UCSF

Rating form completed by:

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Evaluator: BL, CLP. EFA
Date: 10/31/2020

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

DATE: 2020-10-31

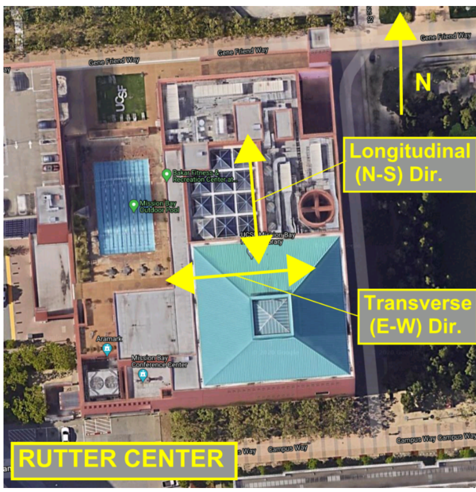
10-31-20

UCSF building seismic ratings

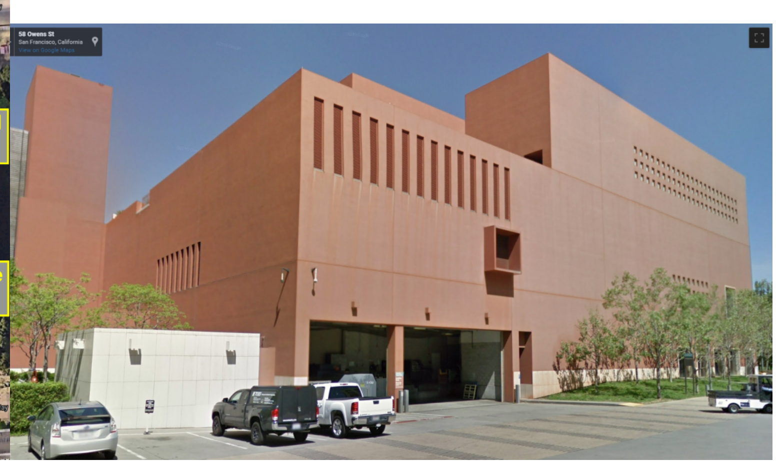
UCSF Rutter Center

CAAN #3003
1675 Owens Street, San Francisco, CA 94158
UCSF Campus: Mission Bay

Plan



Southwest corner (looking northeast)



Rating summary	Entry	Notes
UC Seismic Performance Level (rating)	IV	Findings based on drawing review and ASCE 41-17 Tier 1 evaluation[1]
Rating basis	Tier 1	ASCE 41-17
Date of rating	2020	
Recommended UCSF priority category for retrofit	None	Priority A=Retrofit ASAP Priority B=Retrofit at next permit application for modification
Ballpark total project cost to retrofit to IV rating	N/A	See recommendations on further evaluation and retrofit
Is 2018-2019 rating required by UCOP?	Yes	Does not have a documented previous review
Further evaluation recommended?	No	

[1] The evaluations at UCSF translate the Tier 1 evaluation to a Seismic Performance Level rating using professional judgment discussed among the Seismic Review Committee. Non-compliant items in the Tier 1 evaluation do not automatically put a building into a particular rating category, but such items are evaluated 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.

Building information used in this evaluation

- Architectural drawings entitled "UCSF Mission Bay Campus Community Center Building 21B," by MBT Associates, dated 23 August 2002 (160 sheets).
- Structural drawings entitled "UCSF Mission Bay Campus Community Center Building 21B," by Forell/Elsesser Engineers, Inc., dated 23 August 2002 (37 sheets)
- Shop drawing submittal from Nippon Steel Corporation dated 10/4/2002 (10 pages).
- Submittal entitled "Cyclic Tests of Nippon Steel Corporation Unbonded Braces," by Nippon Steel Corporation, 25 January 2001 (42 pages prepared for Arup and OSHPD for Kaiser Santa Clara Medical Center and submitted 25 Feb 2003 for review).
- Submittal entitled "Design Calculations for Unbonded Braces," by Ian Aiken, dated 6 Feb 2003 and submitted for review 28 February 2003.
- Specification entitled "UCSF Mission Bay Campus Community Center Building 21B, Specifications, Construction Documents," dated 13 November 2002. 2 Volumes. (1,016 pages; R+C reviewed BRB Specification Section 13085).
- "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards," by John Egan dated 18 December 2019.
- Calculations provided by Forell/Elsesser.
    - "90% Construction Document Structural Calculations, Volume 1 of 2, UCSF Mission Bay Campus Community Center (Bldg 21B), by Forell/Elsesser, dated 8 November 2000.
    - "90% Construction Document Structural Calculations, Volume 2 of 2, UCSF Mission Bay Campus Community Center (Bldg 21B), by Forell/Elsesser, dated 8 November 2000.
- Geotechnical report entitled "Geotechnical Investigation, Building 21B, UCSF – Mission Bay, San Francisco, CA," by Treadwell & Rollo, dated 18 November 1999.

Additional building information known to exist

UCSF indicated they have extensive project files; the Nippon submittals were retrieved from their archives at our request.

Scope for completing this form

The architectural and structural drawings for the original 2002 construction are used as the basis for the completed ASCE 41-17 Tier 1 evaluation. The building was designed per the 1998 California Building Code (CBC) which uses the underlying provisions of the 1997 Uniform Building Code (UBC). The Nippon Steel Corporation submittals were reviewed. A site visit was not part of this scope of work due to shelter-in-place orders; photographs presented here were extracted from Google Earth and Google Street View. The ASCE 41-17 criterion and the UC Facilities Manual, UC Seismic Program Guidelines criterion for a BRBF benchmark building are that the design complies with the 2006 International Building Code (IBC) which is referenced by the 2007 California Building Code (CBC). Several Tier 1 type checks were made to assess whether the design is in conformance with the benchmark 2007 CBC/2006 IBC that was based on provisions in ASCE 7-05 and the AISC 341-05 underlying provisions for steel buildings. An ASCE 41-17 Tier 1 evaluation was also performed for comparison.

Brief description of structure

The Rutter Center (originally designated Building 21B) houses the UCSF Mission Bay Campus Community Center and various athletic facilities. It is located at 1675 Owens Street and abuts an adjacent parking garage (Building 21A) along a portion of the west side and has pedestrian walkways to the north and east. The building has many irregularities including large floor openings, an atrium, two elevated swimming pools, an outdoor roof deck, a decorative "clock" tower, offset low and high roof levels, a partial 3rd floor, and a large gym with long span girders. It is a steel framed building with Buckling Restrained Braced Frames (BRBF) for the lateral force-resisting system in both directions. It was constructed in 2002 before design standards were adopted for this type of lateral system. The footprint at the ground floor is 275'-0" in the north-south direction and 225'-2" in the east-west direction. While there is construction at several levels (2nd, 3rd, 4th, low roof, high roof, tower roof), we have idealized it as a three-story building for the purposes of this Tier 1 check and considered the 2nd, 4th, and combined low and high roof levels as the structural levels of the building. It was constructed on a flat site with poor soils that are subject to liquefaction but founded on piles driven to refusal. There is public assembly space on the first floor, and there are athletic facilities throughout the building. It appears there may be heavy mechanical equipment in the building, but mechanical drawings were not available for review to assign specific weights for mechanical equipment. The exterior cladding consists of EIFS panels.

Identification of levels: The top of concrete building levels are designated as the first floor (EL. 0.0'), the second floor (EL. 22.0'), the third floor (EL. 36.0'), the fourth floor (EL. 50.0'), the Low Roof (EL. 79.4'), the top of steel at low edge of sloping High Roof (EL. 83.5'), and top of steel at Tower Roof (EL. 142.33'). The exterior grade is flat. For this evaluation, we have assigned the partial third floor weights to the fourth floor level, combined the Low and High Roof weights at the Low Roof Level, and neglected the Tower weights above the Low Roof as this structure is braced independently with conventional steel braces.

Foundation system: The structural drawings state the design was based on Soil Type E. The building is founded on pile caps supported by 14" square precast prestressed concrete piles driven to an elevation of approximately -87.0 ft. According to "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards," dated 18 December 2019 by John Egan, the piles were driven to refusal. The pile caps are supported by 2, 3, or 4 piles. The slab-on-grade is comprised of a 12" thick concrete slab. The column grid is irregular; column spacing ranges from 15'-4" to 32'-0".

Structural system for vertical (gravity) load: Rutter Center contains a complete gravity load-bearing steel framing system with an irregular column grid due to the large atrium, high ceiling gym, partial third floor, Low and High Roof levels, suspended swimming pools, and other features of the building. The column spacing ranges from 15'-4" to 32'-0". Columns and beams are all rolled wide flange shapes except for several built-up plate girders that function as transfer girders or large spans. The typical floor framing consists of 3" metal deck with 4 ½" of normal weight concrete fill that typically spans between 7ft to 11 ft between steel beams. There are several deck sections, but the typical deck profile is 18 gage Verco W3 Formlok deck or similar. Some framing members have 3/4" dia. headed studs. The High Roof has metal deck without fill that spans to steel trusses in both directions. The Tower structure is 15'-4" square in plan and rises to a height of 142'-4" and is braced independently above the level of the Low Roof with conventional steel braces.

Structural system for lateral forces: This is a Model Building Type S2 steel braced frame with a combination of flexible and rigid diaphragms in both directions. The lateral force-resisting system is comprised of Buckling Restrained Braced Frames (BRBF) in both the N-S and E-W directions. In the longitudinal (N-S) direction, the building has ten braced bays along five grid lines at the first story. This varies over the height with six brace bays from the fourth-floor level to the Low Roof level. Two braced bays on Gridine J only extend from the fourth-floor level to the Low Roof level and are discontinuous below. In the transverse (E-W) direction, the building has thirteen braced bays along seven grid lines at the first story. This varies over the height with six braced bays from the fourth-floor level to either the Low or High Roof levels. One bay of braces on Gridline 3 only extends from the third-floor level to the Low Roof level and is discontinuous below. The braces are all concentric and include a mix of single diagonal braces, V-braces, and chevron braces. Some braces are located to take loads from the partial third floor areas or the two suspended swimming pools at the second and fourth floor levels. Other braces are located along the perimeter of the gym area above at the fourth floor. Braces are reasonably well distributed in both directions with a maximum diaphragm span of 117 ft. The third story has only partial diaphragms. Braces that run through the high bay spaces where there are no diaphragms run the full distance from the second floor to the third floor. As a result, there are no multi-tier braced frames. The floor diaphragms typically consist of 3" deep 18 gage metal deck with 4 ½ normal weight concrete fill and ¾" diameter shear studs. Beam connections along the grid lines with braced bays typically include double rows of bolts or multiple rows of bolts with web doubler plates.

The BRB elements were provided by the Nippon Steel Corporation and include a mix of flat bars and cross-shaped brace elements encased in HSS tubes filled with concrete. The flat bar is Type "-" and the cross-shaped is Type "+". The outer tubes are all either HSS10x10, HSS12x12, or HSS14x14. Based on the BRB schedule and the values indicated on the BRB elevations, the BRB maximum brace yield force ranges from 150 kips to 450 kips. Uniaxial cyclic testing was performed on the braces for another project for Kaiser Permanente; no subassemblage test specimen testing of the BRB assemblies is indicated in the Nippon submittals.

The building has BRB elements by Nippon Steel Corporation. Footnote "f" in the UC Facilities Manual table for Benchmark Building Codes and Standards indicates there is no UBC benchmark year for BRBs. The first consensus standard in the U.S. for BRBFs was AISC 341-05, which was referenced by ASCE 7-05, which was in turn referenced by the 2006 IBC. This project was designed in 2002 prior to inclusion of BRB design provisions in the code, but the project would have required a peer review and the 2001 AISC/SEAOC Recommended Provisions for Buckling-Restrained Frames (which led to the later standards) were published in October 2001 and may have been available in draft form at the time of this design. The design used an *R* value of 6.4 and an *I* value of 1.0 with a design base shear of *V=0.14W*. The design appears to have generally followed the AISC/SEAOC recommendations that were later adopted except that subassemblage test specimen testing of the BRB assemblies was not performed as part of this project.

<u>Building condition</u>: Unknown. No site visit was made due to shelter-in-place orders.

<u>Building response in 1989 Loma Prieta Earthquake</u>: Not applicable; built after the Loma-Prieta Earthquake.

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

Identified and potential seismic deficiencies of the building include the following:

- The ASCE 7-05 check for the beams of a sample BRB chevron-braced bay indicates that the members have acceptable DCRs using the criteria from the benchmark code.
- A comparison with *UC Seismic Safety Policy* requirements for Seismic Performance Level III was made by comparing the values for BSE-1NS obtained from J. Egan to the ASCE 7-05 S_{DS} values. On this basis, the building does not qualify for the SPL III rating.
- The Tier 1 Quick Check for the average axial stress in the braces shows the braces are overstressed at all floors in both directions. This is largely because the forces used for the ASCE 41-17 check are significantly higher than those used for design, but they are also higher than would be required by current code.
- The BRB testing by Nippon in 2001 was limited to uniaxial cyclic testing of the braces. No subassemblage test specimen tests were performed of the BRB brace assemblies.
- Per "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards" by Egan (2019), the mapped liquefaction potential is very high but Note jj states "Available design drawings indicate buildings are supported on piles driven to refusal, so liquefaction-related hazard to building is probably low." Liquefaction has not been included as a structural deficiency for this evaluation.
- Some of the columns do not meet the criteria for compact sections.
- The building has many BRB braced bays in each direction but also has numerous irregularities, making it difficult to make a fair assessment of the structure with Tier 1 hand calculations. Our results are influenced by the simplifications made for this Tier 1 check. To aid our review, we obtained the original calculations from the structural engineer of record which were based on three-dimensional modeling and provide a more refined characterization of the load distribution throughout the braces. Details are described ahead.

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)	Y	URM wall height-to-thickness ratio	N
Torsion	N	URM parapets or cornices	N
Mass – vertical irregularity	Y	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 nonstructural life-safety concerns, including at exit routes. [2]

Unknown. No site visit was conducted due to shelter-in-place orders.

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

Basis of Seismic Performance Level rating

Rutter Center has a rectangular plan with many interior irregular features. The braced bays are well-spaced in both directions, but the building has a large atrium, two elevated swimming pools, and elevated mechanical room, large transfer girders, long spans at the gym, roof trusses, offset floor levels, and other geometric irregularities.

Based on reviews of other BRBFs designed prior to the adoption to AISC 341-05 and later standards, there are two potential issues of concern—the design force level and the rigor of the BRB testing done by the vendor. Per the attached general notes, using Soil Type S_e, an *R* factor of 6.4, and an Importance Factor $I = 1.0$, the design base shear was V=0.14W. Per the benchmark ASCE 7-05, assuming $I = 1.25$ and $R = 8$, the design base shear is the lower of V/W = $[S_{DS} / (R / I_e)] = [0.9]/ (8 / 1.25)] = 0.14g$ (governs) or $V/W = [S_{D1} / (T (R/I_e))] = [1.014 / (0.51 \times (8/1.25))] = 0.31g$, where $T = C_t h_n^{3/4} = 0.02 (75)^{3/4} = 0.51$ sec. This is the same as the design base shear. Per the current ASCE 7-16, assuming $I = 1.25$ and $R = 8$, the design base shear is the lower of $V/W = [S_{DS} / (R / I_e)] = [1.3)/ (8 / 1.25)] = 0.20g$ (governs) or $V/W = [S_{D1} / (T (R/ I_e)] = [1.68 / (0.51 \times (8/1.25)] = 0.51g$, where $T = C_t h_n^{3/4} = 0.02 (75)^{3/4} = 0.51$ sec. Thus, the design base shear was the same as the benchmark code but lower than would be required by current code (0.14g vs 0.20g). On this basis, the building would not qualify for a Seismic Performance Level Rating of III.

[2] 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.

The average brace axial stresses computed using the benchmark ASCE 7-05 code are at 0.9Fy at the top story but within acceptable limits at the lower floors. In addition, the beams of a sample BRB chevron-braced bay were checked in detail using ASCE 7-05 and found to be within acceptable limits. Connections are adequate to develop the adjusted strength of the brace. There are many issues related to noncompact column sections, irregular framing, diaphragm openings, BRB discontinuities, offset floors that are difficult to judge based on this Tier 1 check using hand calculations. Various simplifications of floor levels and lumped masses were made for this Tier 1 check and these simplifications may negatively affect the rating, particularly at the upper story where the average axial stress in the braces appears higher than the allowable. As a result, we obtained the original structural calculations for the building which were based on a three-dimensional model. They have the same base shear as ASCE 7-05 and show a target demand-capacity ratio (DCR) of about 0.8. Based on model results where the DCR was over this they enlarged the BRB core area, with the resulting largest DCR of about 0.84. They also have a more refined determination of seismic weight at each level. For comparison, we scaled the ASCE 41-17 Tier 1 results by the weights in the original calculations and by a factor of 0.8 to represent the calculation typical maximum DCR. This resulted in an adjusted Tier 1 maximum DCR of 1.09 at the top story in the north-south direction and a maximum of 0.82 at the second story in the east-west direction.

Although there are noncompact sections and geometric irregularities, the building is assigned a Seismic Performance Level Rating of IV as it meets the ASCE 7-05 benchmark requirements for force demands and generally meets the underlying AISC 341-05 detailing requirements.

Recommendations for further evaluation or retrofit

No additional assessment is required.

Peer review comments on rating

The structural members of the UCSF Seismic Review Committee (SRC) reviewed the evaluation on 23 June 2020 and were unanimous that the Seismic Performance Level Rating is Level IV. No additional assessment is required.

Additional building data	Entry	Notes
Latitude	37.76808	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Longitude	-122.39301	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Are there other structures besides this one under the same CAAN#	No	
Number of stories above lowest perimeter grade	3	Considering 2nd, 4th and combined roof levels as 3 structural levels
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	153,879	??
Risk Category per 2019 CBC 1604.5	III	
Building structural height, h_n	75.0 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
Estimated fundamental period	0.51 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18

Site data		
975-year hazard parameters S_s, S_1	1.380g, 0.532g	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Site class	E	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Site class basis	Estimated	
Site parameters F_a, F_v	1.3, 4.2	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Ground motion parameters S_{cs}, S_{c1}	1.794g, 2.236g	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
S_a at building period	1.794g	
Site V_{s30}	308 m/s	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
V_{s30} basis	Estimated	
Liquefaction potential/basis	No	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019). Note jj
Landslide potential/basis	No	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Active fault-rupture hazard identified at site?	No	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Site-specific ground motion study?	No	
Applicable code		
Applicable code or approx. date of original construction	Built: 2003 Code: 1998 CBC/ 1997 UBC	
Applicable code for partial retrofit	None	
Applicable code for full retrofit	None	No full retrofit known
Model building data		
Model building type north-south	S2 (BRB) Steel Braced Frames with Rigid Diaphragms	
Model building type east-west	S2 (BRB) Steel Braced Frames with Rigid Diaphragms	
FEMA P-154 score	N/A	Not applicable as an ASCE 41 Tier 1 evaluation was performed
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

DESIGN BASIS

THE DESIGN IS IN ACCORDANCE WITH THE CALIFORNIA BUILDING CODE, 1998 EDITION, AND PROVIDES FOR THE FOLLOWING LOADS:

LIVE LOADS

ROOFS	20 PSF
FLOORS, CORRIDORS, STAIRS	100 PSF
GYMNASIUM	100 PSF
AUDITORIUM	50 PSF
STAGE	125 PSF
OFFICES	80 PSF
MECHANICAL ROOM	100 PSF

WIND LOADS
1998 CBC, 70 MPH ZONE, EXPOSURE C

SEISMIC LOADS
V = 0.14W (ZONE 4, SOURCE TYPE A, SOIL TYPE Se, I=1.0, Na=1.0, Nv=1.08)
LATERAL RESISTING SYSTEM: UNBONDED BRACED FRAME, R = 6.4

STRUCTURAL STEEL

REFER TO SPECIFICATIONS FOR COMPLETE REQUIREMENTS.

STEEL MATERIALS SHALL CONFORM TO THE FOLLOWING:

WIDE FLANGE SHAPES	ASTM A992, GRADE 50
PLATES	ASTM A572, GRADE 50
CHANNELS AND ANGLES	ASTM A36
TUBES	ASTM A500, GRADE B
PIPES	ASTM A53, GRADE B
BASE PLATES	ASTM A36, ASTM A572, GRADE 50
ANCHOR BOLTS	ASTM A307 OR A36
MACHINE BOLTS (M.B.)	ASTM A307
HIGH STRENGTH BOLTS (H.S.B.)	ASTM A325-SC, N, X
WELDED STUDS	ASTM A108

ALL STRUCTURAL STEEL SHALL CONFORM TO AISC SPECIFICATIONS FOR THE DESIGN, FABRICATION, ERECTION OF STRUCTURAL STEEL FOR BUILDINGS.

CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR REVIEW PRIOR TO FABRICATION. FABRICATE FROM APPROVED SHOP DRAWINGS ONLY.

WELDING SHALL ONLY BE DONE BY CERTIFIED WELDERS. ALL WELDING SHALL CONFORM TO AWS SPECIFICATIONS. PROVIDE TEMPORARY BACK-UP PLATES OR WELDS AT ALL COMPLETE PENETRATION (CP) WELD LOCATIONS; REMOVE PLATES AFTER CP WELDING AND GRIND AREA SMOOTH WHERE EXPOSED.

IN GENERAL, NO ATTEMPT HAS BEEN MADE TO DIFFERENTIATE BETWEEN SHOP AND FIELD WELDING OPERATIONS. WHERE FIELD WELDING IS SPECIFICALLY NOTED, THE DESIGNATION IS GIVEN AS A SUGGESTED CONSTRUCTION PROCEDURE ONLY. TRADE CONTRACTOR SHALL DETERMINE SUITABILITY OF SHOP OR FIELD WELDING FOR ALL CONDITIONS.

ALL SHOP AND FIELD WELDING SHALL BE INSPECTED BY AN APPROVED TESTING LABORATORY. SPECIAL INSPECTION REQUIREMENTS OF CHAPTER 17, 1998 CBC, APPLY TO ALL WELDING.

DO NOT CUT THROUGH ERECTED STEEL PLATES, BOLTS, ANGLES OR SHAPES WITHOUT PERMISSION OF THE ARCHITECT. AFTER CUTTING OR BORING, ALL SLAG AND ROUGH EDGES SHALL BE MECHANICALLY REMOVED TO PROVIDE A SMOOTH EDGE. ALL SURFACES CUT BY THERMAL PROCESSES SHALL BE GROUND (1/32 INCH MIN.) BRIGHT METAL.

ALL HIGH STRENGTH BOLTS SHALL BE SNUG TIGHT ONLY UNLESS OTHERWISE NOTED ON THE DRAWINGS. ALL BOLTED CONNECTIONS DESIGNED AS SLIP CRITICAL SHALL BE FULLY TENSIONED AND EQUIPPED WITH A DIRECT TENSION INDICATOR WASHER IN ACCORDANCE WITH THE SPECIFICATION.

STRUCTURAL ELEMENTS FASTENED TO CONCRETE BY DRILLED SLEEVE ANCHORS SHALL BE DRILLED TO PROPER SIZE TO ACCOMMODATE DIAMETER OF ANCHOR SLEEVE.

UNBONDED BRACES SHALL BE AS MANUFACTURED BY NIPPON STEEL. SEE SPECIFICATION.

SEE SPECIFICATION FOR SPECIAL REQUIREMENTS FOR ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS).
IN GENERAL, AESS IS NOT DESIGNATED ON THE STRUCTURAL DRAWINGS.

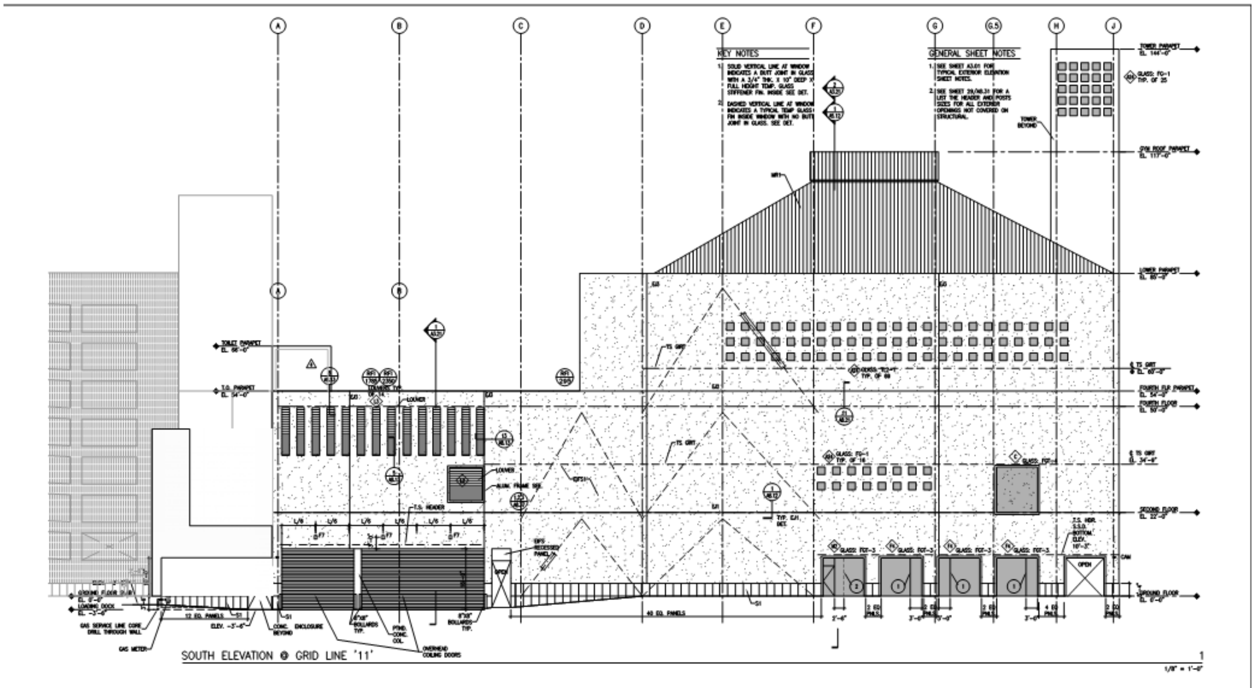
SPECIAL INSPECTION

THE SPECIAL INSPECTION REQUIREMENTS OF CHAPTER 17 OF THE 1998 CBC APPLY TO THE FOLLOWING:

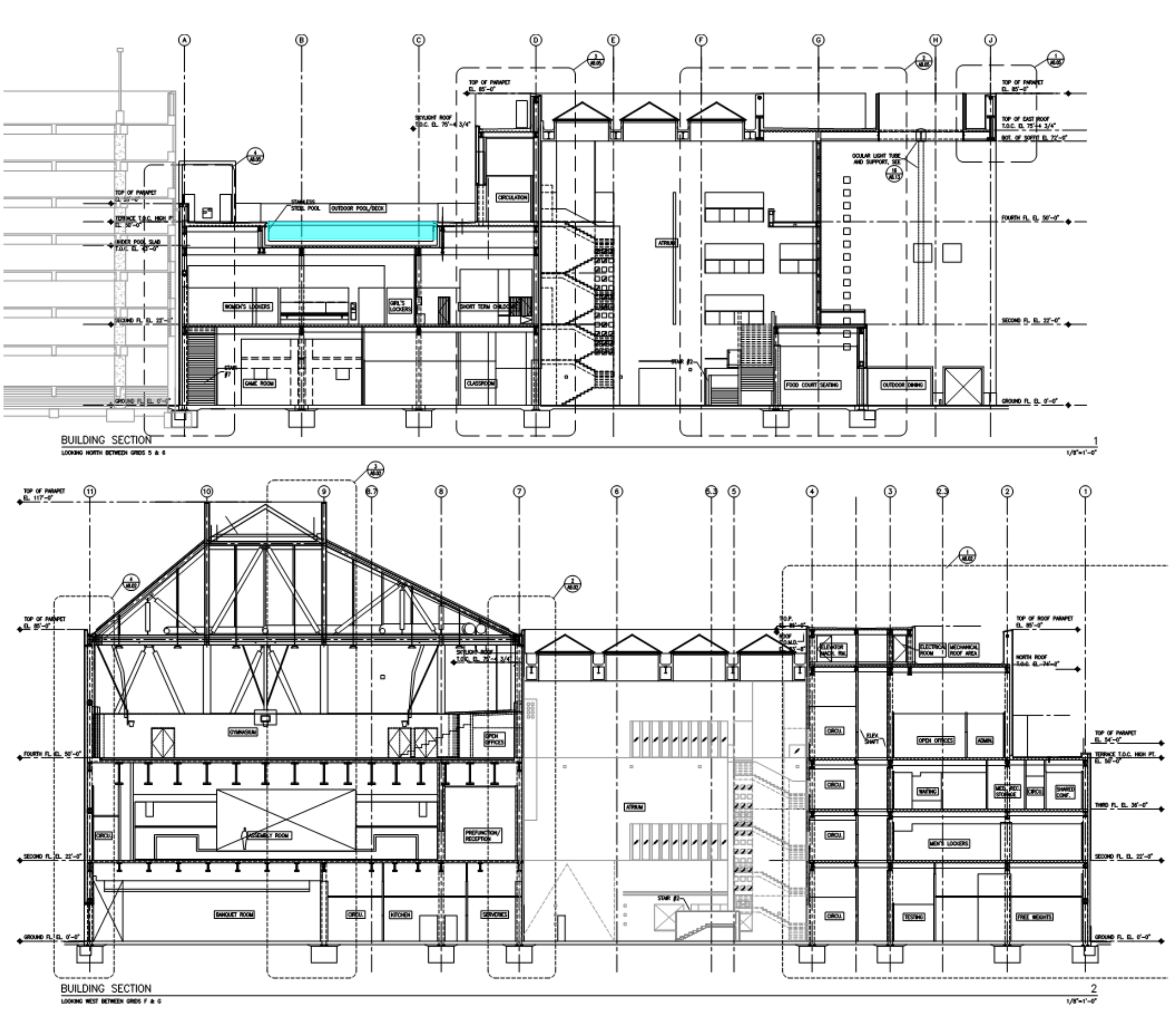
PILING
CAST-IN-PLACE CONCRETE
CAST-IN-PLACE ANCHOR BOLTS
REINFORCING STEEL
STRUCTURAL STEEL WELDING AND BOLTING
EPOXY DOWEL BARS
UNBONDED BRACES
REINFORCED CONCRETE MASONRY UNITS

