



Rating form completed by
Jay Yin

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

DATE: 2019-06-30

UC Santa Cruz building seismic ratings
Social Sciences 2 North

CAAN #7921

712 College Ten Road, Santa Cruz CA 95064

UCSC Campus: Main Campus



6/28/19



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	V (Poor)	
Rating basis	ASCE 41-17 Tier 1	ASCE 41-17 ¹
Date of rating	2019	
Recommended UC Santa Cruz priority 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	Medium (~\$50/sf-\$200/sf)	See recommendations on further evaluation and retrofit.
Is 2018-2019 rating required by UCOP?	Yes	
Further evaluation recommended?	Yes	

¹ We translate this Tier 1 evaluation to a Seismic Performance Level rating using professional judgment. Noncompliant items in the Tier 1 evaluation do not automatically put a building into a particular rating category, but we evaluate such items along with the combination of building features and potential deficiencies, focused on the potential for collapse or serious damage to the gravity supporting structure that may threaten occupant safety. See Section III B of the UC Seismic Policy and Method B of Section 321 of the 2016 California Existing Building Code.

² Per Section 3.A.4.i of the Seismic Program Guidebook, the cost includes all construction cost necessitated by the seismic retrofit, including restoration of finishes and any triggered work on utilities or accessibility. It does not include soft costs such as design fees or campus costs. The cost is in 2019 dollars.

Building information used in this evaluation

- Architectural Drawings by Esherick Homsey Dodge and Davis, "College 10 Academic, University of California Santa Cruz", original issue date 29 July, 1993.
- Structural Drawings by SOH & Associates, original issue date 29 July, 1993

Additional building information known to exist

None.

Scope for completing this form

Reviewed structural drawings for original construction and carried out ASCE 41-17 Tier 1 evaluation. Made site visit to verify actual construction generally conforms to drawings and identify non-structural life-safety hazards.

Brief description of structure

This is the north tower of the two tower structure for Social Science 2 building. The two towers are supported by a common base structure at 1st Floor. The base structure has a sloped foundation system that is consisted of spread footings and grade beams. The south side of the base structure is a full story with "Ground Floor" as the lower level and 1st Floor as the upper level. The north side of the base structure has short shear walls on graded beams, the top of the grade beams is at approximately 5' below "1st Floor". The base structure has perimeter and interior shear walls with some perimeter braced frames. The two towers are seismically separated with a separation joint. The north tower has perimeter braced frames from the 1st Floor to the sloping roof eaves at the mechanical platform elevation. The mechanical platform elevation and has a smaller floor area than the typical floors below, the perimeter braced frames are not connected to the mechanical platform. The mechanical platform is supported by braced frames that are discontinued at the fourth Floor in the east-west direction and by one-story moment frames in the north-south direction.

Identification of levels: 5 Stories: Ground Floor, First Floor, Second Floor, Third Floor, Fourth Floor, and Mechanical Platform/Sloped Roof.

Foundation system: Shallow foundations consisted of grade beams and spread footings.

Structural system for vertical (gravity) load: Concrete over metal deck supported on steel beams, with beams supported on steel columns (First Floor through Mechanical Platform). Metal deck on steel beams at sloped roofs.

Structural system for lateral forces: Steel concentric braced frames with concrete shear walls. Concrete fill over metal deck diaphragms.

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

Identified seismic deficiencies of the building including the following:

- The columns on the lower floors of the braced frames have a lower strength than required based on the quick checks.
- The beams intersected by the chevron braces do not have adequate capacity to resist the net vertical load due to unbalanced tension and compression brace forces from below.
- The brace to the gusset connection does not have the capacity to withstand the expected tensile yield force of the brace as required in AISC 341-10. The main deficiencies are the net section and at the welds connecting the gusset to the brace.
- The seismic joint between Social Sciences North and South does not satisfy ASCE 41-17 Tier 1 Checklist requirements.

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

No nonstructural life-safety concerns seen in or around the structure.

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	N	Unrestrained hazardous materials storage	N
Heavy masonry or stone veneer above exit ways and public access areas	N	Masonry chimneys	N
Unbraced masonry parapets, cornices or other ornamentation above exit ways and public access areas	N	Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.	N

Discussion of rating

The following noncompliance items from the Tier 1 checklist form the basis of rating:

- The columns fail the axial stress quick check at the lower floors.
- The connection strength is not adequate to develop the full yield capacity of the brace where the brace net section is coped at the gusset.
- The beams intersected by the chevron braces do not have adequate capacity to resist the net vertical load due to unbalanced tension and compression brace forces from below.

Recommendations for further evaluation or retrofit

A Tier 3 evaluation and a retrofit of the building are recommended based on the deficiencies found.

A retrofit of this building would consist of strengthening the brace framed columns at the lower level and the beams intersected by the chevron braces. The net section of the brace and the brace to gusset weld also need to be strengthened. Pounding between the two structures should also be investigate further.

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.

Peer review of rating

This seismic evaluation was discussed in a peer review meeting on 24 June 2019. Reviewers present were Bret Lizundia of R+C and Holly Razzano and Joe Maffei of Maffei Structural Engineering. Comments from the reviewers have been incorporated into this report. The reviewers agreed with the assigned rating.

Additional building data	Entry	Notes
Latitude	37.003	
Longitude	-122.059	
Are there other structures besides this one under the same CAAN#	Yes	
Number of stories above lowest perimeter grade	5	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	46,987 sq ft	
Risk Category per 2016 CBC Table 1604.5	II	
Building structural height, h_n	71 ft.	Structural height defined per ASCE 7-16 Section 11.2
Coefficient for period, C_t	0.02	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
Estimated fundamental period	0.49 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975 yr hazard parameters S_s, S_1	1.291, .49	
Site class	D	
Site class basis	Geotech ⁴	See footnote below. ⁴
Site parameters F_a, F_v	1.2, 1.811	
Ground motion parameters S_{cs}, S_{c1}	1.549, .887	
S_o at building period	1.549	
Site V_{s30}	900 ft/s	
V_{s30} basis	Estimated	
Liquefaction potential	Low	
Liquefaction assessment basis	County Map	See footnote below.

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>

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: 1993 Code: 1991 UBC	
Is this a benchmark building	No	
Is this a retrofit building?	No	
Applicable code for retrofit		
Model building data		
Model building type North-South	Steel,S2 - Steel Braced Frames (with Stiff Diaphragm) Concrete,C2 - Concrete Shear Walls (with Stiff Diaphragms)	
Model building type East-West	Steel,S2 - Steel Braced Frames (with Stiff Diaphragm) Concrete,C2 - Concrete Shear Walls (with Stiff Diaphragms)	
FEMA P-154 score	N/A	Not included here because we performed ASCE 41 Tier 1 evaluation.
Previous ratings		
Most recent rating	Unknown	
Date of most recent rating	Unknown	
2 nd most recent rating	-	
Date of 2 nd most recent rating	-	
3 rd most recent rating	-	
Date of 3 rd most recent rating	-	
Appendices		
ASCE 41 Tier 1 checklist included here?	Yes	Refer to attached checklist file in Appendix A.



University of California, Santa Cruz
ASCE 41-17 Tier 1 Seismic Evaluation
7921 - Social Sciences 2 North

Appendix A
ASCE 41-17 Checklists

UC Campus:	UCSC			Date:	6/27/19		
Building CAAN:	7121	Auxiliary CAAN:	-	By Firm:	Degenkolb Engineers		
Building Name:	Social Sciences 2			Initials:	JCY	Checked:	JCY
Building Address:	712 College Ten Road, Santa Cruz, CA 95064			Page:	1	of	3

ASCE 41-17 Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - GENERAL

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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 NC N/A U <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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 NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	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:

BUILDING SYSTEMS - BUILDING CONFIGURATION

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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. A.2.2.2. Tier 2: Sec. 5.4.2.1) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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:

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

UC Campus:	UCSC			Date:	6/27/19		
Building CAAN:	7121	Auxiliary CAAN:	-	By Firm:	Degenkolb Engineers		
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ASCE 41-17 Collapse Prevention Basic Configuration Checklist

C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments: Shear wall length increases at the lower stories.</p>
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments:</p>
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments: Symmetric building.</p>

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

GEOLOGIC SITE HAZARD

	Description
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments:</p>
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments:</p>
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments:</p>

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ASCE 41-17 Collapse Prevention Basic Configuration Checklist

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

FOUNDATION CONFIGURATION

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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 $0.6S_d$. (Commentary: Sec. A.6.2.1. Tier 2: Sec. 5.4.3.3)</p> <p>Comments: $T=Ct*h^b = 0.02*71^{0.75}=.49$ $S_a=S_x1/T=.885/.49=1.81$ $0.6*1.81=1.09$, $80/71=1.13$</p>
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	<p>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)</p> <p>Comments: Slab on grade.</p>

