



Rating form completed by:

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

**UC Santa Cruz building seismic ratings**  
**Theater Arts L Experimental Theater**

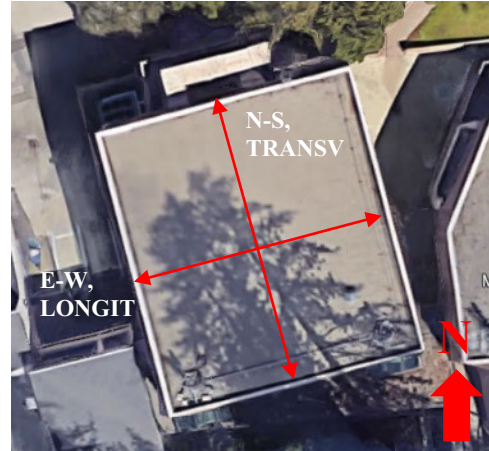
CAAN #7923

455 Kerr Road, Santa Cruz, CA 95064

UCSC Campus: Main Campus



DATE: 2019-06-30



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1	ASCE 41-17 <sup>1</sup>
Date of rating	2019	
Recommended UC Santa Cruz priority category for retrofit	Priority B	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating <sup>2</sup>	Medium (\$50 to \$200 per sf)	
Is 2018-2019 rating required by UCOP?	Yes	Building was not previously rated
Further evaluation recommended?	Yes	Tier 2 – focused on wall anchorage to diaphragm

<sup>1</sup> 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 UC Seismic Policy and Method B of Section 321 of the 2016 California Existing Building Code.

<sup>2</sup> Per Section 3.A.4.i of the Seismic Program Guidebook, 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, Volume A: issued 1 November 1996 (stamped 13 November 1996), sheets A1-A3, A100-A102, A202, A301, A302, A401, A420-A427, A51-A534, A601 and A833 pertinent to Building 'L'.
- Structural drawings by KPFF Consulting Engineers, Volume A: issued 1 November 1996, sheets S1, S101-S104, S201-S203 and S301-S306 pertinent to Building 'L'.
- University of California building database information, "Cowell College," provided by Jose Sanchez (UCSC) on 2019-04-19.

**Additional building information known to exist**

- None

**Scope for completing this form**

Reviewed structural drawings for original construction and carried out a site visit to verify that the existing drawings matched the existing structure to the best of our knowledge. An ASCE 41-17 Tier 1 evaluation was completed. We did not perform an ASCE 41 Tier 1 nonstructural evaluation, but we looked for potentially hazardous nonstructural components during our site visit.

**Brief description of structure**

The Theater Arts L Experimental Theater is one of a cluster of several teaching facilities and theater arts at the campus. The complex was designed in 1996 by the architectural office of Boora Architects and the structural office of KPFF Consulting Engineers; construction was completed in late 1998.

The building is a 2-story structure that contains approximately 5,500 square feet in the shape of a 70' (east-west) by 78' (north-south) rectangle, in addition to outside dock, storage and stairs on the north side and a canopy on the south side. While the first floor extends to the full footprint of the structure, the second floor consists of a 6-foot wide catwalk along the west and east perimeter walls, and several rooms about 10 foot-wide along the north and south perimeter walls. The structure measures 14 feet in height from the first floor to the second floor and an additional 20'8" to the roof floor, for a total height of 36'8" to the top of the 2' parapet on the roof.

Reinforced and fully grouted concrete masonry unit (CMU) walls extend to the full height of the structure on all 4 sides. Floors at the second floor are mostly composite metal deck. The roof consists of steel trusses that span east-west. A walking platform is suspended from the roof trusses.

Two exit doors are at the south end of the building and the dock gate is on the north end. There are exterior exit stairs at the north west corner.

Identification of levels: Level 1 is at elevation 100', Level 2 is at elevation 114', and the roof is at elevation 134'8".

Foundation system: The site is moderately sloping. The superstructure is founded on shallow strip footings located under the RM exterior walls, as well as under the metal stud bearing walls that support the gravity load of the second floor (catwalk and rooms).

