UCSF

Rating form completed by:

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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

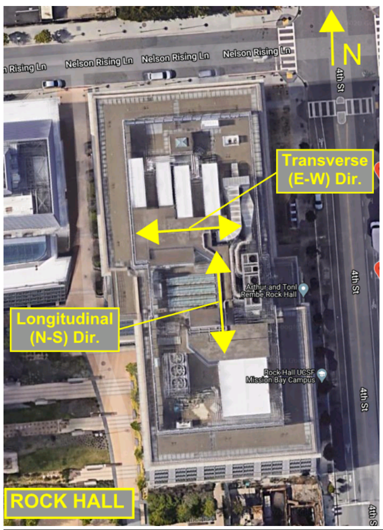
10-31-20

UCSF building seismic ratings

UCSF Rock Hall

CAAN #3001
1550 4th Street, San Francisco, CA 94158
UCSF Campus: Mission Bay

Plan



Northeast corner (looking southwest)

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 "Construction Documents - Volume 1, 19B, UMBC," by Flad & Associates, dated 9 May 2001 (141 sheets).
- Structural drawings entitled "Construction Documents - Volume 1, 19B, UMBC," by Forrell/Elsesser Engineers, Inc., dated 9 May 2001 (30 sheets)
- Shop drawing submittal 0001-13085-0, "Unbonded Braces – Shop Drawings, NS01, NS02, NS03," Nippon Steel Corporation, dated 10/5/2001 (16 pages).
- Report entitled "UCSF Mission Bay Building 19B, Inspection Report of UBB Fabrication," by Nippon Steel Corporation, Rev. 0, January 2002 (60 pages)
- Specification entitled "UCSF Mission Bay Campus Building 19B, Specifications, Construction Documents," dated 9 May 2001. 2 Volumes. (784 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.

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 2001 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 Arthur and Toni Rembe Rock Hall (originally designated Building 19B) is a laboratory building located at the corner of 4th Street and Nelson Rising Lane in San Francisco, California on the UCSF Mission Bay campus. It is a five-story steel framed building with Buckling-Restrained Braced Frames (BRBFs) for the lateral force-resisting system. It was constructed in 2001 before design standards were adopted for this type of lateral system. The footprint consists of two offset rectangles with a small wider section in the middle. The overall length is 274'-0" in the north-south direction. Both ends of the building are 124'-11" wide in the east-west direction, and the central segment is 144'-0" wide. It was constructed on a flat site with poor soils that are subject to liquefaction. There is an auditorium on the first floor, and the remaining floors house laboratory space. The building has a mix of travertine and sandstone thin set veneer cladding.

<u>Identification of levels</u>: The building levels are designated as the first floor (EL. 0.0'), a small mezzanine (EL. 9.0'), the second floor (EL. 20.0'), the third floor (EL. 36.0'), the fourth floor (EL. 52.0'), the fifth floor (EL. 68.0'), the roof (EL. 84.0'), and small penthouse roofs (EL. 95.0' and 101.0'). The exterior grade is flat.

<u>Foundation system</u>: 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 -100.0 ft. The pile caps are supported by 2, 3, 4, 5, or 6 piles. The pile caps range in size from 3.37 ft x 7.34 ft to 7.34 ft x 11.0 ft. The slab-on-grade is comprised of a 10" thick concrete slab. The column grid is typically 21.0 ft in each direction. According to the "Table 1 – UCSF Pre-2006 BRBF Building – Geotechnical Characteristics and Site Hazards" by John Egan, dated 18 December 2019, the piles were driven to refusal and the risk of damage due to liquefaction is low.

Structural system for vertical (gravity) load: Rock Hall contains a complete gravity load-bearing steel framing system with a column grid that is typically 21.0 ft in each direction. Columns and beams are all rolled wide flange shapes except for several built-up plate girders that function as transfer girders above openings such as the loading dock on the north side. The roof and floor framing consist of 3" metal deck with 4 ½" of normal weight concrete fill that typically spans 8.0 ft between steel beams. The deck profile is 18 gage Verco W3 Formlok deck or similar.

Structural system for lateral forces: This is a Model Building Type S2 steel braced frame with rigid diaphragms in both directions. The lateral force-resisting system is comprised of Buckling-Restrained Braced Frames (BRBFs) in both the N-S and E-W directions. In the longitudinal (N-S) direction, the building has twelve braced bays along seven interior grid lines at the first story. This reduces to eight braced bays at the two upper stories. In the transverse (E-W) direction, the building has sixteen braced bays along six grid lines including the two end walls and four interior grid lines. The braces are all concentric, and each bay has one diagonal brace. Braces are well distributed in both directions with a maximum diaphragm span in the transverse direction of 103.0 ft. The roof and floor diaphragms consist of 3" deep 18 gage metal deck with 4½" 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 or HSS12x12. Based on the BRB Schedule 25/S-703, the values indicated on the BRB elevations are the maximum brace yield force. The values on Sheet S-301 for the sixteen bays of braces in the E-W direction range from 100 kips to 575 kips. The values on Sheet S-302 for the twelve bays of braces in the N-S direction range from 275 kips to 550 kips. Data from coupon tests tabulated in the "Inspection Report of UBB Fabrication" indicates tensile yield "YP" between 258 to 297 N/mm2 (37-42 ksi) and ultimate "TS" between 418 and 443 N/mm2 (61-64 ksi). Only one specimen had a tensile yield of 258 N/mm^2; the next lowest value was 265 N/mm^2, so Fy = 38 ksi has been used in the evaluation calculations. Uniaxial cyclic testing was performed on the braces; no 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 2001 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 7 and a design base shear of V = 0.13 W. 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.

Building condition: Unknown. No site visit was made due to shelter-in-place orders. A site visit could be made in the future to help confirm report findings.

Building response in 1989 Loma Prieta Earthquake: 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 braces, beams, and columns of a sample BRB braced bay indicates that the members have acceptable DCRs using the criteria from the benchmark code. For the BRB checked at F.3-12 to F.3-13, the maximum DCRs for the braces, beams, and columns are 0.46, 0.63, and 0.98, respectively. The BRB bay selected is representative of perpendicular braces with shared columns. Tributary areas vary throughout the building; there may be locations in other areas with higher gravity and lateral demands, but for the purpose of this Tier 1 evaluation, the selection is judged to be sufficient.

- A comparison with *UC Seismic Safety Policy* requirements for Seismic Performance Level III was made by scaling these DCRs up to BSE-1N values obtained from Egan (2019). This comparison shows the columns at the lower two stories of the sample BRB braced bay are overstressed, but the beams and braces are within acceptable limits. On this basis, the building does not qualify for the SPL III rating. In addition, 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.
- The ASCE 41-17 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 comparatively higher than those used for design, but they are also higher than would be required by current code.
- Many columns do not meet the criteria for compact sections.
- There are some sizable diaphragm openings adjacent to the BRB braced bays. All lines of bracing have collectors shown on the plans, so it appears this issue was addressed in the original design.
- 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.
- There is an apparent disconnect between the number of bolts specified in the design and the number provided by Nippon for the connections along Line 15, Line B and a portion of Line C. It was not possible to visit the site to investigate, but the shop drawings by Nippon show half the required “total number of bolts” for connections on Line 15, Line B and part of Line C. This error was identified in the shop drawing review comments but should be verified to see that the appropriate number of bolts was provided.

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

Summary of review of nonstructural life-safety concerns, including at exit routes. [2]

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

[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.

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

Rock Hall is a basically rectangular structure with a plan aspect ratio of approximately 1W:2.2L. The braced bays are well-spaced in both directions. The structure is regular, located on a flat site, and does not contain significant discontinuous framing or geometric irregularities. There are many braced bays in each direction. The number of braced bays in the transverse direction is sixteen and is constant over the height. The number of braced bays in the longitudinal direction increases from eight at the top two stories to twelve at the lower three stories. The overturning forces are likely low given the aspect ratio of 1V:1.5H in the transverse direction and 1V:3.3H in the longitudinal direction.

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 7, and an Importance Factor, *I*, of 1.0, the design base shear was $V = 0.13\ W$. Per the benchmark ASCE 7-05, assuming $I = 1.0$ and $R = 8$, the design base shear is the lower of V/W = $[S_{DS} / (R / I_e)] = [0.9] / (8 / 1.0)] = 0.11$g (governs) or V/W = $[S_{D1} / (T (R/I_e))] = [1.006 / (0.55 \times (8/1.0))] = 0.23$g, where $T = C_t\, h_n^{3/4} = 0.02\ (84)^{3/4} = 0.55$ sec. Per the current ASCE 7-16, assuming $I = 1.0$ and $R = 8$, the design base shear is the lower of $V/W = [S_{DS} / (R / I_e)] = [1.3) / (8 / 1.0)] = 0.16$g (governs) or $V/W = [S_{D1} / (T (R/I_e))] = [1.68 / (0.55 \times (8/1.0))] = 0.38$g, where $T = C_t\, h_n^{3/4} = 0.02\ (84)^{3/4} = 0.55$ sec. Thus, the design base shear was slightly higher than the benchmark code (0.13g vs. 0.11g) but lower than would be required by current code (0.13g vs 0.16g). On this basis, the building would not qualify for a Seismic Performance Level Rating of III. In addition, 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.

The average brace axial stresses computed using the benchmark ASCE 7-05 code are less than $0.9F_y$. In addition, the components of a sample BRB braced bay were checked in detail using ASCE 7-05 and found to be within acceptable limits. There are some issues related to noncompact column sections and diaphragm openings, but these are not considered to negatively affect the rating. The building is assigned a Seismic Performance Level Rating of IV because the structure generally meets the requirements of the benchmark code and does not contain significant deficiencies.

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 14 April 2020 and were unanimous that the Seismic Performance Level Rating is Level IV. No additional assessment is required.

Additional building data	Entry	Notes
Latitude	37.76915	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
Longitude	-122.39140	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	5	
Number of stories (basements) below lowest perimeter grade	0	
Building occupiable area (OGSF)	169,500	From Architectural Sheet A-003
Risk Category per 2016 CBC 1604.5	II	
Building structural height, h_n	84.0 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	0.55 sec	Estimated using ASCE 41-17 equation 4-4 and 7-18
Site data		
975-year hazard parameters S_s, S_1	1.379g, 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}	1.793g, 2.233g	UCSF Pre-2006 BRBF Buildings Geotechnical Characteristics and Hazards, Egan (2019)
S_a at building period	1.793g	
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: 2001 Code: 1998 CBC/ 1997 UBC	
Applicable code for partial retrofit	None	No partial retrofit known
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 PLUS MECHANICAL
FLOORS CORRIDORS, STAIRS	100 PSF
LABS	100 PSF
OFFICES	80 PSF
MECHANICAL ROOM	150 PSF

WIND LOADS
1998 CBC, 70 MPH ZONE, EXPOSURE C

SEISMIC LOADS (I=1.0, DIST>13km, SOURCE TYPE A, ZONE 4, SOIL TYPE Se)
V = 0.13W W = STRUCTURE WEIGHT
LATERAL RESISTING SYSTEM: UNBONDED BRACED FRAME, R=7.0

UNBONDED BRACES

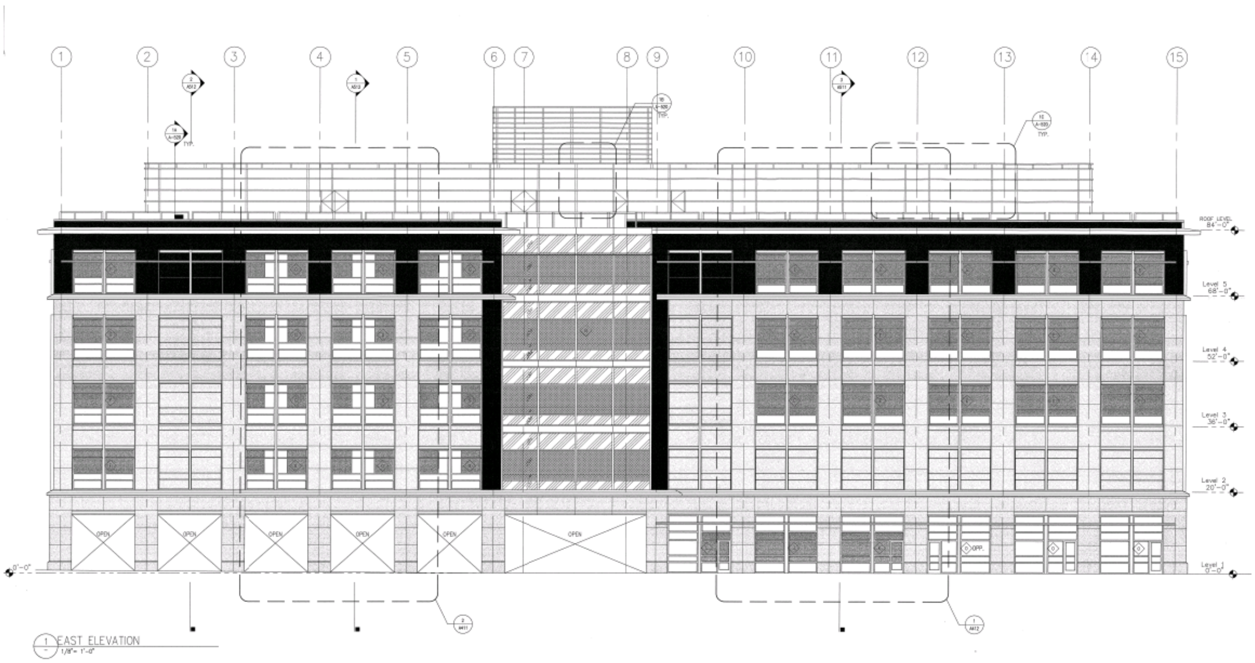
REFER TO SPECIFICATIONS FOR COMPLETE REQUIREMENTS.

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

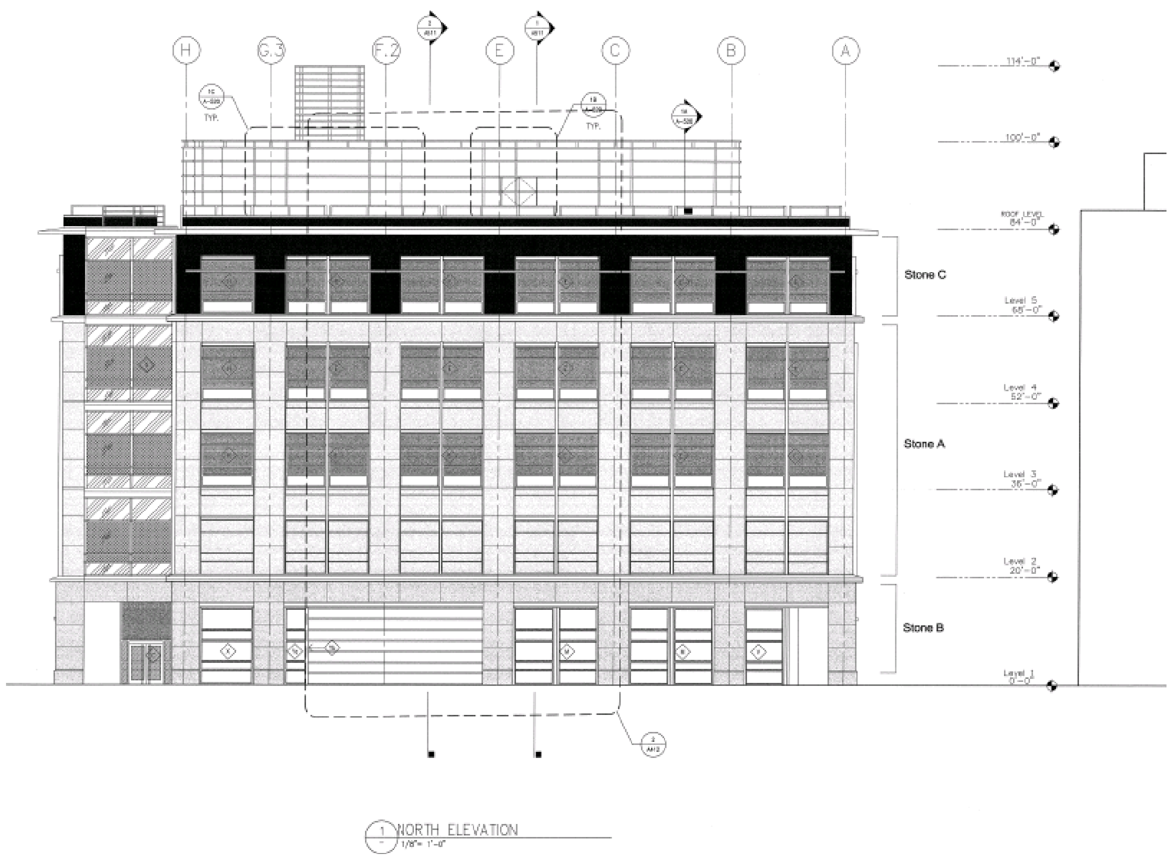
BRACE ELONGATION:
BRACES SHALL BE DESIGNED TO ACCOMMODATE AN ELONGATION EQUAL TO 0.0075 OF THE DISTANCE BETWEEN THE BRACE WORK POINTS. RESULTING MATERIAL STRAINS MUST BE BELOW THE LEVEL JUSTIFIED BY PROTOTYPE TESTING OR RESULTS OF PREVIOUS PROTOTYPE TESTING.

UNBONDED BRACE CASING SHALL BE 14" SQUARE TUBE MAXIMUM.

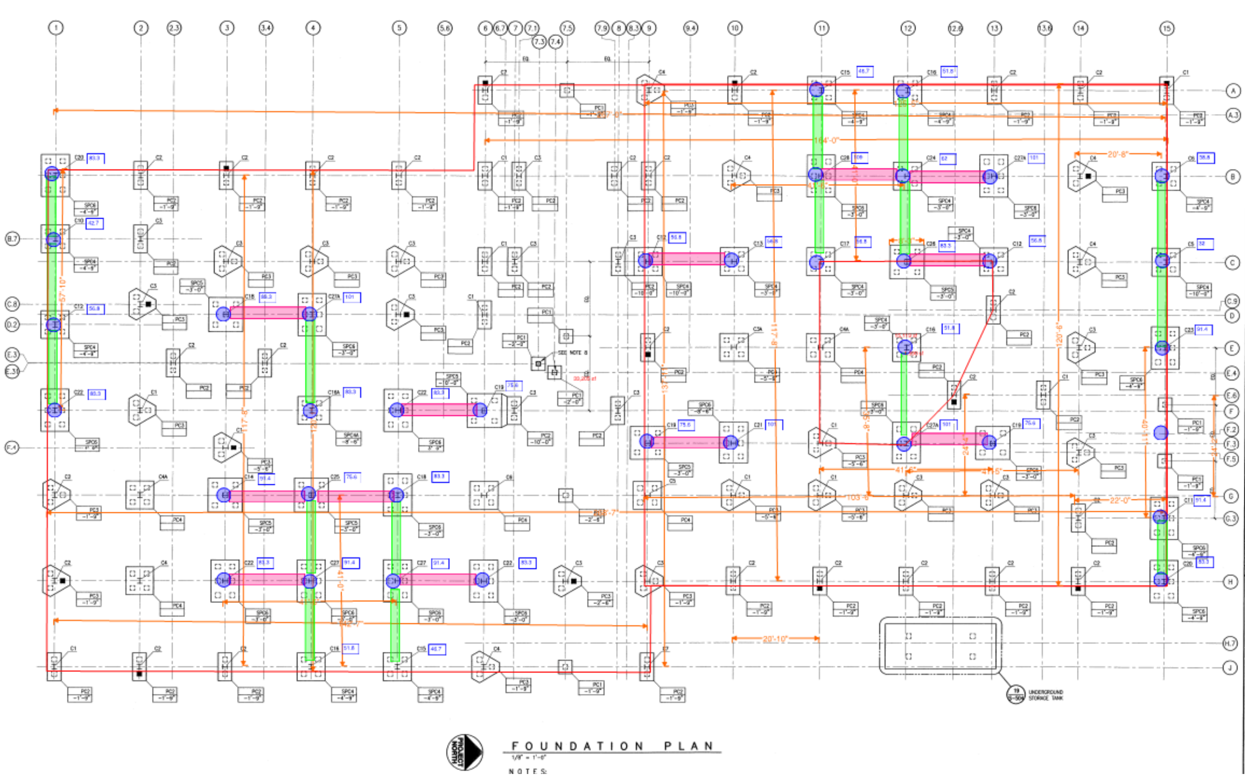
General Notes Sheet S-001 Dated May 2001 Showing Design Per 1998 CBC/1997 UBC, $V = 0.13\,W$, $I = 1.0$, $R = 7$ and Unbonded Braces Supplied by Nippon Steel Corporation



