Rating form completed by:

RUTHERFORD + CHEKENE
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Evaluator: EFA/CLP/WAL/BL
Date: 06/28/2019

Text in green is to be part of UCSC building database and may be part of UCOP database.

DATE: 2019-06-28

UC Santa Cruz Building Seismic Ratings

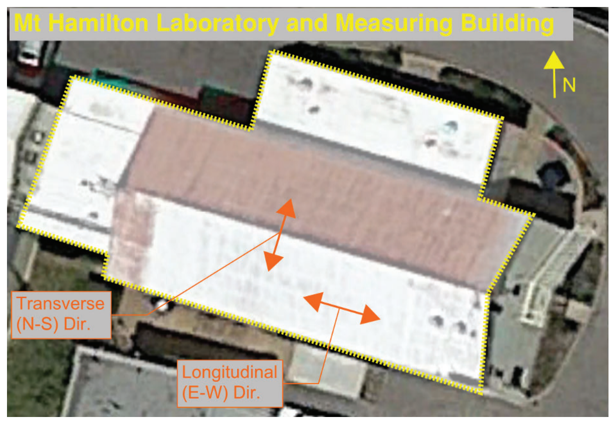
Mt Hamilton Laboratory and Measuring Building

CAAN #7279
29965 Mt Hamilton Road, San Jose, CA 95140

UCSC Campus: Mt Hamilton, Lick Observatory

North Elevation (Looking Southeast)

Plan



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1	ASCE 41-17[1]
Date of rating	2019	
Recommended list assignment (UC Santa Cruz category for retrofit)	Priority B	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating[2]	High ($200-$400/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	
Further evaluation recommended?	Yes	Focus on in-plane and out-of-plane supports for tilt-up panels, transfer from steel ledger to CIP walls, and shear transfer from walls to foundation.

[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 19 May 2017 *UC Seismic Safety Policy* and Method B of Section 321 of the 2016 *California Building Code*.

[2] Per Section III.A.4.i of the 26 March 2019 *UC Seismic Program Guidebook, Version 1.3*, 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 and structural drawings by Corlett and Spackman, Architects, "Laboratory and Measuring Building, University of California, Lick Observatory Mt. Hamilton, California," dated 18 March 1957, Sheets A1 to A6, and S2 to S5. (Original blueprints photographed at the site.)
- Unattributed drawings UCSC File 6600 Misc. C01, File 6600 Misc. P06, and File 6601-018_20021213_0001.

Additional building information known to exist

Drawings for Main Building #7240 were reviewed for details of connections between west one story wing of the Lab & Measuring Building and the Main Buildings, but no details were identified.

Scope for completing this form

Reviewed architectural and structural drawings for original construction, made a brief site visit on 11 June 2019, and carried out ASCE 41-17 Tier 1 evaluation.

Brief description of structure

The building is two stories tall with an attic and two one-story wings on the north side and west sides. The two-story portion is 37'-8" by 81'-8" in plan; the one-story wing to the north is 18'-0" by 49'-8" in plan; and the one-story wing to the south is 29'-10" by 24'-0" in plan. The low roof of the north wing is 11'-8", and the average height of the high roof is 25'. The building includes offices, storage, and some laboratory space. The building has a mix of materials including perimeter concrete tilt up panels at the one-story wing and the two-story longitudinal (east-west) walls, and concrete cast-in-place walls at some interior first story walls and at the transverse (north-south) gable end walls. The gravity framing includes steel columns, steel beams with metal deck and concrete fill at most of the second floor, and steel girders with wood joists and ½" plywood decking at both the high roof and the low roof of the one-story wing. A small area of the second floor has cast-in-place concrete slab above cast-in-place walls below creating a small concrete bunker area in the middle of the building on the south side. The second floor ceiling (attic) is all wood framed. Interior partition walls are all wood stud walls at the second floor but include a mix of partial height and full height cast-in-place concrete walls and wood stud walls at the first floor. From the original architectural plans, it appears the interior poured in place concrete walls and small bunker area were used to provide interior lab spaces for a dark room, optical lab, spectrographic lab, etc. One additional partial height cast-in-place interior wall runs north-south in the middle of the building, north of the bunker walls, and is 9'-7" tall and terminates below the steel beams above but includes embedded steel framing that ties this wall to the floor above and to the foundations. The interior walls in the bunker area are tied to the slab above. There is a mechanical room with tanks and equipment at the southeast corner of the second floor. Two of the ground floor lab areas are shown to have an "isolated slab" with 1" gaps to the surrounding slab on grade or footings.

Building condition: The building shows signs of exterior weathering and interior wear that are typical for buildings of this vintage. Some minor concrete cracking was observed at an exposed column in the attic space.

Identification of levels: The building has a ground floor, second floor, and undeveloped attic space. The roof of the two-story portion has a central ridge line running east-west. Grade is level around the perimeter of the building and paved with asphalt. The north and east edges of the paving are supported by retaining walls and grade drops down to the away to the north and to the east.

Foundation system: The building has individual spread footings for interior steel columns, concrete strip footings under all interior and exterior concrete walls and concrete "partition footings" under the original locations of the wood stud walls. The ground floor plan shows two floor areas labeled "isolated slab" #1 and #2 that are separated from the surrounding floor by a 1" gap. The isolated slab areas are 9" and 12" thick, the typical slab-on-grade is 5" with one layer of wire mesh.

Structural system for vertical (gravity) load: For both the high and low roof areas, a mix of steel girders and wood joists support ½" plywood sheathing. The original drawings show "metal roof" over the plywood at the high roof level. The roof steel girders span to steel columns or to built-up steel and concrete pilasters at the perimeter. Tilt-up panels along three bays at the second floor are supported on steel framing below at the interface between the one-story and two-story portions of the building. The second floor diaphragm is mostly framed with steel girders and beams spanning to steel columns, or built-up columns with concrete fill. The metal deck has 2” of concrete fill. A small area of the second floor has an 8” concrete slab tied to concrete walls below. The 8” slab reinforcing typically has two curtains of #4 bars, but one area has two closely spaced curtains of bottom bars and no top bars at midspan. Some of the columns are embedded in interior concrete walls at the ground floor. The roof framing includes wood ledgers attached to the concrete walls; the metal deck areas have steel ledgers. The building includes many wood stud partitions, but as there is also steel framing, it is not known if any of these are load bearing.

Structural system for lateral forces: Lateral loads are resisted by a mix of tilt-up and poured-in-place concrete walls in combination with steel framing that is anchored to the foundation. The wood roof diaphragms are flexible; the second floor diaphragm with concrete or metal deck and concrete fill is rigid. The second floor diaphragm level includes areas with concrete slab, metal deck and concrete fill, and plywood sheathing at the roof of the one story north and west wings. Loads from the flexible wood roof diaphragms are delivered to perimeter concrete shear walls by way of wood ledgers and limited connections from the steel columns to wall embeds. Loads from the metal deck and fill second floor diaphragm are delivered to interior cast-in-place walls with embedded steel columns and connections and to perimeter concrete walls via welded embeds in the tilt up sections. One section (Detail 6/S-3) shows apparent wood nailers from the steel framing to the poured-in-place concrete walls at the transverse ends. While the poured in place concrete walls clearly show dowels to the footings, the tilt-up details only show positive anchorage from the panels to the footings at a welded embed at each column location. For purposes of this Tier 1 review, the checklist for tilt-up concrete buildings has been used, but this is not strictly a conventional tilt-up building since there are cast-in-place (CIP) walls there are also used. The lateral system includes tilt-up and CIP walls in both directions, but it could also be categorized as a C2 with CIP walls in the N-S direction and primarily PC1 with tilt-up walls in the E-W direction. The small bunker area located on the south side at the ground floor is clearly anchored to the second floor and to the foundation, but in other areas, the connections are not as clear. While the wall shear stresses appear to be low using the Tier 1 Quick Check procedure for tilt-up concrete buildings, these walls have limited connections to the foundation except by way of the steel framing. The shear transfer from diaphragms to walls and from tilt-up walls, cast-in-place walls, and steel columns to the footings involves a combination of mechanisms that are difficult to quantify for a Tier 1 check.

Response in 1989 Loma Prieta Earthquake: Unknown.

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:

- As a result of the mix of materials and systems and the level of detail on the drawings, the lateral system and load path are not entirely clear, and the connections between the various components appear to have limited capacity. The building has been standing for over 60 years and exposed to high winds and distant earthquakes, so it has apparent capacity that is not identified by this Tier 1 check.
- Connections from the steel framing to the walls have limited capacity. The tilt-up panels appear to be connected for both in-plane and out-of-plane loading only by way of welded embeds at the steel columns; we do not find details for the ledger connections to the walls. There are limited positive connections at the steel columns shown in the original drawings from the tilt-up panels to the foundations.
- The steel columns are all anchored at the base, and some of the steel columns are embedded in the interior cast-in-place walls at the ground floor level. The second floor slab is tied in select locations to the cast-in-place walls below, either via dowels in the small bunker area or with steel stub sections along the one wall north-south wall that terminates below the second floor level. None of the steel connections are moment connections, but the steel framing helps tie the walls to the foundation. The drawings do not clearly show the condition from the steel ledgers at the second floor to the walls.
- The poured-in-place concrete walls are doweled to the foundation but have limited connections to the floor and roof diaphragms. Poured-in-place walls at the transverse ends do not appear to be tied to the steel framing inboard of the walls except by way of wood nailers anchored to the concrete walls. The one-story and two-story tilt-up panels along the longitudinal walls are connected to the diaphragms with welded embeds at the columns and the columns are anchored at the base.

