FORTRESS
Structural Engineering

acme
construction supply co., Inc.

Structural Details and Calculations
Generator Exhaust Support

ENGINEERS NORTHWEST, INC. is not responsible for this design or performance of this product.

ENGINEERS NORTHWEST, INC. has reviewed the applied loads only for conformance to the construction documents and has reviewed absolutely nothing else

CAR 08-10-2020
Date By

Costco Building-5 Garage

755 Lake Dr,
Issaquah, WA 98027

Prepared for:
Holaday-Parks, Inc.
On:
July 28, 2020
Job No.
20118

MARCUS KWAME ODEN
STATE OF WASHINGTON
54690
REGISTERED
PROFESSIONAL ENGINEER

1885 The Alameda, Suite 201 ▪ San Jose, CA 95126 ▪ Phone: 408.841.4848 ▪ www.fortressse.com

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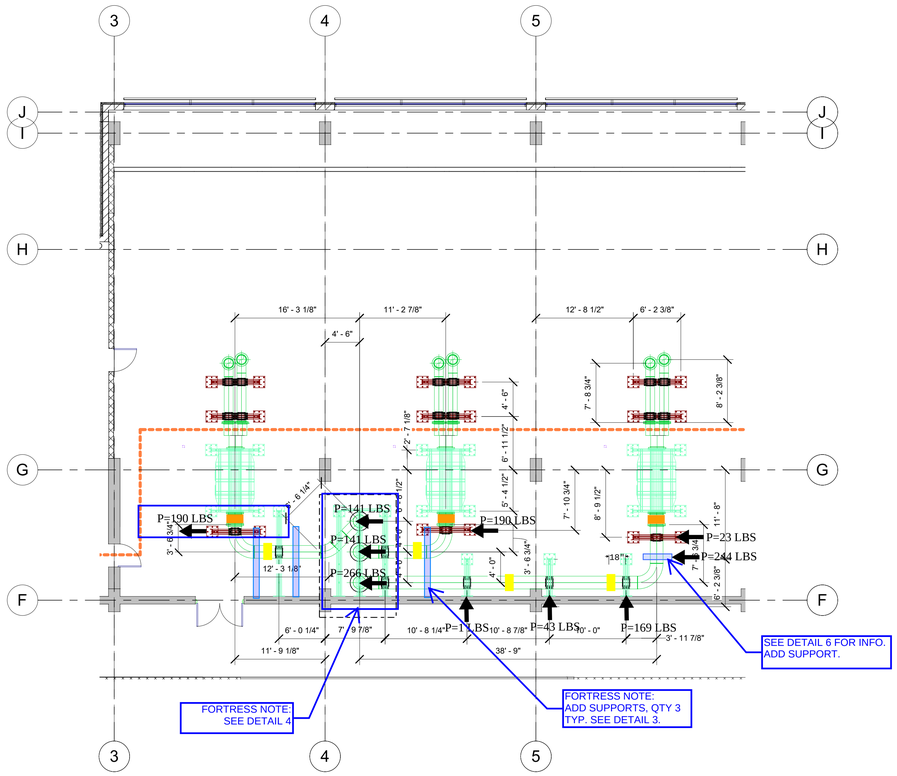
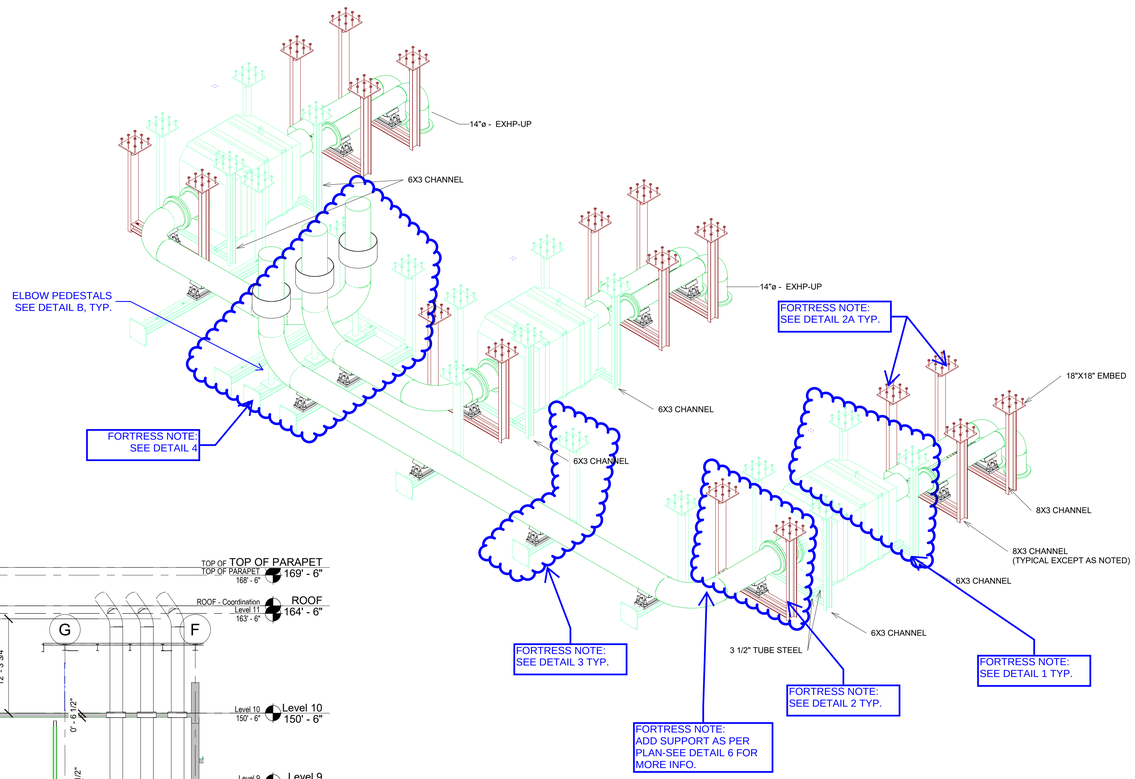
Costco Generator Exhaust Supports

