Rating form completed by: **MAFFEI STRUCTURAL ENGINEERING**
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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 E Classroom

CAAN #7315
459 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[1]
Date of rating	2019	
Recommended UC Santa Cruz priority 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?	Tier 2	Focused on walkway, lateral force path at roof

[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 UC Seismic Policy and Method B of Section 321 of the 2016 California Existing Building Code.

[2] 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 Ralph Rapson and Associates Inc., "Performing Arts Building, University of California Santa Cruz," as-built dated 30 June 1969
- Structural drawings by Pregnoff and Matheu, "Performing Arts Building, University of California Santa Cruz," as-built dated 30 June 1969
- University of California Facilities Link building database information, "7315" provided by José Sanchez (UCSC) on 2019-05-30.

Additional building information known to exist

- None

Scope for completing this form

We reviewed the structural drawings for the 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

Theater Arts E Studio is one of a cluster of eleven buildings that forms the Theater Arts complex. The complex was designed in 1969 by the architectural office of Ralph Rapson and Associates and the structural office of Pregnoff and Matheu.

The building is 2-story structure that contains approximately 2600 square feet. The building is rectangular in plan, with a building footprint approximately 40' x 40' at Level 1. The structure measures 27 feet from the grade at Level 1 to the highest point of the sloping roof. At Level 2, there is an exterior walkway.

The exterior walkway at Level 2 connects this building to Theater Arts A (CAAN 7311), Theater Arts B (CAAN 7312), Theater Arts C (CAAN 7313), and Theater Arts D (CAAN 7314). The walkway consists of a concrete topping slab over wood framing, and is attached to each building with no seismic separation joints.

Identification of levels: Level 1 (elevation 694.0'), Level 2 (elevation 704.0'), Roof (721.0' at highest point)

Foundation system: The superstructure is founded on shallow strip footings located around the building perimeter and under the interior wood bearing wall and posts.

Structural system for vertical (gravity) load: Level 2 is a partial floor, and is framed with wood joists spanning between wood bearing walls. The roof is framed with wood joists spanning between steel beams that are supported on wood posts at each end.

Structural system for lateral forces: Plywood sheathed floor and roof diaphragms transfer lateral inertial forces from floors (and roof) to plywood sheathed wood walls.

Structural system for walkway: The walkway is approximately 7' wide, constructed with wood joists spanning across the width of the walkway, topped with plywood sheathing, a waterproofing membrane, and a sloped concrete topping slab 2.75" thick on average. Gravity support for the joists is provided on one side by the building adjacent to the walkway, and on the other side by steel W-beams supported by wood posts. Where the walkway is perpendicular to the building, steel beams support the joists for the walkway, and the steel beams are supported by wood posts that are located within the exterior walls of the building. The walkway does not have its own lateral system and is supported for lateral demands by the adjacent buildings.

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 Level 2 exterior walkway connects five buildings – CAAN 7311, 7312, 7313, 7314, and 7315. There are no seismic separations in the walkway between buildings, and differential movement between the buildings could cause damage in the walkway.
- At this building, the walkway joists are supported at one end on a ledger attached to the exterior wall of the building, and at the other end by steel W-beams that are supported by a post located in the wall of Building D (CAAN 7314). Differential movements between Building D and this building could cause the walkway joists to lose their support.
- There appears to be no vertical connection of the walls through the floors, and no hold-downs at the base of the walls. For this building with walls of low aspect ratio, we do not consider the lack of hold-downs to be a factor in the rating.
- The roof has only one line of shear walls in the east-west (transverse) direction. This results in plan torsion at the roof, but the roof diaphragm is a flexible diaphragm and cannot accommodate torsion.

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	N	Liquefaction	N
Adjacent buildings	Y	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	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 non-structural life-safety concerns, including at exit routes.[3]

We walked through all floors of the building and we looked for potentially hazardous nonstructural components during our site visit on 13 June 2019. As shown in the table below, no non-structural hazards were observed inside the building. The exterior walkway is connected to multiple buildings at Level 2, with no seismic separation joints between buildings. Review of details of construction of the connection of the walkway to the building and locating seismic separation joints should be the focus of further review and retrofit for nonstructural hazards.

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

[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 the type and location of potential non-structural hazards.