- Three tilt-up panels on the north side of the second floor (Line 2) are supported on steel framing without a clear load path for shear or overturning.
- The one-story lobby wing to the west side is tied to the two-story wing and to the adjacent Main Building (#7240) without a gap. Lateral support for this wing in the north-south direction appears to be a "new wall" in the adjacent building, but we do not find details for this condition in the available drawings for Building 7240. This roof area could separate from the adjacent structure.
- Heavy mechanical equipment, tanks, and concrete housekeeping pads are located at the second floor and appeared to be anchored but not to current standards. It is not known if all the gas lines have flexible connections.

The building has been subjected to strong winds and several distant earthquakes during its 60-year life, but based on our review of the drawings and connection details, we would expect moderate to severe damage to the connections holding the tilt up panels in place for both in-plane and out-of-plane seismic loading. The building has steel beams and columns but no moment connections. The small concrete bunker area provides strength and stiffness at the first floor level but none above, so damage at the upper floor is likely to be more severe.

Structural deficiency	**Affects rating?**	**Structural deficiency**	**Affects rating?**
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	N	Openings at shear walls (concrete or masonry)	N
Load path	Y	Liquefaction	N
Adjacent buildings	Y	Slope failure	N
Weak story	N	Surface fault rupture	N
Soft story	N	Masonry or concrete wall anchorage at flexible diaphragm	Y
Geometry (vertical irregularities)	Y	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	Y
Diaphragm continuity	N		

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

Poorly anchored mechanical equipment is located at the second floor.

UCOP nonstructural checklist item	**Life safety hazard?**	**UCOP nonstructural 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

Basis of rating

The building is assigned a Seismic Performance Level rating of V. The mix of materials and systems has limited capacity and redundancy in the connections between wood, steel and concrete components.

[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 if and where nonstructural hazards may occur.

Recommendations for further evaluation or retrofit

Recommend further field investigation and evaluation to clearly identify load path and capacity of connections between diaphragms and walls, and walls to foundations. Identify in-plane and out-of-plane capacity of supports for tilt-up walls, including second story wall panels supported outboard of steel framing at the second floor.

Peer review of rating

This seismic evaluation was discussed in a peer review meeting on 24 June 2019. Reviewers present were Joe Maffei of Maffei Structural Engineering and Jay Yin of Degenkolb Engineers. Comments from the reviewers have been incorporated into this report. The reviewers agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	37.341725	
Longitude	-121.640540	
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	1, 2	1-story and 2-story portions
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	8,229	
Is the building on a sloping site?	N	Mountain top, but not sloping at this building
Risk Category per 2016 CBC Table 1604.5	II	
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	Estimated using ASCE 41-17 equation 4-4 and 7-18
Coefficient for period, β	0.75	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975-year hazard parameters S_s, S_1	2.236, 0.786	From SEAOC/OSHPD website
Site class	B	
Site class basis	Inferred	The Lick Observatory complex is built on a rocky outcropping at the top of Mt. Hamilton. Fractured rock is visible adjacent to the building.
Site parameters F_a, F_v	0.9, 0.8	From SEAOC/OSHPD website
Ground motion parameters S_{cs}, S_{c1}	1.7, 0.555	From SEAOC/OSHPD website
S_a at building period	1.7	
Site V_{s30}	3,750 ft/s	
V_{s30} basis	Estimated	Estimated based on site classification of B, using middle of 2,500-5,000 ft/s range.
Liquefaction potential	Low	
Liquefaction assessment basis	Inferred	Engineering judgment given the lack of surficial soils and mountaintop location.
Landslide potential	Low	
Landslide assessment basis	Inferred	Engineering judgment given the building site is relatively level.

Active fault rupture identified at site	No	
Fault rupture assessment basis	CGS Website	The Earthquake Zones of Required Investigation Lick Observatory Quadrangle has no Earthquake Fault Zones near Mt. Hamilton. The Mt. Hamilton area was "not evaluated for liquefaction or landslides." See http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/LICK_OBSERVATORY_EZRIM.pdf
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 1957 Code: 1955 UBC	Code date inferred from design date
Applicable code for partial retrofit	None	
Applicable code for full retrofit	None	No full retrofit
FEMA P-154 data		
Model building type – north-south	PC1 -Concrete Tilt-Up and C2 – Shear Wall	Mix of Tilt-up and CIP walls in both directions at first floor; second floor has Tilt-up E-W and CIP walls N-S; roof diaphragms flexible, rest of second floor rigid.
Model building type – east-west	PC1 -Concrete Tilt-Up and C2 – Shear Wall	Mix of Tilt-up and CIP walls in both directions at first floor; second floor has Tilt-up E-W and CIP walls N-S; roof diaphragms flexible, rest of second floor rigid.
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 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

Rating form completed by:

RUTHERFORD + CHEKENE
ruthchek.com

Evaluator: EFA/CLP/WAL/BL

Date: 06/28/2019

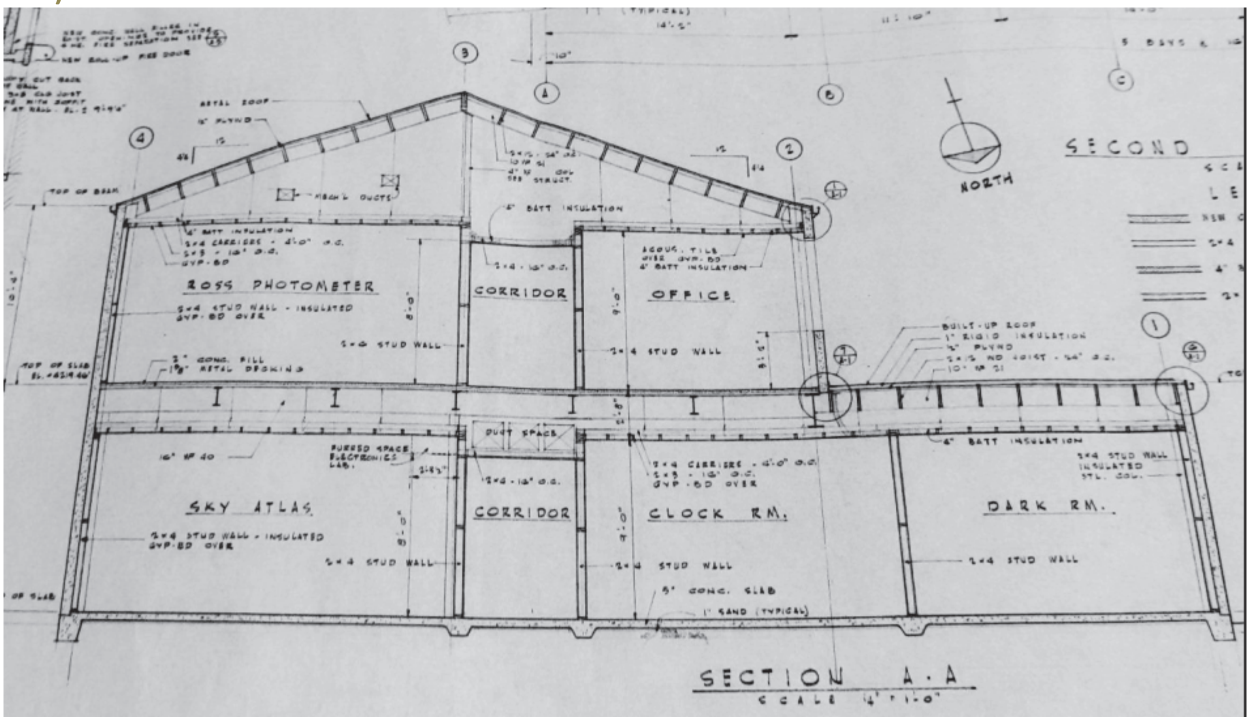
Color Coded First Floor and Foundation Plan S-1

[redacted]

