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

UC Santa Cruz building seismic ratings

Porter College Academic Building, University of California Santa Cruz

CAAN #7306
405 Porter-Kresge Road, Santa Cruz, CA 95064
UCSC Campus: Main Campus

DATE: 2018-12-31

Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	IV (Fair)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating basis	2018	
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]	Low (< $50/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	Building previously rated III (meeting UC policy) but does not have a documented previous review or retrofit
Further evaluation recommended?	Tier 2	Selected columns and collector

[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

- Structural drawings by Clarence Rinne, "Unit-D Academic/Administration, University of California College 5," dated 1968-10-15, 1970-9-15, and 1971-4-13 (14 sheets).
- Architectural drawings by Hugh Stubbins and Associates (Architects) and Corlett and Spackman (Associated Architects) "College No. 5, Unit -D, Academic – Administration, University of California, Santa Cruz" dated 1970-9-11 (and other dates).
- University of California building database information, "Porter College Academic," provided by Jose Sanchez (UCSC) on 2018-11-20.

Additional building information known to exist

- None

Scope for completing this form

We reviewed structural and architectural drawings for original construction. In 1971, an addition was constructed between Lines L to O and 6 to 13 at the Administration Building, forming the final wing of the U. The structural and architectural drawings for the addition were included in the original drawing package, and we assume the addition was built immediately after the initial construction was completed. Our evaluation covers this 1971 addition along with the remainder of the building.

To the south of the Academic Building a two-story L-shaped building of more recent construction is functionally attached but seismically separated. This building looks to be of the same construction type as the original Administration and Academic Buildings, but further examination shows it to be in fact a wood-framed building. For the purposes of seismic rating, this south portion can be considered to have CAAN #7306.1, and is to have a separate seismic evaluation.

We carried out an ASCE 41-17 Tier 1 structural evaluation and made a brief site visit. We did not perform the Tier 1 nonstructural evaluation. During our site visit we looked for potentially hazardous nonstructural components; we did not notice any.

The UC Santa Cruz building inventory spreadsheet lists Porter Academic as being seismically retrofitted in 1996 and being rated III. However, the University did not find any record of retrofit drawings, and our rating is based on the documented original building design. We did not notice in our site visit any obvious signs of retrofitting. It is possible that the indication of 1996 retrofitting in the records in fact refers to the construction of the L-shaped building at the south. If subsequent investigation by UCSC indicates that some or all of these deficiencies have been addressed by retrofitting, this rating could be updated to consider the benefits of the provided retrofitting.

Brief description of structure

This CAAN number and our evaluation covers two adjacent buildings, designed and constructed as part of the same Porter College project. The Administration Building has an area of approximately 21,000 square feet and a U-shaped floor plate. The Academic Building has an area of approximately 11,000 square feet and a rectangular floor plate. Both buildings have two stories above grade with 4:12 sloping roofs covered by clay tiles. The Academic Building has a small partial basement containing mechanical (HVAC) equipment. The buildings were designed in the late 1960s by structural engineer Clarence Rinne and architects Hugh Stubbins and Associates and Corlett and Spackman Associated Architects. Initial construction of both buildings was completed in September 1970. The construction of the final wing of the U-shape at the Administration Building was completed in April 1971 (and is added to the as-built construction drawings).

Structural system for vertical (gravity) load: The Second Floor and Roof of both buildings are framed using reinforced concrete beams to support a one-way, conventionally-reinforced slab. Beams span to reinforced concrete columns, which are typically 12" x 24". Both buildings have gable roofs.

Structural system for lateral forces: Reinforced concrete walls resist lateral forces in each building. At the Administration Building, much of the wall is located surrounding the two interior stairwells. At the Academic Building, north-south walls are located on the building centerline (Line 14), and east-west walls are at the perimeter (Lines P and W).

Typical walls are 8" thick with #4 @16" each face vertical and horizontal reinforcement, and either 2-#6 vertical bars or columns at wall boundaries.