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Building Name:	Social Sciences 2 North			Initials:	JCY	Checked:	JCY
Building Address:	712 College Ten Road, Santa Cruz, CA 95064			Page:	1	of	4

ASCE 41-17 Collapse Prevention Structural Checklist For Building Type S2-S2A

LOW SEISMICITY

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	REDUNDANCY: The number of lines of braced frames in each principal direction is greater than or equal to 2. (Commentary: Sec. A.3.3.1.1. Tier 2: Sec. 5.5.1.1) Comments:
C NC N/A U <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	COLUMN AXIAL STRESS CHECK: The axial stress caused by gravity loads in columns subjected to overturning forces is less than $0.10F_y$. Alternatively, the axial stress caused by overturning forces alone, calculated using the Quick Check procedure of Section 4.4.3.6, is less than $0.30F_y$. (Commentary: Sec. A.3.1.3.2. Tier 2: Sec. 5.5.2.1.3) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	BRACE AXIAL STRESS CHECK: The axial stress in the diagonals, calculated using the Quick Check procedure of Section 4.4.3.4, is less than $0.50F_y$. (Commentary: Sec. A.3.3.1.2. Tier 2: Sec. 5.5.4.1) Comments:

CONNECTIONS

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	TRANSFER TO STEEL FRAMES: Diaphragms are connected for transfer of seismic forces to the steel frames. (Commentary: Sec. A.5.2.2. Tier 2: Sec. 5.7.2) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	STEEL COLUMNS: The columns in seismic-force-resisting frames are anchored to the building foundation. (Commentary: Sec. A.5.3.1. Tier 2: Sec. 5.7.3.1) Comments:

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ASCE 41-17 Collapse Prevention Structural Checklist For Building Type S2-S2A

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

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	REDUNDANCY: The number of braced bays in each line is greater than 2. (Commentary: Sec. A.3.3.1.1. Tier 2: Sec. 5.5.1.1) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	CONNECTION STRENGTH: All the brace connections develop the buckling capacity of the diagonals. (Commentary: Sec. A.3.3.1.5. Tier 2: Sec. 5.5.4.4) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	COMPACT MEMBERS: All brace elements meet compact section requirements in accordance with AISC 360, Table B4.1. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec. 5.5.4) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	K-BRACING: The bracing system does not include K-braced bays. (Commentary: Sec. A.3.3.2.1. Tier 2: Sec. 5.5.4.6) Comments:

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

SEISMIC-FORCE-RESISTING SYSTEM

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	COLUMN SPLICES: All column splice details located in braced frames develop 50% of the tensile strength of the column. (Commentary: Sec. A.3.3.1.3. Tier 2: Sec. 5.5.4.2) Comments:

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ASCE 41-17 Collapse Prevention Structural Checklist For Building Type S2-S2A

C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression have K/l_r ratios less than 200. (Commentary: Sec. A.3.3.1.4. Tier 2: Sec. 5.5.4.3) Comments:
C NC N/A U <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	CONNECTION STRENGTH: All the brace connections develop the yield capacity of the diagonals. (Commentary: Sec. A.3.3.1.5. Tier 2: Sec. 5.5.4.4) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	COMPACT MEMBERS: All brace elements meet section requirements in accordance with AISC 341, Table D1.1, for moderately ductile members. (Commentary: Sec. A.3.3.1.7. Tier 2: Sec.5.5.4) Comments:
C NC N/A U <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	CHEVRON BRACING: Beams in chevron, or V-braced, bays are capable of resisting the vertical load resulting from the simultaneous yielding and buckling of the brace pairs. (Commentary: Sec. A.3.3.2.3. Tier 2: Sec. 5.5.4.6) Comments:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	CONCENTRICALLY BRACED FRAME JOINTS: All the diagonal braces frame into the beam-column joints concentrically. (Commentary: Sec. A.3.3.2.4. Tier 2: Sec. 5.5.4.8) Comments:
DIAPHRAGMS (STIFF OR FLEXIBLE)	
	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	OPENINGS AT FRAMES: Diaphragm openings immediately adjacent to the braced frames extend less than 25% of the frame length. (Commentary: Sec. A.4.1.5. Tier 2: Sec. 5.6.1.3) Comments:
FLEXIBLE DIAPHRAGMS	
	Description
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) Comments:

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ASCE 41-17 Collapse Prevention Structural Checklist For Building Type S2-S2A

C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input type="checkbox"/>	U <input type="checkbox"/>	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:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input type="checkbox"/>	U <input type="checkbox"/>	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:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input type="checkbox"/>	U <input type="checkbox"/>	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:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input type="checkbox"/>	U <input type="checkbox"/>	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:

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UC Campus:	Santa Cruz		Date:	6/28/2019		
Building CAAN:	7921	Auxiliary CAAN:	7921.0	By Firm:	Degenkolb Engineers	
Building Name:	Social Sciences 2			Initials:	JSW	Checked:
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ASCE 41-17 Collapse Prevention Structural Checklist For Building Type C2-C2A

Low And Moderate Seismicity

Seismic-Force-Resisting System

	Description
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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: Equivalent length of wall is one shear wall in each direction. The other half of the building in each direction sits on foundations due to the sloping site
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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) Comments: See quick checks
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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: See quick checks

Connections

	Description
C NC N/A U <input type="checkbox"/> <input type="checkbox"/> <input checked="" type="checkbox"/> <input type="checkbox"/>	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:
C NC N/A U <input checked="" type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	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: Beam parallel to shear wall has shear studs

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

UC Campus:	Santa Cruz		Date:	6/28/2019		
Building CAAN:	7921	Auxiliary CAAN:	7921.0	By Firm:	Degenkolb Engineers	
Building Name:	Social Sciences 2			Initials:	JSW	Checked:
Building Address:	712 College Ten Road Santa Cruz, CA 95064			Page:	2	of 3

ASCE 41-17 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)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Comments: Indicated in drawings

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)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Comments:
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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments: No coupling beams are present

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)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Comments: No split level diaphragms
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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:

Flexible Diaphragms

				Description

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

UC Campus:	Santa Cruz		Date:	6/28/2019		
Building CAAN:	7921	Auxiliary CAAN:	7921.0	By Firm:	Degenkolb Engineers	
Building Name:	Social Sciences 2			Initials:	JSW	Checked:
Building Address:	712 College Ten Road Santa Cruz, CA 95064			Page:	3	of 3

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

C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2)
<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments:
Connections				
Description				
C <input type="checkbox"/>	NC <input type="checkbox"/>	N/A <input checked="" type="checkbox"/>	U <input type="checkbox"/>	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)
<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	Comments: Spread and strip footings utilized

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



University of California, Santa Cruz
ASCE 41-17 Tier 1 Seismic Evaluation
7921 - Social Sciences 2 North

Appendix B
Quick Check Calculations



Subject: Global Data	Job Number: B9956006.00	Date: 06/28/19
Job: UCSC Tier 1 Seismic Evaluations CAAN #7921.0	By: JCY/JSW	Section:
	Checked By:	Page:

GLOBAL DATA

ASCE 41-17 SEISMIC EVALUATION & RETROFIT OF EXISTING BUILDINGS
 CHAPTER 4 - TIER 1 EVALUATION
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 COLLAPSE PREVENTION
 BSE-2E HAZARD LEVEL

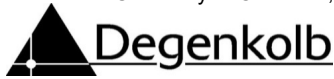
SITE DATA:

Latitude:	37.804813 °N	712 College Ten Road	USGS Seismic Design Map Application:
Longitude:	-122.273562 °W	Santa Cruz, CA 95064	http://geohazards.usgs.gov/hazardtool/application.php
Site Class:	D (default)	(Stiff Soil)	Site Class [ASCE 41-17, §2.4.1.6]
S _s	= 1.291 g	(USGS) (5% / 50 years)	USGS Mapped (T = 0.2 sec) [ASCE 41-17, §2.4.1.3]
S ₁	= 0.490 g	(USGS) (5% / 50 years)	USGS Mapped (T = 1.0 sec) [ASCE 41-17, §2.4.1.3]
F _a	= 1.200	(Site Class D)	Site Coefficient (T = 0.2 sec) [ASCE 7-16, Table 11.4-1]
F _v	= 1.810	(Site Class D)	Site Coefficient (T = 1.0 sec) [ASCE 7-16, Table 11.4-2]
S _{XS}	= 1.549 g	= F _a S _s	Site-Adjusted Design (T = 0.2 sec) [ASCE 41-17, Eq. 2-1]
S _{X1}	= 0.887 g	= F _v S ₁	Site-Adjusted Design (T = 1.0 sec) [ASCE 41-17, Eq. 2-2]

BUILDING DATA:

Building Type:	S2	(Steel Braced Frames with Stiff Diaphragms)	[ASCE 41-17, Table 3-1]
Year Built:	1993		
Number of Stories:	5 stories		
Parapet Height:	4.00 ft		
Roof Height:	71.00 ft		
Total Area:	44,857 sf		

Level	Height [ft]	Elevation [ft]	Length _{N-S} [ft]	Length _{E-W} [ft]	Area [sf]	Diaphragm Stiffness	Diaphragm Description
Roof	17.0	71.0	40	62	2,480	Rigid	Concrete Fill over Metal Deck
4th	13.0	54.0	80	124	9,920	Rigid	Concrete Fill over Metal Deck
3rd	13.0	41.0	80	124	9,920	Rigid	Concrete Fill over Metal Deck
2nd	13.0	28.0	80	124	9,920	Rigid	Concrete Fill over Metal Deck
1st	15.0	15.0	80	124	10,137	Rigid	Concrete Fill over Metal Deck
Ground	0.0	0.0	20	124	2,480	Rigid	Concrete Fill over Metal Deck



Subject: Seismic Mass	Job Number: B9956006.00	Date: 06/28/19
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SEISMIC MASS

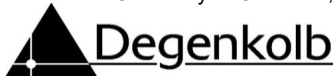
ASCE 41-17 SEISMIC EVALUATION & RETROFIT OF EXISTING BUILDINGS
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ROOF/FLOOR WEIGHT SUMMARY:

Level Type	Weight [psf]
ROOF	161.654
FLR-5	64.58266
FLR-4	63.83831
FLR-3	63.83831
FLR-2	64.09894

SEISMIC MASS SUMMARY:

Level	FLOOR			WALL ABOVE				WALL BELOW				TOTAL WEIGHT [kips]
	Level Type	Weight [psf]	Area [sf]	Wall Type	Weight [psf]	Length [ft]	Height [ft]	Wall Type	Weight [psf]	Length [ft]	Height [ft]	
Roof	ROOF	149	2,480	WALL-P	13.0	0	4.00	WALL-R	13.0	284	8.50	401
4th	FLR-5	59	9,920	WALL-R	13.0	284	8.50	WALL-5	13.0	284	6.50	641
3rd	FLR-4	59	9,920	WALL-5	13.0	284	6.50	WALL-4	13.0	284	6.50	633
2nd	FLR-3	59	9,920	WALL-4	13.0	284	6.50	WALL-3	13.0	284	6.50	633
1st	FLR-2	59	10,137	WALL-3	13.0	284	6.50	WALL-2	13.0	284	7.50	650
											TOTAL	2,958



Subject: Seismic Forces	Job Number: B9956006.00	Date: 06/28/19
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SEISMIC FORCES

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BUILDING TYPE: S2 (Steel Braced Frames with Stiff Diaphragms) [ASCE 41-17, Table 3-1]
SITE CLASS: D (default) #N/A [ASCE 41-17, §2.4.1.6]

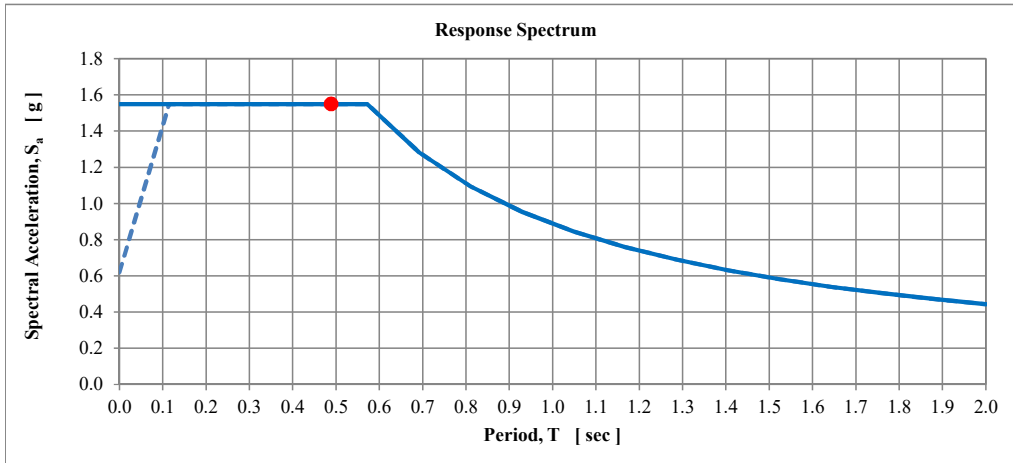
DESIGN SPECTRAL ACCELERATIONS:

S_{XS} = 1.549 g (BSE-2E) Site-Adjusted Design (T = 0.2 sec) [ASCE 41-17, Eq. 2-1]
 S_{X1} = 0.887 g (BSE-2E) Site-Adjusted Design (T = 1.0 sec) [ASCE 41-17, Eq. 2-2]

BUILDING PERIOD:

h_n = 71.0 ft (Base to Roof) Building Height [ASCE 41-17, §4.4.2.4]
 C_t = 0.020 (Building Type S2) Period Coefficient [ASCE 41-17, §4.4.2.4]
 β = 0.750 (Building Type S2) Period Exponent [ASCE 41-17, §4.4.2.4]
 T = 0.489 sec = $C_t h_n^\beta$ Fundamental Period [ASCE 41-17, Eq. 4-4]

RESPONSE SPECTRUM:



PSEUDO LATERAL FORCE:

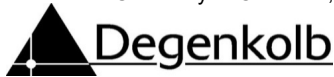
n = 5 ($n \geq 4$) Total Number of Stories
 C = 1.0 (Building Type S2) Modification Factor [ASCE 41-17, Table 4-7]
 S_a = 1.549 g = $\text{MIN} \{ S_{X1} / T, S_{XS} \}$ Spectral Acceleration [ASCE 41-17, Eq. 4-3]
 V = **1.549 W** = $C S_a W$ Pseudo Lateral Force [ASCE 41-17, Eq. 4-1]

VERTICAL DISTRIBUTION OF SEISMIC FORCES:

k = 1.00 ($T \leq 0.5$ sec) Seismic Distribution Exponent [ASCE 41-17, §4.4.2.2]

Level	h_x [ft]	w_x [kips]	$w_x h_x^k$	C_{vx}	F_x [kips]	V_j [kips]
Roof	71.0	401	28,464	0.24	1,120	1,120
4th	54.0	641	34,596	0.30	1,361	2,480
3rd	41.0	633	25,964	0.22	1,021	3,502
2nd	28.0	633	17,732	0.15	697	4,199
1st	15.0	650	9,747	0.08	383	4,582
TOTAL	-	2,958	116,502	1.00	4,582	-

$F_x = C_{vx} V = [w_x h_x^k / \sum (w_x h_x^k)] V$ [ASCE 41-17, Eq. 4-2a]
 $V_j = \sum F_x$ [ASCE 41-17, Eq. 4-2b]



Subject: Quick Checks	Job Number: B9956006.00	Date: 06/28/19
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QUICK CHECKS

ASCE 41-17 SEISMIC EVALUATION & RETROFIT OF EXISTING BUILDINGS

CHAPTER 4 - TIER 1 EVALUATION

LINEAR STATIC PROCEDURE

COLLAPSE PREVENTION

BSE-2E HAZARD LEVEL

BUILDING TYPE:	S2	(Steel Braced Frames with Stiff Diaphragms)	[ASCE 41-17, Table 3-1]
FRAME TYPE:	CBF	(Concentrically Braced Frame)	
CONFIGURATION:	Diagonal	(Diagonal-Bracing)	
BRACE TYPE:	W	(Wide Flange Braces)	
AXIAL LOAD:	T+C	(Tension and Compression)	

LOAD DIRECTION: Transverse**FRAME PROPERTIES:**

Level	n _f [frames]	n _c [columns]	n _{bays} [bays]	n _{br} [braces]	L _f [ft]	L _{typical bay} [ft]	DL [psf]	LL [psf]	A _{trib} [ft ²]	P _D [kips]	P _L [kips]
Roof	2	8	4	4	40.0	20	162	20	310	50	6
4th	2	8	4	4	40.0	20	65	50	310	70	26
3rd	2	8	4	4	40.0	20	64	50	310	90	46
2nd	2	8	4	4	40.0	20	64	50	310	110	66
1st	2	8	4	4	40.0	20	64	50	310	130	86

FRAME MEMBER PROPERTIES:

[ASCE 41-17 §4.2.3]

Material Properties:

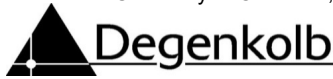
F _{yc}	=	41 ksi	(ASTM A572 / Structural)	Column Yield Stress	(ASCE 41 Default)	[ASCE 41-17, §4.2.3]
F _{ybr}	=	41 ksi	(ASTM A572 / Structural)	Brace Yield Stress	(ASCE 41 Default)	[ASCE 41-13, Table 4-5]
E	=	29,000 ksi		Modulus of Elasticity		[ASCE 41-17, §4.2.3]

