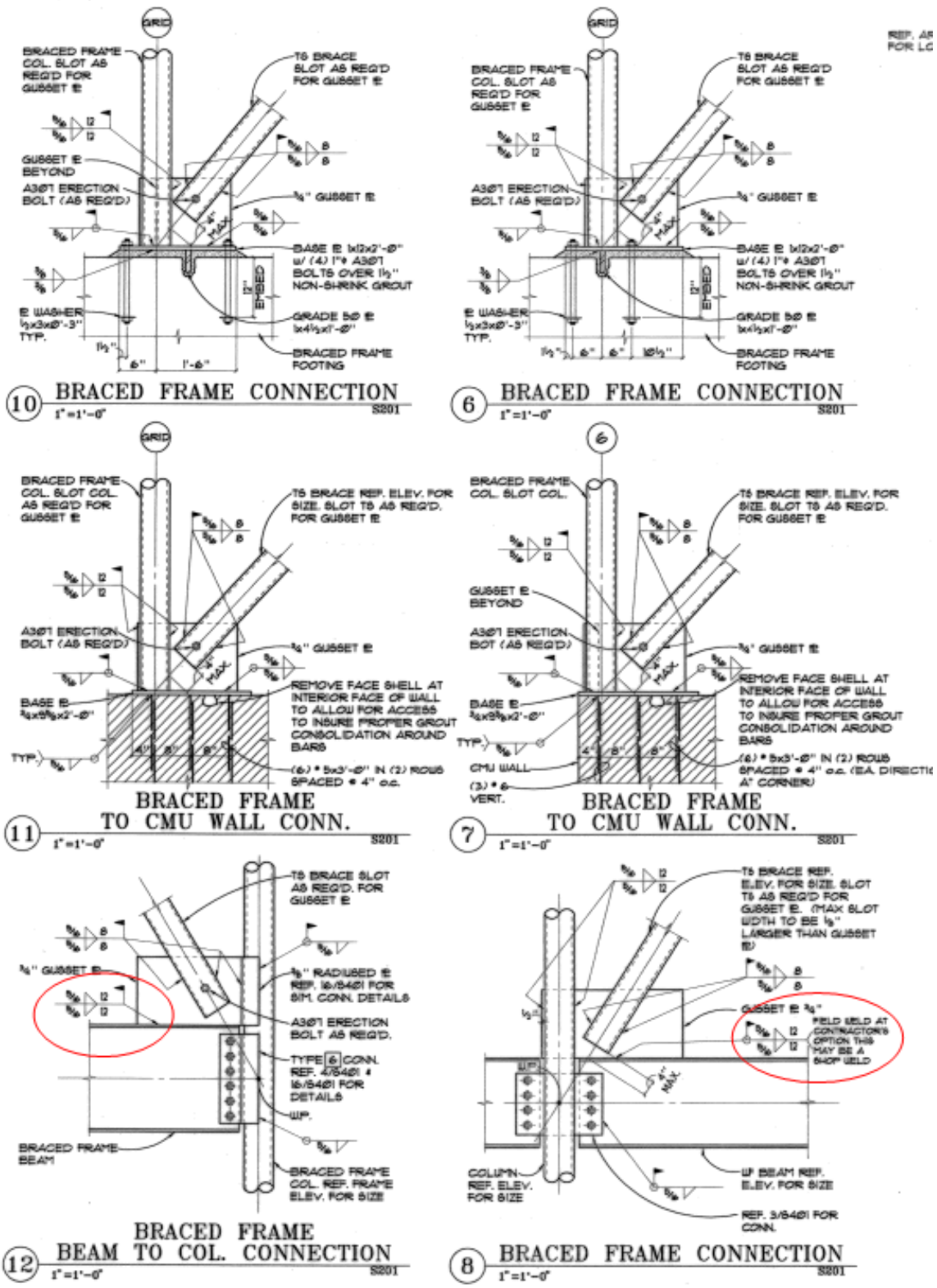
Second Floor Structural Plan with Braced Frame Locations Marked