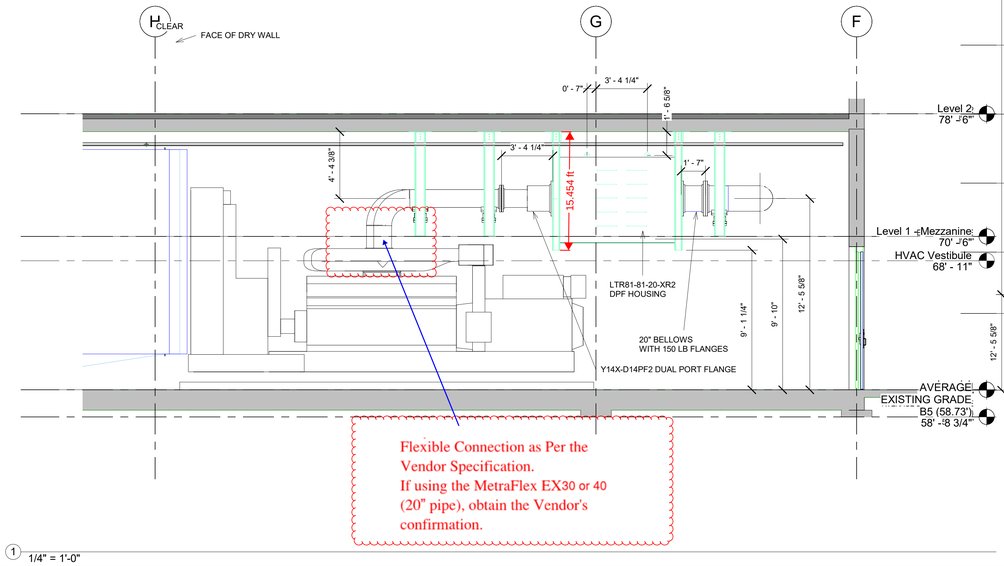


3 1/8" = 1'-0"

Note:
Expansion Bellows only shown on View 3 for horizontal pipe.
Bellows shown on View 4 for vertical pipe

Expansion Joint Bellow Legend
- Metraflex EX402000
- Metraflex EX302000





1 1/4" = 1'-0"

4 1/8" = 1'-0"

LOCATION PLAN FOR REFERENCE ONLY

HOLADAY-PARKS, INC.
SMART Mechanical Solutions©
Mechanical Contracting ● Service
Building Automation Systems
4600 S. 134TH PLACE
SEATTLE, WA 98168 ● (206) 248-9700
WWW.HOLADAYPARKS.COM
WA LICENSE NUMBER: HOLADPI379N0

PROJECT

COSTCO BLDG-5 GARAGE

DESIGN TEAM

Designed by: Designer
Drawn by: Author
Approved by: Approver
Job Number:
Filename:

REGISTRATION

NOT APPROVED
FOR CONSTRUCTION

ISSUE NAME/DATE

SUBMITTAL

3/6/2020 3:41:05 PM

REVISIONS

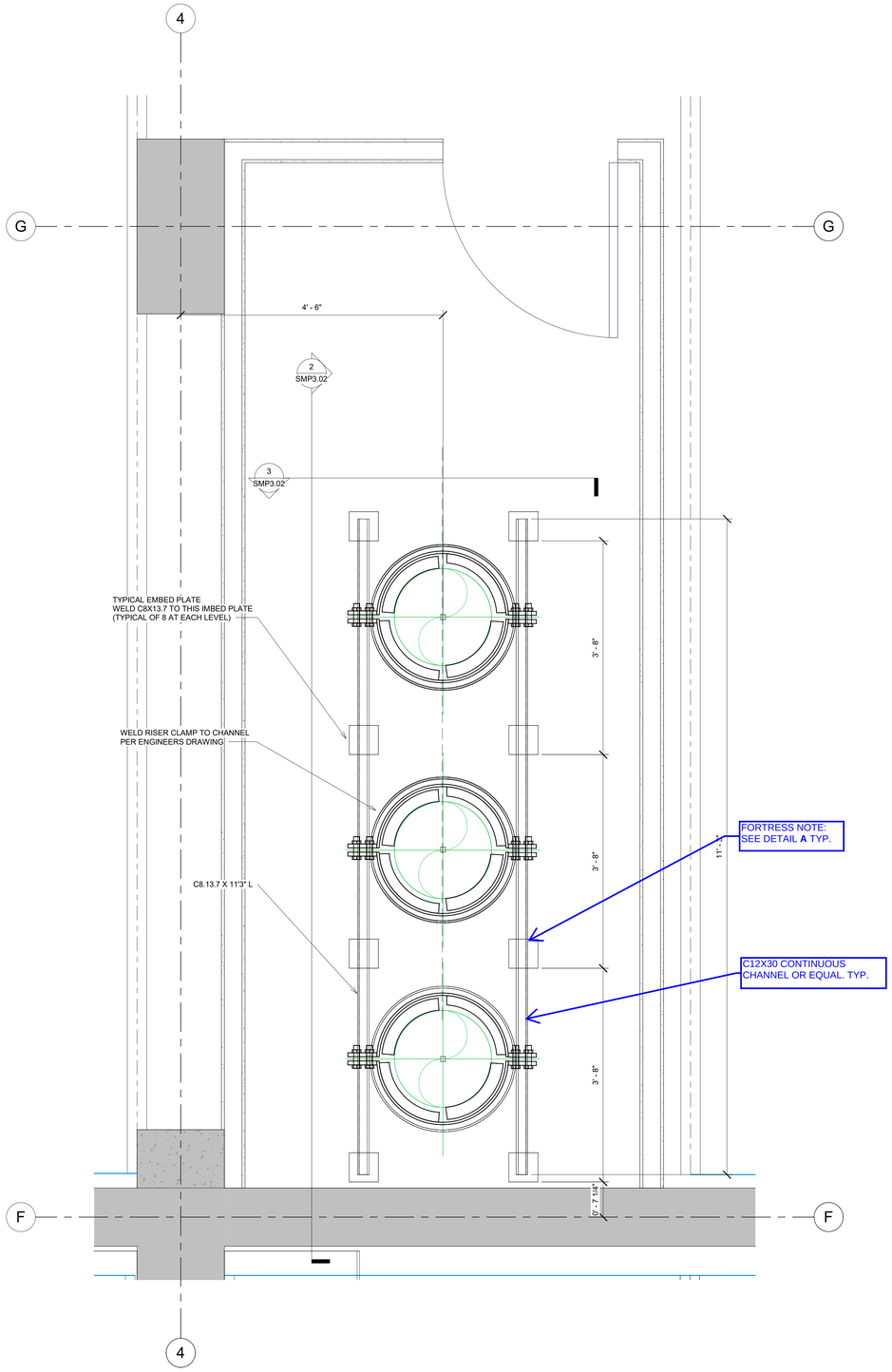
No.	Date	By	Description
A	3/6/20	MH	SUBMITTAL