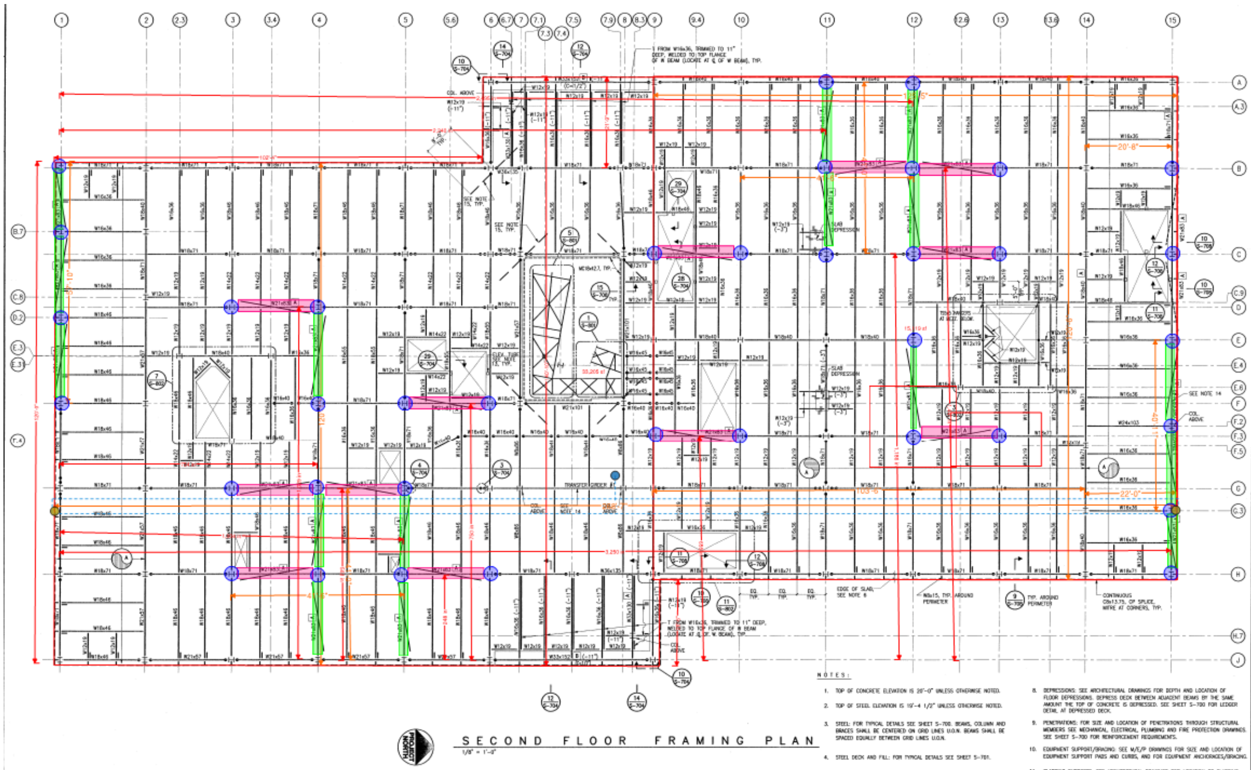
Architectural East Elevation on 4th Street (Gridlines 1 to 15)



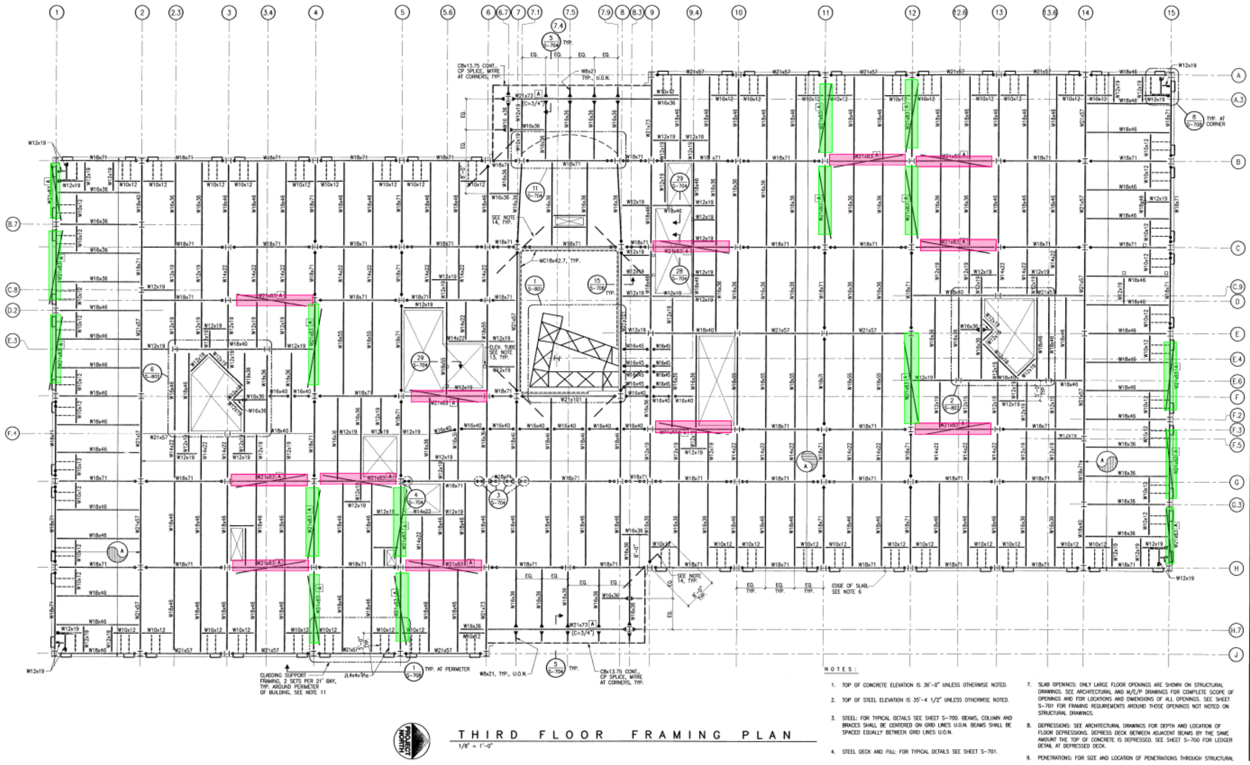
Architectural North Elevation along Nelson Rising Lane.
This is for Gridlines A to J at Gridline 15 with deep transfer girder above loading dock.



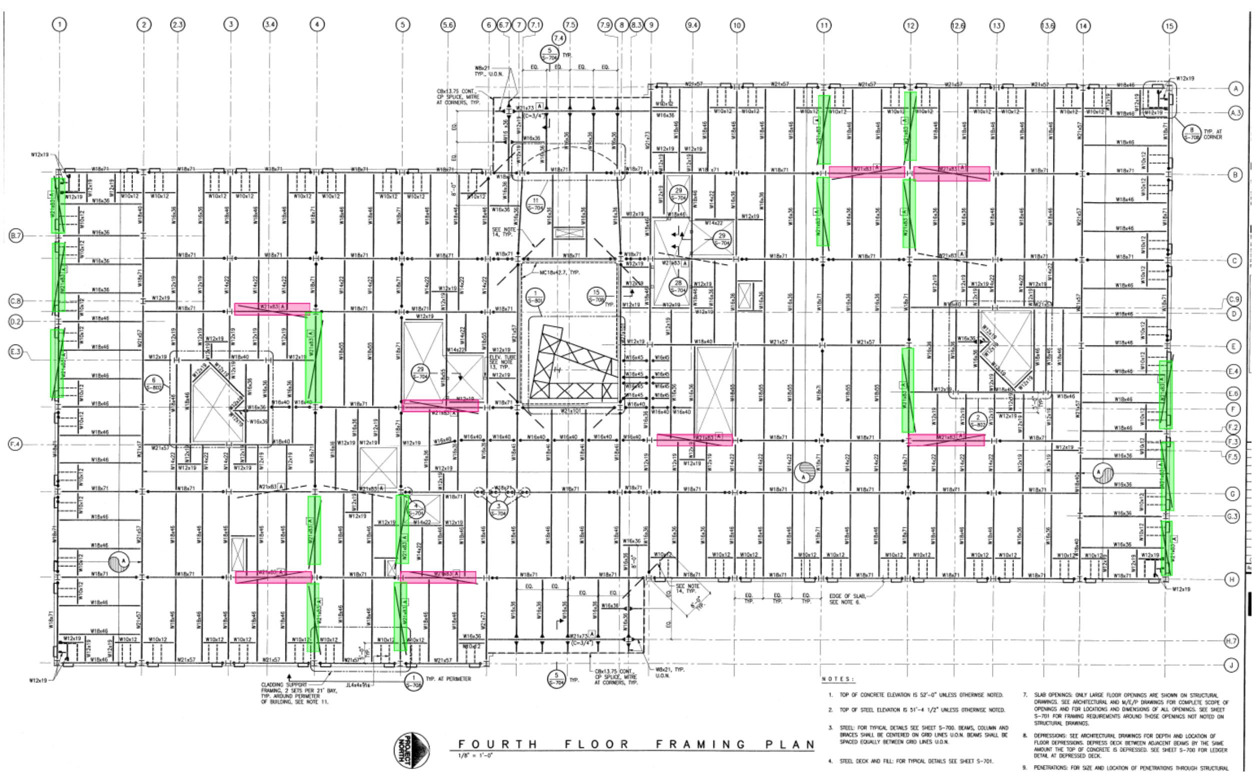
Foundation Plan Sheet S-201.
Plan shows BRB frames in N-S Direction (pink) and BRB frames in E-W direction (green). Note that north is to the right in these plans. E-W Gridlines from 1 to 15 start from the left; N-S Gridlines from A to J start from the top.



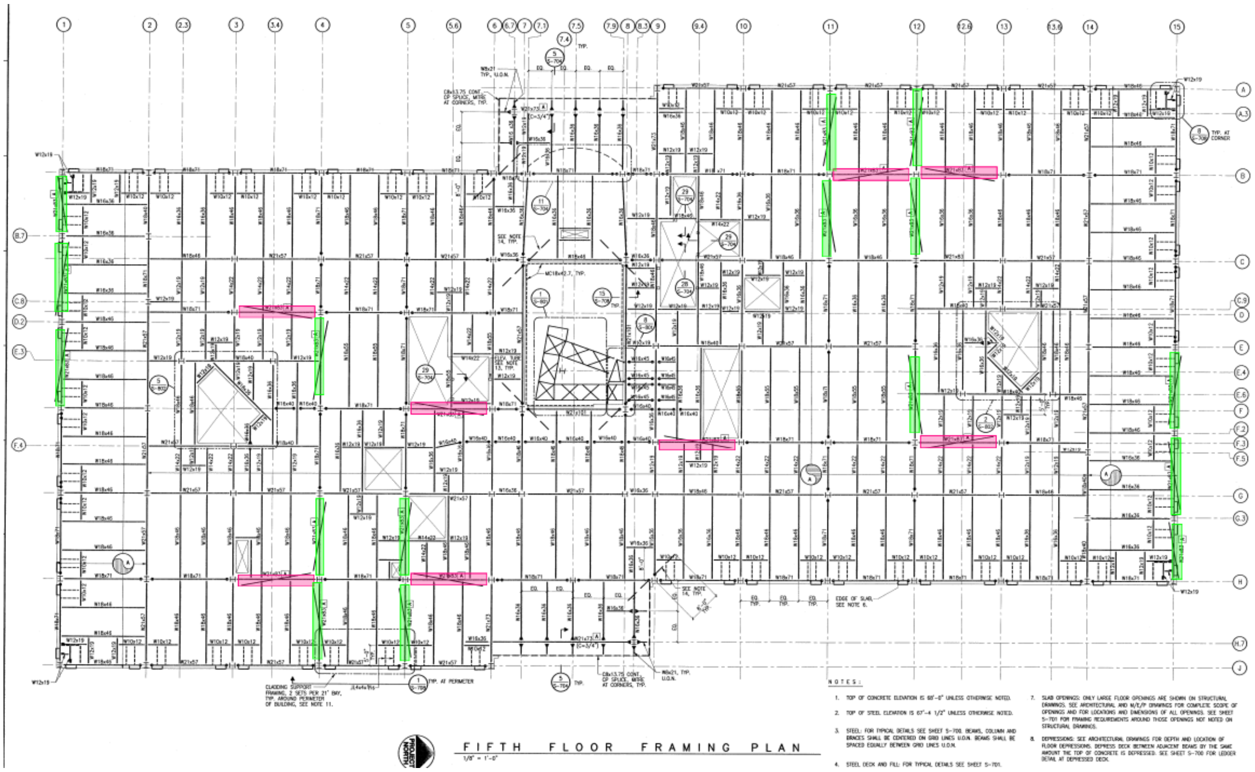
Second Floor Framing Plan Sheet S-203.
There are seven lines of N-S BRB frames (12 braced bays in pink) and six lines of E-W BRB frames (16 braced bays in green). BRB frame layout for Floors 1, 2, and 3 is similar except for variation at Gridline 15.



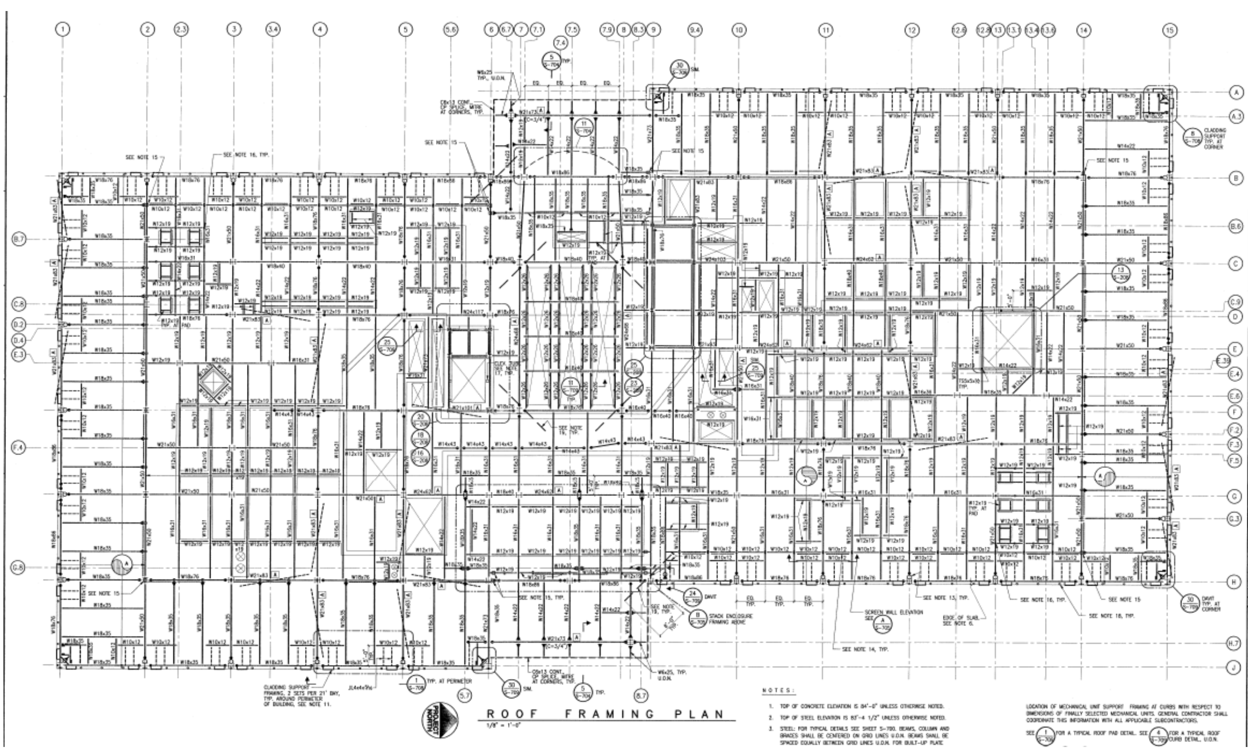
Third Floor Framing Plan Sheet S-204



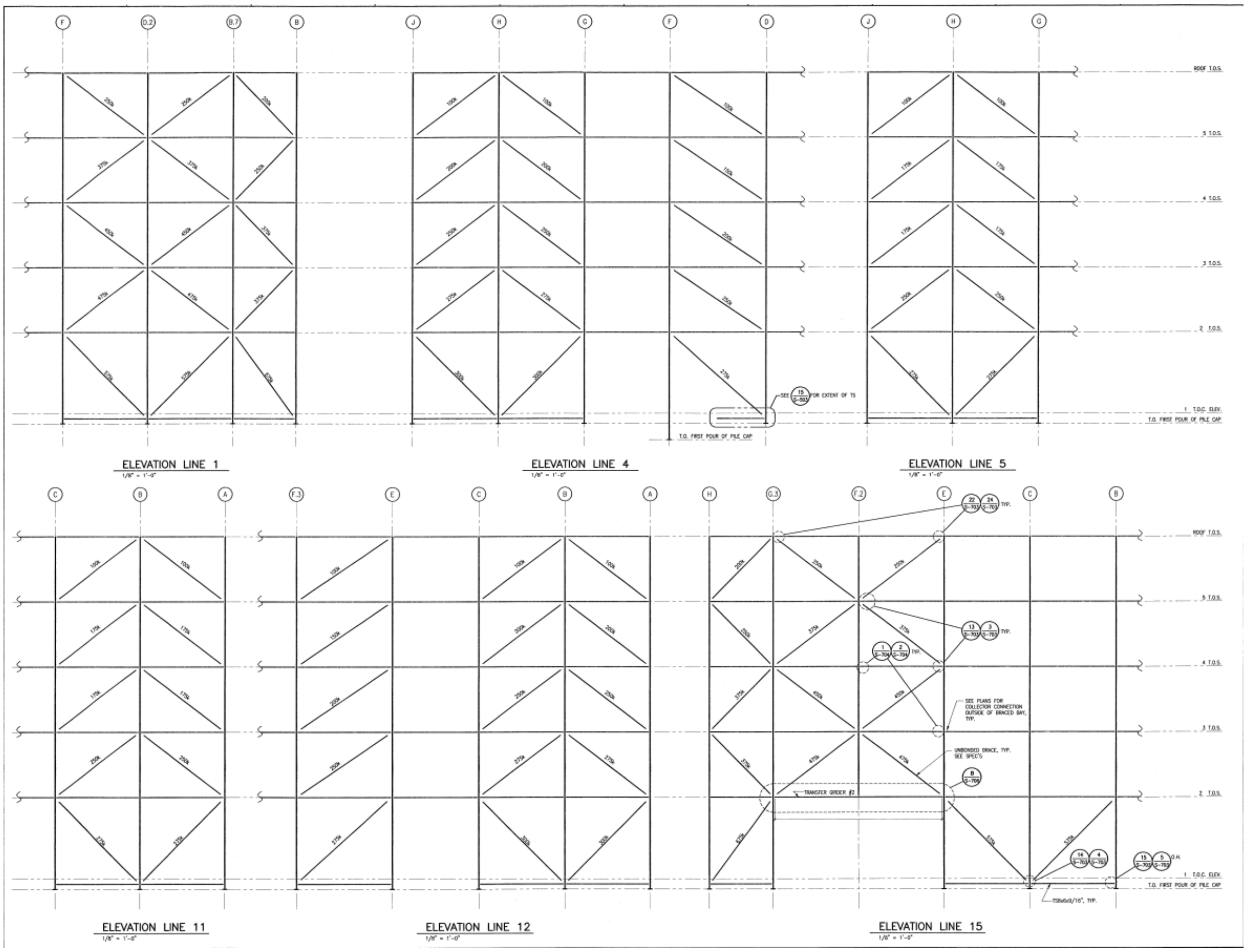
Fourth Floor Framing Plan Sheet S-205



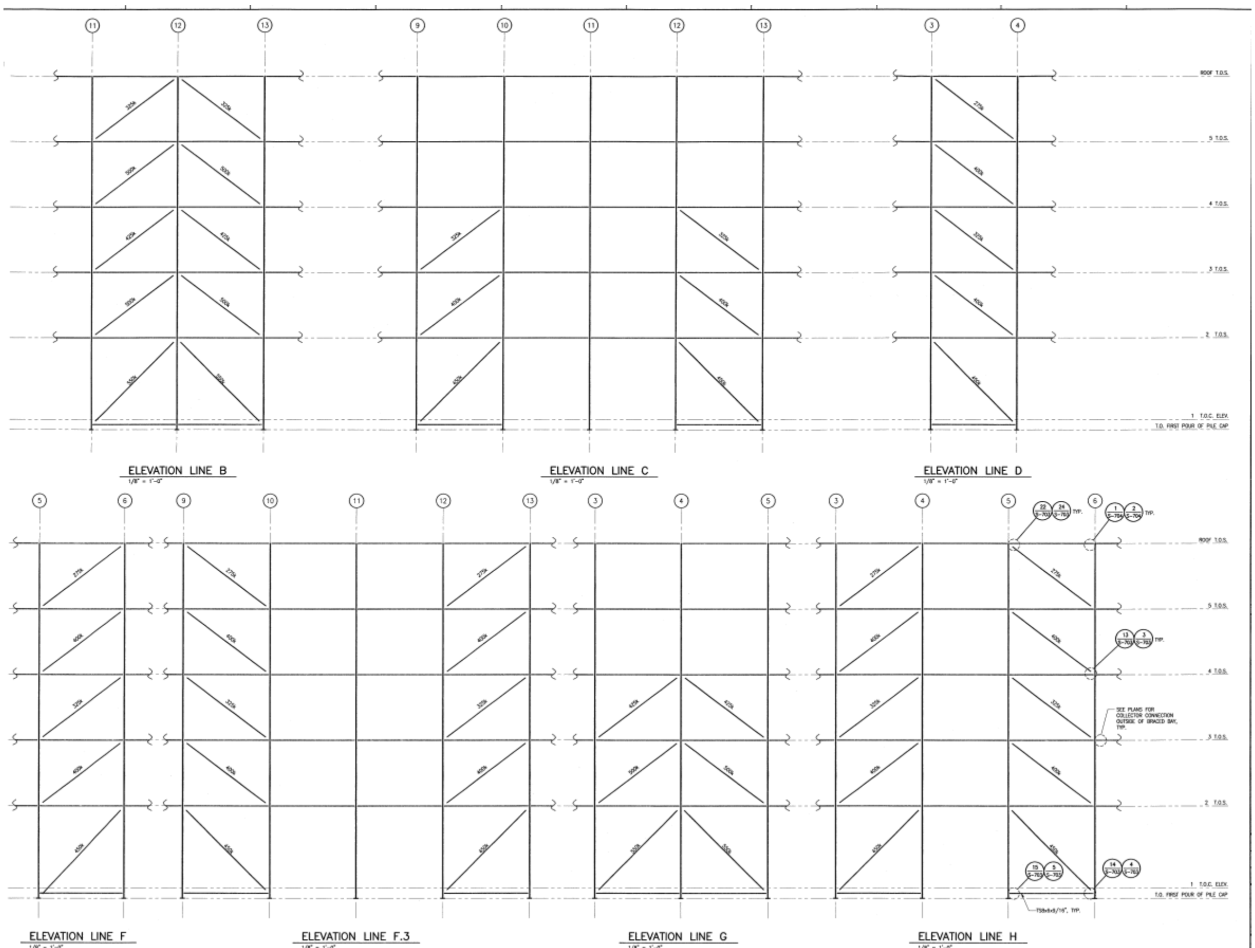
Fifth Floor Framing Plan Sheet S-206



Roof Framing Plan Sheet S-207



Transverse (E-W) BRB Frames. Sixteen braced bays with "Maximum Yield Force" from 100 kips to 675 kips from Sheet S-301.
All braces are concentric, with one brace per bay. Note the framing variation at Gridline 15 with transfer girder above loading dock.