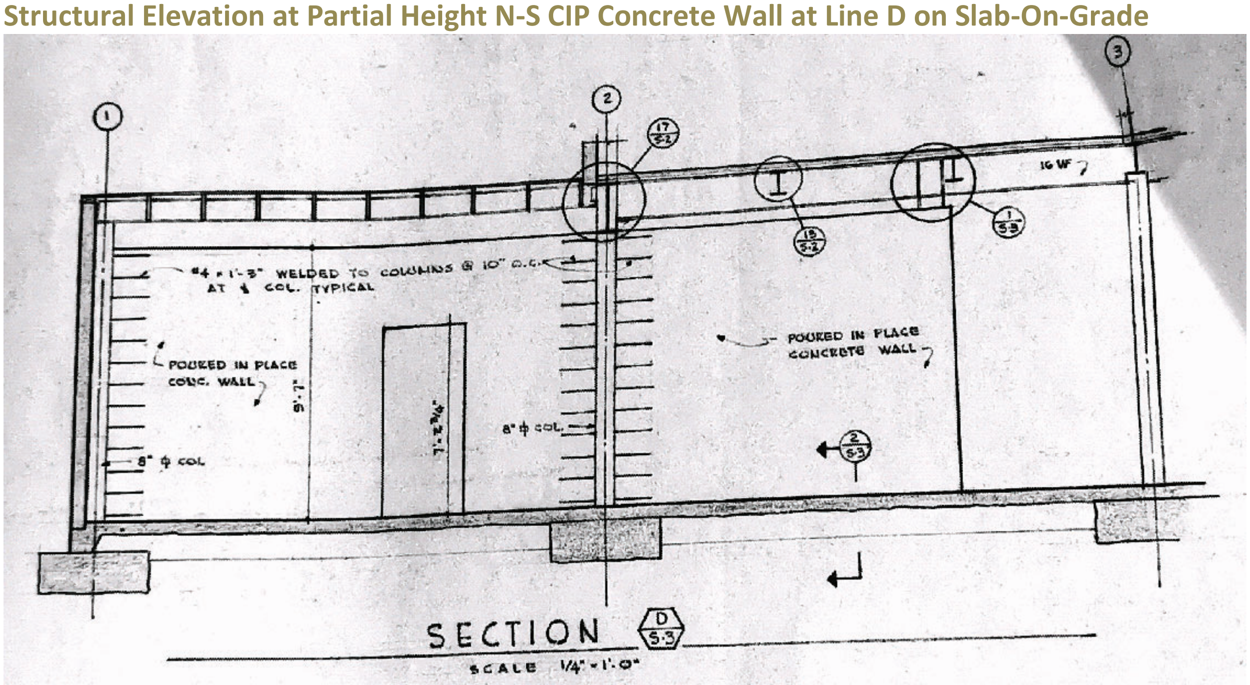
Second Floor and Roof Framing Plans S-1 (Green Tilt-up Concrete Walls, Blue Cast-in-Place Concrete Walls)

[redacted]

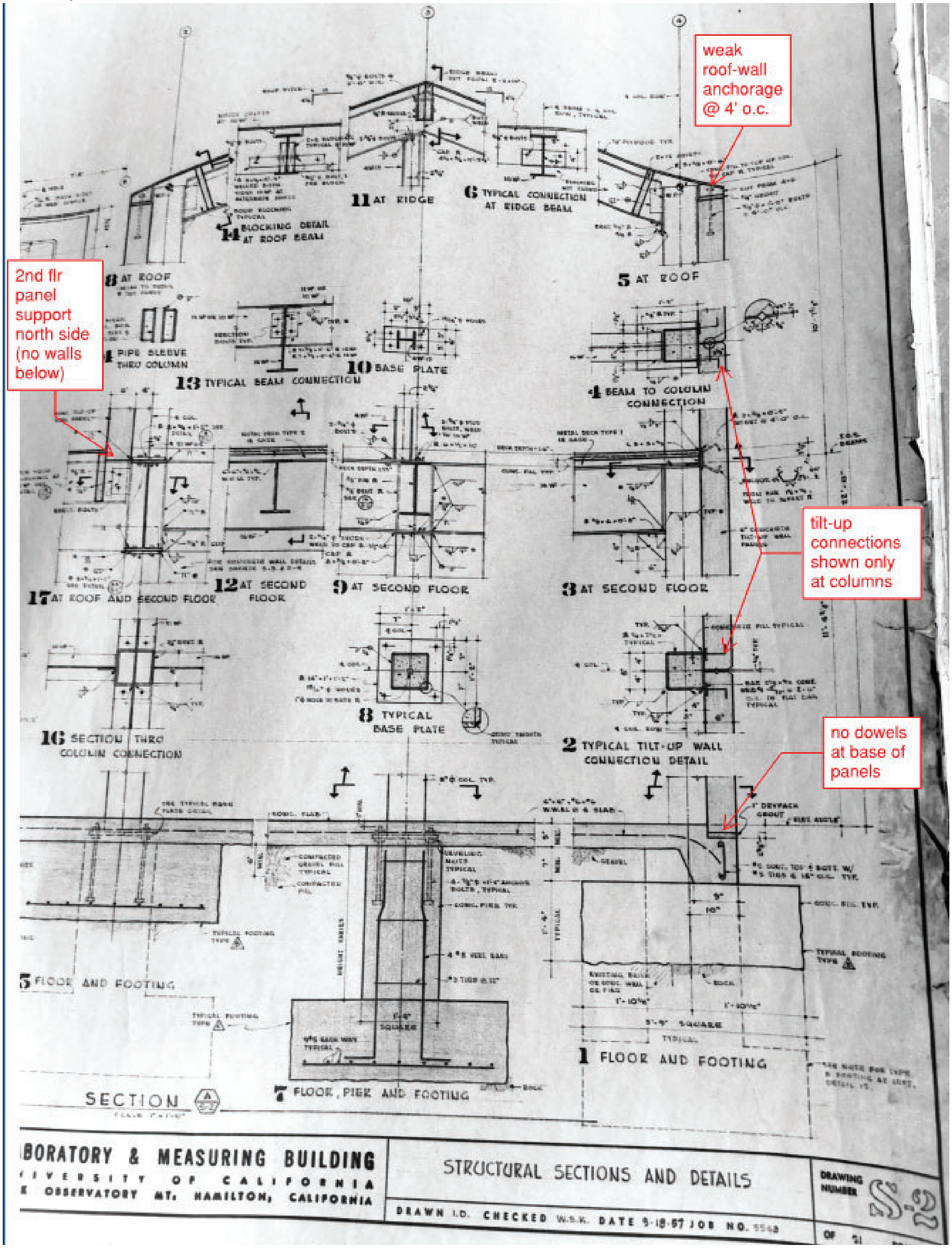
Architectural Section A-A/A-2 (Tilt-Up Panels at Line 2 Supported on Steel Framing. Plywood Roofs Above Second Floor and at Low Roof at Right, Metal Deck with Fill at Second Floor on Left)



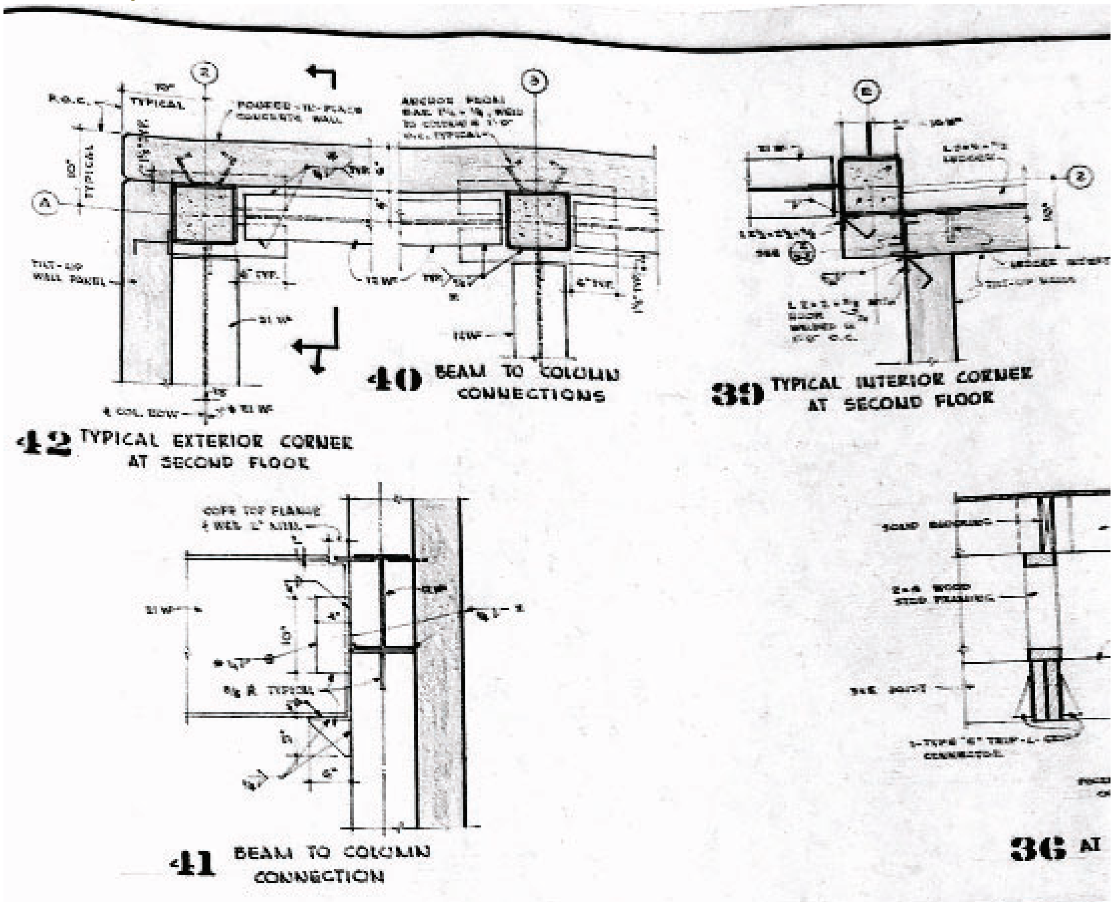
Structural Elevation at Partial Height N-S CIP Concrete Wall at Line D on Slab-On-Grade



Structural Section A/S-2 with Details (Weak In-Plane and Out-of-Plane Anchorage of Tilt-Up Panels)



