Rating form completed by:
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*Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database*

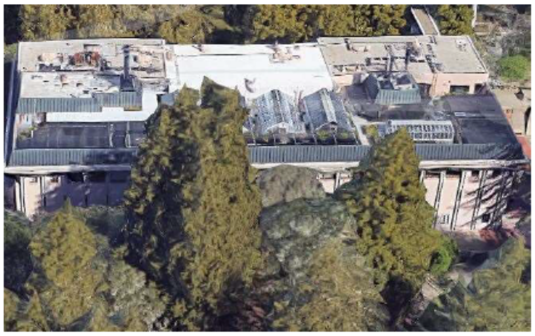
JOSEPH RICHARD MAFFEI
No. 3694

## UC Santa Cruz building seismic ratings

# Thimann Laboratory

CAAN #7116
568 Steinhart Way, Santa Cruz, CA 95064
UCSC Campus: Main Campus

DATE: 2018-12-30



| Rating summary | Entry | Notes |
|---|---|---|
| UC Seismic Performance Level (rating) | VI (Very Poor) | Assumes no prior retrofit was made |
| Rating basis | Tier 1 | ASCE 41-17[1] |
| Date of rating basis | 2018 | |
| Recommended list assignment (UC Santa Cruz category for retrofit) | Priority A | Priority A=Retrofit ASAP<br>Priority B=Retrofit at next permit application |
| Ballpark total construction cost to retrofit to IV rating[2] | High ($200-$400/sf) | See recommendations on further evaluation and retrofit. |
| Is 2018-2019 rating required by UCOP? | Yes | We did not find a documented previous rating |
| Further evaluation recommended? | During retrofit design | To determine if a prior retrofit was made in 1989.<br>If so, reassess. |

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[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 access bility. 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, "Natural Sciences Unit One, University of California, Sant Cruz," 17 Jan 1964.
- Structural drawings by T.Y. Lin & Associates International, "Natural Sciences Unit One, University of California, Sant Cruz," 17 Jan 1964, sheets S1 through S17. Set contains drawings for shops building and lecture hall, which are separate structures not reviewed herein.
- Slab prestress tendon drawings by Western, "Natural Sciences Unit One, University of California, Sant Cruz," 6 sheets from various dates in 1964.
- University of California building database information provided by Jose Sanchez (UCSC) on 2018-11-20.

### Additional building information known to exist

Building database indicates building was retrofit in 1991. A letter by Wildman & Morris to Campus, dated December 6, 1989, indicates that building is currently undergoing a seismic retrofit, as designed by ED2, Architects, and Wildman & Morris, Engineers. However, campus has located no drawings or other records for retrofit and campus facilities personnel have not observed retrofit measures.

### Scope for completing this form

Reviewed structural drawings for original construction and carried out ASCE 41-17 Tier 1 evaluation. We made a brief site visit. We did not perform the Tier 1 nonstructural evaluation, but we looked for potentially hazardous nonstructural components during our site visit. No nonstructural hazards were identified.

Plans contain drawings for Thimann Lecture Hall and a shops building, both of which are separate structures from the Thimann Lab building. These separate structures were not part of this review.

It can be seen from satellite imagery that various penthouse and greenhouse structures have been added to roof of the Lab building. These have not been reviewed or assessed. It can also be seen that a bridge connecting to Sinsheimer has been constructed that appears to closely abut the building; we did not observe whether the bridge is connected to the building.

### Brief description of structure

The Thimann Lab building was designed in 1964 by the architectural office of Anshen & Allen and the structural office of T.Y. Lin International. The building is 3 story structure that contains approximately 89,000 square feet according to campus records. The building is a rectangle in plan, measuring 238 feet long (east-west) by 100 feet wide (north-south). Each story is 13'-0" in height with an overall building height of 39 feet from the Ground Floor to the roof.

The building is of all concrete construction, with cast-in-place post-tensioned concrete floor and roof slabs, cast-in-place conventionally reinforced concrete columns and walls at the interior, and a façade constructed with precast concrete columns and wall panels.