Discussion of rating

The rating of V (Poor) is because of the potential life safety hazard of the heavy exterior walkway, as well as the lack of a seismic-force path at the high roof.

Recommendations for further evaluation or retrofit

We recommend that the Campus perform a more detailed review of the 3-sided support at the roof. This should be investigated further in a Tier 2 analysis. The campus should also check the condition of the exterior walkway and provide separation joints between buildings. We put the building on Priority Category A, because the walkway modifications should be done as soon as possible.

Peer review of rating

The key issues and expected seismic performance of this building are essentially the same as that for buildings 7312 and 7313. The peer review of those buildings, carried out 24 June 2019, applies to this building; reviewers present were Bret Lizundia of R+C and Jay Yin of Degenkolb.

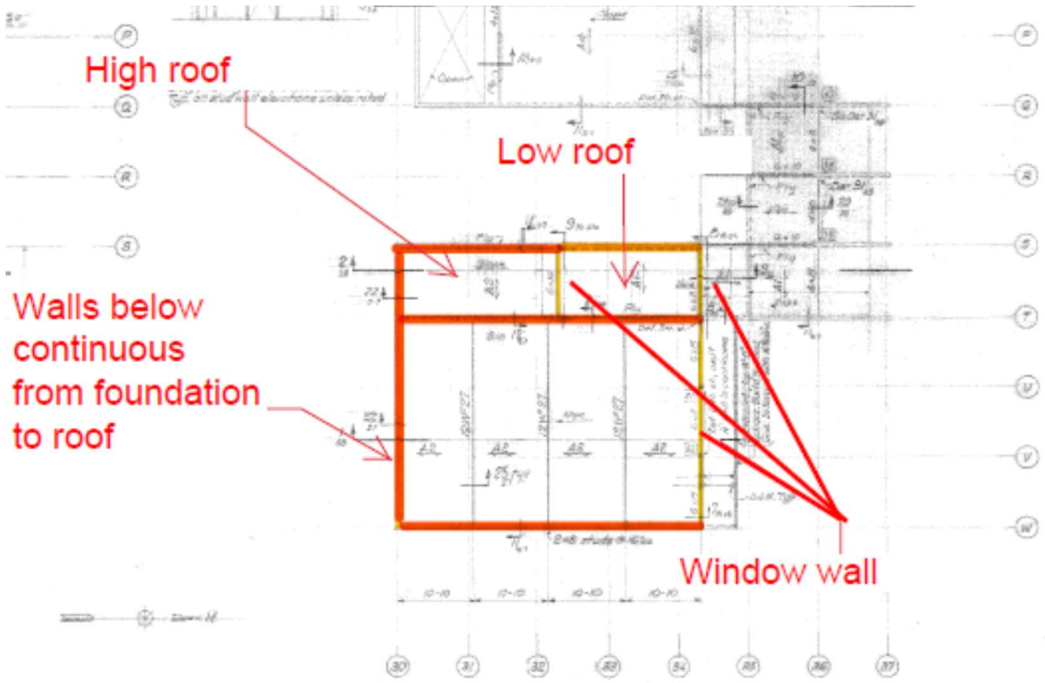
Additional building data	Entry	Notes
Latitude	36.995361	
Longitude	-122.06144	
Are there other structures besides this one under the same CAAN#	Yes	Exterior walkway structure
Number of stories above lowest perimeter grade	2	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	8827 sq. ft.	
Risk Category per 2016 CBC Table 1604.5	II	Educational occupancy (classrooms)
Building structural height, h_n	24 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	0.22 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[4]	Geotech	See footnote below
Site parameters F_a, F_v[5]	1, 1.81	

