Rating form completed by: **MAFFEI STRUCTURAL ENGINEERING**
maffei-structure.com
Dom Campi, Andreas Schellenberg, Joe Maffei

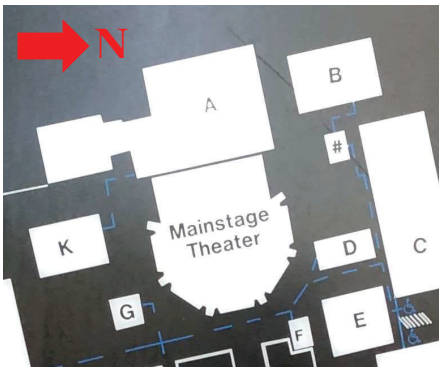
Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

UC Santa Cruz building seismic ratings

Main Stage Theatre Arts (and Unit A)

CAAN #7311 & 7311.1
441 Kerr Road, Santa Cruz, CA 95064
UCSC Campus: Main Campus

DATE: 2018-12-31



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	Assumes nonstructural features were not adequately addressed in 2012 renovation
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating	2019	
Recommended list assignment (UC Santa Cruz 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[2]	Medium ($50 - $200/sf)	See recommendations on further evaluation.
Is 2018-2019 rating required by UCOP?	Yes	
Further evaluation recommended?	Tier 2	Evaluate nonstructural deficiencies, lateral mechanism of high roof, and feasibility of separating Unit A from the theater structure.

[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 Assoc., Inc., "Performing Arts Building, University of California, Santa Cruz," 30 June 1969.
- Structural drawings by Pregnoff & Mattheu, "Performing Arts Building, University of California, Sant Cruz," 30 June 1969, sheets S1 through S10 and SA-1 through SA-5. Set contains also drawings for Buildings B through G, which are independent wood frame structures that are not reviewed as part of this report.
- University of California building database information provided by Jose Sanchez (UCSC) on 2018-11-20.
- Photos of original construction and 2012 renovations, pinned on wall at facility.

Additional building information known to exist

An interior renovation was completed in 2012, based on photos observed during a visit to the building. No drawings were obtained for the renovations in making this review. Of principal interest are modifications to original control room walls facing the theatre and modifications to the catwalk and ceiling grid system over the theatre.

Scope for completing this form

Reviewed structural drawings for original construction and carried out ASCE 41-17 Tier 1 evaluation. A brief site visit was made, but it was not sufficient to evaluate non-structural life-safety hazards in the absence of drawing information consistent with present conditions.

Plans contain drawings for the entire complex of buildings, which includes several small- to moderate-sized wood-framed structures that are structurally separate from the Main Stage and Unit A and are listed under separate CAAN numbers. These separate structures are not part of this review.

Brief description of structure

The Performing Arts complex of buildings was designed in 1969 by the Minneapolis-based architectural office of Ralph Rapson and Associates and the San Francisco-based structural engineering office of Pregnoff and Mattheu. The complex is comprised of several one- and two-story wood frame buildings, each of small to moderate size, that flank a Main Stage theatre. The theatre and the wood frame building that is backstage (west) of the theatre are the subjects of this evaluation.

<u>Theatre (CAAN 7311)</u>

The Main Stage Theatre is a 500+ seat theatre that is U-shaped in plan to wrap a projecting central stage. The open end of the U is closed by attachment to Unit A, a two-story wood-framed building with a solid wall facing the theatre. The straight sidewall portions of the U contain stairs that connect from the second floor of Unit A to the "balcony level" of the theatre. These connections between the theatre proper and Unit A will be discussed later. Refer to Figure 1 for a plan diagram of the theatre.

The theatre has principal levels (refer to Figure 2 for a section through the building):

- A "main level" that contains the stage and a surrounding sloped seating bowl.
- A "balcony level" that contains control rooms and an outdoor corridor/ deck that provides access thereto (catwalks and theatrical lighting also occur at this level); and
- The "soffit level" of the high roof, which occurs at the bottom chord of the 9.5 foot deep trusses that frame the high-roof structure. The gridiron over the backstage occurs at this level.

The "main level" is all concrete-on-grade construction, except at the back of the seating bowl where stepped reinforced concrete floor construction cantilevers out from the back wall of the seating bowl. For purpose of seismic evaluation, the main level is of no interest. In profile, the stage and base of the seating bowl (as well as the Ground Floor of Building A) are sunk 6 feet below grade at the exterior plaza and the back of the bowl rises to 5 feet above grade. The elevation at the top of concrete at the base of the seating bowl is 690.0', which matches the elevation of the stage. The seating bowl steps up such that the elevation at the top of concrete at the top of the seating bowl is 700.79' at the back wall of the bowl.