Penthouses and greenhouses that are presumably of lightweight construction have been added to the roof since its original construction.

Foundation System: The site is moderately sloping. The superstructure is founded on shallow footings. Strip footings run around the building perimeter to support the perimeter columns and the wall elements (of various types) that infill the columns. There are isolated spread footings at interior columns. Strip footings are provided below the wall elements of concrete, precast concrete, and concrete block masonry (CMU) that exist at the first level.

Structural system for vertical (gravity) load: The floors and roof are each constructed using a 13-inch thick, two-way post-tensioned, lightweight concrete flat plate slab. The slab is supported by 2-foot square concrete columns at the interior; bay size is 40 feet in the east-west direction and 40'-20'-40' in the north-south direction. The slab is supported by precast concrete columns, spaced at 10 feet on center, around the perimeter.

Concrete walls that surround and support the stairs also serve as bearing walls for the floors.

Structural system for lateral forces

It is not clear what elements where intended in the design to act as the seismic lateral force resisting system. Elements that may play a role consist of the following:

- 8-inch thick, lightly reinforced (1 layer of #4@10”o.c.) cast-in-place concrete walls, located at the two stairs, can resist some lateral force, but are well below the necessary capacity to resist the seismic demands of the entire building.
- Precast concrete columns at the building façade, shaped for appearance and approximately 1.5 feet x 2 feet in plan, with #3 @ 14” o.c. transverse reinforcement. The precast concrete columns are continuous between floors and can resist some lateral force.
- 4”-thick vertically-prestressed lightweight concrete wall panels at the façade, framing between columns and doweled into floors but not connecting to columns except at floor lines. The panels have large window openings, and furthermore are not doweled into the building foundation, so they do not appear intended to act as shear walls. The panels are also not moment connected to the columns, so frame action does not occur between columns and panels, except possibly through coupling action between the third and second floors.

For this seismic evaluation, we assumed the following lateral force resisting system:

- Between the third floor and the roof, the precast wall panels are perforated with large window openings, and lateral forces are resisted by the precast columns plus the 8” concrete walls at the stairs.
- Between the second and third floors, the columns are perforated with vertical slots for tall window openings, and lateral forces are resisted by the precast wall panels plus the 8” concrete walls at the stairs.
- Between the first and second floors, because the wall panels are not shown in the drawings as doweled to the foundation, lateral forces are resisted only by the precast columns plus the 8” concrete walls at the stairs. Frame action from the wall panel above likely provides added stiffness to reduce drift.

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

The following deficiencies are based on review of original structural drawings for the building from 1964. A letter from 1989 indicates that retrofit work on the building was in progress at that time. However, UCSC has no record of retrofit drawings and is not aware of any additional visual observation of retrofitted items in the building. For the purposes of this rating, we assume that these deficiencies have not been addressed. If subsequent investigation by UCSC indicates that some or all of these deficiencies have been addressed by retrofitting, this rating should be updated to consider the benefits of the provided retrofitting. Also, during our site visit, we observed that the openings in the precast wall panels at the façade do not match the original structural drawings. For example, in locations where the drawings show the wall set back from the face of the building, the wall currently does not step back. Also, window openings are smaller than shown in the drawings.

Seismic deficiencies of the building include the following:

- The wall panels do not connect to the foundation.
- The precast columns between the roof and the third floor appear to be shear critical.
- The exterior precast columns and 8” cast-in-place walls are overstressed by a factor of 1.4 between the roof and the third floor, and a factor of 2.0 between the second and first floor, for seismic demands.
- The exterior precast wall panels are overstressed between the second and third floor by a factor of 3.0 for seismic demands, assuming Tier 1 *Ms*= 2.0 consistent with the Ms value used to evaluate the precast columns.
- The 8” cast-in-place walls are lightly reinforced, with the horizontal steel reinforcement ratio = 0.0016. The wall between the stair and the elevator core is inadequately connected to the floor diaphragm.
- We could not find details of the interior concrete columns other than a detail of the connection to the footing (J-S9). Based on this and other details, we expect that the columns are lightly tied and prone to shear failure.