First Floor Structural Plan with CMU walls and Braced Frame Locations Marked



Elevations of Four Braced Frame/CMU Wall Sections (Details 1, 2, 3, 4/S201)



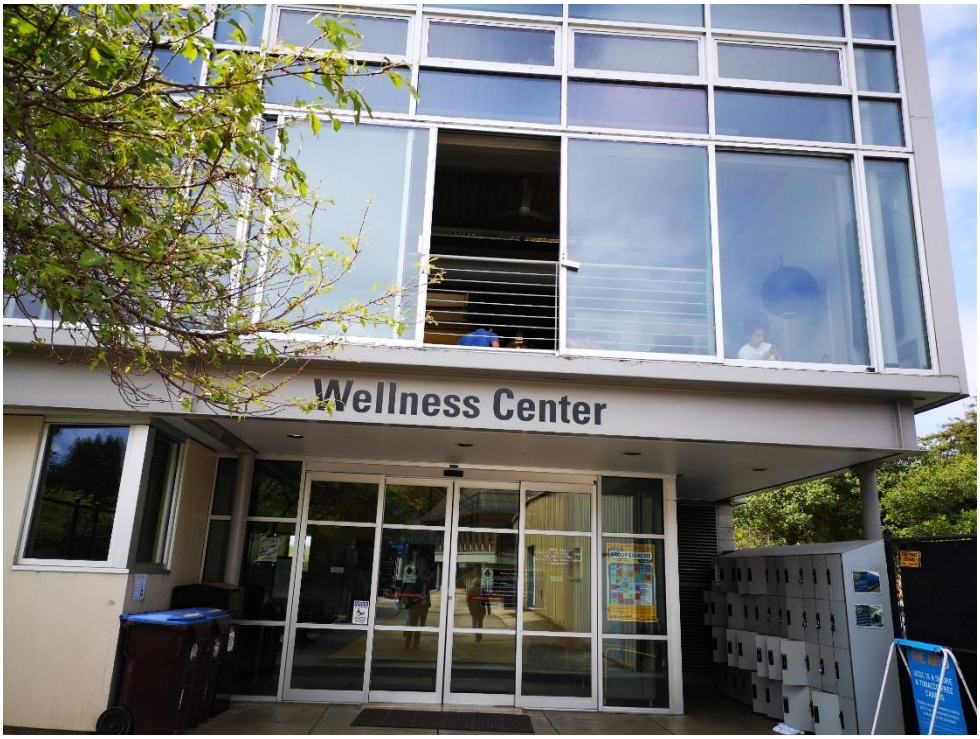
Typical Braced Frame Connections (Note Details 8 and 12 show 5/16 fillet weld from gusset plate to top beam flange)

APPENDIX A

Additional Photos

Southeast Corner (Looking Northwest)

Northeast Corner (Looking Northwest)



Entrance (North Elevation Looking South)

Brace Elements and Metal Deck Roof

Brace Connection Without Weld at Bottom of Gusset Plate as Shown in Structural Details

Gusset Plate is Not Welded to the Floor Beam (Second Floor Connection Along Line A, between Lines 1 and2)

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	Santa Cruz			Date:	06/28/2019		
Building CAAN:	7726	Auxiliary CAAN:		By Firm:	RUTHERFORD + CHEKENE		
Building Name:	P.E. Fitness Center			Initials:	MN	Checked:	WAL/BL
Building Address:	405 East Field Service Road, Santa Cruz, CA 95064			Page:	1	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

C	NC	N/A	U	Description
●	○	○	○	LOAD PATH: The structure contains 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) **Comments:** A steel deck at the roof and a concrete fill over steel deck at the second floor deliver inertial loads to steel concentrically braced frames or one-story CMU perimeter walls which in turn transfer their loads to isolated spread and continuous wall footings.
○	○	●	○	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2) **Comments:** There are no adjacent structures.
○	○	●	○	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) **Comments:** There are no mezzanines.