Foundation System: Walls and columns are founded on continuous reinforced concrete footings, typically 2'-6" wide by 2'-0" deep with 2 - #6 top and bottom longitudinal bars. Ties are provided locally at the ends of some walls. When ties are used, they consist of stirrups with 90 deg. hooks and a tie with 90 deg. hooks (commonly #4 @ 12" or d/2). Both buildings have a 4" thick structural slab on grade.

At the Academic Building, the small partial basement is surrounded by 12" reinforced concrete retaining walls on continuous footings. A column in the basement has a small spread footing.

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

Although the UC Santa Cruz building inventory lists a 1996 seismic retrofit, no record of the retrofit drawings was available. Therefore, our rating is based on the original construction drawings. Identified seismic deficiencies of the building include the following:

- The worst columns (e.g. those at Grid D/12) are shear governed because of heavy longitudinal reinforcement and light widely spaced ties. Typical ties are spaced at 12" (d/1 or d/2) and use 90-degree hooks (rather than 135- or 180-degree hooks, which is now required practice in high-seismic areas).
- Typical columns are flexure-shear governed because of an inadequate tie spacing of 12" (d/1 or d/2). The ties use 90-degree hooks.
- Typical beams (including beams that couple adjacent walls) are flexure-shear governed because of inadequate tie spacing of 12" (d/1.5). The ties use 90-degree hooks.
- Floor openings are present at the Second Floor of the Academic Building adjacent to the walls on Line 14. Our preliminary calculations indicate that the remaining floor diaphragm may not have adequate capacity to transfer shear forces to the walls on Grid Line 14. Additionally, the beams on Line 14 apparently were not designed with capacity beyond that provided for gravity load, thus limiting the ability of the beams to serve as collectors for seismic forces.
- Some continuous footings may not have ductile behavior. Closed ties are not provided at foundations below the ends of some walls (e.g. at Line 5, Line E, Line K). At locations where ties are provided, 90-degree hooks are used.

We identify other "non-conforming" items according to the ASCE 41-17 Tier 1 checklist, but we judge these other items to have minimal impact on the expected seismic performance of the building. This includes "Columns or pilasters are not provided at the stairs." Floor loads are instead supported by the concrete walls, which we believe is acceptable.

We find that the existing shear walls have adequate strength per the ASCE 41-17 Tier 1 quick check. The First Floor walls have an unreduced shear stress of approximately 475 psi (approximately $3.7\sqrt{f'_c}$). This results in a demand/capacity ratio of approximately 1.0 considering the M_s = 3.75 factor specified by ASCE 41-17 for a Risk Category III building.

Generally, we find that the seismic design of the Porter Academic Buildings is slightly better than comparable concrete wall buildings of the same era. The deficiencies related to column and beam ductility may compromise seismic performance under strong ground shaking. Columns and beams may be vulnerable to shear failure, but we judge that such failure has an acceptably low probability of leading to building collapse, partly because we expect that the building's concrete walls will help limit deformation if shear failure occurs in columns or beams.

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	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 did not observe any non-structural life-safety concerns during our building visit.

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 rating of IV is based on columns and beams having widely spaced ties with 90-degree hooks, and on the lack of a reliable collector to the Line 14 walls of the academic building. We judge that these deficiencies are not highly likely to lead to collapse. Nevertheless, if an opportunity arises, the structure could benefit from some targeted retrofitting.

Recommendations for further evaluation or retrofit

We put this building in Priority B, meaning that if any modification work is planned for the building, a further evaluation should be conducted and retrofit carried out if appropriate. The building seismic performance would likely benefit from a low-cost targeted retrofit scope. Efficient and beneficial retrofit measures might include carbon fiber wrapping of selected columns and the addition of a carbon fiber collector at Level 2 of the Academic Building to transfer shear forces from the floor diaphragm to the Line 14 walls.

Additional building data	Entry	Notes
Latitude	--	
Longitude	--	
Are there other structures besides this one under the same CAAN#	No	This CAAN# is for **two seismically separate buildings**.

[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.

Number of stories above lowest perimeter grade	2	
Number of stories (basements) below lowest perimeter grade	1	Partial basement at "Academic" (name per drawing A-2) or west building
Building occupiable area (OGSF)	36329	
Risk Category per 2016 CBC Table 1604.5	III	Educational occupancy above 12th grade, occupant load > 500 (campus to confirm),
Estimated fundamental period	0.22 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Building structural height, h_n	25 ft	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.020	Defined using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Defined 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	
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: 1970 Code: 1967 UBC	Code inferred based on construction year
Applicable code for partial retrofit	None	No documented retrofit[6]

[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.