SHEET TITLE

LEVEL 1 SOUTH
SUBMITTAL EXHAUST
ROUTING SUPPORT

SHEET NUMBER

SMP4.01EXH



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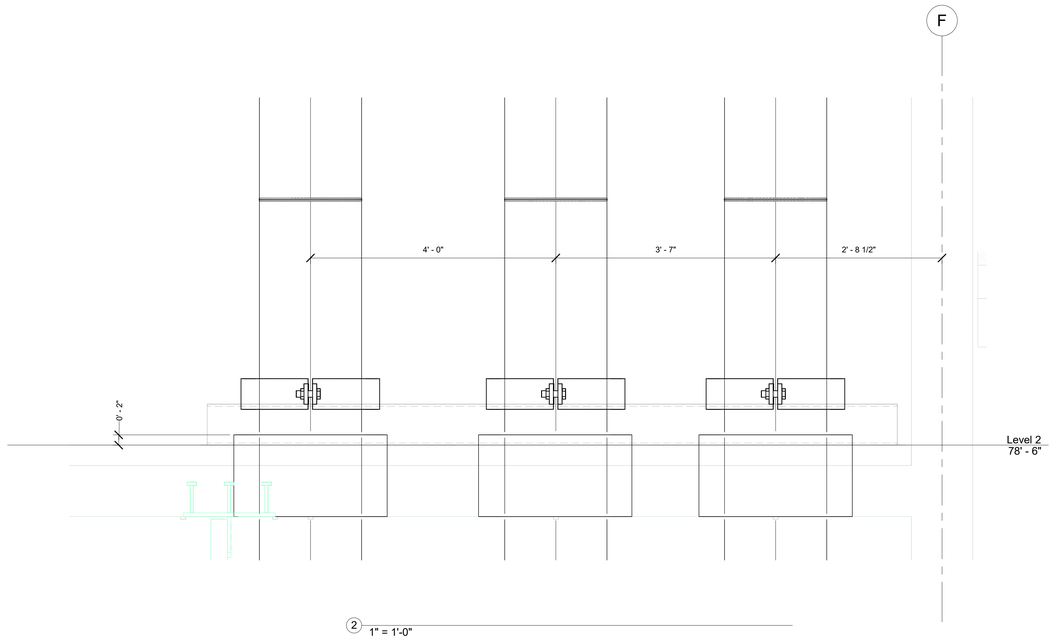

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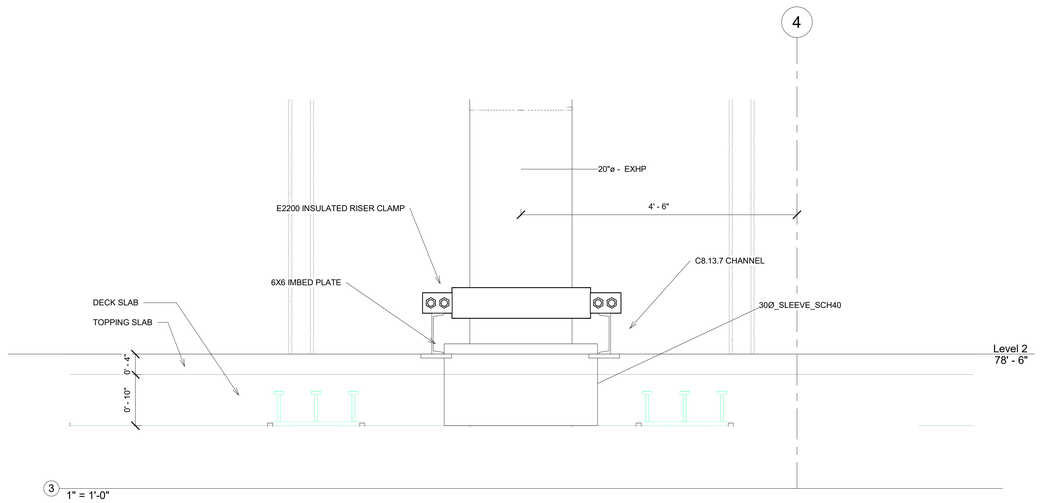


3 1" = 1'-0"

LOCATION PLAN FOR REFERENCE ONLY

HOLADAY-PARKS, INC.
SMART Mechanical Solutions©
Mechanical Contracting ● Service
Building Automation Systems
4600 S. 134TH PLACE
SEATTLE, WA 98168 ● (206) 248-9700
WWW.HOLADAYPARKS.COM
WA LICENSE NUMBER: HOLADPI379N0

PROJECT

COSTCO BLDG-5 GARAGE

DESIGN TEAM

Designed by: Designer
Drawn by: Author
Approved by: Approver
Job Number:
Filename:

REGISTRATION

NOT APPROVED
FOR CONSTRUCTION

ISSUE NAME/DATE

SUBMITTAL

4/14/2020 2:48:45 PM

REVISIONS

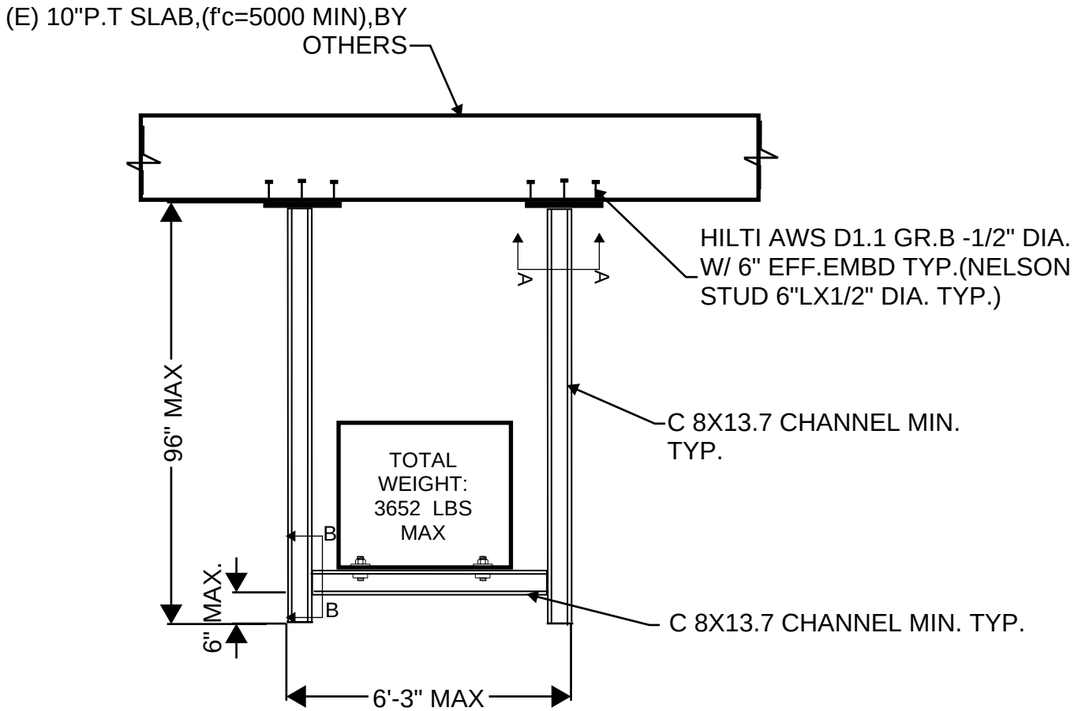
No.	Date	By	Description

SHEET TITLE

EXHAUST RISER CLAMP DETAIL

SHEET NUMBER

SMP3.02



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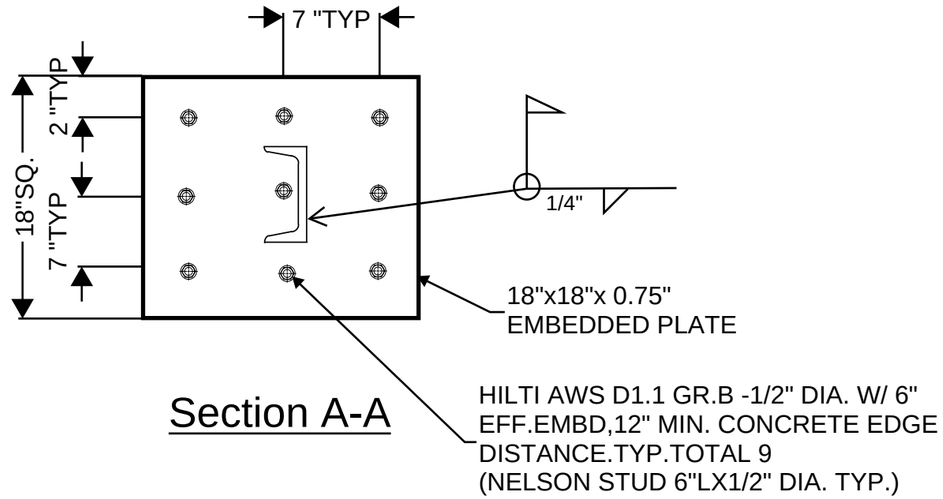
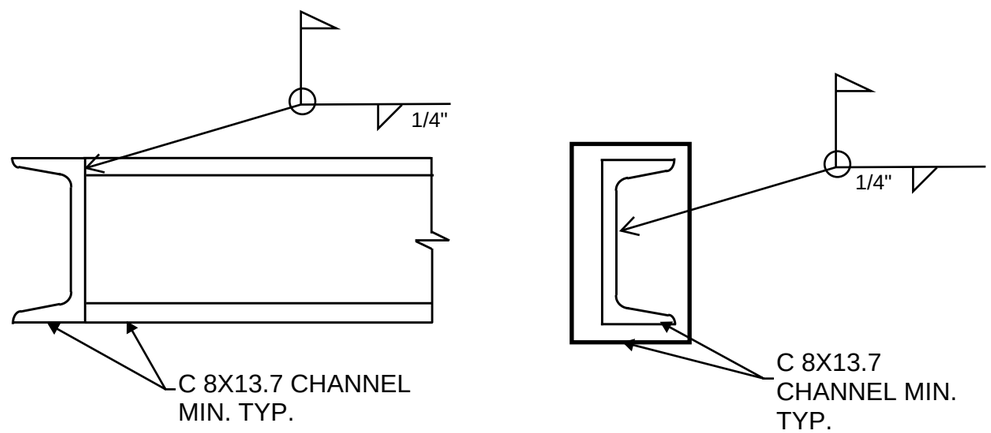


Section A-A

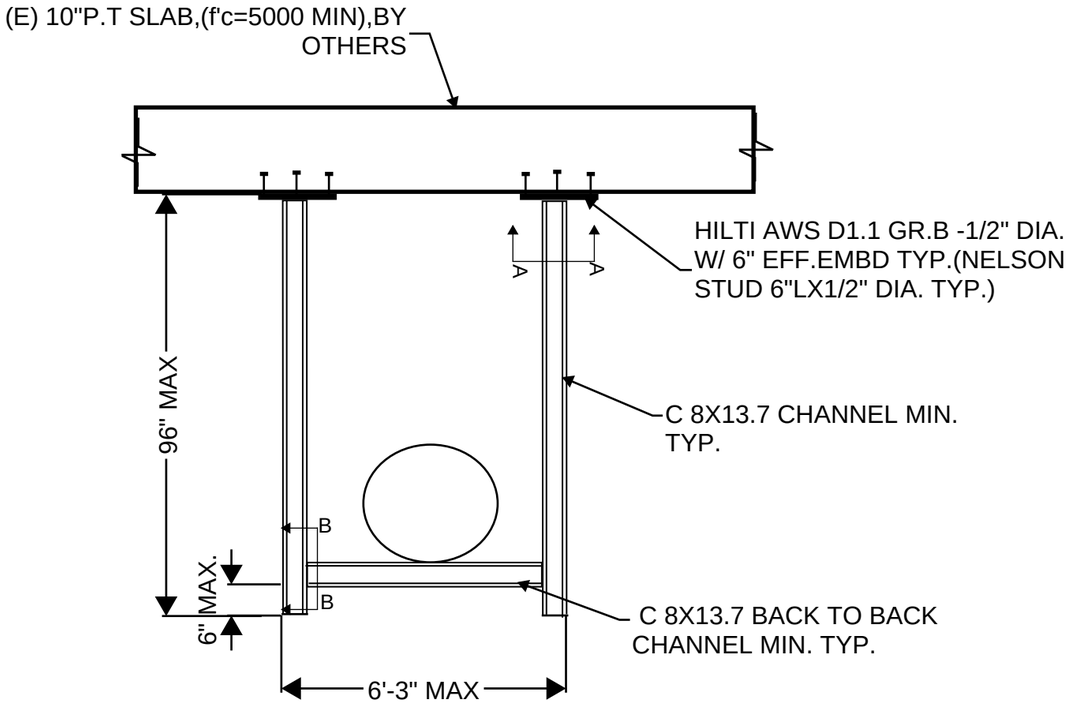


Section B-B

NOTES:
1) MIN. TWO RACKS NEEDED TO SUPPORT FILTER.
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS AND WEIGHT BEFORE CONSTRUCTION.
3) EACH SUPPORT CAN ALSO CARRY 150 LBS FLANGE WEIGHT, 20" STEEL PIPE(123 PLF MAX.)-5'-0" TRIBUTARY. WEIGHT AND METRAFLEX EX402000 WEIGHT.

1 RIGID RACK -SUPPORT FOR FILETER

N.T.S.