Structural Details from Steel Column and Ledger to Tilt-up Panels (Panels Only Tied at Column Locations)



APPENDIX A

Additional Photos

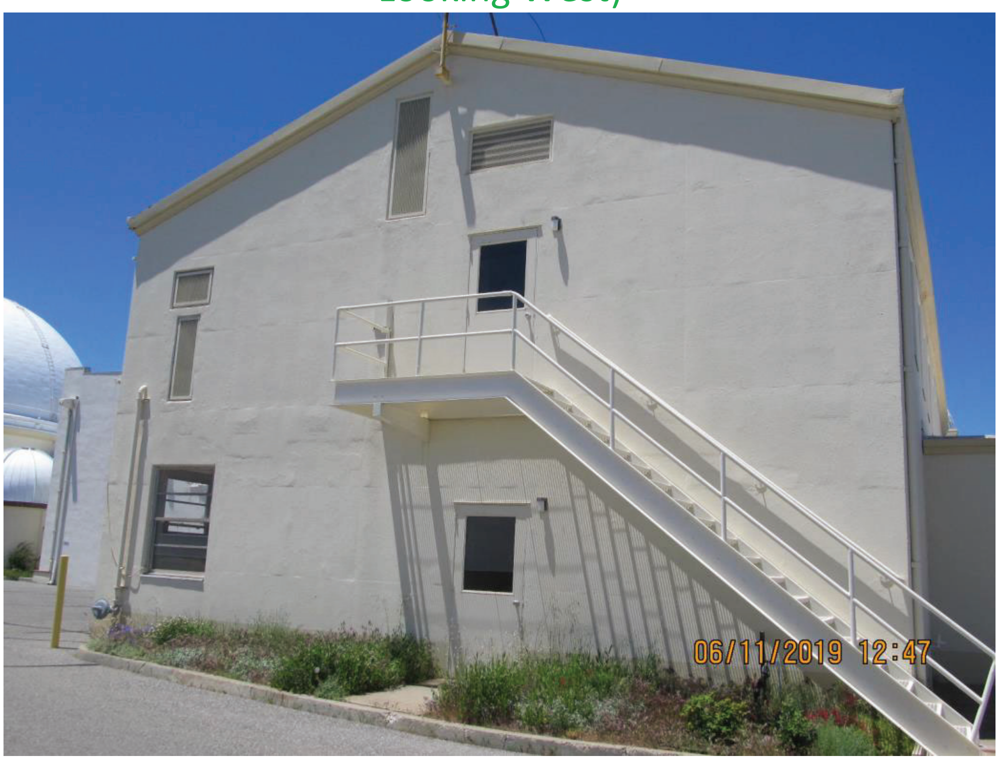
Northwest Corner (One-Story Portion at Left, Two-Story Portion at Right, Looking Southeast)

North Elevation of Canopy (Two-story Portion at Left, Canopy at Center, CAAN 7240 Provides Support at Right, Looking South)

North Elevation of One-Story Portion (Looking West)

Northeast Corner (Two-Story Portion at Left, One-Story Portion at Right, Looking South)

East Elevation (Two-Story Portion at Left, One-Story Portion at Right, Looking West)



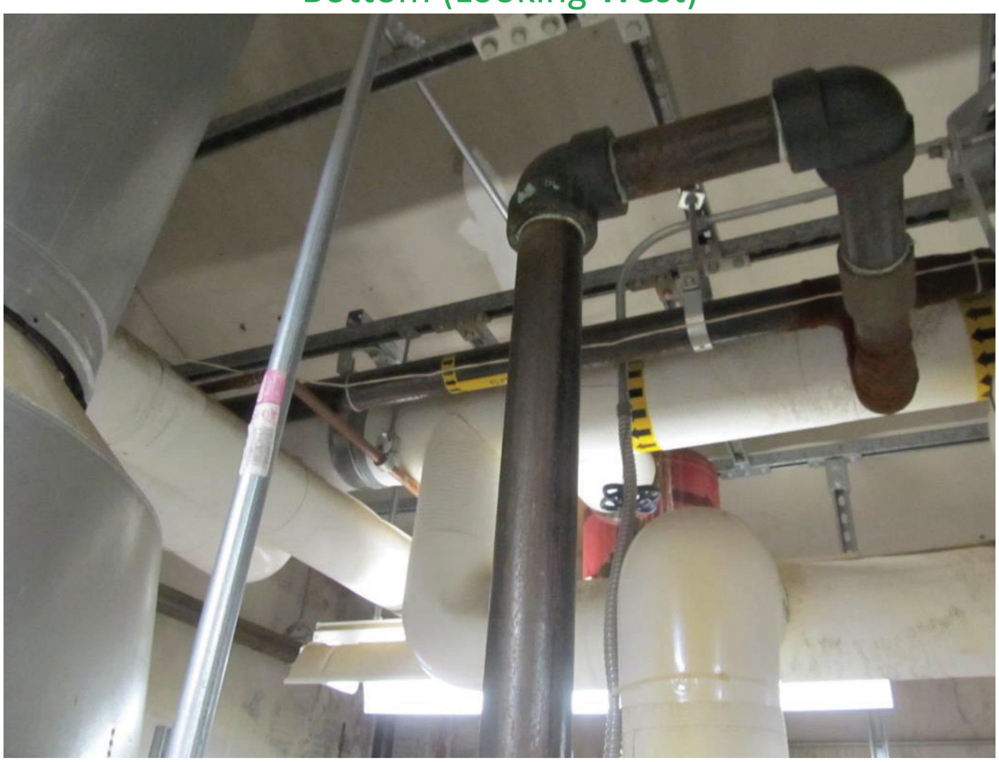
East Elevation (CIP Gable Wall, Looking West)

South Elevation at Right (Looking West)

Typical Interior Corridor

Steel Column Filled with Concrete Attached to Tilt-up Panel in the Attic

Attic Space Showing Wood Framing at Top and Ceiling Framing at Bottom (Looking West)



Braced Piping at Mechanical Room

Anchored Tank at Mechanical Room

Anchored Equipment at Mechanical Room

Anchored Pumps at Mechanical Room

Poorly Anchored Tank at Mechanical Room

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	Santa Cruz			Date:	06/28/2019	
Building CAAN:	7279	Auxiliary CAAN:		By Firm:	Rutherford + Chekene	
Building Name:	Mt Hamilton Laboratory & Measuring Building			Initials:	CLP, EFA	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Road, San Jose, 95140			Page:	1 of 3	

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

C / NC / N/A / U	Description
NC	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:** Tilt up panels not attached to foundation except via steel columns. Some interior concrete walls are not attached properly to beams above. There is no defined out-of-plane ties between the top of the tilt-up walls and the roof. There is only the edge of the plywood nailed to a sill.
NC	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:** Adjacent building provides support for roof at west end without a gap.
N/A	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:** There are no mezzanine levels.

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) **Comments:**. More lineal feet of walls at the ground floor.
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) **Comments:** More lineal feet of walls at the ground floor.
NC	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:** Three tilt-up panels on south side of the low roof are supported on steel framing; the panels do not continue down to the first floor.

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

UC Campus:	Santa Cruz			Date:	06/28/2019	
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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) **Comments:** Two one-story wings add more than 30% to plan dimensions.
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) **Comments:** Second floor heavier than light roof but need not be considered here.
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) **Comments:**. The wood framed high roof and both low roofs are flexible so not considered here. The center of rigidity and center of mass of second floor slab appears to be within 20%.

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

GEOLOGIC SITE HAZARD

C NC N/A U	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) **Comments:** Site is rocky and on top of a mountain. Liquefaction potential is judged by inspection to be negligible.
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) **Comments:**. Engineering judgment given the building site is relatively level.
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) **Comments:** The Earthquake Zones of Required Investigation Lick Observatory Quadrangle map has no Earthquake Fault Zones near Mt. Hamilton. The Mt. Hamilton area was "not evaluated for liquefaction or landslides." See http://gmw.conservation.ca.gov/SHP/EZRIM/Maps/LICK_OBSERVATORY_EZRIM.pdf

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

UC Campus:	Santa Cruz			Date:	06/28/2019		
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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

C NC N/A U	Description
C ◉ NC ○ N/A ○ U ○	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than 0.6S_a. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3) **Comments:** Transverse Frame width B = 36', Building Height is H = 25', B/H = 1.44 Sa = 1.7g per ATC at BSE-2E 0.6 x Sa = 1.02 B/H > 0.6 Sa
C ◉ NC ○ N/A ○ U ○	TIES BETWEEN FOUNDATION ELEMENTS: The foundation has ties adequate to resist seismic forces where footings, piles, and piers are not restrained by beams, slabs, or soils classified as Site Class A, B, or C. (Commentary: Sec. A.6.2.2. Tier 2: Sec. 5.4.3.4) **Comments:** Except for two "isolated slab" areas with surrounding gaps, all foundation elements tied together by the slab on grade which is integrally poured with the continuous strip footings.

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Building Address:	29965 Mt Hamilton Road, San Jose, 95140			Page:	1	of 4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type PC1-PC1A

LOW SEISMICITY

CONNECTIONS

	Description
C NC N/A U ○ ◉ ○ ○	WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm 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:** Gable walls and one-story tilt-up walls are not properly attached to the roof and have only the roof plywood nailed to a sill on top of panel. There is no defined out-of-plane tie. Cross-grain bending will occur in the connection for out of plane forces.