Applicable code for full retrofit	None	No documented retrofit
FEMA P-154 data		
Model building type North-South	C2 Conc. wall	
Model building type East-West	C2 Conc. wall	
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
Previous ratings		
Most recent rating	III (Good)	
Date of most recent rating	Unknown	Indicated on spreadsheet
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

[6] The UC Santa Cruz building inventory spreadsheet identifies that a seismic retrofit was completed in 1996. However, the University has no record of the retrofit drawings. Our rating is based on the documented original building design.

Attachments

Figure: Annotated floor plan

UC Campus:	University of California Santa Cruz			Date:	12/12/2018		
Building CAAN:	7306	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	Porter Academic			Initials:	*LAB*	Checked:	*JRM*
Building Address:	405 Porter-Kresge 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
●	○	○	○	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:**
●	○	○	○	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:** Per S-13 (1971), a 2" seismic gap is provided at Level 2. For the 11'-6" story, the required joint is 138"(0.015) = 2.07". We interpret that this gap is adequate, given the concrete wall lateral system.
○	○	●	○	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3) **Comments:** No mezzanines

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C	NC	N/A	U	Description
●	○	○	○	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:** Wall area does not decrease going down the building.
●	○	○	○	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:** Wall area does not decrease going down the building.
●	○	○	○	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:** Walls are continuous.

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C	NC	N/A	U	
☑	☐	☐	☐	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4) **Comments:**
☑	☐	☐	☐	MASS: There is no change in effective mass of more than 50% from one story to the next. Light roofs, penthouses, and mezzanines need not be considered. (Commentary: Sec. A.2.2.6. Tier 2: Sec. 5.4.2.5) **Comments:**
☑	☐	☐	☐	TORSION: The estimated distance between the story center of mass and the story center of rigidity is less than 20% of the building width in either plan dimension. (Commentary: Sec. A.2.2.7. Tier 2: Sec. 5.4.2.6) **Comments:** See attached calculations for backup.

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

GEOLOGIC SITE HAZARD

C	NC	N/A	U	Description
☑	☐	☐	☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1) **Comments:**
☑	☐	☐	☐	SLOPE FAILURE: The building site is located away from potential earthquake-induced slope failures or rockfalls so that it is unaffected by such failures or is capable of accommodating any predicted movements without failure. (Commentary: Sec. A.6.1.2. Tier 2: 5.4.3.1) **Comments:**
☑	☐	☐	☐	SURFACE FAULT RUPTURE: Surface fault rupture and surface displacement at the building site are not anticipated. (Commentary: Sec. A.6.1.3. Tier 2: 5.4.3.1) **Comments:**

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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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

FOUNDATION CONFIGURATION

C	NC	N/A	U	Description
●	○	○	○	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:** 0.6Sa = 0.6(1.15) = 0.69 24 ft / 25 ft = 0.96 (Academic building subject to E-W shaking) OK
●	○	○	○	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:** Grade beams are provided and site is designated as Class B. Note that grade beams may be nonductile (frequently they do not include closed ties at wall ends).

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Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

C	NC	N/A	U	Description
☐	☑	☐	☐	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) **Comments:** Columns are not provided at stairs.
☑	☐	☐	☐	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:** Academic Building has 2 walls in each direction. Administration Building has more than 2 wall in each direction.
☑	☐	☐	☐	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) Academic Building: Area / wall area = 5569 sq ft / 35 sq ft = 159 Administration Building: Area / wall area = 10,719 / 108 = 99 **Comments:** Therefore, we perform this check for the Academic Building. 1st story wall stress: 470 psi (N/S) or 485 psi (E/W) with Ms = 3.75 factor. 125 psi (N/S) or 129 psi (E/W) with Ms = 3.75 factor. This is equivalent to D/C of ~1.0 in each direction with Ms = 3.75 factor.
☑	☐	☐	☐	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) **Comments:** Typical 8" walls have #4 @ 16" each face. rho horizontal = rho vertical = 0.003125

