Rating form completed by:

MAFFEI STRUCTURAL ENGINEERING
maffei-structure.com
Noelle Yuen, Joe Maffei

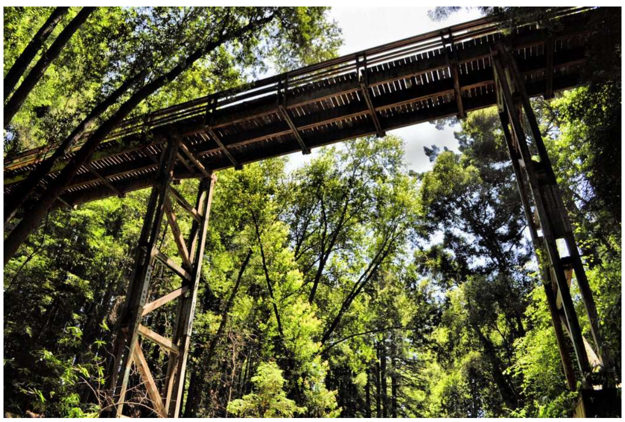
DATE: 2018-12-31

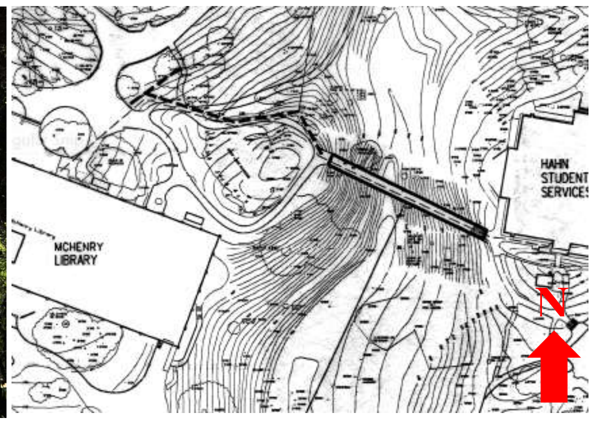
Text in green is to be part of UC Santa Cruz building database and may be part of UCOP database

UC Santa Cruz building seismic ratings

Hahn/McHenry Library Pedestrian Bridge

CAAN #7689A
(Pedestrian bridge between McHenry Library and Hahn Student Services) Santa Cruz, CA 95064
UCSC Campus: Main Campus





Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	Tier 1 Basic Checklist	ASCE 41-17[1]
Date of rating	2018	
Recommended list assignment (UC Santa Cruz category for retrofit)	Priority A	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application
Ballpark total construction cost to retrofit to IV rating[2]	Very High ($200 - $400/sf)	To be multiplied by 3000 sq. ft. See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	No previous rating reported
Further evaluation recommended?	Tier 3 Dynamic	

[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

- Original construction drawings by Stephan J. Medwadowski Consulting Structural Engineer, "Library Pedestrian Bridge," dated 1966-3-29 (2 sheets).
- "1999 Preliminary Seismic Evaluation" by Wildman and Morris Architects and Engineers, dated 1999-04-02.
- Letter from Stephen Ayraud, of UCSC Physical Planning and Construction, to Ellie Ross, Assistant Director of Code and Regulatory Affairs, UCOP, "Revised Seismic Ratings," dated 1999-10-19.
- Construction drawings for seismic retrofit and handrail renovation by Wildman and Morris Architects and Engineers, "McHenry/Hahn Bridge Seismic Corrections," dated 2003-12-18 (4 sheets).

Additional building information known to exist

- None

Scope for completing this form

We reviewed structural drawings for 1966 original construction and the 2003 Seismic Corrections. We completed the Tier 1 Basic checklist, but since there is no checklist for heavy-timber braced frames, we did not complete a checklist specific to the lateral-force-resisting system. We did preliminary calculations to assess the demand-to-capacity ratio of the brace and vertical members in the braced frames. We did not make a site visit. We did not evaluate non-structural life-safety hazards but UCSC staff indicates there are no non-structural items.

This structure is not on the spreadsheet provided by UCOP, but its CAAN number is identified in the 1999 report. From this report it appears that the CAAN number applies to at least two different bridges. We identify this Hahn/McHenry Bridge as CAAN 7689A, and the McLaughlin Bridge, which we have not reviewed, as 7689B.