Structural system for vertical (gravity) load: The second floor catwalk (and rooms) span between the perimeter RM shear walls on the external side and metal stud bearing walls on the internal side of the structure. The roof trusses are spaced 10 feet apart, span east to west and are supported on the perimeter RM shear walls. A walking platform is suspended from the roof trusses.

Structural system for lateral forces: The steel trusses at the roof level support a flexible metal deck diaphragm and transfer the lateral load from the roof to the east and west perimeter RM shear walls. The lateral loads are transferred by 4-3/4" bolts anchored in the RM shear walls. The walking platform (suspended from the roof trusses) is braced laterally to the RM shear walls. The second floor consists of a composite metal deck braced to the perimeter RM shear walls. The 12-inch thick RM shear walls consist of fully grouted concrete masonry units.

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

The following main seismic deficiency is identified:

- The connection of the roof metal deck diaphragm to the wall in the east-west direction (4-3/4" anchor bolts per truss) does not provide enough lateral support for the walls and is inadequate to transfer the diaphragm seismic forces to the perimeter concrete shear walls.

Other seismic deficiencies include:

- The large window opening in the south RM shear wall -see South Elevation drawing below- affects the geometrical regularity of the building; however torsional effects are not a concern because of the relative light weight of the supported roof, where most of the building mass is provided by the shear walls.
- The second-floor composite metal deck catwalk is connected to perimeter supporting walls by puddle welds. Also, the metal deck roof diaphragm is connected to perimeter supporting steel by puddle welds. Current research suggests that welded connections of metal deck to supporting steel provide less ductility than other connection types such as fasteners.

Structural deficiency	Affects rating?	Structural deficiency	Affects rating?
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	N	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	Y
Geometry (vertical irregularities)	N	URM wall height-to-thickness ratio	N
Torsion	N	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	N		

**Summary of review of non-structural life-safety concerns, including at exit routes.<sup>3</sup>**

We walked through all floors of the building. As shown in the table below, no non-structural hazards were observed.

UCOP non-structural checklist item	Life safety hazard?	UCOP non-structural 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	None observed
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

**Discussion of rating**

While the shear stress is estimated to meet the required limit of 70 lb/in<sup>2</sup> at the BSE-C level of motion, the rating of V reflects the inadequacy of the roof to wall connection, as described above.

<sup>3</sup> 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 the type and location of potential non-structural hazards.

**Recommendations for further evaluation or retrofit**

The connection of the roof metal deck diaphragm to the wall in the east-west direction (4-3/4" anchor bolts per truss) does not provide enough lateral support for the walls and is inadequate to transfer the diaphragm seismic forces to the perimeter concrete shear walls. Further evaluation is required to investigate this connection problem, as well as the adequacy of spot welds used to connect the second-floor catwalk to perimeter supporting walls, and the metal deck roof diaphragm to perimeter supporting steel.

**Peer review of rating**

This seismic evaluation was discussed in a peer review meeting on 17 June 2019. The reviewer present was Bret Lizundia of R+C. Comments from the reviewer have been incorporated into this report. The reviewer agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	36.99524	
Longitude	-122.061969	
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)	6,389	
Risk Category per 2016 CBC Table 1604.5	II	Assumed based on the understanding from site visit that occupancy is 200 (less than 300).
Building structural height, $h_n$	34'8" 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, $\beta$	0.75	Estimated using ASCE 41-17 equation 4-4 and 7-18
Estimated fundamental period	0.29 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975 yr hazard parameters $S_s, S_1$	1.286, 0.488	
Site class	D	
Site class basis <sup>4</sup>	Geotech	See footnote below
Site parameters $F_a, F_v$ <sup>5</sup>	1, 1.81	
Ground motion parameters $S_{Xs}, S_{X1}$	1.286, 0.885	
$S_a$ at building period	1.283	

<sup>4</sup> 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:

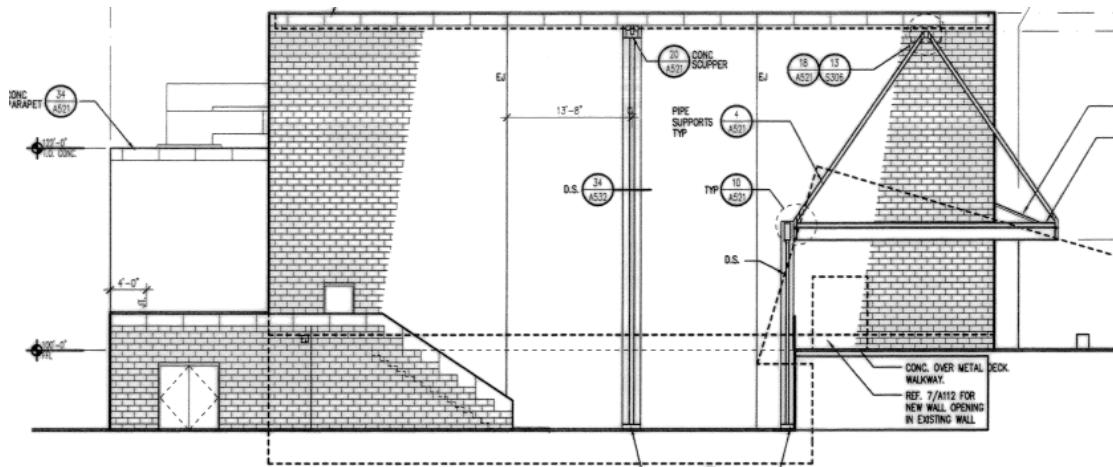
<https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LiquifactionMap2009.pdf>

<https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/LandslideMap2009.pdf>

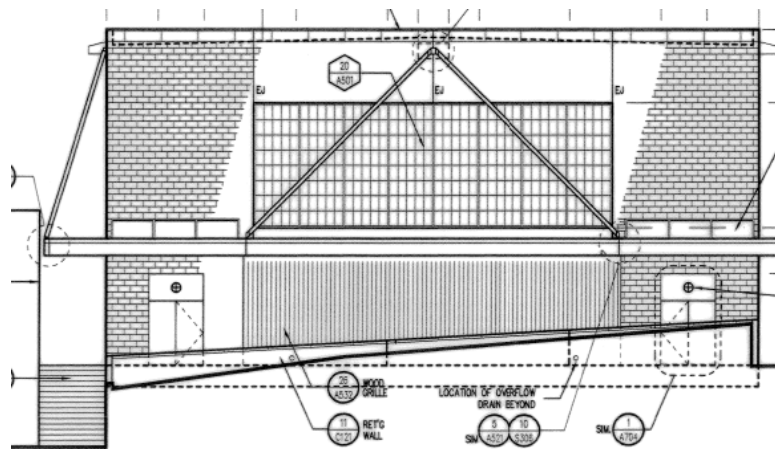
<https://gis.santacruzcounty.us/mapgallery/Emergency%20Management/Hazard%20Mitigation/FaultZoneMap2009.pdf>

<sup>5</sup>  $F_v$  factor used does not include the requirements of Section 11.4.8-3 of ASCE 7-16 that are applicable to Site Class D, and which per Exception 2 would result in an effective  $F_v$  factor of 2.72 (1.5 times larger). At the Santa Cruz main campus this only affects structures with  $T > 0.69$  seconds. We understand that the appropriateness of this requirement of Section 11.4.8 might be reviewed by UCOP.