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C	NC	N/A	U	Description
●	○	○	○	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. A2.2.2. Tier 2: Sec. 5.4.2.1) **Comments:** Brace cross-section area is the same in all stories.
●	○	○	○	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) **Comments:** - Brace cross-section area is the same in all stories. - Brace angles are approximately the same in different stories. - Story heights are approximately the same from floor to floor.

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Collapse Prevention Basic Configuration Checklist

C	NC	N/A	U	
○	●	○	○	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) **Comments:** Braced frames in Gridline 6 (B2-C) and C (5-6) stop at the second floor. They transfer their load to one-story CMU walls, which are continuous to the foundation. Compliance can be achieved if the supporting CMU walls can be demonstrated to have adequate capacity to resist the overturning forces generated by the shear capacity of the braced frames.
○	●	○	○	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) **Comments:** At the second floor, along Gridline C (5-6) (south side), the seismic force-resisting system changes from a one-bay braced frame with a width of 23'-0" to a 63'-long, 10" CMU wall.
●	○	○	○	MASS: There is no change in effective mass of 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) **Comments:** Effective mass does not have significant changes from one story to the next.
○	●	○	○	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) **Comments:** At the first floor, the CMU walls may shift the center of rigidity toward the south elevation. More detailed investigation is recommended in a Tier 2 evaluation.

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

GEOLOGIC SITE HAZARD

C	NC	N/A	U	Description
●	○	○	○	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1) **Comments:** **Per 2009 County map at** https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LiquifactionMap2009.pdf
●	○	○	○	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1) **Comments:** **Per 2009 County map at** https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LandslideMap2009.pdf

Note: **C =** Compliant **NC =** Noncompliant **N/A =** Not Applicable **U =** Unknown

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

GEOLOGIC SITE HAZARD

C	NC	N/A	U	
◉	○	○	○	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1) **Comments:** Per 2009 County map at https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/FaultZoneMap2009.pdf

HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR MODERATE SEISMICITY)

FOUNDATION CONFIGURATION

				Description
C	NC	N/A	U	
○	◉	○	○	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) **Comments:** Least horizontal dimension of the seismic-force resisting system: B = 18'-9", Building Height: H = 28'-2", B/H = 0.665 Sa = 1.28g 0.6x Sa = 0.77 B/H < 0.6 Sa
C	NC	N/A	U	
◉	○	○	○	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) **Comments:** Site Class D is assumed. Slab at the foundation level restrains the single and strip footings.

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type RM1-RM2

LOW AND MODERATE SEISMICITY

SEISMIC-FORCE-RESISTING SYSTEM

C	NC	N/A	U	Description
○	●	○	○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:** At the second story, two lines of braced frames are provided in each principal direction. At the first story, one line of CMU shear wall is provided in the east-west (C/5-C/6) and north-south (6/B2-6/C) directions. Also at the first story, one line of braced frame is provided in each principal direction.
●	○	○	○	SHEAR STRESS CHECK: The shear stress in the reinforced masonry shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than 70 lb/in.^{2} (0.48 MPa). (Commentary: Sec. A.3.2.4.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** The calculated average shear stresses in the reinforced masonry shear walls are 28 and 50 psi in the E-W and N-S direction, respectively.
●	○	○	○	REINFORCING STEEL: The total vertical and horizontal reinforcing steel ratio in reinforced masonry walls is greater than 0.002 of the wall with the minimum of 0.0007 in either of the two directions; the spacing of reinforcing steel is less than 48 in. (1220 mm), and all vertical bars extend to the top of the walls. (Commentary: Sec. A.3.2.4.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** Per the masonry reinforcing steel information given in structural drawings, Sheet S1: horizontal reinforcing steel ratio = 0.0009 > 0.0007 → OK vertical reinforcing steel ratio = 0.0018 > 0.0007 → OK Total reinforcing steel ratio = 0.0027 > 0.002 → OK Horizontal and vertical spacing = 48” = 48” → OK

STIFF DIAPHRAGMS

C	NC	N/A	U	Description
○	○	●	○	TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab. (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4) **Comments:** There are no precast concrete diaphragm elements.