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

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C NC N/A U ◉ ○ ○ ○	REDUNDANCY: The number of lines of shear walls in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.2.1.1. Tier 2: Sec. 5.5.1.1) **Comments:** There are two lines of walls in each direction at the second floor level. The ground floor has five lines of CIP walls and two lines of tilt-up walls in the transverse direction and two CIP walls and three lines of tilt-up walls in the longitudinal direction.
C NC N/A U ○ ◉ ○ ○	WALL SHEAR STRESS CHECK: The shear stress in the precast panels, 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.3.2.3.1. Tier 2: Sec. 5.5.3.1.1) **Comments:** Maximum shear stress computed in walls using Quick Check procedure is 10 psi at second story and 40 psi at ground story < 109 psi. But the tilt-up walls are only attached to the foundation at the steel columns at each end.
C NC N/A U ◉ ○ ○ ○	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.3.2.3.2. Tier 2: Sec. 5.5.3.1.3) **Comments:** #4@12 EW for 6" tilt-up panels (0.0028) #4@10" EW for 8" CIP end walls (0.0025); ok.

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Building CAAN:	7279	Auxiliary CAAN:		By Firm:	Rutherford + Chekene		
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Building Address:	29965 Mt Hamilton Road, San Jose, 95140			Page:	2	of	4

ASCE 41-17
Collapse Prevention Structural Checklist For Building Type PC1-PC1A

C NC N/A U	
(•) C ( ) NC ( ) N/A ( ) U	WALL THICKNESS: Thicknesses of bearing walls are not less than 1/40 the unsupported height or length, whichever is shorter, nor less than 4 in. (101 mm) (Commentary: Sec. A.3.2.3.5. Tier 2: Sec. 5.5.3.1.2) **Comments:** h=11.34ft L/40=3.4in walls thickness is 6in, ok.

DIAPHRAGMS

	Description
C NC N/A U ( ) C ( ) NC (•) N/A ( ) U	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) **Comments:** No precast diaphragm or topping slab.

CONNECTIONS

	Description
C NC N/A U ( ) C (•) NC ( ) N/A ( ) U	WOOD LEDGERS: The connection between the wall panels and the diaphragm does not induce cross-grain bending or tension in the wood ledgers. (Commentary: Sec. A.5.1.2. Tier 2: Sec. 5.7.1.3) **Comments:** Connection at wood diaphragms includes cross-grain bending at one story roofs and canopy roof.
C NC N/A U ( ) C (•) NC ( ) N/A ( ) U	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) **Comments:** Perimeter walls are connected at the steel column locations but no ledger connection to tilt-up panels between columns
C NC N/A U ( ) 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) **Comments:** No precast diaphragm or topping slab.
C NC N/A U (•) C ( ) NC ( ) N/A ( ) U	GIRDER–COLUMN CONNECTION: There is a positive connection using plates, connection hardware, or straps between the girder and the column support. (Commentary: Sec. A.5.4.1. Tier 2: Sec. 5.7.4.1) **Comments:** Steel framing connected with bolted shear tabs, welded plates to nonstandard steel built-up columns some of which are filled with concrete.

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

UC Campus:	Santa Cruz		Date:	06/28/2019		
Building CAAN:	7279	Auxiliary CAAN:	By Firm:	Rutherford + Chekene		
Building Name:	Mt Hamilton, Laboratory and Measuring Building		Initials:	CLP, EFA	Checked:	WAL/BL
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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type PC1-PC1A

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
N/A (selected)	DEFLECTION COMPATIBILITY FOR RIGID DIAPHRAGMS: 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:** Second floor has rigid diaphragm. Secondary components below second floor include steel columns and flexible interior wood stud walls.
C (selected)	WALL OPENINGS: The total width of openings along any perimeter wall line constitutes less than 75% of the length of any perimeter wall when the wall piers have aspect ratios of less than 2-to-1. (Commentary: Sec. A.3.2.3.3. Tier 2: Sec. 5.5.3.3.1) **Comments:** The openings are about 50% and the piers are 1 to 1.

DIAPHRAGMS

C NC N/A U	Description
C (selected)	CROSS TIES IN FLEXIBLE DIAPHRAGMS: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** Steel framing is part of wood diaphragms and functions as cross ties at the roof.
N/A (selected)	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:** Roofs have plywood sheathing.
C (selected)	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:** Roofs have plywood sheathing
N/A (selected)	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:** Roofs have plywood sheathing; blocking at 8'.

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

UC Campus:	Santa Cruz			Date:	06/28/2019		
Building CAAN:	7279	Auxiliary CAAN:		By Firm:	Rutherford + Chekene		
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Collapse Prevention Structural Checklist For Building Type PC1-PC1A

C NC N/A U	
(●) 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:** All diaphragms are plywood, metal deck with concrete fill, concrete slab.

CONNECTIONS

	Description
(●) C ( ) NC ( ) N/A ( ) U	MINIMUM NUMBER OF WALL ANCHORS PER PANEL: There are at least two anchors connecting each precast wall panel to the diaphragm elements. (Commentary: Sec. A.5.1.3. Tier 2: Sec. 5.7.1.4) **Comments:** Tilt-up wall panels connected to steel columns at each end.
(●) C ( ) NC ( ) N/A ( ) U	PRECAST WALL PANELS: Precast wall panels are connected to the foundation. (Commentary: Sec. A.5.3.6. Tier 2: Sec. 5.7.3.4) **Comments:** Limited capacity, but one anchor at column at each end.
( ) 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.
(●) C ( ) NC ( ) N/A ( ) U	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. 5.7.4.2) **Comments:** Girders have 2 anchor bolts.

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	Santa Cruz		Date:	06/28/2019	
Building CAAN:	7279	Auxiliary CAAN:	By Firm:	Rutherford + Chekene	
Building Name:	Mt Hamilton Laboratory and Measuring Building		Initials:	CLP, EFA	Checked: WAL/BL
Building Address:	29965 Mt Hamilton Road, San Jose, 95140		Page:	1	of 1

UCOP SEISMIC SAFETY POLICY
Falling Hazard Assessment Summary

	Description
P ☐ N/A ☒	**Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)** **Comments:** There are no heavy ceilings, features, or ornamentation.
P ☐ N/A ☒	**Heavy masonry or stone veneer above exit ways or public access areas** **Comments:** There is no masonry or stone veneer.
P ☐ N/A ☒	**Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas** **Comments:**. There are no masonry parapets, cornices or other ornamentation
P ☐ N/A ☒	**Unrestrained hazardous material storage** **Comments:** None observed.
P ☐ N/A ☒	**Masonry chimneys** **Comments:** There are no masonry chimneys.
P ☒ N/A ☐	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:** Some equipment at second floor poorly anchored and not known if all had flex connections.
P ☒ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**

Falling Hazards Risk: Low

Note: P= Present, N/A = Not Applicable

APPENDIX D

Quick Check Calculations

Rating form completed by:

RUTHERFORD + CHEKENE
ruthchek.com

Evaluator: CLP/EFA

Date: 06/28/2019

Unit Weights:

Building 7279

	Seismic Wei	Dead Load	
	psf		Remarks
Sloping			
metal roofing	4.5		
1/2" plywood	1.5	1.5	at 36 pcf
membrane	1.0	1.0	
rafters	3.5	3.5	2x12 @ 24" o.c. plus steel
MEP+misc+lighting	2.0	2.0	sprinklers, lighting, projectors etc.
ceiling	2.0	2.0	typ. gypboard ceiling panels
subtotal on slope	14.5	10.0	scale this by 1.07 to account for
partition including shear walls	33.9	0.0	see below
Total weight per unit area	48.4	10.0	psf
Projected area under sloping r	3076.5		ft^2
Total Seismic weight at r	152047.7		lbs
	49.42		equivalent psf

	Seismic Wei	Dead Load	
2nd floor	psf		Remarks
metal deck and 2" HR fill	60.0	60.0	
steel framing	5.0	5.0	
ceiling	2.0	2.0	typ. gypboard ceiling panels
MEP+misc+lighting	3.0	3.0	sprinklers, lighting, radiators, projectors etc.
partition including shear walls	58.1		see below
Total weight per unit area conc	128.1		
total weight per unit area wood	73.1		say 15psf for low roofs
low roof plywood area	1610.0		ft^1
Floor area	3076.5		ft^2
Total Seismic weight at 2	511583.4		lbs
	109.2		equiv psf

estimate partition/wall w	ft		Remarks
lineal feet exterior concrete tilt	163.3	5.2	
weight ext tilt-up walls		56.3	6" at 75psf 25% windows
lineal feet CIP	75.3	5.2	8" at 100psf
		100.0	8" at 100psf few windows
lineal feet interior wall at 2nd flo	353.4	5.2	height avg trib to roof
		10.0	2x4 @ 16 plus plus insulation +misc+ 2 layers 5/8 gyp
Area at roof		3076.5	ft^2
total ext plus int above 2nd flo	516.7		
Weight, roof		104315.7	lbs
Weight per unit area at roof		33.9	psf actual trib to roof

estimate partition/wall w	ft		Remarks
lineal feet exterior concrete tilt	163.3	11.0	
	36.0	5.5	
weight ext tilt-up walls		56.3	6" at 75psf 25% windows
lineal feet CIP	75.3	11.0	8" at 100psf
	100.0	5.5	
		100.0	8" at 100psf few windows
lineal feet interior wall at 2nd flo	200.0	11.0	height avg trib to roof
		10.0	2x4 @ 16 plus plus insulation +misc+ 2 layers 5/8 gyp
Area at 2nd		4686.5	ft^2
total ext plus int above 2nd flo	363.3		
Weight, roof		272078.1	lbs
Weight per unit area at roof		58.1	psf actual trib to 2nd