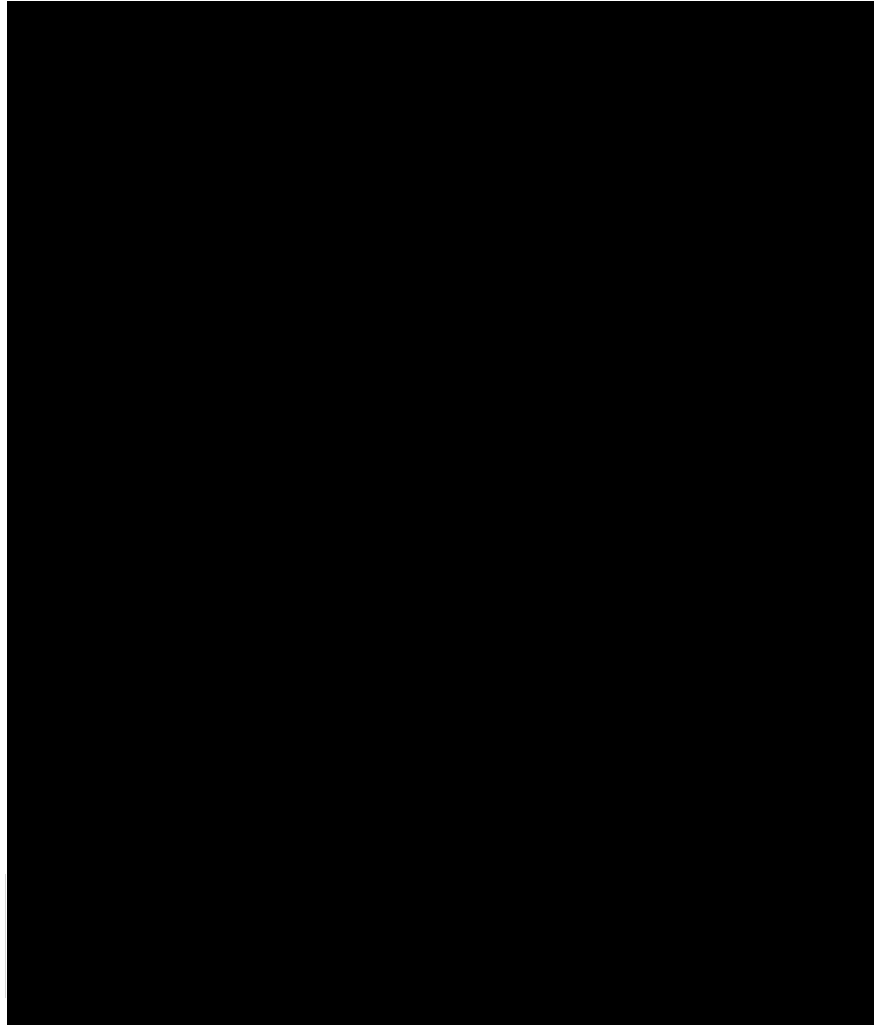
Site $V_{s30}$	900 ft/s	
$V_{s30}$ basis	Estimated	Estimated based on site classification of D
Liquefaction potential	Low	
Liquefaction assessment basis	County map	See footnote below
Landslide potential	Low	
Landslide assessment basis	County map	See footnote below
Active fault-rupture identified at site?	No	
Fault rupture assessment basis	County map	See footnote below
Site-specific ground motion study?	No	
<b>Applicable code</b>		
Applicable code or approx. date of original construction	Built: 1998 Code: 1991 UBC	Code specified on structural drawings
Applicable code for partial retrofit	N/A	
Applicable code for full retrofit	N/A	
<b>Model building data</b>		
Model building type North-South	RM1 – Reinforced Masonry (Flexible Diaphragm)	
Model building type East-West	RM1 – Reinforced Masonry (Flexible Diaphragm)	
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
<b>Previous ratings</b>		
Most recent rating	N/A	
Date of most recent rating		
2 <sup>nd</sup> most recent rating	-	
Date of 2 <sup>nd</sup> most recent rating	-	
3 <sup>rd</sup> most recent rating	-	
Date of 3 <sup>rd</sup> most recent rating	-	
<b>Appendices</b>		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file



West Elevation



South Elevation



**Annotated floor plan (2<sup>nd</sup> floor shown)**

UC Campus:	UC Santa Cruz		Date:	6/30/2019		
Building CAAN:	7376	Auxiliary CAAN:	By Firm:	Maffei Structural Engineering		
Building Name:	Kerr Hall		Initials:	NY	Checked:	JM
Building Address:	500 Kerr Road, Santa Cruz CA 95064		Page:	1	of	3

## ASCE 41-17 Collapse Prevention Basic Configuration Checklist

### LOW SEISMICITY

#### BUILDING SYSTEMS - GENERAL

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>NC</b>	<p><b>LOAD PATH:</b> 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)</p> <p><b>Comments:</b> Collectors to walls are not provided. Caisson reinforcement is developed only 20db into pier caps versus current ACI 318-14 development length of 28db.</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p><b>ADJACENT BUILDINGS:</b> 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)</p> <p><b>Comments:</b> C - No adjacent buildings</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p><b>MEZZANINES:</b> 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)</p> <p><b>Comments:</b> C - No mezzanines</p>

