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*

REGISTERED PROFESSIONAL ENGINEER RICHARD JOSEPH MAFFEI No. 3694 STRUCTURAL STATE OF CALIFORNIA

**UC Santa Cruz building seismic ratings**

# Natural Science Building Unit 2 Annex

CAAN #7180
570 Red Hill 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 B | Priority A=Retrofit ASAP<br>Priority B=Retrofit at next permit application for modification |
| 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 | |
| Further evaluation recommended? | Tier 2 | Focused on roof connection to precast wall piers |

[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 Anshen & Allen Architects "Natural Science Unit II, University of California Santa Cruz" record set dated 26 February 1971 (original drawings dated 25 February 1967), sheets A2 (site plan), A27-A29 Library drawings.
- Structural drawings by T.Y. Lin, Kulka, Yang & Associate, "Natural Science Unit II, University of California Santa Cruz" as-built drawings dated 3 Dec 1969 (original drawings dated 25 February 1967), sheets S1, S2 (General Notes and site plan) S13—S17, SR-2 and SR-3 Library drawings.
- Architectural drawings by Fong & Chan Architects, "Science Library Released Space Alterations" dated 30 November 1991 (16 sheets).
- Structural drawings by Structus, "Science Library Released Space Alterations" dated 31 January 1991 (17 sheets).

**Additional building information known to exist**

- Record set drawings for Electrical, Mechanical, Plumbing, dated December 1969

**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**

Natural Sciences II Annex (Nat Sci Annex) was designed in 1967 by the architectural office of Anshen and Allen and the structural office of by T.Y. Lin, Kulka, Yang & Associate. Construction was completed in late 1969. The building was renovated in 1991, when the interior was converted from library to office and classroom occupancy.

The building has 2 stories, and contains approximately 9,524 square feet. Above grade, the building is rectangular in plan, measuring 65 feet in the north-south direction by 42 feet in the east-west direction.

At the north side of the building, the finished grade elevation is approximately level with Level 2. The main entry lobby to the building is on Level 2 on the east side of the building. The building site is sloped, with finished grade sloping downward from north to south. Level 1 is largely below grade, with a footprint larger than that of the floor above, and a below-grade tunnel connects the Annex to the Natural Science II building to the east.

The building has a sloped roof, and the overall building height from Level 1 to the top of the sloped roof is 42.33'.

The exterior of the building consists 12" cast-in-place concrete walls. The walls do not extend all the way up to the roof. Instead, a clerestory window occurs at the top of the walls all around the building perimeter. The clerestory windows are framed with vertical steel tubes which are anchored to the wall below. The roof beams bear on a 6"x8" wood beam which in turn is supported by these vertical steel tubes. Lateral support for the roof is provided by two precast concrete wall piers at each side of the building; these piers are the only elements that are continuous from foundation to roof.

The original building had mezzanines above both Level 1 and Level 2. These mezzanines were removed in the 1988 renovation.

Identification of levels: Level 1 is at elevation 798.5', Level 2 is at elevation 816.0'.

Foundation system: The foundations consists of 3' wide strip footings under all walls, and individual spread footings under all columns.

Structural system for vertical (gravity) load: Level 1 consists of a 5" thick concrete slab on grade. Level 2 consists of precast prestressed concrete T-beams spanning east-west between perimeter walls. The roof framing consists of pairs of wood trusses that span east-west, with each wood truss spanning half the width of the building. bearing at one end on the perimeter wall and at the other end on one of two glulam girders that span north-south between perimeter walls. The glulam girders frame a skylight that runs north-south down the center of the roof.

The perimeter walls are 12" thick cast-in-place walls. At each side of the building, the cast-in-place walls are interrupted by a precast concrete wall element. These precast elements form the doors and windows in the wall as well as support the tributary T-beams at Level 2 and the wood trusses at the roof.

Structural system for lateral forces: The lateral-force-resisting system of the building consists of the cast-in-place 12" thick perimeter walls, supplemented by the precast piers provided at each side of the building. At the roof, plywood sheathing is provided for the roof diaphragm, and at Level 2 a floor diaphragm consisting of a 2-1/2" concrete topping slab is provided on top of the T-beams and is doweled into the perimeter concrete walls.