SEE SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

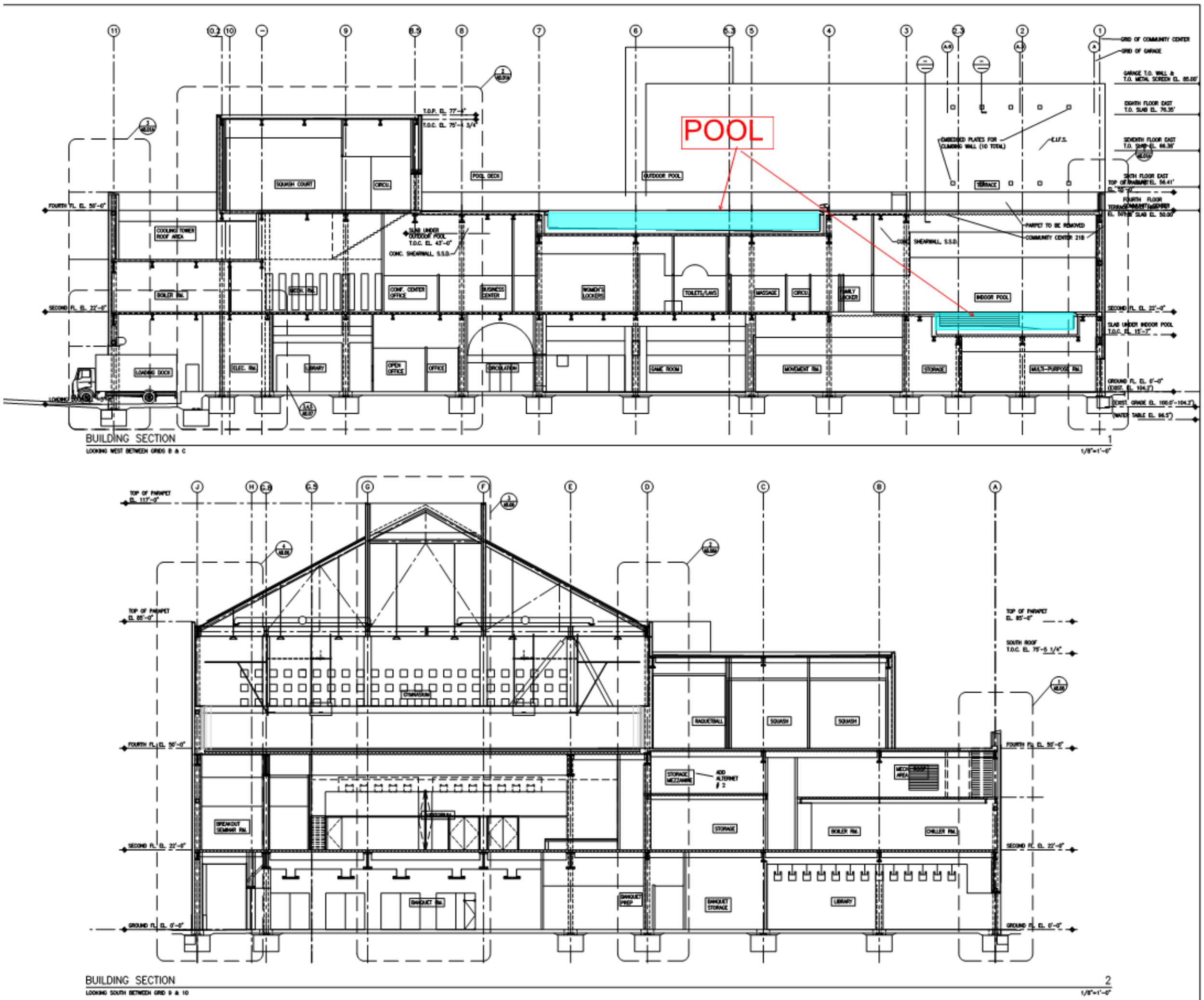
Design Basis and Steel Notes from Sheet S0.01 Dated June 2002 Showing Design Per 1998 CBC/1997 UBC, *V*=0.14*W*, *I*=1.0, *R*=6.4, Unbonded Braces Supplied by Nippon Steel Corporation



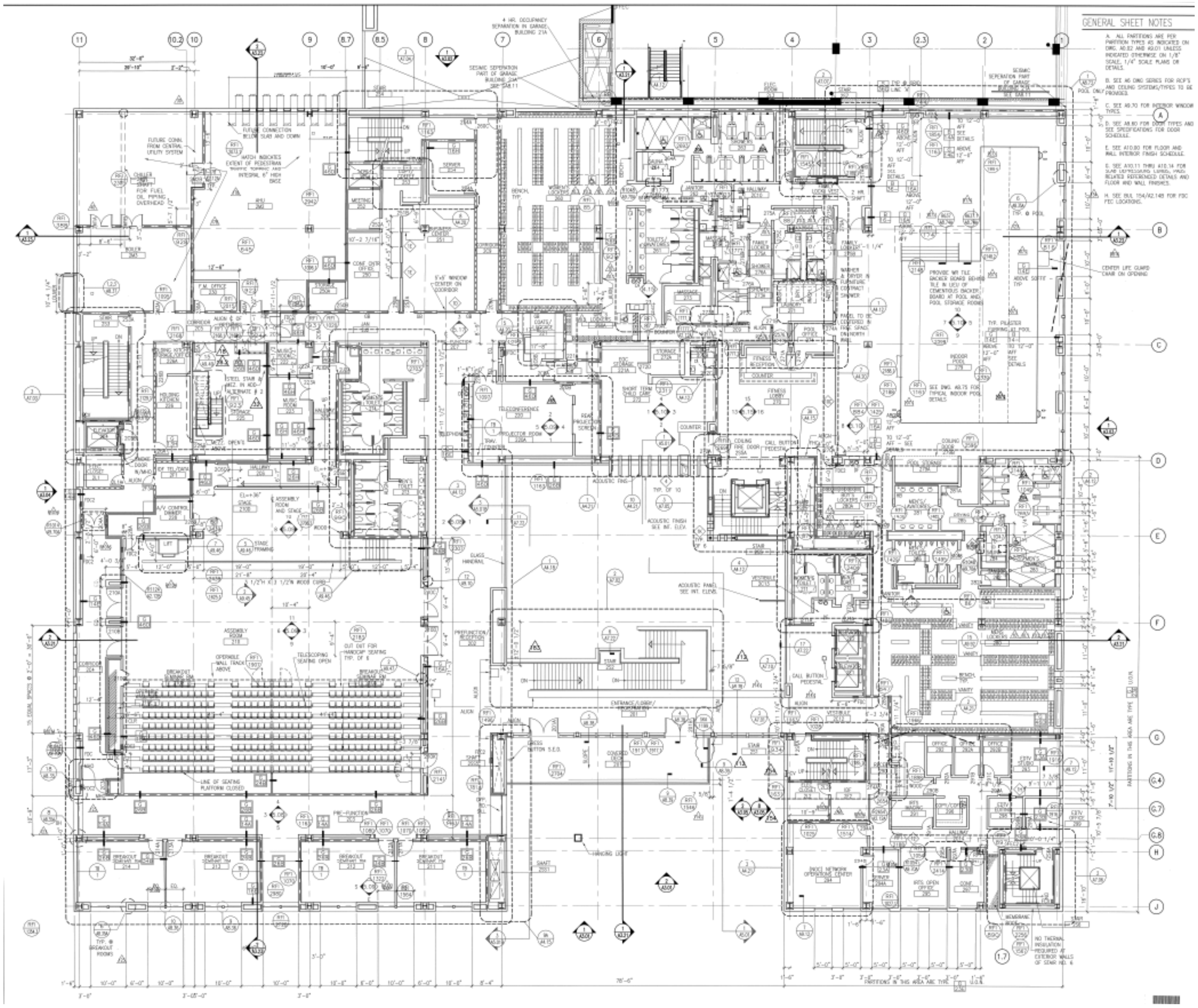
South Elevation of Rutter Center, Garage at Left



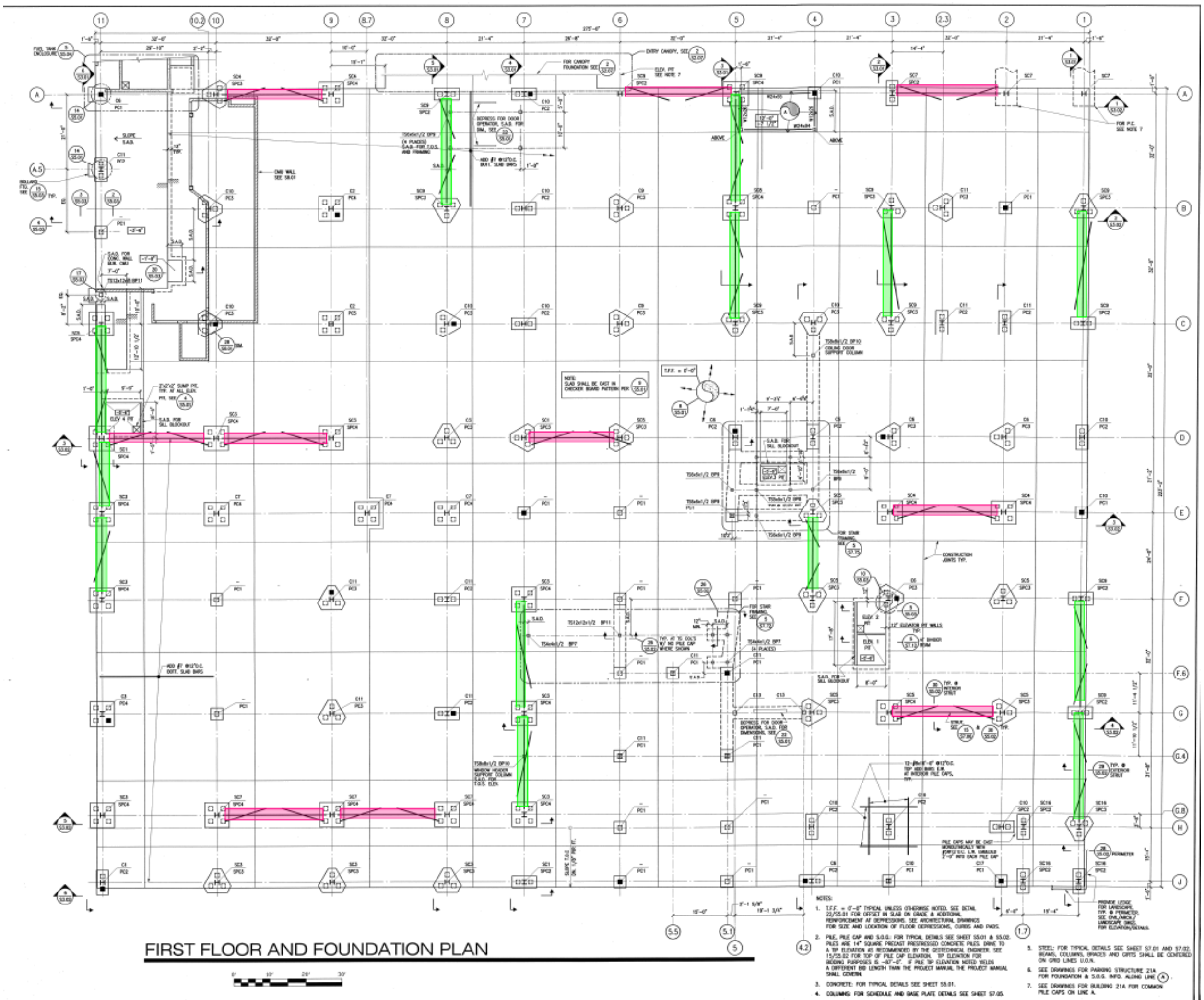
Architectural Sections Looking North (top view), Looking West (bottom view).



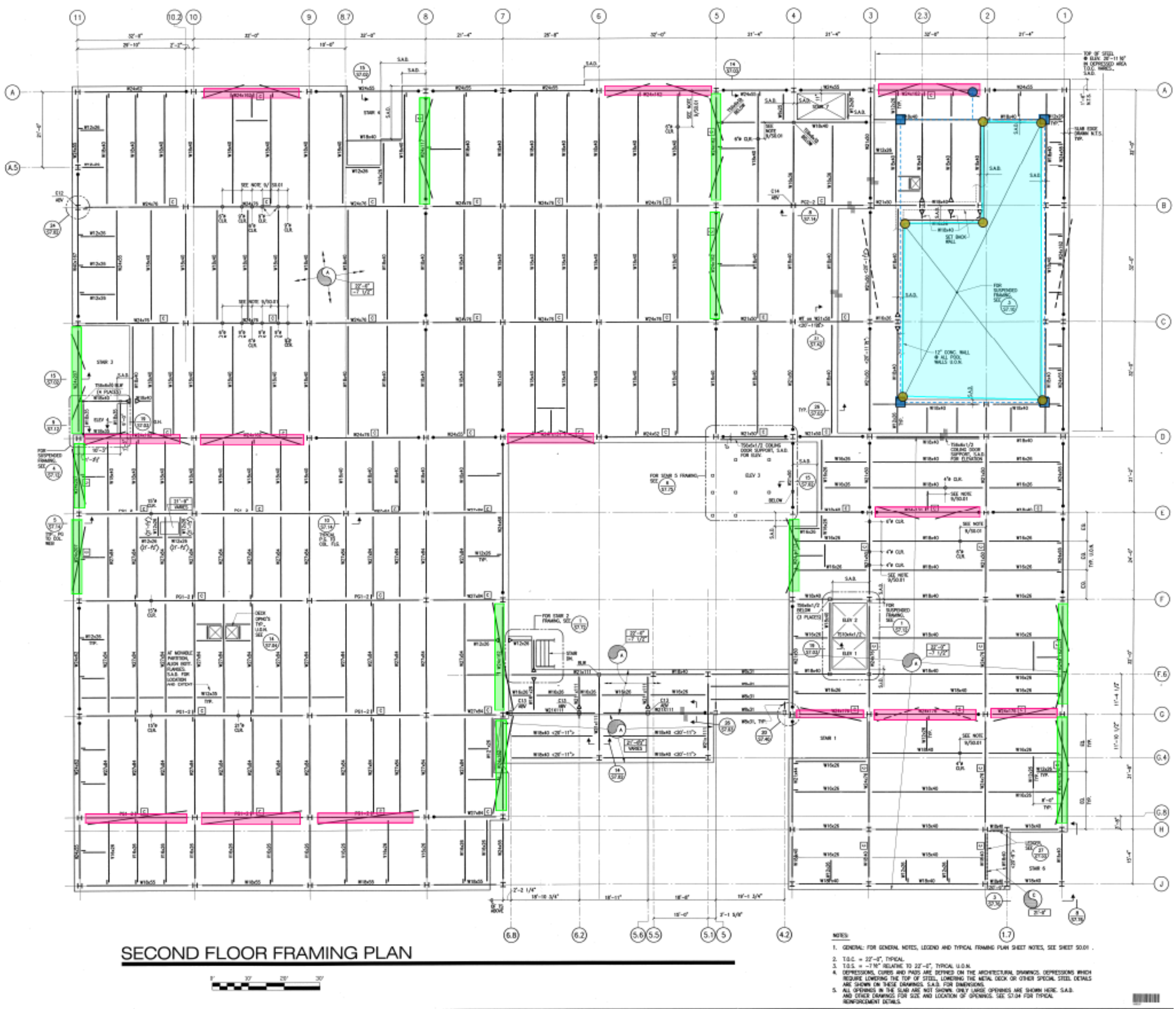
Architectural Sections Looking West (top view) and Looking South (bottom view)



Architectural Second Floor Plan showing Auditorium with Stage, Atrium with Bridge, Locker Rooms, Mechanical Rooms, and Swimming Pool

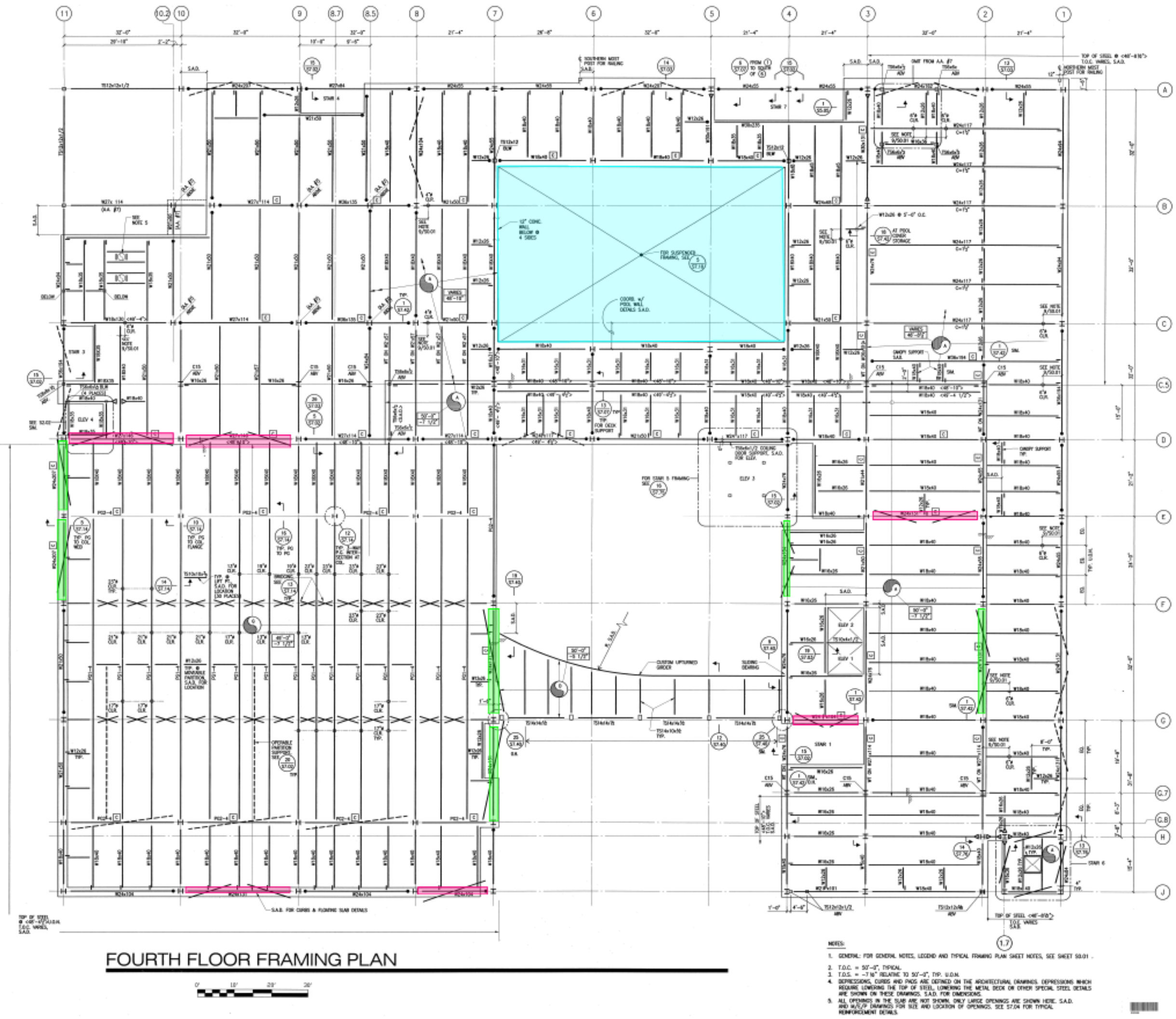


First Floor and Foundation Plan Sheet S2.01 with N-S BRBs (pink) and E-W BRBs (green). North is to the right in all plans.

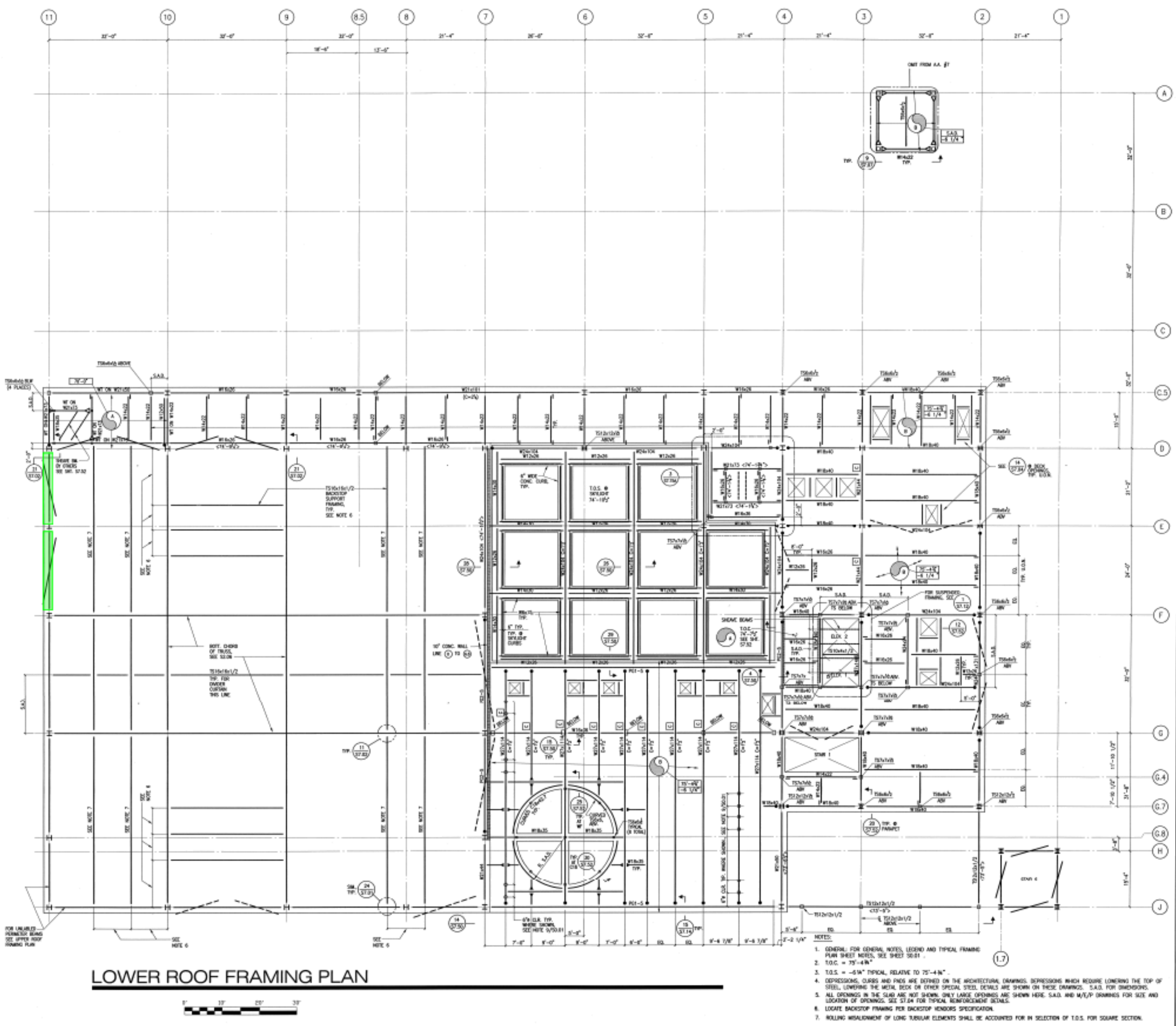


Second Floor Framing Plan Sheet S2.02 (Indoor pool at upper left)

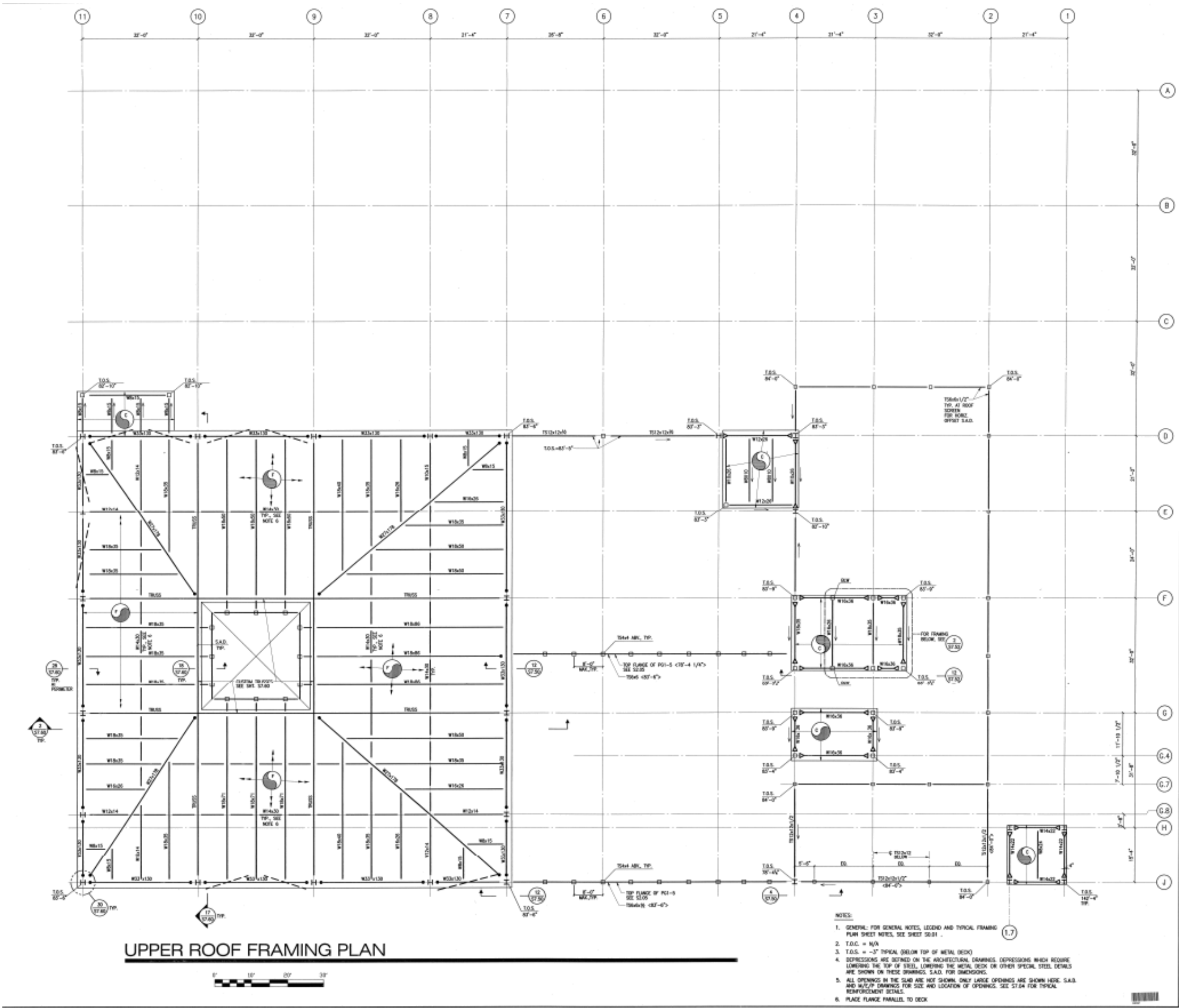
Third Floor Framing Plan Sheet S2.04 Showing BRB Frames, including Many that do not Engage Third Floor Framing



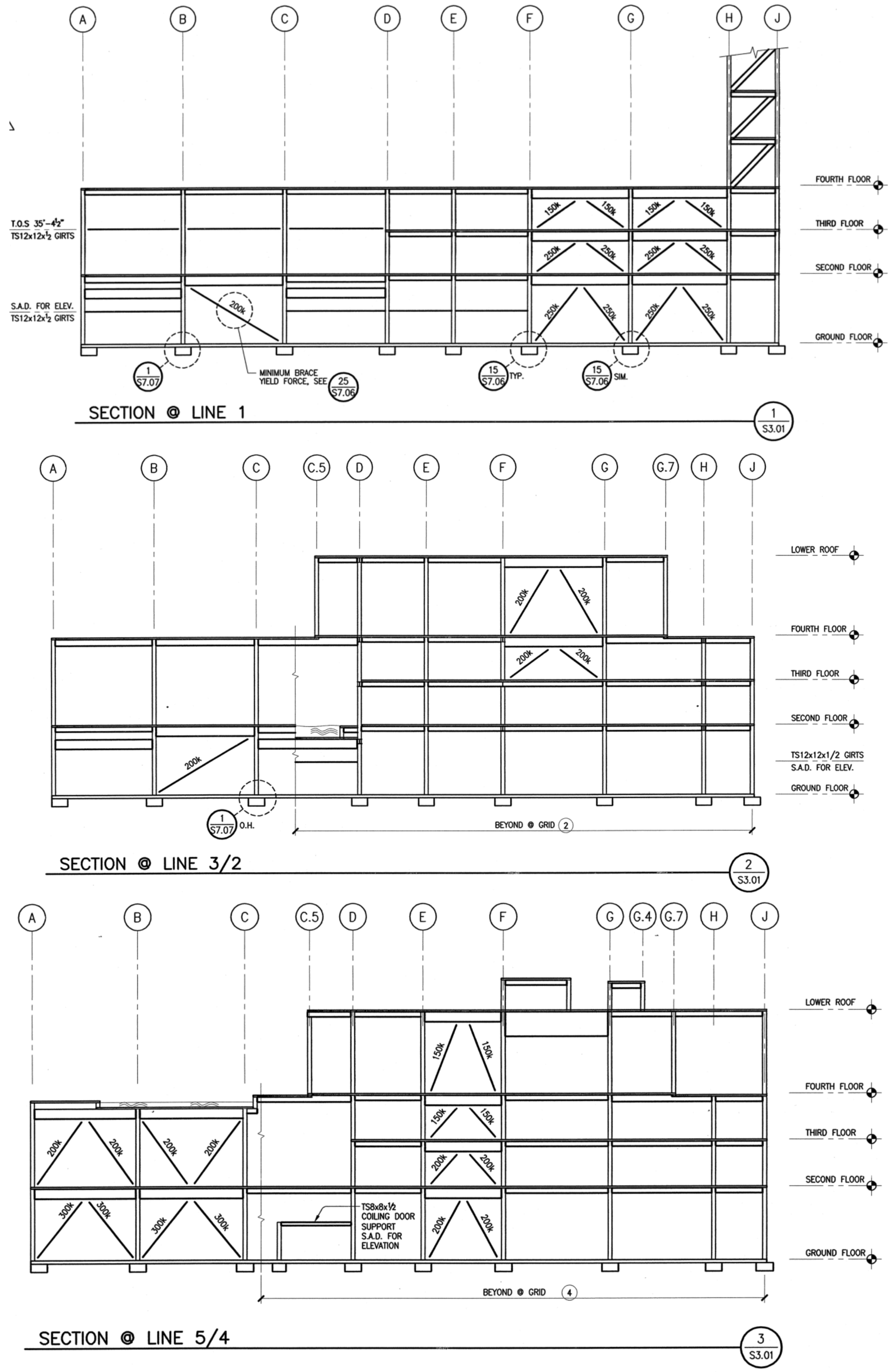
Fourth Floor Framing Plan Sheet S2.05 (west side of floor is outdoor deck and pool)