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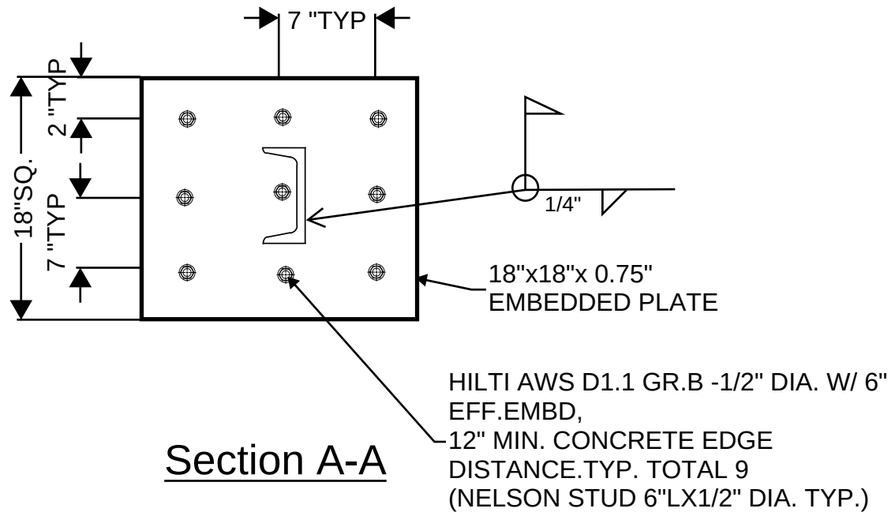
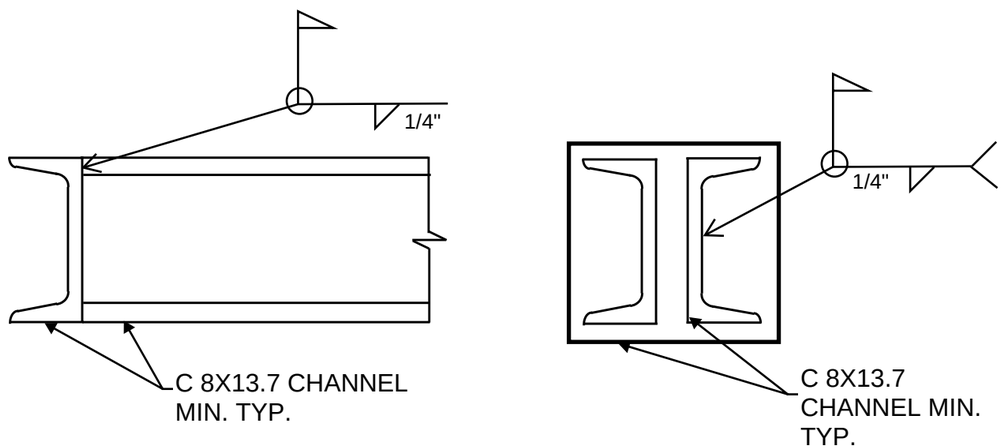


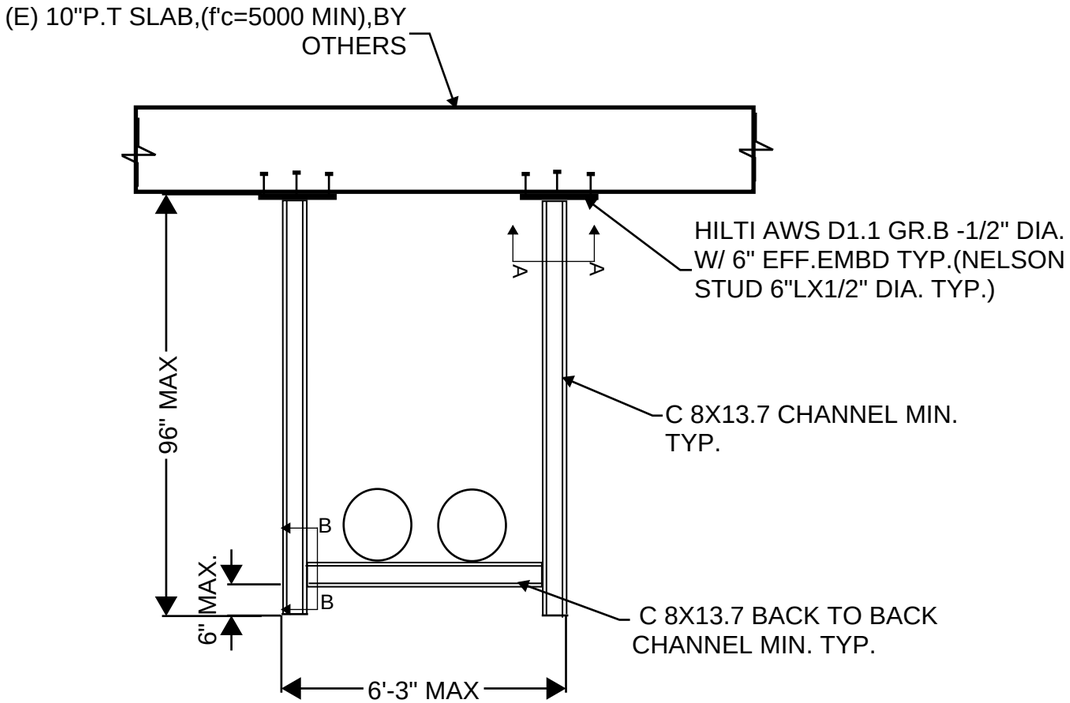
Section A-A



Section B-B

NOTES:
1) SUPPORT SPACING = 10'-0" MAX
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
3) DESIGN IS APPLICABLE FOR (1) 20" STEEL PIPE WITH 3" INSULATION (123 PLF MAX/PIPE) , 506 LBS FOR 90 DEGREE FITTING(IF REQUIRED),(2)150 LBS FLANGE WEIGHT (IF REQUIRED) AND METRAFLEX EX402000 WEIGHT .
4) FOR ROLLER SUPPORT SEE DETAIL 5.

2 RIGID RACK -SUPPORT FOR 20" STEEL PIPE
N.T.S.



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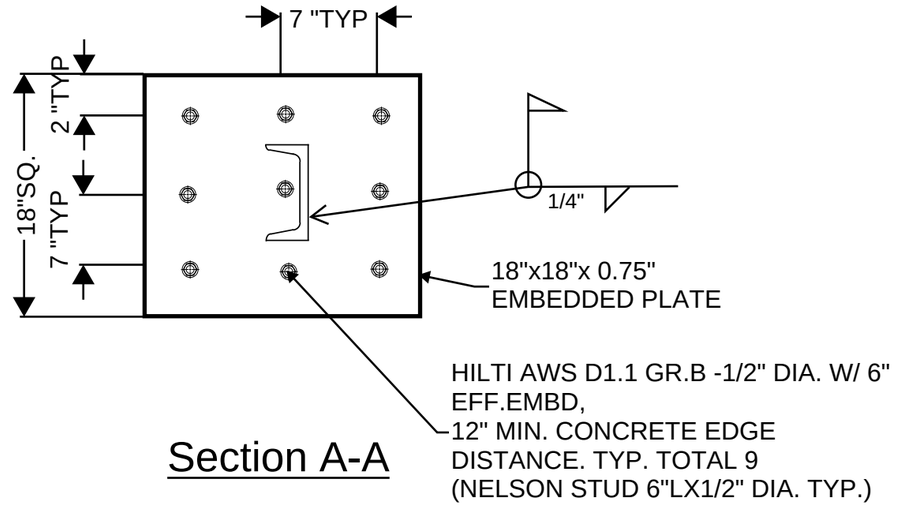