#### BUILDING SYSTEMS - BUILDING CONFIGURATION

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p><b>WEAK STORY:</b> 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)</p> <p><b>Comments:</b> C – wall length/thickness increases with height.</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p><b>SOFT STORY:</b> 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)</p> <p><b>Comments:</b> C</p>

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



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## ASCE 41-17 Collapse Prevention Basic Configuration Checklist

<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p><b>Comments:</b> C – interior walls are continuous to foundation.</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>NC</b>	<p>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)</p> <p><b>Comments:</b> NC – Level 1 has more than 30% increase in wall length versus Level 2. This is due to the wall added at the north end of the building for retaining soil.</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p><b>Comments:</b> C – There is a 44% change in mass between Level 3 (larger floor footprint) and Level 4 (smaller floor footprint).</p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>NC</b>	<p>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)</p> <p><b>Comments:</b> NC – Level 1 has significantly more wall at the north end of the building, resulting in the eccentricity between center of mass and center of rigidity in the north-south direction.</p>

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

#### GEOLOGIC SITE HAZARD

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p><b>Comments:</b></p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p><b>Comments:</b></p>

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

#### GEOLOGIC SITE HAZARD

<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p>Comments:</p>
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### HIGH SEISMICITY (COMPLETE THE FOLLOWING ITEMS IN ADDITION TO THE ITEMS FOR MODERATE SEISMICITY)

#### FOUNDATION CONFIGURATION

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>NC</b>	<p>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 <math>0.6S_a</math>. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)</p> <p>Comments: <b>NC</b> – At stair core, wall is 16' long and 65' high (including basement depth), so <math>16'/65' = 0.25 &lt; 0.6S_a = 0.6*1.28 = 0.77</math></p>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<p>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)</p> <p>Comments: <b>C</b> – tie beams are provided</p>

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## ASCE 41-17 Collapse Prevention Structural Checklist For Building Type C2-C2A

### Low And Moderate Seismicity

#### Seismic-Force-Resisting System

	Description
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>NA</b></p>	<p><b>COMPLETE FRAMES:</b> 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. 5.5.2.5.1)</p> <p><b>Comments:</b> NA – no frames provided</p>
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>C</b></p>	<p><b>REDUNDANCY:</b> 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)</p> <p><b>Comments:</b></p>
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>NC</b></p>	<p><b>SHEAR STRESS CHECK:</b> The shear stress in the concrete shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the greater of 100 lb/in.<sup>2</sup> (0.69 MPa) or <math>2\sqrt{f_c}</math>. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1)</p> <p><b>Comments:</b> NC – walls in north-south direction are overstressed at Level 2 where the building footprint increases but wall length do not increase proportionally.</p>
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>C</b></p>	<p><b>REINFORCING STEEL:</b> 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)</p> <p><b>Comments:</b> C</p>

#### Connections

	Description
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>NA</b></p>	<p><b>WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS:</b> 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 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)</p> <p><b>Comments:</b> NA – rigid diaphragm at floor and roof</p>
<p><b>C</b> <b>NC</b> <b>N/A</b> <b>U</b></p> <p><input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/></p> <p style="text-align: center;"><b>NC</b></p>	<p><b>TRANSFER TO SHEAR WALLS:</b> Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)</p> <p><b>Comments:</b> NC – no collectors provided</p>

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## ASCE 41-17 Collapse Prevention Structural Checklist For Building Type C2-C2A

<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<b>FOUNDATION DOWELS:</b> Wall reinforcement is doweled into the foundation with vertical bars equal in size and spacing to the vertical wall reinforcing directly above the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)  <b>Comments:</b> C
---	---