Column Properties:

Level	Section	Bending Axis	L _c [ft]	A _c [in ²]
Roof	W12x79	x	17.0	23.2
4th	W12x79	x	13.0	23.2
3rd	W12x96	x	13.0	28.2
2nd	W12x96	x	13.0	28.2
1st	W12x336	x	15.0	98.9

Brace Properties:

Level	Section	L _{br,x} [ft]	L _{br,y} [ft]	L _{br} [ft]	A _{br} [in ²]	d _{br} / t _{br}	b/t	λ _r	λ _{hd}	Kl/r
Roof	W12x58	20.0	17.0	26.2	17.00	n/a	7.82	14.89	10.14	125.49
4th	W12x65	20.0	13.0	23.9	19.10	n/a	9.92	14.89	10.14	94.78
3rd	W12x79	20.0	13.0	23.9	23.20	n/a	8.22	14.89	10.14	93.85
2nd	W12x87	20.0	13.0	23.9	25.60	n/a	7.48	14.89	10.14	93.24
1st	W12x96	20.0	15.0	25.0	28.20	n/a	6.76	14.89	10.14	97.09



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QUICK CHECKS

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 BSE-2E HAZARD LEVEL

BUILDING TYPE: S2 (Steel Braced Frames with Stiff Diaphragms) [ASCE 41-17, Table 3-1]
LOAD DIRECTION: Transverse

COLUMN AXIAL STRESS CHECK: [ASCE 41-17, §A.3.1.3.2]

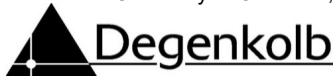
M_s	=	2.5	COLLAPSE PREVENTION	System Modification Factor	[ASCE 41-17, §4.4.3.6]
F_{yc}	=	41 ksi	(ASTM A572 / Structural)	Column Yield Stress	[ASCE 41-17, §4.2.3]
$P_{n,E} / A_c$	=	12.3 ksi	= 0.30 F_{yc}	Seismic Axial Stress Capacity	[ASCE 41-17, §A.3.1.3.2]
$P_{n,G} / A_c$	=	4.1 ksi	= 0.10 F_{yc}	Gravity Axial Stress Capacity	[ASCE 41-17, §A.3.1.3.2]
$M_{x,ot}$	=	$\Sigma (F_x h_x)$		Global Overturning Moment	[ASCE 41-17, §4.4.3.6]
P_E	=	$(1 / M_s) (M_{x,ot} / n_f) / L_f$		Seismic Axial Load due to Overturning	[ASCE 41-17, §4.4.3.6]
P_G	=	$P_D + P_L$		Unfactored Gravity Load	[ASCE 41-17, §A.3.1.3.2]
P_D	=	$\Sigma (DL A_{trib})$		Gravity Dead Load	[ASCE 41-17, §4.4.3.6]
P_L	=	$\Sigma (LL A_{trib})$		Gravity Live Load	[ASCE 41-17, §4.4.3.6]

Level	Section	A _c [in ²]	h _x [ft]	F _x [kips]	M _{x,ot} [k-ft]	P _E [kips]	P _E / F _{yc} A _c	P _G [kips]	P _G / F _{yc} A _c	DCR		Quick Check
										Seismic	Gravity	
Roof	W12x79	23.2	71.0	1,120	19,033	95	0.10	56	0.06	0.33	0.59	OK
4th	W12x79	23.2	54.0	1,361	51,277	256	0.27	96	0.10	0.90	1.01	OK
3rd	W12x96	28.2	41.0	1,021	96,797	484	0.42	136	0.12	1.40	1.18	NO GOOD
2nd	W12x96	28.2	28.0	697	151,384	757	0.65	176	0.15	2.18	1.52	NO GOOD
1st	W12x336	98.9	15.0	383	220,119	1,101	0.27	215	0.05	0.90	0.53	OK

BRACE AXIAL STRESS CHECK: [ASCE 41-17, §A.3.3.1.2]

M_s	=	}	7.0	(Tube, $d_{br} / t_{br} < 90 / \sqrt{F_{yebr}}$)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			3.5	(Tube, $d_{br} / t_{br} > 190 / \sqrt{F_{yebr}}$)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			7.0	(Pipe, $d_{br} / t_{br} < 1500 / F_{yebr}$)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			3.5	(Pipe, $d_{br} / t_{br} > 6000 / F_{yebr}$)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			3.5	(Tension-Only Braces)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			3.5	(Cold-formed steel strap-braced w/)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
			7.0	(All Other Brace Types)	System Modification Factor (CP)	[ASCE 41-17, Table 4-9]
F_{ybr}	=	41 ksi	(ASTM A572 / Structural)	Brace Yield Stress	[ASCE 41-13, Table 4-5]	
F_{yebr}	=	51 ksi	= 1.25 F_{ybr}	Brace Expected Yield Stress	[ASCE 41-17, §4.4.3.4]	
f_{nbr}	=	21 ksi	= 0.50 F_{ybr}	Brace Axial Stress Capacity	[ASCE 41-17, §A.3.3.1.2]	
$f_{j,avg}$	=	$(1 / M_s) (V_j / (L_{br,x} n_{br})) (L_{br} / A_{br})$		Average Brace Axial Stress	[ASCE 41-17, Eq. 4-9]	

Level	V _j [kips]	n _{br} [braces]	L _{br,x} [ft]	L _{br} [ft]	A _{br} [in ²]	d _{br} / t _{br}	M _s	f _{j,avg} [ksi]	DCR	Quick Check
Roof	1,120	4	20.0	26.2	17.00	n/a	7.00	3.1	0.15	OK
4th	2,480	4	20.0	23.9	19.10	n/a	7.00	5.5	0.27	OK
3rd	3,502	4	20.0	23.9	23.20	n/a	7.00	6.4	0.31	OK
2nd	4,199	4	20.0	23.9	25.60	n/a	7.00	7.0	0.34	OK
1st	4,582	4	20.0	25.0	28.20	n/a	7.00	7.3	0.35	OK



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BUILDING TYPE: S2 (Steel Braced Frames with Stiff Diaphragms) [ASCE 41-17, Table 3-1]

LOAD DIRECTION Longitudinal

FRAME PROPERTIES:

Level	n _f [frames]	n _c [columns]	n _{bays} [bays]	n _{br} [braces]	L _f [ft]	L _{typical bay} [ft]	DL [psf]	LL [psf]	A _{trib} [ft ²]	P _D [kips]	P _L [kips]
Roof	2	10	4	8	62.0	31.0	162	20	310	50	6
4th	2	10	4	8	62.0	31.0	65	50	310	70	26
3rd	2	10	4	8	62.0	31.0	64	50	310	90	46
2nd	2	10	4	8	62.0	31.0	64	50	310	110	66
1st	2	10	4	8	62.0	31.0	64	50	310	130	86

FRAME MEMBER PROPERTIES:

[ASCE 41-17, §4.2.3]

Material Properties:

(ASCE 41 Default)

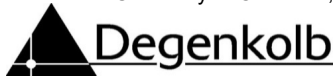
F _{yc}	=	41 ksi	(ASTM A572 / Structural)	Column Yield Stress	[ASCE 41-17, §4.2.3]
F _{ybr}	=	41 ksi	(ASTM A572 / Structural)	Brace Yield Stress	[ASCE 41-13, Table 4-5]
E	=	29,000 ksi		Modulus of Elasticity	[ASCE 41-17, §4.2.3]

Column Properties:

Level	Section	Bending Axis	L _c [ft]	A _c [in ²]
Roof	W12x79	x	17.0	23.2
4th	W12x79	x	13.0	23.2
3rd	W12x96	x	13.0	28.2
2nd	W12x96	x	13.0	28.2
1st	W12x336	x	15.0	98.9

Brace Properties:

Level	Section	L _{br,x} [ft]	L _{br,y} [ft]	L _{br} [ft]	A _{br} [in ²]	d _{br} / t _{br}	b/t	λ _r	λ _{hd}	KI/r
Roof	W12x53	15.5	17.0	23.0	15.60	n/a	8.69	14.89	10.14	111.32
4th	W12x58	15.5	13.0	20.2	17.00	n/a	7.82	14.89	10.14	96.72
3rd	W12x65	15.5	13.0	20.2	19.10	n/a	9.92	14.89	10.14	80.38
2nd	W12x72	15.5	13.0	20.2	21.10	n/a	8.99	14.89	10.14	79.85
1st	W12x79	15.5	15.0	21.6	23.20	n/a	8.22	14.89	10.14	84.86



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BUILDING TYPE: S2 (Steel Braced Frames with Stiff Diaphragms) [ASCE 41-17, Table 3-1]
LOAD DIRECTION Longitudinal