The lateral force path from the roof to the concrete walls is complicated by the fact that the clerestory windows create a discontinuity between the roof diaphragm and the top of the concrete walls. The inertial force from the roof is carried to concrete walls via the precast piers, which are the only structural elements that cross the discontinuity created by the clerestory. In the original design, no adequate connection was provided from the roof diaphragm to the precast piers, but the 1988 renovation added short plywood sheathed walls above the piers along the north-south walls, and wood diagonals above the piers along the east-west walls, to drag the roof inertial forces to the precast piers, and this force path is now much improved. The precast piers then carry the lateral force through shear in the pier for a height of about 4 feet, before sharing the load with the adjacent 12" cast-in-place wall. Our calculations show that the precast pier shear strength is the weakest link along the lateral force path from roof to concrete wall, since the piers are unreinforced for shear. Assuming $Vn = A_w \times 2rt(f'c)$ and phi =0.6 and f'c=3750 psi, phi*Vn = 34.5 k/pier, or 34.5 x 4 = 138 k for the whole roof. The estimated weight of the roof is 111 k, thus an acceleration of the roof of 1.24W can be transferred to the concrete 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:

- Nonductile force path from roof to walls, with weak point being lightly reinforcement precast pier in shear.

| Structural deficiency | Affects rating? | Structural deficiency | Affects rating? |
|---|---|---|---|
| Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable) | Y | Openings at shear walls (concrete or masonry) | N |
| Load path | 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]**

We walked through all floors of the building and looked for potentially hazardous nonstructural components during our site visit on 22 May 2019. As shown in the table below, no non-structural hazards were 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.

| 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**

The building is rated V (Poor). The 1988 renovation improved the connection of the roof to the concrete walls; however, the force path is complicated and could not be fully evaluated with the Tier 1 evaluation process. In addition, the precast panel is a nonductile link in the force path, thus preventing a rating of IV (Fair).

**Recommendations for further evaluation or retrofit**

We recommend a Tier 2 evaluation of connection of the roof diaphragm to the concrete walls, and of the adequacy of the precast concrete piers.

**Peer review of rating**

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

| Additional building data | Entry | Notes |
|---|---|---|
| Latitude | 36.998508 | |
| Longitude | -122.061059 | |
| 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 | Finished grade slopes such that Level 1 is below grade at the east side of the building |
| Building occupiable area (OGSF) | 9524 | |
| Risk Category per 2016 CBC Table 1604.5 | II | Office and educational (classroom) occupancy |
| Building structural height, $h_n$ | 38 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 | 0.75 | Estimated using ASCE 41-17 equation 4-4 and 7-18 |
| Estimated fundamental period | 0.31 sec | Estimated using ASCE 41-17 equation 4-4 and 7-18 |