### High Seismicity (Complete The Following Items In Addition To The Items For Low And Moderate Seismicity)

#### Seismic-Force-Resisting System

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>NC</b>	<b>DEFLECTION COMPATIBILITY:</b> 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)  <b>Comments:</b> NC – gravity columns do not have shear capacity to develop their flexural strength, at levels 3 and below.
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<b>FLAT SLABS:</b> Flat slabs or plates not part of the 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)  <b>Comments:</b>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<b>COUPLING BEAMS:</b> The ends of both walls to which the coupling beam is attached are supported at each end to resist vertical loads caused by overturning. (Commentary: Sec. A.3.2.2.3. Tier 2: Sec. 5.5.3.2.1)  <b>Comments:</b>

#### Diaphragms (Stiff Or Flexible)

	Description
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<b>DIAPHRAGM CONTINUITY:</b> 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)  <b>Comments:</b>
<b>C</b> <b>NC</b> <b>N/A</b> <b>U</b> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <b>C</b>	<b>OPENINGS AT SHEAR WALLS:</b> 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)  <b>Comments:</b>

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

UC Campus:	UC Santa Cruz		Date:	6/30/2019		
Building CAAN:	7376	Auxiliary CAAN:	By Firm:	Maffei Structural Engineering		
Building Name:	Kerr Hall		Initials:	NY	Checked:	JM
Building Address:	500 Kerr Road, Santa Cruz CA 95064		Page:	3	of	3

## ASCE 41-17 Collapse Prevention Structural Checklist For Building Type C2-C2A

Flexible Diaphragms						
		Description				
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b>		
<b>NA</b>						
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	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)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b>		
<b>NA</b>						
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	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)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b>		
<b>NA</b>						
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	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)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b>		
<b>NA</b>						
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	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)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b>		
<b>NA</b>						
Connections						
		Description				
<b>C</b>	<b>NC</b>	<b>N/A</b>	<b>U</b>	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)		
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<b>Comments:</b> NC – pile caps have top reinforcement, but pile reinforcement is inadequately developed into pile cap (development length is specified 20db and not 28db as required by ACI 318-14)		
<b>NC</b>						

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



Project: \_\_\_\_\_

Subject: \_\_\_\_\_

By: \_\_\_\_\_

Date: \_\_\_\_\_

## SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

### ASCE 41-17 Chapter 4

General		Reference	Location
Building	Kerr Hall		
Architect	Germano, Milono & Associates		
Structural Engineer	T.Y. Lin, Kulka, Yang & Associate		
Location	513 Cowell Service Road, Santa Cruz, CA 95064		
Design date	1969		
Latitude	36.99699	<a href="https://hazards.atcouncil.org/">https://hazards.atcouncil.org/</a>	
Longitude	-122.06210	"	
Stories above grade	4		
<b>Seismic parameters</b>			
Risk Category	II	2016 CBC Table 1604.5	
Site Class	D	(ASCE 41-17 2.4.1.6, ASCE 7-16 Chapter 20)	See ASCE 7
Liquefaction hazard	Low	<a href="http://data-sccqis.opendata.arcgis.com/datasets/77d380d355934b38a44894154377e28d_62">http://data-sccqis.opendata.arcgis.com/datasets/77d380d355934b38a44894154377e28d_62</a>	(ASCE 41-17 3.3.4) See ASCE 41
Landslide hazard	Low	<a href="http://data-sccqis.opendata.arcgis.com/datasets/7984aab55ec4a4794ae33d7919bd9c7_133">http://data-sccqis.opendata.arcgis.com/datasets/7984aab55ec4a4794ae33d7919bd9c7_133</a>	
$S_{DS}$	0.85	Based on ASCE 7-16 DE, used to determine "Level of Seismicity" <a href="https://hazards.atcouncil.org/">https://hazards.atcouncil.org/</a>	(ASCE 41-17 Eq 2-4) See ASCE 41
$S_{D1}$	0.59	Based on ASCE 7-16 DE, used to determine "Level of Seismicity" <a href="https://hazards.atcouncil.org/">https://hazards.atcouncil.org/</a>	(ASCE 41-17 Eq 2-5) See ASCE 41
$S_{XS}$	1.281	For BSE-2E hazard level <a href="https://hazards.atcouncil.org/">https://hazards.atcouncil.org/</a>	(ASCE 41-17 Table 2-2) Copied at right
$S_{X1}$	0.88	For BSE-2E hazard level <a href="https://hazards.atcouncil.org/">https://hazards.atcouncil.org/</a>	(ASCE 41-17 Table 2-2) Copied at right
<b>Scope</b>			
Performance level	Collapse Prevention	(ASCE 41-17 Table 2-2)	Copied at right
Seismic hazard level	BSE-2E	(ASCE 41-17 Table 2-2)	Copied at right
Level of seismicity	High	(ASCE 41-17 Table 2-4)	Copied at right
Building type	C2: Concrete shear walls with rigid diaphragms	(ASCE 41-17 Table 3-1)	Copied at right
<b>Material properties</b>			
Concrete	$f'_c$	4000 psi	Notes: Specified on drawings, NWC (ASCE 41-17 Table 10-4) See ASCE 41
Reinf.	$f_y$	40 ksi	Specified on Drawings for #5 and smaller (ASCE 41-17 Table 10-4) See ASCE 41
		60 ksi	Specified on Drawings for #6 and larger
Steel	$F_y$	N/A ksi	N/A (ASCE 41-17 Table 9-1) See ASCE 41