CONNECTIONS

C	NC	N/A	U	Description

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type RM1-RM2

C	NC	N/A	U	
◉	○	○	○	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 have strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.1.1. Tier 2: Sec. 5.7.1.1) **Comments:** Per Detail 18-S401, the concrete fill over metal deck is supported by a L4x4x1/4 with ¾" Φ anchor bolts at 2'-0" o.c. The metal deck is connected to the ledger angle with puddle welds. The CMU wall is connected to the concrete fill via #4 dowels at 24" o.c.
○	○	◉	○	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3) **Comments:** No wood elements are present.
◉	○	○	○	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) **Comments:** Per Detail 18-S401, the concrete fill over metal deck is supported by a L4x4x1/4 with ¾" Φ anchor bolts at 2'-0" o.c. The metal deck is connected to the ledger angle with puddle welds. The CMU wall is connected to the concrete fill via #4 dowels at 24" o.c.
○	○	◉	○	TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2) **Comments:** No topping slabs are present.
◉	○	○	○	FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4) **Comments:** Per Detail 10-S301, wall reinforcement is doweled into the foundation.
◉	○	○	○	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1) **Comments:** Per Details 2-S202, 8-S201, and 12-S201, steel girders are positively support by steel columns.

HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW AND MODERATE SEISMICITY)

STIFF DIAPHRAGMS

C	NC	N/A	U	Description
◉	○	○	○	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments:** There are no diaphragm opening adjacent to CMU walls.

Note: **C** = Compliant **NC** = Noncompliant **N/A** = Not Applicable **U** = Unknown

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Collapse Prevention Structural Checklist For Building Type RM1-RM2

C	NC	N/A	U	
●	○	○	○	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft (2.4 m) long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3) **Comments:** There are no diaphragm opening adjacent to exterior CMU walls

FLEXIBLE DIAPHRAGMS

C	NC	N/A	U	Description
○	○	●	○	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
○	○	●	○	OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
○	○	●	○	OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls are not greater than 8 ft (2.4 m) long. (Commentary: Sec. A.4.1.6. Tier 2: Sec. 5.6.1.3) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
○	○	●	○	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) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
○	○	●	○	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
○	○	●	○	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.
●	○	○	○	OTHER DIAPHRAGMS: Diaphragms do 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) **Comments:** The diaphragm connected to CMU walls is a stiff diaphragm.

CONNECTIONS

C	NC	N/A	U	Description

Note: **C** = Compliant **NC** = Noncompliant **N/A** = Not Applicable **U** = Unknown

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Collapse Prevention Structural Checklist For Building Type RM1-RM2

C	NC	N/A	U	
○	○	◉	○	STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements are installed taut and are stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 in. (3 mm) before engagement of the anchors. (Commentary: Sec. A.5.1.4. Tier 2: Sec. 5.7.1.2) **Comments:** There are no wood structural elements.

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Collapse Prevention Structural Checklist For Building Type S2-S2A

LOW SEISMICITY

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C ● NC ○ N/A ○ U ○	REDUNDANCY: The number of lines of braced frames in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.3.1.1. Tier 2: Sec. 5.5.1.1) **Comments:** At the second story, two lines of braced frames are provided in each principal direction. At the first story, one line of CMU shear wall is provided in the east-west (C/5-C/6) and north-south (6/B2-6/C) directions. Also at the first story, one line of braced frame is provided in each principal direction.
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 4.4.3.6, is less than 0.30F_y. (Commentary: Sec. A.3.1.3.2. Tier 2: Sec. 5.5.2.1.3) **Comments:** The maximum calculated axial stress caused by gravity loads (DL+LL) in columns subjected to overturning: 5.8 ksi 0.1*Fy = 3.5 ksi 5.8 ksi > 0.1*Fy → Not OK.
C ● NC ○ N/A ○ U ○	BRACE AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 4.4.3.4, is less than 0.50F_y. (Commentary: Sec. A.3.3.1.2. Tier 2: Sec. 5.5.4.1) **Comments:** • Maximum calculated average axial stress in the diagonals: fj avg = 20 ksi • 0.50Fy = 23 ksi • fj avg < 0.50Fy → OK.