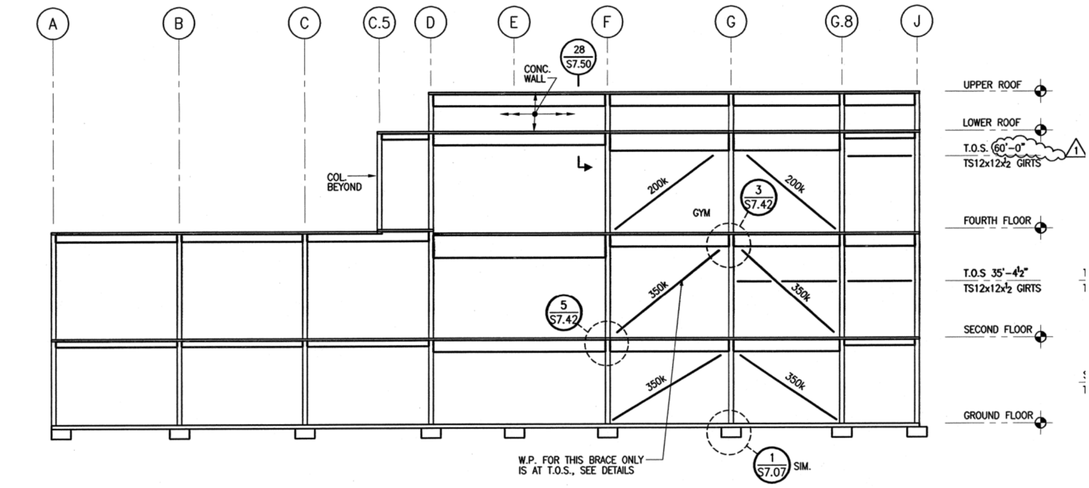
Low Roof Framing Plan Sheet S2.06



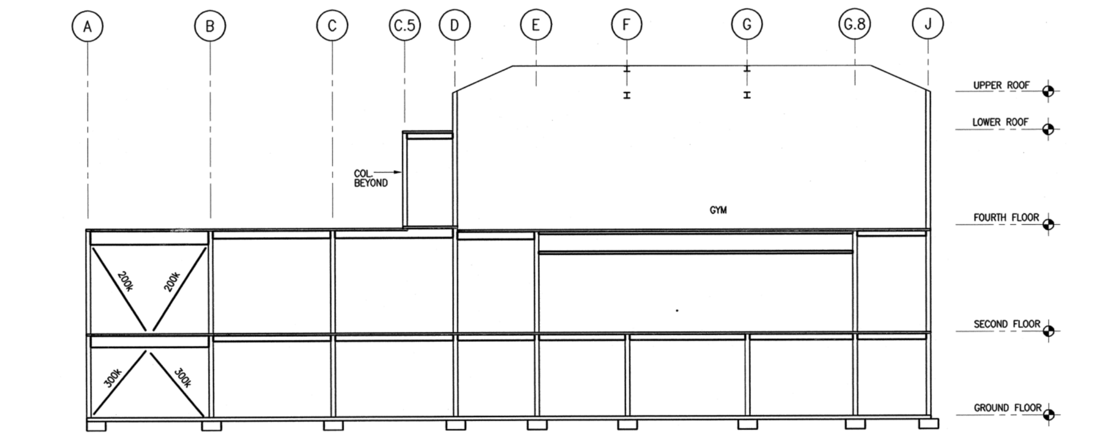
High Roof Framing Plan Sheet S2.07 (Tower at north east corner extends above this level)



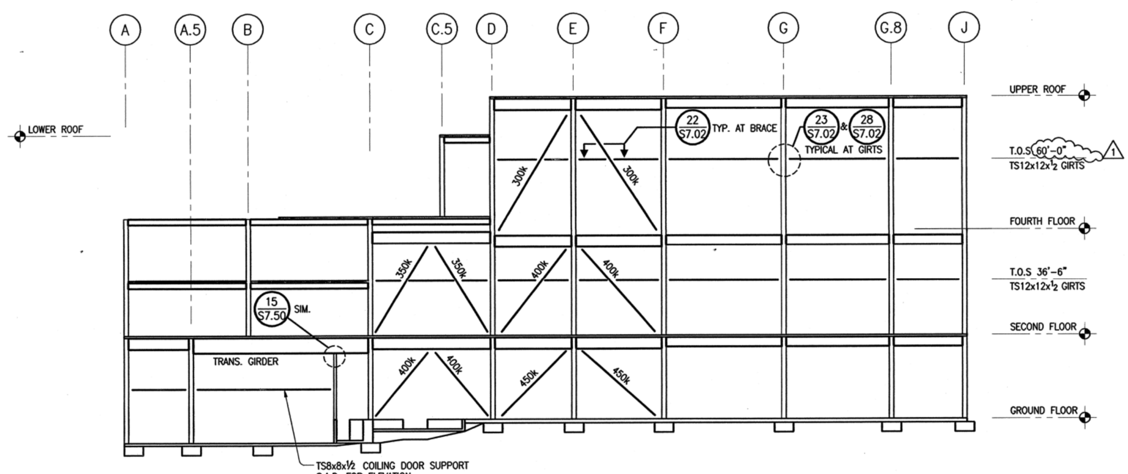
Transverse (E-W) BRB Frames. Thirteen braced bays at first floor. “Maximum Yield Force” from 150 kips to 450 kips from Sheet S3.01. Discontinuous braces at Line 3.



SECTION @ LINE 7 (4 / S3.01)

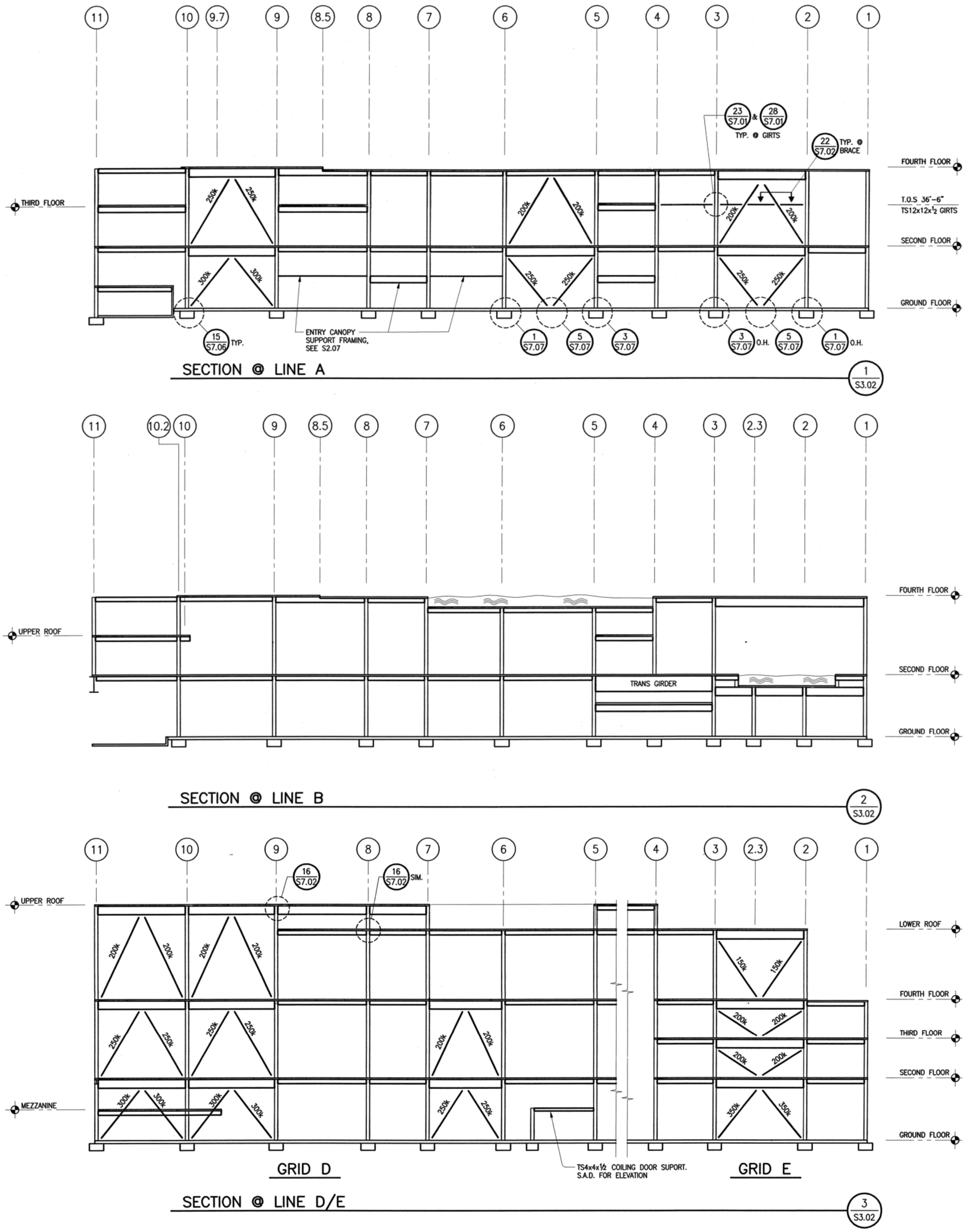


SECTION @ LINE 8 (5 / S3.01)

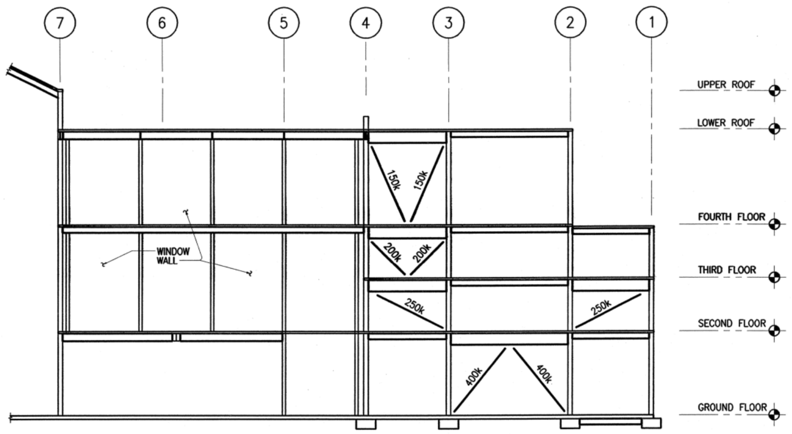


SECTION @ LINE 11 (6 / S3.01)

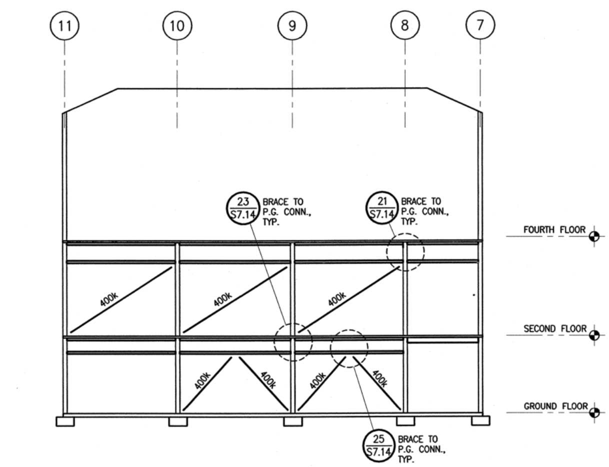
Transverse (E-W) BRB Frames. Thirteen braced bays at first floor. “Maximum Yield Force” from 150 kips to 450 kips from Sheet S3.01. Discontinuous braces at Line 3 (continuation).



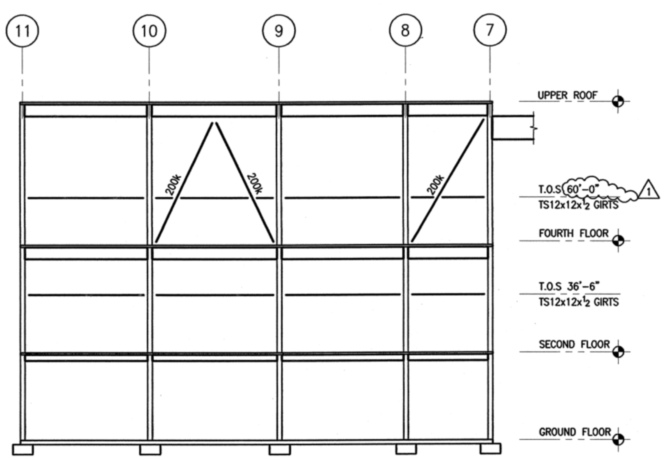
Longitudinal (N-S) BRB Frames. Ten braced bays at first floor. "Maximum Yield Force" from 150 kips to 450 kips from S3.02. Discontinuous Braces on Gridline J.



SECTION @ LINE G (4 / S3.02)

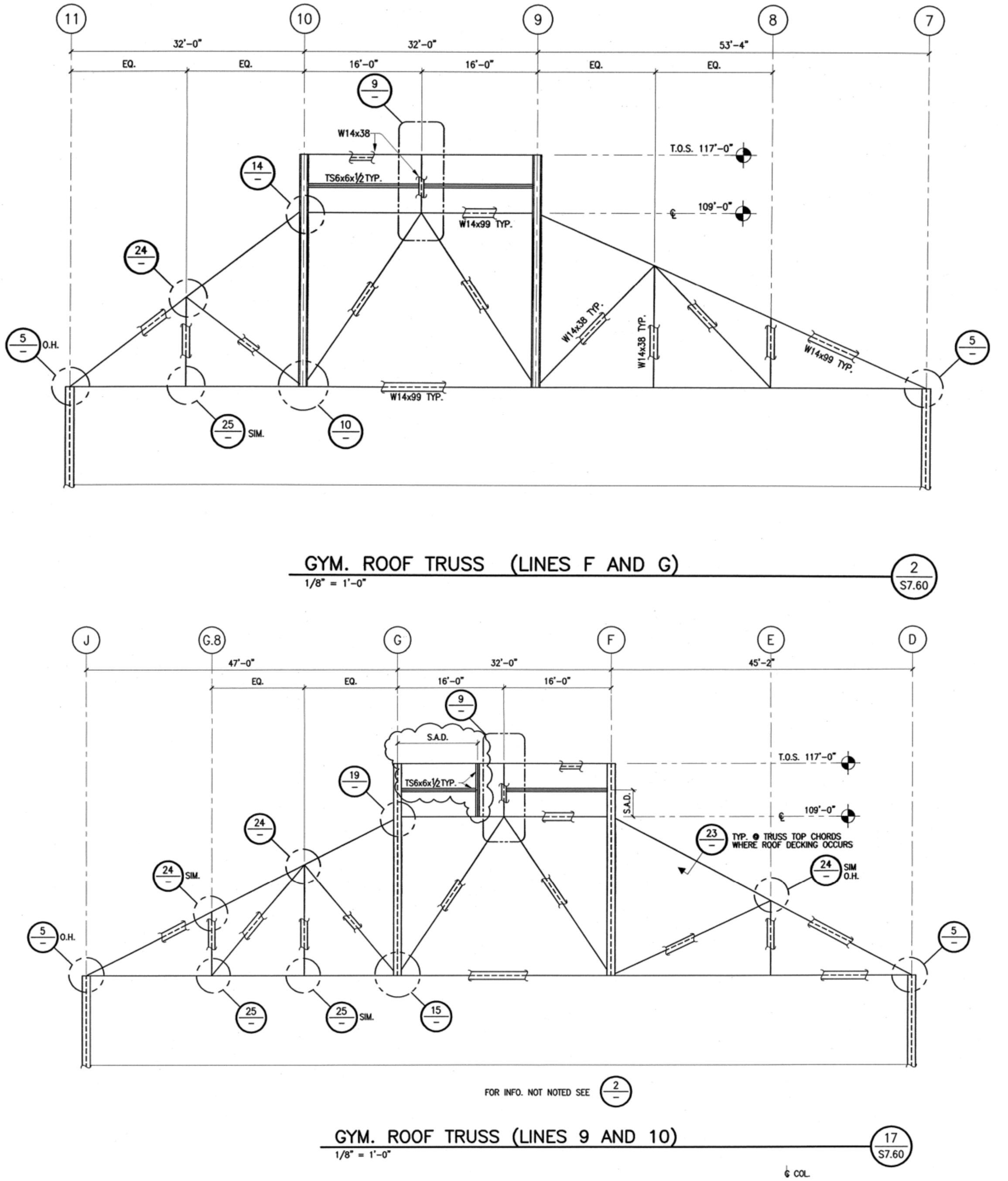


SECTION @ LINE G.8 (5 / S3.02)

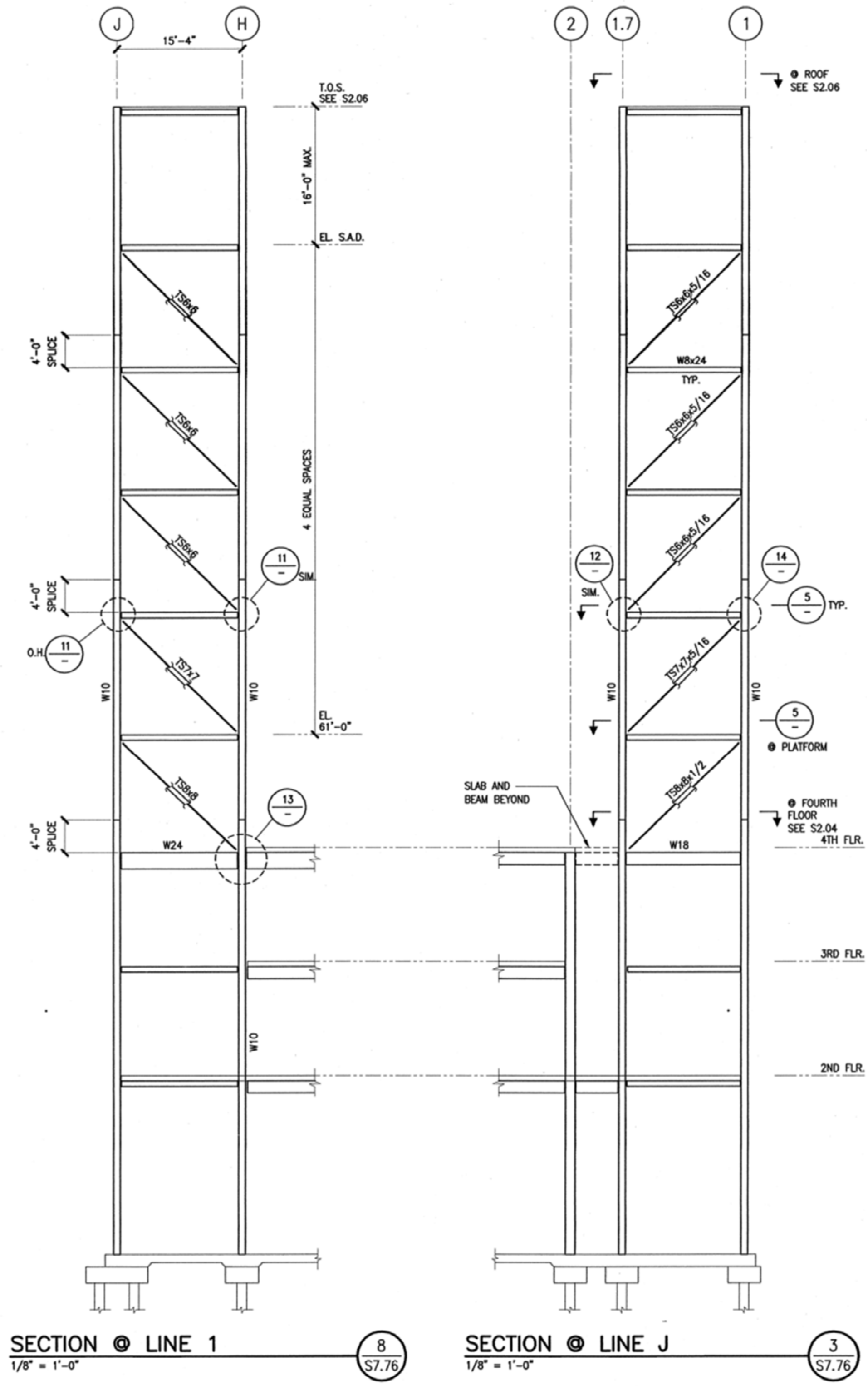


SECTION @ LINE J (6 / S3.02)

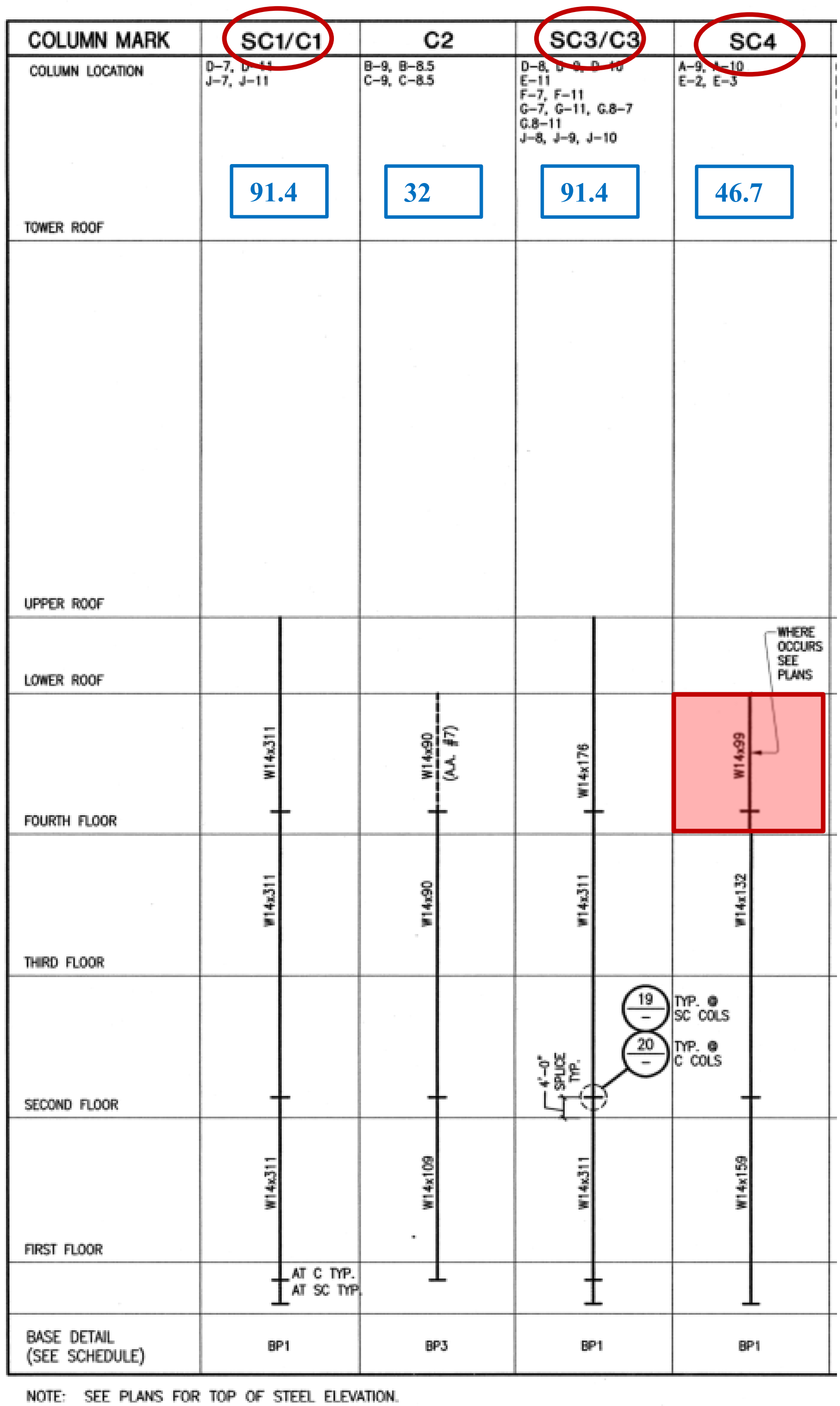
Longitudinal (N-S) BRB Frames. Ten braced bays at first floor. “Maximum Yield Force” from 150 kips to 450 kips from S3.02. Discontinuous braces on Gridline J (continuation).



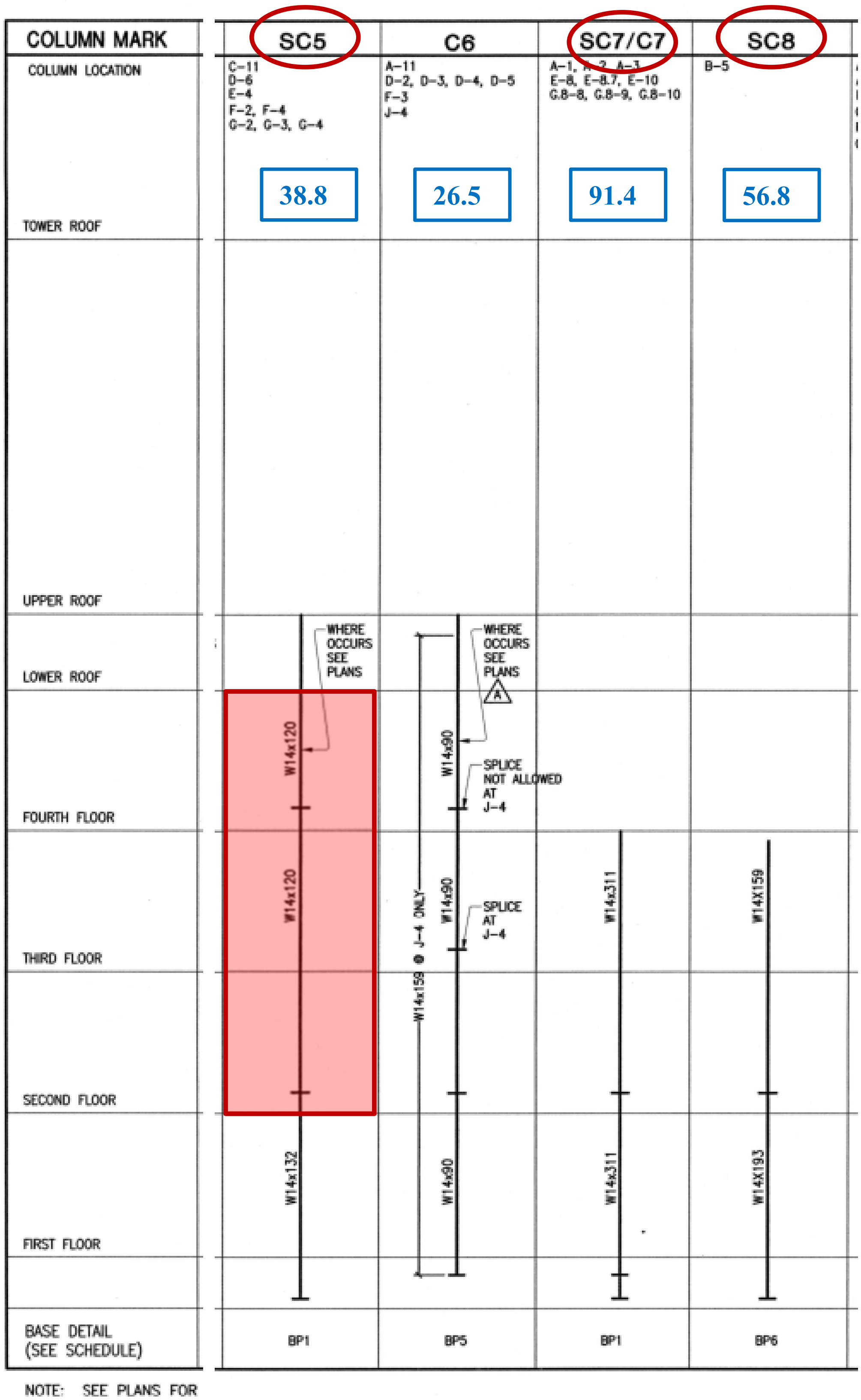
Framing at High Roof Above Gym



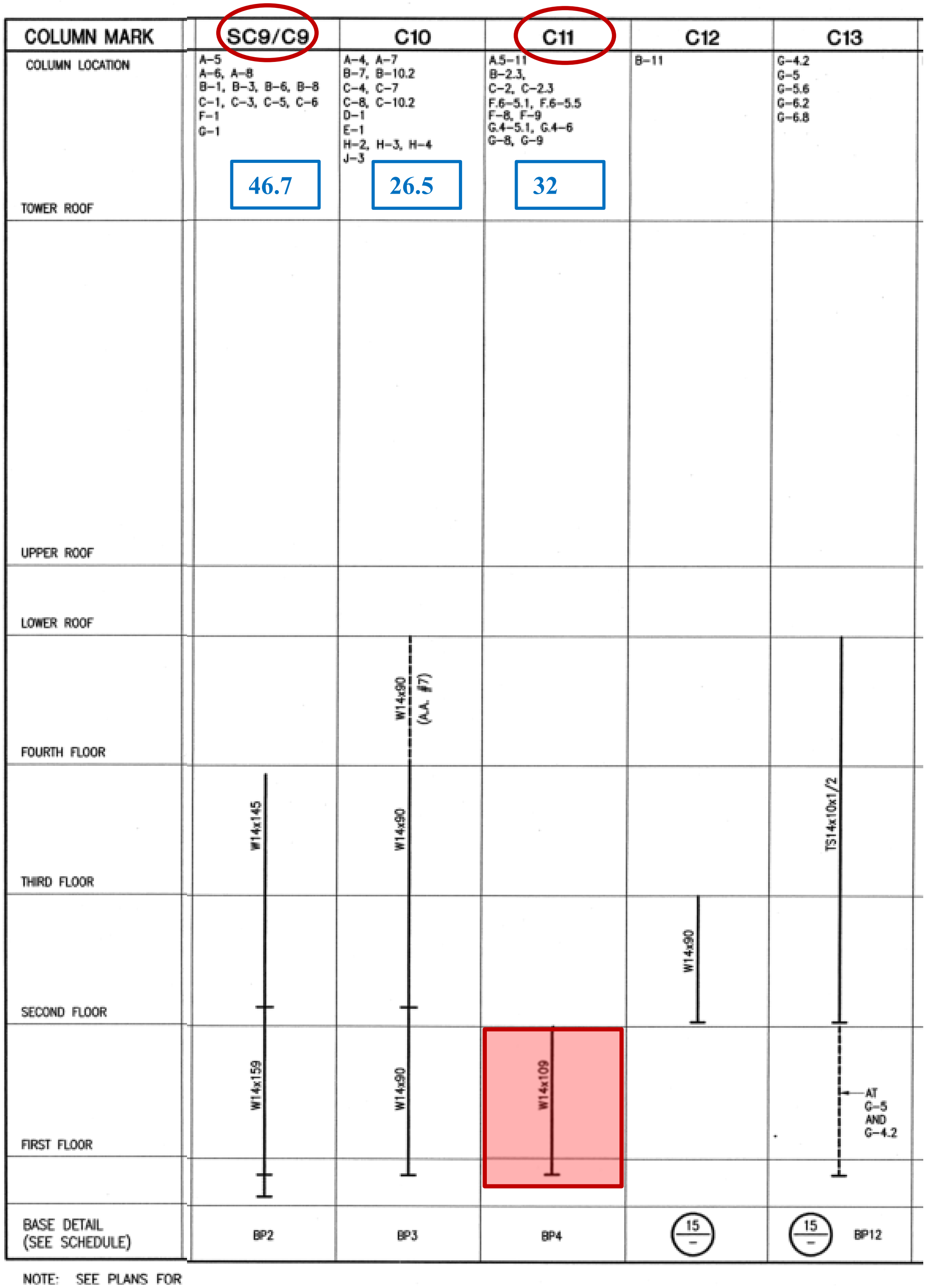
Framing for Tower at Northeast Corner of Building