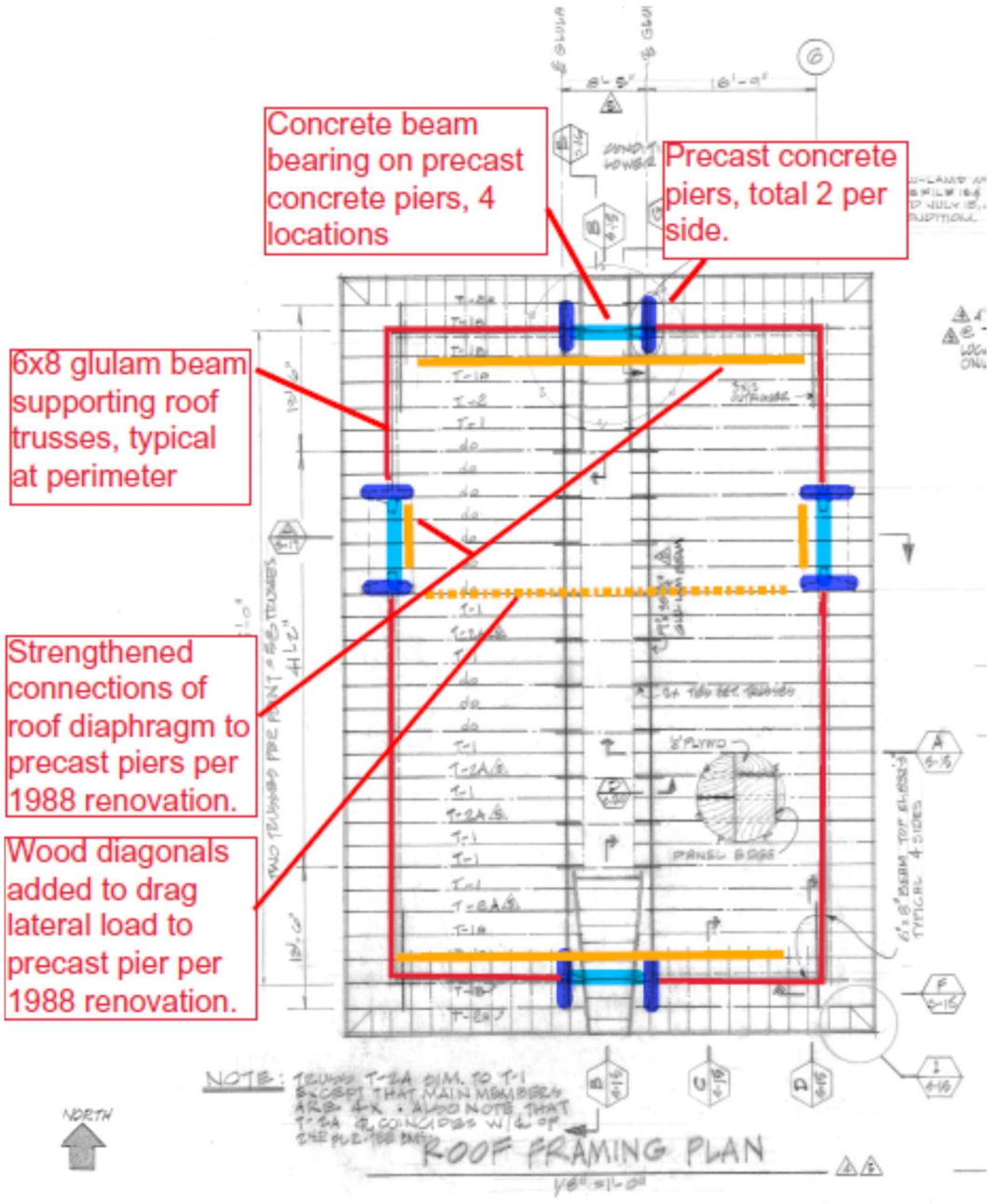
| | | |
|---|---|---|
| **Site data** | | |
| 975 yr hazard parameters $S_s$, $S_1$ | 1.286, 0.488 | |
| Site class | D | |
| Site class basis[4] | Geotech | See footnote below |
| Site parameters $F_a$, $F_v$[5] | 1, 1.81 | |
| Ground motion parameters $S_{xs}$, $S_{x1}$ | 1.286, 0.885 | |
| $S_a$ at 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 | Built: 1969<br>Code: 1964 UBC | |
| Applicable code for partial retrofit | 1985 UBC | |
| Applicable code for full retrofit | None | |
| **Model building data** | | |
| Model building type North-South | C2 - Conc. wall (Rigid and flexible Diaphragm) | |
| Model building type East-West | C2 - Conc. wall (Rigid and flexible Diaphragm) | |
| FEMA P-154 score | N/A | Not included here. Tier 1 evaluation. |
| **Previous ratings** | | |
| Most recent rating | None | |
| Date of most recent rating | - | |