Brief description of structure

The pedestrian bridge is a wood structure, 8 feet wide and 192 feet long, supported by heavy-timber braced frame piers. The canyon crossed by the bridge is approximately 50 feet deep below the bridge deck at the deepest point. The bridge was designed in 1966 by Stephan J. Medwadowski Consulting Structural Engineer.

In 1999, a seismic evaluation was conducted by Wildman Morris Architects and Engineers, and a seismic rating of "Poor" was assigned to the structure. A seismic strengthening was designed in 2003 by Wildman Morris, which included strengthening of the splice in the vertical legs of the braced frames, and adding new steel bracing under the bridge deck at each pier to provide a lateral-force-path between the bridge deck and the top of the pier for forces in the transverse direction.

<u>Structural system for vertical (gravity) load:</u> The bridge deck consists of 3" solid wood deck, supported by three 22-3/4"deep glulam beams, evenly spaced over the 8-foot width of the bridge and running the length of the bridge. The bridge is supported on seven vertical support piers, and splices in the glulam beams occur over each of the center three support piers. The seven piers that support the glulam beams are timber braced frames. The piers are spaced such that a pair of shorter-height piers is located close to each end of the bridge, with three taller piers evenly spaced along the remainder of the span. (See Figure.) The original construction drawings do not show the bridge abutments, and appear to show that the end spans cantilever 6' from the end piers without bearing on abutments at their ends. Piers are constructed to each have two vertical columns with 8x10 timber diagonal brace members. Each column is a built-up double 8x8 timber member.

<u>Structural system for lateral forces:</u> In the transverse direction the bridge deck, with straight 3x decking presumably with spaces between deck boards, is not detailed to provide floor diaphragm action. Nevertheless, the two nails per board per glulam provide some amount of de facto floor diaphragm action that, combined with the glulam beams spanning weak-way, can effectively distribute the transverse lateral forces from the inertial mass of the bridge to the bridge piers. The piers, varying in height from 6' to 50' tall, provide the lateral-force-resisting system for the bridge in the transverse direction. The braces and legs of the piers are secured to concrete pedestals at their base with anchor bolts. The seismic retrofit in 2003 provided strengthening at the splices in the vertical legs of the pier. The 2003 retrofit also and added steel V-bracing between girders at the top of the piers. The V-bracing acts like blocking (of like bridge girder diaphragms) to improve the lateral stability of the girders. It also improves the connection between the braces and the bridge deck.

In the longitudinal direction the lateral-force-resisting system is unclear. Timber buttresses retain soil and act as abutments at each of end of the bridge. We believe they are not connected to the bridge, and we have not inspected if there is space between these abutments and the end of the bridge. The 2003 seismic corrections replaced the transverse end timber of the bridge in the vicinity of the abutments.

In general the bridge piers do not have braces in the longitudinal direction, although there is a single diagonal 8x8 timber brace between the two end piers at each end of the bridge aligned with the center glulam girder. Assuming there is not a large gap at the ends, it is likely that the bridge will resist lateral forces in the longitudinal direction by bearing of the deck against the abutments. This may be an acceptable force path, and should be investigated further in the field for its adequacy.

Foundation System: The bridge is supported by seven heavy-timber braced frame piers of varying heights, with the tallest pier at the center of the bridge being approximately 50 feet tall. Each pier is supported on a concrete pedestal, rectangular-shaped in plan, bearing on a spread footing 15’ wide (perpendicular to length of bridge) x 4’-6” long (parallel to length of bridge), and founded on rock and embedded at least 4’ below grade.