COLUMN AXIAL STRESS CHECK: [ASCE 41-17, §A.3.1.3.2]

$M_s = 2.5$ COLLAPSE PREVENTION System Modification Factor [ASCE 41-17, §4.4.3.6]
 $F_{yc} = 41$ ksi (ASTM A572 / Structural) Column Yield Stress [ASCE 41-17, §4.2.3]
 $P_{n,E} / A_c = 12.3$ ksi = $0.30 F_{yc}$ Seismic Axial Stress Capacity [ASCE 41-17, §A.3.1.3.2]
 $P_{n,G} / A_c = 4.1$ ksi = $0.10 F_{yc}$ Gravity Axial Stress Capacity [ASCE 41-17, §A.3.1.3.2]
 $M_{x,ot} = \Sigma (F_x h_x)$ Global Overturning Moment [ASCE 41-17, §4.4.3.6]
 $P_E = (1 / M_s) (M_{x,ot} / n_f) / L_f$ Seismic Axial Load due to Overturning [ASCE 41-17, §4.4.3.6]
 $P_G = P_D + P_L$ Unfactored Gravity Load [ASCE 41-17, §A.3.1.3.2]
 $P_D = \Sigma (DL A_{trib})$ Gravity Dead Load [ASCE 41-17, §4.4.3.6]
 $P_L = \Sigma (LL A_{trib})$ Gravity Live Load [ASCE 41-17, §4.4.3.6]

Level	Section	A _c [in ²]	h _x [ft]	F _x [kips]	M _{x,ot} [k-ft]	P _E [kips]	P _E / F _{yc} A _c	P _G [kips]	P _G / F _{yc} A _c	DCR		Quick Check
										Seismic	Gravity	
Roof	W12x79	23.2	71.0	1,120	19,033	61	0.06	56	0.06	0.22	0.59	OK
4th	W12x79	23.2	54.0	1,361	51,277	165	0.17	96	0.10	0.58	1.01	OK
3rd	W12x96	28.2	41.0	1,021	96,797	312	0.27	136	0.12	0.90	1.18	OK
2nd	W12x96	28.2	28.0	697	151,384	488	0.42	176	0.15	1.41	1.52	NO GOOD
1st	W12x336	98.9	15.0	383	220,119	710	0.18	215	0.05	0.58	0.53	OK

BRACE AXIAL STRESS CHECK: [ASCE 41-17, §A.3.3.1.2]

$M_s =$

- 7.0 (Tube, $d_{br} / t_{br} < 90 / \sqrt{F_{yebr}}$) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 3.5 (Tube, $d_{br} / t_{br} > 190 / \sqrt{F_{yebr}}$) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 7.0 (Pipe, $d_{br} / t_{br} < 1500 / F_{yebr}$) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 3.5 (Pipe, $d_{br} / t_{br} > 6000 / F_{yebr}$) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 3.5 (Tension-Only Braces) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 3.5 (Cold-formed steel strap-braced w/) System Modification Factor (CP) [ASCE 41-17, Table 4-9]
- 7.0 (All Other Brace Types) System Modification Factor (CP) [ASCE 41-17, Table 4-9]

 $F_{ybr} = 41$ ksi (ASTM A572 / Structural) Brace Yield Stress [ASCE 41-13, Table 4-5]
 $F_{yebr} = 51$ ksi = $1.25 F_{ybr}$ Brace Expected Yield Stress [ASCE 41-17, §4.4.3.4]
 $f_{nbr} = 21$ ksi = $0.50 F_{ybr}$ Brace Axial Stress Capacity [ASCE 41-17, §A.3.3.1.2]
 $f_{j,avg} = (1 / M_s) (V_j / (L_{br,x} n_{br})) (L_{br} / A_{br})$ Average Brace Axial Stress [ASCE 41-17, Eq. 4-9]

Level	V _j [kips]	n _{br} [braces]	L _{br,x} [ft]	L _{br} [ft]	A _{br} [in ²]	d _{br} / t _{br}	M _s	f _{j,avg} [ksi]	DCR	Quick Check
Roof	1,120	8	15.5	23.0	15.60	n/a	7.00	1.9	0.09	OK
4th	2,480	8	15.5	20.2	17.00	n/a	7.00	3.4	0.17	OK
3rd	3,502	8	15.5	20.2	19.10	n/a	7.00	4.3	0.21	OK
2nd	4,199	8	15.5	20.2	21.10	n/a	7.00	4.6	0.23	OK
1st	4,582	8	15.5	15.0	23.20	n/a	7.00	3.4	0.17	OK



Purpose: To check if the W12x53 brace connection can develop the full tensile capacity of the diagonal

Procedure: The calculation steps are as follows

Step 1: Check the brace net section rupture capacity

Step 2: Check brace to gusset weld

Step 1: Check the brace net section rupture capacity

Per AISC 341-10 the connection must develop the expected tensile yield strength of the brace
 Per the general notes, structural steel members are ASTM A36. Per S37 the gussets are ASTM A572 Gr. 50. The expected material strength of the braces is calculated by multiplying f_y by R_y per table A3.1

$$f_y := 36 \text{ ksi}$$

$$f_u := 58 \text{ ksi}$$

$$A_{brace} := 15.6 \text{ in}^2$$

$$R_y := 1.5$$

$$t_f := 0.575 \text{ in}$$

$$t_w := 0.345 \text{ in}$$

$$f_{ye} := f_y \cdot R_y = 54 \text{ ksi}$$

$$b_f := 10 \text{ in}$$

$$d := 12.1 \text{ in}$$

$$T_u := f_{ye} \cdot A_{brace} = 842.4 \text{ kip}$$

$$l_{weld} := 22 \text{ in}$$

Original drawings say gusset is 1" thick. Drawings indicated that beam flange is coped to beam web on one side for brace to gusset attachment. Take this as the net section area for tensile rupture

$$A_n := A_{brace} - 2 \cdot t_f \cdot \frac{(b_f - t_w)}{2} = 10.05 \text{ in}^2$$

$$l_{weld} > 2 \cdot d = 0$$

$$2 \cdot d > l_{weld} > 1.5 \cdot d = 1$$

$$U := .87 \quad \text{Table D3.1 AISC 360-10}$$

$$A_e := A_n \cdot U = 8.74 \text{ in}^2$$

$$T_n := f_u \cdot A_e = 507.04 \text{ kip}$$

Existing building so use a phi of 1

$$\phi := 1$$

$$DCR := \frac{T_u}{\phi \cdot T_n} = 1.66$$

Step 2: Check brace to gusset weld

$$l_{weld} = 22 \text{ in}$$

$$T_u = 842.4 \text{ kip}$$

$$t_{weld} := 0.69 \text{ in}$$

$$\phi = 1$$

$$F_{EXX} := 70 \text{ ksi}$$

$$\text{Eq 8-1} \\ R_n := 2 \cdot 0.6 \cdot F_{EXX} \cdot \frac{\sqrt{2}}{2} t_{weld} \cdot l_{weld} = 901.65 \text{ kip}$$

$$DCR_{weld} := \frac{T_u}{\phi \cdot R_n} = 0.93$$



Purpose: To check if the W24x76 beam can resist the effect of the combine tensile and compressive brace capacities applied at midspan

Procedure: The calculation steps are as follows

Step 1: Determine brace capacities

Step 2: Check beam in chevron configuration

Step 1: Determine brace capacities

Per AISC 341-10 the connection must develop the expected tensile yield strength of the brace
 Per the general notes, wide flange sections are either ASTM A36 and/or ASTM A572 Gr. 50. The expected material strength of each is close after multiplying by R_y per table A3.1

$$f_y := 36 \text{ ksi}$$

$$A_{brace} := 15.6 \text{ in}^2$$

$$R_y := 1.5$$

$$f_u := 58 \text{ ksi}$$

$$E := 29000 \text{ ksi}$$

Tension

$$f_{ye} := f_y \cdot R_y = 54 \text{ ksi}$$

$$T_u := f_{ye} \cdot A_{brace} = 842.4 \text{ kip}$$

Compression

No slender elements from quick check worksheet. Kl/r calculated in quick check worksheet

$$Klr := 132.8$$

$$F_e := \frac{\pi^2 \cdot E}{Klr^2} = 16.23 \text{ ksi}$$

$$\frac{f_y}{F_e} = 2.22 \quad \frac{f_y}{F_e} \leq 2.25 = 1$$

$$F_{cr} := \left(0.658 \frac{f_y}{F_e} \right) \cdot f_y = 14.23 \text{ ksi}$$

$$P_n := A_{brace} \cdot F_{cr} = 221.93 \text{ kip}$$

$$C_u := 0.3 \cdot P_n = 66.58 \text{ kip}$$

AISC 341-10 F1.4a


Step 2: Check W24x76 beam in chevron configuration

$$l_{beam} := 31 \text{ ft}$$

$$\theta := \arccos\left(\frac{15.5 \text{ ft}}{21.6 \text{ ft}}\right) = 44.14 \text{ deg}$$

$$P := \sin(\theta) \cdot (T_u - C_u) = 540.33 \text{ kip}$$

$$M_u := \frac{P \cdot l_{beam}}{4} = 50250.76 \text{ kip} \cdot \text{in}$$

Pin Pin per connection assumed based on details

$$Z_{beam} := 200 \text{ in}^3$$

$$M_n := f_{ye} \cdot Z_{beam} = 10800 \text{ kip} \cdot \text{in}$$

$$\phi := 1$$

$$DCR := \frac{M_u}{\phi \cdot M_n} = 4.65$$



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BUILDING TYPE: C2 (Concrete Shear Walls with Stiff Diaphragms) [ASCE 41-17, Table 3-1]