[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

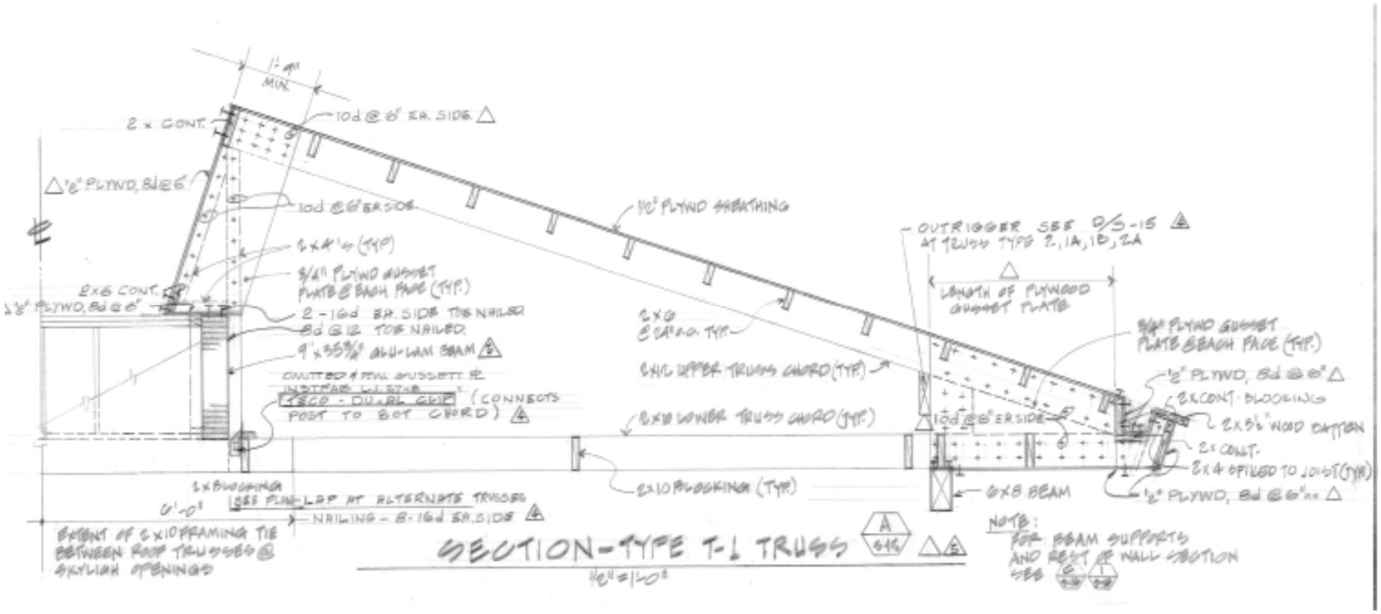
[5] $F_V$ factor used does not include the requirements of Section 11.4.8-3 of ASCE 7-16 that are applicable to Site Class D, and which per Exception 2 would result in an effective $F_V$ factor of 2.72 (1.5 times larger). At the Santa Cruz main campus this only affects structures with $T$>0.69 seconds.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