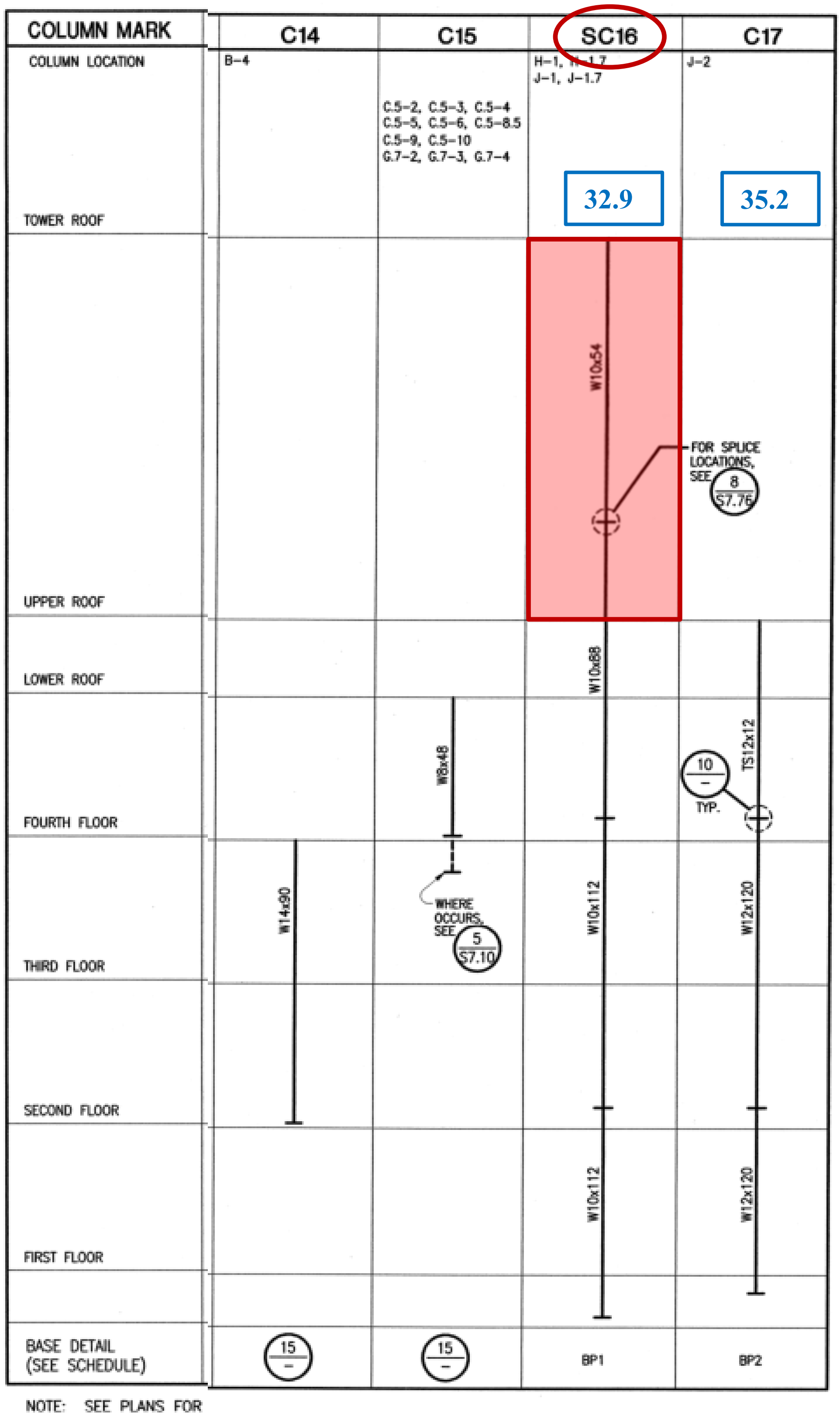
Column Schedule Sheet S7.05. All circled columns are in BRB Frames. Columns with red highlighting do not comply with compact section criteria in AISC 341-05.



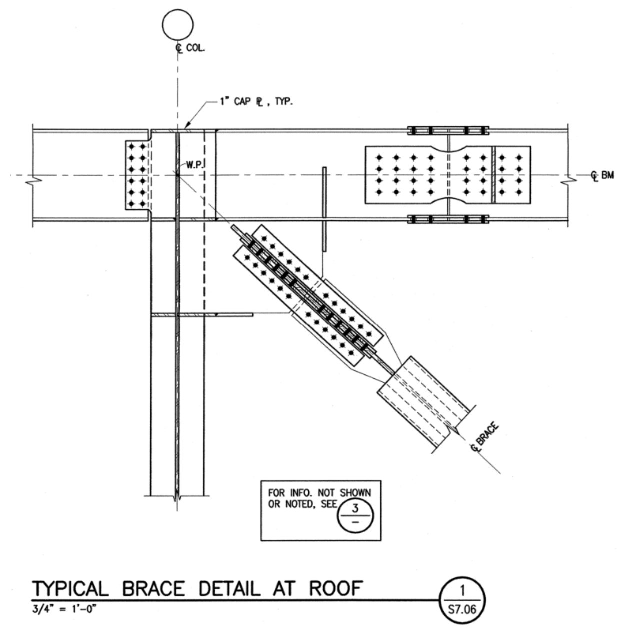
Column Schedule Sheet S7.05. All circled columns are in BRB Frames. Columns with red highlighting do not comply with compact section criteria in AISC 341-05 (continuation).

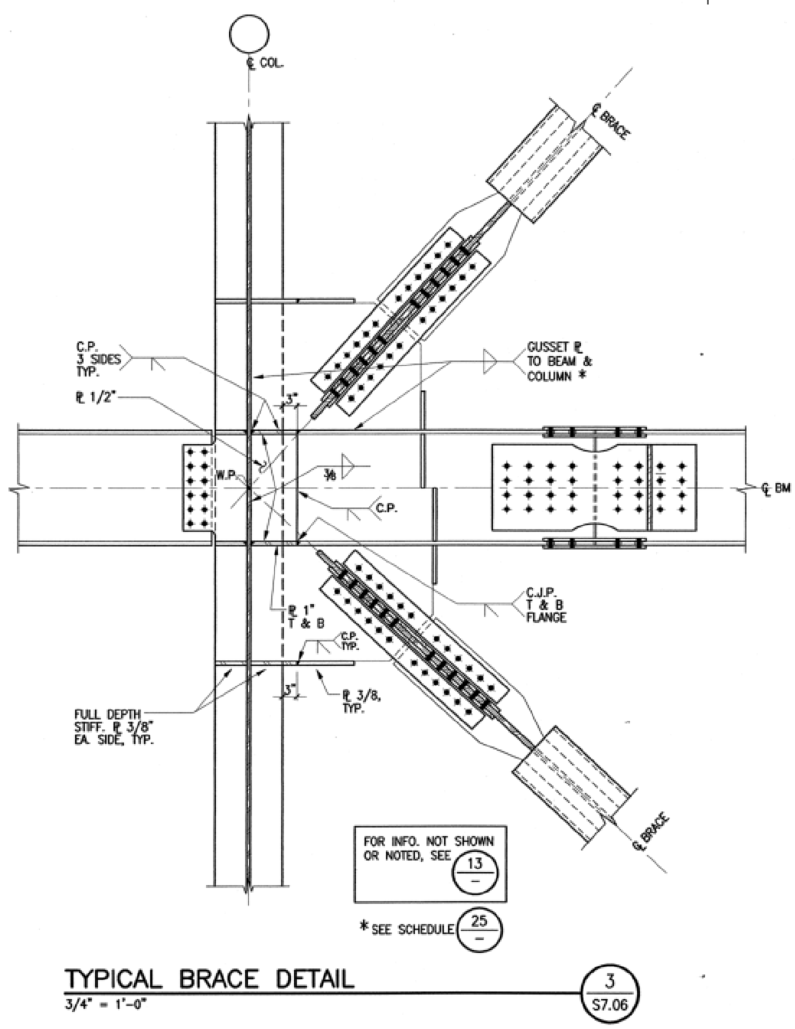


Column Schedule Sheet S7.05. All circled columns are in BRB Frames. Columns with red highlighting do not comply with compact section criteria in AISC 341-05 (continuation).

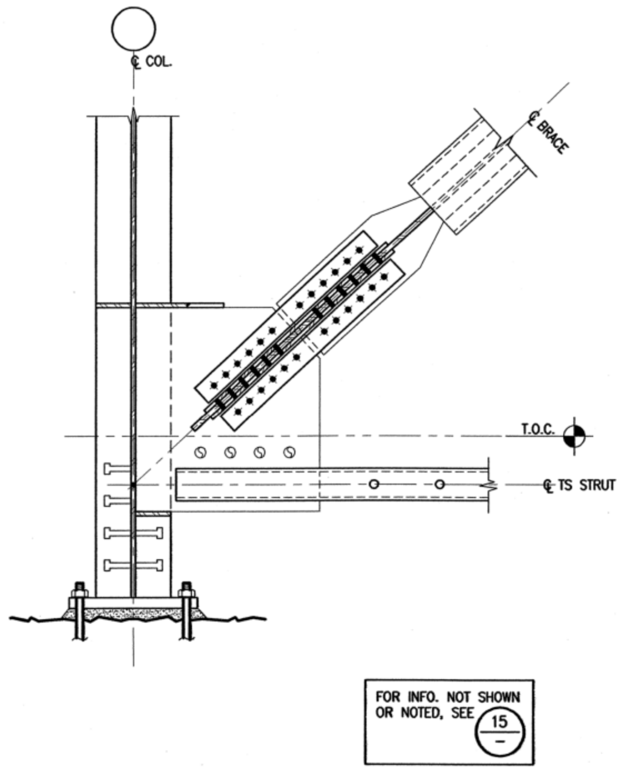


Column Schedule Sheet S7.05. All Circled Columns are in BRB Frames. Columns with Red Highlighting Do Not Comply with Compact Section Criteria in AISC 341-05 (continuation).

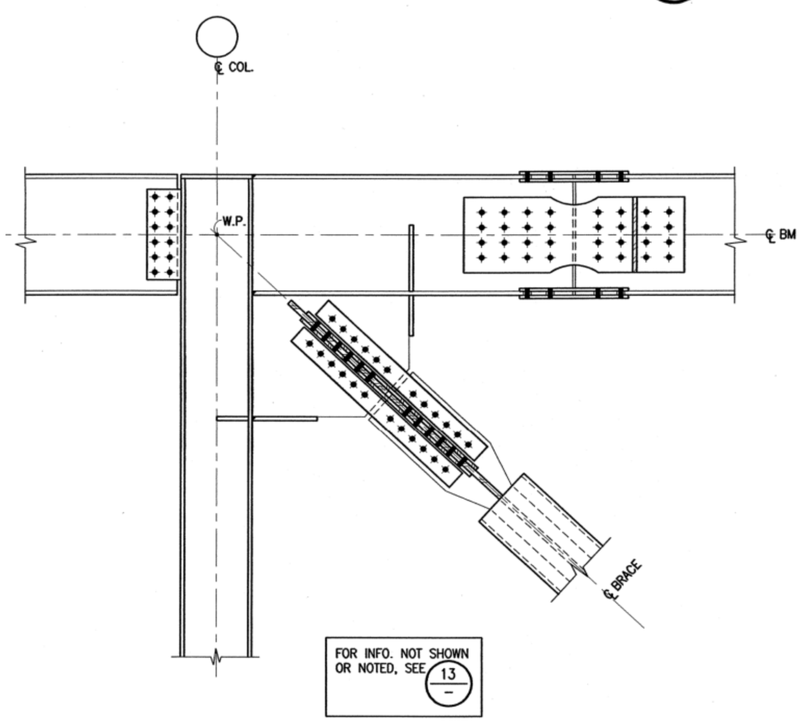




Brace Details Sheet S7.05

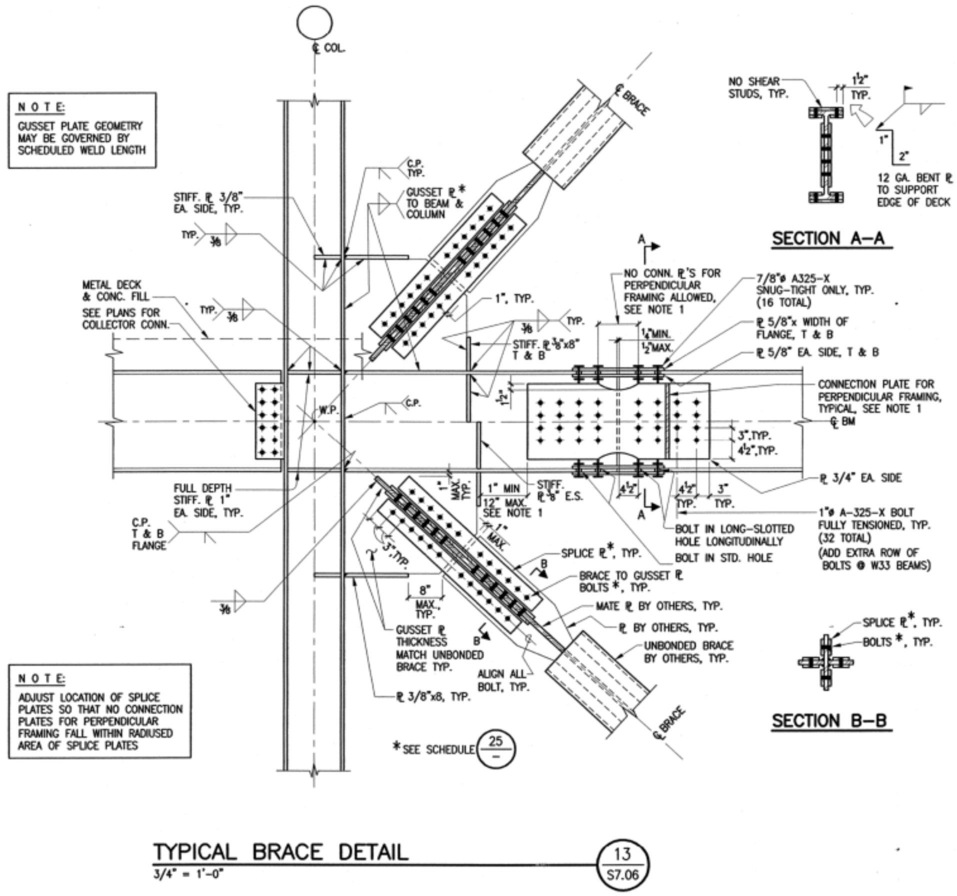


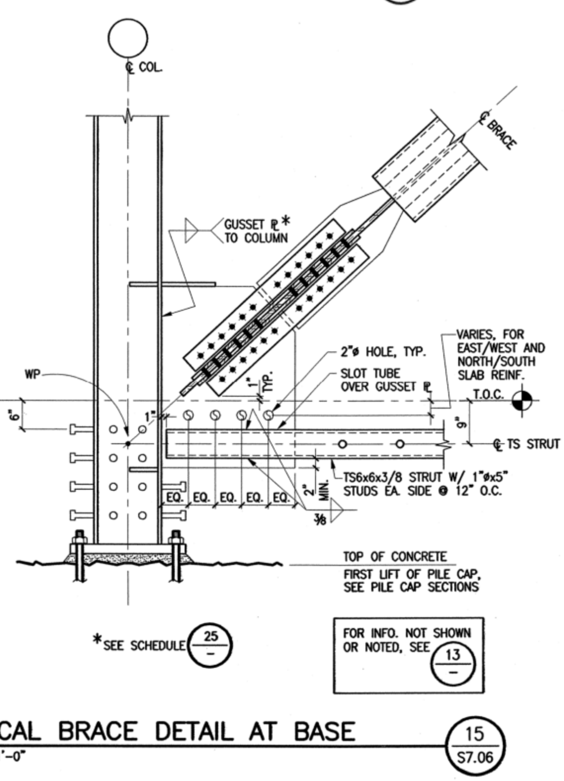
TYPICAL BRACE DETAIL AT BASE 5 / S7.06
3/4" = 1'-0"



TYPICAL BRACE DETAIL AT ROOF 11 / S7.06
3/4" = 1'-0"

Brace Details Sheet S7.05 (continuation)





Brace Details Sheet S7.05 (continuation)

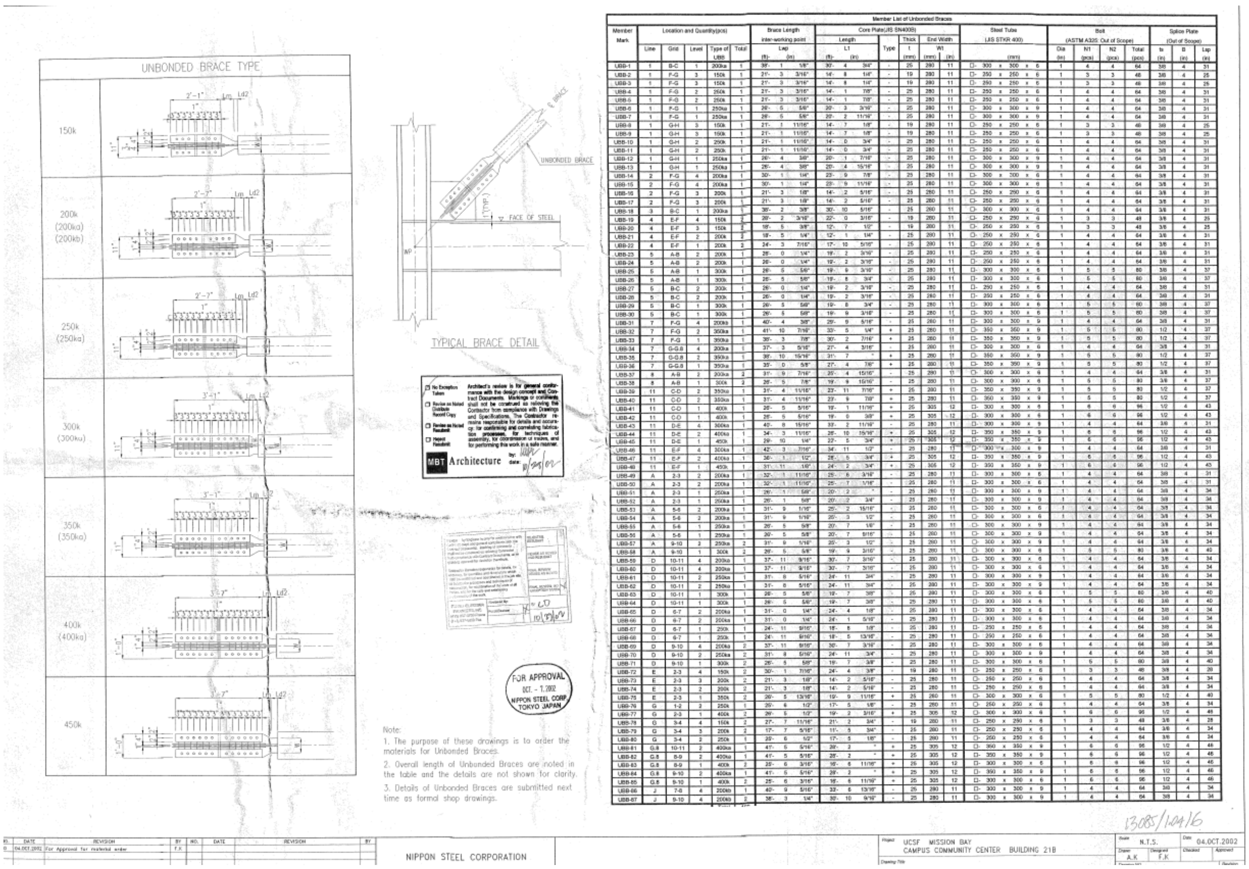
BRACED FRAME CONNECTION SCHEDULE							
MINIMUM BRACE YIELD FORCE (SEE ELEVS.)	MAXIMUM BRACE YIELD FORCE	BRACE SPLICE ℙ TO GUSSET ℙ TOTAL # OF BOLTS (1)	MININUM INITIAL STIFFNESS (2) Ki L (K in/in)	SPLICE ℙ's 4" WIDE THICKNESS (in.)	WELD OF GUSSET ℙ TO BEAM OR COLUMN (PER BRACE)		
					SIZE	MINIMUM LENGTH BEAM	MINIMUM LENGTH COLUMN
100k	115k	12	89,610	3/8"	3/8"	6"	12"
150k	173k	12	134,270	3/8"	3/8"	14"	16"
200k	230k	16	178,930	3/8"	3/8"	20"	24"
250k	288k	16	223,880	3/8"	3/8"	24"	30"
300k	345k	20	268,540	1/2"	1/2"	16"	22"
350k	403k	20	313,200	1/2"	1/2"	26"	28"
400k	460k	24	356,700	1/2"	1/2"	28"	28"
450k	518k	24	403,100	1/2"	1/2"	30"	32"

1. BOLTS ARE A325-SC 1"ø BOLTS IN SHORT SLOTTED HOLES (PARALLEL TO LENGTH OF BRACE) NUMBER OF BOLTS LISTED IS FOR EACH SIDE OF SPLICE. USE EQUAL NUMBER FOR BRACE TO BRACE SPLICE PLATES. (24 BOLT CONDITION SHOWN)
2. THE MINIMUM INITIAL BRACE STIFFNESS APPLIES TO ENTIRE BRACE ASSEMBLY (L) FROM EDGE OF GUSSET TO EDGE OF GUSSET.
3. THE PORTION OF THE BRACE ASSEMBLY FROM THE WORK POINT TO THE EDGE OF THE GUSSET PLATE SHALL BE ASSUMED AS RIGID FOR THE PURPOSES OF CALCULATING INITIAL STIFFNESS.

SCHEDULE
NO SCALE

25
S7.06

BRB Connection Schedule from Sheet S7.06



Nippon Submittal for BRB Sizes 150k to 450k Using HSS10x10, HSS12x12 and HSS14x14 Sections
Excerpts from Nippon Submittals in following pages – Design Calculations by Ian Aiken submitted Feb 2003

Member Mark	Location and Quantity(pcs)					Bolt (ASTM A325: Out of Scope)			
	Line	Grid	Level	Type of UBB	Total	Dia (in)	N1 (pcs)	N2 (pcs)	Total (pcs)
UBB-1	1	B-C	1	200ka	1	1	4	4	64
UBB-2	1	F-G	3	150k	1	1	3	3	48
UBB-3	1	F-G	3	150k	1	1	3	3	48
UBB-4	1	F-G	2	250k	1	1	4	4	64
UBB-5	1	F-G	2	250k	1	1	4	4	64
UBB-6	1	F-G	1	250ka	1	1	4	4	64
UBB-7	1	F-G	1	250ka	1	1	4	4	64
UBB-8	1	G-H	3	150k	1	1	3	3	48
UBB-9	1	G-H	3	150k	1	1	3	3	48
UBB-10	1	G-H	2	250k	1	1	4	4	64
UBB-11	1	G-H	2	250k	1	1	4	4	64
UBB-12	1	G-H	1	250ka	1	1	4	4	64
UBB-13	1	G-H	1	250ka	1	1	4	4	64
UBB-14	2	F-G	4	200ka	1	1	4	4	64
UBB-15	2	F-G	4	200ka	1	1	4	4	64
UBB-16	2	F-G	3	200k	1	1	4	4	64
UBB-17	2	F-G	3	200k	1	1	4	4	64
UBB-18	3	B-C	1	200ka	1	1	4	4	64
UBB-19	4	E-F	4	150k	2	1	3	3	48
UBB-20	4	E-F	3	150k	2	1	3	3	48
UBB-21	4	E-F	2	200k	2	1	4	4	64
UBB-22	4	E-F	1	200k	2	1	4	4	64

Member Mark, Location and Quantity — Joint Type, Bolt

Enlarged Detail of Nippon Steel Shop Drawing Submittal Page 1 of 1 for UBB-1 to UBB-22. Shows number of bolts at Gridlines 1 through 4 with no comments in the original drawing set.

Mission Bay Building 21B
University of California, San Francisco

Design Calculations for Unbonded Braces

Project: UCSF Mission Bay Campus Community Center Building 21B

Introduction

This document presents design calculations for the Unbonded Braces, in accordance with the requirements of Specification section 13085.1.04.E.

The calculations address:

- Global brace buckling - the properties of the confinement tube.
- Welding - the connection of the rib plates to the ends of the core plate, in the cruciform end connection region.
- Bolts - shear capacity.
- End cruciform net tension capacity.

Calculations are provided below for **Unbonded Brace design UBB-1 (UBB Mark 200ka)**. A complete set of calculations for all Unbonded Braces are presented in the attached spreadsheets.

FOR APPROVAL

FEB 25 03

SUBMITTAL NO.

X17

TURNER/UCSF 28 FEB 2003 MISSION BAY

HENSEL PHELPS CONSTRUCTION CO.
☐ RESUBMITTAL NOT REQUIRED ☒ APPROVED
☐ APPROVED AS NOTED
☐ RESUBMITTAL REQ'D ☐ REJECTED
THIS SUBMITTAL HAS BEEN REVIEWED FOR COMPLIANCE W/ THE CONTRACT DOCUMENTS. APPROVAL DOES NOT RELIEVE THE SUBCONTRACTOR/SUPPLIER OF THE RESPONSIBILITY FOR CONFORMANCE TO THE QUALITY STANDARDS AS SET FORTH IN THE CONTRACT DOCUMENTS NOR DOES IT RELIEVE HIS RESPONSIBILITY FOR FIELD VERIFICATION OF ALL CONDITIONS RELATING TO THIS CONTRACT.
CK'D BY JEB DATE 2/27/03
SUBMITTAL NO. 0002-13085B-0/003

REGISTERED PROFESSIONAL ENGINEER IAN AIKEN No. C 048734 Exp. 9/30/04 CIVIL STATE OF CALIFORNIA

RECEIVED FEB 10 2003 STROCAL INC.

2/6/2003 Page 1 SIE, Inc.