[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

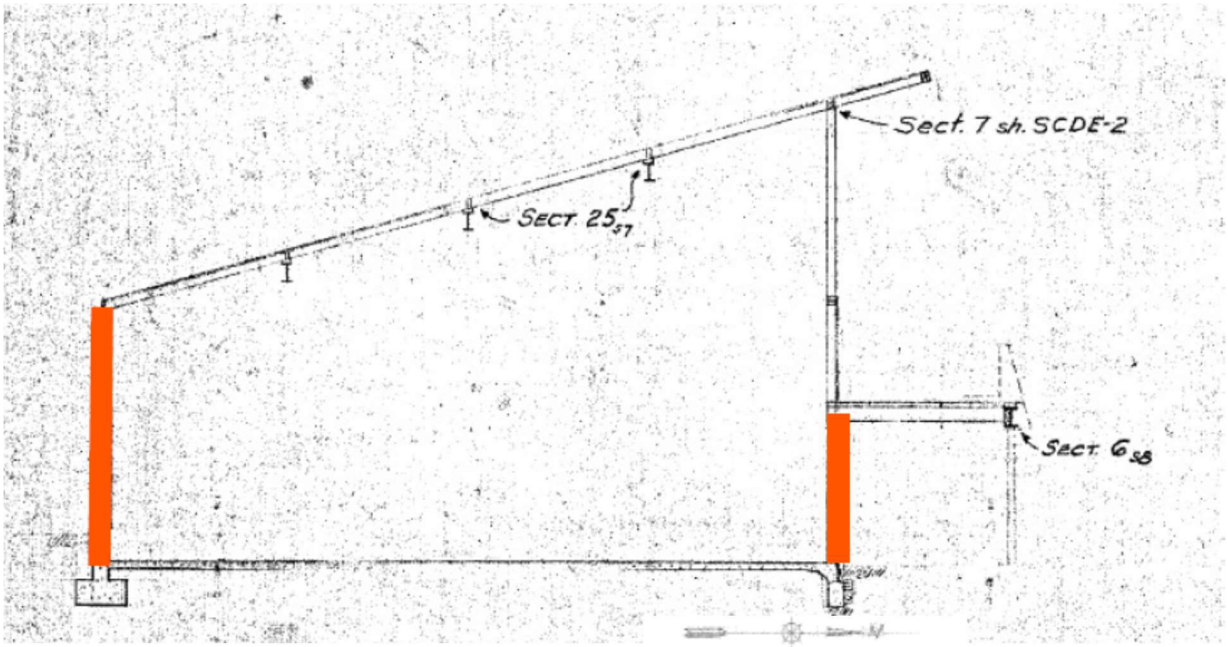
[5] F_V factor used does not include the requirements of Section 11.4.8-3 of ASCE 7-16 that are applicable to Site Class D, and which per Exception 2 would result in an effective F_V factor of 2.72 (1.5 times larger). At the Santa Cruz main campus this only affects structures with T>0.69 seconds. We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

Ground motion parameters S_{cs}, S_{c1}	1.286, 0.885	
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	Designed: 1969 Code: 1967 UBC	Code inferred based on design year
Applicable code for partial retrofit	None	None
Applicable code for full retrofit	None	None
Model building data		
Model building type North-South	W2 – Wood frame	
Model building type East-West	W2 – Wood frame	
FEMA P-154 score	N/A	Not included here. Tier 1 evaluation.
Previous ratings		
Most recent rating	None	
Date of most recent rating	-	
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

Annotated plan (roof shown)