Connections

C	NC	N/A	U	Description
☐	☐	☑	☐	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) **Comments:** No flexible diaphragms.
☐	☑	☐	☐	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) Academic Building, 2nd Floor: slab has #4 @ 12" T&B. Vn = Avfyμ = 2(0.2)(40)(1) = 16 kips/ft **Comments:** Approximately 54 ft of slab connect N/S walls to diaphragm, so 864 kips can be transferred to wall. Story shear at Level 2 is 1525 kips. Beams are not designed and detailed to provide the required collector capacity.

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Collapse Prevention Structural Checklist For Building Type C2-C2A

C	NC	N/A	U	
●	○	○	○	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) **Comments:** Dowel size matches typical wall reinforcement.

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	
○	●	○	○	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) **Comments:** Columns: worst columns are shear critical. Typical columns are flexure-shear governed. All columns lack closed ties. Ties are spaced at d/1 (12") in worst direction and d/2 in strong direction. Beams: most beams are flexure-shear governed. All beams lack closed ties. Ties are typically spaced at d/1.5 (12").
C	NC	N/A	U	
○	○	●	○	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) **Comments:** No flat slabs.
C	NC	N/A	U	
○	○	●	○	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) **Comments:** Walls are generally not coupled and are support on continuous footings.

Diaphragms (Stiff Or Flexible)

				Description
C	NC	N/A	U	
●	○	○	○	DIAPHRAGM CONTINUITY: The diaphragms are not composed of split-level floors and do not have expansion joints. (Commentary: Sec. A.4.1.1. Tier 2: Sec. 5.6.1.1) **Comments:**
C	NC	N/A	U	
○	●	○	○	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) **Comments:** Approximately 25% of the North-South wall length at Level 2 in the Academic Building is open.

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Collapse Prevention Structural Checklist For Building Type C2-C2A

Flexible Diaphragms

	Description
C ☐ NC ☐ N/A ◉ U ☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** No flexible diaphragms.
C ☐ NC ☐ N/A ◉ U ☐	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2) **Comments:** No flexible diaphragms.
C ☐ NC ☐ N/A ◉ U ☐	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:** No flexible diaphragms.
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 aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:** No flexible diaphragms.
C ☐ NC ☐ N/A ◉ U ☐	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) **Comments:** No flexible diaphragms.

Connections

	Description
C ☐ NC ☐ N/A ◉ U ☐	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) **Comments:** No piles are used.

MAFFEI STRUCTURAL ENGINEERING

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

SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General				Reference
Building	Porter Academic			
Architect	Hugh Stubbins and Associates / Corlett and Spackman			
Structural Engineer	Clarence Rinne			
Location	405 Porter-Kresge Road, Santa Cruz, CA 95064			
Design date	1970			
Latitude	36.994116			(Google Earth)
Longitude	-122.06505			"
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		
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}	0.977	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 type	C2: Concrete shear walls with stiff diaphragms	(ASCE 41-17 Table 3-1)

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

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 C2	(ASCE 41-17 Table 4-6)
	~~17.19 Nonstructural Checklist~~ (not performed)	(ASCE 41-17 Table 4-6)

Seismic forces

V	2736	kip	$V = Cs_a W$	= 1.54W	(ASCE 41-17 Eq 4-1)
W	1773	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	1.29	g	$S_a = S_{x1}/T \le S_{XS}$		(ASCE 41-17 Eq 4-3)
T	0.22	sec	$T = C_t h_n^{\beta}$		(ASCE 41-17 Eq 4-4)
C_t	0.020				(ASCE 41-17 Eq 4-4)
β	0.75				(ASCE 41-17 Eq 4-4)
h_n	25	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	775		25	18988	0.62	1705	
2	998	13.0	12	11477	0.38	1031	1705
1		11.5	0				2736
Total	1773			30465	1.0	2736	
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	3360	5040	135	90	1.1	0.7
1	5232	5040	139	145	1.1	1.1
Total						
M_s	3.75			(ASCE 41-17 Table 4-8)		

v_{limit} 126 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)