| | | |
|---|---|---|
| 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 |

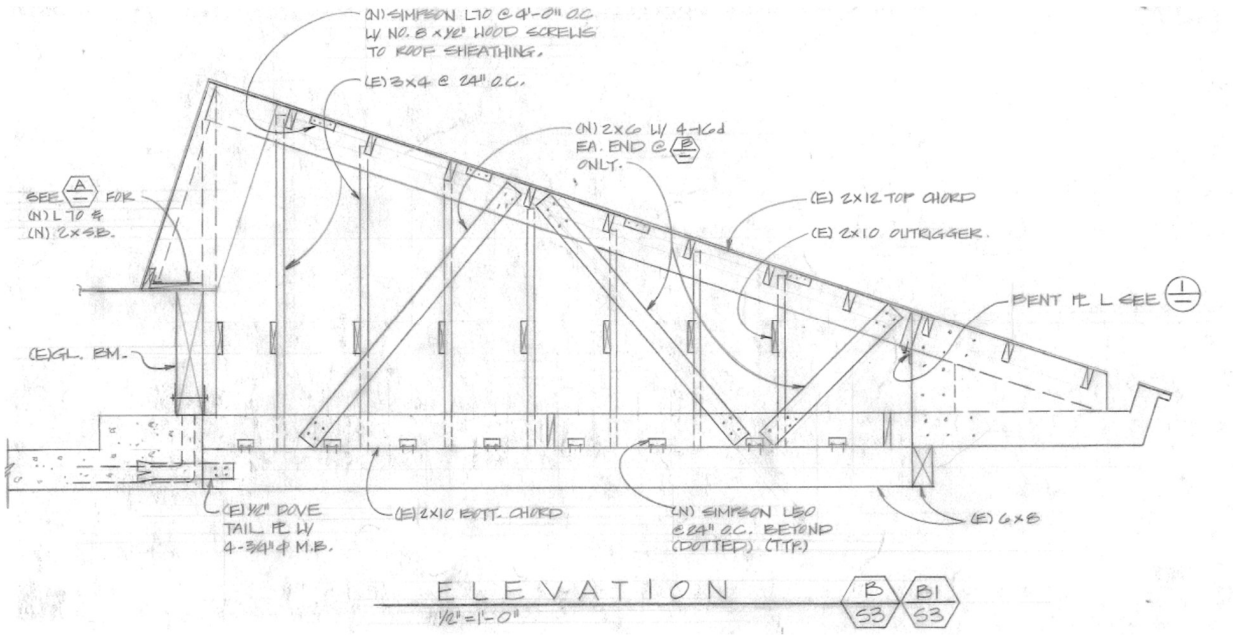
**Annotated roof plan**

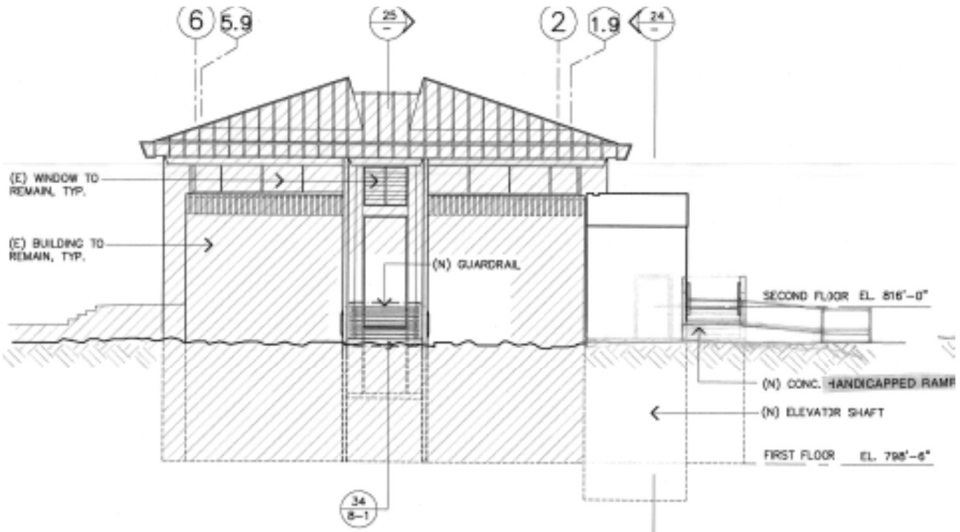


**Typical roof truss (original construction)**

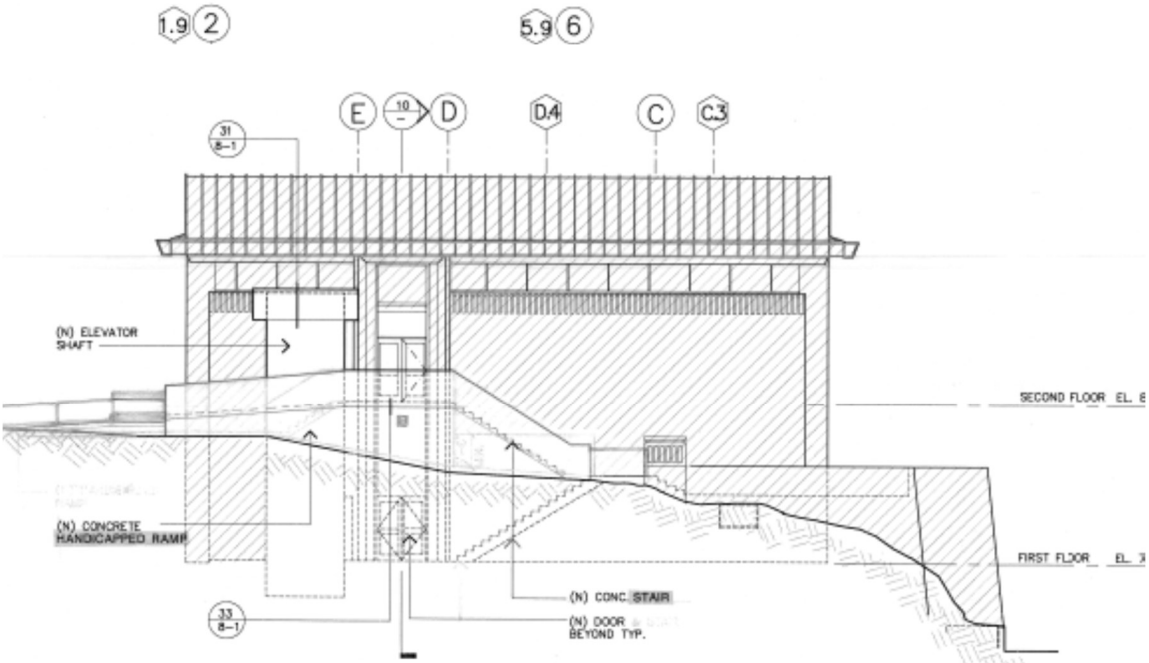



**Roof truss at east-west walls with added diagonals to improve connection to precast piers (1988 seismic strengthening)**