CONNECTIONS

	Description
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) **Comments:** Diaphragms are connected to the steel frames. This is true except for one condition where the braced frame along Line 1 between Lines A and B is adjacent to a stair opening at the second floor.
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) **Comments:** Per Details 6-S201 and 10-S201, the 6" STD pipe columns are welded to their 1x12x2'-0" base plate which in turn are anchored to the foundation with four 1"Φ A307 bolts with 1/2x3x0'-3" plate washers at the bottom of the anchor bolts.

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Collapse Prevention Structural Checklist For Building Type S2-S2A

MODERATE SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR LOW SEISMICITY)

SEISMIC-FORCE-RESISTING SYSTEM

C	NC	N/A	U	Description
○	●	○	○	REDUNDANCY: 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) **Comments:** Only one braced bay in each line.
○	●	○	○	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) **Comments:** There is a non-conformance with Detail 12/S201 observed during the site visit. The horizontal weld between the gusset and the beam is missing at the second floor connection along Line A, between Lines 1 and 2. There is a discontinuous load path deficiency.
●	○	○	○	COMPACT MEMBERS: All brace elements meet compact section requirements in accordance with AISC 360, Table B4.1. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec. 5.5.4) **Comments:** E 29000 ksi F_y 46 ksi b/t 22.8 1.4*sqrt(E/F_y) 35.1 b/t<35.1 → compact
●	○	○	○	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) **Comments:** There are no K-braced bays.

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	Description
○	○	●	○	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) **Comments:** There are no column splices in the braced frames.

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Collapse Prevention Structural Checklist For Building Type S2-S2A

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) **Comments:** K 1 l 16 ft r 2.34 in Kl/r 82.1 Kl/r < 200 → OK.
○	◉	○	○	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) **Comments:** By inspection of the relevant details of S201, the net section of the brace is not reinforced. As a result, the limit state of net section fracture will occur before the yielding capacity of the brace is reached. Additionally, there is a nonconformance with Detail 12/S201 as previously noted. The horizontal weld between the gusset and the beam is missing at the second floor connection along Line A, between Lines 1 and2. There is a discontinuous load path deficiency.
○	◉	○	○	COMPACT MEMBERS: All brace elements meet section requirements in accordance with AISC 341, Table D1.1, for moderately ductile members. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec.5.5.4) **Comments:** E 29000 ksi F_y 46 ksi R_y= 1.4 b/t 22.8 0.76*sqrt(E/(R_y*F_y)) 16 b/t > 16 → Noncompact.
○	◉	○	○	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) **Comments:** Deficiency is apparent by inspection and by knowledge of the applicable codes. The structure is an OCBF designed and detailed per the 1995 CBC which used the 1994 UBC as a model code which did not require compliance with the provision defined herein.
◉	○	○	○	CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces frame into the beam–column joints concentrically. (Commentary: Sec. A.3.3.2.4. Tier 2: Sec. 5.5.4.8) **Comments:** All the diagonal braces frame into the beam–column joints concentrically.

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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type S2-S2A

DIAPHRAGMS (STIFF OR FLEXIBLE)

C	NC	N/A	U	Description
○	●	○	○	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) **Comments:** At the second floor the braced frame along Line A between Lines 1 and 2 and the braced frame along Line 1 between Lines A and B are adjacent to a stair opening that creates the noncompliance.