The building's lack of a reliable lateral force resisting system makes it a potential collapse risk in a major earthquake.

| 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) | Y |
| Load path | Y | Liquefaction | N |
| Adjacent buildings | N | Slope failure | N |
| Weak story | N | Surface fault rupture | N |
| Soft story | N | Masonry or concrete wall anchorage at flexible diaphragm | N |
| Geometry (vertical irregularities) | 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 | N | | |

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

In our brief site visit, we did not observe any non-structural life-safety concerns, but there are a number of areas of the building that we did not observe. When more detailed evaluations of the building are made, as we recommend, they should include a review of details of construction of glazed wall at entry lobby and condition of connections of steel tube stringers to landings at exterior exit stairs.

| 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 | PC panels | 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

Because of the potential collapse risk, we rate the building as VI (Very Poor). The rating applies unless subsequent investigation indicates that the deficiencies described herein have been addressed by retrofit. We and UCSC have not yet found any documentation of retrofit.

### Recommendations for further evaluation or retrofit

We recommend that the University retrofit this building as a high priority. One option for retrofitting would include new cast-in-place concrete walls that are sufficiently strong to resist the high lateral forces anticipated at this site and sufficiently stiff to protect the concrete frame and façade panel elements. Further evaluation and drawing search is needed to determine if any retrofit was constructed, and would be done to further define the scope of required retrofitting. Otherwise no further evaluation is needed to confirm the inadequacy of the seismic performance.

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[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.

**Peer review of rating**

This seismic evaluation was discussed in a peer review meeting on 24 July 2019. The reviewers present were Bret Lizundia of R+C and Jay Yin of Degenkolb. Comments from the reviewers have been incorporated into this report. The reviewer agreed with the assigned rating.

| **Additional building data** | **Entry** | **Notes** |
|---|---|---|
| Latitude | 36.998097 | |
| Longitude | -122.061995 | |
| Are there other structures besides this one under the same CAAN# | Not Known | There is a structurally separate Lecture Hall and Shops Building that are shown on drawings. |
| Number of stories above lowest perimeter grade | 3 | |
| Number of stories (basements) below lowest perimeter grade | 0 | Unoccupied Crawl Space is not considered a story |
| Building occupiable area (OGSF) | 88989 | |
| Risk Category per 2016 CBC Table 1604.5 | II | Classroom occupancy |
| Estimated fundamental period | 0.25 sec | Estimated using ASCE 41-17 equation 4-4 and 7-18 |
| Building height, $h_n$ | 39 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 |
| Exponent on height, $\beta$ | 0.75 | 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 $S_{cs}$, $S_{c1}$ | 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 | |

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[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

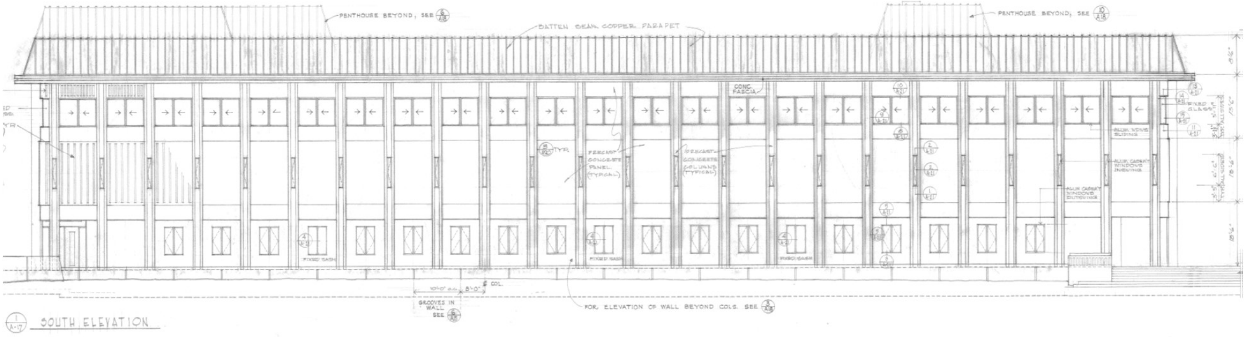
[5] $F_V$ factor used does not include the requirements of Section 11.4.8-3 of ASCE 7-16 that are applicable to Site Class D, and which per Exception 2 would result in an effective $F_V$ factor of 2.72 (1.5 times larger). At the Santa Cruz main campus this only affects structures with $T$>0.69 seconds.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