Approximate calcs

$A_{roof} := 3077 ft^2$ $\quad$ $A_{2nd} := 4687 ft^2$

Assume

$w_{roof} := 49.4 psf$ $\quad$ $w_{roof} = 241.192 \frac{kgf}{m^2}$ $\quad$ $w_{2nd} := 109.4 psf$ $\quad$ $w_{2nd} = 534.1 \frac{kgf}{m^2}$

$W_{roof} := A_{roof} \cdot w_{roof} = 152.004 \cdot kip$

$W_{2nd} := A_{2nd} \cdot w_{2nd} = 512.758 \cdot kip$

Building weight

$Total := W_{roof} + W_{2nd} = 664.762 \cdot kip$

Story Weights

This is the summary of the story weight obtained from calculations

Wroof=152kip

W2nd=513kip

Wtotal-665kip

Period

Period is calculated using Mathcad and is attached with the Mathcad calculations below

Rating form completed by:

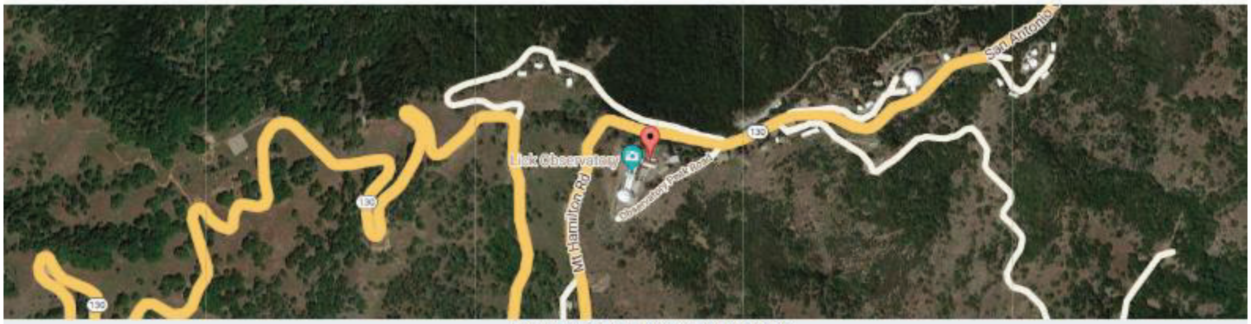
RUTHERFORD + CHEKENE
ruthchek.com

Evaluator: CLP/EFA

Date: 06/28/2019

BSE-2E Response Spectrum

OSHPD Seismic Design Maps   Home   About   Report an Issue   Contact



Lat: 37.34165600, Lng: -121.64253200

Search for Address or Coordinates

Reference: ASCE 41-17 | Custom Probability: for eg. 0.10 | Site Class: B - Rock

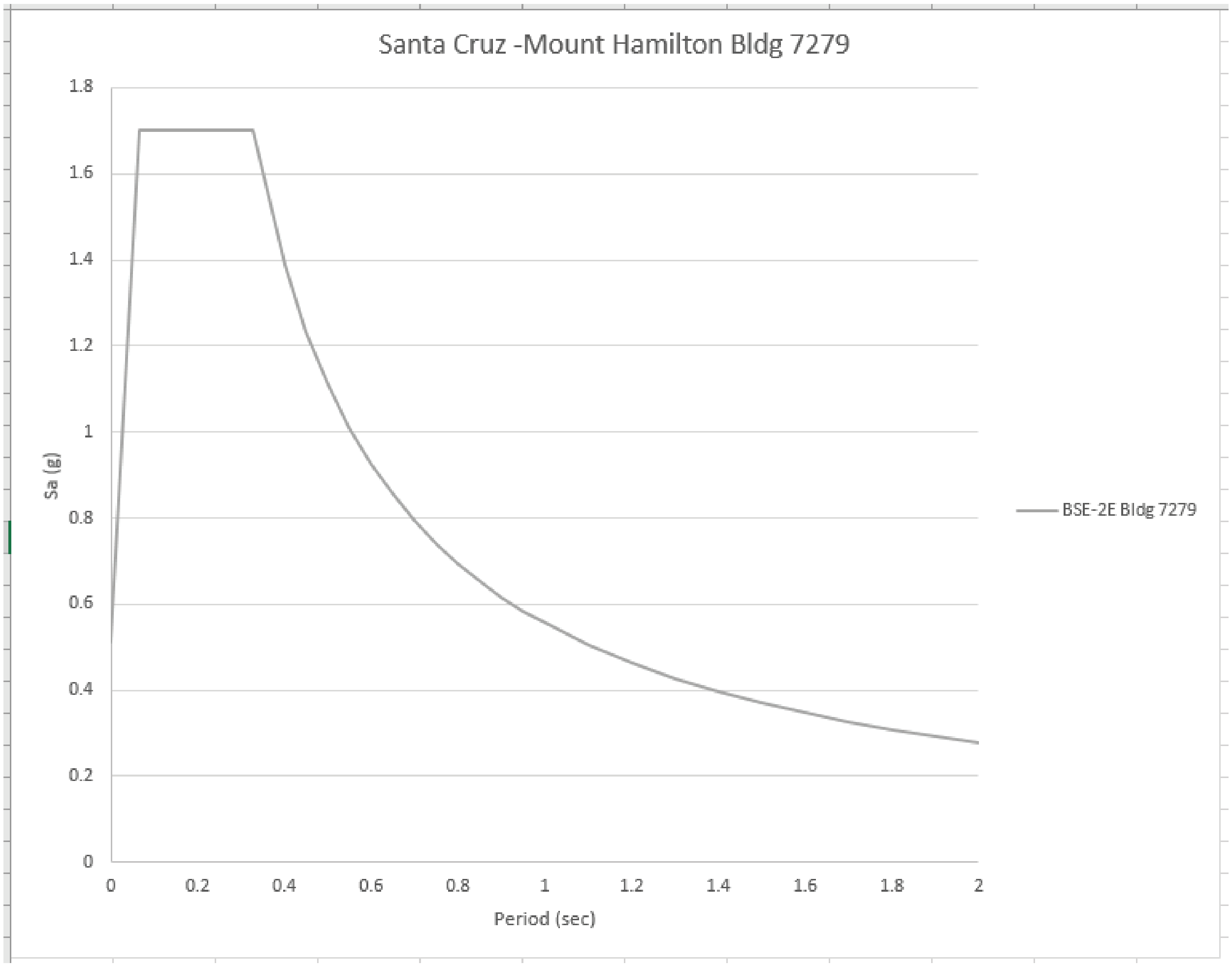
Project Title (optional) | Address | Coords | 37.341656 | -121.642532 | Go

Latitude, Longitude: 37.341656, -121.642532

Print

Date	6/27/2019, 1:31:26 PM
Design Code Reference Document	ASCE41-17
Custom Probability	
Site Class	B - Rock

Type	Description	Value
Hazard Level		BSE-2E
S_S	spectral response (0.2 s)	2.236
S_1	spectral response (1.0 s)	0.786
S_{XS}	site-modified spectral response (0.2 s)	1.7
S_{X1}	site-modified spectral response (1.0 s)	0.555
f_a	site amplification factor (0.2 s)	0.9
f_v	site amplification factor (1.0 s)	0.8


Santa Cruz -Mount Hamilton Bldg 7279
Sa (g)
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
Period (sec)
BSE-2E Bldg 7279

Calculations required for checklists were performed using the program Mathcad, and are attached in the following pages

Concrete Tilt Up Building Check

Shear stress in the wall check

Period Calculation

Calculation of total shear force

Calculation of Ratio of steel

Shear stress in wall

4.4.3.3 Shear Stress in Shear Walls. The average shear stress in shear walls, v_j^{avg}, shall be calculated in accordance with Eq. (4-8).

$$v_j^{avg} = \frac{1}{M_s}\left(\frac{V_j}{A_w}\right) \quad (4\text{-}8)$$

where

V_j = Story shear at level j computed in accordance with Section 4.4.2.2;

A_w = Summation of the horizontal cross-sectional area of all shear walls in the direction of loading. Openings shall be taken into consideration where computing A_w. For masonry walls, the net area shall be used. For wood-framed walls, the length shall be used rather than the area; and

M_s = System modification factor; M_s shall be taken from Table 4-8.

Table 4-8. M_s Factors for Shear Walls

Wall Type	Level of Performance CP[a]	LS[a]	IO[a]
Reinforced concrete, precast concrete, wood, reinforced masonry, and cold-formed steel	4.5	3.0	1.5
Unreinforced masonry	1.75	1.25	1.0

[a] CP = Collapse Prevention, LS = Life Safety, IO = Immediate Occupancy.