1.04E

REGISTERED PROFESSIONAL ENGINEER
IAN AIKEN
No. C 048734
Exp. 9/30/04
CIVIL
STATE OF CALIFORNIA

Unbonded Brace Design Details

UCSF Mission Bay Campus Community Center Building 21B

Feb. 6, 2003

Brace Location and Quantity: UBB Mark	ID	Grid Line	Grid	Floor Level	Qty	Design Requirements: Min. Yield Load (kips)	Max. Yield Load (kips)	Min. Initial Stiffness (k in/in)	1. Length: Intersection WP Lwp (in)	Lwp (mm)	Type (+ / -)	2. Core Plate (SN400B): Thickness t (mm)	Thickness t (in)	Width W (mm)	Width W (in)	Sectional Area A2 (cm^2)	Actual Yield Point, Fy (MPa)	Mill Certificate Plate #	End width Wt (mm)	Actual Yield Force, Py (kN)	Actual Yield Force, Py (kips)	3. Steel Tube (JIS STKR400): Height H (mm)	Width B (mm)	Thk. t (mm)	Moment of Inertia Ix, Iy (cm^4)	Moment of Inertia Ix, Iy (in^4)	Buckling Strength Pe (kN)	Buckling Strength Pe (kips)	Pe / Py
200ka	UBB-1	1	B-C	1	1	200	230	178,930	457.12	11,611	-	25	0.98425	127	5.000	31.75	313	1477821	280	994	223	300	300	6	10,169	244.314	1,540	345	1.55
150k	UBB-2	1	F-G L	3	1	150	173	134,270	255.21	6,482	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	2,825	633	4.13
150k	UBB-3	1	F-G R	3	1	150	173	134,270	255.21	6,482	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	2,825	633	4.13
250k	UBB-4	1	F-G L	2	1	250	288	223,880	255.21	6,482	-	25	0.98425	159	6.260	39.75	317	1480731	280	1,260	282	250	250	6	5,814	139.687	2,825	633	2.24
250k	UBB-5	1	F-G R	2	1	250	288	223,880	255.21	6,482	-	25	0.98425	159	6.260	39.75	317	1480731	280	1,260	282	250	250	6	5,814	139.687	2,825	633	2.24
250ka	UBB-6	1	F-G R	1	1	250	288	223,880	317.61	8,067	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,642	1,040	3.72
250ka	UBB-7	1	F-G L	1	1	250	288	223,880	317.61	8,067	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,642	1,040	3.72
150k	UBB-8	1	G-H L	3	1	150	173	134,270	253.71	6,444	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	2,858	640	4.17
150k	UBB-9	1	G-H R	3	1	150	173	134,270	253.71	6,444	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	2,858	640	4.17
250k	UBB-10	1	G-H L	2	1	250	288	223,880	253.71	6,444	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	250	250	6	5,814	139.687	2,858	640	2.29
250k	UBB-11	1	G-H R	2	1	250	288	223,880	253.71	6,444	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	250	250	6	5,814	139.687	2,858	640	2.29
250ka	UBB-12	1	G-H L	1	1	250	288	223,880	316.40	8,037	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,678	1,048	3.75
250ka	UBB-13	1	G-H R	1	1	250	288	223,880	316.40	8,037	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,678	1,048	3.75
200ka	UBB-14	2	F-G R	4	1	200	230	178,930	361.25	9,176	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	300	300	6	10,169	244.314	2,466	552	2.45
200ka	UBB-15	2	F-G L	4	1	200	230	178,930	361.25	9,176	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	300	300	6	10,169	244.314	2,466	552	2.45
200k	UBB-16	2	F-G L	3	1	200	230	178,930	255.12	6,480	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	250	250	6	5,814	139.687	2,827	633	2.81
200k	UBB-17	2	F-G R	3	1	200	230	178,930	255.12	6,480	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	250	250	6	5,814	139.687	2,827	633	2.81
200ka	UBB-18	3	B-C	1	1	200	230	178,930	458.26	11,640	-	25	0.98425	127	5.000	31.75	313	1477821	280	994	223	300	300	6	10,169	244.314	1,532	343	1.54
150k	UBB-19	4	E-F	4	2	150	173	134,270	338.19	8,590	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	1,609	360	2.35
150k	UBB-20	4	E-F	3	2	150	173	134,270	221.35	5,622	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	3,755	841	5.48
200k	UBB-21	4	E-F	2	2	200	230	178,930	221.27	5,620	-	25	0.98425	127	5.000	31.75	314	1498891	280	997	223	250	250	6	5,814	139.687	3,758	842	3.77
200k	UBB-22	4	E-F	1	2	200	230	178,930	291.43	7,402	-	25	0.98425	127	5.000	31.75	314	1498891	280	997	223	250	250	6	5,814	139.687	2,166	485	2.17
200k	UBB-23	5	A-B R	2	1	200	230	178,930	312.26	7,931	-	25	0.98425	127	5.000	31.75	295	1477941	280	937	210	250	250	6	5,814	139.687	1,887	423	2.01
200k	UBB-24	5	A-B L	2	1	200	230	178,930	312.26	7,931	-	25	0.98425	127	5.000	31.75	295	1477941	280	937	210	250	250	6	5,814	139.687	1,887	423	2.01
300k	UBB-25	5	A-B R	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	314	1498892	280	1,499	336	300	300	6	10,169	244.314	3,190	715	2.13
300k	UBB-26	5	A-B L	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	314	1498892	280	1,499	336	300	300	6	10,169	244.314	3,190	715	2.13
200k	UBB-27	5	B-C L	2	1	200	230	178,930	312.26	7,931	-	25	0.98425	127	5.000	31.75	295	1477941	280	937	210	250	250	6	5,814	139.687	1,887	423	2.01
200k	UBB-28	5	B-C R	2	1	200	230	178,930	312.26	7,931	-	25	0.98425	127	5.000	31.75	295	1477941	280	937	210	250	250	6	5,814	139.687	1,887	423	2.01
300k	UBB-29	5	B-C L	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	314	1498892	280	1,499	336	300	300	6	10,169	244.314	3,190	715	2.13
300k	UBB-30	5	B-C R	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	314	1498892	280	1,499	336	300	300	6	10,169	244.314	3,190	715	2.13
200kb	UBB-31	7	F-G	4	1	200	230	178,930	484.38	12,303	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	9	14,799	355.558	1,996	447	2.01
350ka	UBB-32	7	F-G	2	1	350	403	313,200	487.00	12,370	+	25	0.98425	124	4.882	55.75	295	1477942	280	1,645	368	350	350	9	23,808	571.981	3,176	712	1.93
350ka	UBB-33	7	F-G	1	1	350	403	313,200	459.85	11,680	+	25	0.98425	124	4.882	55.75	295	1477942	280	1,645	368	350	350	9	23,808	571.981	3,562	798	2.17
200ka	UBB-34	7	G-G.8	4	1	200	230	178,930	447.28	11,361	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	6	10,169	244.314	1,608	360	1.62
350ka	UBB-35	7	G-G.8	2	1	350	403	313,200	466.95	11,860	+	25	0.98425	124	4.882	55.75	295	1477942	280	1,645	368	350	350	9	23,808	571.981	3,455	774	2.10
350ka	UBB-36	7	G-G.8	1	1	350	403	313,200	420.60	10,683	+	25	0.98425	124	4.882	55.75	282	1274581	280	1,572	352	350	350	9	23,808	571.981	4,258	954	2.71
200ka	UBB-37	8	A-B	2	2	200	230	178,930	381.44	9,689	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	300	300	6	10,169	244.314	2,211	495	2.20
300k	UBB-38	8	A-B	1	2	300	345	268,540	317.90	8,075	-	25	0.98425	191	7.520	47.75	314	1498891	280	1,499	336	300	300	6	10,169	244.314	3,184	713	2.12
350ka	UBB-39	11	C-D R	2	1	350	403	313,200	376.71	9,568	+	25	0.98425	124	4.882	55.75	282	1274582	280	1,572	352	350	350	9	23,808	571.981	5,308	1,189	3.38
350ka	UBB-40	11	C-D L	2	1	350	403	313,200	376.71	9,568	+	25	0.98425	124	4.882	55.75	282	1274582	280	1,572	352	350	350	9	23,808	571.981	5,308	1,189	3.38
400k	UBB-41	11	C-D R	1	1	400	460	356,700	317.32	8,060	+	25	0.98425	140	5.512	63.75	295	1477941	305	1,881	421	300	300	6	10,169	244.314	3,196	716	1.70
400k	UBB-42	11	C-D L	1	1	400	460	356,700	317.32	8,060	+	25	0.98425	140	5.512	63.75	295	1477941	305	1,881	421	300	300	6	10,169	244.314	3,196	716	1.70
300ka	UBB-43	11	D-E	4	1	300	345	268,540	488.96	12,420	-	25	0.98425	191	7.520	47.75	313	1477821	280	1,495	335	350	350	9	23,808	571.981	3,151	706	2.11
400ka	UBB-44	11	D-E	2	1	400	460	356,700	411.69	10,457	+	25	0.98425	140	5.512	63.75	282	1274581	305	1,798	403	350	350	9	23,808	571.981	4,445	996	2.47
450k	UBB-45	11	D-E	1	1	450	518	403,100	358.25	9,100	+	25	0.98425	156	6.142	71.75	282	1274582	305	2,023	453	350	350	9	23,808	571.981	5,870	1,315	2.90
300ka	UBB-46	11	E-F	4	1	300	345	268,540	507.45	12,889	-	25	0.98425	191	7.520	47.75	313	1477821	280	1,495	335	350	350	9	23,808	571.981	2,925	655	1.96
400ka	UBB-47	11	E-F	2	1	400	460	356,700	433.50	11,011	+	25	0.98425	140	5.512	63.75	295	1477942	305	1,881	421	350	350	9	23,808	571.981	4,009	898	2.13
450k	UBB-48	11	E-F	1	1	450	518	356,700	383.11	9,731	+	25	0.98425	156	6.142	71.75	282	1274582	305	2,023	453	350	350	9	23,808	571.981	5,133	1,150	2.54
200ka	UBB-49	A	2-3 R	2	1	200	230	178,930	385.69	9,796	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	300	300	6	10,169	244.314	2,163	485	2.15
200ka	UBB-50	A	2-3 L	2	1	200	230	178,930	385.69	9,796	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	6	10,169	244.314	2,163	485	2.18
250ka	UBB-51	A	2-3 R	1	1	250	288	223,880	313.64	7,966	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,761	1,066	3.81
250ka	UBB-52	A	2-3 L	1	1	250	288	223,880	313.64	7,966	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,761	1,066	3.81
200ka	UBB-53	A	5-6 R	2	1	200	230	178,930	381.05	9,679	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	6	10,169	244.314	2,216	496	2.23
200ka	UBB-54	A	5-6 L	2	1	200	230	178,930	381.05	9,679	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	6	10,169	244.314	2,216	496	2.23
250ka	UBB-55	A	5-6 R	1	1	250	288	223,880	317.61	8,067	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	300	300	9	14,799	355.558	4,642	1,040	3.72
250ka	UBB-56	A	5-6 L	1	1	250	288	223,880	317.61	8,067	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	300	300	9	14,799	355.558	4,642	1,040	3.72

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Unbonded Brace Design Details

UCSF Mission Bay Campus Community Center Building 21B

Feb. 6, 2003

Brace Location and Quantity						Design Requirements			1. Length		2. Core Plate (SN400B)												3. Steel Tube (JIS STKR400)							
UBB Mark	ID	Grid Line	Grid	Floor Level	Qty	Min. Yield Load	Max. Yield Load	Min. Initial Stiffness	Interstory WP Lwp		Type	Thickness t		Width W		Sectional Area A2	Actual Yield Point, Fy	Mill Certificate Plate #	End width Wt	Actual Yield Force, Py		Height H	Width B	Thk. t	Moment of Inertia Ix, Iy		Buckling Strength Pe		Pe / Py
						(kips)	(kips)	(k in/in)	(in)	(mm)	(+ / -)	(mm)	(in)	(mm)	(in)	(cm^2)	(MPa)		(mm)	(kN)	(kips)	(mm)	(mm)	(mm)	(cm^4)	(in^4)	(kN)	(kips)	
250ka	UBB-57	A	9-10	2	2	250	288	223,880	381.05	9,679	-	25	0.98425	159	6.260	39.75	317	1480731	280	1,260	282	300	300	9	14,799	355.558	3,225	722	2.56
300k	UBB-58	A	9-10	1	2	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	314	1498892	280	1,499	336	300	300	6	10,169	244.314	3,190	715	2.13
200ka	UBB-59	D	10-11 L	4	1	200	230	178,930	455.58	11,572	-	25	0.98425	127	5.000	31.75	313	1477821	280	994	223	300	300	6	10,169	244.314	1,550	347	1.56
200ka	UBB-60	D	10-11 R	4	1	200	230	178,930	455.58	11,572	-	25	0.98425	127	5.000	31.75	313	1477821	280	994	223	300	300	6	10,169	244.314	1,550	347	1.56
250ka	UBB-61	D	10-11 L	2	1	250	288	223,880	380.33	9,660	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	300	300	9	14,799	355.558	3,237	725	2.59
250ka	UBB-62	D	10-11 R	2	1	250	288	223,880	380.33	9,660	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	300	300	9	14,799	355.558	3,237	725	2.59
300k	UBB-63	D	10-11 L	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	282	1274581	280	1,347	302	300	300	6	10,169	244.314	3,190	715	2.37
300k	UBB-64	D	10-11 R	1	1	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	282	1274581	280	1,347	302	300	300	6	10,169	244.314	3,190	715	2.37
200ka	UBB-65	D	6-7 L	2	1	200	230	178,930	372.25	9,455	-	25	0.98425	127	5.000	31.75	314	1498891	280	997	223	300	300	6	10,169	244.314	2,322	520	2.33
200ka	UBB-66	D	6-7 R	2	1	200	230	178,930	372.25	9,455	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	300	300	6	10,169	244.314	2,322	520	2.31
250k	UBB-67	D	6-7 L	1	1	250	288	223,880	299.57	7,609	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	250	250	6	5,814	139.687	2,050	459	1.64
250k	UBB-68	D	6-7 R	1	1	250	288	223,880	299.57	7,609	-	25	0.98425	159	6.260	39.75	295	1477941	280	1,173	263	250	250	6	5,814	139.687	2,050	459	1.75
200ka	UBB-69	D	9-10	4	2	200	230	178,930	455.58	11,572	-	25	0.98425	127	5.000	31.75	313	1477821	280	994	223	300	300	6	10,169	244.314	1,550	347	1.56
250ka	UBB-70	D	9-10	2	2	250	288	223,880	380.33	9,660	-	25	0.98425	159	6.260	39.75	314	1498891	280	1,248	280	300	300	9	14,799	355.558	3,237	725	2.59
300k	UBB-71	D	9-10	1	2	300	345	268,540	317.61	8,067	-	25	0.98425	191	7.520	47.75	295	1477941	280	1,409	316	300	300	6	10,169	244.314	3,190	715	2.26
150k	UBB-72	E	2-3	4	2	150	173	134,270	361.43	9,180	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	1,408	315	2.06
200k	UBB-73	E	2-3	3	2	200	230	178,930	255.12	6,480	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	250	250	6	5,814	139.687	2,827	633	2.81
200k	UBB-74	E	2-3	2	2	200	230	178,930	255.12	6,480	-	25	0.98425	127	5.000	31.75	317	1480731	280	1,006	225	250	250	6	5,814	139.687	2,827	633	2.81
350k	UBB-75	E	2-3	1	2	350	403	313,200	317.81	8,072	+	25	0.98425	124	4.882	55.75	295	1477941	280	1,645	368	300	300	6	10,169	244.314	3,186	714	1.94
250k	UBB-76	G	1-2	2	1	250	288	223,880	306.47	7,784	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	250	250	6	5,814	139.687	1,959	439	1.57
400k	UBB-77	G	2-3	1	2	400	460	356,700	317.51	8,065	+	25	0.98425	140	5.512	63.75	295	1477941	305	1,881	421	300	300	6	10,169	244.314	3,192	715	1.70
150k	UBB-78	G	3-4	4	2	150	173	134,270	331.69	8,425	-	19	0.74803	126	4.961	23.94	286	951800501	280	685	153	250	250	6	5,814	139.687	1,672	375	2.44
200k	UBB-79	G	3-4	3	2	200	230	178,930	211.29	5,367	-	25	0.98425	127	5.000	31.75	314	1498891	280	997	223	250	250	6	5,814	139.687	4,121	923	4.13
250k	UBB-80	G	3-4	2	1	250	288	223,880	306.47	7,784	-	25	0.98425	159	6.260	39.75	314	1498892	280	1,248	280	250	250	6	5,814	139.687	1,959	439	1.57
400ka	UBB-81	G.8	10-11	2	1	400	460	356,700	497.30	12,632	+	25	0.98425	140	5.512	63.75	295	1477942	305	1,881	421	350	350	9	23,808	571.981	3,046	682	1.62
400ka	UBB-82	G.8	8-9	2	1	400	460	356,700	497.30	12,632	+	25	0.98425	140	5.512	63.75	282	1274581	305	1,798	403	350	350	9	23,808	571.981	3,046	682	1.69
400k	UBB-83	G.8	8-9	1	2	400	460	356,700	306.18	7,777	+	25	0.98425	140	5.512	63.75	282	1274582	305	1,798	403	300	300	6	10,169	244.314	3,432	769	1.91
400ka	UBB-84	G.8	9-10	2	1	400	460	356,700	497.30	12,632	+	25	0.98425	140	5.512	63.75	282	1274581	305	1,798	403	350	350	9	23,808	571.981	3,046	682	1.69
400k	UBB-85	G.8	9-10	1	2	400	460	356,700	306.18	7,777	+	25	0.98425	140	5.512	63.75	282	1274582	305	1,798	403	300	300	6	10,169	244.314	3,432	769	1.91
200kb	UBB-86	J	7-8	4	1	200	230	178,930	489.30	12,428	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	9	14,799	355.558	1,956	438	1.97
200kb	UBB-87	J	9-10	4	2	200	230	178,930	459.26	11,665	-	25	0.98425	127	5.000	31.75	313	1477822	280	994	223	300	300	9	14,799	355.558	2,220	497	2.23

NOTES: 1. Lwp = brace length between lower floor work point and upper floor work point.
2. Py = Unbonded Brace actual yield strength = core cross-sectional area x Fy, where Fy = actual material yield point from mill certificate
3. Pe = Unbonded Brace buckling strength = $\pi^2 E I / L_k^2$, where L_k = Lwp, E = modulus of elasticity, I = tube moment of inertia

Other Notations

L and/or R in the Grid locations refer to "Left" and/or "Right" respectively.
Type = core plate cross-section, either flat plate (-) or cruciform (+)

Criteria:

Max. yield load > Py > Min. yield load => OK
Pe / Py > 1.5 => OK

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UCSF Mission Bay Campus Community Center Building 21B

Calculations for Unbonded Brace welds, bolts, and end cruciform net area

Feb. 6, 2003

Brace Location				4. Stiffness								5. Welding									6. Bolts(ASTM A325SC)				7. End Connection Cruciform					
UBB Mark	Grid Line	Grid	Floor Level	Length of Unbonded Brace L1 (mm)	L1 (in)	L2 (in)	L3 (in)	A3 (in²)	Stiffness	Ke	Ke/K	Length (mm)	Weld Type	Weld size s (mm)	Weld size s (in)	Shear Capacity Pb (kN)	Weld Capacity Pw (kN)	Weld Capacity Pw (kips)	Min. (Pb, Pw) Ps (kips)	Ps/Py	No. per joint (pcs)	Shear Capacity of Bolt Pa (kN)	Shear Capacity of Bolt Pa (kips)	Pb/Py	Width Wt (mm)	Thk. t (mm)	Bolt hole d (mm)	Net Area (4 holes) Anet (in²)	Tension Capacity Pnet (kips)	Pnet/Py
200ka	1	B-C	1	9,266	364.81	329.50	17.66	20.73	436.95	159,406	0.89	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
150k	1	F-G L	3	4,297	169.19	139.87	14.66	15.93	758.84	128,385	0.96	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
150k	1	F-G R	3	4,297	169.19	139.87	14.66	15.93	758.84	128,385	0.96	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
250k	1	F-G L	2	4,315	169.88	135.74	17.07	20.73	1267.01	215,233	0.96	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.51	16	2,299	517	1.83	280	25	29	16.24	746	2.64
250k	1	F-G R	2	4,315	169.88	135.74	17.07	20.73	1267.01	215,233	0.96	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.51	16	2,299	517	1.83	280	25	29	16.24	746	2.64
250ka	1	F-G R	1	6,177	243.19	209.05	17.07	20.73	843.25	205,067	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	1	F-G L	1	6,166	242.75	208.62	17.07	20.73	844.93	205,107	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
150k	1	G-H L	3	4,272	168.19	138.87	14.66	15.93	764.04	128,503	0.96	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
150k	1	G-H R	3	4,272	168.19	138.87	14.66	15.93	764.04	128,503	0.96	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
250k	1	G-H L	2	4,286	168.75	134.62	17.07	20.73	1276.85	215,469	0.96	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.56	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250k	1	G-H R	2	4,286	168.75	134.62	17.07	20.73	1276.85	215,469	0.96	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.56	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	1	G-H L	1	6,133	241.44	207.30	17.07	20.73	850.03	205,230	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	1	G-H R	1	6,221	244.94	210.80	17.07	20.73	836.57	204,907	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
200ka	2	F-G R	4	7,263	285.94	250.62	17.66	20.73	570.02	162,989	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.16	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200ka	2	F-G L	4	7,258	285.75	250.44	17.66	20.73	570.43	163,001	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.16	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200k	2	F-G L	3	4,328	170.38	135.06	17.66	20.73	1029.24	175,357	0.98	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.92	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200k	2	F-G R	3	4,328	170.38	135.06	17.66	20.73	1029.24	175,357	0.98	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.92	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200ka	3	B-C	1	9,403	370.19	334.87	17.66	20.73	430.11	159,221	0.89	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
150k	4	E-F	4	6,709	264.13	234.81	14.66	15.93	460.70	121,681	0.91	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
150k	4	E-F	3	3,848	151.50	122.19	14.66	15.93	862.87	130,725	0.97	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
200k	4	E-F	2	3,689	145.25	109.94	17.66	20.73	1247.80	181,243	1.01	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.98	16	2,299	517	2.31	280	25	29	16.24	739	3.31
200k	4	E-F	1	5,453	214.69	179.37	17.66	20.73	786.33	168,815	0.94	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.98	16	2,299	517	2.31	280	25	29	16.24	739	3.31
200k	5	A-B R	2	5,845	230.13	194.81	17.66	20.73	726.59	167,206	0.93	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	6.37	16	2,299	517	2.46	280	25	29	16.24	695	3.31
200k	5	A-B L	2	5,845	230.13	194.81	17.66	20.73	726.59	167,206	0.93	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	6.37	16	2,299	517	2.46	280	25	29	16.24	695	3.31
300k	5	A-B R	1	6,025	237.19	198.04	19.57	20.73	1047.28	248,401	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20
300k	5	A-B L	1	6,013	236.75	197.60	19.57	20.73	1049.44	248,455	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20
200k	5	B-C L	2	5,845	230.13	194.81	17.66	20.73	726.59	167,206	0.93	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	6.37	16	2,299	517	2.46	280	25	29	16.24	695	3.31
200k	5	B-C R	2	5,845	230.13	194.81	17.66	20.73	726.59	167,206	0.93	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	6.37	16	2,299	517	2.46	280	25	29	16.24	695	3.31
300k	5	B-C L	1	6,013	236.75	197.60	19.57	20.73	1049.44	248,455	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20
300k	5	B-C R	1	6,025	237.19	198.04	19.57	20.73	1047.28	248,401	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20
200kb	7	F-G	4	9,076	357.31	322.00	17.66	20.73	446.87	159,673	0.89	799.1	partial	14	0.551	6,753	6,212	1,397	1,397	6.27	16	2,299	517	2.32	280	25	29	16.24	737	3.31
350ka	7	F-G	2	10,192	401.25	359.74	20.76	20.73	687.56	275,883	0.88									N/A	20	2,873	646	1.75	280	25	29	16.24	695	1.89
350ka	7	F-G	1	9,206	362.44	320.93	20.76	20.73	766.46	277,793	0.89									N/A	20	2,873	646	1.75	280	25	29	16.24	695	1.89
200ka	7	G-G.8	4	8,336	328.19	292.87	17.66	20.73	490.07	160,836	0.90	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
350ka	7	G-G.8	2	9,628	379.06	337.55	20.76	20.73	730.55	276,924	0.88									N/A	20	2,873	646	1.75	280	25	29	16.24	695	1.89
350ka	7	G-G.8	1	8,355	328.94	287.43	20.76	20.73	850.72	279,833	0.89									N/A	20	2,873	646	1.83	280	25	29	16.24	664	1.89
200ka	8	A-B	2	7,745	304.94	269.62	17.66	20.73	531.06	161,940	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.16	16	2,299	517	2.29	280	25	29	16.24	746	3.31
300k	8	A-B	1	6,044	237.94	198.79	19.57	20.73	1043.58	248,308	0.92	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20
350ka	11	C-D R	2	7,303	287.50	245.99	20.76	20.73	984.61	283,074	0.90									N/A	20	2,873	646	1.83	280	25	29	16.24	664	1.89
350ka	11	C-D L	2	7,263	285.94	244.43	20.76	20.73	990.48	283,216	0.90									N/A	20	2,873	646	1.83	280	25	29	16.24	664	1.89
400k	11	C-D R	1	5,834	229.69	181.98	23.85	22.67	1461.91	335,782	0.94									N/A	24	3,448	775	1.84	305	25	29	18.17	777	1.85
400k	11	C-D L	1	5,802	228.44	180.73	23.85	22.67	1470.97	336,026	0.94									N/A	24	3,448	775	1.84	305	25	29	18.17	777	1.85
300ka	11	D-E	4	10,127	398.69	359.54	19.57	20.73	594.46	237,002	0.88	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	3.86	16	2,299	517	1.54	280	25	29	16.24	737	2.20
400ka	11	D-E	2	8,182	322.13	274.42	23.85	22.67	1004.15	323,462	0.91									N/A	24	3,448	775	1.93	305	25	29	18.17	743	1.85
450k	11	D-E	1	6,817	268.38	221.26	23.56	22.67	1365.28	366,408	0.91									N/A	24	3,448	775	1.71	305	25	29	18.17	743	1.64
300ka	11	E-F	4	10,655	419.50	380.35	19.57	20.73	563.08	236,212	0.88	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	3.86	16	2,299	517	1.54	280	25	29	16.24	737	2.20
400ka	11	E-F	2	8,680	341.75	294.04	23.85	22.67	941.56	321,778	0.90									N/A	24	3,448	775	1.84	305	25	29	18.17	777	1.85
450k	11	E-F	1	7,347	289.25	242.13	23.56	22.67	1257.84	363,829	1.02									N/A	24	3,448	775	1.71	305	25	29	18.17	743	1.64
200ka	A	2-3 R	2	7,745	304.94	269.62	17.66	20.73	531.06	161,940	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.16	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200ka	A	2-3 L	2	7,768	305.81	270.50	17.66	20.73	529.39	161,895	0.90	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
250ka	A	2-3 R	1	6,147	242.00	207.87	17.07	20.73	847.84	205,177	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	A	2-3 L	1	6,166	242.75	208.62	17.07	20.73	844.93	205,107	0.92	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
200ka	A	5-6 R	2	7,695	302.94	267.62	17.66	20.73	534.91	162,044	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
200ka	A	5-6 L	2	7,710	303.56	268.25	17.66	20.73	533.70	162,011	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
250ka	A	5-6 R	1	6,277	247.13	212.99	17.07	20.73	828.37	204,710	0.91	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	A	5-6 L	1	6,288	247.56	213.43	17.07	20.73	826.74	204,671	0.91	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	A	9-10	2	7,710	303.56	269.43	17.07	20.73	661.14	200,698	0.90	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.58	16	2,299	517	1.83	280	25	29	16.24	746	2.64
300k	8	9-10	1	6,025	237.19	198.04	19.57	20.73	1047.28	248,401	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.09	20	2,873	646	1.92	280	25	29	16.24	739	2.20

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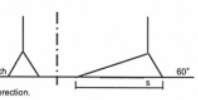
Calculations for Unbonded Brace welds, bolts, and end cruciform net area

UCSF Mission Bay Campus Community Center Building 21B — **Feb. 6, 2003**

Brace Location				4. Stiffness								5. Welding									6. Bolts(ASTM A325SC)				7. End Connection Cruciform					
UBB Mark	Grid Line	Grid	Floor Level	Length of Unbonded Brace L1 (mm)	L1 (in)	L2 (in)	L3 (in)	A3 (in^2)	Stiffness ke (k/in)	Stiffness Ke (k in/in)	Ke/K	Length Lsp (mm)	Weld Type	Weld size s (mm)	Weld size s (in)	Shear Capacity Pb (kN)	Weld Capacity Pw (kN)	Weld Capacity Pw (kips)	Min. (Pb, Pw) Ps (kips)	Ps/Py	No. per joint (pcs)	Shear Capacity of Bolt P_B (kN)	Shear Capacity of Bolt P_B (kips)	Pb/Py	Width Wt (mm)	Thk. t (mm)	Bolt hole d (mm)	Net Area (4 holes) Anet (in^2)	Tension Capacity Pnet (kips)	Pnet/Py
200ka	D	10-11 L	4	9,327	367.19	331.87	17.66	20.73	433.90	159,324	0.89	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
200ka	D	10-11 R	4	9,327	367.19	331.87	17.66	20.73	433.90	159,324	0.89	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
250ka	D	10-11 L	2	7,614	299.75	265.62	17.07	20.73	670.28	200,918	0.90	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250ka	D	10-11 R	2	7,614	299.75	265.62	17.07	20.73	670.28	200,918	0.90	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
300k	D	10-11 L	1	5,980	235.44	196.29	19.57	20.73	1055.99	248,620	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.55	20	2,873	646	2.14	280	25	29	16.24	664	2.20
300k	D	10-11 R	1	5,980	235.44	196.29	19.57	20.73	1055.99	248,620	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.55	20	2,873	646	2.14	280	25	29	16.24	664	2.20
200ka	D	6-7 L	2	7,420	292.13	256.81	17.66	20.73	556.72	162,631	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.22	16	2,299	517	2.31	280	25	29	16.24	739	3.31
200ka	D	6-7 R	2	7,347	289.25	253.94	17.66	20.73	562.82	162,796	0.91	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.16	16	2,299	517	2.29	280	25	29	16.24	746	3.31
250k	D	6-7 L	1	5,693	224.13	189.99	17.07	20.73	923.56	206,994	0.92	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.56	16	2,299	517	1.85	280	25	29	16.24	739	2.64
250k	D	6-7 R	1	5,634	221.81	187.68	17.07	20.73	934.36	207,253	0.93	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.85	16	2,299	517	1.97	280	25	29	16.24	695	2.64
200ka	D	9-10	4	9,327	367.19	331.87	17.66	20.73	433.90	159,324	0.89	794.1	partial	14	0.551	6,711	6,174	1,388	1,388	6.23	16	2,299	517	2.32	280	25	29	16.24	737	3.31
250ka	D	9-10	2	7,614	299.75	265.62	17.07	20.73	670.28	200,918	0.90	739.1	partial	14	0.551	6,246	5,746	1,292	1,292	4.62	16	2,299	517	1.85	280	25	29	16.24	739	2.64
300k	D	9-10	1	5,980	235.44	196.29	19.57	20.73	1055.99	248,620	0.93	785.3	partial	14	0.551	6,637	6,105	1,373	1,373	4.35	20	2,873	646	2.05	280	25	29	16.24	695	2.20
150k	E	2-3	4	7,426	292.38	263.06	14.66	15.93	412.47	120,597	0.90	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
200k	E	2-3	3	4,328	170.38	135.06	17.66	20.73	1029.24	175,357	0.98	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.92	16	2,299	517	2.29	280	25	29	16.24	746	3.31
200k	E	2-3	2	4,328	170.38	135.06	17.66	20.73	1029.24	175,357	0.98	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.92	16	2,299	517	2.29	280	25	29	16.24	746	3.31
350k	E	2-3	1	6,037	237.69	196.18	20.76	20.73	1214.35	288,636	0.92									N/A	20	2,873	646	1.75	280	25	29	16.24	695	1.89
250k	G	1-2	2	5,312	209.13	174.99	17.07	20.73	998.39	208,789	0.93	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.56	16	2,299	517	1.85	280	25	29	16.24	739	2.64
400k	G	2-3	1	5,845	230.13	182.42	23.85	22.67	1458.76	335,697	0.94									N/A	24	3,448	775	1.84	305	25	29	18.17	777	1.85
150k	G	3-4	4	6,471	254.75	225.44	14.66	15.93	479.29	122,099	0.91	692.9	partial	12	0.472	4,450	4,344	977	977	6.37	12	1,724	388	2.53	280	19	29	12.52	519	3.38
200k	G	3-4	3	3,500	137.81	102.50	17.66	20.73	1331.50	183,497	1.03	764.1	partial	14	0.551	6,458	5,940	1,336	1,336	5.98	16	2,299	517	2.31	280	25	29	16.24	739	3.31
250k	G	3-4	2	5,312	209.13	174.99	17.07	20.73	998.39	208,789	0.93	729.1	partial	14	0.551	6,162	5,668	1,274	1,274	4.56	16	2,299	517	1.85	280	25	29	16.24	739	2.64
400ka	G.8	10-11	2	8,585	338.00	290.29	23.85	22.67	952.91	322,083	0.90									N/A	24	3,448	775	1.84	305	25	29	18.17	777	1.85
400ka	G.8	8-9	2	8,585	338.00	290.29	23.85	22.67	952.91	322,083	0.90									N/A	24	3,448	775	1.93	305	25	29	18.17	743	1.85
400k	G.8	8-9	1	5,048	198.75	151.04	23.85	22.67	1725.11	342,865	0.96									N/A	24	3,448	775	1.93	305	25	29	18.17	743	1.85
400ka	G.8	9-10	2	8,585	338.00	290.29	23.85	22.67	952.91	322,083	0.90									N/A	24	3,448	775	1.93	305	25	29	18.17	743	1.85
400k	G.8	9-10	1	5,048	198.75	151.04	23.85	22.67	1725.11	342,865	0.96									N/A	24	3,448	775	1.93	305	25	29	18.17	743	1.85
200kb	J	7-8	4	10,252	403.63	368.31	17.66	20.73	391.93	158,193	0.88	799.1	partial	14	0.551	6,753	6,212	1,397	1,397	6.27	16	2,299	517	2.32	280	25	29	16.24	737	3.31
200kb	J	9-10	4	9,412	370.56	335.25	17.66	20.73	429.64	159,209	0.89	799.1	partial	14	0.551	6,753	6,212	1,397	1,397	6.27	16	2,299	517	2.32	280	25	29	16.24	737	3.31

NOTES:
1. Ke = Unbonded Brace stiffness = ke x L1 [kips/in x in], where L1 = length of Unbonded Brace, and
   ke = ExA2xA3/(L2xA3+2xL3xA2), where A2=area of center portion, A3=area of end portion, L2=length of center portion and L3=length of end portion of unbonded braces respectively.
2. Lsp = welded length of rib plate
3. s = leg length of weld
4. Pb = shear capacity of two rib plates = $\phi F_{BM} A_{BM}$ = 0.9 x 0.6Fy x A
5. Pw = weld capacity of two rib plates = $\phi F_W A_W$ = 0.75 x 0.6 x F_{EXX} x A_W
   where: F_{EXX} is minimum tensile strength of electrode (70ksi)
   A_W is effective cross-sectional area of weld
   Partial penetration weld $A_W = (s \times \sqrt{(3)}/2 - 1/8") \times Lsp$
   For the cruciform (+) type braces, Pw is not applicable because the design concept assumes that each leg of the yielding cruciform transfers its load directly to the end cruciform section of the connection. The purpose of the fillet weld is only to maintain the cruciform configuration during manufacture and erection.