| | | |
|---|---|---|
| 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: 1964<br>Code: 1964 UBC | Code inferred based on design year |
| Applicable code for partial retrofit | - | Possible retrofit in 1989 |
| Applicable code for full retrofit | - | |
| **FEMA P-154 data** | | |
| Model building type North-South | PC2 – Precast concrete frames (with shear walls) | |
| Model building type East-West | PC2 – Precast concrete frames (with shear walls) | |
| FEMA P-154 score | N/A | Not included here. Tier 1 evaluation. |
| **Previous ratings** | | |
| Most recent rating | - | |
| 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 |

[redacted]

**Annotated floor plan (2nd floor shown)**

**East elevation from original structural drawings**



**South elevation from original structural drawings**

East elevation

West elevation

**Roof greenhouses**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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| Building Name: | Thimann Laboratory | | | Initials: | | Checked: | |
| Building Address: | 568 Steinhart Way | | | Page: | 1 | of | 3 |

# ASCE 41-17
# Collapse Prevention Basic Configuration Checklist

## LOW SEISMICITY

### BUILDING SYSTEMS - *GENERAL*

| | Description |
|---|---|
| C NC N/A U<br>X ○ ○ ○ | 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>**Comments:** |
| C NC N/A U<br>○ ○ ○ X | 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>**Comments:** *Bridge to Sinseimer appears closely abutting from Google Satellite- no drawings reviewed.* |
| C NC N/A U<br>X ○ ○ ○ | 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>**Comments:** |

### BUILDING SYSTEMS - *BUILDING CONFIGURATION*

| | Description |
|---|---|
| C NC N/A U<br>X ○ ○ ○ | 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>**Comments:** |
| C NC N/A U<br>X ○ ○ ○ | 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>**Comments:** |
| C NC N/A U<br>○ X ○ ○ | 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>**Comments:** *If thin precast-prestressed wall panels were considered as part of the seismic force resisting, then the panels at the second level are not continuous to foundation. Panels are connected to columns only at floors.* |

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

| | | | | | | | |
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# ASCE 41-17
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| | |
|---|---|
| C NC N/A U<br>☒ ○ ○ ○ | 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>**Comments:** |
| C NC N/A U<br>☒ ○ ○ ○ | 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>**Comments:** |
| C NC N/A U<br>☒ ○ ○ ○ | 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>**Comments:** |

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

## GEOLOGIC SITE HAZARD

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

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*If thin precast-prestressed wall panels were considered as part of the seismic force resisting, then there is torsion in the east-west direction, based on position of cast-in-place concrete shear walls.*

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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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>○ ☒ ○ ○ | 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:** *14'-4" long by 39 foot high walls do not meet test for Sa = 1.5. Wall foundations are not substantial.* |
| **C NC N/A U**<br>○ ○ ☒ ○ | 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:** |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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# ASCE 41-17
# Collapse Prevention Structural Checklist For Building Type PC2

## LOW AND MODERATE SEISMICITY

### SEISMIC-FORCE-RESISTING SYSTEM

| | Description |
|---|---|
| C NC N/A U<br>○ ☒ ○ ○ | 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:** *Cast-in-place concrete walls at stair cores, which resist lateral seismic forces, are used to support gravity loads.* |
| C NC N/A U<br>☒ ○ ○ ○ | 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>○ ☒ ○ ○ | 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 b/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:** *Walls are overstressed by factor of 1.4 at third level and 2.6 at first level* |
| C NC N/A U<br>○ ☒ ○ ○ | 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:** *8 inch thick walls with #4 at 10" centers each way are .0016.* |

### DIAPHRAGMS

| | Description |
|---|---|
| C NC N/A U<br>○ ○ ☒ ○ | TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab with a minimum thickness of 2 in. (51 mm). (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4)<br>**Comments:** |