Longitudinal (N-S) BRB Frames. Eight/Twelve Braced Bays with “Maximum Yield Force” from 275 kips to 550 kips from Sheet S-302.
All braces are concentric, with one brace per bay.

BRACED FRAME CONNECTION SCHEDULE					
MAXIMUM BRACE YIELD FORCE (SEE ELEVS.)	BRACE TO SPLICE PL's # OF BOLTS (1,2)	SPLICE PL's 4" WIDE THICKNESS (in.) (8 TOTAL)	WELD OF GUSSET PL TO BEAM OR COLUMN		
			SIZE	MINIMUM LENGTH BEAM	MINIMUM LENGTH COLUMN
200k	8	3/8"	3/8"	18"	16"
300k	10	1/2"	1/2"	20"	18"
400k	14	5/8"	1/2"	22"	20"
500k	16	3/4"	5/8"	25"	22"
600k	20	1"	5/8"	27"	25"
675k	22	1"	5/8"	26"	34"

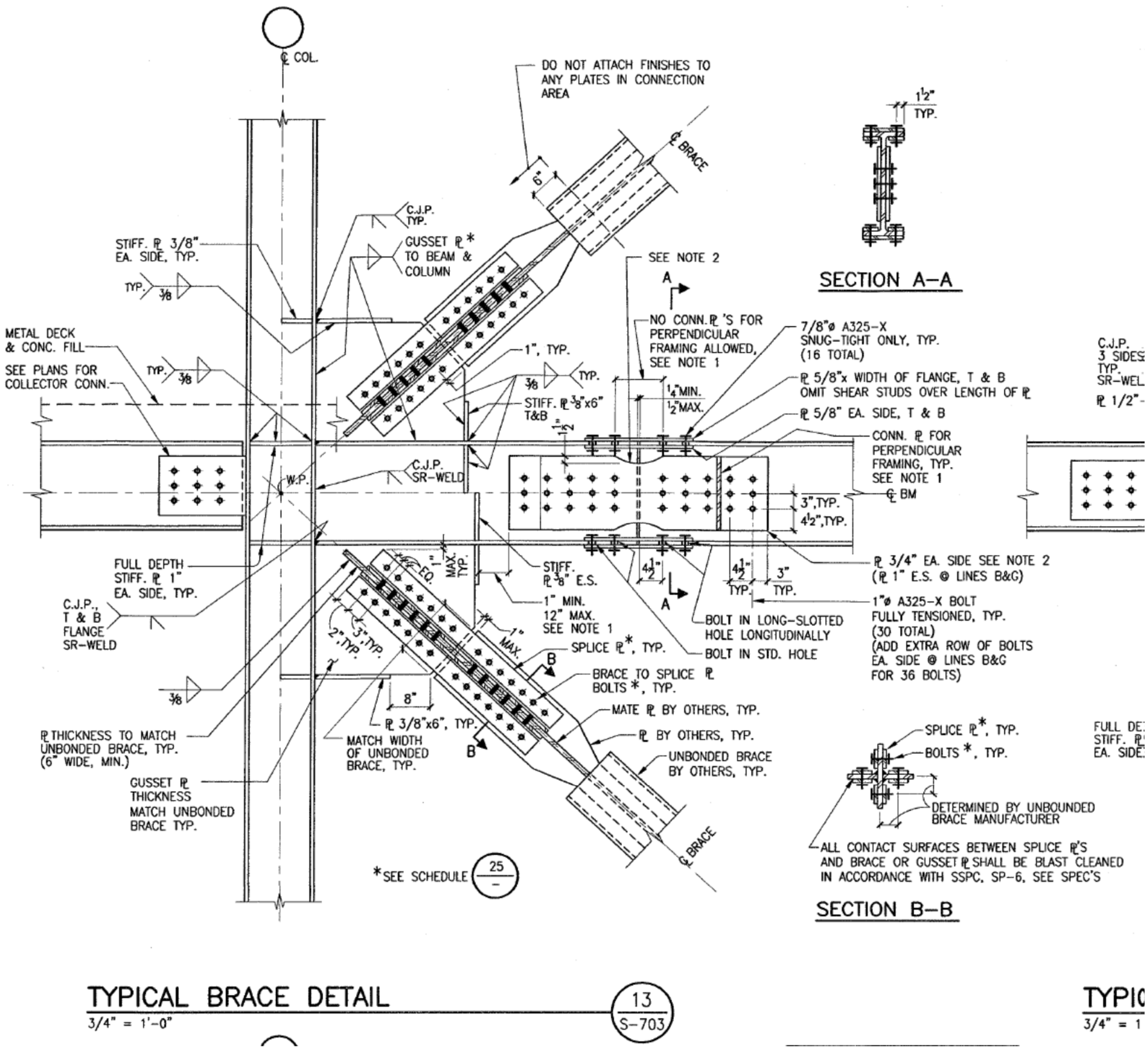
(1) BOLTS ARE A490-SC 1"ø BOLTS IN OVERSIZED HOLES

(2) THE # OF BOLTS SHOWN SHALL BE PROVIDED AT EACH SIDE OF THE SPLICE CONNECTION

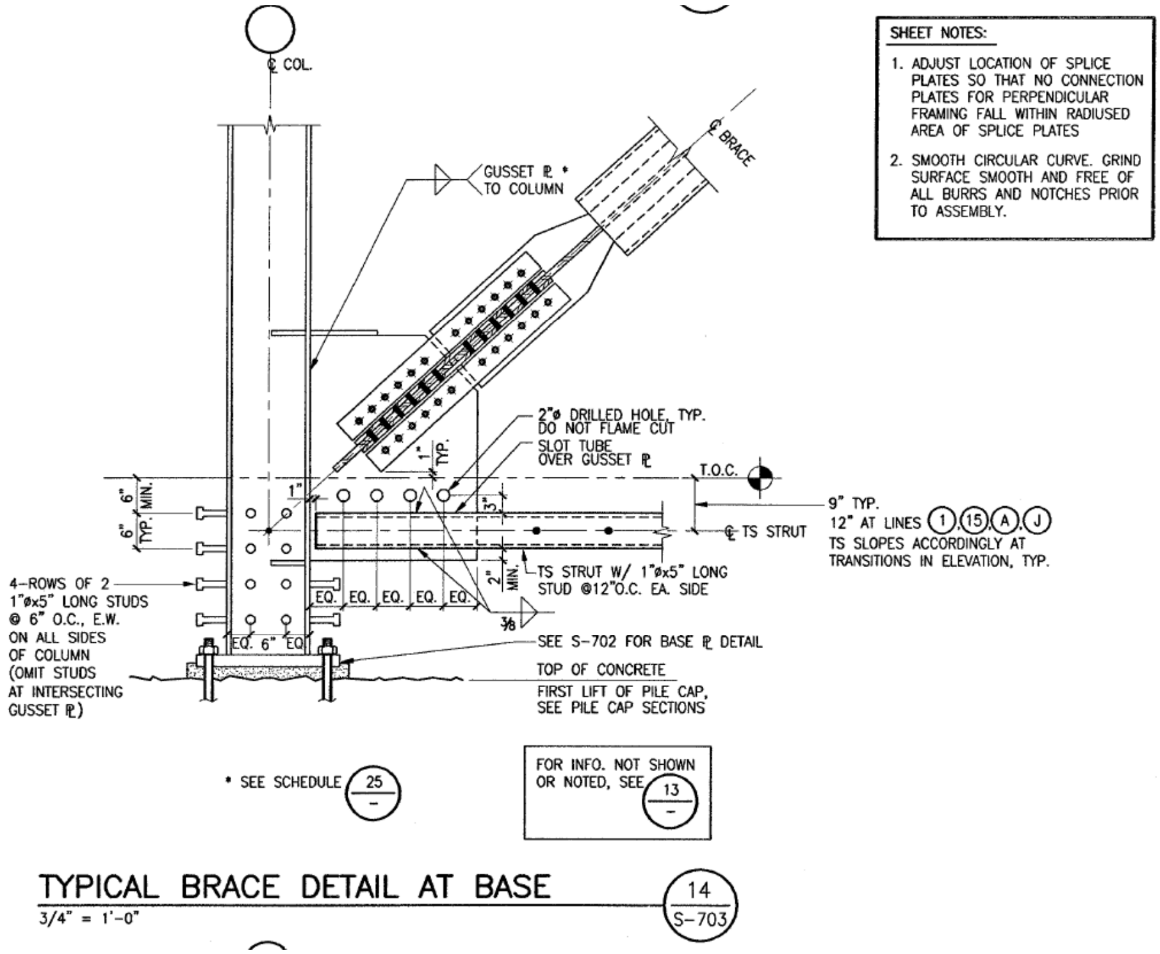
SCHEDULE
3/4"=1'-0"

25
S-703

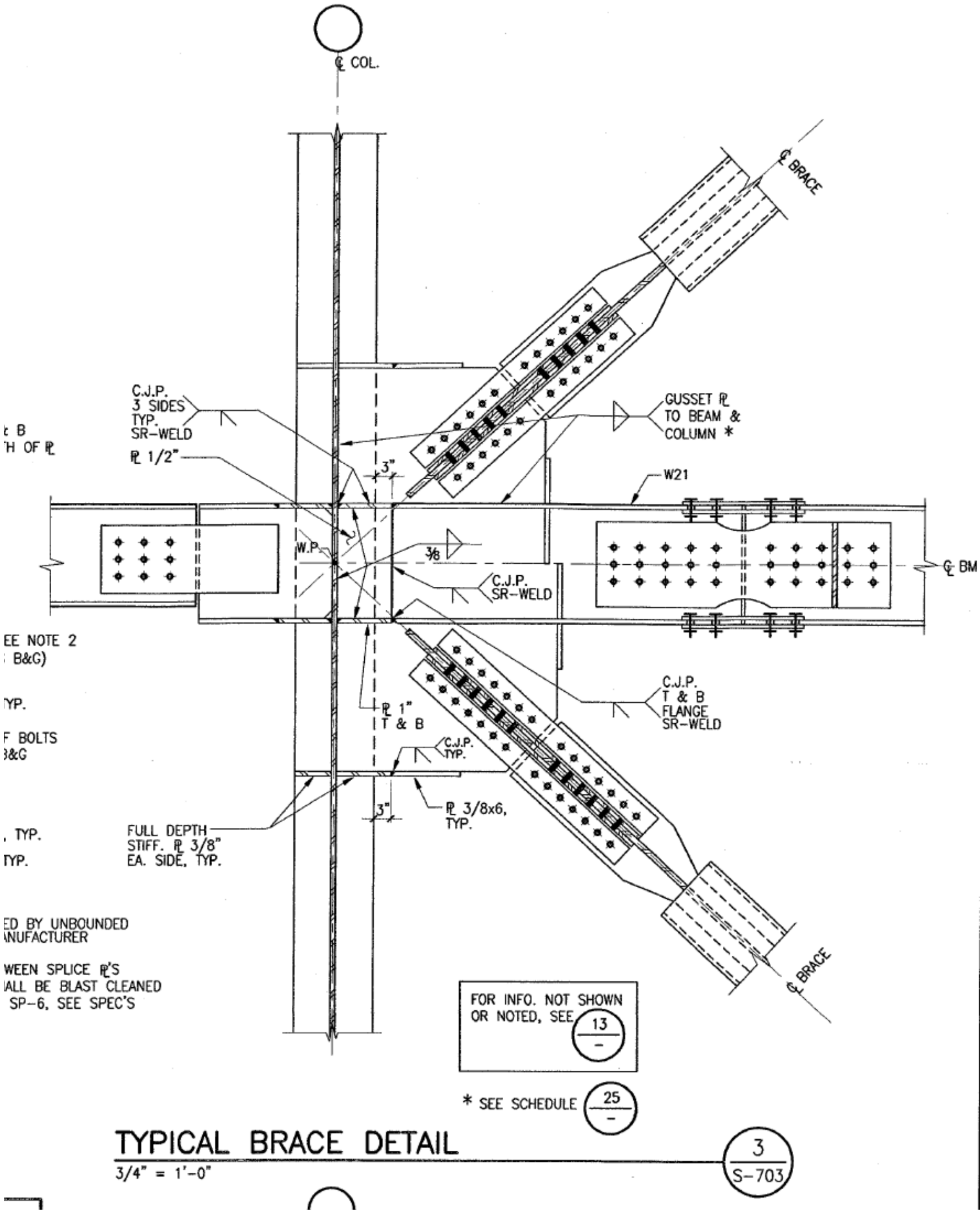
BRB Connection Schedule Sheet S-703



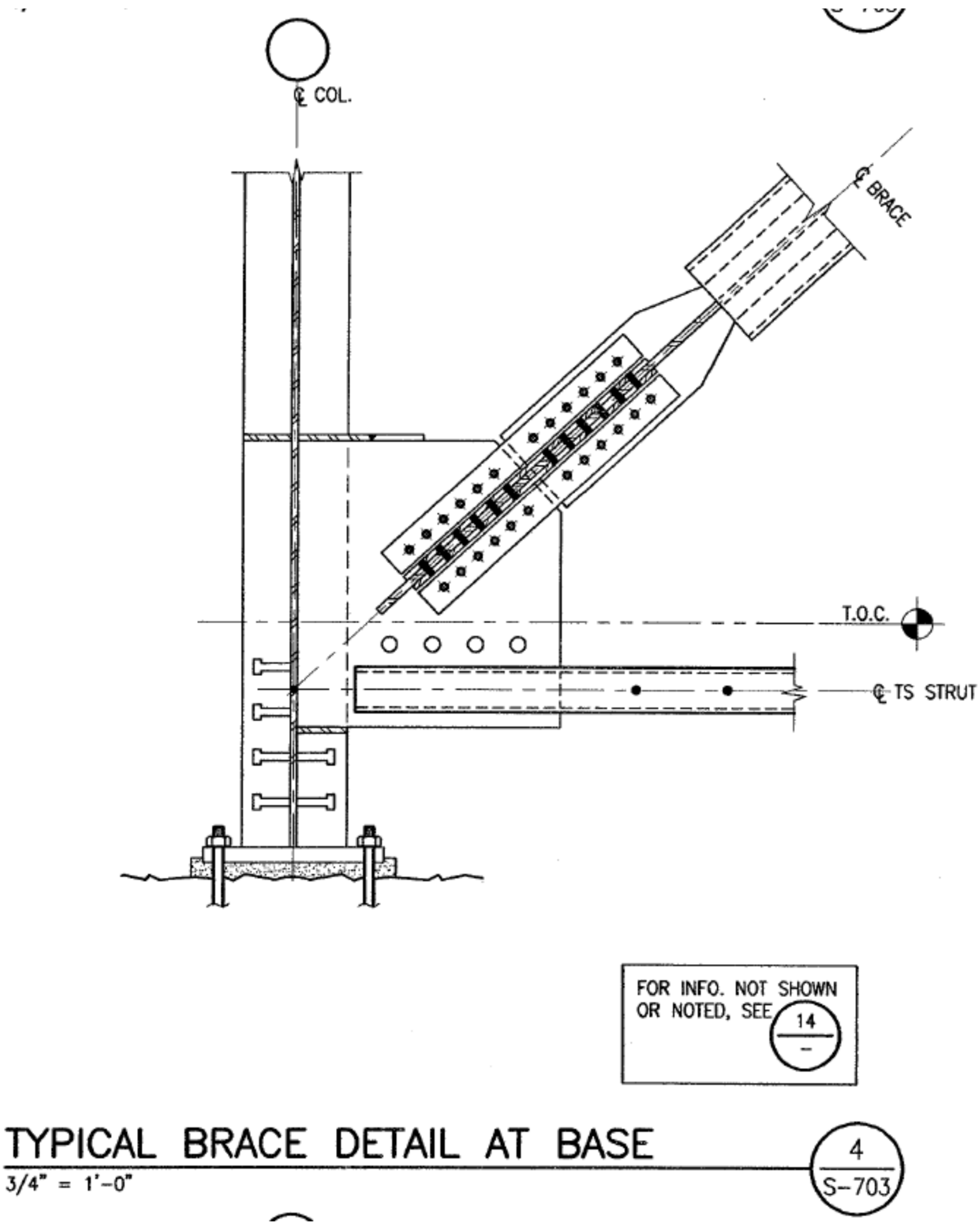
Typical BRB Brace Details from S-703: Strong Direction of Column



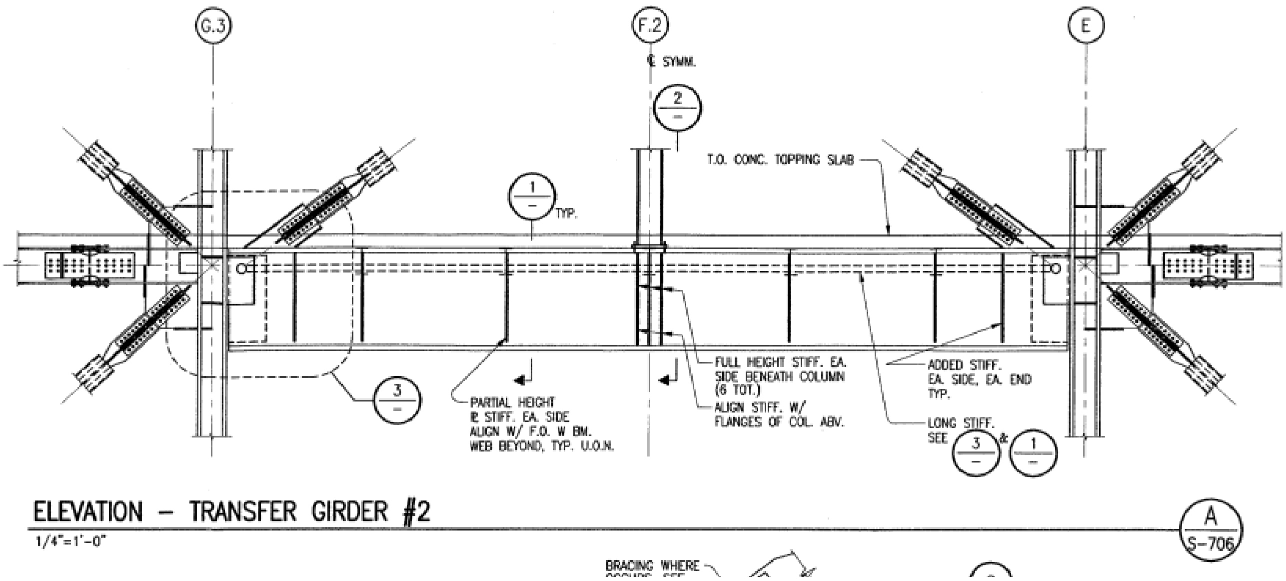
Typical BRB Brace Details from S-703: Strong Direction of Column at Base