6. P_B = design shear capacity of bolts (A325-SC, 1"dia., OVS)
7. Pnet = tension capacity of end cruciform net cross-section

Criteria:
Min(Pb, Pw) / Py > 1.0 => OK
P_B / Py >1.0 => OK

REGISTERED PROFESSIONAL ENGINEER
IAN AIKEN
No. C 048734
Exp. 9/30/04
CIVIL
STATE OF CALIFORNIA

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CYCLIC TESTS OF NIPPON STEEL CORPORATION UNBONDED BRACES

PROJECT: Kaiser Santa Clara Medical Center

DATE: January 25, 2001

A Report to Ove Arup & Partners California, Ltd.
and
Office of Statewide Health Planning and Development

Submitted By

Nippon Steel Corporation
Tokyo, Japan

FOR APPROVAL

FEB 25 '03

Prepared By

SUBMITTAL NO.

X 17

SIE inc.
Seismic Isolation Engineering

TURNER/UCSF
28 FEB 2003
MISSION BAY

Nippon Submittals with Uniaxial Cyclic Tests Performed for Kaiser Santa Clara Medical Center

APPENDIX A

Additional Images

Plan View Rutter Center (Google Maps. Note outdoor swimming pool at 4th floor deck and high roof in blue over the 4th floor gym. Adjacent parking structure at upper left.)

West Elevation (Google StreetView. Parking and stair at far left.)

South Elevation (Google StreetView, looking northeast. Transfer girder supports load above loading dock.
Stair tower for parking at far left.)

East Elevation with Tower at Northeast Corner (Google StreetView, looking south)

Northeast Corner with Tower (Google StreetView, looking southwest)

East Elevation at Atrium Entrance (Google StreetView, looking south)

North Elevation (Google StreetView, looking southeast)

Atrium at East Entrance (Google Earth photo)

UC Campus:	**San Francisco Mission Bay**		Date:	**10/31/2020**		
Building CAAN:	**3003**	Auxiliary CAAN:	By Firm:	**RUTHERFORD + CHEKENE**		
Building Name:	**UCSF Rutter Center**		Initials:	**EFA/ CLP**	Checked:	**BL**
Building Address:	**1675 Owens St, San Francisco, CA 94158**		Page:	**1**	of	**3**

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

LOW SEISMICITY

BUILDING SYSTEMS - *GENERAL*

	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:** Metal deck or metal deck with concrete fill spanning to steel beam crossties function as the diaphragms at each level to deliver lateral forces to the steel braced frames (BRBFs) in both directions. The load path is not always well-defined but is judged to comply with the intent of this check.
☐ 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:** An adjacent garage structure of unknown height is separated from Rutter Center by an unknown seismic separation joint. The shorter Rutter Center is 50’ so the gap should be 9”.
☐ 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:** There are no mezzanine levels.

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

	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:** The total BRB area increases from the top story down to the first story.
☒ 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:** The total BRB area increases from the top story down to the first story.
☐ 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:** Several BRB frames have braces that terminate above the ground floor. This occurs on Gridlines 3 and J.

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

UC Campus:	**San Francisco Mission Bay**		Date:	**10/31/2020**		
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ASCE 41-17
Collapse Prevention Basic Configuration Checklist

C NC N/A U	
☒ C ☐ NC ☐ N/A ☐ U	GEOMETRY: There are no changes in the net horizontal dimension of the seismic-force-resisting system of more than 30% in a story relative to adjacent stories, excluding one-story penthouses and mezzanines. (Commentary: Sec. A.2.2.5. Tier 2: Sec. 5.4.2.4) **Comments:** The structure is largely rectangular, and the BRB frames are continuous from the roof to the first floor. The steps are primarily at the upper roof which is similar to a penthouse.
☒ C ☐ NC ☐ N/A ☐ U	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:** The weights of the 2nd and 4th floors are similar, and the roof level is lighter.
☒ C ☐ NC ☐ N/A ☐ U	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 building footprint is approximately square in plan and the floors have eccentricities less than 20%.

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

GEOLOGIC SITE HAZARD

	Description
☒ C ☐ NC ☐ N/A ☐ U	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:** Per "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards" by Egan (2019), the mapped liquefaction potential is very high but Note jj states "Available design drawings indicate buildings are supported on piles driven to refusal, so liquefaction-related hazard to building is probably low."
☒ C ☐ NC ☐ N/A ☐ U	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:** Per "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards" by Egan (2019), the building is not subject to slope failure.
☒ C ☐ NC ☐ N/A ☐ U	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:** Per "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards" by Egan (2019), the site is 8.5 miles from the San Andreas Fault and not susceptible to surface fault rupture.

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

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:** The building width is B = 220' for all but the small central section. The building height from the 1st floor to the roof is H = 75', B/H = 2.939 Sa = 1.794g for BSE-2E 0.6 x Sa = 1.08 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:** Per "Table 1 - UCSF Pre-2006 BRBF Buildings – Geotechnical Characteristics and Site Hazards" by Egan (2019), the location is Site Class E. The building is supported on piles driven to refusal, pile caps, and a 12" thick slab-on-grade.

UC Campus:	San Francisco Mission Bay			Date:	10/31/2020		
Building CAAN:	3003	Auxiliary CAAN:		By Firm:	Rutherford + Chekene		
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Building Address:	1675 Owens St., San Francisco, CA 94158			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 ☒ ☐ ☐ ☐	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:** There are seven lines of BRB frames in the longitudinal (E-W) direction and five lines of BRB frames in the transvers (N-S) direction.
C NC N/A U ☐ ☒ ☐ ☐	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:** Spot checks for a typical BRB column, typical interior column, and typical exterior column show dead load axial stresses only slightly less than 0.10Fy. For the dead + live case, the stress exceeds 0.10Fy.
C NC N/A U ☐ ☒ ☐ ☐	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:** The Quick Check procedure was used to calculate an average axial brace stress for the BRBs at every floor and results in an average stress in excess of 0.5Fy at every floor with DCRs ranging from 3.4 to 6.2 in the longitudinal (N-S) direction and 3.3 to 4.7 in the transverse (E-W) direction.

CONNECTIONS

	Description
C NC N/A U ☒ ☐ ☐ ☐	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:** Diaphragms consisting of 3" metal deck and 4.5" of normal weight concrete fill are used to deliver loads to the BRB frames.
C NC N/A U ☒ ☐ ☐ ☐	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**: Steel columns in the BRB frames are all anchored to the building foundation consisting of piles, pile caps, and a 12" slab-on-grade.

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

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

C NC N/A U	Description
(•) C ☐ NC ☐ N/A ☐ U	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:** There are many braced bays in multiple lines of braced frames in both directions. **T**he building is judged to comply with the intent of this check.
☐ C ☐ NC (•) N/A ☐ U	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:** As the braces are unbonded buckling restrained braces (BRBs), the braces will not buckle, and this check is not applicable. As the braces are unbonded buckling restrained braces (BRBs), they are typically designed for the yield capacity of the braces. Connections were checked for a sample bay and have sufficient capacity to develop the adjusted brace strength of the BRBs.
☐ C ☐ NC (•) N/A ☐ U	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:** As the braces are unbonded buckling restrained braces (BRBs), this check for compactness of the steel section is not applicable.
(•) C ☐ NC ☐ N/A ☐ U	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:** There are no K-braced bays.

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

SEISMIC-FORCE-RESISTING SYSTEM

	Description

UC Campus:	San Francisco Mission Bay			Date:	10/31/2020		
Building CAAN:	3003	Auxiliary CAAN:		By Firm:	Rutherford + Chekene		
Building Name:	UCSF Rutter Center			Initials:	EFA/ CLP	Checked:	BL
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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type S2-S2A

C NC N/A U	
☒ ☐ ☐ ☐	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:** Splice details show full penetration welds for the smaller section at the splice, so these develop the tensile strength of the smaller section.
☐ ☐ ☒ ☐	SLENDERNESS OF DIAGONALS: All diagonal elements required to carry compression have *Kl/r* ratios less than 200. (Commentary: Sec. A.3.3.1.4. Tier 2: Sec. 5.5.4.3) **Comments:** As the braces are unbonded buckling restrained braces (BRBs), this check for slenderness of diagonals is not applicable.
☒ ☐ ☐ ☐	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:** As the braces are unbonded buckling restrained braces (BRBs), they are typically designed for the yield capacity of the braces. Connections were checked for a sample bay and have sufficient capacity to develop the adjusted brace strength of the BRBs.
☐ ☐ ☒ ☐	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:** As the braces are unbonded buckling restrained braces (BRBs), this check for compactness of the steel section is not applicable.
☒ ☐ ☐ ☐	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:** There are both chevron braced and V-braced bays. A spot check shows the beams are adequate.
☒ ☐ ☐ ☐	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:** All the concentric braces in the BRB frames are framed concentrically into the beam-column joints.

DIAPHRAGMS (STIFF OR FLEXIBLE)

	Description

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

UC Campus:	**San Francisco Mission Bay**			Date:	**10/31/2020**		
Building CAAN:	**3003**	Auxiliary CAAN:		By Firm:	**Rutherford + Chekene**		
Building Name:	**UCSF Rutter Center**			Initials:	**EFA/ CLP**	Checked:	**BL**
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ASCE 41-17
Collapse Prevention Structural Checklist For Building Type S2-S2A

C NC N/A U ☐ ☒ ☐ ☐	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:** There are many large openings, including openings adjacent to braced frames.

FLEXIBLE DIAPHRAGMS

	Description
C NC N/A U ☐ ☐ ☒ ☐	CROSS TIES: There are continuous cross ties between diaphragm chords. (Commentary: Sec. A.4.1.2. Tier 2: Sec. 5.6.1.2) **Comments:** The diaphragms are metal deck with concrete fill.
C NC N/A U ☐ ☐ ☒ ☐	STRAIGHT SHEATHING: All straight-sheathed diaphragms have aspect ratios less than 2-to-1 in the direction being considered. (Commentary: Sec. A.4.2.1. Tier 2: Sec. 5.6.2) **Comments:** The diaphragms are metal deck with concrete fill.
C NC N/A U ☐ ☐ ☒ ☐	SPANS: All wood diaphragms with spans greater than 24 ft (7.3 m) consist of wood structural panels or diagonal sheathing. (Commentary: Sec. A.4.2.2. Tier 2: Sec. 5.6.2) **Comments:** The diaphragms are metal deck with concrete fill.
C NC N/A U ☐ ☐ ☒ ☐	DIAGONALLY SHEATHED AND UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms have horizontal spans less than 40 ft (12.2 m) and aspect ratios less than or equal to 4-to-1. (Commentary: Sec. A.4.2.3. Tier 2: Sec. 5.6.2) **Comments:** The diaphragms are metal deck with concrete fill.
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:** The diaphragms are metal deck with concrete fill.

UC Campus:	San Francisco			Date:	10/31/2020		
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Building Name:	UCSF Rutter Hall			Initials:	CLP/EFP	Checked:	BL
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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:** Unknown; the site was not visited.
P ☐ N/A ☒	**Heavy masonry or stone veneer above exit ways or public access areas** **Comments:** Unknown; the site was not visited.
P ☐ N/A ☒	**Unbraced masonry parapets, cornices, or other ornamentation above exit ways or public access areas** **Comments:** Unknown; the site was not visited.
P ☐ N/A ☒	**Unrestrained hazardous material storage** **Comments:** Unknown; the site was not visited.
P ☐ N/A ☒	**Masonry chimneys** **Comments:** Given the building vintage and type, it is assumed there are no masonry chimneys.
P ☐ N/A ☒	**Unrestrained natural gas-fueled equipment such as water heaters, boilers, emergency generators, etc.** **Comments:** Unknown; the site was not visited.
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**
P ☐ N/A ☐	**Other:** **Comments:**

Falling Hazards Risk: Low (Assumed based on vintage, but not evaluated as site was not visited.)

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

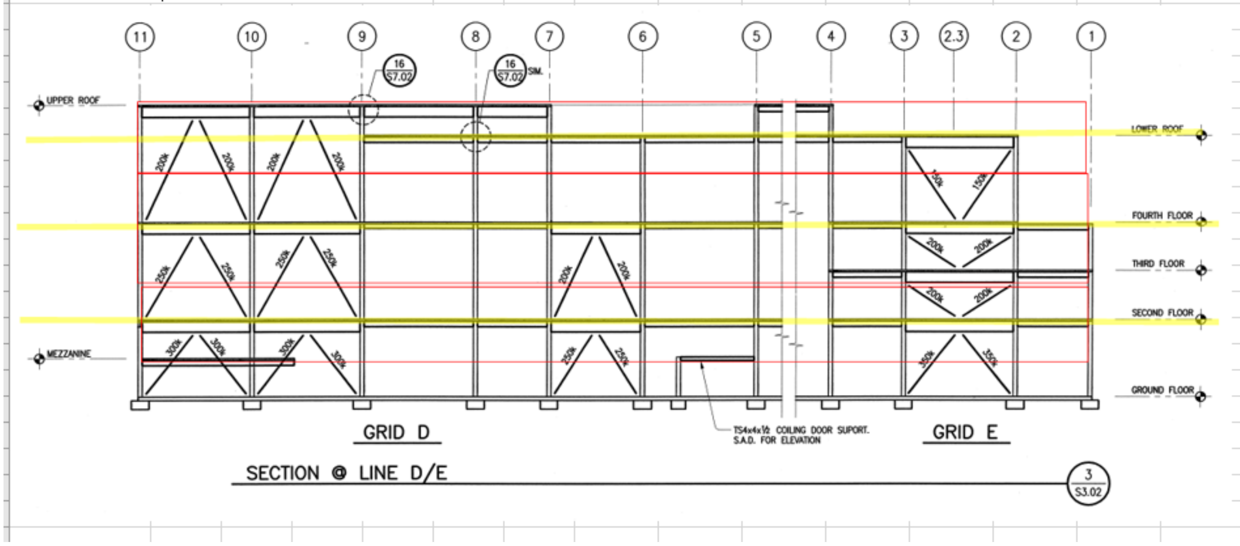
APPENDIX D

Quick Check Calculations Per ASCE 41-17

Floor Areas, Story Idealization

	Area From Bluebeam							
Tower Roof	235							ignore, braced separately
Upper Roof	15546							combined with low roof
Lower Roof		34574				34574		
4	50529	1118				64957		
3	9534	2806	638	332			13310	combine with 4th
2	52608	1740				54348		
						153879		

Idealized as 3-story structure as shown below.



Note:

1. The Upper Roof has 15,546 sf. The Lower Roof has 19,028 sf. The Upper Roof is lumped together with the Lower Roof, for a total of 15,546 sf + 19,028 sf = 34,574 sf.
2. The mezzanines at the Level 3 sum to 13,310 sf. This is lumped together with the area at the Level 4 of 50,529 sf + 1,118 sf = 51,647 sf to add to 64,957 sf.

Weight Take-off

Weight Take-Off for Steel, BRBs, Cladding										
GIRDERS: Take off all steel at second floor from Line 8 to 11 as representative										
		γ concr =	150	pcf			Area tota	54348		
		γsteel =	490	pcf			sample a	21657		
SECOND FLOOR										
	Girder ID	Length (ft)	B (in)	D (in)	No.	Area (ft^2)	Unit weight (pcf)	Weight (plf)	Weight (kips)	
NS	W12x16	32			7			26	5.82	
	W18x55	32			3			55	5.28	
	W24X55	32			1			55	1.76	
	W24X62	32			2			62.0	3.97	
	W24X76	32			7			76.0	17.02	
	W24X162	32			2			162.0	10.37	
	PG1-2	32			12	1.25	490.00	612.5	235.20	
EW	W16x26	15.33			10			26	3.99	
	W18x40	21.167			12			40.0	10.16	
	W18x40	32			28			40.0	35.84	
	W24x55	68.33			1			55.0	3.76	
	W24x62	63.67			1			62.0	3.95	
	W27x84	87.67			12			84.0	88.37	
	W24x117	32			1			117.0	3.74	
	W40x167	32			1			167.0	5.34	
	W24x207	77.17			1			207.0	15.97	
							NS	Σ =	279.4	kips
							EW	Σ =	171.1	kips
							Sum NS+EW		450.5	kips
							Area, ft^	21657		
						1.1	weight, psf		22.88	

Columns: Take off all columns from schedule at first floor; scale other floors										
		γ concr =	150	pcf						
		γsteel =	490	pcf						
	COLUMNS									
	Columns	**Height, ft**			**No. cols**	**Area (ft^2)**	**Scale Factor**	**Weight (psf)**	**Weight (kips)**	
Tower Roof										
Upper Roof	W14xNN	8.625			38					
Lower Roof	W14xNN	25.5	74.875	21.38	75	34574	0.25	3.06	105.94	hand calc
4	W14xNN	28	49.375	26.75	88	64957	0.74	4.84	314.56	
3	W14xNN				89					
2	W14xNN	21.375	21.375	24.69	96	54348	1.00	7.82	424.84	
								Σ =	845.3	kips

Note: Weight take-off for first floor columns; others estimated from col schedule by scaling for story height and col sizes.

Columns at First Floor to third floor												
	W14x90		W10x112	W12x120					HSS4x10x1/2			
plf	90	109	112	120	132	159	193	311	42.05			
no. of col	21	16	4	1	8	17	1	26	2	96		
kips	46.66	*26.27*	11.06	2.96	26.07	66.73	4.76	199.62	2.08	386.22	0.00	0.
h,ft	24.69							kips	1.1	424.84		
								area, ft^	54348			

BRBs: Estimate weigths using BRB 12 as average for all braces

		γ concr =	150	pcf				1.1		
		γsteel =	490	pcf			Weight E	226.05		
	BRBs in BRACED FRAME									
	Girder ID	**Height, ft**	**Bay, ft**	**Length,ft**	**#NS BRB**	**#EW BRB**	**Total BRB**	**Weight (psf)**	**Weight (kips)**	
Tower Roof										
Upper Roof	BRB 12	8.625	16							
Lower Roof	BRB 12	25.5	16	15.05	11	8	19	1.87	64.65	
4	BRB 12	14	16	31.17	14	14	28	3.04	197.29	
3	BRB 12	14	16							
2	BRB 12	21.375	16	29.42	20	20	40	2.45	133.00	
								Σ =	394.9	kips

Weight BRB12 205.5

Drawings only show forces. Based on review of Corebrace sizes, have used BRB 12 as average brace size for this weight take-off

	Cladding Weight at Exterior Wall								
	Exterior Lineal Ft.	Height, ft	Trib Height, ft		Area (ft^2)	Cladding Wt, psf	Line load plf	Weight (psf)	Weight (kips)
Tower Roof									
Upper Roof		8.63							
Lower Roof	772	25.50	21.38		34574	10	213.75	4.77	165.02
4	1002	28.00	26.75		64957	10	267.50	4.13	268.04
3									
2	1002	21.38	24.69		54348	10	246.88	4.55	247.37
Cladding is EIFS; assume 10psf									680.42

Indoor Pool at 2nd Floor			water	62.4	pcf
				Weight, kips	
Lineal feet of 12" side wall			237.84		
Pool depth			6.418	229	
area surface			2445		
depth assumed			6.168	941	
				1170	kips
Outdoor Pool at Fourth Floor					
				Weight, kips	
Lineal feet of 12" side wall			265		
Pool depth			7	278.3	
area surface			4060		
depth assumed			6.75	1710	
				1988	kips

Flat Load Tables

	Seismic Weight	Dead Load	Area Tower
TOWER ROOF	**psf**	**psf**	**Remarks**
Roofing	5.0	5.0	
Waterproofing / insulation	5.0	5.0	
3" Deck no fill type C	72.5	72.5	from Verco W3 Formlok tables
MEP	10.0	10.0	MEP , screens, Penthouse
Lighting and misc.	4.0	4.0	Lay-in ceiling or exposed structure
Beams/ girders	22.9	22.9	Steel beams, girders
Columns W10X54 X 58.83 FT	0.0	0.0	Steel Col
BRB	0.0	0.0	BRB assume BRB 12 for all
Cladding	0.0	0.0	
Partitions	5.0	0.0	
Total	124.4	119.4	

UPPER ROOF assumed to have similar values to the LOWER ROOF.

	Seismic Weight	Dead Load	
LOWER ROOF	**psf**	**psf**	**Remarks**
Roofing	5.0	5.0	
Waterproofing / insulation	5.0	5.0	allowance,
3" Deck with 4.5" NWC fill	63.3	63.3	from Verco W3 Formlok tables
MEP	5.0	5.0	MEP hung from underside of floor slab
Ceiling, lighting and misc.	4.0	4.0	Lay-in ceiling or exposed structure
Beams/ girders	22.9	22.9	Steel beams, girders
Columns	3.1	3.1	Steel Col
BRB	1.9	1.9	BRB assume BRB 12 for all
Cladding	4.8	4.8	
Partitions	5.0	0.0	
Total	114.9	109.9	

	Seismic Weight	Dead Load	
4th FLOOR	**psf**	**psf**	**Remarks**
Flooring	5.0	5.0	allowance,
3" Deck with 3.25" NWC fill	75.4	75.4	from Verco W3 Formlok tables
MEP	5.0	5.0	MEP hung from underside of floor slab
Ceiling, lighting and misc.	4.0	4.0	Lay-in ceiling or exposed structure
Beams/ girders	22.9	22.9	Steel beams, girders
Columns	4.8	4.8	Steel Col
BRB	3.0	3.0	BRB assume BRB 12 for all
Cladding	4.1	4.1	
Partitions	10.0	10.0	
Total	134.3	134.3	
Add Outdoor Pool side walls + water	1170.0	kips	

3rd FLOOR is assumed similar value to 4th FLOOR.

	Seismic Weight	Dead Load	
2nd FLOOR	**psf**	**psf**	**Remarks**
Flooring	5.0	5.0	allowance, no arch dwgs
3" Deck with 4.5" NWC fill	75.4	75.4	from Verco W3 Formlok tables
MEP	5.0	5.0	MEP hung from underside of floor slab
Ceiling, lighting and misc.	4.0	4.0	Lay-in ceiling or exposed structure
Beams/ girders	22.9	22.9	Steel beams, girders
Columns	7.8	7.8	Steel Col
BRB	2.4	2.4	BRB assume BRB 12 for all
Cladding	4.6	4.6	
Partitions	10.0	10.0	
Total	137.1	137.1	
Add Indoor Pool side walls + water	1988.3	kips	

Story Weight

Floor Levels	Story Height, ft	Height, ft	Area (ft^2)	Weight, psf	Added Pool weight,	Weight, kips	
Tower Roof	58.83	142.33		0.00		0.0	ignore, braced independently
Upper Roof	8.625	83.5				0.0	combine with lower roof
Lower Roof	25.5	74.875	34574	114.89		3972.2	
4	14	49.375	64957	134.29	1170.01	9893.1	
3	14	35.375	0	0.00		0.0	combine with 4th floor
2	21.375	21.375	54348	137.10	1988.32	9439.4	
1			153879				
						23304.8	

Period

C_t=	0.02	
h_n(ft)=	75.00	
B=	0.75	
T=	0.51	sec

Notes:

1- The period calculated per ASCE 41-17 Equation 4-4.

$$T = C_t \cdot h_n^{B}$$

2- Ct and B are for "all other framing system" per ASCE 41-17 Section 4.4.2.4.

3- The building height is taken from the 1st floor to the base of the high roof.

Seismic Hazard

BSE-2N SXS=1.95
BSE-1N SXS=1.3
BSE-2E SXS=1.794
BSE-1E SXS=0.974

T0=0.2585
Ts=1.2923

William J. Rutter Center, 1675 Owens St, San Francisco, CA 94158, USA

Latitude, Longitude: 37.7680799, -122.393011

Date	3/2/2020, 11:26:28 AM
Design Code Reference Document	ASCE41-17
Custom Probability	
Site Class	E - Soft Clay Soil

Type	Description	Value
Hazard Level		BSE-2E
S_S	spectral response (0.2 s)	1.38
S_1	spectral response (1.0 s)	0.532
S_{XS}	site-modified spectral response (0.2 s)	1.794
S_{X1}	site-modified spectral response (1.0 s)	2.236
f_a	site amplification factor (0.2 s)	1.3
f_v	site amplification factor (1.0 s)	4.2

See also Table 1 from John Egan.

Seismic Force Distribution

ATC Horizontal Response Spectrum Seismic Parameters			
Hazard Level	BSE-2E		
Site Class	E		
S_{XS}=	1.794	g	(See Note 2)
S_{X1}=	2.236	g	(See Note 2)
T=	0.51	s	
Sa=	1.794	g	
W=	23,305	kips	
C=	1.1	Per ASCE 41-17 Table 4-7	
V=	45,990	kips	
k=	1.00	Per ASCE 41-17 Section 4.4.2.2, K = 1.0 for periods less than 0.5 sec and K = 2.0 for T >2.5 sec. It varies linearly inbetween 0.5 sec	

Table 4-7. Modification Factor, *C*

Building Type[a]	Number of Stories 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.

Floor Levels	Story Height (ft)	Total Height, H (ft)	Weight, W (kips)	W x H^k	coeff	Fx (kips)	Story Shear, V (kips)
Tower Roof	58.83	142.33	0	0			
Upper Roof	8.625	83.5					
Lower Roof	25.5	74.875	3,972	303,722	0.30	13,880	13,880
4	28	49.375	9,893	497,811	0.49	22,750	36,631
3			0	0	0.00	0	36,631
2	21.375	21.375	9,439	204,791	0.20	9,359	45,990
	142.3		23,305	1,006,324	1	45,990	

Notes:

1- Base of building is assumed to be at 1st floor.

2- S_{XS} and S_{X1} refer to the spectral response at 0.2s and 1.0s, respectively, after applying site amplification factors. These values match S_{CS} and S_{C1} for the building, per the table UCSF Group 3 Buildings - Assessment of Geotechnical

3- Per Section 4.4.2.3 in ASCE 41-17, the spectral acceleration, Sa, is computed as the least value of S_{X1}/T, and S_{XS}.

4- Modification Factor, C, per ASCE 41-17, Table 4-7.

Repeat using ASCE 7-05 for comparison

W=	23,305	kips
C=	0.1406	Per ASCE 7-05
rho	1.0	
V=	3,277	kips

k= 1.00

Per ASCE 41-17 Section 4.4.2.2, K = 1.0 for periods less than 0.5 sec and K = 2.0 for T

Floor Levels	Story Height (ft)	Total Height, H (ft)	Weight, W (kips)	W x H^k	coeff	Fx (kips)	Story Shear, V (kips)
Tower Roof	58.83	142.33	0.00	0.00	0.00	0.00	0.00
Upper Roof	8.625	83.5	0.00	0.00	0.00	0.00	0.00
Lower Roof	25.5	74.875	3972.24	297421.67	0.30	983.89	983.89
4	28	49.375	9893.11	488472.11	0.49	1615.89	2599.78
3	0	0	0.00	0.00	0.00	0.00	
2	21.375	21.375	9439.43	204791.05	0.21	677.46	3277.24
	142.3		23,305	990,685	1.00	3,277	

Note I=1.25, R=8, rho=1.0. Despite irregularities, we do not have easy way to check deflections but have not penalized design with rho factor since there are many frames in both directions.