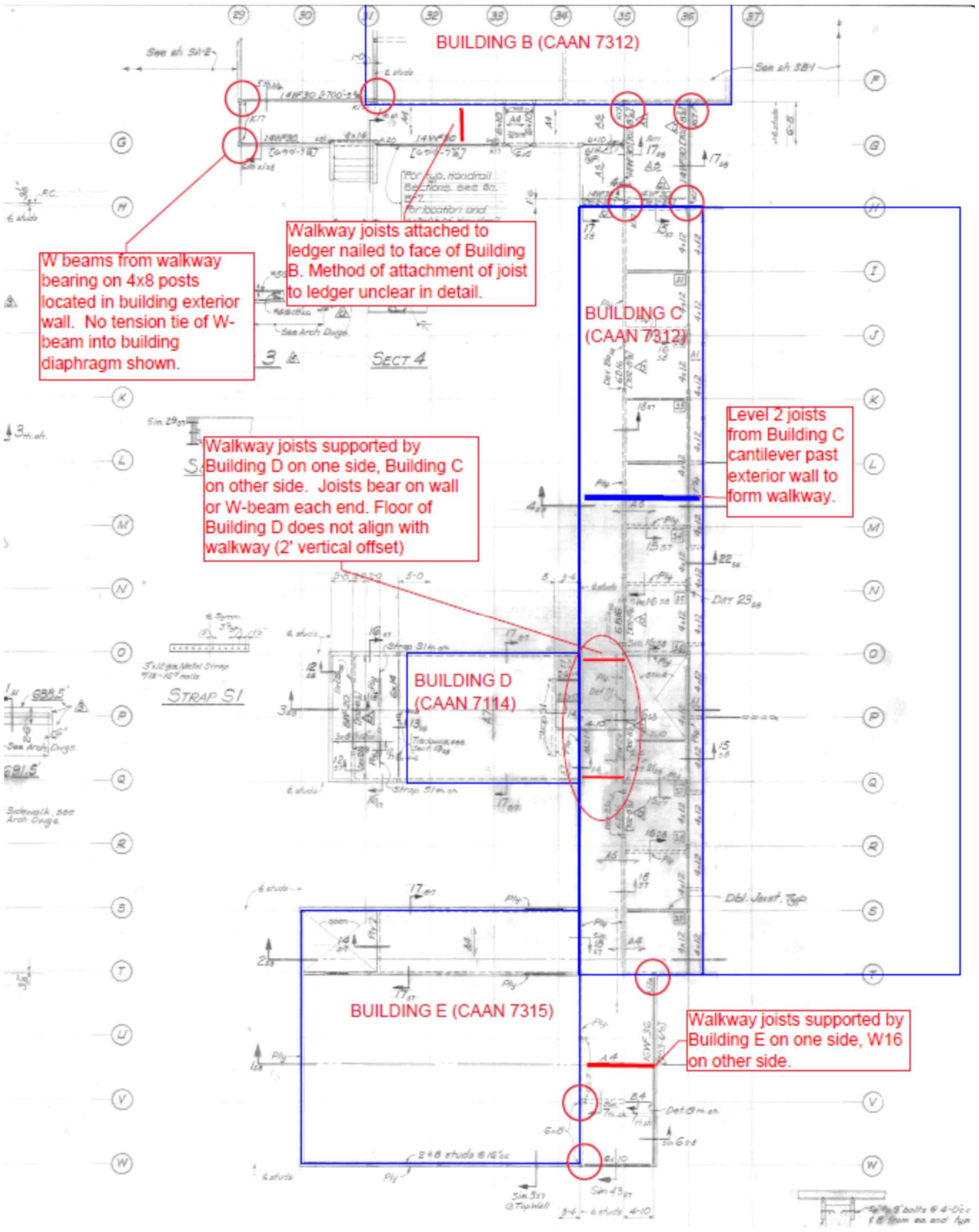


Building section (looking west)