STEEL REINFORCING RATIO CHECK: [ASCE 41-17, §A.3.2.2.2]

Wall Type	t_w [in]	Horizontal Reinforcing					Vertical Reinforcing				
		$n_{curtains}$ [curtains]	Bar Size No.	Spacing [in]	ρ_h	$\rho_h \geq 0.0020$	$n_{curtains}$ [curtains]	Bar Size No.	Spacing [in]	ρ_v	$\rho_v \geq 0.0012$
WALL-2	12	2	5	10	0.0052	OK	2	6	8	0.0092	OK

AVERAGE SHEAR STRESS CHECK:

f'_c	=	4,000 psi	(ASCE 41 Default)	Concrete Compressive Strength	[ASCE 41-17, Table 4-2]
v_n	=	126 psi	= MAX { 100 psi , $2 \sqrt{f'_c}$ }	Shear Wall Capacity	[ASCE 41-17, §A.3.2.2.1]
M_s	=	4.5	COLLAPSE PREVENTION	System Modification Factor	[ASCE 41-17, Table 4-8]
$v_{j, avg}$	=	$(1 / M_s) (V_j / A_w)$		Average Shear Wall Stress	[ASCE 41-17, Eq. 4-8]
A_w	=	$t_w (L_{w, total} - L_{w, openings})$		Net Wall Area	[ASCE 41-17, §4.4.3.3]

North-South Direction:

Level	$V_j/2$ [kips]	Wall Type	t_w [in]	$L_{w, total}$ [ft]	$L_{w, openings}$ [ft]	L_w [ft]	A_w [in ²]	$v_{j, avg}$ [psi]	DCR	Quick Check
1st	2,291	WALL-2	12	80	0	80	11,520	44	0.35	OK

East-West Direction:

Level	$V_j/2$ [kips]	Wall Type	t_w [in]	$L_{w, total}$ [ft]	$L_{w, openings}$ [ft]	L_w [ft]	A_w [in ²]	$v_{j, avg}$ [psi]	DCR	Quick Check
1st	2,291	WALL-2	16	93	0	93	17,856	29	0.23	OK



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Appendix C
Photos and Details



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Figure 1 - North Elevation View of the North Tower



Figure 2 - Seismic Joint between the North and South Towers (North is to the right)



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Figure 3 - View of hall way looking toward north. Seismic Joint is seen above the doors.



Figure 4 - View of stepped perimeter shear wall (East Elevation)



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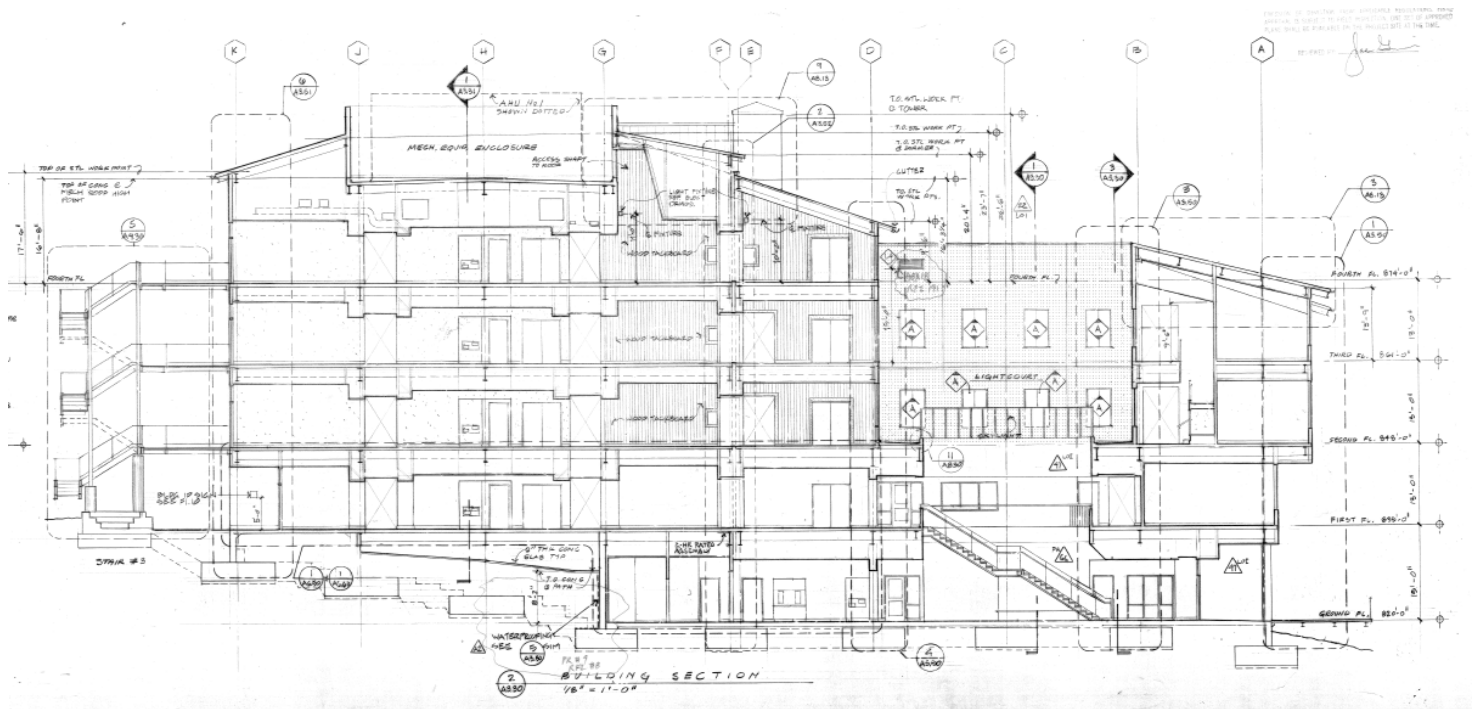