The "balcony level" is C-shaped in plan, consisting of 5 segments of an octagon containing approximately 3,000 square feet total. Each segment is approximately 17 feet wide and 31 feet long when measured along its centerline. The floor is split by an exterior wall (above) down the center spine that separates an exterior deck/ access walk on the outboard side from theatre control rooms on the interior side. The top of floor of the balcony level is at elevation 714.33'.

The balcony level is constructed with concrete fill over steel deck supported by steel framing that is arranged to allow for a column-free interior. Seismic lateral forces from the balcony are resisted by five single-bay steel moment-resisting frames that are located at the exterior walls at the back of the seating bowl. These are supplemented by light steel double-angle braced frames at the west end, where the octagonal shape is truncated. Moment frames are constructed with W14x43 fixed-base columns that are about 15 feet high and W21 and W24 beams that were sized for gravity loads and are generally stronger than the columns.

Sloped exterior walls of plaster on wood stud construction at the back of the seating bowl rise 13'-6" from the top of the bowl to the balcony level, then transition to stud walls along the spine of the balcony level that rise 8'-6" to the soffit level above. A deflection track of bent steel was used at the top of the wood stud walls to accommodate vertical roof deflection. The connection should serve to accommodate differential in-plane earthquake movement, except as short-circuited by corners.

6' wide stairs on each side of the theatre connect from the second floor of Unit A, which is roughly aligned with the top of the seating bowl, to the balcony level (about 13'-6" higher). The exterior wall in this area extends from grade to railing height above the stair. Above the stair the exterior wall transitions to the inside face of the stair and extends to the roof soffit level above. The stair, which is exterior exposure, consists of a wood frame ramp with waterproofing and a substantial concrete topping that forms the tread and riser.

The theatre and a portion of Unit A are covered by a freestanding high-roof structure, 144 feet square in plan of trusses 9'-0" deep, that floats above and extends out beyond the irregularly shaped theatre below (refer to Figure 1). The bottom of this high-roof structure is the "soffit level" at elevation 722.83'.

The roof structure is supported by 4 columns spaced at 92 feet on center. The 9' deep steel trusses are framed with double angles. They span between the columns in each direction and cantilever 26 feet at both ends to provide the gravity framing for the roof. These trusses also form frames with the columns to provide resistance to lateral wind and seismic forces. The columns are structural steel, with 13.25"x0.75" side plates applied to W14x142 steel columns to make box sections. The columns are fixed at their bases to pier-supported foundation caps and extend continuously to the top of the roof trusses to develop moment-resisting frame action with the trusses for seismic lateral force resistance. The columns are encased in 4-foot diameter concrete sections from the foundation to 1 foot below the underside of the roof trusses. The encasement appears to have been considered architectural, but will act to stiffen the frame.

The main framing at the roof includes 9'-0" deep secondary trusses and bracing trusses to create a 30'-8" framing grid at the roof and soffit level. Secondary beams at the roof level are placed midspan of the trusses. 4-1/2" deep steel deck spans between the steel framing to support the roofing and form a roof diaphragm of sorts. Trusses at the perimeter of the roof support a fascia framed with wood studs and cement plaster finish. Where the roof extends beyond the exterior walls of the theatre, a cement plaster soffit is suspended by wire hangers from the steel deck above.

<u>Unit A (CAAN 7311.1)</u>

Unit A is a wood-framed structure, that is irregular in plan and profile. It contains one- and two-story portions under a sloping roof.

Mechanical services are contained in an 80 foot (north-south) by 35 foot (east-west) partially subterranean basement at the west end of the building. The mechanical room is surrounded on all sides by concrete basement walls, except the upper 5 feet of wall on the west (long) side is open for louvers and affords minimal lateral bracing.

The sloping roof areas are framed with beams at 8 feet on center, running upslope, that support conventional wood joist framing and ½" plywood sheathing. Beams are wood or steel, depending on span, and supported on

wood posts with post-to-beam connections. Flat roof areas are typically framed with joists that span to bearing walls.

Second floor framing typically consists of plywood sheathing over conventional joist framing that is supported by wood stud bearing walls.