FLEXIBLE DIAPHRAGMS

C	NC	N/A	U	Description
○	○	●	○	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** Roof diaphragm consists of a 18-GA 1 ½" type B steel deck.
○	○	●	○	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) **Comments:** There are no straight-sheathed diaphragms.
○	○	●	○	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:** There are no wood diaphragms.
○	○	●	○	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:** There are no diagonally sheathed and unblocked wood diaphragms.
●	○	○	○	OTHER DIAPHRAGMS: Diaphragms do 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) **Comments:** The diaphragm systems consist of either metal deck or concrete fill over metal deck.

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	Santa Cruz			Date:	06/28/2019		
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UCOP SEISMIC SAFETY POLICY
Falling Hazard Assessment Summary

	Description
P ☐ N/A ☒	**Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)** **Comments:** There are no heavy ceilings, features, or ornamentation above the fitness spaces.
P ☐ N/A ☒	**Heavy masonry or stone veneer above exit ways or public access areas** **Comments:** There is no masonry or stone veneer.
P ☐ N/A ☒	**Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas** **Comments:** There are no masonry parapets, cornices, or other ornamentation.
P ☐ N/A ☒	**Unrestrained hazardous material storage** **Comments:** No hazardous material storage was observed.
P ☐ N/A ☒	**Masonry chimneys** **Comments:** There are no masonry chimneys.
P ☐ N/A ☒	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:** Unknown
P ☒ N/A ☐	**Other:** Full height glazing adjacent to and above Wellness Center entrance **Comments:** We recommend this be checked by the University to confirm the glazing is tempered or the like.
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**

Falling Hazards Risk: Low

Note: P= Present, N/A = Not Applicable

APPENDIX D

Quick Check Calculations

Unit Weights:

	Seismic Weight	Dead Load	
Roof	**psf**	**psf**	**Remarks**
Roofing	3	3	Metal roof per arch dwg; Product specification not available
Steel deck	2	2	1-1/2" – 18 gage acoustic metal deck
Sheathing Board	2	2	
Ceiling	2	2	typ. gypboard ceiling panels
Steel frame	6.500	6.500	Wide flange beams and 6" std pipe
MEP	3	3	
Lighting and misc.	5	5	
Partition	5	5	Half of 10 psf
Total	29	29	

	Seismic Weight	Dead Load	
2nd Floor	**psf**	**psf**	**Remarks**
Equipment	45	45	Assumed for typ. fitness rooms
Finishing	3	3	Assumed
Slab	63	63	3" -18 gage deck with 3.5" normal weight fill (from sample deck catalog)
Steel frame	6.000	6.000	Wide flange beams and 6" std pipe
MEP	3	3	
Lighting and misc.	5	5	
Partition	10	10	
Total	135	135	

Story Weights

W_CMU= 104 psf
w_CMU= 124.8 pcf
W_cladding= 15 psf

Floor Levels	Floor Area (ft2)	Floor Weight (psf)	Wall Weight [1,2,3]					Additional Weight (kips) [4,5]	Total Seismic Weight (kips)
			Wall height below floor level (ft)	Wall height tributary to each floor level (ft)	Wall Area below (ft^2)	Wall Weight below (kips)	Wall Seismic Weight (kips)		
Roof	7,229	29	14.67					32	238
2nd Floor	6,638	135	11.50	5.75	102	147	73	33.6	1,003
1st Floor									
								Total Weight =	1,241

Notes:
1 - Seismic base is set at the 1st floor. Soil-structure interaction is ignored for ASCE 41-17 Tier 1.
2 - Wall weight includes area of exterior and interior concrete walls.
3 - Wall weight is caculated for solid grouted wall with normal weight CMUs (135 pcf) and grout weight of 140 pcf.
4 - 5 psf extra seismic dead load is considered for the pipes hanging from the roof of mechanical room.
5 - The weight of cladding around the perimeter is added to the roof and second floor.