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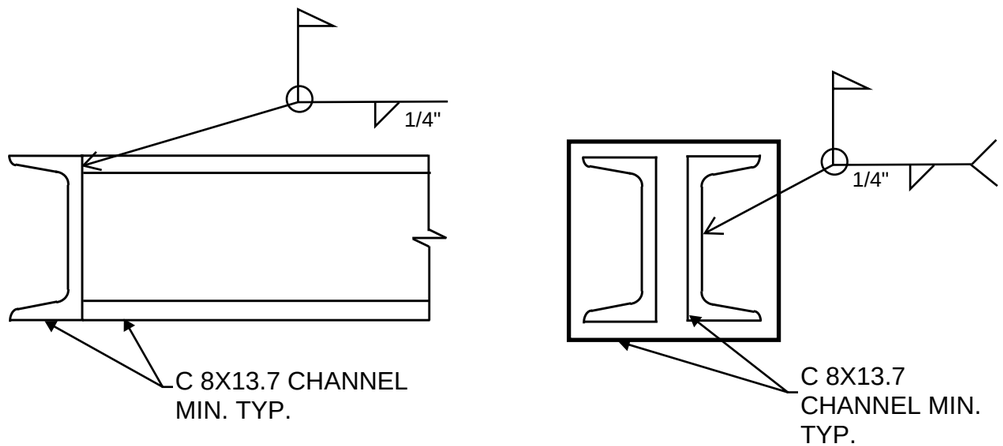
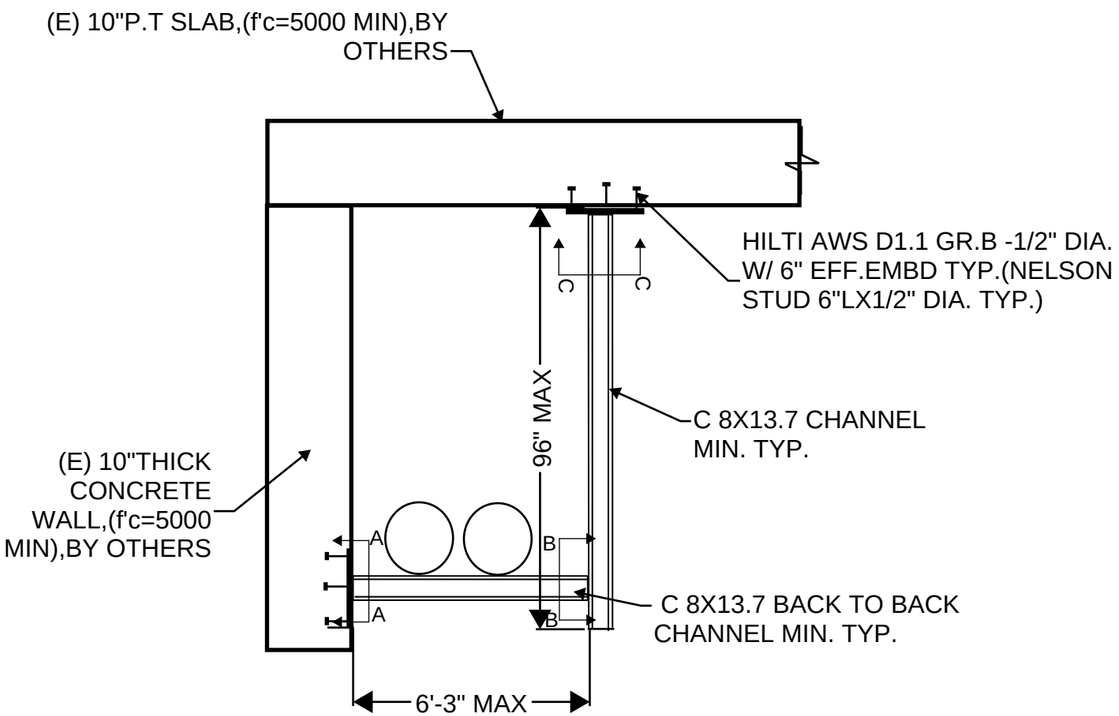


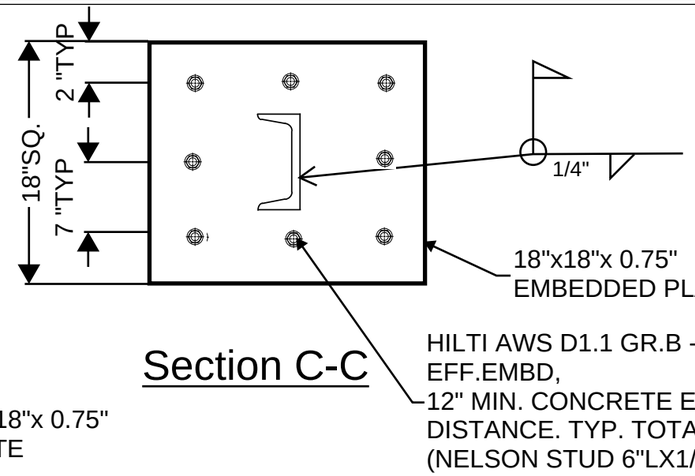
Section B-B

NOTES:
1) SUPPORT SPACING = 7'-0" MAX
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
3) DESIGN IS ONLY APPLICABLE FOR MAX. (2) 20" STEEL PIPE WITH 3" INSULATION (123 PLF MAX/PIPE), 506 LBS FOR 90 DEGREE FITTING(IF REQUIRED) AND (2)150 LBS FLANGE WEIGHT (IF REQUIRED).
4) FOR ROLLER SUPPORT SEE DETAIL 5.

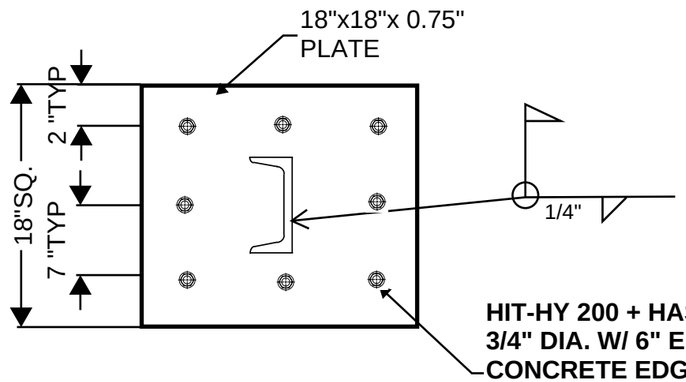
2A RIGID RACK -SUPPORT FOR 20" STEEL PIPE
N.T.S.