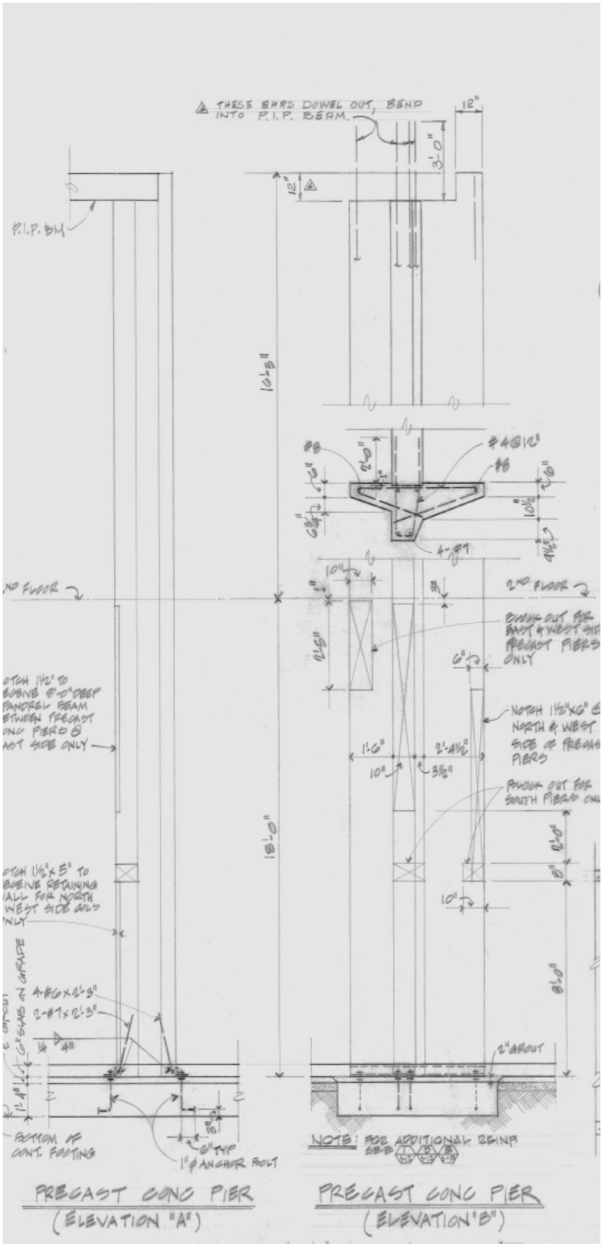



7 NORTH ELEVATION




22 WEST ELEVATION

**Wall elevations**




**Precast pier elevation**

**Roof – clerestory window with steel tubes supporting a perimeter 6x8 wood beam that supports the roof**

**Building interior – precast piers and clerestory windows**

**Main entry at Level 2, looking west**


**Below-grade tunnel from Natural Science Building to Natural Science Annex, looking west**

| UC Campus: | UC Santa Cruz | | | Date: | June 30, 2019 | | |
|---|---|---|---|---|---|---|---|
| Building CAAN: | 7180 | Auxiliary CAAN: | | By Firm: | Maffei Structural Engineering | | |
| Building Name: | Natural Sciences Annex | | | Initials: | NY | Checked: | |
| Building Address: | 570 Red Hill Road, Santa Cruz, CA 95064 | | | Page: | 1 | of | 3 |

# ASCE 41-17
# Collapse Prevention Basic Configuration Checklist

## LOW SEISMICITY

### BUILDING SYSTEMS - *GENERAL*

| C NC N/A U | Description |
|---|---|
| C | 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)<br><br>**Comments:** C - The structure was retrofitted in 1991, and the lateral force transfer from the roof trusses to the underlying 6”x8” wood beam was secured. |
| C | 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)<br><br>**Comments:** C – Adjacency occurs below-grade. |
| NA | MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3)<br><br>**Comments:** The structure was retrofitted in 1991, and the 1st and 2nd floor mezzanines were demolished. |

### BUILDING SYSTEMS - *BUILDING CONFIGURATION*

| C NC N/A U | Description |
|---|---|
| C | 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)<br><br>**Comments:** |
| C | 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)<br><br>**Comments:** |
| C | 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)<br><br>**Comments:** |

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

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# ASCE 41-17
# Collapse Prevention Basic Configuration Checklist

| C | NC | N/A | U | |
|---|---|---|---|---|
| | NC | | | 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)<br><br>**Comments:** Above the 1st floor, with the introduction of the terrace, the supporting shear walls are increased. The increase in shear strength in the E-W direction is close to 100%. This is not seen as a deficiency. |
| C | | | | 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)<br><br>**Comments:** |
| C | | | | 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)<br><br>**Comments:** |