Walls are conventional wood stud framed. Notes on the drawings indicate that all exterior walls are sheathed with 3/8-inch plywood. Some of the interior walls are identified on structural plans as being plywood sheathed. Other interior walls are not indicated as plywood sheathed, but the presence of plywood sheathing can be inferred from details. These walls are typically at conditions where wall is exterior above a lower roof level and becomes interior below. Section details at the transition typically show plywood at the interior wall below. A definitive determination would require field exploration.

The exterior wall on the south façade is sloped with clerestory windows across the upper portion. Windows present a greater than average risk of falling glass at the building interior, based on their location and framing conditions.

Foundation System: The site is lightly sloping. The various structures and structural elements are founded on shallow footings bearing on native site soils or engineered fill, except piercaps and drilled piers are used to form a fixed-base foundation for the 4 major columns that support the high-roof structure that covers the building.

Recap of structural systems for lateral forces:

The high-roof structure of the theatre is structurally independent of the buildings below for vertical and lateral forces. The lateral system consists of two fixed-base truss moment frames in each direction, with concrete encasement of steel box columns affording additional stiffness to the frames. The height of frame columns is approximately 30 feet from the foundation to the soffit of the truss above, and the trusses span 92 feet between columns.

Lateral forces from the theatre balcony level, a 3,000 square foot floor level constructed with concrete fill over steel deck and steel framing, are resisted by five, one-story single-bay ordinary steel moment frames and two, light steel angle ordinary braced frames.

Lateral forces at 'Unit A', a one- and two-story wood frame building, are resisted by plywood sheathed stud walls.

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:

- For the high-roof structure, the desired mechanism of nonlinear lateral response would be hinging at the base of the columns and hinging of the top of column at the underside of the roof trusses. A preliminary analysis of the high-roof structure indicates that the desired mechanism would not occur because columns are sufficiently strong to cause failures in the trusses prior to hinging at the top or bottom of the column. Initial failure is buckling of truss bottom chords, which is potentially problematic because of the roof cantilever. However, this is somewhat mitigated by the redundant gravity load path that result from two-way truss framing. Quick checks, made as part of Tier 1 analysis, indicate DCR = 0.88 based on the prescribed M_s = 7 for flexural steel members and Risk Category III buildings.
- Preliminary analysis indicates that high-roof structure will drift approximately 4 inches. The high roof typically floats above the building below. Exterior walls that frame to the underside of roof are typically connected with deflection tracks that can also accommodate in-plane drift, except as restrained at corners. The primary concern is at the front wall of control rooms, if they exist as shown on drawings. The walls, which are angled out over the seating below, would be likely to fail and fall under large displacement. In a 2012 renovation, walls may have been removed, along with catwalks located at the balcony level, and replaced with a new theatrical services grid. Conditions should be further reviewed to accommodate large drift between the balcony and high roof soffit levels.
- The theatre structure, which is comprised of the 3,000 sq. ft. raised balcony level, is structurally connected to Unit A, a wood frame building, by wood-framed exterior walls and wood-framed stairs with a concrete topping of substantial mass. We expect separation of the walls and stair from either the theatre balcony or Unit A as a

result of differential seismic movement. Based on framing conditions (but in the absence of details on the drawings) we expect the 6 foot wide stairs to be supported by the wood stud walls on each side. If this is the case, we expect that collapse of the stairs is unlikely, even though the stairs may separate from the walls.

- The basement mechanical room has strip louver openings along one side for intake air. Based on the 35 foot depth of the floor diaphragm, the diaphragm aspect ratio, and the concrete retaining walls on three sides, we judge that this condition does not pose an appreciable risk of collapse.

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	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)	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.[3]

No review was conducted, but the following are suggested for further review:

- Confirm whether walls at front of control room have been removed.
- Review theatrical grid above seating area for ability to accommodate differential drift between roof soffit level and balcony (grid) level.
- Review conditions at exit doors (at top of seating bowl) to assess whether doors are likely to jam under earthquake movement. Safe exiting may be of greater than average concern as a source of potential panic because of the high occupancy and absence of windows in the theatre.

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

Recommendations for further evaluation or retrofit

We recommend that the University:

- Perform a more detailed evaluation of the high-roof structure, to determine that seismic-induced damage does not compromise ability to support gravity loads.
- Review the feasibility of making a reliable separation joint between the theatre and Unit A, including provision for lateral support of stair at joint.

[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.