### CONNECTIONS

| | Description |
|---|---|
| C NC N/A U<br>○ ☒ ○ ○ | 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:** *No substantial connection to wall between stair and elevator #2* |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
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# ASCE 41-17
# Collapse Prevention Structural Checklist For Building Type PC2

| C | NC | N/A | U | |
|---|---|---|---|---|
| ○ | ○ | ☒ | ○ | TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2)<br>**Comments:** |
| ☒ | ○ | ○ | ○ | FOUNDATION DOWELS: Wall reinforcement is doweled into the foundation. (Commentary: Sec. A.5.3.5. Tier 2: Sec. 5.7.3.4)<br>**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)<br>**Comments:** *The connection is from the 13" thick floor slab to precast columns at perimeter. Connection has a small steel ledger for transfer of gravity load and a substantial embed dowel with plate washer connected to tendon into floor to tie column to floor..* |

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

### SEISMIC-FORCE-RESISTING SYSTEM

| C | NC | N/A | U | Description |
|---|---|---|---|---|
| ○ | ○ | ○ | ☒ | PRECAST FRAMES: For buildings with concrete shear walls, precast concrete frame elements are not considered as primary components for resisting seismic forces. (Commentary: Sec. A.3.1.5.2. Tier 2: Secs. 5.5.2.4, 5.5.2.5.1, and 5.5.2.5.2)<br>**Comments:** *Reviewer cannot clearly discern intended SLFRS for this building and considers the cast-in-place concrete shear walls as the only reliable vertical elements of the SLFRS.* |
| ☒ | ○ | ○ | ○ | PRECAST CONNECTIONS: For buildings with concrete shear walls, the connection between precast frame elements, such as chords, ties, and collectors in the seismic-force-resisting system, develops the capacity of the connected members. (Commentary: Sec. A.3.1.5.3. Tier 2: Sec. 5.6.1.1)<br>**Comments:** *Connections of precast columns to floors generally appear adequate to maintain connection* |
| ○ | ☒ | ○ | ○ | 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>**Comments:** *Reviewer could not locate a detail for the 2'-0" square reinforced concrete columns at the interior. Based on footing detail J-S9, columns have (16) and there are some light ties at wide spacing.* |
| ○ | ○ | ☒ | ○ | 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>**Comments:** |

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

| | | | | | | |
|---|---|---|---|---|---|---|
| UC Campus: | Santa Cruz | | | Date: | 12/27/2018 | |
| Building CAAN: | 7116 | Auxiliary CAAN: | | By Firm: | Maffei | |
| Building Name: | Thimann Laboratory | | | Initials: | | Checked: |
| Building Address: | 568 Steinhart Way | | | Page: | 3 of 3 | |

# ASCE 41-17
## Collapse Prevention Structural Checklist For Building Type PC2

### DIAPHRAGMS

| | Description |
|---|---|
| **C NC N/A U**<br>○ ☒ ○ ○ | 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. 5.5.3.3.1)<br>**Comments:** *Wall between stair and elevator core not engaged to diaphragm.* |

### CONNECTIONS

| | Description |
|---|---|
| **C NC N/A U**<br>○ ○ ☒ ○ | 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:** |
| **C NC N/A U**<br>○ ○ ☒ ○ | CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing is greater than 3 in. (76 mm) (Commentary: Sec. A.5.4.3. Tier 2: Sec. 5.7.4.3)<br>**Comments:** |
| **C NC N/A U**<br>○ ○ ☒ ○ | CORBEL CONNECTIONS: The frame girders are not connected to corbels with welded elements. (Commentary: Sec. A.5.4.4. Tier 2: Sec. 5.7.4.3)<br>**Comments:** |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| UC Campus: | **UC Santa Cruz** | | | Date: | **12/30/19** | | |
| Building CAAN: | **7116** | Auxiliary CAAN: | | By Firm: | **Maffei Structural Engineering** | | |
| Building Name: | **Thimann Labs** | | | Initials: | ***NY*** | Checked: | |
| Building Address: | **568 Steinhart Way, CA 95064** | | | Page: | **1** | of | **3** |