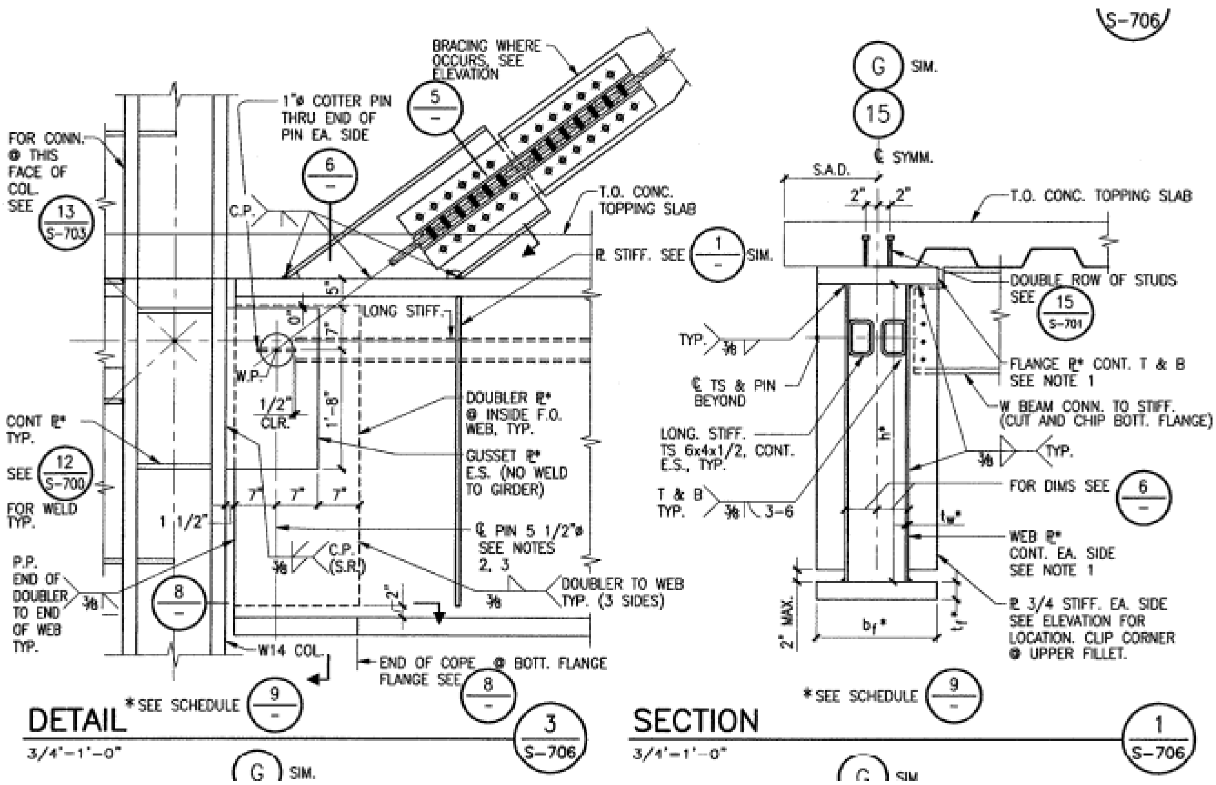
Typical BRB Brace Details from S-703: Weak Direction of Column



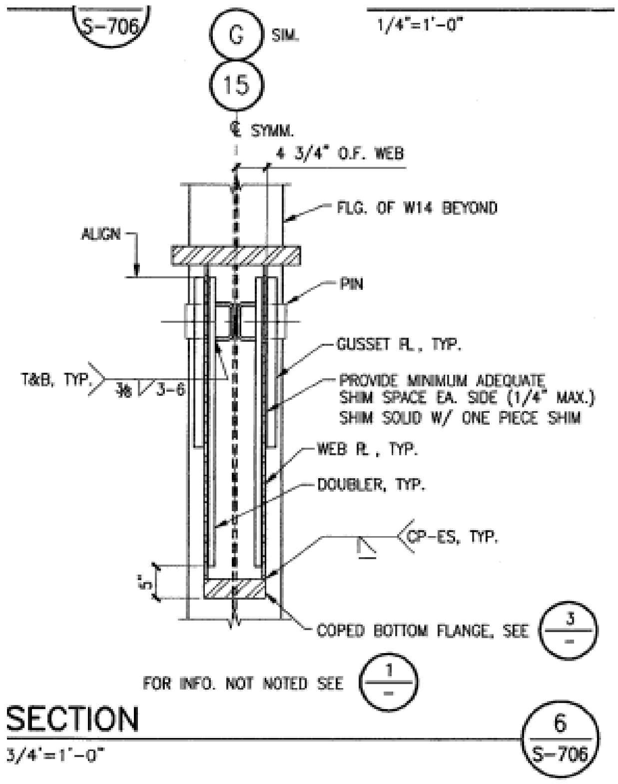
Typical BRB Brace Details from S-703: Weak Direction of Column at Base



BRB Elevation at Gridline 15 with Transfer Girder from Sheet S-706



BRB Details at Gridline 15 with Transfer Girder from Sheet S-706



BRB Details at Gridline 15 with Transfer Girder from Sheet S-706

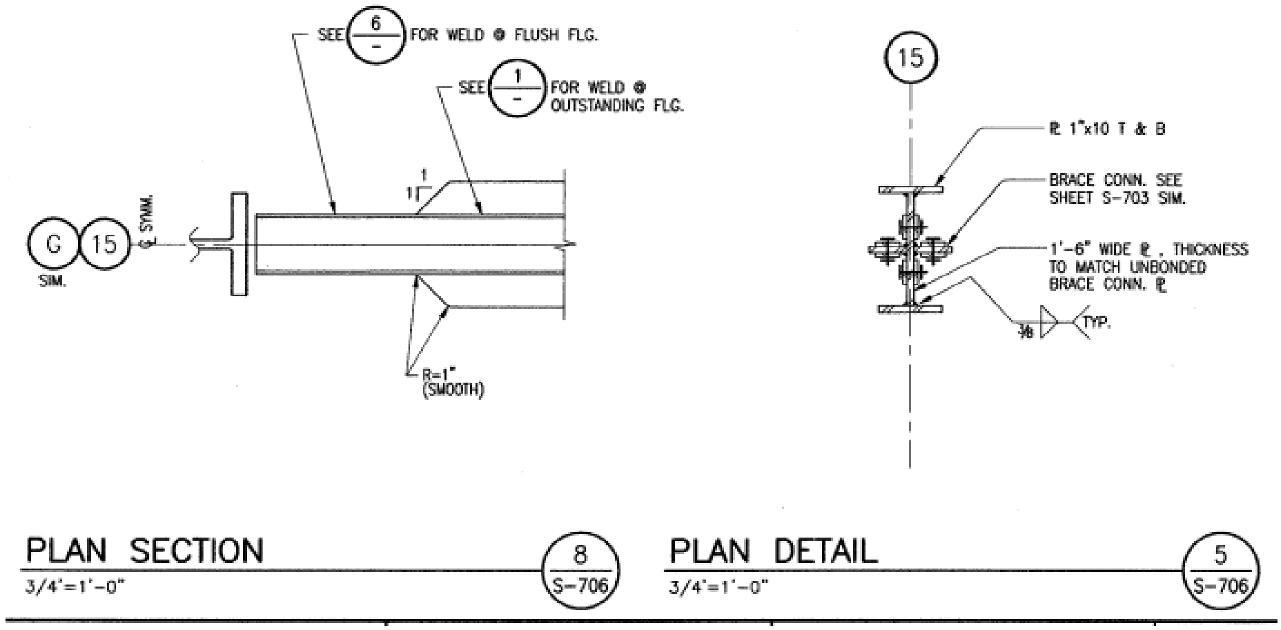
NOTES:

1. ALL PLATE USED FOR TRANSFER GIRDERS SHALL BE ASTM A992-50.

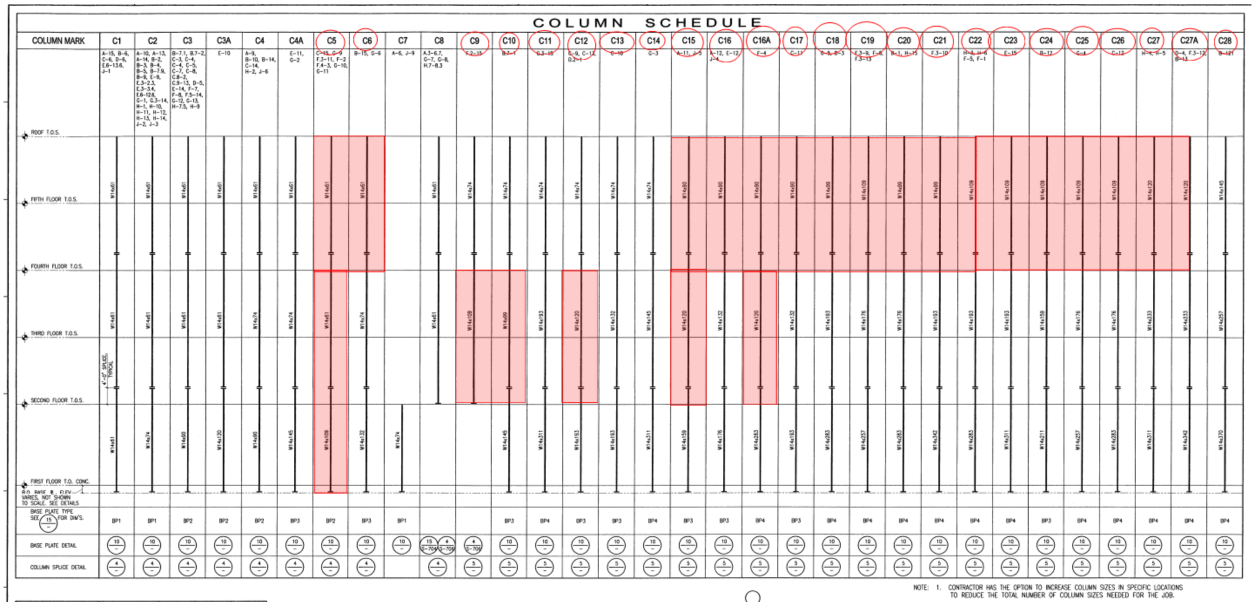
2. SHEAR PIN MATERIAL SHALL BE ASTM A668 CLASS G SOLID FORGED STEEL. PIN SHALL BE MACHINED TO 125 RMS (MAXIMUM) FINISH, WITH FINISHED DIAMETER AS SHOWN.

3. ALL PLATES THROUGH WHICH SHEAR PINS ARE PLACED SHALL BE MATCH BORED AFTER ALL GIRDER WELDING IS COMPLETE. BORED HOLE DIAMETER SHALL NOT EXCEED FINISHED PIN DIAMETER BY MORE THAN 1/32" (SLIDING FIT REQUIRED). FINISH OF INNER SURFACE OF HOLE SHALL MATCH THAT OF FINISHED PIN. BORING SHALL BE DONE IN FIELD IF REQUIRED FOR PROPER ALIGNMENT OR PRACTICALITY.

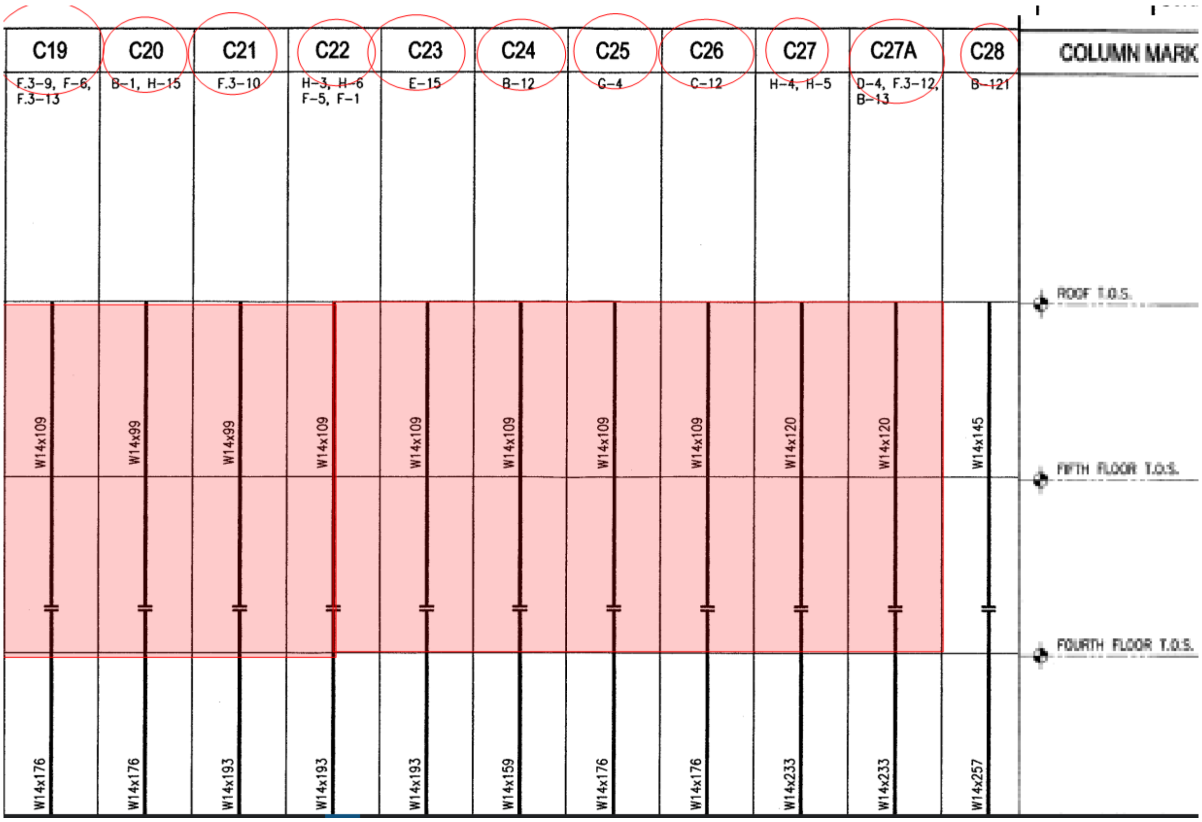
Sheet Notes for BRB and Transfer Girder from Sheet S-706



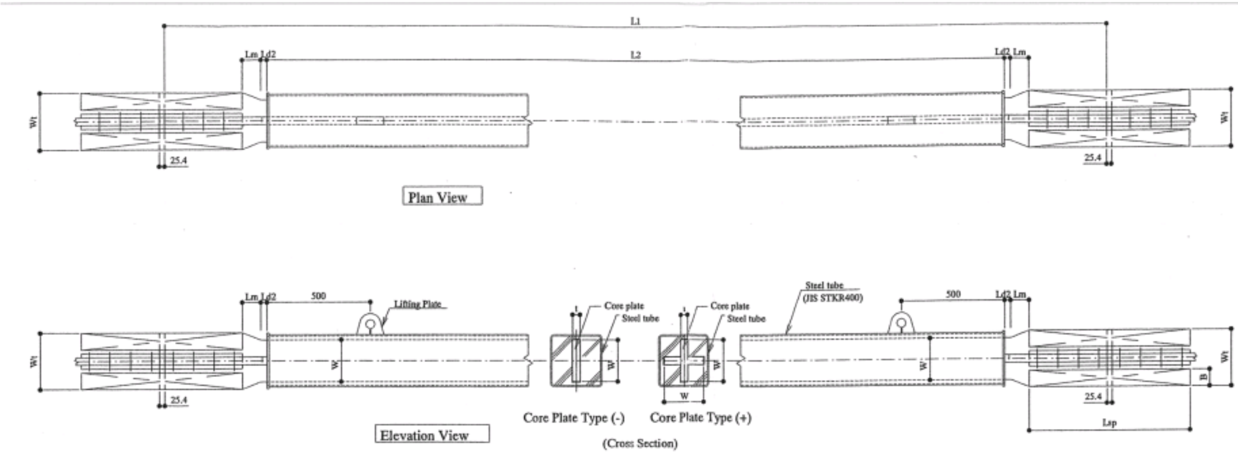
BRB Connection from Sheet S-706 Using WF Section Welded to Top Flange of Transfer Girder at Line 15.
There is no Indication that the number of bolts differs from other locations with same BRB size (details are not drawn correctly but refer to schedule on Sheet S-703).



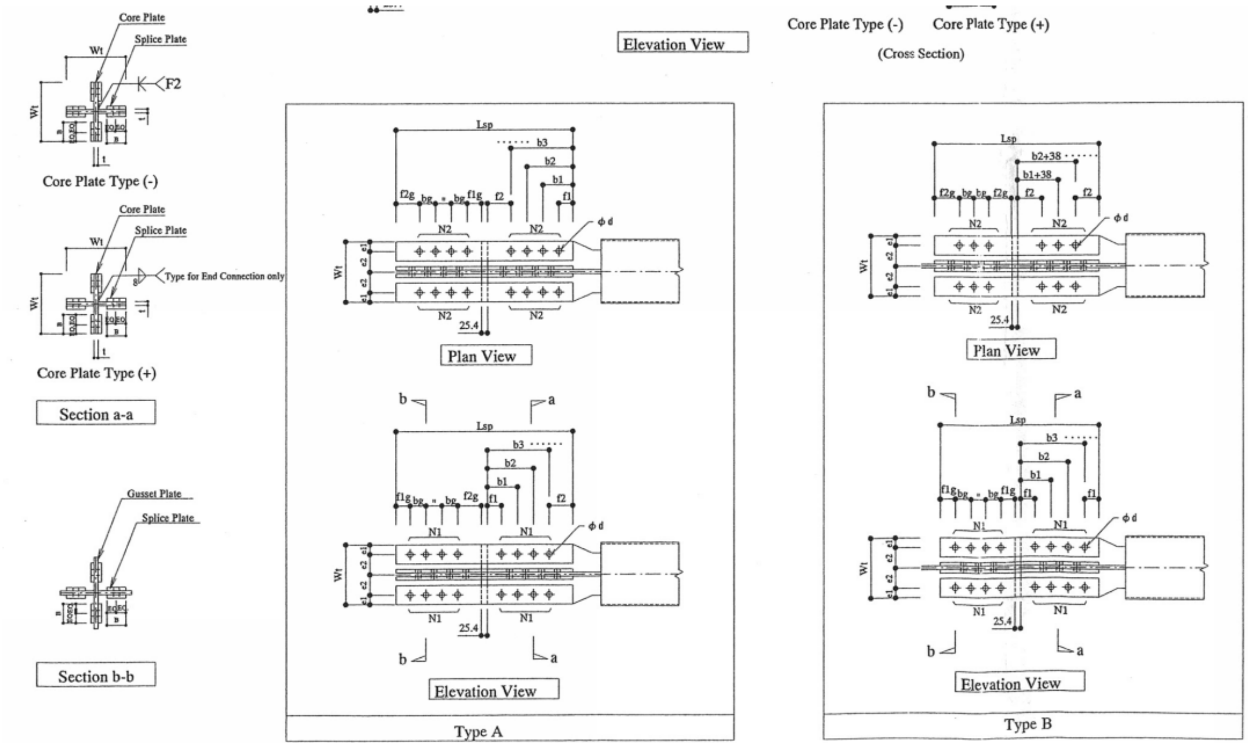
Column Schedule Sheet S-702. All circled columns are in BRB frames.
Columns with red highlighting do not comply with compact section criteria in AISC 341-05.
Column F.3-12 (Type C19) and F.3-13 (Type C27A) in BRB frames were
checked for ASCE 7-05 forces. See enlarged detail below.