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

Identified seismic deficiencies of the bridge include the following:

- The bridge does not appear to have a lateral-force-resisting system in the longitudinal direction, and the ability of the bridge to bear against the abutments for lateral seismic loads in its longitudinal direction is unclear from the drawings. The end members of the bridge that will bear against the abutment in an earthquake should be inspected in the field, and analyzed to determine if they have adequate strength.
- In the transverse direction, the piers have a high aspect ratio (maximum height of 50’ and width of 8’), thus leading to high overturning demands on the pier vertical legs and on the anchor bolts at the base of the tower. Preliminary calculations show that the capacity of the bridge for transverse lateral forces is controlled by the strength of these elements. Initial Tier 1 Quick Check calculations show that the demand-to-capacity ratio of the vertical members is approximately 1.0 in the 25’ high pier. The anchor bolts should be inspected in the field, and analyzed to determine if they have adequate strength. The vertical legs of the tower consist of 8x8 posts stitched together at 8’-10” o.c. with bolted connections; additional calculations are required to determine whether the posts are stitched together adequately, and the connections should be inspected in the field.
- As noted in the 1999 seismic evaluation, the splices of the bridge girders over the supports use 1” diameter bolts with 3” edge distance to connect the girders. The splice should be investigated for adequate strength, given the short edge distance.

Structural deficiency	Affects rating?	Structural deficiency	Affects rating?
Lateral system stress check (wall shear, column shear or flexure, or brace axial as applicable)	N	Openings at shear walls (concrete or masonry)	N
Load path	N	Liquefaction	N
Adjacent buildings	N	Slope failure	N
Weak story	N	Surface fault rupture	N
Soft story	N	Masonry or concrete wall anchorage at flexible diaphragm	N
Geometry (vertical irregularities)	N	URM wall height-to-thickness ratio	N
Torsion	N	URM parapets or cornices	N
Mass – vertical irregularity	N	URM chimney	N
Cripple walls	N	Heavy partitions braced by ceilings	N
Wood sills (bolting)	N	Appendages	N
Diaphragm continuity	N		

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

We assume there are no items that would cause non-structural life-safety concerns.

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 unknown conditions for longitudinal resistance, and the overturning of the tall piers for transverse resistance leads us to recommend a rating of V (Poor). We recommend that further study, such as a Tier 2 or Tier 3 analysis to confirm the rating. A linear analysis should be acceptable unless it is found that substantial yielding of elements is expected. The evaluation might show acceptably low risk to life safety to allow a rating of IV (Fair).

Recommendations for further evaluation or retrofit

We recommend that the University perform a more detailed seismic evaluation to determine whether retrofitting is required. Although the bridge was retrofitted in 2003, there were no calculations available to determine the criteria used for the retrofit, nor did the General Notes on the retrofit construction drawings indicate the criteria used for design. A linear dynamic analysis may be appropriate, including calculations to determine the adequacy of the heavy-timber braced frame vertical elements and their anchorage to the pedestal at their base. Applicable retrofit measures may include improving the anchor bolts of the braced frames for force or deformation capacity in the transverse direction, providing reliable bearing of the bridge at the abutments for lateral resistance in the longitudinal direction, strengthening the splice detail at the glulam girders, and providing additional bolts to stitch together the vertical 8x8 posts in the braced frames.

Additional building data	Entry	Notes
Latitude	36.996456	Coordinates are for midpoint between McHenry Library and UCSC Office of the Registrar
Longitude	-122.058089	Coordinates are for midpoint between McHenry Library and UCSC Office of the Registrar
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	1	Bridge is considered a one-story structure
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	3000 sq. ft.	(3000 sq. ft.) x (assembly occupancy factor) should give approximate equivalent occupancy. Actual area of roof bridge deck is smaller.
Risk Category per 2016 CBC Table 1604.5	II	

[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.

Estimated fundamental period	0.27 sec	See attached calculations
Building structural height, h_n	Varies	ASCE 41-17 equation 4-4 not used, see attached calculations
Coefficient for period, C_t	N/A	ASCE 41-17 equation 4-4 not used, see attached calculations
Coefficient for period, β	N/A	ASCE 41-17 equation 4-4 not used, see attached calculations
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: 1966 Code: 1964 UBC	Code inferred based on construction year
Applicable code for partial retrofit	Built: 2003 Code: 1999 UBC	Criteria of retrofit (partial or full) unknown
Applicable code for full retrofit	None	-
FEMA P-154 data		
Model building type North-South	-	Heavy timber braced frame
Model building type East-West	-	Heavy timber braced frame
FEMA P-154 score	N/A	Not included here, ASCE 41 Tier 1 evaluation performed.