# ASCE 41-17
# Collapse Prevention Structural Checklist For Building Type PC2A

## LOW AND MODERATE SEISMICITY

### SEISMIC-FORCE-RESISTING SYSTEM

| | **Description** |
|---|---|
| **C NC N/A U**<br>● ○ ○ ○ | REDUNDANCY: The number of lines of moment frames in each principal direction is greater than or equal to 2. The number of bays of moment frames in each line is greater than or equal to 2. (Commentary: Sec. A.3.1.1.1. Tier 2: Sec. 5.5.1.1)<br>**Comments:** |
| **C NC N/A U**<br>○ ● ○ ○ | COLUMN SHEAR STRESS CHECK: The shear stress in the concrete columns, calculated using the Quick Check procedure of Section 4.4.3.2, is less than the greater of 100 lb/in.$^2$ (0.69 MPa) or 2 $\sqrt{f'_c}$. (Commentary: Sec. A.3.1.4.1. Tier 2: Sec. 5.5.2.3.4)<br>**Comments:** *At Level 3, Vavg = 147 psi > 2*sqrt(5000)*0.75 = 106.1 psi. At Level 1, Vavg = 271 psi > 106.1 psi.* |
| **C NC N/A U**<br>● ○ ○ ○ | COLUMN AXIAL STRESS CHECK: The axial stress caused by gravity loads in columns subjected to overturning forces is less than 0.10$f'_c$. Alternatively, the axial stress caused by overturning forces alone, calculated using the Quick Check procedure of Section 4.4.3.6, is less than 0.30$f'_c$. (Commentary: Sec. A.3.1.4.2. Tier 2: Sec. 5.5.2.1.3)<br>**Comments:** |
| **C NC N/A U**<br>○ ○ ○ ● | PRECAST CONNECTION CHECK: The precast connections at frame joints have the capacity to resist the shear and moment demands calculated using the Quick Check procedure of Section 4.4.3.5. (Commentary: Sec. A.3.1.5.1. Tier 2: Sec. 5.5.2.4)<br>**Comments:** *Some frame action may have been assumed in the design through the couple between the connection to the 3rd and 2nd floors. Because the strength of the columns governed the building behavior, we did not check the capacity of the precast connections in moment.* |

### DIAPHRAGMS

| | **Description** |
|---|---|
| **C NC N/A U**<br>● ○ ○ ○ | TOPPING SLAB: Precast concrete diaphragm elements are interconnected by a continuous reinforced concrete topping slab with a minimum thickness of 2 in. (51 mm). (Commentary: Sec. A.4.5.1. Tier 2: Sec. 5.6.4)<br>**Comments:** *No topping slab occurs, but floor diaphragm consists of continuous post-tensioned concrete slab.* |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| UC Campus: | **UC Santa Cruz** | | | Date: | **12/30/19** | | |
| Building CAAN: | **7116** | Auxiliary CAAN: | | By Firm: | **Maffei Structural Engineering** | | |
| Building Name: | **Thimann Labs** | | | Initials: | ***NY*** | Checked: | |
| Building Address: | **568 Steinhart Way, CA 95064** | | | Page: | **2** | of | **3** |