Enlarged Detail of Column Schedule: C19 (W14x109) and C27A (W14x120) both non-compact sections highlighted in red



Elevation and Cross Sections from Nippon Submittal showing BRB Type (-) and Type (+)



Connections from Nippon Shop Drawings. Type A (N1 Equals N2) and Type B (N1 Not Equal to N2)

Member List of Unbonded Braces

Member Mark	Location and Quantity(pcs)					Steel Tube (JIS STKR 400)	Core Plate(JIS SN400B)																Joint Type	Bolt*2 (ASTM A490: Out of Scope)				Splice Plate*2 (Out of Scope)						Maximum Length		
	Line	Grid	Level	Type of UBB	Total		Type	t (mm)	W*3 (mm)	Wt (mm)	Lm (mm)	Ld2 (mm)	e1 (mm)	e2 (mm)	f1 (mm)	f2 (mm)	b1 (mm)	b2	b3	b4	b5	d (mm)		Dia (in)	N1 (pcs)	N2 (pcs)	Total*1 (pcs)	ts (in)	B (in)	Lsp (mm)	f1g (in)	f2g (in)	bg (in)	L1 (mm)	L1 (in)	L2 (mm)
UBB-1	1	B-B.7	1	Y	1	□- 300 x 300 x 12	+	28	242	356	100	60	51	127.0	51	89	127	203	279	356	432	29	B	1	6	5	88	25.4	102	991	2	3.5	3.0	5402	212.677	4116
UBB-2	1	B.7-D.2	1	X	1	□- 300 x 300 x 12	+	25	230	356	110	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	80	25.4	102	915	2	3.5	3.0	6486	255.354	5246
UBB-3	1	D.2-F	1	X	1	□- 300 x 300 x 12	+	25	230	356	110	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	80	25.4	102	915	2	3.5	3.0	6486	255.354	5246
UBB-4	1	B-B.7	2	P	1	□- 300 x 300 x 6	-	28	254	305	45	55	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	4955	195.079	4094
UBB-5	1	B.7-D.2	2	U	1	□- 300 x 300 x 9	-	36	250	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-6	1	D.2-F	2	U	1	□- 300 x 300 x 9	-	36	250	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-7	1	B-B.7	3	P	1	□- 300 x 300 x 6	-	28	254	305	45	55	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	4955	195.079	4094
UBB-8	1	B.7-D.2	3	T	1	□- 300 x 300 x 6	-	36	237	356	105	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4744
UBB-9	1	D.2-F	3	T	1	□- 300 x 300 x 6	-	36	237	356	105	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4744
UBB-10	1	B-B.7	4	I	1	□- 300 x 300 x 6	-	19	249	305	50	55	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	5107	201.063	4388
UBB-11	1	B.7-D.2	4	O	1	□- 300 x 300 x 6	-	28	254	305	45	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5083
UBB-12	1	D.2-F	4	O	1	□- 300 x 300 x 6	-	28	254	305	45	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5083
UBB-13	1	B-B.7	5	F	1	□- 250 x 250 x 6	-	19	199	305	95	55	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	5183	204.055	4450
UBB-14	1	B.7-D.2	5	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-15	1	D.2-F	5	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-16	4	D-F	1	J	1	□- 300 x 300 x 6	-	22	237	305	60	70	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	7455	293.504	6686
UBB-17	4	G-H	1	M	1	□- 300 x 300 x 6	-	22	258	305	45	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6243
UBB-18	4	H-J	1	M	1	□- 300 x 300 x 6	-	22	258	305	45	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6243
UBB-19	4	D-F	2	G	1	□- 300 x 300 x 6	-	19	249	305	50	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6601	259.882	5862
UBB-20	4	G-H	2	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-21	4	H-J	2	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-22	4	D-F	3	D	1	□- 250 x 250 x 6	-	19	199	305	95	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5924
UBB-23	4	G-H	3	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-24	4	H-J	3	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-25	4	D-F	4	A	1	□- 250 x 250 x 6	-	19	150	305	135	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5844
UBB-26	4	G-H	4	E	1	□- 250 x 250 x 6	-	19	199	305	95	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5439
UBB-27	4	H-J	4	E	1	□- 250 x 250 x 6	-	19	199	305	95	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5439
UBB-28	4	D-F	5	A	1	□- 250 x 250 x 6	-	19	150	305	135	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5844
UBB-29	4	G-H	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-30	4	H-J	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-31	5	G-H	1	K	1	□- 300 x 300 x 6	-	22	237	305	60	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6213
UBB-32	5	H-J	1	K	1	□- 300 x 300 x 6	-	22	237	305	60	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6213
UBB-33	5	G-H	2	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-34	5	H-J	2	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-35	5	G-H	3	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-36	5	H-J	3	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-37	5	G-H	4	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-38	5	H-J	4	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-39	5	G-H	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-40	5	H-J	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-41	11	A-B	1	K	1	□- 300 x 300 x 6	-	22	237	305	60	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6213
UBB-42	11	B-C	1	K	1	□- 300 x 300 x 6	-	22	237	305	60	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6213
UBB-43	11	A-B	2	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-44	11	B-C	2	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-45	11	A-B	3	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-46	11	B-C	3	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-47	11	A-B	4	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-48	11	B-C	4	C	1	□- 250 x 250 x 6	-	19	175	305	115	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5399
UBB-49	11	A-B	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-50	11	B-C	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-51	12	A-B	1	M	1	□- 300 x 300 x 6	-	22	258	305	45	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6243
UBB-52	12	B-C	1	M	1	□- 300 x 300 x 6	-	22	258	305	45	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6972	274.488	6243
UBB-53	12	E-F.3	1	J	1	□- 300 x 300 x 6	-	22	237	305	60	70	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	7455	293.504	6686
UBB-54	12	A-B	2	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-55	12	B-C	2	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-56	12	E-F.3	2	G	1	□- 300 x 300 x 6	-	19	249	305	50	65	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6601	259.882	5862
UBB-57	12	A-B	3	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-58	12	B-C	3	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-59	12	E-F.3	3	D	1	□- 250 x 250 x 6	-	19	199	305	95	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5924
UBB-60	12	A-B	4	E	1	□- 250 x 250 x 6	-	19	199	305	95	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5439
UBB-61	12	B-C	4	E	1	□- 250 x 250 x 6	-	19	199	305	95	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5439
UBB-62	12	E-F.3	4	A	1	□- 250 x 250 x 6	-	19	150	305	135	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5844
UBB-63	12	A-B	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-64	12	B-C	5	B	1	□- 250 x 250 x 6	-	19	150	305	135	60	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6182	243.386	5359
UBB-65	12	E-F.3	5	A	1	□- 250 x 250 x 6	-	19	150	305	135	65	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	32	9.6	102	458	2	3.5	3.0	6677	262.874	5844
UBB-66	15	B-C	1	X	1	□- 300 x 300 x 12	+	25	230	356	110	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	80	25.4	102	915	2	3.5	3.0	6486	255.354	5246

1. Total Quantities include the Bolts at both Side of Unbonded Brace and Gusset Plates 2. Supplies of Splice Plates and Bolts are Out of Scope for NSC 3. Width of Core Plate shall be adjusted in accordance with the actual Yield Strength obtained by Coupon Test.

SUBMITTED FOR APPROVAL BY THE HERRICK CORP.

NO.	DATE	REVISION	BY
0	25 JUL. 01	FOR APPROVAL	K.H.
1	27 JUL. 01	FOR APPROVAL	K.H.
2	10 AUG. 01	MODIFICATION OF e2	K.H.
3	23 AUG. 23	MODIFICATION OF L1 & L2	K.H.

NIPPON STEEL CORPORATION

FOR APPROVAL AUG. 24 2001 NIPPON STEEL CORP.

Project: 19B UMBC

Drawing Title: Member List of Unbonded Braces (2)

Scale: N.T.S — Date: 23 August 2001 — Drawn: K.H. — Designed: K.H. — Drawing NO.: UBB/19B/NS02 — Revision: 3

Nippon Steel Shop Drawing Submittal Page 1 of 2 for UBB-1 to UBB-66 showing Configuration (+ or -), Size of Plates, No. of Bolts N1 and N2, Total No. of Bolts, Length Lsp of Bolt Group, etc. See enlarged detail below.

SHOULD BE DOUBLED? PLEASE VERIFY RV

Member List of Unbonded Braces

Member Mark	Line	Grid	Level	Type of UBB	Total	Steel Tube (JIS STKR 400)	Type	t (mm)	W[*3] (mm)	Wt (mm)	Lm (mm)	Ld2 (mm)	e1 (mm)	e2 (mm)	f1 (mm)	f2 (mm)	b1 (mm)	b2	b3	b4	b5	d (mm)	Joint Type	Bolt[*2] Dia (in)	N1 (pcs)	N2 (pcs)	Total[*1] (pcs)	Splice Plate[*2] ts (in)	B (in)	Lsp (mm)	f1g (in)	f2g (in)	bg (in)	L1 (mm)	L1 (in)	L2 (mm)
UBB-67	15	C-E	1	X	1	□- 300 x 300 x 12	+	25	230	356	110	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	40	25.4	102	915	2	3.5	3.0	6486	255.354	5246
UBB-68	15	G.3-H	1	Y	1	□- 300 x 300 x 12	+	28	242	356	100	60	51	127.0	51	89	127	203	279	356	432	29	B	1	6	5	44	25.4	102	991	2	3.5	3.0	5402	212.677	4116
UBB-69	15	E-F.2	2	U	1	□- 300 x 300 x 9	-	36	250	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5814	228.898	4767
UBB-70	15	F.2-G.3	2	U	1	□- 300 x 300 x 9	-	36	250	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5814	228.898	4767
UBB-71	15	G.3-H	2	P	1	□- 300 x 300 x 6	-	28	254	305	45	55	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	4955	195.079	4094
UBB-72	15	E-F.2	3	T	1	□- 300 x 300 x 6	-	36	237	356	105	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5811	228.780	4744
UBB-73	15	F.2-G.3	3	T	1	□- 300 x 300 x 6	-	36	237	356	105	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5811	228.780	4744
UBB-74	15	G.3-H	3	P	1	□- 300 x 300 x 6	-	28	254	305	45	55	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	4955	195.079	4094
UBB-75	15	E-F.2	4	O	1	□- 300 x 300 x 6	-	28	254	305	45	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	5954	234.409	5083
UBB-76	15	F.2-G.3	4	O	1	□- 300 x 300 x 6	-	28	254	305	45	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	5954	234.409	5083
UBB-77	15	G.3-H	4	I	1	□- 300 x 300 x 6	-	19	249	305	50	55	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	20	12.7	102	534	2	3.5	3.0	5107	201.063	4388
UBB-78	15	E-F.2	5	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	20	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-79	15	F.2-G.3	5	H	1	□- 300 x 300 x 6	-	19	249	305	50	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	20	12.7	102	534	2	3.5	3.0	6106	240.394	5377
UBB-80	15	G.3-H	5	F	1	□- 250 x 250 x 6	-	19	199	305	95	55	51	101.5	51	89	127	-	-	-	-	29	A	1	2	2	16	9.6	102	458	2	3.5	3.0	5183	204.055	4450
UBB-81	B	11-12	1	W	1	□- 300 x 300 x 12	+	22	248	356	95	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	40	25.4	102	915	2	3.5	3.0	6536	257.323	5326
UBB-82	B	12-13	1	W	1	□- 300 x 300 x 12	+	22	248	356	95	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	40	25.4	102	915	2	3.5	3.0	6536	257.323	5326
UBB-83	B	11-12	2	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-84	B	12-13	2	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-85	B	11-12	3	R	1	□- 300 x 300 x 6	-	32	251	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-86	B	12-13	3	R	1	□- 300 x 300 x 6	-	32	251	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-87	B	11-12	4	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-88	B	12-13	4	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-89	B	11-12	5	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-90	B	12-13	5	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	28	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-91	C	9-10	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-92	C	12-13	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	32	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-93	C	9-10	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-94	C	12-13	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-95	C	9-10	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-96	C	12-13	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-97	D	3-4	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-98	D	3-4	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-99	D	3-4	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-100	D	3-4	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-101	D	3-4	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-102	F	5-6	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-103	F	5-6	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-104	F	5-6	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-105	F	5-6	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-106	F	5-6	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6108	240.472	5359
UBB-107	F.3	9-10	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-108	F.3	12-13	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-109	F.3	9-10	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-110	F.3	12-13	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-111	F.3	9-10	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-112	F.3	12-13	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5063
UBB-113	F.3	9-10	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-114	F.3	12-13	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-115	F.3	9-10	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-116	F.3	12-13	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-117	G	3-4	1	W	1	□- 300 x 300 x 12	+	22	248	356	95	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	80	25.4	102	915	2	3.5	3.0	6536	257.323	5326
UBB-118	G	4-5	1	W	1	□- 300 x 300 x 12	+	22	248	356	95	65	51	127.0	51	89	127	203	279	356	-	29	A	1	5	5	80	25.4	102	915	2	3.5	3.0	6536	257.323	5326
UBB-119	G	3-4	2	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-120	G	4-5	2	V	1	□- 300 x 300 x 9	+	22	226	305	70	60	51	101.5	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5878	231.417	4881
UBB-121	G	3-4	3	R	1	□- 300 x 300 x 6	-	32	251	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-122	G	4-5	3	R	1	□- 300 x 300 x 6	-	32	251	356	95	60	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	5811	228.780	4764
UBB-123	H	3-4	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-124	H	5-6	1	S	1	□- 300 x 300 x 9	-	36	237	356	105	65	51	127.0	51	89	127	203	279	-	-	29	A	1	4	4	64	19.1	102	762	2	3.5	3.0	6689	263.346	5612
UBB-125	H	3-4	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-126	H	5-6	2	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	5053
UBB-127	H	3-4	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	[illegible]
UBB-128	H	5-6	3	N	1	□- 300 x 300 x 6	-	25	246	305	55	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	[illegible]
UBB-129	H	3-4	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	[illegible]
UBB-130	H	5-6	4	Q	1	□- 300 x 300 x 6	-	32	237	305	60	60	51	101.5	51	89	127	203	279	-	-	29	B	1	4	3	56	15.9	102	686	2	3.5	3.0	5954	234.409	[illegible]
UBB-131	H	3-4	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357
UBB-132	H	5-6	5	L	1	□- 300 x 300 x 6	-	22	237	305	60	60	51	101.5	51	89	127	203	-	-	-	29	B	1	3	2	40	12.7	102	534	2	3.5	3.0	6106	240.394	5357

Location and Quantity (pcs): Line, Grid, Level, Type of UBB, Total. Core Plate (JIS SN400B): Type through d. Bolt (ASTM A490: Out of Scope): Dia, N1, N2, Total. Splice Plate (Out of Scope): ts, B, Lsp, f1g, f2g, bg. Maximum Length: L1, L2.

1. Total Quantities include the Bolts at both Side of Unbonded Brace and Gusset Plates 2. Supplies of Splice Plates and Bolts are Out of Scope for NSC 3. Width of Core Plate shall be adjusted in accordance with the actual Yield Strength obtained by Coupon Test.

NO.	DATE	REVISION	BY	NO.	DATE	REVISION	BY
0	25 JUL. 01	FOR APPROVAL	K.H.				
1	27 JUL. 01	FOR APPROVAL	K.H.				
2	10 AUG. 01	MODIFICATION OF e2	K.H.				
3	23 AUG. 01	MODIFICATION OF L1 & L2	K.H.				

NIPPON STEEL CORPORATION

Project: 19B UMBC

Drawing Title: Member List of Unbonded Braces (3)

Scale: N.T.S. Date: 23 A[illegible] Drawn: K.H. Designed: K.H. Drawing NO. UBB/19B/NS03

Nippon Steel Shop Drawing Submittal Page 2 of 2 for UBB-67 to UBB-132 showing Configuration (+ or -), Size of Plates, No. of Bolts N1 and N2, Total No. of Bolts, Length Lsp of Bolt Group, etc. Note that in this review copy, the clouded "Total (pcs)" for number of bolts at Gridlines 15 and B and part of C is flagged as half that indicated by the schedule. It is assume this was corrected, but it should be verified. See enlarged detail below.

SHOULD BE DOUBLED? PLEASE VERIFY RV

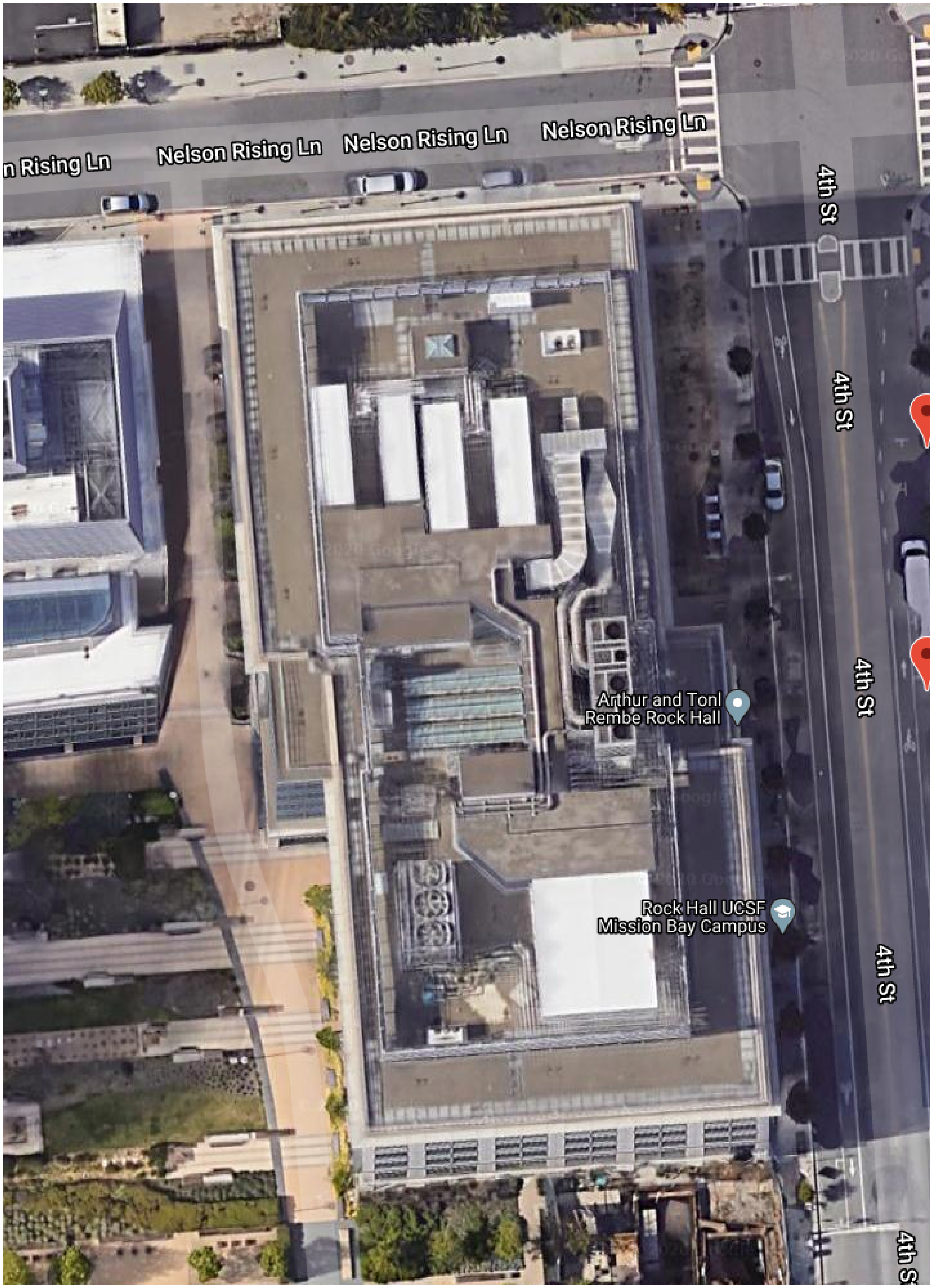
Member Mark	Location and Quantity(pcs)					Joint Type	Bolt[*2] (ASTM A490: Out of Scope)			
	Line	Grid	Level	Type of UBB	Total		Dia (in)	N1 (pcs)	N2 (pcs)	Total[*1] (pcs)
UBB-67	15	C-E	1	X	1	A	1	5	5	40
UBB-68	15	G.3-H	1	Y	1	B	1	6	5	44
UBB-69	15	E-F.2	2	U	1	A	1	4	4	32
UBB-70	15	F.2-G.3	2	U	1	A	1	4	4	32
UBB-71	15	G.3-H	2	P	1	B	1	4	3	28
UBB-72	15	E-F.2	3	T	1	A	1	4	4	32
UBB-73	15	F.2-G.3	3	T	1	A	1	4	4	32
UBB-74	15	G.3-H	3	P	1	B	1	4	3	28
UBB-75	15	E-F.2	4	O	1	B	1	4	3	28
UBB-76	15	F.2-G.3	4	O	1	B	1	4	3	28
UBB-77	15	G.3-H	4	I	1	B	1	3	2	20
UBB-78	15	E-F.2	5	H	1	B	1	3	2	20
UBB-79	15	F.2-G.3	5	H	1	B	1	3	2	20
UBB-80	15	G.3-H	5	F	1	A	1	2	2	16
UBB-81	B	11-12	1	W	1	A	1	5	5	40
UBB-82	B	12-13	1	W	1	A	1	5	5	40
UBB-83	B	11-12	2	V	1	A	1	4	4	32
UBB-84	B	12-13	2	V	1	A	1	4	4	32
UBB-85	B	11-12	3	R	1	A	1	4	4	32
UBB-86	B	12-13	3	R	1	A	1	4	4	32
UBB-87	B	11-12	4	V	1	A	1	4	4	32
UBB-88	B	12-13	4	V	1	A	1	4	4	32
UBB-89	B	11-12	5	N	1	B	1	4	3	28
UBB-90	B	12-13	5	N	1	B	1	4	3	28
UBB-91	C	9-10	1	S	1	A	1	4	4	32
UBB-92	C	12-13	1	S	1	A	1	4	4	32
UBB-93	C	9-10	2	Q	1					
UBB-94	C	12-13	2	Q	1					
UBB-95	C	9-10	3	N	1					
UBB-96	C	12-13	3	N	1					

Member Mark, Location and Quantity | Joint Type, Bolt

Enlarged Detail of Nippon Steel Shop Drawing Submittal Page 2 of 2 for UBB-67 to UBB-96. Shows clouded number of bolts at Gridlines, 15, B and C and Reviewer comment that total number of bolts should be doubled. This should be verified.

APPENDIX A

Additional Images



Plan View Rock Hall (Google Earth). North is up on the page.

Northeast Corner (Google Street View, looking southwest). Nelson Rising Lan runs up the right. Fourth Street runs up to the left.

North Elevation at Loading Dock (Google Street View, looking south)

Northwest Corner (Google Street View, looking south)

Southwest Corner (Google Street View, looking northeast)

South Elevation (Google Street View, looking north)

Southeast Corner (Google Street View, looking northwest)

APPENDIX B

ASCE 41-17 Tier 1 Checklists (Structural)

UC Campus:	San Francisco Mission Bay		Date:	10/31/2020		
Building CAAN:	3001	Auxiliary CAAN:	By Firm:	RUTHERFORD + CHEKENE		
Building Name:	UCSF Rock Hall		Initials:	EFA/ CLP	Checked:	BL
Building Address:	1550 4th 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 (C selected)	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 with concrete fill spanning to steel beam crossties function as the diaphragms at each level to deliver lateral forces to the steel braced frames (BRBF) in both directions.
C NC N/A U (N/A selected)	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:** The are no adjacent buildings near Rock Hall.
C NC N/A U (C selected)	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 three small mezzanine areas below the second floor as shown on S-208. The larger two (Details 2 and 4/S-208) are tied into the lateral force-resisting system of the building. The smallest one (Detail 11/S-208) is partially suspended from the second floor and is tied to the building framing for loads in the E-W direction and braced independently at one end for loads in the N-S direction.