- Perform additional reviews of nonstructural components, as discussed above. Recommend to also include review of details and condition of hanging system for plaster soffit at high-roof structure, based on the potential safety hazard of falling plaster.

Comments on rating

The rating of V is based on our concerns regarding the collapse mechanism of the high-roof level, the possible presence of falling hazards associated with the control room walls, and lack of reliability associated with connection of dissimilar building types. (Note that these types of concerns are not well addressed in Tier 1 procedures, but are based on fundamental principals.) If these concerns are addressed, a rating of IV could be achieved.

Additional building data	Entry	Notes
Latitude	36.994811	
Longitude	-122.062309	
Are there other structures besides this one under the same CAAN#	No	The complex includes other buildings constructed using same drawings, but they have separate CAAN#.
Number of stories above lowest perimeter grade	2	
Number of stories (basements) below lowest perimeter grade	Partial	Basement mechanical room below a portion of Unit A
Building occupiable area (OGSF) Theatre	35000	
Building occupiable area (OGSF) Unit A	8200	
Risk Category per 2016 CBC Table 1604.5	III	Assembly (>300)
Estimated fundamental period	0.68 sec 0.23 sec	Long period for high-roof structure. Short period for theatre balcony and Unit A.
Building height, h_n	35 ft 15 ft 23 feet	Mean height of high-roof structure. Height from seating bowl to balcony. Roof height at Unit A
Coefficient for period, C_t	0.035	For high-roof structure
Exponent on height, β	0.80	For high-roof structure
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

Ground motion parameters S_{cs}, S_{c1}	1.286, 0.885	
S_a at building period	1.29	
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	Possible retrofit of nonstructural at theatre in 2012
Applicable code for full retrofit		
FEMA P-154 data		
Model building type – Theatre	S1a - Steel Frame (Flexible Diaphragm)	For high roof. Balcony is S1 (rigid diaphragm)
Model building type – Unit A	W2 - Wood Frame, Commercial	
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
Previous ratings		
Most recent rating	IV (Fair)	
Date of most recent rating	Unknown	
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

[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.

Figure 1: Annotated floor plan (Theatre and Unit A)

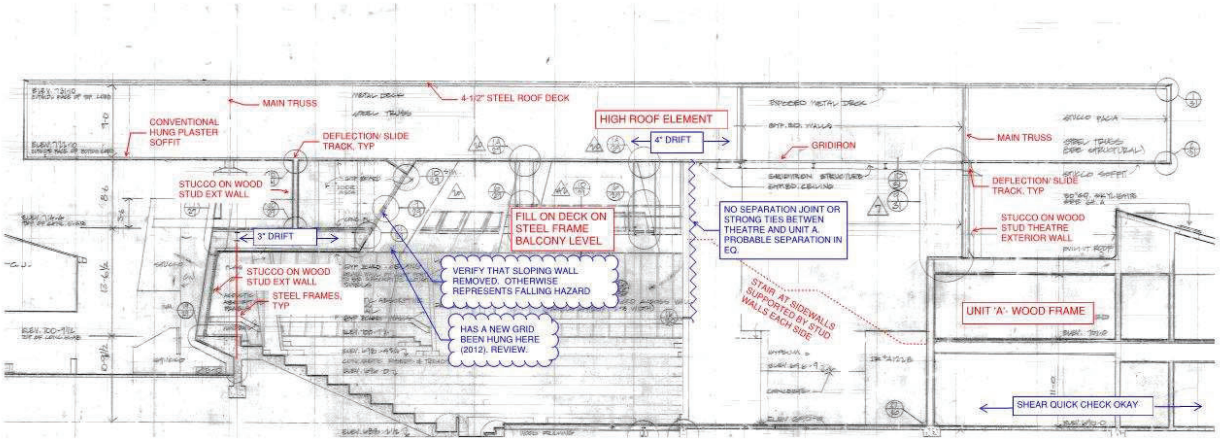


Figure 2: Annotated section (Theatre and Unit A)

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	1	of	3

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:** Steel space truss roof (with stucco facia & soffit) is support on four W14x142 steel sections encased in 4 ft RC columns. Two story wood frame building below has well defined lateral load path into slab on grade with grade beams concrete foundation.
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:** 0.015 * 20 ft = 4 in. --> OK
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:** Control room floor above auditorium is a well braced steel structure. Catwalk over open auditorium space is hanging from roof space truss. Gridiron framing above stage is also supported from roof space truss.