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

### GEOLOGIC SITE HAZARD

| | Description |
|---|---|
| C | 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)<br><br>**Comments:** |
| C | 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)<br><br>**Comments:** |
| C | 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)<br><br>**Comments:** |

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

| UC Campus: | UC Santa Cruz | | | Date: | June 30, 2019 | | |
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# 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<br>○ ○ ○ ○<br>C | 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)<br>**Comments:** W/H = 44/34=1.29<br>0.69 Sa = 0.69 x 1.54 = 0.92 g |
| C NC N/A U<br>○ ○ ○ ○<br>NC | 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)<br>**Comments:** NC – tie beams not provided at 4 interior column footings |

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

| UC Campus: | UC Santa Cruz | | | Date: | 30 June 2019 | | |
|---|---|---|---|---|---|---|---|
| Building CAAN: | 7180 | Auxiliary CAAN: | | By Firm: | Maffei Structural Engineering | | |
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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 |
|---|---|
| C NC N/A U<br>○ ○ ○ ○<br>N/A | COMPLETE FRAMES: 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)<br>**Comments:** |
| C NC N/A U<br>○ ○ ○ ○<br>C | 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)<br>**Comments:** |
| C NC N/A U<br>○ ○ ○ ○<br>C | SHEAR STRESS CHECK: 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.$^2$ (0.69 MPa) or $2\sqrt{f'_c}$. (Commentary: Sec. A.3.2.2.1. Tier 2: Sec. 5.5.3.1.1)<br>**Comments:** |
| C NC N/A U<br>○ ○ ○ ○<br>C | REINFORCING STEEL: 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)<br>**Comments:** Compliant for both the 12" R.C. shear walls and the precast piers |

## Connections

| | Description |
|---|---|
| C NC N/A U<br>● ○ ○ ○<br>C | WALL ANCHORAGE AT FLEXIBLE DIAPHRAGMS: 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)<br>**Comments:** |
| C NC N/A U<br>○ ○ ○ ○<br>C | TRANSFER TO SHEAR WALLS: Diaphragms are connected for transfer of seismic forces to the shear walls. (Commentary: Sec. A.5.2.1. Tier 2: Sec. 5.7.2)<br>**Comments:** |

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

| C NC N/A U | |
|---|---|
| C | FOUNDATION DOWELS: 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)<br><br>**Comments:** |

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

### Seismic-Force-Resisting System

| | Description |
|---|---|
| C NC N/A U<br>NA | DEFLECTION COMPATIBILITY: 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)<br><br>**Comments:** NA – no secondary components |
| C NC N/A U<br>NA | FLAT SLABS: 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)<br><br>**Comments:** |
| C NC N/A U<br>NA | COUPLING BEAMS: 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)<br><br>**Comments:** |

### Diaphragms (Stiff Or Flexible)

| | Description |
|---|---|
| C NC N/A U<br>C | 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)<br><br>**Comments:** |
| C NC N/A U<br>C | OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls are less than 25% of the wall length. (Commentary: Sec. A.4.1.4. Tier 2: Sec. 5.6.1.3)<br><br>**Comments:** |

### Flexible Diaphragms

| | Description |
|---|---|

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

| UC Campus: | UC Santa Cruz | | | Date: | 30 June 2019 | | |
|---|---|---|---|---|---|---|---|
| Building CAAN: | 7180 | Auxiliary CAAN: | | By Firm: | Maffei Structural Engineering | | |
| Building Name: | Natural Sciences Library | | | Initials: | | Checked: | |
| Building Address: | 570 Red Hill Road, Santa Cruz, CA 95064 | | | Page: | 3 | of | 3 |

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

| C NC N/A U | |
|---|---|
| C | CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)<br>**Comments:** |
| N/A | 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)<br>**Comments:** |
| C | 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)<br>**Comments:** |
| N/A | 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)<br>**Comments:** |
| C | 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)<br>**Comments:** |

## Connections

| C NC N/A U | Description |
|---|---|
| N/A | 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)<br>**Comments:** |