Project: \_\_\_\_\_  
 Subject: \_\_\_\_\_  
 By: \_\_\_\_\_  
 Date: \_\_\_\_\_

**Checklists**

Benchmark building	No	Retrofit also pre-benchmark	(ASCE 41-17 Table 3-2)	Copied at right
Checklist(s) req'd	17.1.2 Basic Configuration		(ASCE 41-17 Table 4-6)	Copied at right
	17.12 Structural Checklist for Building Types C2a		(ASCE 41-17 Table 4-6)	Copied at right
	17.19 Nonstructural Checklist (not performed)		(ASCE 41-17 Table 4-6)	Copied at right

**Seismic forces**

V	16589	kip	$V = C_s a W$	= 1.28W	(ASCE 41-17 Eq 4-1)	See ASCE 41
W	12950	kip	building weight		(ASCE 41-17 4.4.2.1)	See ASCE 41
C	1.0		Convert linear elastic to inelastic disp.		(ASCE 41-17 Table 4-7)	Copied at right
$S_a$	1.28	g	$S_a = S_{x1} / T \leq S_{x5}$		(ASCE 41-17 Eq 4-3)	See ASCE 41
T	0.39	sec	$T = C_t h_n^\beta$		(ASCE 41-17 Eq 4-4)	See ASCE 41
$C_t$	0.020				(ASCE 41-17 Eq 4-4)	Copied at right
$\beta$	0.75				(ASCE 41-17 Eq 4-4)	Copied at right
$h_n$	52	ft	building height		(ASCE 41-17 Eq 4-4)	Copied at right

**Story Forces**

(ASCE 41-17 4-2a) (ASCE 41-17 4-2b)

Story	w kip	story ht ft	h ft	$wh^k$	$F_{story}$	$F_{story}$ kip	$V_{story}$ kip
Roof	2069		52	107588	0.29	4828	
4	2447	13.0	39	95433	0.26	4283	4828
3	4385	13.0	26	114010	0.31	5116	4828
2	4049	13.0	13	52637	0.14	2362	14227
1		13.0	0				16589
<b>Total</b>	<b>12950</b>			<b>369668</b>	<b>1.0</b>	<b>16589</b>	

k 1.00 k = 1.0 for T < 0.5, 2.0 for T > 2.5, linear interpolation between

$F_{story} = V (wh^k) / (\sum wh^k)$  (ASCE 41-17 4-2a)

$V_{story} = \sum_{above} F_{story}$  (ASCE 41-17 4-2b)



Project: \_\_\_\_\_  
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**Shear stress in shear walls** (ASCE 41-17 4-8) (ASCE 41-17 4-8)

Story	$A_{wN-S}$ in <sup>2</sup>	$A_{wE-W}$ in <sup>2</sup>	$v_{NS}^{avg}$ psi	$v_{EW}^{avg}$ psi	$D/C_{NS}$	$D/C_{EW}$
Roof						
4	11220	18860	96	57	0.8	0.4
3	13464	20760	80	52	0.6	0.4
2	17735	26208	178	121	1.4	1.0
1	48936	48480	75	76	0.6	0.6