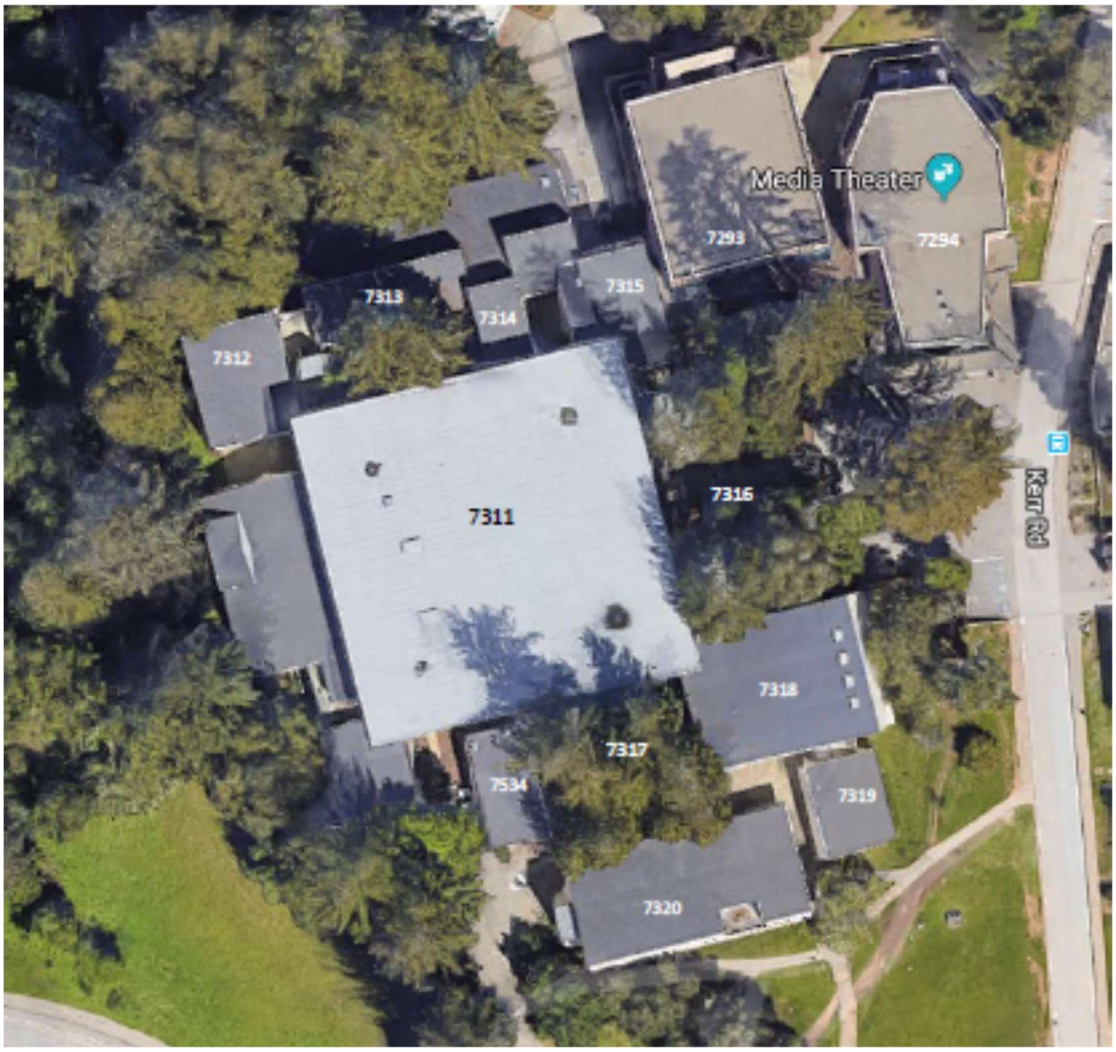


Plan at walkway:

- Locations where walkway W-beams are supported on posts located within building exterior walls shown:
- Locations where walkway joists are attached to ledger nailed to face of building exterior wall shown:



Site map at Theater Arts complex



- Theatre Arts A Main Stage (CAAN 7311)
- Theater Arts B Drama (CAAN 7312)
- Theater Arts C Studio (CAAN 7313)
- Theater Arts D Student Production (CAAN 7314)
- Theater Arts E Classroom (CAAN 7315)
- Theater Arts F Ticket Office (CAAN 7316)
- Theater Arts G Toilet Room (CAAN 7317)
- Theater Arts H Second Stage (CAAN 7318)
- Theater Arts I Second Stage Annex (CAAN 7319)
- Theater Arts J Office (CAAN 7320)
- Theater Arts L Experimental Theater (CAAN 7293)
- Theater Arts M Media Theater (CAAN 7294)

North elevation, showing walkway connection between Building D (CAAN 7314) and Building E (CAAN 7315)

West elevation

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

	Description
C NC N/A U ○ ◉ ○ ○	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:** The roof has only one line of shear walls in the east-west direction. This is not a complete load path for the roof since it is a flexible diaphragm and cannot accommodate torsion.
C NC N/A U ○ ◉ ○ ○	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**: No seismic joints at walkway between buildings
C NC N/A U ○ ○ ◉ ○	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:** No mezzanine

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

	Description
C NC N/A U ◉ ○ ○ ○	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:**
C NC N/A U ◉ ○ ○ ○	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:**
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:**

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C	NC	N/A	U	
○	○	○	○	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:**
○	○	○	○	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:**
○	○	○	○	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:** Does not comply at roof (only one line of resistance and not aligned with center of mass).