Period

C_t=	0.02
h_n (ft)=	26.17
B=	0.75

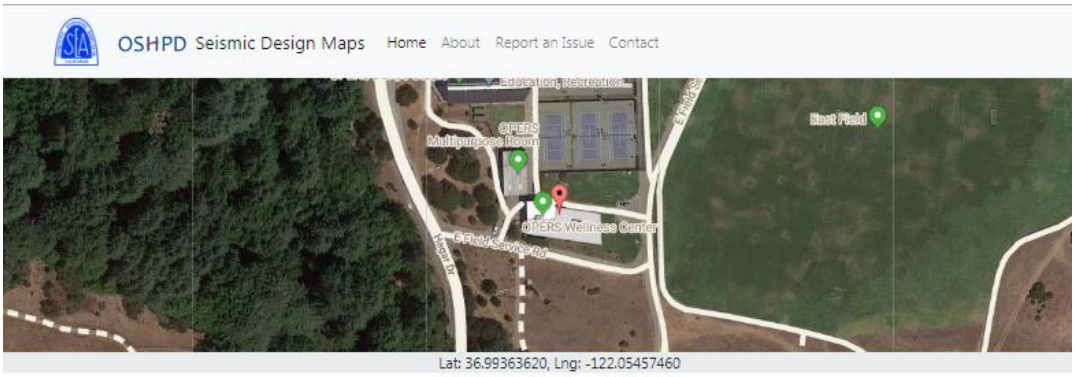
T=	0.23	sec

Notes:
1- The period calculated per ASCE 41-17 Equation 4-4.

$$T = C_t \cdot h_n^{\,B}$$

2- Ct and B are for "all other framing system" per ASCE 41-17 Section 4.4.2.4.
3- The building height is taken from the 1st floor to the roof.

BSE-2E Response Spectrum



Search for Address or Coordinates

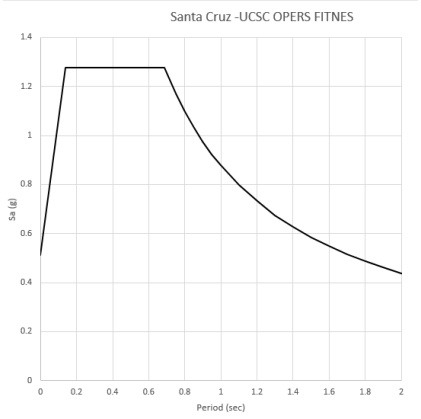
Reference: ASCE 41-17 | Custom Probability: for eg. 0.10 | Site Class: D - Stiff Soil

Project Title (optional) | Address | Coords | 36.9936362 | -122.0545746 | Go

Latitude, Longitude: 36.9936362, -122.0545746 — Print

Date	6/27/2019, 4:26:46 PM
Design Code Reference Document	ASCE41-17
Custom Probability	
Site Class	D - Stiff Soil

Type	Description	Value
Hazard Level		BSE-2E
S_S	spectral response (0.2 s)	1.284
S_1	spectral response (1.0 s)	0.486
S_{XS}	site-modified spectral response (0.2 s)	1.284
S_{X1}	site-modified spectral response (1.0 s)	0.882
f_a	site amplification factor (0.2 s)	1
f_v	site amplification factor (1.0 s)	1.814



Story Shears

Sa=	1.284	
W=	1,241	kips
C=	1.2	Per ASCE 41-17 Table 4-7

V=	1,912	kips

k=	1.00	

Floor Levels	Story Height (ft)	Total Height, H (ft)	Weight, W (kips)	W x H^k	coeff	Fx (kips)	Story Shear, V (kips)
Roof	14.67	26.17	238	6,217	0.35	669	669
2nd Floor	11.50	11.50	1,003	11,535	0.65	1,242	1,912
			Σ=	17,752	1	1,912	

Notes:
1- The base of building is assumed to be at the 1st floor.
2- Modification Factor, C, per ASCE 41-17, Table 4-7.