$M_S := 4.5$

Period calculation

4.4.2.4 Period. The fundamental period of a building, in the direction under consideration, shall be calculated in accordance with Eq. (4-4).

$$T = C_t h_n^{\beta} \qquad (4\text{-}4)$$

where

T = Fundamental period (s) in the direction under consideration;

C_t = 0.035 for moment-resisting frame systems of steel (Building Types S1 and S1a);

= 0.018 for moment-resisting frames of reinforced concrete (Building Type C1);

= 0.030 for eccentrically braced steel frames (Building Types S2 and S2a);

= 0.020 for all other framing systems;

h_n = Height (ft) above the base to the roof level;

β = 0.80 for moment-resisting frame systems of steel (Building Types S1 and S1a);

= 0.90 for moment-resisting frame systems of reinforced concrete (Building Type C1); and

= 0.75 for all other framing systems.

$C_t := 0.02 \qquad h_{tot} := 25 \frac{ft}{ft} \qquad \beta := 0.75$

$$T_1 := C_t \cdot h_{tot}^{\beta} = 0.224$$

$S_{x1} := 0.555$

$S_{a1} := \frac{S_{x1}}{T_1} = 2.482$ Larger than 1.7g use 1.7g

$S_a := 1.7$

Approximate calcs

$A_{roof} := 3077ft^2$ $A_{2nd} := 4687ft^2$

Assume

$w_{roof} := 49.4psf$ $w_{roof} = 241.192 \cdot \frac{kgf}{m^2}$ $w_{2nd} := 109.4psf$ $w_{2nd} = 534.1 \cdot \frac{kgf}{m^2}$

$W_{roof} := A_{roof} \cdot w_{roof} = 152.004 \cdot kip$

$W_{2nd} := A_{2nd} \cdot w_{2nd} = 512.758 \cdot kip$

Building weight

$Total := W_{roof} + W_{2nd} = 664.762 \cdot kip$

Table 4-7. Modification Factor, *C*

	Number of Stories			
Building Type[a]	**1**	**2**	**3**	**≥4**
Wood and cold-formed steel shear wall (W1, W1a, W2, CFS1) Moment frame (S1, S3, C1, PC2a)	1.3	1.1	1.0	1.0
Shear wall (S4, S5, C2, C3, PC1a, PC2, RM2, URMa) Braced frame (S2) Cold-formed steel strap-brace wall (CFS2)	1.4	1.2	1.1	1.0
Unreinforced masonry (URM) Flexible diaphragms (S1a, S2a, S5a, C2a, C3a, PC1, RM1)	1.0	1.0	1.0	1.0

[a] Defined in Table 3-1.

Calculation of total shear force

$C_{mod} := 1.2$

$w_1 := 253kip$ $w_2 := 69kip$

$W_{total} := w_1 + w_2 = 322 \cdot kip$

$V_{total} := C_{mod} \cdot S_a \cdot W_{total} = 657 \cdot kip$

$h_1 := 11.33ft$ $h_2 := 25ft$

4.4.2.2 Story Shear Forces. The pseudo seismic force calculated in accordance with Section 4.4.2.1 shall be distributed vertically in accordance with Eqs. (4-2a and 4-2b). For buildings six stories or fewer high, the value of k shall be permitted to be taken as 1.0.

$$F_x = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k} V \qquad (4\text{-}2a)$$

$$V_j = \sum_{x=j}^{n} F_x \qquad (4\text{-}2b)$$

where

V_j = Story shear at story level j;
n = Total number of stories above ground level;
j = Number of story levels under consideration;
W = Total seismic weight, per Section 4.4.2.1;
V = Pseudo seismic force from Eq. (4-1);
w_i = Portion of total building weight W located on or assigned to floor level i;
w_x = Portion of total building weight W located on or assigned to floor level x;
h_i = Height (ft) from the base to floor level i;
h_x = Height (ft) from the base to floor level x; and
k = 1.0 for $T \leq 0.5$ s and 2.0 for $T > 2.5$ s; linear interpolation shall be used for intermediate values of k.

For buildings with stiff or rigid diaphragms, the story shear forces shall be distributed to the lateral-force-resisting elements based on their relative rigidities. For buildings with flexible diaphragms (Types S1a, S2a, S5a, C2a, C3a, PC1, RM1, and URM), story shear shall be calculated separately for each line of lateral resistance.

$k_{0.5} := 1$ $\qquad$ $k_{2.5} := 2$

$k_{inter} := 1$ $\qquad$ no interpolation needed but kept nomenclature from previous sheet

$\left(\frac{h_1}{ft}\right)^{k_{inter}} = 11.33$ $\qquad$ $\left(\frac{h_2}{ft}\right)^{k_{inter}} = 25$

$$F_1 := \left[\frac{w_1 \cdot ft \cdot \left(\frac{h_1}{ft}\right)^{k_{inter}} \cdot V_{total}}{\left[w_1 \cdot ft \cdot \left(\frac{h_1}{ft}\right)^{k_{inter}} + w_2 \cdot ft \cdot \left(\frac{h_2}{ft}\right)^{k_{inter}} \right]} \right] = 410.093 \cdot kip$$

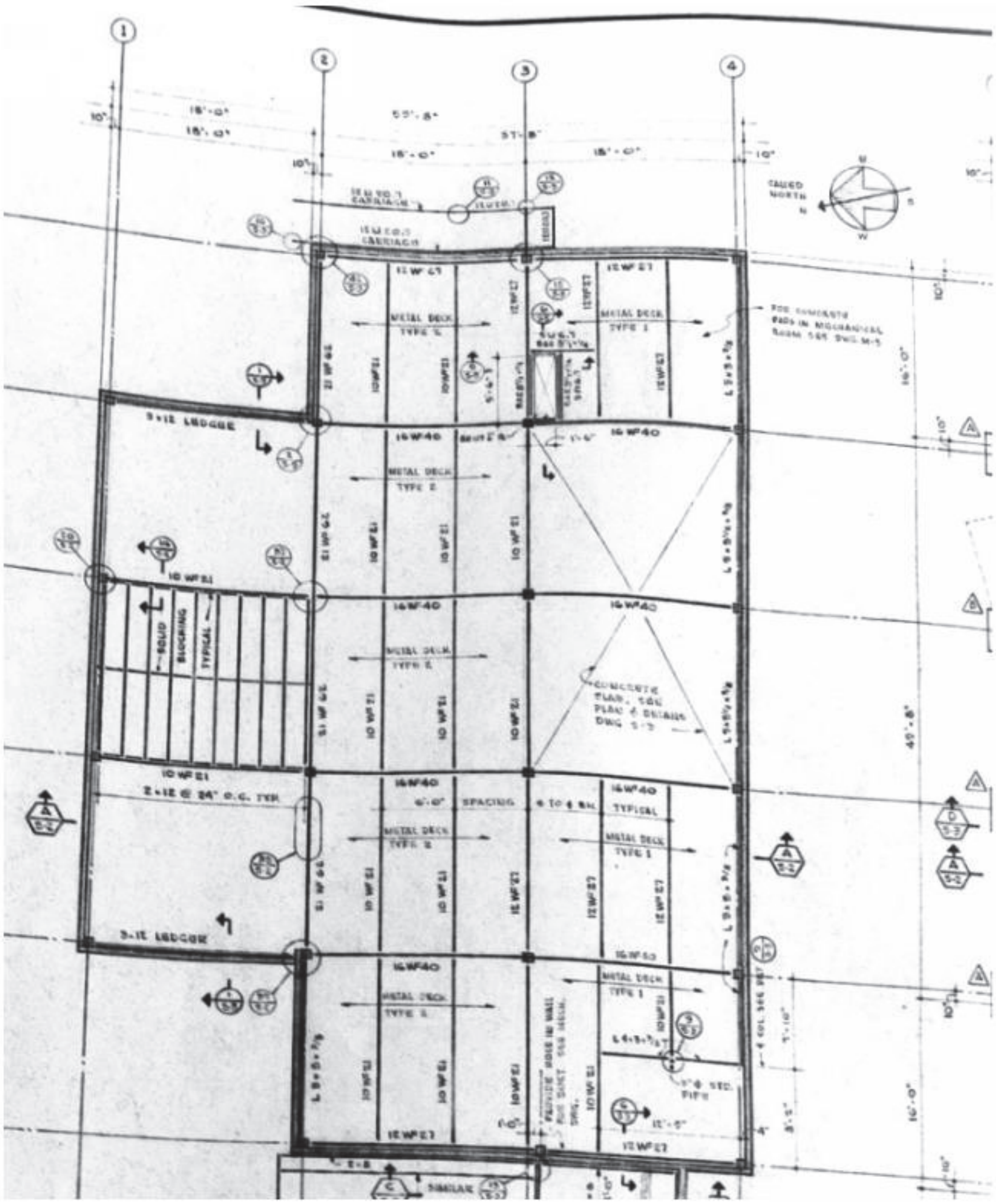
$$F_2 := \left[\frac{w_2 \cdot ft \cdot \left(\frac{h_2}{ft}\right)^{k_{inter}} \cdot V_{total}}{\left[w_1 \cdot ft \cdot \left(\frac{h_1}{ft}\right)^{k_{inter}} + w_2 \cdot ft \cdot \left(\frac{h_2}{ft}\right)^{k_{inter}} \right]} \right] = 246.787 \cdot kip$$