Elevation



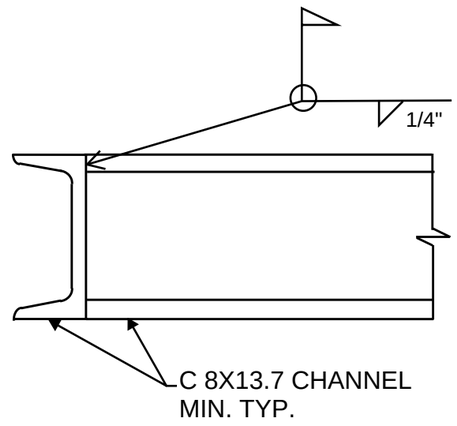
Section C-C



Section A-A- WALL

NOTES:
1) SUPPORT SPACING = 10**'-0" MAX**
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
3) DESIGN IS ONLY APPLICABLE FOR (2) 20" STEEL PIPE WITH 3" INSULATION (123 PLF MAX/PIPE) ,506 LBS FOR 90 DEGREE FITTING(IF REQUIRED), AND (2)150 LBS FLANGE WEIGHT (IF REQUIRED)
4) FOR ROLLER SUPPORT SEE DETAIL 5.

3 RIGID RACK FOR 20" STEEL PIPE -ATTACHED TO WALL AND CEILING
N.T.S.



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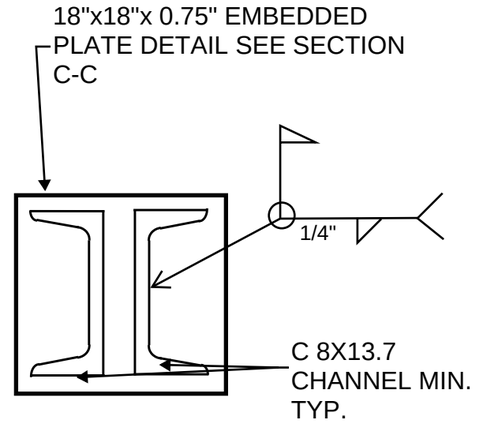
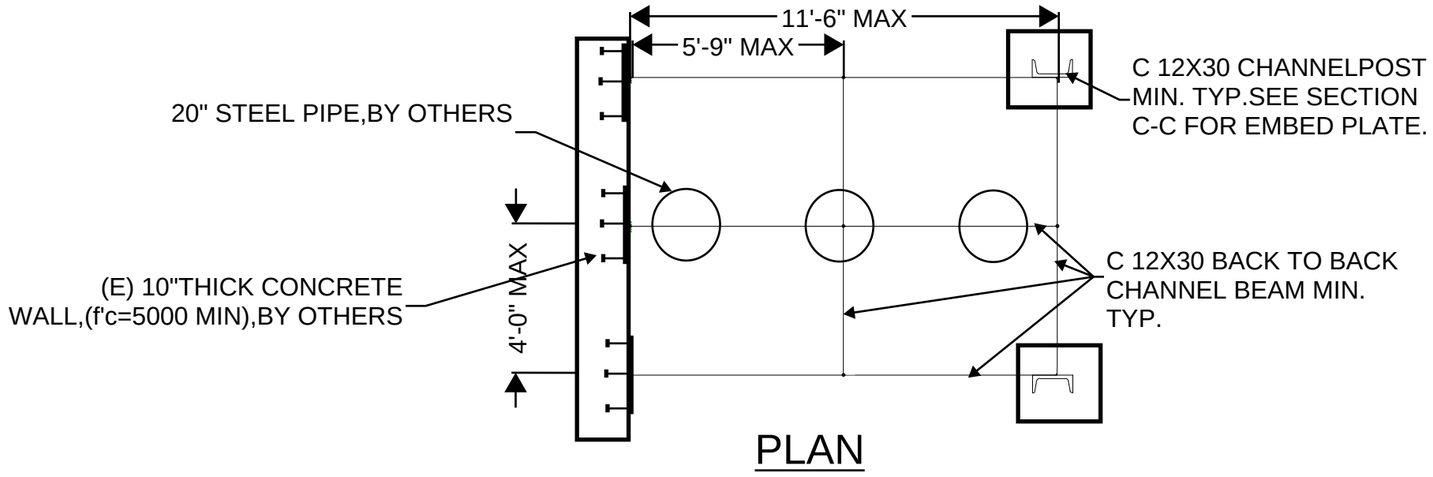
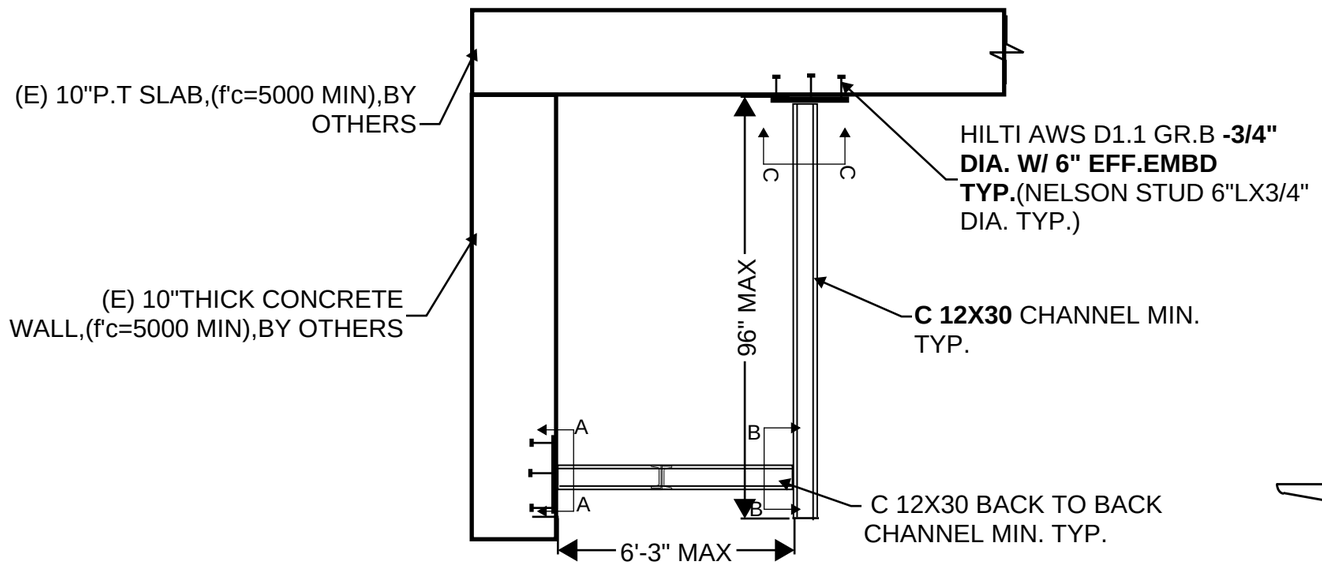