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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.

Previous ratings		
Most recent rating	-	Design of seismic corrections by Wildman and Morris. No calculations or design criteria were found, nor was a design code indicated on the drawings.
Date of most recent rating	2003-12-18	
2nd most recent rating	Poor	
Date of 2nd most recent rating	1999-10-19	
3rd most recent rating	-	
Date of 3rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file

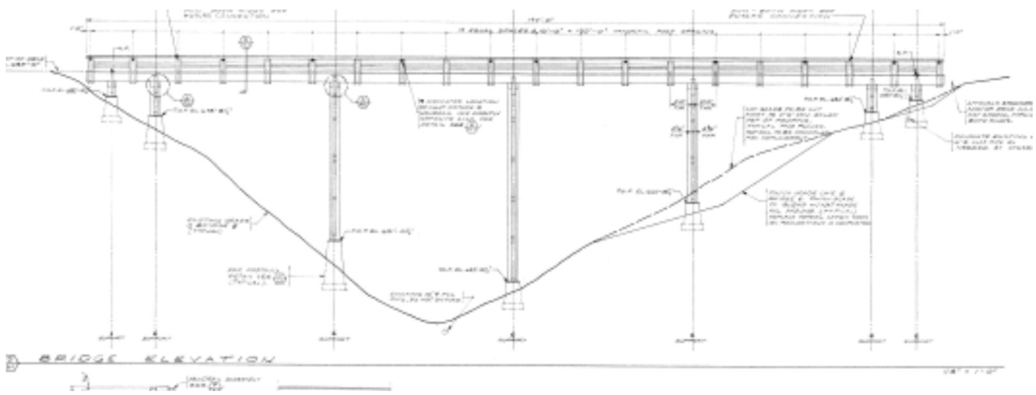

Figure: Bridge elevation

Figure: Elevation of bridge tower

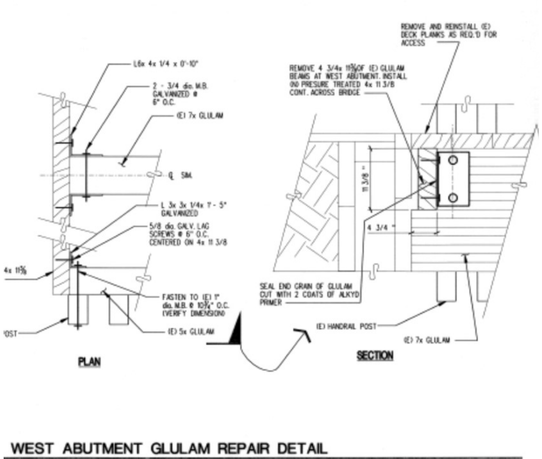

Figure: Detail at bridge abutment from seismic retrofit drawings

UC Campus:	University of California Santa Cruz			Date:	12/26/2018		
Building CAAN:	7689 (University to confirm)	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	McHenry/Hahn Bridge			Initials:	NY	Checked:	JRM
Building Address:	Footpath between Hahn Student Services and McHenry Library, Santa Cruz, CA 95064			Page:	1	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS – *GENERAL*

C NC N/A U	Description
C ● NC ○ N/A ○ U ○	LOAD PATH: The structure contains a complete, well-defined load path, including structural elements and connections, that serves to transfer the inertial forces associated with the mass of all elements of the building to the foundation. (Commentary: Sec. A.2.1.1. Tier 2: Sec. 5.4.1.1) **Comments: C** – bridge deck is supported by 7 braced-frame towers of varying height
C ● NC ○ N/A ○ U ○	ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building is greater than 0.25% of the height of the shorter building in low seismicity, 0.5% in moderate seismicity, and 1.5% in high seismicity. (Commentary: Sec. A.2.1.2. Tier 2: Sec. 5.4.1.2) **Comments: C** – no adjacent buildings
C ○ NC ○ N/A ● U ○	MEZZANINES: Interior mezzanine levels are braced independently from the main structure or are anchored to the seismic-force-resisting elements of the main structure. (Commentary: Sec. A.2.1.3. Tier 2: Sec. 5.4.1.3) **Comments: N/A –** no mezzanine level