Average Stress in CMU wall:

Average Stresses

Ms =	4.5

Longitudinal (E-W direction)					
Story	**Story Shear[1]**	**Wall Area**	**Average Shear Stress**	**Tier 1 Shear Stress Limit**	**Wall OK?**
	(kips)	(in^2)	(psi)	(psi)	
Longitudinal (E-W direction)	956	7,560	28	70	OK
Transverse (N-S direction)	956	4,260	50	70	OK

1 - Story shear is equally splitted between the braced frame and CMU wall.

Column Axial Stress Check:

F_y=	35	(ksi)

	Roof	**2nd Floor**	**Total (kips)**
Tributary Area[1] (ft^2)	113	113	
Dead load (psf)	29	135	
Live Load (psf)	20	100	
Total (DL+LL) (kips)	5.537	26.555	**32**

Column Cross-section Area (in^2)	**Column Axial Stress (ksi)**	**0.1*F_y**	**Check**
5.58	5.8	3.5	Not OK

1 - The column axial stress is checked for the most critical column subjected to overturning forces at A-2.

Brace Axial Stress Check:

F_y =	46	(ksi)	Per structural drawings, Sheet S1
D/t=	22.8	-	
F_ye=	57.5	(ksi)	
90/(F_ye)$^{1/2}$=	11.9	-	
190/(F_ye)$^{1/2}$=	25.1	-	
M_s =	4.10	-	Per ASCE 41-17, Table 4-9

Story	V (kips)[1]	L_br (ft)	N_br	s (ft)	A_br (in^2)	f_avg (ksi)	0.5*Fy (ksi)	Check
First Story	956	15	2	17	5.24	20	23	OK

1- Total story shear force is distributed equally between the brace elements and CMU wall.

Table 4-9. M_s Factors for Diagonal Braces

Brace Type	d/t[b]	Level of Performance CP[a]	LS[a]	IO[a]
Tube[b]	$<90/(F_{ye})^{1/2}$	7.0	4.5	2.0
	$>190/(F_{ye})^{1/2}$	3.5	2.5	1.25
Pipe[c]	$<1{,}500/F_{ye}$	7.0	4.5	2.0
	$>6{,}000/F_{ye}$	3.5	2.5	1.25
Tension-only		3.5	2.5	1.25
Cold-formed steel strap-braced wall		3.5	2.5	1.25
All others		7.0	4.5	2.0

Note: $F_{ye} = 1.25F_y$; expected yield stress.
[a] CP = Collapse Prevention, LS = Life Safety, IO = Immediate Occupancy.
[b] Depth-to-thickness ratio.
[c] Interpolation to be used for tubes and pipes.

Compactness of Brace Elements Check:

Modulus of elasticity of steel	**E=**	29000	(ksi)
Specified minimum yield stress	**F_y=**	46	(ksi)
Depth-to-thickness ratio	**D/t=**	22.8	-
Ratio of the expected yield stress to the specified minimum yield stress	**R_y=**	1.4	-

Limiting Width-to-Thickness Ratio (λ_r) (nonslender/slender) (AISC 360, Table B4.1)	$1.4*(E/F_y)^{1/2}$=	35.2
Limiting Width-to-Thickness Ratio (λ_md) for moderately ductile member (AISC 341, Table D1.1)	$0.76*(E/(R_y*F_y))^{1/2}$=	16.1

ASCE 41-17, Commentary: Sec. A.3.3.1.7	Check (1): D/t < λ_r (?)	Yes	**Nonslender**
	Check (2): D/t < λ_md (?)	No	**Noncompact**

Slenderness of Diagonals Check:

Effective length factor	**K=**	1	
Laterally unbraced length of the member	**l =**	16	(ft)
Radius of gyration	**r =**	2.34	(in)
Maximum effective slenderness ratio (ASCE 41-17)	**(kl/r)_max=**	200.0	-
Effective slenderness ratio	**Kl/r =**	82.1	-

Check (1): Kl/r < 200 (?)	Yes	**Nonslender**