Column Axial Force Tier 1 Check

Story Weight

Floor Levels	Story Height, ft	Height, ft	Area (ft^2)	Weight, psf	Added Pool weight, kips	Weight, kips	
Tower Roof	58.83	142.33		0.00		0.0	ignore, braced independently
Upper Roof	8.625	83.5				0.0	combine with lower roof
Lower Roof	25.5	74.875	34574	114.89		3972.2	
4	14	49.375	64957	134.29	1170.01	9893.1	
3	14	35.375	0	0.00		0.0	combine with 4th floor
2	21.375	21.375	54348	137.10	1988.32	9439.4	
1			153879				
						23304.8	

$w_{Lowroof} := 114.9psf$ $\quad\quad A_{trib} := \frac{26.66ft \cdot 32ft}{1} = 853.12 \cdot ft^2$

$w_5 := 0psf$ $\quad\quad F_y := 50ksi$

$w_4 := 134.3psf$

$w_3 := 0psf$

$w_2 := 137psf$

$F_{1st} := (w_{Lowroof} + w_5 + w_4 + w_3 + w_2) \cdot A_{trib} = 329.475 \cdot kip$

Column at 4-H is C27 W14x311 $\quad\quad A_{W14311} := 91.4in^2$

$Axial_{stress} := \frac{F_{1st}}{A_{W14311}} = 3.605 \cdot ksi$ $\quad\quad 0.1 \cdot F_y = 5 \cdot ksi$

To check all interior columns choose the columns with smaller area and largest tributary area for the interior columns

$F_{1stsmall} := (w_5 + w_4 + w_3 + w_2) \cdot A_{trib} = 231.451 \cdot kip$

$F_{inta} := F_{1stsmall} = 231.451 \cdot kip$

$A_{minint} := 46.7in^2$

$Axial_{stressint} := \frac{F_{inta}}{A_{minint}} = 4.956 \cdot ksi$ $\quad\quad$ less than 5ksi ok

To check the exterior columns choose the columns with smaller area and the largest tributary area for the exterior colemns

$F_{ext} := \frac{F_{1st}}{2} = 164.737 \cdot kip$ $\quad A_{minext} := 46.7 in^2$

$Axial_{stressext} := \frac{F_{ext}}{A_{minext}} = 3.528 \cdot ksi$ $\quad$ less than 5ksi ok

All columns have Axial stress less than 0.1Fy

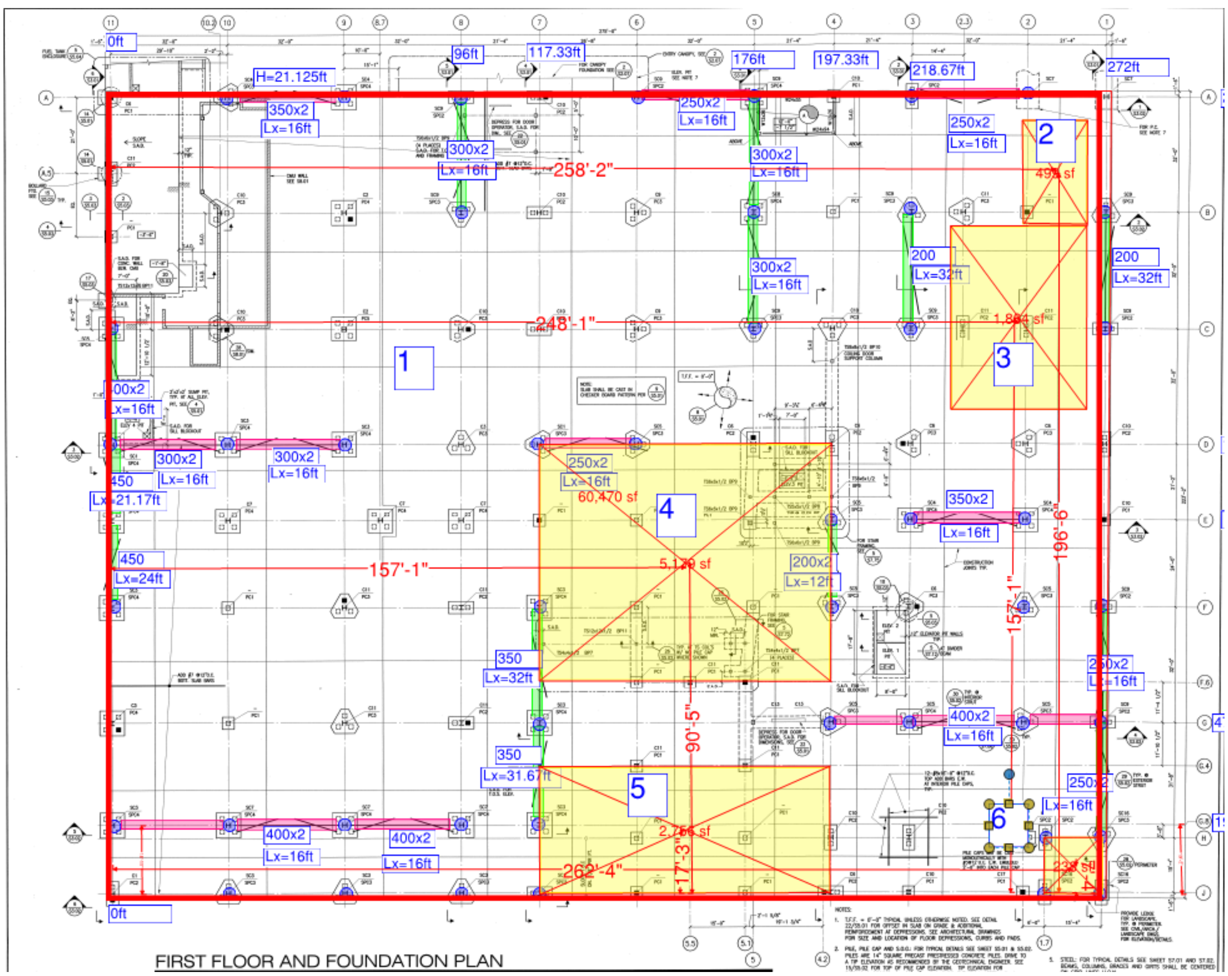
ALL other colums have smaller tributary and force

Note that check above was done using dead loads only.

If live loads are included, with a roof load of 20 psf, and conservative loads of 100 psf for the floors, and the ASCE 41-17 Section 7.2.2 assumption of Q_L = 0.25 x total loads, then Q_L = (0.25) (26.66 ft x 32 ft) (0.02 + 4 x 0.100) = 89.6 kips. For the interior column above, $Q_D + Q_L$ = (231.5 k + 89.6 k) = 321.1 k and stress is then (321.1 k / 46.7 in^2) = 6.9 ksi > 5 ksi.

Center of Gravity

Calculation to fing the center of gravity of the floor							
Item	Lx	Ly	xcg	ycg	Area	Area*xcg	Area*ycg
	ft	ft	ft	ft	ft^2	ft^3	ft^3
1	Not used area calculated using blue beam	Not used area calculated using blue beam	136	110.085	60470	8223920	6656840
2			258.17	196.5	0	0	0
3			248.08	157.08	0	0	0
4			157.08	90.46	-5179	-813517	-468492
5			157.08	17.25	-2756	-432912	-47541
6			262.33	7.33	-238	-62434.5	-1744.54
	0	0			52297	6915056	6139062



Xtotcg=	132.2266
Ytotcg=	117.3884

Total bldg area=	156891
total bldg weight=	20395.83
total bldg shear=	36590.12

Eccentricity and Brace Avg. Axial Stress Check

Brace Axial Stress Check

Per Section 4.4.3.4 in ASCE 41-17:

$$f_j^{avg} = \frac{1}{M_s}\left(\frac{V_j}{sN_{br}}\right)\left(\frac{L_{br}}{A_{br}}\right) \quad (4\text{-}9)$$

where

L_{br} = Average length of the braces (ft);
N_{br} = Number of braces in tension and compression if the braces are designed for compression, number of diagonal braces in tension if the braces are designed for tension only;
s = Average span length of braced spans (ft);
A_{br} = Average area of a diagonal brace (in.^{2});
V_j = Maximum story shear at each level (kip); and
M_s = System modification factor; M_s shall be taken from Table 4-9.

Table 4-9. M_s Factors for Diagonal Braces

		Level of Performance		
Brace Type	**d/t[b]**	**CP[a]**	**LS[a]**	**IO[a]**
Tube[b]	$<90/(F_{ye})^{1/2}$	7.0	4.5	2.0
	$>190/(F_{ye})^{1/2}$	3.5	2.5	1.25
Pipe[c]	$<1,500/F_{ye}$	7.0	4.5	2.0
	$>6,000/F_{ye}$	3.5	2.5	1.25
Tension-only		3.5	2.5	1.25
Cold-formed steel strap-braced wall		3.5	2.5	1.25
All others		7.0	4.5	2.0

Note: $F_{ye} = 1.25F_y$; expected yield stress.
[a] CP = Collapse Prevention, LS = Life Safety, IO = Immediate Occupancy.
[b] Depth-to-thickness ratio.
[c] Interpolation to be used for tubes and pipes.

Since we did not have the brace areas we calculated the areas based on the capacity of the brace assuming Fy=39ksi

Ratio of diagonal forces to horizontal forces for bra

	Ly	Lx	Lx	Lx	Lx	Lx	Lx	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ
Upper roof	409	192	160	256	188	384	144	0.42	0.36	0.53	0.42	0.68	0.33
lower roof	306	192	160	256	188	384	144	0.53	0.46	0.64	0.52	0.78	0.43
4th	336	192	160	256	188	384	144	0.50	0.43	0.61	0.49	0.75	0.39
3rd	168	192						0.75					
2nd	253.5	192	160	254	288	384	144	0.60	0.53	0.71	0.75	0.83	0.49

Center of Rigidity

X dir braced frames	Floor level	Fbrace from drawings (kip)	Fbrace from drawings (kip)	Fbrace from drawings (kip)	Total horizontal force (kip)	Distance from Origin (in) Dy	Fhorx*Dy
line A					0	2642	0
					0	2642	0
	4				0	2642	0
	2	500	400	400	645	2642	1704065
	1	600	500	500	966	2642	2552282
Line D					0	1490	0
					0	1490	0
	4	400	400		340	1490	506547
	2	500	500	400	668	1490	995514
	1	600	600	500	991	1490	1477213
Line E					0	1236	0
					0	1236	0
	4	300			149	1236	183968
	2	400			301	1236	372074
	1	700			423	1236	522379
Line G					0	564	0
					0	564	0
	4	300			149	564	83947
	2	400			301	564	169781
	1	800			483	564	272420
Line G.8					0	228	0
					0	228	0
	4				0	228	0
	2	1200			903	228	205905
	1	800	800		966	228	220254

Y dir braced frames	Floor level	Fbrace from drawings (kip)	Fbrace from drawings (kip)	Fbrace from drawings (kip)	Total horizontal force (kip)	Distance from Origin (in) Dx	Fhorx*Dx
line 1					0	3264	0
					0	3264	0
	4				0	3264	0
	2	300	300		452	3264	1473846
	1	200	500	500	771	3264	2515489
Line 3					0	2616	0
					0	2616	0
	4	400			213	2616	556152
	2	400			301	2616	787496
	1	200			167	2616	436636
Line 4					0	2368	0
					0	2368	0
	4	300			149	2368	352451
	2	300			226	2368	534621
	1	400			198	2368	467834
Line 5					0	2112	0
					0	2112	0
	4				0	2112	0
	2	400	400		397	2112	838276
	1	600	600		725	2112	1530187
Line 7					0	1408	0
					0	1408	0
	4	400			313	1408	440443
	2	700			527	1408	741719
	1	700			584	1408	822509
Line 8					0	1152	0
					0	1152	0
	4				0	1152	0
	2	400			198	1152	228621
	1	600			362	1152	417324
Line 11					0	0	0
					0	0	0
	4		300	300	350	0	0
	2	700	400	400	785	0	0
	1	800	450	450	1139	0	0

CG from CG calc page		
Xtotcg=	132.2266	
Ytotcg=	117.3884	
	(ft)	20% (ft)
Bldg length=	272	54.4
Bldg width=	220.17	44.034

Floor level	Yrig (in)				
4	1214.58	101.21	62.00	39.21	
2	1223.22	101.94	117.39	15.45	
1	1317.43	109.79	117.39	7.60	no more than 20%

Floor level	Yrig (in)				
4	1214.58	101.21	62.00	39.21	
2	1223.22	101.94	117.39	15.45	
1	1317.43	109.79	117.39	7.60	no more than 20%

Brace Average Axial Stress

X DIRECTION		Fy=	38		
Floor level	Sum of all brace capacity forces (kip)	Sum of all brace capacity forces* MS=7 (kip)	sum Area of braces (in^2)	Demand (kip) BSE-2E	ASCE 7-05 Demand
4	637.64	4463.47	117.46	13880.28	983.89
2	2818.25	19727.72	519.15	36630.57	2599.78
1	3829.10	26803.67	705.36	45989.66	3277.24

Y DIRECTION					
Floor level	Sum of all brace capacity forces (kip)	Sum of all brace capacity forces* MS=7 (kip)	sum Area of braces (in^2)	Demand (kip) BSE-2E	ASCE 7-05 Demand
4	1023.80	7166.62	188.60	13880.28	983.89
2	2885.55	20198.85	531.55	36630.57	2599.78
1	3945.43	27618.02	726.79	45989.66	3277.24

Ratios to convert from BSE-2E to BSE-1E, BSE-2N and BSE-1N for Information Only							
Existing				New			
1.794	7	0.256	1.000	1.95	7	0.279	1.087
0.974	4.5	0.216	0.845	1.3	4.5	0.289	1.127

Calculation of stress demand for braces

X direction (N-S)						
Tier 1 Capacity		Fy		38 0.5Fy	19	34.2
	BSE-2E	*BSE-1E*	*BSE-2N*	*BSE-1N*	**ASCE 41-17 DCR**	*ASCE 7-05 DCR*
Floor level	**KSI DEMAND**	*KSI DEMAND*	*KSI DEMAND*	*KSI DEMAND*	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25
4	**118.17**	*99.80*	*128.45*	*133.20*	**6.22**	**1.71**
2	**70.56**	*59.59*	*76.69*	*79.53*	**3.71**	1.02
1	**65.20**	*55.06*	*70.87*	*73.49*	**3.43**	0.95

Y direction (E-W)						
		Fy		38 0.5Fy	19	34.2
	BSE-2E	*BSE-1E*	*BSE-2N*	*BSE-1N*	**ASCE 41-17 DCR**	*ASCE 7-05 DCR*
Floor level	**KSI DEMAND**	*KSI DEMAND*	*KSI DEMAND*	*KSI DEMAND*	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25
4	**73.60**	*62.16*	*80.00*	*82.96*	**3.87**	**1.07**
2	**68.91**	*58.20*	*74.91*	*77.68*	**3.63**	1.00
1	**63.28**	*53.44*	*68.78*	*71.33*	**3.33**	0.92

Notes:

1. Check done for ASCE 41-17 and repeated using same method for forces from ASCE 7-05. See Appendix E for more detailed check per ASCE 7-05.
2. The BSE-2N and BSE-1N columns are provided for comparison only. The BSE-1N ratios are larger than the BSE-2N ratios because of the ratio of demand and the Ms factor used at each level. The BSE-2E values are used as the starting reference point. For example, for Story 1, the BSE-2E stress in the X-direction is 65.20 ksi. The BSE-2N stress is (BSE-2E = 65.20 ksi) x (BSE-2N Sxs = 1.95 / CP Ms = 7) / (BSE-2E Sxs = 1.794 / CP Ms = 7) = 70.87. The BSE-1N stress is (BSE-2E = 65.20ksi) x (BSE-1N Sxs = 1.30 / CP Ms = 4.5) / (BSE-2E Sxs = 1.794 / CP Ms = 7) = 73.47 ksi.
3. This is a highly irregular building with intermediate floors, large diaphragm openings, offset floors, discontinuous braced bays, etc. This Tier 1 analysis has simplified the floor levels and lumped weights. An analysis using a SAP or ETABS model would provide a better understanding of the force distribution and building behavior. See Appendix F for a comparison using the original calculations.

APPENDIX E

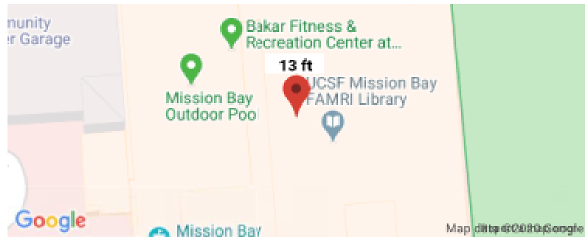
Sample Calculations Per ASCE 7-05

Seismic Hazard per ASCE 7-05

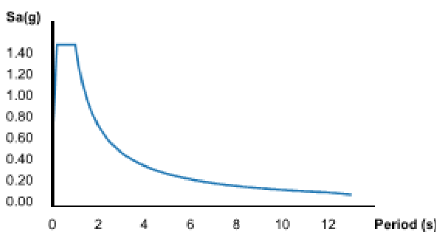
ATC Hazards by Location

Search Information

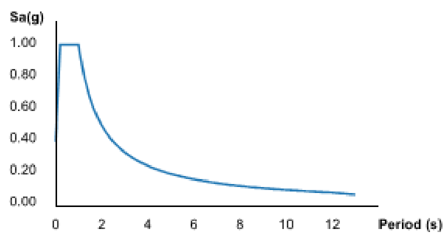
Coordinates:	37.768122169980366, -122.39310076635075
Elevation:	13 ft
Timestamp:	2020-03-09T23:43:43.725Z
Hazard Type:	Seismic
Reference Document:	ASCE7-05
Risk Category:	III
Site Class:	E



MCER Horizontal Response Spectrum



Design Horizontal Response Spectrum



Basic Parameters

Name	Value	Description
S_S	1.5	MCE_R ground motion (period=0.2s)
S_1	0.634	MCE_R ground motion (period=1.0s)
S_{MS}	1.35	Site-modified spectral acceleration value
S_{M1}	1.521	Site-modified spectral acceleration value
S_{DS}	0.9	Numeric seismic design value at 0.2s SA
S_{D1}	1.014	Numeric seismic design value at 1.0s SA

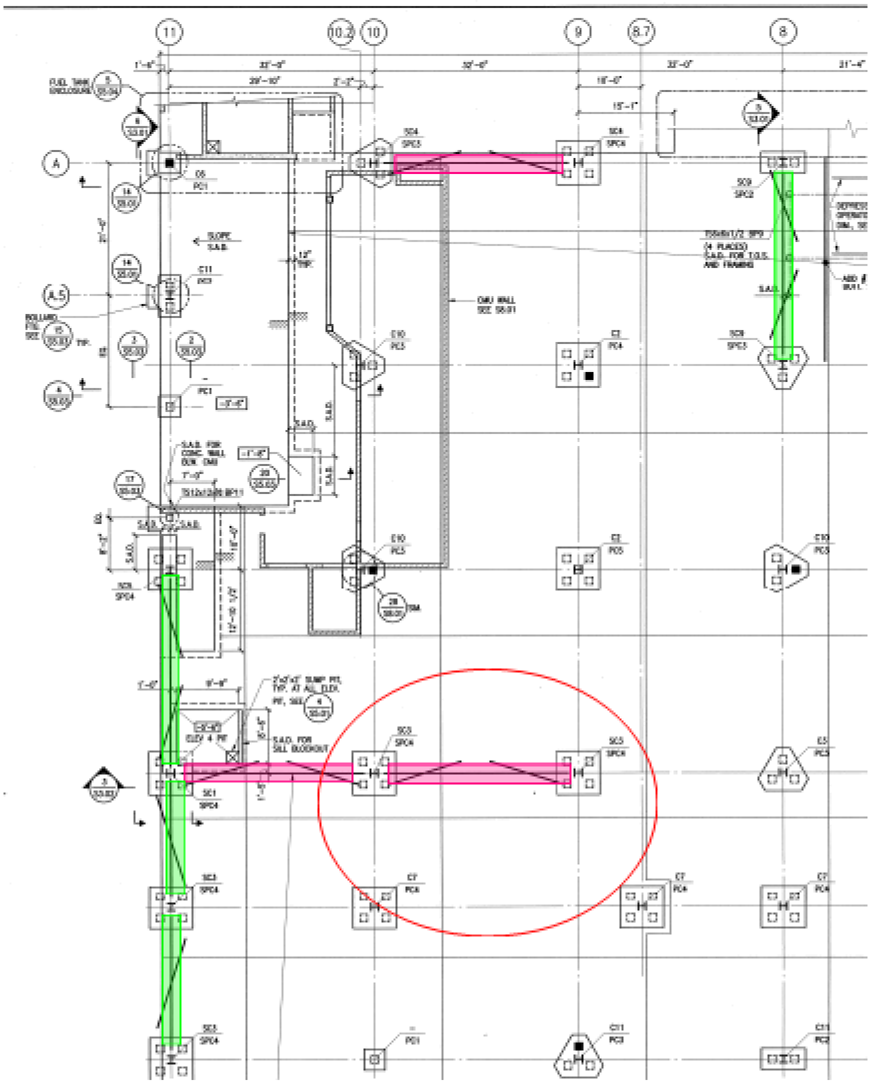
▾Additional Information

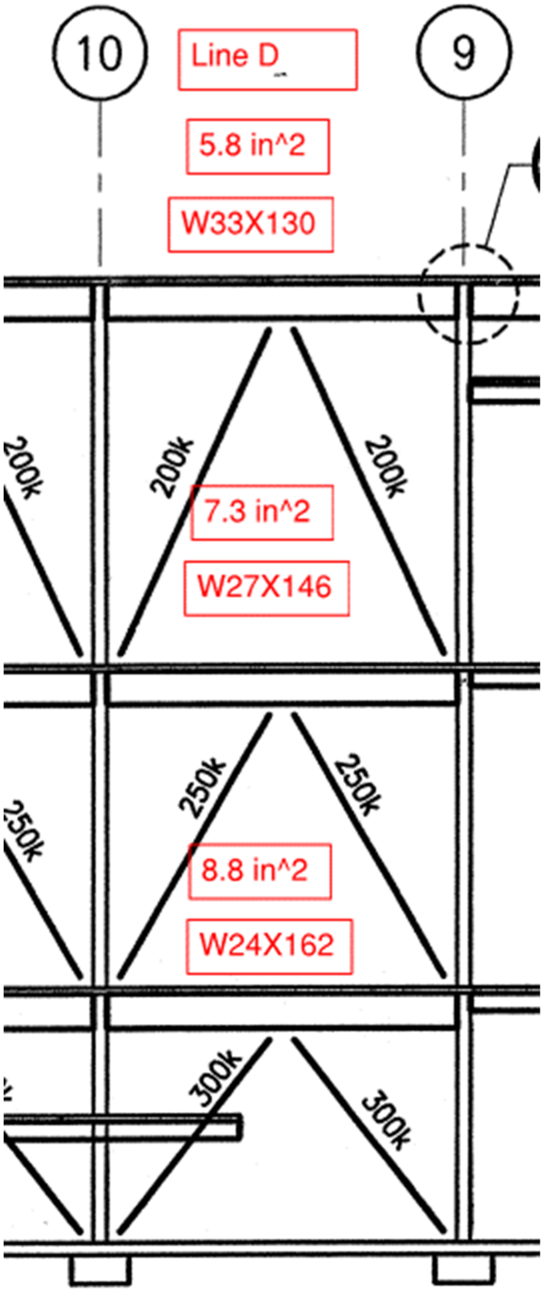
Name	Value	Description
SDC	D	Seismic design category
F_a	0.9	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
T_L	12	Long-period transition period (s)

ASCE-7-05 Comparison			
V=Cs W			
SDS	0.9		
SD1	1.014		
S1	0.634		
R	8	Table 12.2-1(25)	
I	1.25		
T	0.55	sec	
Cs	SDS/(R/I)	12.8-2	
	0.140625		
Csmax	SD1/(T(R/I))	12.8.3	
	0.285508157		
Csmin	0.5S1/(R/I)	12.8.4	
	0.04953125		
Cs	0.140625		

Note that this is essentially the same as the original design for V=0.14W

Check BRB Chevron Brace at Line D-9 to D-10




10
Line D
9
5.8 in^2
W33X130
200k
200k
200k
7.3 in^2
W27X146
250k
250k
250k
8.8 in^2
W24X162
300k
300k

ASCE 7-05 Check of Beam in Chevron Braced Bay

See pdf of spreadsheet below

SINGLE BAY BRBF DESIGN - CHEVRON

BRBF LOCATION	Line D - 9-10

GENERAL DESIGN PARAMETERS:

ϕ_b (flexure)=	0.9	C_d=	5	ρ=	1
ϕv (shear)=	0.9	I=	1.25	Ω=	2.5
ϕc (compression)=	0.9	ϕ_w (weld)=	0.75	S_{DS}=	0.9
ϕ_b (brace)=	0.9	ϕ_t (tension)=	0.9	E=	29000 ksi

BRBF GEOMETRY:

	Level 2	Level 4	Upper roof	
L(ft)=	32.00	32.00	32.00	Bay Width (Columns C-C)
hi(ft)	21.38	28.00	25.63	Story Height
L_{diag}(ft)=	26.70	32.25	30.21	Work Point - Work Point
cosΨ=	0.599	0.496	0.530	Ψ = angle between brace and horizontal axis
sin=Ψ	0.801	0.868	0.848	

BRACE DESIGN:

AISC 341-05 Section 16.2 -Brace Strength

	12-E-F.3	12-E-F.3	12-E-F.3	Brace ID
F_{ysc} (ksi)	38	38	38	Minimum yield stress of the steel core
$F_{ymax\ (ksi)}$	46	46	46	Maximum yield stress of the steel core
Steel Core Area (in2)	8.8	7.3	5.8	

AISC 341-05 Section 16.2d -Adjusted Brace Strength

ω=	1.25	1.25	1.25	Strain Hardening Adjustment Factor (Assumed)
β=	1.35	1.35	1.35	Compression Adjustment Factor (Assumed)
βω=	1.688	1.688	1.688	
ωF_{ymax} Asc	506	420	334	Adjusted Brace Strength in Tension
$\beta\omega F_{ymax} A_{sc}$=	683	567	450	Adjusted Brace Strength in Compression

Beam Design

Beam Demands

	12-E-F.3	12-E-F.3	12-E-F.3	Brace ID
P_{Emh} (kip)=	428	269	228	Axial load due to sum of adj. braces (tension and compresion) use 0.6 of horizontal force for compression
P_y (kip)=	142	128	99	Vertical unbalanced force due to adj. brace strength
M_{Emh} (kip-ft)	1134	1020	792	V_{emh}*L/4
V_{Emh} (kip)	71	64	50	Seismic shear due to adjacent brace strength
V_{ug} (kip)=	8	15	15	Factored gravity shear from analysis
V_u (kip)=	79	79	65	$V_{ug} + V_{emh}$

Beam Geometric Properties

F_y (ksi)=	50	50	50
Beam Size=	W24x162	W27x146	W33x130
A_g (in^2)=	47.8	43.2	38.3
t_f (in)=	1.22	0.975	0.855
t_w (in)=	0.705	0.605	0.58
d (in)=	25	27.4	33.1
b_f (in)=	13	14	11.5
S_x (in^3)	414	414	406
Z_x (in^3)	468	464	467
r_y (in)=	10.4	11.5	13.2
r_x (in)=	3.05	3.2	2.39
r_{ts} (in)=	3.57	3.76	2.94
h_0 (in)=	23.8	26.4	32.2

J (in^4)=	18.5	11.3	7.37	
c=	1	1	1	

Seismic Compactness Per AISC 341-05 Section 16.5a/8.2b

Beam Compact Flange $b_f/2t_f$=	5.3	7.2	6.7	
$(b/2t)_{max}=0.3(E/F_y)^{0.5}$=	7.2	7.2	7.2	
$b_f/2t_f \leq (b/2t)_{max}$=	Beam OK	Beam OK	Beam OK	
Beam Compact Web $(d-2t_f)/t_w$=	32.0	42.1	54.1	
$Ca = P_u/\phi P_y$=	0.20	0.14	0.13	
$2.45\ (E/F_y)^{0.5}\ (1-0.93)C_a$=	48.1	51.4	51.7	if $C_a \leq 0.125$
$0.77\ (E/F_y)0.5\ \ (2.93-C_a)$=	50.6	51.8	51.9	if $C_a > 0.125$
$1.49\ (E/F_y)^{0.5}$=	35.9	35.9	35.9	if $C_a > 0.125$ (min. limit)
$(h/t_w)_{max}$	50.6	51.8	51.9	
$(d-2t_f)/t_w \leq (h/t_w)_{max}$	Beam OK	Beam OK	REVISE	

AISC 360-05 Section D2 - Tension

ϕP_{nt} (kip)=	2151	1944	1724	AISC 360 Equation D2-1
DCR=	0.20	0.14	0.13	
	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section E - Compression

L_x (ft)=	15	15	15	Strong axis unbraced length
L_y (ft)=	15	15	15	Weak axis unbraced length
k_x=	1.0	1.0	1.0	
$(kL/r)_x$=	17.3	15.7	13.6	
k_y=	0.5	0.5	0.5	
$(kL/r)_y$=	29.5	28.1	37.7	
F_e (ksi)=	328.71	361.84	201.84	AISC 360-05 Equaltion E3-4
F_{cr} (ksi)=	46.9	47.2	45.1	AISC 360-05 Equaltion E3-2 or E3-3
$\phi_c P_{nc}$ (kip)=	2018	1835	1554	AISC 360-05 Equaltion E3-1
DCR=	0.21	0.15	0.15	
	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section F - Flexure

L_p (ft)=	10.8	11.3	8.4	AISC 360-05 Equation F2-5
L_r (ft)=	35.8	33.3	24.2	AISC 360-05 Equation F2-6
C_b=	1	1	1	
S_x (in^3)=	414	414	406	
M_p (kip-ft)=	1950	1933	1946	Z_xF_y
M_n (kip-ft)=	1824	1812	1630	AISC 360-05 Equation F2-2
ϕM_n (kip-ft)=	1642	1630	1467	
DCR	0.69	0.63	0.54	
	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section H1 - Combined Compression & Flexure

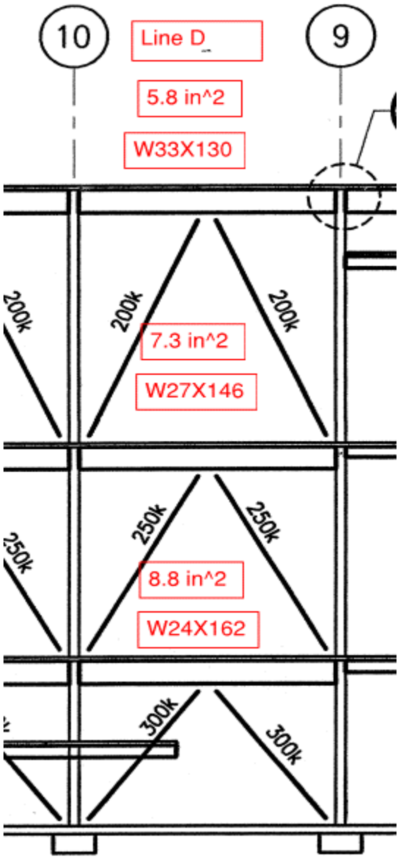
P_u (kip)=	428	269	228	
M_u (kip-ft)=	1134	1020	792	
$P_u/\phi_c P_{nc}$=	0.21	0.15	0.15	
combined equation=	0.83	0.70	0.61	AISC 360-05 Equation H1-1a or H1-1b
	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section H1 - Combined Tension & Flexure

P_u (kip)=	428	269	228	
M_u (kip-ft)=	1134	1020	792	
$P_u/\phi t P_{nt}$=	0.20	0.14	0.13	
combined equation=	0.79	0.70	0.61	AISC 360-05 Equation H1-1a or H1-1b
	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section G2 - Shear

$\phi_v V_n$ (kip)=	429	416	492	AISC 360-05 Equation G2-1
DCR	0.18	0.19	0.13	
	Beam OK	Beam OK	Beam OK	



ASCE 7-05 Check Connection in Chevron Braced Bay

BRB brace connection check

	Adjusted Brace strenght						Bolt Shear						
BRB Size, A_{sc}	Fy_{max}	ω	β	βω	T_{max}	P_{max}	$n_{bolts/leg}$	n_{legs}	n_{bolts}	ϕV_{bolt}	ϕV_n	V_u	DCR
(in2)	(ksi				(kip)	(kip)				(kip)	(kip)	(kip)	
8.1	46	1.25	1.35	1.688	466	629	2	4	8	80.7	646	629	0.97
11.8	46	1.25	1.35	1.688	679	916	2	4	8	80.7	646	916	1.42
9.5	46	1.25	1.35	1.688	546	737	3	4	12	80.7	968	737	0.76
11.8	46	1.25	1.35	1.688	679	916	3	4	12	80.7	968	916	0.95
13.2	46	1.25	1.35	1.688	759	1025	4	4	16	80.7	1291	1025	0.79

	Gusset Plate Yield							Splice Plate yield						
BRB Size, A_{sc}	t_{GP}	L	$b_{Whitmore}$	Fy_{GP}	ϕT_n	T_u	DCR	t_{SP}	b_{SP}	Fy_{SP}	n_{SP}	ϕT_n	T_u	DCR
(in^2)	(in)	(in)	(in)	(ksi)	(kip)	(kip)		(in)	(in)	(ksi)		(kip)	(kip)	
8.1	1	8	16.6	50	830	629	0.76	1	4	50	8	1600	629	0.39
11.8	1.25	8	16.6	50	1038	916	0.88	1	4	50	8	1600	916	0.57
9.5	1.25	12	18.9	50	1181	737	0.62	1	4	50	8	1600	737	0.46
11.8	1.25	12	18.9	50	1181	916	0.78	1	4	50	8	1600	916	0.57
13.2	1.25	16	21.2	50	1325	1025	0.77	1	4	50	8	1600	1025	0.64

	Wing Plate Welds					
BRB Size, A_{sc}	W1	L1	n_{welds}	ϕV_n	T_u	DCR
(in^2)	(in)	(in)		(kip)	(kip)	
8.1	0.375	10	4	334	314	0.94
11.8	0.375	10	4	334	458	1.37
9.5	0.375	14	4	468	369	0.79
11.8	0.375	14	4	468	458	0.98
13.2	0.375	18	4	601	512	0.85

Notes:
1.Gusset plate buckling ok by inspection
2.Gusset plate blok shear is not applicable
3.Gusset plate to column/base plate welds not checked for Tier 1 analysis

APPENDIX F

Comparison of F/E and R+C Tier 1 calcs

Weight Take-Off Comparison R+C Based on 2002 Bid Set and F/E Original Nov 2000 Calculations

Story Weight

Floor Levels	Story Height, ft	Height, ft	Area (ft^2)	Weight, psf	Added Pool weight, kips	Weight, kips	
Tower Roof	58.83	142.33		0.00		0.0	ignore, braced independently
Upper Roof	8.625	83.5				0.0	combine with lower roof
Lower Roof	25.5	74.875	34574	114.89		3972.2	
4	14	49.375	64957	134.29	1170.01	9893.1	
3	14	35.375	0	0.00		0.0	combine with 4th floor
2	21.375	21.375	54348	137.10	1988.32	9439.4	
1			153879				
						23304.8	

Comparison with Story Weights used in Forell Elsesser Calculations dated Nov 2000 with R+C weight take-off

Level	F/E Weight, kips	F/E Weights lumped, kips	R+C Lumped Weights, kips	Ratio FE/R+C	
T85	916				combine with lower roof
T75	2235	3151	3972	0.79	
4	8848	10144	9893	1.03	
3	1296				combine with 4th floor
2	7557	7557	9439	0.80	
Sum	20852	20852	23305	0.89	

Brace Forces from SAP2000 Elastic Analysis in F/E Calculations from November 2000

Appears target DCR was <=0.8. Some sizes apparently increased after this run.