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:**
○	○	○	○	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:**
○	○	○	○	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:**

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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:** Controlling wall is 10' long, L/h = 10/10 = 1.0 > 0.6(1.28) = 0.77, compliant
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:**

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LOW AND MODERATE SEISMICITY

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C NC N/A U ○ ● ○ ○	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:** The roof diaphragm has only one line of shear walls in the east-west (transverse) direction.
C NC N/A U ● ○ ○ ○	SHEAR STRESS CHECK: The shear stress in the shear walls, calculated using the Quick Check procedure of Section 4.4.3.3, is less than the following values: (Commentary: Sec. A.3.2.7.1. Tier 2: Sec. 5.5.3.1.1) Structural panel sheathing: 1,000 lb/ft Diagonal sheathing: 700 lb/ft Straight sheathing: 100 lb/ft All other conditions: 100 lb/ft **Comments:**
C NC N/A U ○ ○ ● ○	STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multi-story buildings do not rely on exterior stucco walls as the primary seismic-force-resisting system. (Commentary: Sec. A.3.2.7.2. Tier 2: Sec. 5.5.3.6.1) **Comments:**
C NC N/A U ○ ○ ● ○	GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard is not used for shear walls on buildings more than one story high with the exception of the uppermost level of a multi-story building. (Commentary: Sec. A.3.2.7.3. Tier 2: Sec. 5.5.3.6.1) **Comments:**
C NC N/A U ● ○ ○ ○	NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2-to-1 are not used to resist seismic forces. (Commentary: Sec. A.3.2.7.4. Tier 2: Sec. 5.5.3.6.1) **Comments:**
C NC N/A U ○ ● ○ ○	WALLS CONNECTED THROUGH FLOORS: Shear walls have an interconnection between stories to transfer overturning and shear forces through the floor. (Commentary: Sec. A.3.2.7.5. Tier 2: Sec. 5.5.3.6.2) **Comments:** No hold-downs provided at any wall, at any floor.

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C	NC	N/A	U	
●	○	○	○	HILLSIDE SITE: For structures that are taller on at least one side by more than one-half story because of a sloping site, all shear walls on the downhill slope have an aspect ratio less than 1-to-1. (Commentary: Sec. A.3.2.7.6. Tier 2: Sec. 5.5.3.6.3) **Comments:** Not a hillside site
○	○	●	○	CRIPPLE WALLS: Cripple walls below first-floor-level shear walls are braced to the foundation with wood structural panels. (Commentary: Sec. A.3.2.7.7. Tier 2: Sec. 5.5.3.6.4) **Comments:**
●	○	○	○	OPENINGS: Walls with openings greater than 80% of the length are braced with wood structural panel shear walls with aspect ratios of not more than 1.5-to-1 or are supported by adjacent construction through positive ties capable of transferring the seismic forces. (Commentary: Sec. A.3.2.7.8. Tier 2: Sec. 5.5.3.6.5) **Comments:**

CONNECTIONS

C	NC	N/A	U	Description
●	○	○	○	WOOD POSTS: There is a positive connection of wood posts to the foundation. (Commentary: Sec. A.5.3.3. Tier 2: Sec. 5.7.3.3) **Comments:**
●	○	○	○	WOOD SILLS: All wood sills are bolted to the foundation. (Commentary: Sec. A.5.3.4. Tier 2: Sec. 5.7.3.3) **Comments:**
●	○	○	○	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:**

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

CONNECTIONS

	Description
C NC N/A U	WOOD SILL BOLTS: Sill bolts are spaced at 6 ft (1.8 m) or less with acceptable edge and end distance provided for wood and concrete. (Commentary: A.5.3.7. Tier 2: Sec. 5.7.3.3) **Comments:**

DIAPHRAGMS

	Description
C NC N/A U	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments:**
C NC N/A U	ROOF CHORD CONTINUITY: All chord elements are continuous, regardless of changes in roof elevation. (Commentary: Sec. A.4.1.3. Tier 2: Sec. 5.6.1.1) **Comments:**
C NC N/A U	DIAPHRAGM REINFORCEMENT AT OPENINGS: There is reinforcing around all diaphragm openings larger than 50% of the building width in either major plan dimension. (Commentary: Sec. A.4.1.8. Tier 2: Sec. 5.6.1.5) **Comments:**
C NC N/A U	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2) **Comments:** Wood structural panels at all diaphragms
C NC N/A U	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:** Wood structural panels at all diaphragms

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Collapse Prevention Structural Checklist For Building Type W2

C	NC	N/A	U	
○	○	○	○	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and have aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:**
○	○	○	○	OTHER DIAPHRAGMS: The 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:**