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

C NC N/A U	Description
C ○ NC ○ N/A ● U ○	WEAK STORY: The sum of the shear strengths of the seismic-force-resisting system in any story in each direction is not less than 80% of the strength in the adjacent story above. (Commentary: Sec. A2.2.2. Tier 2: Sec. 5.4.2.1) **Comments: N/A –** consider bridge as one-story. The braced-frame support towers have braces of same size and length for full-height of tower, so shear strength is constant for height of towers.
C ○ NC ○ N/A ● U ○	SOFT STORY: The stiffness of the seismic-force-resisting system in any story is not less than 70% of the seismic-force-resisting system stiffness in an adjacent story above or less than 80% of the average seismic-force-resisting system stiffness of the three stories above. (Commentary: Sec. A.2.2.3. Tier 2: Sec. 5.4.2.2) **Comments: N/A –** consider bridge as one-story. The braced-frame support towers have braces of same size and length for full-height of tower, so stiffness is constant for height of towers.
C ● NC ○ N/A ○ U ○	VERTICAL IRREGULARITIES: All vertical elements in the seismic-force-resisting system are continuous to the foundation. (Commentary: Sec. A.2.2.4. Tier 2: Sec. 5.4.2.3) **Comments: C –** braces provide continuous force-path from bottom of bridge girders to top of foundation piers. Steel braces added in the seismic retrofit provided connection from top of bridge girders to braces.

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

UC Campus:	University of California Santa Cruz			Date:	12/26/2018		
Building CAAN:	7689 (University to confirm)	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	McHenry/Hahn Bridge			Initials:	NY	Checked:	JRM
Building Address:	Footpath between Hahn Student Services and McHenry Library, Santa Cruz, CA 95064			Page:	2	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

C NC N/A U	
N/A	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: N/A –** consider bridge as one-story.
N/A	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: N/A –** consider bridge as one-story.
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: C**

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: C**
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: C –** Building is on sloped site but probability of landslide is low according to USGS maps. North (downhill) side is supported on concrete drilled pier foundation, remainder of building is tied together by 4" slab on grade over entire footprint.
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: C**

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

UC Campus:	University of California Santa Cruz			Date:	12/26/2018		
Building CAAN:	7689 (University to confirm)	Auxiliary CAAN:	-	By Firm:	Maffei Structural Engineering		
Building Name:	McHenry/Hahn Bridge			Initials:	NY	Checked:	JRM
Building Address:	Footpath between Hahn Student Services and McHenry Library, Santa Cruz, CA 95064			Page:	3	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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

FOUNDATION CONFIGURATION

	Description
C NC N/A U ○ ● ○ ○	OVERTURNING: The ratio of the least horizontal dimension of the seismic-force-resisting system at the foundation level to the building height (base/height) is greater than $0.6S_a$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3) **Comments: NC –** least horizontal dimension occurs at center tower, L=8' and h= 43.71'. L/h = 0.18 < 0.6Sa = 0.6*1.55 = 0.93
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: C** – Individual towers are supported on concrete piers bearing on rock and embedded 2.5' minimum below grade. No tie exists between piers, however, piers are embedded in soil Site C minimum, so compliant.

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

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Subject:__________________
By:__________________
Date:__________________

SEISMIC EVALUATION OF EXISTING BUILDINGS - TIER 1 SCREENING

ASCE 41-17 Chapter 4

General			**Reference**
Building	McHenry/Hahn pedestrian bridge		
Architect	-		
Structural Engineer	Stephan J. Medwadowski Consulting Structural Engineer		
Location	Pedestrian walkway between McHenry Library and UCSC Student Services		
Design date	1966		
Latitude	36.996456		(Google Earth)
Longitude	-122.05809		"
Stories above grade	1		

Seismic parameters

Risk Category	II	2016 CBC Table 1604.5		
Site Class	C	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}	1.307	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		(ASCE 41-17 Table 2-2)
S_{X1}	0.885	For BSE-2E hazard level		(ASCE 41-17 Table 2-2)