# ASCE 41-17
# Collapse Prevention Structural Checklist For Building Type PC2A

## CONNECTIONS

| | Description |
|---|---|
| **C NC N/A U**<br>○ ● ○ ○ | TOPPING SLAB TO WALLS OR FRAMES: Reinforced concrete topping slabs that interconnect the precast concrete diaphragm elements are doweled for transfer of forces into the shear wall or frame elements, and the dowels are able to develop the least of the shear strength of the walls, frames, or slabs. (Commentary: Sec. A.5.2.3. Tier 2: Sec. 5.7.2)<br>**Comments:** *No topping slab occurs, but floor diaphragm consists of continuous post-tensioned concrete slab. Dowels from the slab to the shear wall or frame elements cannot develop the shear strength of the walls or frames.* |
| **C NC N/A U**<br>○ ○ ● ○ | 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)<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>○ ○ ○ ● | PRESTRESSED FRAME ELEMENTS: The seismic-force-resisting frames do not include any prestressed or post-tensioned elements where the average prestress exceeds the lesser of 700 lb/in.$^2$ (4.83 MPa) or $f'_c/6$ at potential hinge locations. The average prestress is calculated in accordance with the Quick Check procedure of Section 4.4.3.8. (Commentary: Sec. A.3.1.4.4. Tier 2: Sec. 5.5.2.3.2)<br>**Comments:** |
| **C NC N/A U**<br>● ○ ○ ○ | CAPTIVE COLUMNS: There are no columns at a level with height/depth ratios less than 50% of the nominal height/depth ratio of the typical columns at that level. (Commentary: Sec. A.3.1.4.5. Tier 2: Sec. 5.5.2.3.3)<br>**Comments:** |
| **C NC N/A U**<br>○ ● ○ ○ | JOINT REINFORCING: Beam–column joints have ties spaced at or less than $8d_b$. (Commentary: Sec. A.3.1.4.13. Tier 2: Sec. 5.5.2.3.8)<br>**Comments:** *Precast columns have ties spaces at 14" = 16db for #7 vertical column reinforcement.* |
| **C NC N/A U**<br>○ ● ○ ○ | 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>**Comments:** *We could not find details of the interior concrete columns other than a detail of the connection to the footing (J-S9). Based on this and other details, we expect that the columns are lightly tied and prone to shear failure.* |

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

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| UC Campus: | UC Santa Cruz | | | Date: | 12/30/19 | | |
| Building CAAN: | 7116 | Auxiliary CAAN: | | By Firm: | Maffei Structural Engineering | | |
| Building Name: | Thimann Labs | | | Initials: | *NY* | Checked: | |
| Building Address: | 568 Steinhart Way, CA 95064 | | | Page: | 3 | of | 3 |

# ASCE 41-17
# Collapse Prevention Structural Checklist For Building Type PC2A

## CONNECTIONS

| | Description |
|---|---|
| C NC N/A U<br>○ ○ ● ○ | 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:** |
| C NC N/A U<br>● ○ ○ ○ | GIRDERS: Girders supported by walls or pilasters have at least two ties securing the anchor bolts unless provided with independent stiff wall anchors with strength to resist the connection force calculated in the Quick Check procedure of Section 4.4.3.7. (Commentary: Sec. A.5.4.2. Tier 2: Sec. 5.7.4.1)<br>**Comments:** |
| C NC N/A U<br>○ ○ ● ○ | CORBEL BEARING: If the frame girders bear on column corbels, the length of bearing is greater than 3 in. (76 mm) (Commentary: Sec. A.5.4.3. Tier 2: Sec. 5.7.4.3)<br>**Comments:** |
| C NC N/A U<br>○ ○ ● ○ | CORBEL CONNECTIONS: The frame girders are not connected to corbels with welded elements. (Commentary: Sec. A.5.4.4. Tier 2: Sec. 5.7.4.3)<br>**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 | Anshen & Allen | | |
| Structural Engineer | TY Lin and Assoc | | |
| Location | 568 Steinhart Way, Santa Cruz, CA 95064 | | |
| Design date | 1964 | | |
| Latitude | 36.998097 | | https://hazards.atcouncil.org/ |
| Longitude | -122.061995 | | " |
| Stories above grade | 3 | plus rooftop structures | |

**Seismic parameters**

| | | | | |
|---|---|---|---|---|
| Risk Category | II | 2016 CBC Table 1604.5 | | |
| Site Class | D | Assumed | | (ASCE 41-17 2.4.1.6, ASCE 7-16 Chapter 20) |
| Liquefaction hazard | Low | Assumed | | (ASCE 41-17 3.3.4) |
| Landslide hazard | Low | Assumed | | |
| $S_{DS}$ | 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) |
| $S_{XS}$ | 1.286 | For BSE-2E hazard level | https://hazards.atcouncil.org/ | (ASCE 41-17 Table 2-2) |
| $S_{X1}$ | 0.89 | For BSE-2E hazard level | https://hazards.atcouncil.org/ | (ASCE 41-17 Table 2-2) |