Figure 5 - Architectural Section of Both Towers Looking Toward East

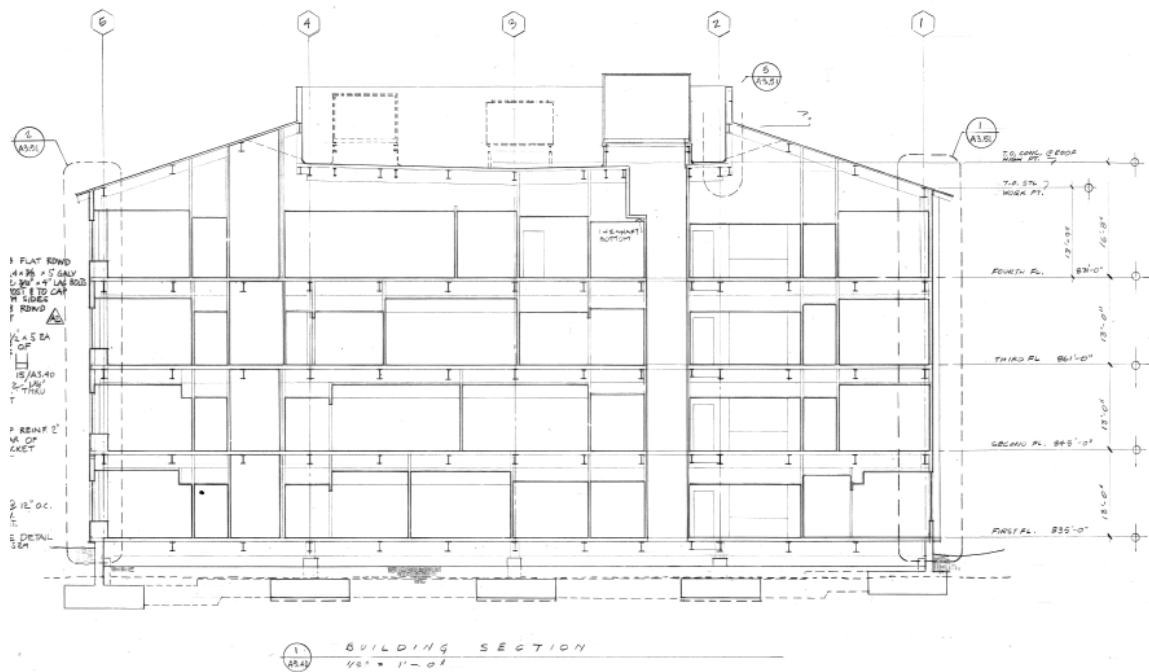


Figure 6 - Architectural Section of North Tower Looking Toward North



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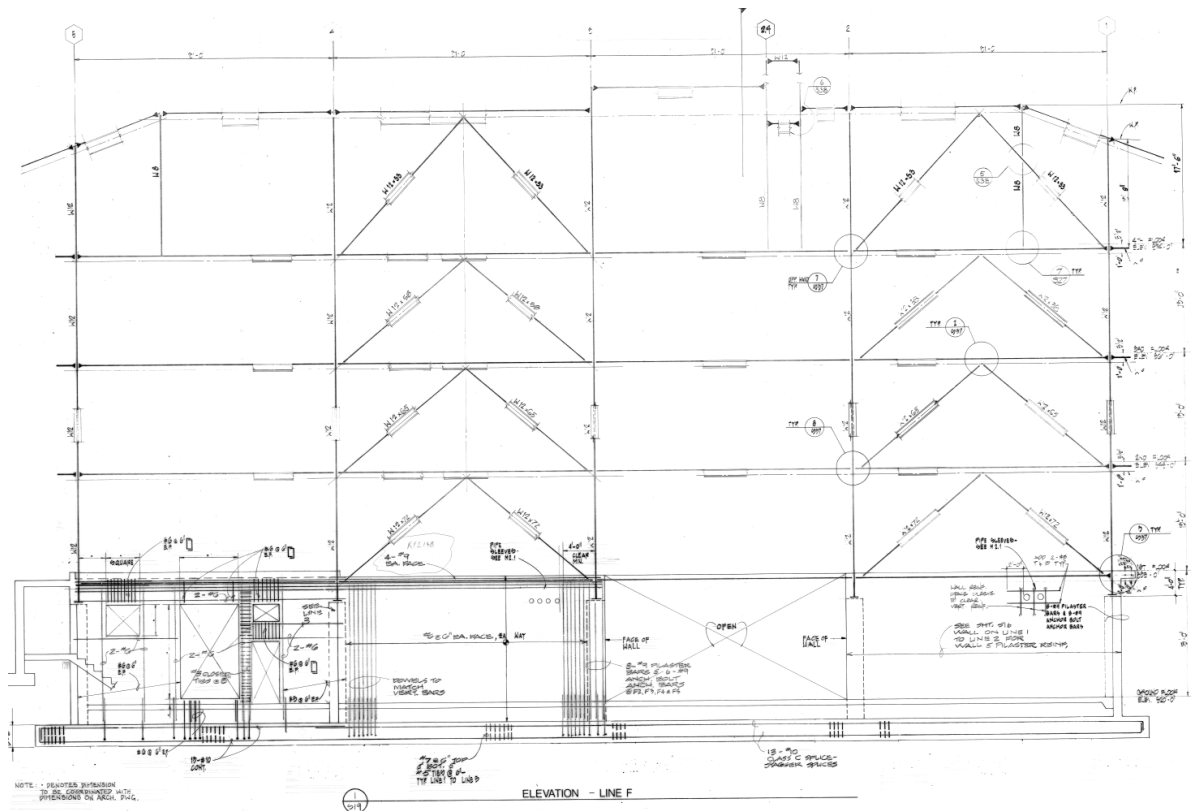
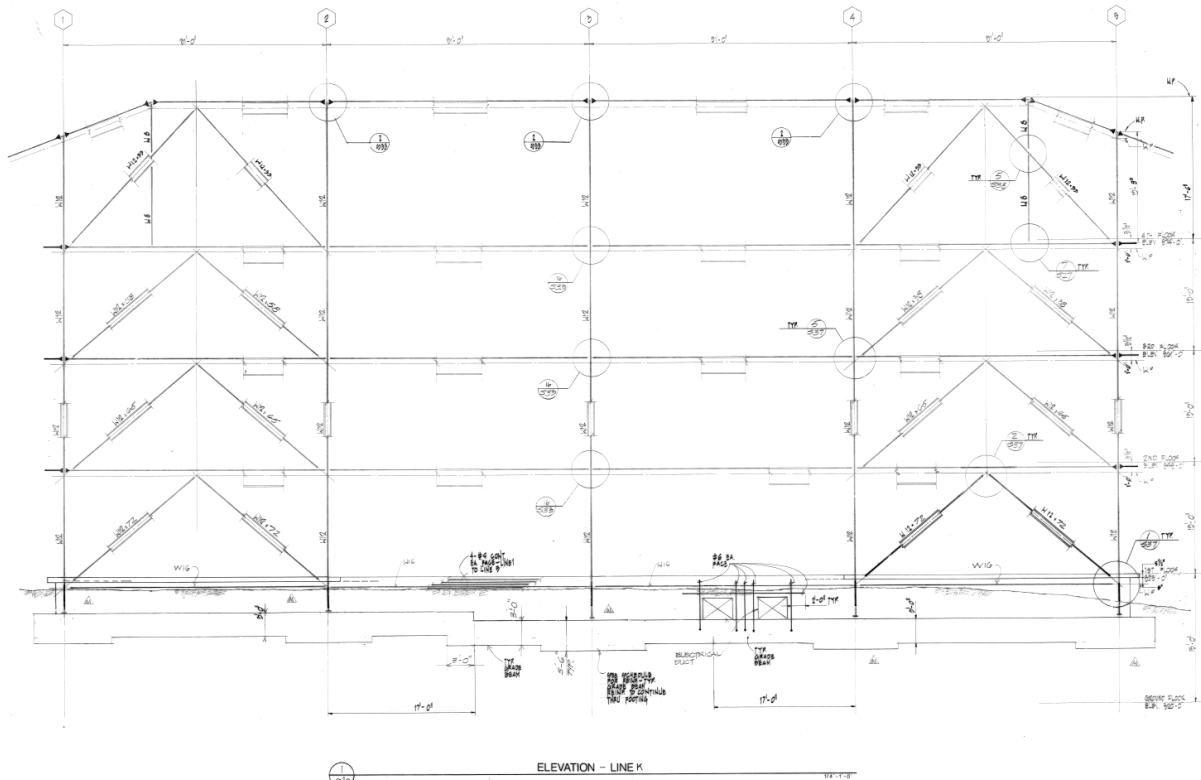


Figure 8 - Longitudinal Frame Elevation (South Elevation)



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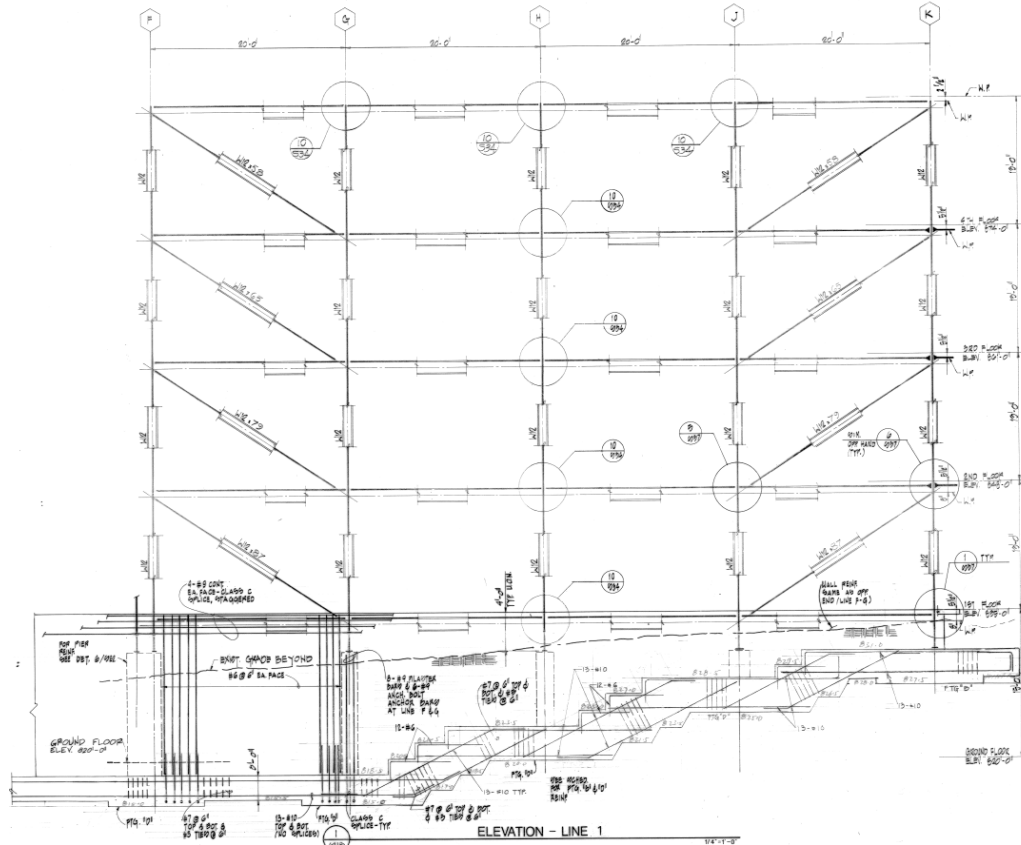