Scope

Performance level	Collapse Prevention	(ASCE 41-17 Table 2-2)
Seismic hazard level	BSE-2E	(ASCE 41-17 Table 2-2)
Level of seismicity	High	(ASCE 41-17 Table 2-4)
Building type	Heavy timber braced frame with flexible diaphragm	(ASCE 41-17 Table 3-1)

Material properties				Notes	
Concrete	f'_c	3000	psi	Specified on drawings, NWC	(ASCE 41-17 Table 10-4)
Reinf.	f_y	40	ksi	Specified on drawings, A-15 Intermediate	(ASCE 41-17 Table 10-4)
Wood		N/A	ksi	Specified on drawings, DFCR SS	(ASCE 41-17 Table 9-1)

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Checklists

Benchmark building	yes	Retrofitted in 2003, but criteria is unknown	(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~~	(not performed)	(ASCE 41-17 Table 4-6)
	~~17.19 Nonstructural Checklist~~	(not performed)	(ASCE 41-17 Table 4-6)

Seismic forces

V	56	kip	$V = Cs_a W$	= 1.29W	(ASCE 41-17 Eq 4-1)
W	44	kip	building weight		(ASCE 41-17 4.4.2.1)
C	1.0		Assume elastic		(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	0.27	sec	see below		(ASCE 41-17 Eq 4-4)
C_t			*not used*		(ASCE 41-17 Eq 4-4)
β			*not used*		(ASCE 41-17 Eq 4-4)
h_n			*not used*		(ASCE 41-17 Eq 4-4)

Assume center span lateral load distributed to piers by tributary width (ignore end piers)

Pier	*h*	*Trib w*	*w/SUM(w)*	*V,pier*	*P,brace*	*P,vert*
	ft	ft		kip	kip	kip
Pier 1	6	36	0.19	10.5	9.5	7.9
Pier 2	34	40	0.21	11.7	17.4	49.7
Pier 3	44	40	0.21	11.7	17.4	64.3
Pier 4	26	40	0.21	11.7	17.4	38.0
Pier 5	6	36	0.19	10.5	9.5	7.9
Total		192.000	1.000			

M_s	**0.81**	**required**	**controlled by compression capacity of vertical**
P,nc	329	kip	for 12' long brace, assume LRFD Kf = 2.4 for comp, phi = 1.0
P,nt	299	kip	for 12' long brace, assume LRFD Kf = 2.7 for tension, phi = 1.0
P,nc	79.2	kip	for 44' long built up column, assume LRFD Kf = 2.4 for comp, phi = 1.0
P,nt	478	kip	for 44' long built up column, assume LRFD Kf = 2.7 for tension, phi = 1.0

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Project:________________
Subject:________________
By:________________
Date:________________

Bridge weight

	psf		
3" deck	8.5		
3 glulam girders	11.4		
Railing and miscellaneous	5.5		
Total	25	psf	
Bridge deck weight	39005	lb	(Area = 8'*192')

2- 8x8 legs (total 2)	60.4 lb/ft		
8x10 diagonals	18.9 lb/ft		
Total	79	lb/ft	
Tower weight	4641	lb	(Trib h = (35'+44'+26'+6'+6')/2 = 58.5'
Total bridge weight =	**43646**	lb	

Calculate bridge period

Assume that period is governed by period of 25' high pier (shortest of the tall piers):

W of pier = 9093 lb, assuming trib L = 40' , and W per pier = (40'/192')(total bridge weight)

k per pier = 12670 lb/in, see calcs below

Period = 2*pi*(M/K)^0.5 = 0.27 sec

To calculate stiffness of pier = k, calculate the shortening/lengthening of the vertical legs of the pier to calculate rotation.

Then translate the rotation to calculate drift.

Assume 100k lateral force at top of 25' high pier:

Pc = Pt = Mot/b=F*h/b	F =	100	kip	
Elongation e = PL/AE	h=	25	ft	
Rotation alpha = 2e/b	b=	8	ft	
Drift d = alpha*h	Pc = Pt =	312.5	kip	
Stiffness k = F/d	A=	128	in^2	2 8x8 verticals
	E=	580000	psi	Emin for DF Select Structural
	e=	1.26	in	
	alpha =	0.026		
	d=	7.89	in	
	k=	12.67	kip/in