**Scope**

| | | | | |
|---|---|---|---|---|
| Performance level | Collapse Prevention | Ms = 2 | (ASCE 41-17 Sec 4.4.3.2) | (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 | PC2a - Precast Concrete Frame without Shear Walls | | | (ASCE 41-17 Table 3-1) |

| **Material properties** | | | | Notes | |
|---|---|---|---|---|---|
| Concrete | $f'_c$ | 5,000 Ltwt | psi | Precast Columns | (ASCE 41-17 Table 10-4) |
| | | 4,000 Ltwt | | Floors | |
| | | 5,000 Ltwt | | P/C walls | |
| Reinf. | $f_y$ | 40 | ksi | Typical | (ASCE 41-17 Table 10-4) |
| | $f_y$ | 60 | ksi | Column Verticals | |
| Steel | $F_y$ | N/A | ksi | N/A | (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 PC2a | (ASCE 41-17 Table 4-6) |
| | ~~17.19 Nonstructural Checklist~~ (not performed) | (ASCE 41-17 Table 4-6) |

**Seismic forces**

| | | | | | |
|---|---|---|---|---|---|
| $V$ | 16718 | kip | $V = Cs_a W$ | = 1.29W | (ASCE 41-17 Eq 4-1) |
| $W$ | 13000 | kip | building weight | | (ASCE 41-17 4.4.2.1) |
| $C$ | 1.0 | | Convert linear elastic to inelastic disp. | | (ASCE 41-17 Table 4-7) |
| $S_a$ | 1.29 | g | $S_a = S_{x1}/T \leq S_{XS}$ | | (ASCE 41-17 Eq 4-3) |
| $T$ | 0.32 | 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) |
| $h_n$ | 41 | 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 | 5000 | | 41 | 202500 | 0.56 | 9288 | |
| 3 | 4000 | 13.5 | 27 | 108000 | 0.30 | 4953 | 9288 |
| 2 | 4000 | 13.5 | 14 | 54000 | 0.15 | 2477 | 14241 |
| 1 | | 13.5 | 0 | | | | 16718 |
| Total | 13000 | | | 364500 | 1.0 | 16718 | |

$k$ 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 precast columns** (ASCE 41-17 4-7)

| Story | $n_c$ | $n_f$ | $A_c$ in$^2$ | $v^{avg}$ psi | $D/C$ | |
|---|---|---|---|---|---|---|
| Roof | | | | | | |
| 3 | 68 | 2 | 32544 | 147 | 1.4 | Includes 68 column plus 3168 in^2 for 8" wall |
| 2 N/S | | | 24672 | 289 | 2.7 | Includes 7680 in^2 4" wall + 3168 in^2 8" wall + 48 col *2* 6" x 24" columns at N and S walls |
| 2 E/W | | | 22240 | 320 | 3.0 | Includes 17280 in^2 4" wall + 4960 in^2 8" wall |
| 1 | 68 | 2 | 31824 | 271 | 2.6 | Includes 68 columns plus 3168 in^2 for 8" wall |
| Total | | | | | | |

$M_s$ 2.00 (ASCE 41-17 Table 4-8)

$v_{limit}$ 106 psi $v_{limit} = 2\sqrt{f_c'} \geq 100$ psi

$v^{avg} = (1/M_s)(n_c/(n_c-n_f))(V_{story}/A_c)$ (ASCE 41-17 Eq 4-8)

*When no columns,* $v^{avg} = (1/MS)(V_{story}/A_c)$

*Weight takeoff*

| | Floor | Roof |
|---|---|---|
| *Floor Slab* | 120 psf | 120 psf |
| *Rooftop* | | 40 psf |
| *Partitions* | 10 | 5 |
| *Ceiling, Mech* | 12 | 12 |
| *Exterior cladding* | 15 | 30 |
| *Columns* | 10 psf | 5 psf |
| *Total* | 167 psf | 212 psf |
| *Weight* | **3925 kps** | **4982 kps** |