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:** One story roof structure. Two story wood framing portions of the building have similar story shear strengths.
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:** One story roof structure. Two story wood framing portions of the building have similar story stiffnesses.
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:** No vertical irregularities.

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

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	2	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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:**

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:**

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

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	3	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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:** 92'/40'-4" = 2.28 > 0.69 = 0.6 * 1.15 --> OK
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:** 6" - 12" concrete slab on grade with grade beams under wall lines. Concrete retaining wall on west side of unit A. Site class is B.

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:		By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	1	of	4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type W2

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:**
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:**

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:		By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	2	of	4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type W2

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:**
○	○	●	○	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

				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:** 5/8" x 12" bolts @ 48" o.c. max
●	○	○	○	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:**

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:		By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	3	of	4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type W2

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

CONNECTIONS

C	NC	N/A	U	Description
●	○	○	○	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:** 5/8" x 12" bolts @ 48" o.c. max

DIAPHRAGMS

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

UC Campus:	University of California Santa Cruz			Date:	12/19/2018		
Building CAAN:	7311	Auxiliary CAAN:		By Firm:	Maffei Structural Engineering		
Building Name:	Main Stage Theatre Arts			Initials:	*AHS*	Checked:	*JRM*
Building Address:	441 Kerr Road, Santa Cruz, CA 95064			Page:	4	of	4

ASCE 41-17
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

SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General				Reference
Architect	Ralph Rapson and Associates / Ernest J Kump			
Structural Engineer	Pregnoff & Matheu			
Location	441 Kerr Road, Santa Cruz, CA 95064			
Design date	1971			
Latitude	36.994811			(Google Earth)
Longitude	-122.06231			"
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	III*	2016 CBC Table 1604.5 (Assembly Group A-1 with >300 occupants)		
Site Class	B	https://earthquake.usgs.gov/hazards/urban/sfbay/soiltype/		(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}	0.978	https://hazards.atcouncil.org/	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-4)
S_{D1}	0.333	https://hazards.atcouncil.org/	Based on ASCE 7-16 DE, used to determine "Level of Seismicity"	(ASCE 41-17 Eq 2-5)
S_{XS}	1.286	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)
S_{X1}	0.885	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)

Scope		
Performance level	Limited Safety	(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 types	W2: Wood Frames, Commercial and Industrial	(ASCE 41-17 Table 3-1)
	S1a: Steel Moment Frames with Flexible Diaphragms	(ASCE 41-17 Table 3-1)

Material properties				Notes	
Concrete	f'_c	3000	psi	Specified on drawings, NWC	(ASCE 41-17 Table 10-4)
Reinf.	f_y	60	ksi	#5 and larger A615 gr 60	(ASCE 41-17 Table 10-4)
	f_y	40	ksi	#4 and smaller A615 gr 40	(ASCE 41-17 Table 10-4)
Steel	F_y	N/A	ksi	Comply with AISC 6th edition	(ASCE 41-17 Table 9-1)

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	1277	kip	$V = Cs_a W$	= 1.672W		(ASCE 41-17 Eq 4-1)
W	764	kip	building weight			(ASCE 41-17 4.4.2.1)
m	1.98	kip-sec^2/in				
k	187	kip/in				
C	1.3		Convert linear elastic to inelastic disp.			(ASCE 41-17 Table 4-7)
S_a	1.29	g	$S_a = S_{x1}/T \le S_{XS}$			(ASCE 41-17 Eq 4-3)
T	0.67	sec	$T = C_t h_n^{\beta}$	(= 0.78 sec from model)		(ASCE 41-17 Eq 4-4)
C_t	0.035	0.035	0.03	0.02		(ASCE 41-17 Eq 4-4)
β	0.80	0.8	0.9	0.75		(ASCE 41-17 Eq 4-4)
h_n	40.3	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	764		40	42499	1.00	1277	
1		40.3	0				1277
Total	764			42499	1.0	1277	
k	1.09	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)

Drifts

Dr(N-S)	1.05 %	Taller column on West side
Dr(N-S)	0.99 %	Shorter column on East side
Dr(E-W)	0.92 %	Taller column on West side
Dr(E-W)	1.04 %	Shorter column on East side

Demands in steel members

Ms	7.5	System modification factor for steel flexural members between CP and LS
DCR	0.33	maximum PMM demand-capacity ratio at base of column
Ms	5.75	System modification factor for steel truss members between CP and LS
DCR	0.86	maximum PMM demand-capacity ratio in roof truss