BUILDING SYSTEMS - *BUILDING CONFIGURATION*

	Description
C NC N/A U (C selected)	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 tory down to the first story.
C NC N/A U (C selected)	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.

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

UC Campus:	San Francisco Mission Bay		Date:	10/31/2020		
Building CAAN:	3001	Auxiliary CAAN:	By Firm:	RUTHERFORD + CHEKENE		
Building Name:	UCSF Rock Hall		Initials:	EFA/ CLP	Checked:	BL
Building Address:	1550 4th St, San Francisco, CA 94158		Page:	2	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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:** All BRB frames are continuous to the foundation, except at Gridline 15 where there is a large transfer girder over the loading dock.
☒ ☐ ☐ ☐	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 top story down to the first story.
☒ ☐ ☐ ☐	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 floor and roof levels are similar and vary by less than 10%.
☒ ☐ ☐ ☐	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 rectangular in plan, and the floor plans are essentially the same at each floor with eccentricities less than 20%.

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

GEOLOGIC SITE HAZARD

C NC N/A U	Description
☒ ☐ ☐ ☐	LIQUEFACTION: Liquefaction-susceptible, saturated, loose granular soils that could jeopardize the building's seismic performance do not exist in the foundation soils at depths within 50 ft (15.2m) under the building. (Commentary: Sec. A.6.1.1. Tier 2: 5.4.3.1) **Comments:** 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."
☒ ☐ ☐ ☐	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.

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

UC Campus:	San Francisco Mission Bay		Date:	10/31/2020		
Building CAAN:	3001	Auxiliary CAAN:	By Firm:	RUTHERFORD + CHEKENE		
Building Name:	UCSF Rock Hall		Initials:	EFA/ CLP	Checked:	BL
Building Address:	1550 4th St, San Francisco, CA 94158		Page:	3	of	3

ASCE 41-17
Collapse Prevention Basic Configuration Checklist

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

GEOLOGIC SITE HAZARD

C NC N/A U	
☒ 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.

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 = 125' for all but the small central section. The building height from the 1st floor to the roof is H = 84', B/H = 1.49 Sa = 1.793g for BSE-2E/BSE-C 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 10" thick slab-on-grade.

UC Campus:	San Francisco Mission Bay		Date:	10/31/2020		
Building CAAN:	3001	Auxiliary CAAN:	By Firm:	Rutherford + Chekene		
Building Name:	UCSF Rock Hall		Initials:	EFA/ CLP	Checked:	BL
Building Address:	1550 4th 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 direction and six lines of BRB frames in the transverse 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 = 5 ksi. For the dead + live case, the value of 8.3 ksi is over 0.1Fy = 5 ksi.
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 2.05 to 2.86 in the longitudinal (E-W) direction and 1.97 to 2.70 in the transverse (N-S) 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 10” slab-on-grade.

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

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

C NC N/A U	Description
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.
C ☐ NC ☐ N/A ☒ U ☐	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.
C ☒ NC ☐ N/A ☐ U ☐	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.
C ☐ NC ☐ N/A ☒ U ☐	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.
C ☐ NC ☐ N/A ☒ U ☐	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 no chevron braced bays.
C ☒ NC ☐ N/A ☐ U ☐	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

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

C	NC	N/A	U	Description
☐	☒	☐	☐	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 a number of large openings adjacent to braced bays. This condition is alleviated to some extent by collectors in line with all BRBs.

FLEXIBLE DIAPHRAGMS

C	NC	N/A	U	Description
☐	☐	☒	☐	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.
☐	☐	☒	☐	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.
☐	☐	☒	☐	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.
☐	☐	☒	☐	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.
☒	☐	☐	☐	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.

APPENDIX C

UCOP Seismic Safety Policy Falling Hazards Assessment Summary

UC Campus:	San Francisco		Date:	10/31/2020	
Building CAAN:	3001	Auxiliary CAAN:	By Firm:	Rutherford+Chekene	
Building Name:	UCSF Rock Hall		Initials:	CLP/EFP	Checked: BL
Building Address:	1550 4th Street, San Francisco, CA 94158		Page:	1	of 1

UCOP SEISMIC SAFETY POLICY
Falling Hazard Assessment Summary

	Description
P ☐ N/A ☒	**Heavy ceilings, features or ornamentation above large lecture halls, auditoriums, lobbies, or other areas where large numbers of people congregate (50 ppl or more)** **Comments:** 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

Weight Take-off

Weight Take-Off for Steel, BRBs, Cladding

GIRDERS: Take off all steel at second floor from Line 9 to 16 and A to H as representative										
		γ concr =	150	pcf			Area tota	35455		
		γsteel =	490	pcf			sample a	15766		
SECOND FLOOR										
	Girder ID	**Length (ft)**	**B (in)**	**D (in)**	**No.**	**Area (ft^2)**	**Unit weight (pcf)**	**Weight (plf)**	**Weight (kips)**	
NS	W12x19	20.67			7			19	2.75	
	W16x36	20.67			17			36.0	12.65	
	W16x45	20.67			2			45.0	1.86	
	W18x40	125.5			2			40.0	10.04	
	W18x71	125.5			3.6667			71.0	32.67	
	W21x83	125.5			1			83.0	10.42	
	W24x103	20.67			1			103.0	2.13	
EW	W12x19	20.67			6			19	2.36	
	W16x36	120.5			14			36.0	60.73	
	W16x45							45.0	0.00	
	W18x40							40.0	0.00	
	W18x71	196.5			1			71.0	13.95	
	W21x83	41			4			83.0	13.61	
	W24x103							103.0	0.00	
	Transfer Girder #2	41			1	1.11	490.00	543.6	22.29	
							NS	Σ =	72.5	kips
							EW	Σ =	112.9	kips
							Sum NS+EW		185.5	kips
							Area, ft^	15766		
						1.1	weight, psf		12.94	

Columns: Take off all columns from schedule at first floor; scale other floors									
		γ concr =	150	pcf					
		γsteel =	490	pcf					
	COLUMNS								
	Columns	Height, ft				Area (ft^2)	Scale Factor	Weight (psf)	Weight (kips)
Roof	W14xNN	16				35455	0.23	1.91	67.75
5	W14xNN	16				35455	0.45	3.82	135.50
4	W14xNN	16				35455	0.61	5.12	181.57
3	W14xNN	16				35455	0.61	5.12	181.57
2	W14xNN	19.375				35455	1.00	8.45	299.58
								Σ =	866.0 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 splice above second floor																	
	W14x61	W14x74														W14x370	
plf	61	74	90	109	120	132	145	159	176	193	211	257	283	311	342	370	
	1	2	2	1	1	1	2	1	1	3	1	2	5	4	2	1	30
no. of co	8	25	25	7.5	1	2	3	2	3	5	1	4	10	5	4	1	106.5
kips	8.63	32.72	39.80	14.46	2.12	4.67	7.69	5.62	9.34	17.07	3.73	18.18	50.06	27.50	24.20	6.54	272.34
h,ft	17.69														kips	1.1	299.58
															area, ft^	35455	

BRBs: Estimate weights 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)
Roof	BRB 12	16	20.67	26.14	8	16	24	2.00	70.90
5	BRB 12	16	20.67	26.14	8	16	24	4.00	141.81
4	BRB 12	16	20.67	26.14	12	16	28	4.67	165.44
3	BRB 12	16	20.67	26.14	12	16	28	4.67	165.44
2	BRB 12	19.375	20.67	28.33	12	16	28	4.86	172.38
							Σ =	716.0	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			Unit weight, psf (See Below)	Line load plf	Weight (psf)	Weight (kips)
Roof	819	16	11.5			25	287.50	6.64	235.46
5	819	16	16			25	400.00	9.24	327.60
4	819	16	16			25	400.00	9.24	327.60
3	819	16	16			25	400.00	9.24	327.60
2	819	19.38	17.69			25	442.19	10.21	362.15
	Area, ft2	35455							

Stone Calculator

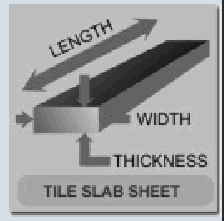
MARBLECARVE.COM

Email us at mail@artfiberglass.com for your order information
Phone: 1 541-359-4708

Weight Calculator

Marble * Granite * Stone * Miscellaneous

Material : Travertine
Density : 2.5000 g/cc
Shape : Tile Slab Sheet
Quantity : 1
Thickness : 2 inch
Width : 12 inch
Length : 12 inch



Total Weight :
11.7987
Kgs
26.0161
Lbs

Calculate Reset All

Stone Calculator

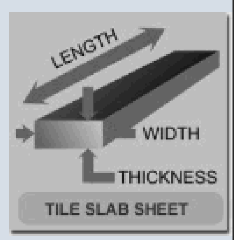
MARBLECARVE.COM

Email us at mail@artfiberglass.com for your order information
Phone: 1 541-359-4708

Weight Calculator

Marble * Granite * Stone * Miscellaneous

Material : Sandstone
Density : 2.3230 g/cc
Shape : Tile Slab Sheet
Quantity : 1
Thickness : 2 inch
Width : 12 inch
Length : 12 inch



Total Weight :
10.9633
Kgs
24.1742
Lbs

Calculate Reset All

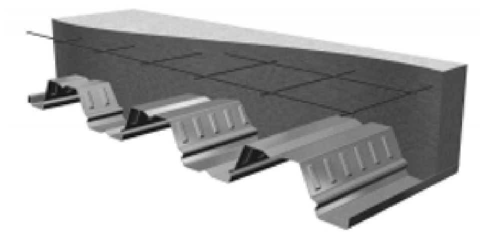
2" travertine		26	
6" studs 16 gage		1.5	
1/2" ext gyp		2.2	
waterproofing		1	
5/8" int gyp		3	
HSS framing		6	
		39.7	
	say 40	40	
glazing		8	
50/50 glazing and stone		(40+8)/2	
		24	
	Use	25	psf

Weight of Verco Deck 3" with 4 1/2" NWC fill: Use 72.5psf

(Note says does not include weight of deck at 2.8- 2.9 psf. Neglected. Extra for sag and deck are part of flooring allowance.)

PLW3™ or W3 FORMLOK™

- **7½ in. TOTAL SLAB DEPTH**
- **Normal Weight Concrete**
- **2 Hour Fire Rating**



Maximum Unshored Clear Span (ft-in.)

Deck Gage	Number of Deck Spans 1	2	3
22	8'-3"	7'-4"	7'-4"
21	8'-11"	9'-2"	9'-2"
20	9'-7"	10'-4"	10'-8"
19	10'-6"	11'-5"	11'-10"
18	11'-0"	12'-5"	12'-10"
16	11'-8"	13'-10"	13'-8"

Shoring is required for spans greater than those shown above. See Footnote 1 on page 69 for required bearing.

Concrete Properties

Density (pcf)	Uniform Weight (psf)	Uniform Volume ($yd^3/100\ ft^2$)	Compressive Strength, f'_c (psi)
145	72.5	1.852	3000

Notes:
1. Volumes and weights do not include allowance for deflection.
2. Weights are for concrete only and do not include weight of steel deck.
3. Total slab depth is nominal depth from top of concrete to bottom of steel deck.

Flat Load Tables

TYPICAL ROOF	Seismic Weight psf	Dead Load psf	Remarks
Roofing	5.0	5.0	
Waterpoofing / insulation	5.0	5.0	
3" Deck with 4.5" NWC fill	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	12.9	12.9	Steel beams, girders
Columns	1.9	1.9	Steel Col
BRB	2.0	2.0	BRB assume BRB 12 for all
Cladding	6.6	6.6	
Partitions	5.0	0.0	
Total	125.0	120.0	

5th FLOOR	Seismic Weight psf	Dead Load psf	Remarks
Flooring	5.0	5.0	allowance, no arch dwgs
3" Deck with 4.5" NWC fill	72.5	72.5	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	12.9	12.9	Steel beams, girders
Columns	3.8	3.8	Steel Col
BRB	4.0	4.0	BRB assume BRB 12 for all
Cladding	9.2	9.2	
Partitions	10.0	0.0	
Total	126.5	116.5	

	Seismic Weight	Dead Load	
4th FLOOR	**psf**	**psf**	**Remarks**
Flooring	5.0	5.0	allowance, no arch dwgs
3" Deck with 4.5" NWC fill	72.5	72.5	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	12.9	12.9	Steel beams, girders
Columns	5.1	5.1	Steel Col
BRB	4.7	4.7	BRB assume BRB 12 for all
Cladding	9.2	9.2	
Partitions	10.0	0.0	
Total	128.5	118.5	

	Seismic Weight	Dead Load	
3rd FLOOR	**psf**	**psf**	**Remarks**
Flooring	5.0	5.0	allowance, no arch dwgs
3" Deck with 4.5" NWC fill	72.5	72.5	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	12.9	12.9	Steel beams, girders
Columns	5.1	5.1	Steel Col
BRB	4.7	4.7	BRB assume BRB 12 for all
Cladding	9.2	9.2	
Partitions	10.0	0.0	
Total	128.5	118.5	

	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	72.5	72.5	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	12.9	12.9	Steel beams, girders
Columns	8.4	8.4	Steel Col
BRB	4.9	4.9	BRB assume BRB 12 for all
Cladding	10.2	10.2	
Partitions	10.0	0.0	
Total	133.0	123.0	

Story Weight

Floor Levels	Story Height, ft	Height, ft	Area (ft^2)	Weight, psf	Weight, kips
Roof	16	83.375	35,455	124.99	4431.6
5	16	67.375	35,455	126.50	4485.1
4	16	51.375	35,455	128.47	4554.8
3	16	35.375	35,455	128.47	4554.8
2	19.375	19.375	35,455	132.97	4714.3
1			177,275		
					22740.5

Period

C_t=	0.02
h_n(ft)=	84.00
B=	0.75

T=	0.55	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 high roof.

Seismic Hazard

Arthur and Toni Rembe Rock Hall, 1550 4th St, San Francisco, CA 94158, USA

Latitude, Longitude: 37.769165, -122.3914178

Date	3/2/2020, 11:24:30 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)	1.379
S_1	spectral response (1.0 s)	0.532
S_{XS}	site-modified spectral response (0.2 s)	1.793
S_{X1}	site-modified spectral response (1.0 s)	2.233
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}=	1.793	g	(See Note 2)
S_{X1}=	2.233	g	(See Note 2)
T=	0.55	s	
Sa=	1.793	g	
W=	22,741	kips	
C=	1.0	Per ASCE 41-17 Table 4-7	
V=	40,774	kips	

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.

k= 1.03

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 and 2.5 sec period.

Floor Levels	Story Height (ft)	Total Height, H (ft)	Weight, W (kips)	$W \times H^k$	coeff	Fx (kips)	Story Shear, V (kips)
Roof	16.00	83.38	4,432	417,211	0.32	13,147	13,147
5	16.00	67.38	4,485	339,227	0.26	10,689	23,836
4	16.00	51.38	4,555	260,740	0.20	8,216	32,052
3	16.00	35.38	4,555	177,706	0.14	5,600	37,651
2	19.38	19.38	4,714	99,086	0.08	3,122	40,774
1	0.00		0				
	83.4		22,741	1,293,970	1	40,774	

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 2 Buildings - Assessment of Geotechnical Characteristics and Geohazards.

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.

Column Axial Force Tier 1 Check

Story Weight

Floor Levels	Story Height, ft	Height, ft	Area (ft^2)	Weight, psf	Weight, kips
Roof	16	83.375	35,455	124.99	4431.6
5	16	67.375	35,455	126.50	4485.1
4	16	51.375	35,455	128.47	4554.8
3	16	35.375	35,455	128.47	4554.8
2	19.375	19.375	35,455	132.97	4714.3
1			177,275		
					22740.5

$w_{roof} := 125psf$ $\qquad$ $A_{trib} := \frac{41ft \cdot 41ft}{4} = 420.25\,ft^2$

$w_5 := 126.5psf$ $\qquad$ $F_y := 50ksi$

$w_4 := 128.5psf$

$w_3 := 128.5psf$

$w_2 := 133psf$

$F_{1st} := (w_{roof} + w_5 + w_4 + w_3 + w_2) \cdot A_{trib} = 269.59\,kip$

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

$Axial_{stress} := \frac{F_{1st}}{A_{W14311}} = 2.95\,ksi$ $\qquad$ $0.1 \cdot F_y = 5\,ksi$

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

$F_{int} := F_{1st} = 269.59\,kip$

$A_{minint} := 56.8in^2$ $\qquad$ $A_{51.8} := 51.8in^2$

$Axial_{stressint} := \frac{F_{int}}{A_{minint}} = 4.746\,ksi$ $\qquad$ less than 5ksi ok

To check the column with A=51.8 Inch^2 $\qquad$ $A_{trib518} := 397ft^2$

$F_{1st518} := (w_{roof} + w_5 + w_4 + w_3 + w_2) \cdot A_{trib518} = 254.676\,kip$

$Axial_{stressint518} := \frac{F_{1st518}}{A_{51.8}} = 4.917\,ksi$ $\qquad$ less than 5ksi ok

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

$F_{ext} := \frac{F_{int}}{2} = 134.795\,kip$ $\quad A_{minext} := 32in^2$

$Axial_{stressext} := \frac{F_{ext}}{A_{minext}} = 4.212\,ksi$ $\quad$ less than 5ksi ok

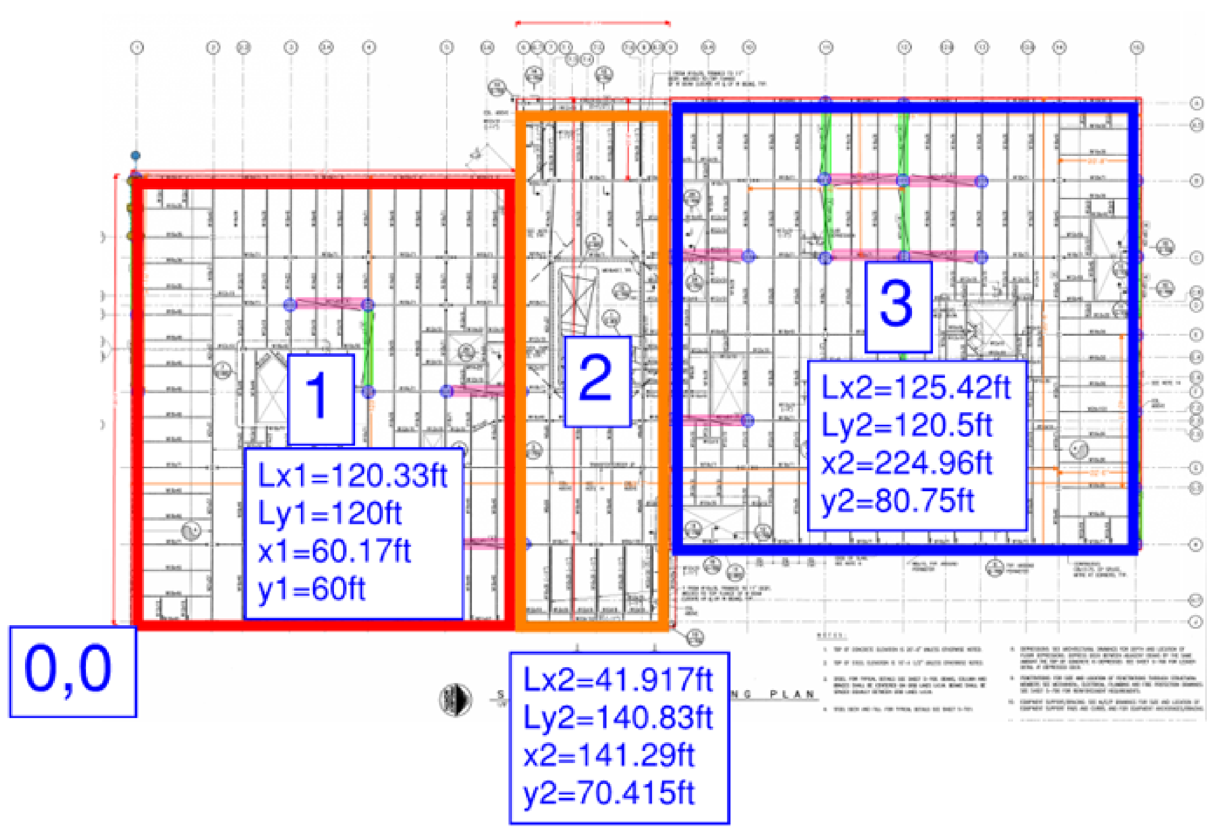
All columns have Axial stress less than 0.1Fy

Note that check above was done using dead loads only.

If live loads are included, with a roof load of 20 psf, lab floor loads of 100 psf, and the ASCE 41-17 Section 7.2.2 assumption of Q_L = 0.25 x total loads, then Q_L = (0.25) (41 ft x 41 ft) (0.02 + 4 x 0.100) = 176.5 kips. For the interior column above, $Q_D + Q_L$ = (254.7 + 176.5) = 431.2 k and stress is then (431.2 k / 51.8 in^2) = 8.32 ksi > 5 ksi.