Figure 9 - Transverse Frame Elevation (East)

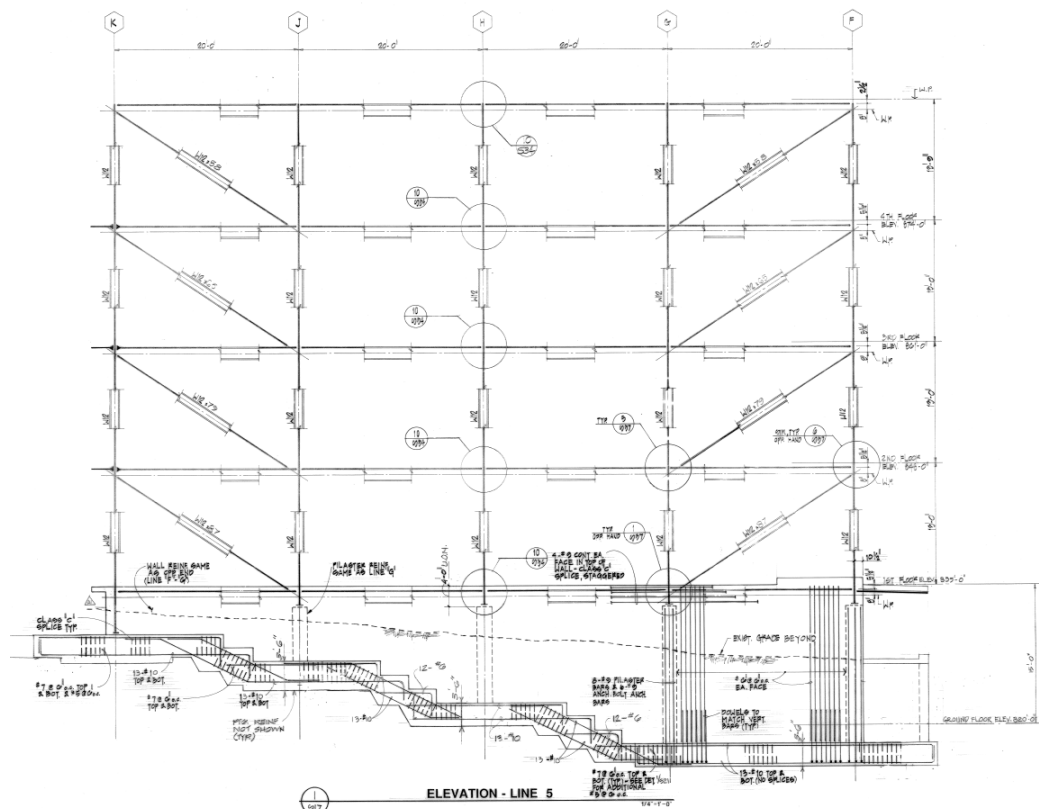


Figure 10 - Transverse Frame Elevation (West)



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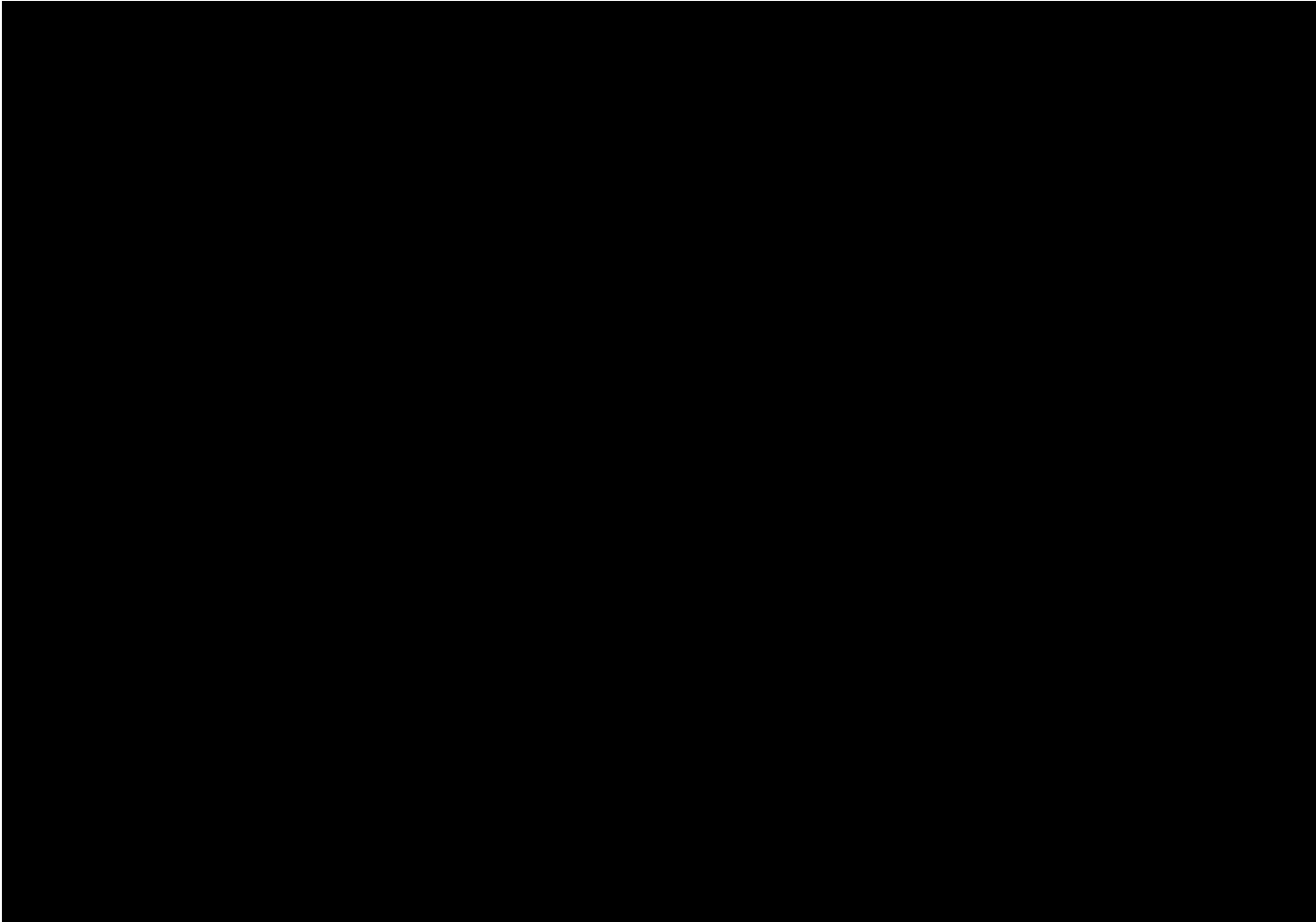


Figure 11 - Typical Floor Plan (Second Floor Shown, North is to the Left)

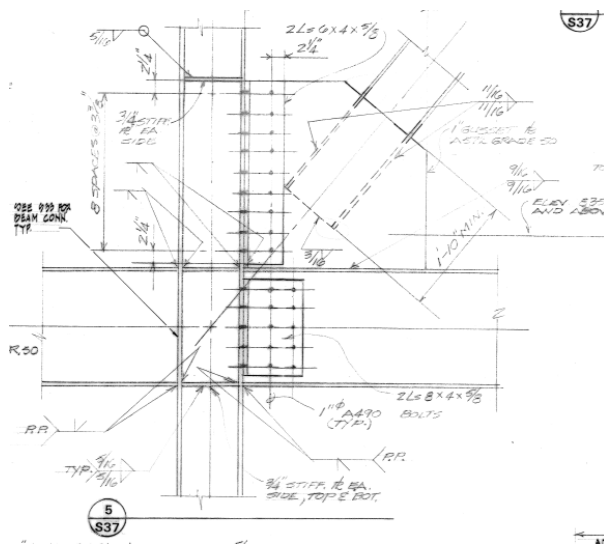


Figure 12- Typical Gusset Connection