MAFFEI STRUCTURAL ENGINEERING



Project:_____
Subject:_____
By:_____
Date:_____

# SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

## ASCE 41-17 Chapter 4

| General | | | Reference |
|---|---|---|---|
| Building | Naural Sciences 2 Library | | |
| Architect | Anshen & Allen Architects | | |
| Structural Engineer | T.Y.Lin, KULKA, Yang & Associates | | |
| Location | 570 Red Hill Toad, Santa Cruz, CA 95064 | | |
| Design date | 1967 | | |
| Latitude | 36.99856 | , | https://hazards.atcouncil.org/ |
| Longitude | -122.06097 | | " |
| Stories above grade | 2 | in addition to 2 mezzanines | |

| Seismic parameters | | | | |
|---|---|---|---|---|
| Risk Category | II | 2016 CBC Table 1604.5 | | |
| Site Class | D | | | (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 | | |
| $S_{DS}$ | 1.306 | https://hazards.atcouncil.org/ | Based on ASCE 7-16 DE, used to determine "Level of Seismicity" | (ASCE 41-17 Eq 2-4) |
| $S_{D1}$ | 0.585 | https://hazards.atcouncil.org/ | Based on ASCE 7-16 DE, used to determine "Level of Seismicity" | (ASCE 41-17 Eq 2-5) |
| $S_{XS}$ | 1.283 | For BSE-2E hazard level | https://hazards.atcou | (ASCE 41-17 Table 2-2) |
| $S_{X1}$ | 0.882 | For BSE-2E hazard level | https://hazards.atcouncil.org/ | (ASCE 41-17 Table 2-2) |

| Scope | | | |
|---|---|---|---|
| Performance level | Collapse Prevention | | (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 | C2a: Concrete shear walls with flexible diaphragms | | (ASCE 41-17 Table 3-1) |

| Material properties | | | | Notes | |
|---|---|---|---|---|---|
| Concrete | $f'_c$ | 3750 | psi | Specified on drawings, 5000 psi for Precast | (ASCE 41-17 Table 10-4) |
| Reinf. | $f_y$ | 60 | ksi | Specified on Drawings | (ASCE 41-17 Table 10-4) |
| Steel | $F_y$ | 36 | ksi | Assumed ASTM A36 | (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 C2a | (ASCE 41-17 Table 4-6) |
| | ~~17.19 Nonstructural Checklist~~ (not performed) | (ASCE 41-17 Table 4-6) |

**Seismic forces**

| | | | | | |
|---|---|---|---|---|---|
| $V$ | 1894 | kip | $V = Cs_a W$ | = 1.54W | (ASCE 41-17 Eq 4-1) |
| $W$ | 1230 | kip | building weight | | (ASCE 41-17 4.4.2.1) |
| $C$ | 1.2 | | 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) |
| $T$ | 0.31 | sec | $T = C_t h_n^{\beta}$ | | (ASCE 41-17 Eq 4-4) |
| $C_t$ | 0.020 | | | | (ASCE 41-17 Eq 4-4) |
| $\beta$ | 0.75 | | | | (ASCE 41-17 Eq 4-4) |
| $h_n$ | 38 | 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 | 111 | | 38.3 | 4246 | 0.23 | 432 | |
| 2 | 596 | 20.75 | 17.5 | 10430 | 0.56 | 1062 | 432 |
| Terrace | 523 | 10.0 | 7.5 | 3923 | 0.21 | 399 | 1494 |
| 1 | | 7.5 | 0.0 | | | | 1894 |
| Total | 1230 | | | 18598 | 1.0 | 1894 | |
| $k$ | 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)

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

| Story | $A_{w\,N\text{-}S}$ in$^2$ | $A_{w\,E\text{-}W}$ in$^2$ | $v_{NS}^{avg}$ psi | $v_{EW}^{avg}$ psi | $D/C_{NS}$ | $D/C_{EW}$ |
|---|---|---|---|---|---|---|
| Roof | | | | | | |
| 2 | 15360 | 9408 | 6 | 10 | 0.1 | 0.1 |
| Terrace | 15360 | 9408 | 22 | 35 | 0.2 | 0.3 |
| 1 | 18252 | 18192 | 23 | 23 | 0.2 | 0.2 |
| Total | | | | | | |

$M_s$ 4.50 3.75? (ASCE 41-17 Table 4-8)

$v_{limit}$ 122 psi $v_{limit} = 2\sqrt{f_c'} \geq 100$ psi

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

*Weight takeoff*

| | Floor | | Roof | |
|---|---|---|---|---|
| *Floor Slab* | x | psf | x | psf |
| *Rooftop* | | | x | psf |
| *Partitions* | x | | x | |
| *Ceiling, Mech* | x | | x | |
| *Exterior cladding* | x | | x | |
| *Columns* | x | psf | x | psf |
| *Total* | | 0 psf | | 0 psf |
| *Weight* | | **0 kps** | | **0 kps** |