Center of Gravity

Calculation to find 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	120.33	120	60.17	60	14439.6	868830.73	866376
2	41.91	140.83	141.29	70.415	5902.1853	833919.76	415602.3779
3	125.42	120.5	224.96	80.75	15113.11	3399845.2	1220383.633
					Total area	Sum A*xcg	Sum A*Ycg
	287.66	140.83			35454.895	5102595.7	2502362.01



Xtotcg=	143.9179	used in C rigid page to evaluate the 20% excentricity
Ytotcg=	70.57874	

Quick check for total weight and total shear			
No of floors=	5		
weight of typ floor=	0.13	ksf	
Total bldg area=	177274.5		
total bldg weight=	23045.68	kip	
XSX=	1.7914		
total bldg shear=	41284.03		close to more refined calculation

Eccentricity and Brace Avg. Axial Stress Check

Brace Axial Stress Check

Per Section 4.4.3.4 in ASCE 41-17:

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

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

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

(Level of Performance: CP, LS, IO)

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.

Use Ms= 7

Since we did not have the brace areas we calculated the areas based on the capacity of the brace assuming Fy=38ksi

Ratio of diagonal forces to horizontal forces for braces

	Ly	Lx	Lx	Lx	Lx	Lx	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ	Ratio DIA/HORZ
upper	192	252	186	286.00	188	282	0.7954317	0.6957952	0.8302595	0.6996248	0.8265992
Lower	256	252	186	286.00	188	282	0.7015173	0.5877958	0.745105	0.5919095	0.7404151

Center of Rigidity

Calculation of center of rigidity based on the capacity of the braces

X dir braced frames	Floor level	Fbrace from drawings (kip)	Fbrace from drawings (kip)	Total horizontal force (kip)	Distance from Origin (in) Dy	Fhorx*Dy
line B	5	325	325	517.03	1441	745041.1
	4	500	500	795.43	1441	1146217
	3	425	425	676.12	1441	974284.5
	2	500	500	795.43	1441	1146217
	1	550	550	771.67	1441	1111975
Line C	5	0	0	0.00	1186	0
	4	0	0	0.00	1186	0
	3	325	325	517.03	1186	613198.3
	2	400	400	636.35	1186	754705.6
	1	450	450	631.37	1186	748799.5
Line D	5	275		218.74	1029	225087.3
	4	400		318.17	1029	327399.7
	3	325		258.52	1029	266012.3
	2	400		318.17	1029	327399.7
	1	450		315.68	1029	324837.6
Line F	5	275		218.74	750	164057.8
	4	400		318.17	750	238629.5
	3	325		258.52	750	193886.5
	2	400		318.17	750	238629.5
	1	450		315.68	750	236762.1
Line F.3	5	275	275	437.49	655	286554.3
	4	400	400	636.35	655	416806.2
	3	325	325	517.03	655	338655.1
	2	400	400	636.35	655	416806.2
	1	450	450	631.37	655	413544.4
Line G	5	0	0	0.00	502	0
	4	0	0	0.00	502	0
	3	425	425	676.12	502	339410.7
	2	500	500	795.43	502	399306.7
	1	550	550	771.67	502	387377.8
Line H	5	275	275	437.49	248	108496.9
	4	400	400	636.35	248	157813.7
	3	325	325	517.03	248	128223.6
	2	400	400	636.35	248	157813.7
	1	450	450	631.37	248	156578.7

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	5	250	250	200	536.87	0	0.00
	4	375	375	250	770.52	0	0.00
	3	450	450	375	976.81	0	0.00
	2	475	475	375	1016.58	0	0.00
	1	575	575	675	1203.51	0	0.00
Line 4	5	100	100	100	242.11	752	182068.45
	4	200	200	150	442.71	752	332919.13
	3	250	250	200	563.77	752	423953.36
	2	275	275	250	645.05	752	485079.35
	1	300	300	275	625.81	752	470612.31
Line 5	5	100	100		159.09	1004	159722.69
	4	175	175		278.40	1004	279514.71
	3	175	175		278.40	1004	279514.71
	2	250	250		397.72	1004	399306.72
	1	275	275		385.83	1004	387377.83
Line 11	5	100	100		159.09	2240	356353.41
	4	175	175		278.40	2240	623618.47
	3	175	175		278.40	2240	623618.47
	2	250	250		397.72	2240	890883.53
	1	275	275		385.83	2240	864269.27
Line 12	5	100	100	100	241.75	2495	603156.94
	4	150	200	200	442.16	2495	1103195.63
	3	200	250	250	563.04	2495	1404774.10
	2	250	275	275	644.14	2495	1607122.46
	1	275	300	300	624.52	2495	1558188.66
Line 15	5	200	250	250	563.04	3250	1829866.06
	4	250	375	375	803.22	3250	2610476.71
	3	375	450	450	1025.86	3250	3334055.61
	2	375	475	475	1065.63	3250	3463313.27
	1	375	575	575	1084.40	3250	3524301.69

CG from CG calc page	
Xtotcg=	143.9179
Ytotcg=	70.57874

	(ft)	20% (ft)	
Bldg length=	287.66	57.532	X
Bldg width=	140.83	28.166	Y

Calculation of 20% excentricity

Floor level	Yrig (in)	Yrig(ft)	Ytotcg(ft)	Yecc(ft)	
5	835.88	69.66	70.58	0.92	
4	845.59	70.47	70.58	0.11	
3	834.32	69.53	70.58	1.05	
2	831.88	69.32	70.58	1.26	
1	830.68	69.22	70.58	1.36	Less than 20%
				28.17	

Floor level	Xrig (in)	Xrig (ft)	Xtotcg(ft)	Xecc(ft)	
5	1646.30	137.19	143.92	6.73	
4	1641.47	136.79	143.92	7.13	
3	1645.54	137.13	143.92	6.79	
2	1642.90	136.91	143.92	7.01	
1	1578.86	131.57	143.92	12.35	Less than 20%
				57.532	

Brace Average Axial Stress

Calculation of Brace area per floor

X DIRECTION	Fy brace=	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
5	1829.49	12806.45	337.01	13146.57	816.18
4	2704.47	18931.27	498.19	23835.82	1483.70
3	3420.36	23942.49	630.07	32051.88	2000.61
2	4136.24	28953.71	761.94	37651.49	2356.54
1	4068.80	28481.60	749.52	40773.75	2558.31

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
5	1901.94	13313.59	350.36	13,147	816.18
4	3015.42	21107.96	555.47	23,836	1483.70
3	3686.28	25803.96	679.05	32,052	2000.61
2	4166.84	29167.88	767.58	37,651	2356.54
1	4309.92	30169.41	793.93	40,774	2558.31

Ratios to convert from BSE-2E to BSE-1E, BSE-2N and BSE-1N (For information only)

Existing				New			
1.793	7.000	0.256	1.000	1.95	7.000	0.279	1.088
0.974	4.500	0.216	0.845	1.30	4.500	0.289	1.128

Calculation of stress demand for braces

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**	including rho=1.0
5	**39.01**	*32.96*	*42.42*	*44.00*	**2.05**	0.50
4	**47.84**	*40.43*	*52.03*	*53.96*	**2.52**	0.61
3	**50.87**	*42.99*	*55.33*	*57.37*	**2.68**	0.65
2	**49.42**	*41.76*	*53.74*	*55.73*	**2.60**	0.63
1	**54.40**	*45.97*	*59.16*	*61.35*	**2.86**	0.70

		Fy	38	0.5Fy	19.00	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**	including rho=1.0
5	**37.52**	*31.71*	*40.81*	*42.32*	**1.97**	0.48
4	**42.91**	*36.26*	*46.67*	*48.40*	**2.26**	0.55
3	**47.20**	*39.89*	*51.33*	*53.24*	**2.48**	0.60
2	**49.05**	*41.45*	*53.35*	*55.32*	**2.58**	0.63
1	**51.36**	*43.40*	*55.85*	*57.92*	**2.70**	0.66

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 54.40 ksi. The BSE-2N stress is (BSE-2E = 54.40 ksi) x (BSE-2N Sxs = 1.95 / CP Ms = 7) / (BSE-2E Sxs = 1.793 / CP Ms = 7) =59.16. The BSE-1N stress is (BSE-2E = 54.40 ksi) x (BSE-1N Sxs = 1.30 / CP Ms = 4.5) / (BSE-2E Sxs = 1.793 / CP Ms = 7) = 61.35 ksi.

APPENDIX E

Sample Calculations Per ASCE 7-05

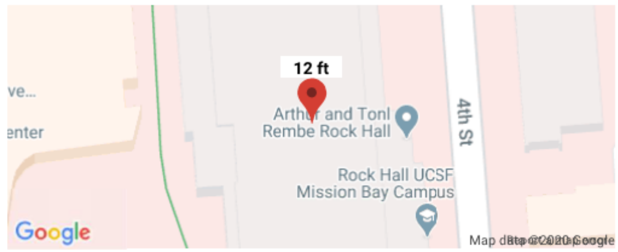
Seismic Hazard per ASCE 7-05

ATC Hazards by Location]

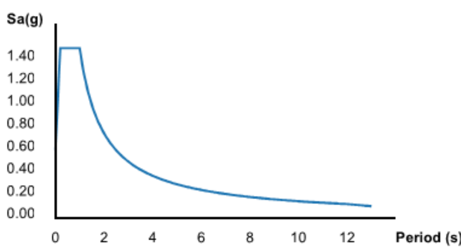
ATC Hazards by Location

Search Information

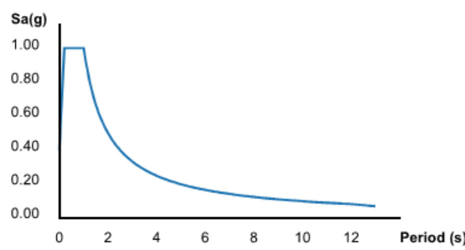
Coordinates:	37.76919404616286, -122.39140802414323
Elevation:	12 ft
Timestamp:	2020-03-09T23:45:43.780Z
Hazard Type:	Seismic
Reference Document:	ASCE7-05
Risk Category:	II
Site Class:	E



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	0.629	MCE_R ground motion (period=1.0s)
S_{MS}	1.35	Site-modified spectral acceleration value
S_{M1}	1.509	Site-modified spectral acceleration value
S_{DS}	0.9	Numeric seismic design value at 0.2s SA
S_{D1}	1.006	Numeric seismic design value at 1.0s SA

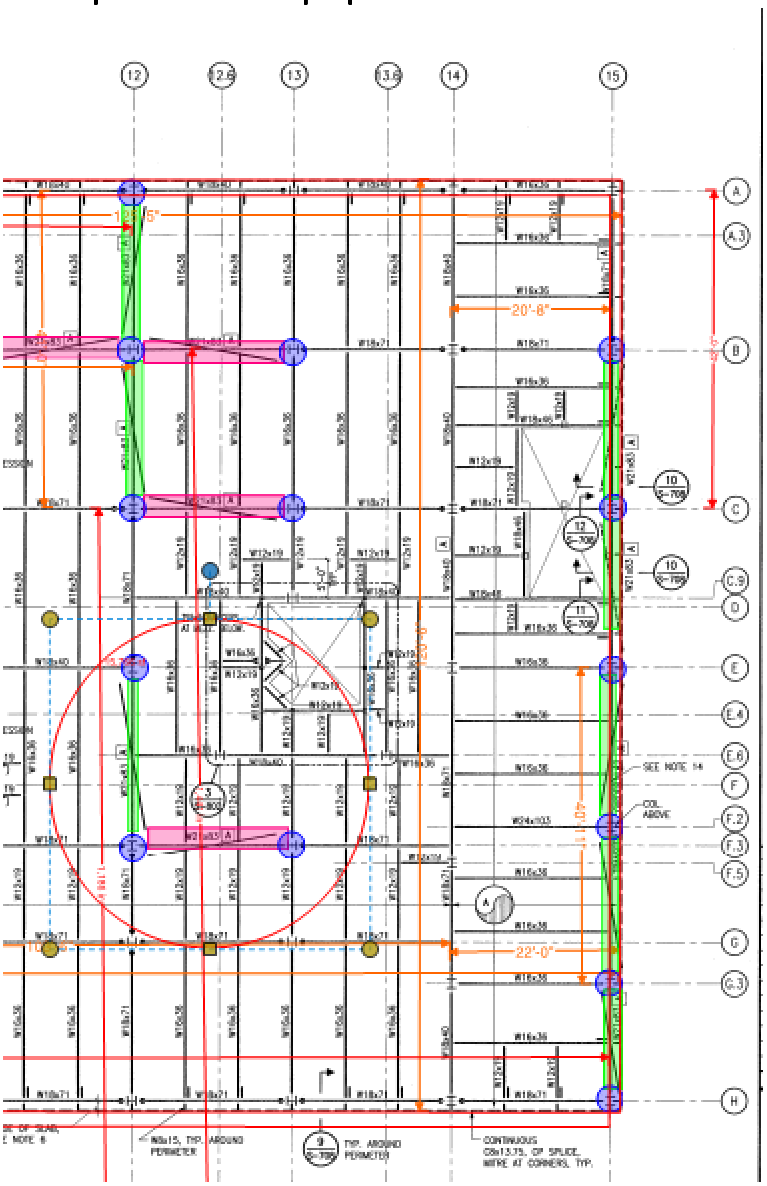
Additional Information

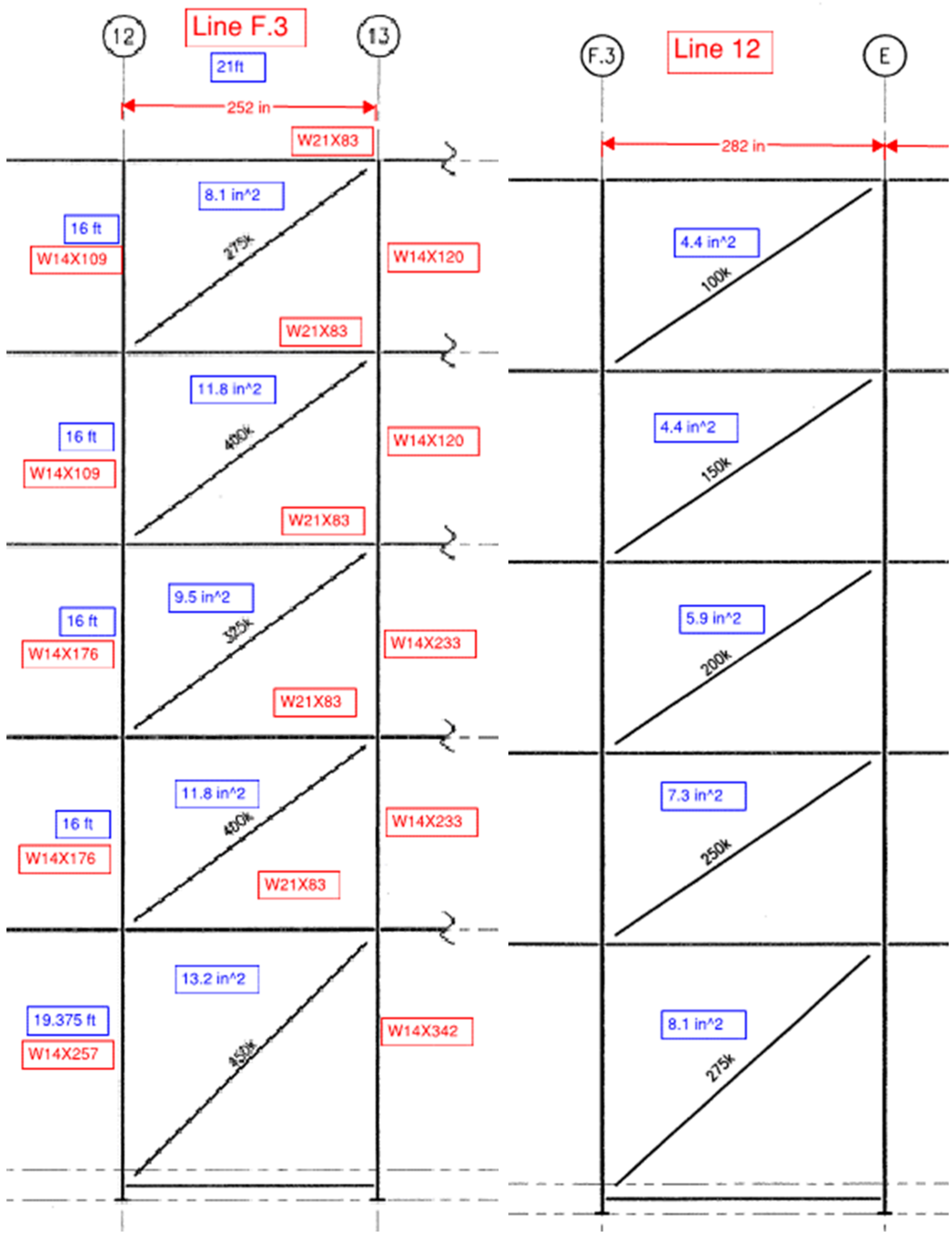
Name	Value	Description
SDC	D	Seismic design category
F_a	0.9	Site amplification factor at 0.2s
F_v	2.4	Site amplification factor at 1.0s
T_L	12	Long-period transition period (s)

ASCE-7-05 (for Comparison with ASCE 41-17)			
V=Cs W			
SDS	0.9		
SD1	1.006		
S1	0.629		
R	8	Table 12.2-1(26)	
I	1		
T	0.55	sec	
Cs	SDS/(R/I)	12.8-2	
	0.1125		
Csmax	SD1/(T(R/I))	12.8.3	
	0.226604502		
Csmin	0.5S1/(R/I)	12.8.4	
	0.0393125		
Cs	0.1125		

Check BRB at Line F.3-12 to F.3-13

BRB representative of perpendicular braces with shared column at F.3-12.




Line F.3
12
13
21ft
252 in
W21X83
8.1 in^2
275k
16 ft
W14X109
W14X120
W21X83
11.8 in^2
400k
16 ft
W14X109
W14X120
W21X83
9.5 in^2
325k
16 ft
W14X176
W14X233
W21X83
11.8 in^2
400k
16 ft
W14X176
W14X233
W21X83
13.2 in^2
450k
19.375 ft
W14X257
W14X342
Line 12
F.3
E
282 in
4.4 in^2
100k
4.4 in^2
150k
5.9 in^2
200k
7.3 in^2
250k
8.1 in^2
275k

Estimate DL and LL for F.3-12 and F.2-13

Estimate DL and LL for BRB Frame at F.3-12 to 13							
Floor	Trib Area, Ft2						
	F.3-12	DL, psf	LL, psf	PDL	PDL	PLL	
Roof	370.1	124.99	50	46.26	46.26	18.50	18.50
5	370.1	126.50	100	46.81	93.07	37.01	55.51
4	370.1	128.47	100	47.54	140.61	37.01	92.52
3	370.1	128.47	100	47.54	188.16	37.01	129.53
2	370.1	132.97	100	49.21	237.36	37.01	166.53
1							
Floor	Trib Area, Ft2						
	F.3-13	DL, psf	LL, psf	PDL	PDL	PLL	PLL
Roof	252.4	124.99	50	31.55	31.55	12.62	12.62
5	252.4	126.50	100	31.93	63.48	25.24	37.86
4	252.4	128.47	100	32.43	95.91	25.24	63.11
3	252.4	128.47	100	32.43	128.34	25.24	88.35
2	252.4	132.97	100	33.56	161.90	25.24	113.59
1							
Roof Live says 20psf plus mechanical. Estimate 50psf.							