Total  $M_s$  4.50 (ASCE 41-17 Table 4-8)

$v_{limit} = 126 \text{ psi}$   $v_{limit} = 2\sqrt{f_c'} \geq 100 \text{ psi}$   
 $v^{avg} = (1/M_s)(V_{story}/A_w)$  (ASCE 41-17 Eq 4-8)



**SHEAR STRENGTH OF CONCRETE ELEMENTS****FEMA 306 Section 5.3.6****Input**

$f'_{ce}$	4000 psi	concrete expected strength
$\lambda$	1.00	lightweight aggregate factor = 1.0 NWC, 0.85 sand LWC, 0.75 LWC
$\mu$	1.4 $\lambda$	per ACI 318 11.7.4 = 1.4 monolithic, 1.0 roughened, 0.6 not roughened, 0.7 bars
$f_{ye\_transverse}$	46 ksi	expected transverse steel yield strength
$f_{ye\_longitudinal}$	70 ksi	expected shear friction steel yield strength
$b_w$	32.0 in	width
$l_w$	24.0 in	length of wall (depth of beam or column)
$h_w$	12.3 ft	clear height of wall or column (length of beam or spandrel)
$\rho_n$	0.00115	transverse reinforcement ratio
$A_s$	8.0 in <sup>2</sup>	longitudinal reinforcement area
$P$	600 kip	axial load
$M_{n1}$	645 k-ft	moment strength at one end of element (e.g. top)
$M_{n2}$	645 k-ft	moment strength at other end of element (e.g. bottom)
$c$	12.5 in	distance from extreme compressive fiber to neutral axis
$\theta$	35 degrees	35 degrees unless limited to larger angles by the potential corner to corner crack for corner to corner crack, use $\theta = \max(35, \text{atan}(l_w/h_w)) = 35$

**Behavior Mode****Flexure/ Diagonal**

$V_{n\_flexure} = (M_{n1} + M_{n2})/h =$	105 kip	
$V_{n\_diagonal\_tension\_at\_low\_ductility\_demand} =$	170 kip	( $\mu \leq 2$ )
$V_{n\_diagonal\_tension\_at\_high\_ductility\_demand} =$	91 kip	( $\mu \geq 5$ )
$V_{n\_sliding\_shear} =$	614 kip	

**Diagonal Tension Shear**

	$\mu \leq 2$	$\mu \geq 5$	flexural ductility demand
$V_{n\_diagonal}$	170	91 kip	$= V_c + V_s + V_p$
$V_c$	96	17 kip	$= \alpha \beta k_{rc} (f'_{ce})^{1/2} b_w (0.8 l_w)$
$V_s$	28	28 kip	$= \rho_n f_{ye} b_w h_d$
$V_p$	46	46 kip	$= ((l_w - c) N_u) / (2M/V)$
$k_{rc}$	3.5	0.6	
$\alpha$	1.0	1.0	$= 3 - M/(0.8 l_w V) \quad (1.0 \leq \alpha \leq 1.5)$
$\beta$	0.708	0.708	$= 0.5 + 20 \rho_g \quad (\leq 1.0)$
$\rho_g$	0.01042	0.01042	longitudinal reinforcement ratio
$M/V$	74.0	74.0 in	$= h_w/2$ assumes that beams/floors are stiffer than column (fixed- Adjust M/V calculation for other conditions.
$h_d$	16.4	16.4 in	$= (l_w - c) \cot \theta \quad (\leq h_w)$
$N_u$	600	600 k	axial load
$2M/V$	147.96	147.96 in	$= h_w$ assumes that beams/floors are stiffer than column (fixed- Adjust M/V calculation for other conditions.

**Sliding Shear**

$V_{n\_sliding}$	614 kip	$= A_{vf} f_y \mu \quad (\leq 0.2 f_c A_c, 800 A_c)$
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Project: \_\_\_\_\_

Subject: \_\_\_\_\_

By: \_\_\_\_\_

Date: \_\_\_\_\_

$A_{vf}$

8.0 in<sup>2</sup>

area of shear friction reinforcement