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

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SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General				**Reference**
Architect	Ralph Rapson and Associates Inc			
Structural Engineer	Pregnoff & Matheu			
Location	459 Kerr Road			
Design date	1971			
Latitude	36.995361			(Google Earth)
Longitude	-122.06144			"
Stories above grade	2	*MSE rule for establishing occupant load for risk category is needed. Here, I assume 20 net sf/person per 2016 CBC table 1004.1.2 for "Educational, classroom" function or 100 gross sf/person (need a good reference for this assumption, I saw it mentioned online in a discussion). Assume 0.6Gross square feet = Net square feet. Therefore, 20640 sf/100 = 206 and 20640 sf(0.6)/20 = 620. Assume 620 occupants. Propose to use a similar approach for other buildings.		
Seismic parameters				
Risk Category	II	2016 CBC Table 1604.5		
Site Class	D	https://earthquake.usgs.gov/hazards/urban/sfbay/soilt		(ASCE 41-17 2.4.1.6, ASCE 7-16 Chapter 20)
Liquefaction hazard	Low	http://data-sccgis.opendata.arcgis.com/datasets/77d380d355934b38a44894154377e28d_62		(ASCE 41-17 3.3.4)
Landslide hazard	Low	http://data-sccgis.opendata.arcgis.com/datasets/7984aabd55ec4a4794ae33d7919bd9c7_133		
S_{DS}	1.087	https://hazards.atcour	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-4)
S_{D1}	N/A	https://hazards.atcouncil.org/	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-5)
S_{XS}	1.281	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)
S_{X1}	0.88	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)

Scope		
Performance level	Collapse Preventon	(ASCE 41-17 Table 2-2)
Seismic hazard level	BSE-2E	(ASCE 41-17 Table 2-2)
Level of seismicity	High	(ASCE 41-17 Table 2-4)
Building type	W2: Wood Frames, Commerical and Industrial	(ASCE 41-17 Table 3-1)

Material properties				Notes	
Concrete	f'_c	4000	psi	Specified on drawings, NWC	(ASCE 41-17 Table 10-4)
Reinf.	f_y	60	ksi	#6 and larger A432	(ASCE 41-17 Table 10-4)
	f_y	40	ksi	All other bars A-15 Intermediate	(ASCE 41-17 Table 10-4)
Steel	F_y	N/A	ksi	N/A	(ASCE 41-17 Table 9-1)

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Checklists

Benchmark building	No	(ASCE 41-17 Table 3-2)
Checklist(s) req'd	17.1.2 Basic Configuration	(ASCE 41-17 Table 4-6)
	17.12 Structural Checklist for Building Types W2	(ASCE 41-17 Table 4-6)
	~~17.19 Nonstructural Checklist~~ (not performed)	(ASCE 41-17 Table 4-6)

Seismic forces

V	58	kip	$V = Cs_a W$	= 1.41W	(ASCE 41-17 Eq 4-1)
W	41	kip	building weight		(ASCE 41-17 4.4.2.1)
C	1.1		Convert linear elastic to inelastic disp.		(ASCE 41-17 Table 4-7)
S_a	1.28	g	$S_a = S_{x1}/T \le S_{XS}$		(ASCE 41-17 Eq 4-3)
T	0.22	sec	$T = C_t h_n^{\beta}$		(ASCE 41-17 Eq 4-4)
C_t	0.020				(ASCE 41-17 Eq 4-4)
β	0.75				(ASCE 41-17 Eq 4-4)
h_n	24	ft	building height		(ASCE 41-17 Eq 4-4)

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

Story	w	story ht	h	wh^k	F_{story}	F_{story}	V_{story}
	kip	ft	ft			kip	kip
Roof	41.4	11.0	21	869	0.64	37	37
2	49	10.0	10	490	0.36	21	58
Total	41			1359	1.0	58	

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

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

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

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Shear stress in shear walls (ASCE 41-17 4-8) (ASCE 41-17 4-8)

Story	$L_{w\ N\text{-}S}$ ft	$L_{w\ E\text{-}W}$ ft	v_{NS}^{avg} p/ft	v_{EW}^{avg} p/ft	D/C_{NS}	D/C_{EW}
Roof	100	40	83	207	0.1	0.2
2	120	80	108	162	0.1	0.2
Total						

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

v_{limit} 1000 p/ft

$v^{avg} = (1/M_S)(V_{story}/L_w)$ (ASCE 41-17 Eq 4-8)