Note F/E SAP2000 Nov 2000 analysis done with V=0.14W including
R=6.4
rho=1.15
I=1.0

ASCE 7-05 Simplified BRB analysis by R+C for comparison
V=0.14W
R=8
rho=1.0
I=1.25
Simplified scaling of R+C results using ratios of FE/ R+C weights and another 0.8 reduction to account for average F/E brace forces compared to yield forces used in R+C calculations.

Calculation of stress demand for braces

X direction (N-S)						
Tier 1 Capacity		Fy	38	0.5Fy	19	34.2
	BSE-2E	*BSE-1E*	*BSE-2N*	*BSE-1N*	**ASCE 41-17 DCR**	*ASCE 7-05 DCR*
Floor level	**KSI DEMAND**	*KSI DEMAND*	*KSI DEMAND*	*KSI DEMAND*	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25
4	**118.17**	*99.80*	*128.45*	*133.20*	**6.22**	**1.71**
2	**70.56**	*59.59*	*76.69*	*79.53*	**3.71**	1.02
1	**65.20**	*55.06*	*70.87*	*73.49*	**3.43**	0.95

X direction (N-S)					
		ASCE 41-17 DCR	*ASCE 7-05 DCR*	**ASCE 41-17 DCR multiplied by 0.8 to account for the ratio of forces obtained in F/E analysis**	*ASCE 7-05 DCR multiplied by 0.8 to account for the ratio of forces obtained in F/E analysis*
	Ratio FE/R+C	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25		
DCRs Scaled by FE/R+C weight ratio overall	0.89	**5.56**	**1.53**	**4.45**	**1.23**
	0.89	**3.32**	0.92	**2.66**	0.73
	0.89	**3.07**	0.85	**2.46**	0.68
DCRs Scaled by FE/R+C weight ratio by story	0.79	**4.93**	**1.36**	**3.95**	**1.09**
	1.03	**3.81**	**1.05**	**3.05**	0.84
	0.80	**2.75**	0.76	**2.20**	0.61

Y direction (E-W)						
		Fy		38 0.5Fy	19	34.2
	BSE-2E	*BSE-1E*	*BSE-2N*	*BSE-1N*	**ASCE 41-17 DCR**	*ASCE 7-05 DCR*
Floor level	**KSI DEMAND**	*KSI DEMAND*	*KSI DEMAND*	*KSI DEMAND*	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25
4	**73.60**	*62.16*	*80.00*	*82.96*	**3.87**	**1.07**
2	**68.91**	*58.20*	*74.91*	*77.68*	**3.63**	1.00
1	**63.28**	*53.44*	*68.78*	*71.33*	**3.33**	0.92

Y direction (E-W)				
	ASCE 41-17 DCR	*ASCE 7-05 DCR*	**ASCE 41-17 DCR multiplied by 0.8 to account for the ratio of forces obtained in F/E analysis**	*ASCE 7-05 DCR multiplied by 0.8 to account for the ratio of forces obtained in F/E analysis*
Ratio FE/R+C	**BSE-2E/ 0.5Fy**	includes rho=1.0, I=1.25		
0.89	**3.47**	0.96	**2.77**	0.76
0.89	**3.25**	0.90	**2.60**	0.72
0.89	**2.98**	0.83	**2.38**	0.66
0.79	**3.07**	0.85	**2.46**	0.68
1.03	**3.72**	**1.03**	**2.98**	0.82
0.80	**2.67**	0.74	**2.13**	0.59

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UCSF MISSION BAY
COMMUNITY CENTER

JOB NO. 9932
DATE 7/25/00
BY DY SHEET NO. 2-46

SEISMIC ANALYSIS: EAST-WEST DIRECTION
BRACE AXIAL FORCES (1st Iteration)

Brace Member Number	Elevation	Grid Line	Location Line	Horizontal Projected Brace Length (ft)	Vertical Projected Brace Height (ft)	Brace Member Length (ft)	(note 1) Max. Brace Axial Force (k)	Brace Yield Force (k)	D/C Ratio	(note 1) Horiz. Shear Demand (k)
411020	0	1	B	32	22	38.8	157	200	0.79	130
411060	0	1	F	16.0	22	27.2	214	250	0.86	126
411065	0	1	F.5	16.0	22	27.2	212	250	0.85	125
411070	0	1	G	16.0	22	27.2	213	250	0.85	125
411075	0	1	G.5	16.0	22	27.2	216	250	0.86	127
413020	0	3	B	32	22	38.8	157	200	0.79	130
414050	0	4	E	12.0	22	25.1	148	200	0.74	71
414055	0	4	E.5	12.0	22	25.1	148	200	0.74	71
415010	0	5	A	16	22	27.2	232	300	0.77	137
415015	0	5	A.5	16	22	27.2	231	300	0.77	136
415020	0	5	B	16	22	27.2	233	300	0.78	137
415025	0	5	B.5	16	22	27.2	245	300	0.82	144
417060	0	7	F	32.0	22	38.8	274	350	0.78	226
417070	0	7	G	28.0	22	35.6	278	350	0.79	219
418010	0	8	A	16	22	27.2	243	300	0.81	143
418015	0	8	A.5	16	22	27.2	242	300	0.81	142
419930	0	11	C	16	22	27.2	343	400	0.86	202
419935	0	11	C.5	16	22	27.2	337	400	0.84	198
419940	0	11	D	21.2	22	30.5	353	400	0.88	245
419950	0	11	E	24.0	22	32.6	378	400	0.94	278
421060	22	1	F	16.0	14	21.3	178	200	0.89	134
421065	22	1	F.5	16.0	14	21.3	177	200	0.88	133
421070	22	1	G	16.0	14	21.3	176	200	0.88	133
421075	22	1	G.5	16.0	14	21.3	177	200	0.89	133
424050	22	4	E	12.0	14	18.4	151	200	0.76	98
424055	22	4	E.5	12.0	14	18.4	151	200	0.76	98
425010	22	5	A	16	28	32.2	169	200	0.84	84
425015	22	5	A.5	16	28	32.2	166	200	0.83	83
425020	22	5	B	16	28	32.2	156	200	0.78	78
425025	22	5	B.5	16	28	32.2	146	200	0.73	73
427060	22	7	F	32.0	28	42.5	291	350	0.83	219
427070	22	7	G	28.0	28	39.6	281	350	0.80	199
428010	22	8	A	16	28	32.2	144	200	0.72	71
428015	22	8	A.5	16	28	32.2	144	200	0.72	72
429930	22	11	C	16	28	32.2	278	350	0.79	138
429935	22	11	C.5	16	28	32.2	276	350	0.79	137
429940	22	11	D	21.2	28	35.1	381	400	0.95	230
429950	22	11	E	24.0	28	36.9	362	400	0.91	236
431060	36	1	F	16.0	14	21.3	105	150	0.70	79
431065	36	1	F.5	16.0	14	21.3	105	150	0.70	79
431070	36	1	G	16.0	14	21.3	106	150	0.71	80
431075	36	1	G.5	16.0	14	21.3	106	150	0.71	80
432060	36	2	F	16.0	14	21.3	116	200	0.58	87
432065	36	2	F.5	16.0	14	21.3	116	200	0.58	87
434050	36	4	E	12.0	14	18.4	85	150	0.57	56
434055	36	4	E.5	12.0	14	18.4	85	150	0.57	55
442060	50	2	F	16.0	25	29.7	159	200	0.79	86
442065	50	2	F.5	16.0	25	29.7	159	200	0.79	86
444050	50	4	E	12.0	25	27.7	107	150	0.71	46
444055	50	4	E.5	12.0	25	27.7	107	150	0.71	46
447060	50	7	F	32.0	35	47.4	131	200	0.66	89
447070	50	7	G	28.0	35	44.8	123	200	0.61	77
449930	50	11	C	16	25	29.7	202	250	0.81	109
449935	50	11	C.5	16	25	29.7	203	250	0.81	109
449940	50	11	D	21.2	35	40.9	171	250	0.68	88
449950	50	11	E	24.0	35	42.4	149	250	0.60	84
467060	75	7	F	16.0	10	18.9	52	100	0.52	44
467065	75	7	F.5	0.0	10	10.0	13	100	0.13	0
467075	75	7	G.5	0.0	10	10.0	16	100	0.16	0
467078	75	7	G.8	12.0	10	15.6	54	100	0.54	41
469940	75	11	D	21.2	10	23.4	18	#N/A	#N/A	16

Reliability/Redundancy Factor, ρ

Elevation 0:

TRY 450k

$\rho = 2-(20/(rmax*sqrt(Ab))$

Story Shear (El. 0) = 2908 kips
Ab = 49950 sq. ft.
max (ri) = 278.5
rmax = max(ri)/story shear 0.096
ρ = **1.065**

Elevation 22:

TRY 250k

CHECK MAX D/C RATIO TO SATISFY max ρ = 1.148
=> D/C < 1/ρ = 0.87

$\rho = 2-(20/(rmax*sqrt(Ab))$

Story Shear (El. 22) = 2245 kips
Ab = 49950 sq. ft.
max (ri) = 235.9
rmax = max(ri)/story shear 0.105
ρ = **1.148**

Elevation 36:

TRY 450k

Partial Floor Height
ρ not calculated

Note 1: Based on SAP output. Maximum force includes 5% accidental eccentricity in all directions.

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UCSF MISSION BAY
COMMUNITY CENTER

JOB NO. 9932
DATE 7/25/00
BY DY SHEET NO. 2-47

SEISMIC ANALYSIS: NORTH-SOUTH DIRECTION
BRACE AXIAL FORCES (1st Iteration)

Brace Member Number	Elevation	Grid Line	Location Line	Horizontal Projected Brace Length (ft)	Vertical Projected Brace Height (ft)	Brace Member Length (ft)	(note 1) Max. Brace Axial Force (k)	Brace Yield Force (k)	D/C Ratio	(note 1) Horiz. Shear Demand (k)	Reliability/Redundancy Factor, ρ
512010	0	A	2	16	22	27.2	179	250	0.71	105	
512510	0	A	2.5	16	22	27.2	179	250	0.72	105	
515010	0	A	5	16	22	27.2	183	250	0.73	108	
515510	0	A	5.5	16	22	27.2	179	250	0.71	105	
519010	0	A	9	16	22	27.2	265	300	**0.88**	156	
519310	0	A	9.5	16	22	27.2	265	300	**0.88**	156	
516040	0	D	6	13.3	22	25.7	196	250	0.79	102	
516540	0	D	6.5	13.3	22	25.7	197	250	0.79	102	
519040	0	D	9	16	22	27.2	248	300	0.83	146	
519340	0	D	9.5	16	22	27.2	244	300	0.81	144	
519540	0	D	10	16	22	27.2	244	300	0.81	143	
519740	0	D	10.5	16	22	27.2	247	300	0.82	145	
512050	0	E	2	16	22	27.2	294	350	0.84	173	
512550	0	E	2.5	16	22	27.2	292	350	0.84	172	ρ = 2-(20/(rmax*sqrt(Ab))
512070	0	G	2	16	22	27.2	340	400	0.85	200	
512570	0	G	2.5	16	22	27.2	338	400	0.84	199	Story Shear (El. 0) = 2908 kips
518078	0	G.8	8	16	22	27.2	323	400	0.81	190	Ab = 49950 sq. ft.
518578	0	G.8	8.5	16	22	27.2	320	400	0.80	188	max (ri) = 199.8
519078	0	G.8	9	16	22	27.2	330	400	0.82	194	rmax = max(ri)/story shear 0.069
519378	0	G.8	9.5	16	22	27.2	330	400	0.83	194	ρ = **0.698**
522010	22	A	2	16	28	32.2	156	200	0.78	77	
522510	22	A	2.5	16	28	32.2	156	200	0.78	77	
525010	22	A	5	16	28	32.2	161	200	0.81	80	
525510	22	A	5.5	16	28	32.2	161	200	0.81	80	
529010	22	A	9	16	28	32.2	212	250	0.85	105	**CHECK MAX D/C RATIO TO**
529310	22	A	9.5	16	28	32.2	212	250	0.85	105	**SATISFY max ρ = 1.155**
526040	22	D	6	13.3	28	31.0	150	200	0.75	64	**=> D/C < 1/ρ = 0.87**
526540	22	D	6.5	13.3	28	31.0	150	200	0.75	64	
529040	22	D	9	16	28	32.2	205	250	0.82	102	
529340	22	D	9.5	16	28	32.2	203	250	0.81	101	
529540	22	D	10	16	28	32.2	208	250	0.83	103	
529740	22	D	10.5	16	28	32.2	210	250	0.84	104	
522050	22	E	2	16	14	21.3	152	200	0.76	114	ρ = 2-(20/(rmax*sqrt(Ab))
522550	22	E	2.5	16	14	21.3	153	200	0.76	115	
521070	22	G	1	21.3	14	25.5	211	250	0.84	177	Story Shear (El. 22) = 2245 kips
523070	22	G	3	21.3	14	25.5	163	250	0.65	136	Ab = 49950 sq. ft.
528078	22	G.8	8	32	28	42.5	304	400	0.76	229	max (ri) = 237.9
529078	22	G.8	9	32	28	42.5	316	400	0.79	238	rmax = max(ri)/story shear 0.106
529578	22	G.8	10	32	28	42.5	288	400	0.72	217	ρ = **1.155**
532050	36	E	2	16	14	21.3	140	200	0.70	105	
532550	36	E	2.5	16	14	21.3	140	200	0.70	105	Partial Floor Height
533070	36	G	3	10.7	14	17.6	136	200	0.68	83	ρ not calculated
533570	36	G	3.5	10.7	14	17.6	136	200	0.68	82	
549010	50	A	9	16	25	29.7	135	200	0.67	73	
549310	50	A	9.5	16	25	29.7	135	200	0.67	73	
549040	50	D	9	16	35	38.5	137	200	0.69	57	
549340	50	D	9.5	16	35	38.5	137	200	0.69	57	
549540	50	D	10	16	35	38.5	144	200	0.72	60	
549740	50	D	10.5	16	35	38.5	144	200	0.72	60	
542050	50	E	2	16	25	29.7	121	150	0.80	65	
542550	50	E	2.5	16	25	29.7	121	150	0.80	65	
543070	50	G	3	10.7	25	27.2	64	100	0.64	25	
543570	50	G	3.5	10.7	25	27.2	64	100	0.64	25	
547090	50	J	7	21.3	35	41.0	181	250	0.72	94	
549090	50	J	9	16	35	38.5	177	250	0.71	73	
549390	50	J	9.5	16	35	38.5	177	250	0.71	73	
567040	75	D	7	53.3	10	54.3	75	#N/A	#N/A	74	
567090	75	J	7	21.3	10	23.6	109	#N/A	#N/A	99	

Note 1: Based on SAP output. Maximum force includes 5% accidental eccentricity in all directions.

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UCSF MISSION BAY
COMMUNITY CENTER

JOB NO. 9932
DATE 7/25/00
BY DY
SHEET NO. 2-48

SEISMIC ANALYSIS: EAST-WEST DIRECTION
BRACE AXIAL FORCES (Final)

Brace Member Number	Elevation	Grid Line	Location Line	Horizontal Projected Brace Length (ft)	Vertical Projected Brace Height (ft)	Brace Member Length (ft)	(note 1) Max. Brace Axial Force (k)	Brace Yield Force (k)	D/C Ratio	(note 1) Horiz. Shear Demand (k)	Reliability/Redundancy Factor, ρ
411020	0	1	B	32	22	38.8	157	200	0.79	129	
411060	0	1	F	16.0	22	27.2	215	250	0.86	127	
411065	0	1	F.5	16.0	22	27.2	213	250	0.85	125	
411070	0	1	G	16.0	22	27.2	214	250	0.86	126	
411075	0	1	G.5	16.0	22	27.2	217	250	0.87	128	
413020	0	3	B	32	22	38.8	157	200	0.79	130	
414050	0	4	E	12.0	22	25.1	148	200	0.74	71	
414055	0	4	E.5	12.0	22	25.1	148	200	0.74	71	
415010	0	5	A	16	22	27.2	232	300	0.77	136	
415015	0	5	A.5	16	22	27.2	230	300	0.77	135	
415020	0	5	B	16	22	27.2	232	300	0.77	136	
415025	0	5	B.5	16	22	27.2	244	300	0.81	143	
417060	0	7	F	32.0	22	38.8	273	350	0.78	225	
417070	0	7	G	28.0	22	35.6	277	350	0.79	218	ρ = 2-(20/(rmax*sqrt(Ab)))
418010	0	8	A	16	22	27.2	242	300	0.81	143	
418015	0	8	A.5	16	22	27.2	242	300	0.81	142	Story Shear (El. 0) = 2908 kips
419930	0	11	C	16	22	27.2	343	400	0.86	202	Ab = 49950 sq. ft.
419935	0	11	C.5	16	22	27.2	337	400	0.84	198	max (ri) = 278.7
419940	0	11	D	21.2	22	30.5	353	450	0.79	245	rmax = max(ri)/story shear 0.096
419950	0	11	E	24.0	22	32.6	378	450	0.84	279	ρ = **1.07**
421060	22	1	F	16.0	14	21.3	187	250	0.75	141	
421065	22	1	F.5	16.0	14	21.3	186	250	0.74	140	
421070	22	1	G	16.0	14	21.3	185	250	0.74	139	
421075	22	1	G.5	16.0	14	21.3	186	250	0.75	140	**CHECK MAX D/C RATIO TO**
424050	22	4	E	12.0	14	18.4	144	200	0.72	93	**SATISFY max ρ = 1.149**
424055	22	4	E.5	12.0	14	18.4	143	200	0.72	93	**=> D/C < 1/ρ = 0.87**
425010	22	5	A	16	28	32.2	165	200	0.82	82	
425015	22	5	A.5	16	28	32.2	162	200	0.81	81	
425020	22	5	B	16	28	32.2	153	200	0.76	76	
425025	22	5	B.5	16	28	32.2	143	200	0.72	71	
427060	22	7	F	32.0	28	42.5	289	350	0.83	217	
427070	22	7	G	28.0	28	39.6	279	350	0.80	197	ρ = 2-(20/(rmax*sqrt(Ab)))
428010	22	8	A	16	28	32.2	143	200	0.71	71	
428015	22	8	A.5	16	28	32.2	143	200	0.72	71	Story Shear (El. 22) = 2245 kips
429930	22	11	C	16	28	32.2	278	350	0.79	138	Ab = 49950 sq. ft.
429935	22	11	C.5	16	28	32.2	276	350	0.79	137	max (ri) = 236
429940	22	11	D	21.2	28	35.1	381	450	0.85	230	rmax = max(ri)/story shear 0.105
429950	22	11	E	24.0	28	36.9	363	450	0.81	236	ρ = **1.149**
431060	36	1	F	16.0	14	21.3	107	150	0.71	81	
431065	36	1	F.5	16.0	14	21.3	107	150	0.72	81	
431070	36	1	G	16.0	14	21.3	109	150	0.73	82	Partial Floor Height
431075	36	1	G.5	16.0	14	21.3	109	150	0.73	82	ρ not calculated
432060	36	2	F	16.0	14	21.3	118	200	0.59	89	
432065	36	2	F.5	16.0	14	21.3	118	200	0.59	89	
434050	36	4	E	12.0	14	18.4	85	150	0.56	55	
434055	36	4	E.5	12.0	14	18.4	85	150	0.56	55	
442060	50	2	F	16.0	25	29.7	159	200	0.79	86	
442065	50	2	F.5	16.0	25	29.7	159	200	0.79	86	
444050	50	4	E	12.0	25	27.7	107	150	0.72	46	
444055	50	4	E.5	12.0	25	27.7	107	150	0.71	46	
447060	50	7	F	32.0	35	47.4	131	200	0.65	88	
447070	50	7	G	28.0	35	44.8	123	200	0.61	77	
449930	50	11	C	16	25	29.7	202	250	0.81	109	
449935	50	11	C.5	16	25	29.7	203	250	0.81	109	
449940	50	11	D	21.2	35	40.9	171	250	0.68	88	
449950	50	11	E	24.0	35	42.4	149	250	0.60	84	
467060	75	7	F	16.0	10	18.9	52	100	0.52	44	
467065	75	7	F.5	0.0	10	10.0	13	100	0.13	0	
467075	75	7	G.5	0.0	10	10.0	16	100	0.16	0	
467078	75	7	G.8	12.0	10	15.6	54	100	0.54	41	
469940	75	11	D	21.2	10	23.4	18	#N/A	#N/A	16	

Note 1: Based on SAP output. Maximum force includes 5% accidental eccentricity in all directions.

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UCSF MISSION BAY	JOB NO.	9932	
COMMUNITY CENTER	DATE	7/25/00	
	BY DY	SHEET NO.	2-49

SEISMIC ANALYSIS: NORTH-SOUTH DIRECTION
BRACE AXIAL FORCES (Final)

Brace Member Number	Elevation	Grid Line	Location Line	Horizontal Projected Brace Length (ft)	Vertical Projected Brace Height (ft)	Brace Member Length (ft)	(note 1) Max. Brace Axial Force (k)	Brace Yield Force (k)	D/C Ratio	(note 1) Horiz. Shear Demand (k)	**Reliability/Redundancy Factor, ρ**
512010	0	A	2	16	22	27.2	179	250	0.71	105	
512510	0	A	2.5	16	22	27.2	179	250	0.72	105	
515010	0	A	5	16	22	27.2	183	250	0.73	108	
515510	0	A	5.5	16	22	27.2	179	250	0.71	105	
519010	0	A	9	16	22	27.2	265	300	**0.88**	156	<= D/C = 0.88 O.K. by insp. (see note 1)
519310	0	A	9.5	16	22	27.2	265	300	**0.88**	156	<= D/C = 0.88 O.K. by insp. (see note 1)
516040	0	D	6	13.3	22	25.7	196	250	0.79	102	
516540	0	D	6.5	13.3	22	25.7	197	250	0.79	102	
519040	0	D	9	16	22	27.2	248	300	0.83	146	
519340	0	D	9.5	16	22	27.2	244	300	0.81	144	
519540	0	D	10	16	22	27.2	244	300	0.81	143	
519740	0	D	10.5	16	22	27.2	247	300	0.82	145	
512050	0	E	2	16	22	27.2	294	350	0.84	173	
512550	0	E	2.5	16	22	27.2	292	350	0.84	172	ρ = 2-(20/(rmax*sqrt(Ab))
512070	0	G	2	16	22	27.2	340	400	0.85	200	
512570	0	G	2.5	16	22	27.2	338	400	0.84	199	Story Shear (El. 0) = 2908 kips
518078	0	G.8	8	16	22	27.2	323	400	0.81	190	Ab = 49950 sq. ft.
518578	0	G.8	8.5	16	22	27.2	320	400	0.80	188	max (ri) = 199.9
519078	0	G.8	9	16	22	27.2	330	400	0.82	194	rmax = max(ri)/story shear 0.069
519378	0	G.8	9.5	16	22	27.2	330	400	0.82	194	ρ = **0.70**
522010	22	A	2	16	28	32.2	155	200	0.78	77	
522510	22	A	2.5	16	28	32.2	155	200	0.78	77	
525010	22	A	5	16	28	32.2	161	200	0.80	80	
525510	22	A	5.5	16	28	32.2	161	200	0.80	80	
529010	22	A	9	16	28	32.2	211	250	0.85	105	**CHECK MAX D/C RATIO TO**
529310	22	A	9.5	16	28	32.2	211	250	0.85	105	**SATISFY max ρ = 1.155**
526040	22	D	6	13.3	28	31.0	150	200	0.75	64	**=> D/C < 1/ρ = 0.87**
526540	22	D	6.5	13.3	28	31.0	150	200	0.75	64	
529040	22	D	9	16	28	32.2	205	250	0.82	102	
529340	22	D	9.5	16	28	32.2	203	250	0.81	101	
529540	22	D	10	16	28	32.2	208	250	0.83	103	
529740	22	D	10.5	16	28	32.2	210	250	0.84	104	
522050	22	E	2	16	14	21.3	151	200	0.76	114	ρ = 2-(20/(rmax*sqrt(Ab))
522550	22	E	2.5	16	14	21.3	152	200	0.76	115	
521070	22	G	1	21.3	14	25.5	211	250	0.84	176	Story Shear (El. 22) = 2245 kips
523070	22	G	3	21.3	14	25.5	162	250	0.65	136	Ab = 49950 sq. ft.
528078	22	G.8	8	32	28	42.5	304	400	0.76	228	max (ri) = 237.8
529078	22	G.8	9	32	28	42.5	316	400	0.79	238	rmax = max(ri)/story shear 0.106
529578	22	G.8	10	32	28	42.5	288	400	0.72	217	ρ = **1.155**
532050	36	E	2	16	14	21.3	139	200	0.70	105	
532550	36	E	2.5	16	14	21.3	139	200	0.70	105	Partial Floor Height
533070	36	G	3	10.7	14	17.6	136	200	0.68	83	ρ not calculated
533570	36	G	3.5	10.7	14	17.6	136	200	0.68	82	
549010	50	A	9	16	25	29.7	135	200	0.67	73	
549310	50	A	9.5	16	25	29.7	135	200	0.67	73	
549040	50	D	9	16	35	38.5	137	200	0.69	57	
549340	50	D	9.5	16	35	38.5	137	200	0.69	57	
549540	50	D	10	16	35	38.5	144	200	0.72	60	
549740	50	D	10.5	16	35	38.5	144	200	0.72	60	
542050	50	E	2	16	25	29.7	121	150	0.80	65	
542550	50	E	2.5	16	25	29.7	121	150	0.80	65	
543070	50	G	3	10.7	25	27.2	64	100	0.64	25	
543570	50	G	3.5	10.7	25	27.2	64	100	0.64	25	
547090	50	J	7	21.3	35	41.0	181	250	0.72	94	
549090	50	J	9	16	35	38.5	177	250	0.71	73	
549390	50	J	9.5	16	35	38.5	177	250	0.71	73	
567040	75	D	7	53.3	10	54.3	75	#N/A	#N/A	74	
567090	75	J	7	21.3	10	23.6	109	#N/A	#N/A	99	

Note 1: Based on SAP output. Maximum force includes 5% accidental eccentricity in all directions.

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