$V_{check} := F_1 + F_2 = 656.9 \cdot kip$ $\quad$ $V_{total} = 656.9 \cdot kip$

$V_1 := F_1 + F_2 = 657 \cdot kip$

$V_2 := F_2 = 247 \cdot kip$

Calculation of shear stress per wall



$A_{1and2} := 1488ft^2 - 1149ft^2 = 339 \cdot ft^2$ $\quad A_{tot} := 1488ft^2$

$A_{2and4} := 1149ft^2$

$V_1 = 656.88 \cdot kip$

$V_2 = 246.787 \cdot kip$

$$A_{trib1} := \frac{A_{1and2}}{2} = 169.5 \cdot ft^2$$

$$A_{trib2} := \frac{A_{1and2} + A_{2and4}}{2} = 744 \cdot ft^2$$

$$A_{trib4} := \frac{A_{2and4}}{2} = 574.5 \cdot ft^2$$

$$A_{tribA} := \frac{A_{2and4}}{2} = 574.5 \cdot ft^2$$

$$A_{tribF} := \frac{A_{2and4}}{2} = 574.5 \cdot ft^2$$

Forces for line 1,2 and 4

$$V_{L11st} := V_1 \cdot \left(\frac{A_{trib1}}{A_{tot}}\right) = 74.826 \cdot kip$$

$$V_{L21st} := V_1 \cdot \left(\frac{A_{trib2}}{A_{tot}}\right) = 328.44 \cdot kip$$

$$V_{L41st} := V_1 \cdot \left(\frac{A_{trib4}}{A_{tot}}\right) = 253.614 \cdot kip$$

Check $\quad V_{1stcheck} := V_{L11st} + V_{L21st} + V_{L41st} = 656.88 \cdot kip$ $\quad$ ok

$$V_{L22nd} := \frac{V_2}{2} = 123.393 \cdot kip$$

$$V_{L42nd} := \frac{V_2}{2} = 123.393 \cdot kip$$

Forces for line A and B

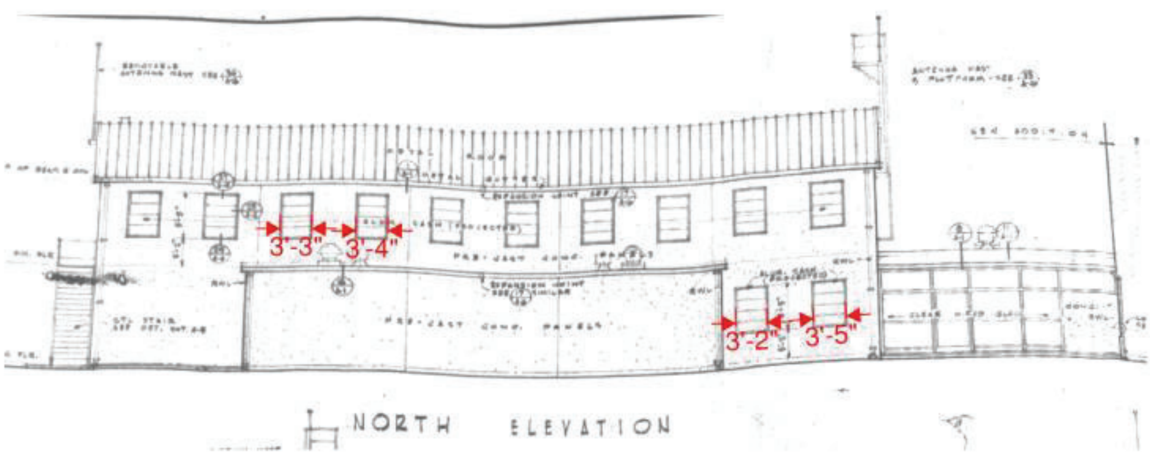
$$V_{LA1st} := V_1 \cdot \left(\frac{A_{tribA}}{A_{tot}}\right) = 253.614 \cdot kip$$

$$V_{LF1st} := V_1 \cdot \left(\frac{A_{tribF}}{A_{tot}}\right) = 253.614 \cdot kip$$

$$V_{LA2nd} := V_2 \cdot \left(\frac{A_{tribA}}{A_{tot}}\right) = 95.282 \cdot kip$$

$$V_{LF2nd} := V_2 \cdot \left(\frac{A_{tribF}}{A_{tot}}\right) = 95.282 \cdot kip$$

Line 2



Line L2

$$Length_{L22nd} := 80ft - 10 \cdot 3.25ft = 570 \cdot in$$

$$Length_{L21st} := 2 \cdot 16ft - 2 \cdot 3.25ft = 306 \cdot in$$

$$t_{wall} := 6in$$

$$Awall_{L22nd} := Length_{L22nd} \cdot t_{wall} = 3420 \cdot in^2$$

$$Awall_{L21st} := Length_{L21st} \cdot t_{wall} = 1836 \cdot in^2$$

$$S_{limit1} := 2\sqrt{3000}psi = 109.545 \cdot psi$$ or 100psi use 109psi

$$Swall_{L22nd} := \frac{V_{L22nd}}{M_s \cdot Awall_{L22nd}} = 8.018 \cdot psi$$ ok complies

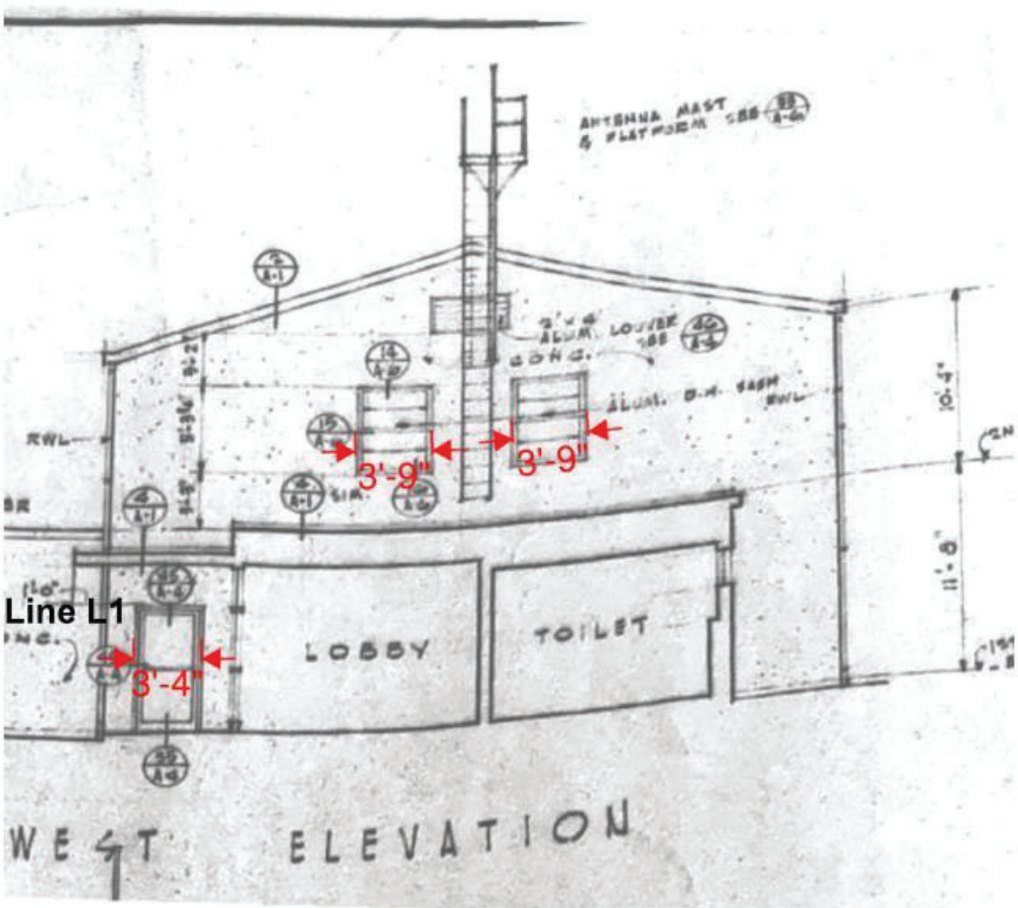
$$Swall_{L21st} := \frac{V_{L21st}}{M_s \cdot Awall_{L21st}} = 39.753 \cdot psi$$ ok complies

Line L4

Line 4 has the same area in the 2nd floor and a larger area than line 1 in the 1st floor

Ok it will comply

Line A



Line LA

$Length_{LA2nd} := 36ft - 2 \cdot 3.75ft = 342 \cdot in$

$Length_{LA1st} := 36ft - 2.8ft - 6ft - 2.5ft = 296.4 \cdot in$

$t_{wall} = 6 \cdot in$

$Awall_{LA2nd} := Length_{LA2nd} \cdot t_{wall} = 2052 \cdot in^2$

$Awall_{LA1st} := Length_{LA1st} \cdot t_{wall} = 1778 \cdot in^2$

$Swall_{LA2nd} := \frac{V_{LA2nd}}{M_s \cdot Awall_{LA2nd}} = 10.319 \cdot psi$ ok complies

$Swall_{LA1st} := \frac{V_{LA1st}}{M_s \cdot Awall_{LA1st}} = 31.691 \cdot psi$ ok complies

Line LF

Line F has more area and the same shears for both floors it will comply