Connection Check F.3-12 to 13

BRB Connection Check F.3-12 to 13

		Adjusted Brace strength						Bolt Shear						
BRB	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)	
275	8.1	46	1.25	1.35	1.688	466	629	5	2	10	80.7	807	629	0.78
400	11.8	46	1.25	1.35	1.688	679	916	7	2	14	80.7	1130	916	0.81
325	9.5	46	1.25	1.35	1.688	546	737	7	2	14	80.7	1130	737	0.65
400	11.8	46	1.25	1.35	1.688	679	916	7	2	14	80.7	1130	916	0.81
450	13.2	46	1.25	1.35	1.688	759	1025	8	2	16	80.7	1291	1025	0.79

		Gusset Plate Yield							Splice Plate yield						
BRB	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)	
275	8.1	1	8	16.6	50	830	629	0.76	1	4	50	8	1600	629	0.39
400	11.8	1.25	8	16.6	50	1038	916	0.88	1	4	50	8	1600	916	0.57
325	9.5	1.25	12	18.9	50	1181	737	0.62	1	4	50	8	1600	737	0.46
400	11.8	1.25	12	18.9	50	1181	916	0.78	1	4	50	8	1600	916	0.57
450	13.2	1.25	16	21.2	50	1325	1025	0.77	1	4	50	8	1600	1025	0.64

		Wing Plate Welds					
BRB	BRB Size, A_{sc}	W1	L1	n_{welds}	ϕV_n	T_u	DCR
	(in^2)	(in)	(in)		(kip)	(kip)	
275	8.1	0.375	13	4	434	314	0.72
400	11.8	0.375	16	4	534	458	0.86
325	9.5	0.375	16	4	534	369	0.69
400	11.8	0.375	16	4	534	458	0.86
450	13.2	0.375	16	4	534	512	0.96

Notes:
1. Gusset plate buckling ok by inspection
2. Gusset plate block shear is not applicable
3. Gusset plate to column/base plate welds not checked for Tier 1 analysis
4. Wing plate not dimensioned. Assume (max(n1,n2)-1)*3"+2*2"+3"

ASCE 7-05 Check Brace, Beam, Column

Summary for BRB F.3-12 to 13

Summary of Results for ASCE 7-05

	ASCE 7-05	SDS	0.9					
Brace			Level 2	Level 3	Level 4	Level 5	PH Floor	Max DCR
	ASCE 7-05	DCR	0.44	0.45	0.46	0.43	0.35	0.46
Beam								
	ASCE 7-05	DCR	0.63	0.60	0.49	0.59	0.44	0.63
Column								
	ASCE 7-05	DCR	0.93	0.98	0.69	0.58	0.16	0.98

See pdf of spreadsheet below

SINGLE BAY BRBF DESIGN - SINGLE DIAGONAL

BRBF LOCATION	F.3/12-13

GENERAL DESIGN PARAMETERS:

ϕ_b (flexure)=	0.9	C_d=	5	ρ=	1
ϕv (shear)=	0.9	I=	1	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 3	Level 4	Level 5	PH Floor	
L(ft)=	23.50	23.50	23.50	23.50	23.50	Bay Width (Columns C-C)
hi(ft)	19.38	16.00	16.00	16.00	16.00	Story Height
L_{diag}(ft)=	30.46	28.43	28.43	28.43	28.43	Work Point - Work Point
cosΨ=	0.772	0.827	0.827	0.827	0.827	Ψ = angle between brace and horizontal axis
sin=Ψ	0.636	0.563	0.563	0.563	0.563	

BRBF TRANSVERSE GEOMETRY:

	Level 2	Level 3	Level 4	Level 5	PH Floor
L(ft)=	21.00	21.00	21.00	21.00	21.00
hi(ft)	19.38	16.00	16.00	16.00	16.00
L_{diag}(ft)=	28.57	26.40	26.40	26.40	26.40
cosΨ=	0.735	0.795	0.795	0.795	0.795
sin=Ψ	0.678	0.606	0.606	0.606	0.606

BRACE DESIGN:

AISC 341-05 Section 16.2 -Brace Strength

	F.3-12-13	F.3-12-13	F.3-12-13	F.3-12-13	F.3-12-13	Brace ID
F_{ysc} (ksi)	38	38	38	38	38	Minimum yield stress of the steel core
$F_{ymax\ (ksi)}$	46	46	46	46	46	Maximum yield stress of the steel core
Dead Load (kip)	0.0	0.0	0.0	0.0	0.0	Gravity load on brace neglected
Live Load (kip)	0.0	0.0	0.0	0.0	0.0	Gravity load on brace neglected
Seismic Load (kip)	198.0	181.0	151.0	175.0	97.0	Estimate from ASCE 41-17 analysis based on brace capacities (I, rho=1.0)
Combined Axial Load, P_u (kip)	198.0	181.0	151.0	175.0	97.0	(1.2+0.2SDS)D+0.5L+ρE
Steel Core Area (in2)	13.2	11.8	9.5	11.8	8.1	
ϕP_{ysc} (kip)	451.4	403.6	324.9	403.6	277.0	$\phi Fy_{sc}A_{sc}$ (AISC 341-05 Equation 16-1)
DCR	0.44	0.45	0.46	0.43	0.35	Pu/ϕPysc

AISC 341-05 Section 16.2d -Adjusted Brace Strength

ω=	1.25	1.25	1.25	1.25	1.25	Strain Hardening Adjustment Factor (Assumed)
β=	1.35	1.35	1.35	1.35	1.35	Compression Adjustment Factor (Assumed)
βω=	1.688	1.688	1.688	1.688	1.688	
ωF_{ymax} Asc	759	679	546	679	466	Adjusted Brace Strength in Tension
$\beta\omega F_{ymax} A_{sc}$=	1025	916	737	916	629	Adjusted Brace Strength in Compression

AISC 341-05 Section 16.2d -Adjusted Brace Strength TRANSVERSE FRAME

Steel Core Area (in2)	8.1	7.3	5.9	4.4	4.4
ω=	1.25	1.25	1.25	1.25	1.25
β=	1.35	1.35	1.35	1.35	1.35
βω=	1.688	1.688	1.688	1.688	1.688
ωF_{ymax} Asc	466	420	339	253	253
$\beta\omega F_{ymax} A_{sc}$=	629	567	458	342	342
VERTICAL COMPONENT TENSION	342	334	270	201	201
VERTICAL COMPONENT COMPRESSION	462	451	364	272	272

Beam Design

Beam Demands	F.3-12-13	F.3-12-13	F.3-12-13	F.3-12-13	F.3-12-13	Brace ID
$P_{ubm,c}$ (kip)=	586	561	452	561	385	Max. compression due to brace tension, $P_{ubm,c} = \cos(\Psi_b)\omega F_{ymax}A_{sc,b}$
$P_{ubm,t}$ (kip)=	791	757	610	757	520	Max. tension due to brace compression, $P_{ubm,t} = \cos(\Psi_b)\beta\omega F_{ymax}A_{sc,b}$
$M_{E,drift}$=	0	0	0	0	0	Drift induced Seismic moment neglected

M_{Embr} (kip-ft)=	0	0	0	0	0	Seismic moment due to adjacent brace strenth, 0 for single diagonal configuration
M_{ug-} (kip-ft)	32	31	27	26	35	Factored gravity moment from analysis
M_u (kip-ft)	32	31	27	26	35	$M_{ug-} + M_{Embr}$
V_{Emh} (kip)	0	0	0	0	0	Seismic shear due to adjacent brace strenth, 0 for single diagonal configuration
V_{ug} (kip)=	12	15	15	15	15	Factored gravity shear from analysis
V_u (kip)=	12	15	15	15	15	$V_{ug} + V_{emh}$
Beam Geometric Properties						
F_y (ksi)=	50	50	50	50	50	
Beam Size=	W21x83	W21x83	W21x83	W21x83	W21x83	
A_g (in^2)=	24.4	24.4	24.4	24.4	24.4	
t_f (in)=	0.835	0.835	0.835	0.835	0.835	
t_w (in)=	0.515	0.515	0.515	0.515	0.515	
d (in)=	21.4	21.4	21.4	21.4	21.4	
b_f (in)=	8.36	8.36	8.36	8.36	8.36	
S_x (in^3)	171	171	171	171	171	
Z_x (in^3)	196	196	196	196	196	
r_y (in)=	1.83	1.83	1.83	1.83	1.83	
r_x (in)=	8.67	8.67	8.67	8.67	8.67	
r_{ts} (in)=	2.21	2.21	2.21	2.21	2.21	
h_0 (in)=	20.6	20.6	20.6	20.6	20.6	
J (in^4)=	4.34	4.34	4.34	4.34	4.34	
c=	1	1	1	1	1	
Seismic Compactness Per AISC 341-05 Section 16.5a/8.2b						
Beam Compact Flange $b_f/2t_f$=	5.0	5.0	5.0	5.0	5.0	
$(b/2t)_{max}=0.3(E/F_y)^{0.5}$=	7.2	7.2	7.2	7.2	7.2	
$b_f/2t_f \le (b/2t)_{max}$=	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	
Beam Compact Web $(d-2t_f)/t_w$=	38.3	38.3	38.3	38.3	38.3	
Ca = $P_u/\phi P_y$=	0.53	0.51	0.41	0.51	0.35	
$2.45\ (E/F_y)^{0.5}\ (1-0.93)C_a$=	29.7	31.0	36.4	31.0	39.8	if $C_a \le 0.125$
$0.77\ (E/F_y)0.5\ \ (2.93-C_a)$=	44.4	44.9	46.7	44.9	47.8	if $C_a > 0.125$
$1.49\ (E/F_y)^{0.5}$=	35.9	35.9	35.9	35.9	35.9	if $C_a > 0.125$ (min. limit)
$(h/t_w)_{max}$	44.4	44.9	46.7	44.9	47.8	
$(d-2t_f)/t_w \le (h/t_w)_{max}$	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	
AISC 360-05 Section D2 - Tension						
ϕP_{nt} (kip)=	1098	1098	1098	1098	1098	AISC 360 Equation D2-1
DCR=	0.72	0.69	0.56	0.69	0.47	
AISC 360-05 Section E - Compression						
L_x (ft)=	19.6	19.6	19.75	19.75	19.8	Strong axis unbraced length
L_y (ft)=	19.6	19.6	19.75	19.75	19.8	Weak axis unbraced length
k_x=	1.0	2.0	3.0	4.0	5.0	
$(kL/r)_x$=	128.5	128.5	129.5	129.5	129.8	
k_y=	1.0	1.0	1.0	1.0	1.0	
$(kL/r)_y$=	27.1	27.1	27.3	27.3	27.4	
F_e (ksi)=	388.92	388.92	383.04	383.04	381.10	AISC 360-05 Equation E3-4
F_{cr} (ksi)=	47.4	47.4	47.3	47.3	47.3	AISC 360-05 Equation E3-2 or E3-3
$\phi_c P_{nc}$ (kip)=	1040	1040	1040	1040	1039	AISC 360-05 Equation E3-1
DCR=	0.56	0.54	0.43	0.54	0.37	
	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	
AISC 360-05 Section F - Flexure						
L_p (ft)=	30.6	30.6	30.6	30.6	30.6	AISC 360-05 Equation F2-5
L_r (ft)=	20.2	20.2	20.2	20.2	20.2	AISC 360-05 Equation F2-6
C_b=	1	1	1	1	1	
S_x (in^3)=	171	171	171	171	171	
M_p (kip-ft)=	817	817	817	817	817	Z_xF_y
M_n (kip-ft)=	481	481	485	485	487	AISC 360-05 Equation F2-2

ϕM_n (kip-ft)=	433	433	437	437	438	
DCR	0.07	0.07	0.06	0.06	0.08	
	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section H1 - Combined Compression & Flexure

P_u (kip)=	586	561	452	561	385	
M_u (kip-ft)=	32	31	27	26	35	
$P_u/\phi_c P_{nc}$=	0.56	0.54	0.43	0.54	0.37	
combined equation=	0.63	0.60	0.49	0.59	0.44	AISC 360-05 Equation H1-1a or H1-1b
	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	

AISC 360-05 Section G2 - Shear

$\phi_v V_n$ (kip)=	274	274	274	274	274	AISC 360-05 Equation G2-1
DCR	0.04	0.05	0.05	0.05	0.05	
	Beam OK	Beam OK	Beam OK	Beam OK	Beam OK	

COLUMN DESIGN (RIGHT)

Column Demands

	F.3-13	F.3-13	F.3-13	F.3-13	F.3-13	column ID
PDL (kip)	161.90	128.34	95.91	63.48	31.55	Estimated DL from Trib Area
PLL (kip)	113.59	88.35	63.11	37.86	12.62	Estimated LL from Trib Area
1.2DL+f1LL+Ev=	280	221	164	107	50	$E_v=0.2S_{DS}DL$
0.9DL-Ev=	117	92	69	46	23	
column orientation=	Strong	Strong	Strong	Strong	Strong	

Brace in Tension-Beam in Compression-Column in Compresion

$V_{t,br}$ (kip)	483	382	307	382	262	Vert. component of the adj. brace force in tension
$V_{t,br,perp}$(kip)	0	0	0	0	0	Vert. component of the adj. brace force from perpendicular frames
$\Sigma P_{em}+0.3*\Sigma P_{em,perp}$ (kip)=	1816	1333	951	644	262	Sum of the axial forces in column due to adj. brace forces at all levels
$P_{uc}=\Sigma P_{em}+P_{u,grav}$ (kip)=	2096	1555	1115	751	312	

Brace in Compression-Beam in tension-Column in Tension

$V_{c,br}$ (kip)	652	516	415	516	354	Vert. component of the adj. brace force in compression
$V_{c,br,perp}$(kip)	0	0	0	0	0	Vert. component of the adj. brace force from perpendicular frames
$\Sigma P_{em}+0.3*\Sigma P_{em,perp}$ (kip)=	2452	1800	1284	869	354	Sum of the axial forces in column due to adj. brace forces at all levels
$P_{uc}=\Sigma pemx-P_{u,grav}$ (kip)=	2335	1707	1215	824	331	

Column Geometric Properties

F_y (ksi)=	50	50	50	50	50
Column Size=	W14x342	W14x233	W14x233	W14x120	W14x120
A_g (in^2)=	101	68.5	68.5	35.3	35.3
t_f (in)=	2.47	1.72	1.72	0.94	0.94
t_w (in)=	1.54	1.07	1.07	0.59	0.59
d (in)=	17.5	16	16	14.5	14.5
b_f (in)=	16.4	15.9	15.9	14.7	14.7
S_x (in^3)	558	375	375	190	190
Z_x (in^3)	672	436	436	212	212
Z_y (in^3)	338	221	221	102	102
r_x (in)=	6.98	6.63	6.63	6.24	6.24
r_y (in)=	4.24	4.1	4.1	3.74	3.74
L (ft)=Lx (ft)=Ly (ft)=	17.6	14.2	14.2	14.2	14.2
kx=	1.0	1.0	1.0	1.0	1.0
ky=	1.0	1.0	1.0	1.0	1.0
(kl/r)x	30.3	25.7	25.7	27.3	27.3
(kL/r)Y	49.8	41.6	41.6	45.6	45.6

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

Column Compact Flange $b_f/2t_f$=	3.3	4.6	4.6	7.8	7.8	
$(b/2t)_{max}=0.3(E/F_y)^{0.5}$=	7.2	7.2	7.2	7.2	7.2	
$b_f/2t_f \leq (b/2t)_{max}$=	Column OK	Column OK	Column OK	NO GOOD	NO GOOD	Columns at Upper Floors Noncompact
Column Compact Web $(d-2t_f)/t_w$=	8.2	11.7	11.7	21.4	21.4	

$C_a = P_u/\phi P_y$=	0.46	0.50	0.36	0.47	0.20		
$2.45\ (E/F_y)^{0.5}\ (1\text{-}0.93)C_a$=	33.7	31.3	39.1	33.1	48.2		
$0.77\ (E/F_y)0.5\ \ (2.93\text{-}C_a)$=	45.8	45.0	47.6	45.6	50.7		
$1.49\ (E/F_y)^{0.5}$=	35.9	35.9	35.9	35.9	35.9		
$(h/t_w)_{max}$	45.8	45.0	47.6	45.6	50.7		
$(d\text{-}2t_f)/t_w \leq (h/t_w)_{max}$	Column OK	Column OK	Column OK	Column OK	Column OK		

AISC 360-05 Section D2 - Tension

ϕP_{nt} (kip)=	4545	3083	3083	1589	1589	AISC 360 Equation D2-1
DCR=	0.51	0.55	0.39	0.52	0.21	
	Column OK	Column OK	Column OK	Column OK	Column OK	

AISC 360-05 Section E - Compression

F_e (ksi)=	115.36	165.70	165.70	137.88	137.88	AISC 360-05 Equaltion E3-4
F_{cr} (ksi)=	41.7	44.1	44.1	43.0	43.0	AISC 360-05 Equaltion E3-2 or E3-3
$\phi_c P_{nc}$ (kip)=	3791	2717	2717	1365	1365	AISC 360-05 Equaltion E3-1
DCR=	0.55	0.57	0.41	0.55	0.23	
	Column OK	Column OK	Column OK	Column OK	Column OK	

COLUMN DESIGN (LEFT)

Column Demands

	F.3-12	F.3-12	F.3-12	F.3-12	F.3-12	column ID
PDL (kip)	237.36	188.16	140.61	93.07	46.26	Estimated DL from Trib Area
PLL (kip)	166.53	129.53	92.52	55.51	18.50	Estimated LL from Trib Area
1.2DL+f1LL+Ev=	411	324	240	156	73	$E_v=0.2S_{DS}DL$
0.9DL-Ev=	171	135	101	67	33	
column orientation=	Weak	Weak	Weak	Weak	Weak	

Brace in Tension-Beam in Compression-Column in Compresion

$V_{t,br}$ (kip)	516	415	516	354	0		Vert. component of the adj. brace force in compression
$V_{t,br,perp}$(kip)	0	342	334	270	201	201	Vert. component of the adj. brace force from perpendicular frames
$\Sigma P_{em}+0.3*\Sigma P_{em,perp}$ (kip)=	2204	1689	1171	556	121	60	Sum of the axial forces in column due to adj. brace forces at all levels
$P_{uc}=\Sigma P_{em}+P_{u,grav}$ (kip)=	2615	2013	1412	712	194		

Brace in Compression-Beam in tension-Column in Tension

$V_{c,br}$ (kip)	382	307	382	262	0		Vert. component of the adj. brace force in tension
$V_{c,br,perp}$(kip)	0	462	451	364	272	272	Vert. component of the adj. brace force from perpendicular frames
$\Sigma P_{em}+0.3*\Sigma P_{em,perp}$ (kip)=	1879	1498	1051	534	163	82	Sum of the axial forces in column due to adj. brace forces at all levels
$P_{uc}=\Sigma pemx\text{-}P_{u,grav}$ (kip)=	1709	1362	950	467	130		

Column Geometric Properties

F_y (ksi)=	50	50	50	50	50
Column Size=	W14x257	W14x176	W14x176	W14x109	W14x109
A_g (in^2)=	75.6	51.8	51.8	32	32
t_f (in)=	1.89	1.31	1.31	0.86	0.86
t_w (in)=	1.18	0.83	0.83	0.525	0.525
d (in)=	16.4	15.2	15.2	14.3	14.3
b_f (in)=	16	15.7	15.7	14.6	14.6
S_x (in^3)	415	281	281	173	173
Z_x (in^3)	487	320	320	192	192
Z_y (in^3)	246	163	163	92.7	92.7
r_x (in)=	6.71	6.43	6.43	6.22	6.22
r_y (in)=	4.13	4.02	4.02	3.73	3.73
L (ft)=Lx (ft)=Ly (ft)=	17.6	14.2	14.2	14.2	14.2
kx=	1.0	1.0	1.0	1.0	1.0
ky=	1.0	1.0	1.0	1.0	1.0
(kl/r)x	31.5	26.5	26.5	27.4	27.4
(kL/r)Y	51.1	42.4	42.4	45.7	45.7

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

Column Compact Flange $b_f/2t_f$=	4.23	5.99	5.99	8.49	8.49
$(b/2t)_{max}=0.3(E/F_y)^{0.5}$=	7.22	7.22	7.22	7.22	7.22

$b_f/2t_f \le (b/2t)_{max}$=	Column OK	Column OK	Column OK	NO GOOD	NO GOOD	Columns at Upper Floors Noncompact
Column Compact Web $(d-2t_f)/t_w$=	10.7	15.2	15.2	24.0	24.0	
Ca = $P_u/\phi P_y$=	0.77	0.86	0.61	0.49	0.13	
$2.45\ (E/F_y)^{0.5}\ (1-0.93)C_a$=	16.8	11.6	25.8	31.9	51.6	
$0.77\ (E/F_y)0.5\ \ (2.93-C_a)$=	40.1	38.3	43.1	45.2	51.8	
$1.49\ (E/F_y)^{0.5}$=	35.9	35.9	35.9	35.9	35.9	
$(h/t_w)_{max}$	40.1	38.3	43.1	45.2	51.8	
$(d-2t_f)/t_w \le (h/t_w)_{max}$	Column OK	Column OK	Column OK	Column OK	Column OK	

AISC 360-05 Section D2 - Tension

ϕP_{nt} (kip)=	3402	2331	2331	1440	1440	AISC 360 Equation D2-1
DCR=	0.50	0.58	0.41	0.32	0.09	
	Column OK	Column OK	Column OK	Column OK	Column OK	

AISC 360-05 Section E - Compression

F_e (ksi)=	109.45	159.30	159.30	137.14	137.14	AISC 360-05 Equaltion E3-4
F_{cr} (ksi)=	41.3	43.8	43.8	42.9	42.9	AISC 360-05 Equaltion E3-2 or E3-3
$\phi_c P_{nc}$ (kip)=	2810	2044	2044	1236	1236	AISC 360-05 Equaltion E3-1
DCR=	0.93	0.98	0.69	0.58	0.16	
	Column OK	Column OK	Column OK	Column OK	Column OK	

Summary of Results for ASCE 7-05

from John Egan, Table 1 for UCSF BRBs

ASCE 7-05 SDS 0.9 — from I8 above

Brace			Level 2	Level 3	Level 4	Level 5	PH Floor	Max DCR		Axial Compression
	ASCE 7-05	DCR	0.44	0.45	0.46	0.43	0.35	0.46		All OK
Beam										Compression + Flexure
	ASCE 7-05	DCR	0.63	0.60	0.49	0.59	0.44	0.63		All OK
Column										Compression
	ASCE 7-05	DCR	0.93	0.98	0.69	0.58	0.16	0.98		All OK

Summary Comparison ASCE 7-05 to Current ASCE 7-16

ASCE 7-16 BSE-1NS	1.3		from John Egan, Table 1 for UCSF BRBs
ASCE 7-05 SDS	0.9		from I8 above
Ratio ASCE 7-16/ASCE 7-05		1.44	

Brace			Level 2	Level 3	Level 4	Level 5	PH Floor			Axial Compression
	ASCE 7-05	DCR	0.44	0.45	0.46	0.43	0.35			All OK
	ASCE 7-16	DCR	0.63	0.65	0.67	0.63	0.51			All OK
Beam										Compression + Flexure
	ASCE 7-05	DCR	0.63	0.60	0.49	0.59	0.44			All OK
	ASCE7-16	DCR	0.91	0.87	0.71	0.86	0.64			All OK
Column										Compression
	ASCE 7-05	DCR	0.93	0.98	0.69	0.58	0.16			All OK
	ASCE 7-16	DCR	1.34	1.42	1.00	0.83	0.23			Fails, Lower 2 Floors