Section A-A-WELD



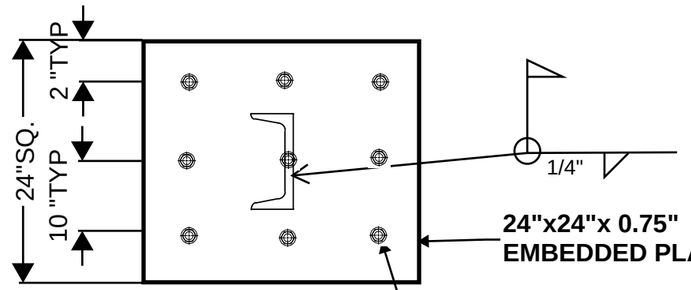
PLAN



Elevation

NOTES:
1) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
2) DESIGN IS ONLY APPLICABLE FOR (3) 20" STEEL PIPE WITH 3" INSULATION (123 PLF MAX/PIPE) AND 506 LBS FOR 90 DEGREE FITTING(IF REQUIRED) .
3) FOR ROLLER SUPPORT SEE DETAIL 5.

4 FOR 20" STEEL PIPE -ATTACHED TO WALL AND CEILING
N.T.S.



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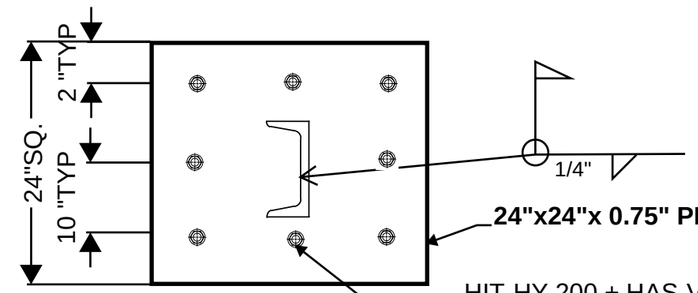
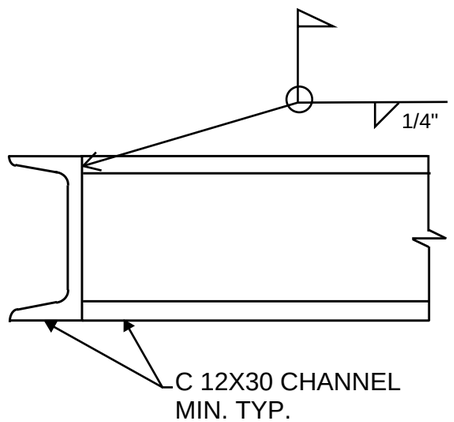
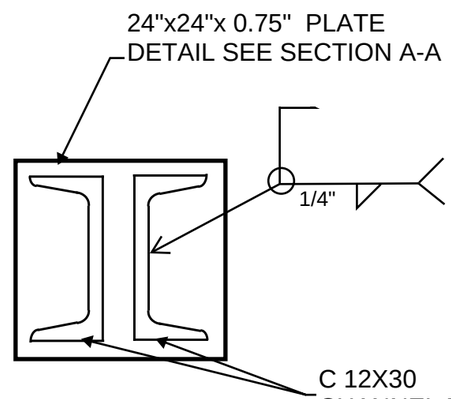


Section A-A- WALL



Section B-B



Section A-A WELD

B3117SL Steel Roller Stand (TOLCO Fig.327)

Size Range: 2" (50mm) thru 42" (1067mm)

Material: Cast Iron Roller and Steel Base

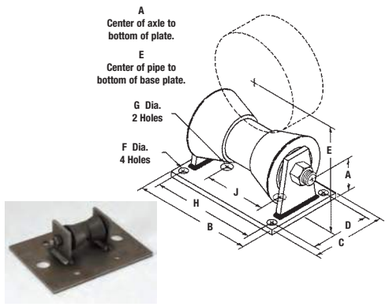
Function: Designed to support pipe where movement may occur due to thermal expansion. When used with insulated pipe, see B3160-B3165 pipe covering protection saddle charts for proper sizing on pages 155 thru 160.

Approvals: Conforms to Federal Specification WW-H-171E & A-A-1192A, Type 45 and Manufacturers Standardization Society ANSI/MSS SP-69 & SP-58, Type 44.

Standard Finish: Plain, Available in Electro-Galvanized and HDG finish or Stainless Steel material

Order By: Part number and finish.

Notes: If using D.I. pipe refer to page 298 for sizing. Non-metallic rollers with stainless steel stand and hardware are available for most sizes (B3117SLNM-Pipe Size). Contact B-Line Engineering for more information. Not for continuous cycling applications.



Part No.	Pipe Size in.	Pipe Size (mm)	A in.	A (mm)	B in.	B (mm)	C in.	C (mm)	D in.	D (mm)	E in.	E (mm)
B3117SL-2 to 3 1/2	2"	(50)	1 3/4"	(44.4)	8 3/8"	(212.7)	6"	(152.4)	4"	(101.6)	3 11/16"	(93.7)
	2 1/2"	(65)	1 3/4"	(44.4)	8 3/8"	(212.7)	6"	(152.4)	4"	(101.6)	3 15/16"	(100.0)
	3"	(80)	1 3/4"	(44.4)	8 3/8"	(212.7)	6"	(152.4)	4"	(101.6)	4 1/4"	(107.9)
	3 1/2"	(90)	1 3/4"	(44.4)	8 3/8"	(212.7)	6"	(152.4)	4"	(101.6)	4 1/2"	(114.3)
B3117SL-4 to 6	4"	(100)	2 1/16"	(52.4)	9 7/8"	(250.8)	6"	(152.4)	4 1/4"	(107.9)	5"	(127.0)
	5"	(125)	2 1/16"	(52.4)	9 7/8"	(250.8)	6"	(152.4)	4 1/4"	(107.9)	5 9/16"	(141.3)
	6"	(150)	2 1/16"	(52.4)	9 7/8"	(250.8)	6"	(152.4)	4 1/4"	(107.9)	6 1/16"	(154.0)
B3117SL-8 to 10	8"	(200)	3 7/16"	(87.3)	8 5/8"	(219.1)	8"	(203.2)	5"	(127.0)	8 13/16"	(223.8)
	10"	(250)	3 7/16"	(87.3)	8 5/8"	(219.1)	8"	(203.2)	5"	(127.0)	9 7/8"	(250.8)
B3117SL-12 to 14	12"	(300)	3 7/8"	(98.4)	10 15/16"	(277.8)	8"	(203.2)	6"	(152.4)	11 7/16"	(290.5)
	14"	(350)	3 7/8"	(98.4)	10 15/16"	(277.8)	8"	(203.2)	6"	(152.4)	12 1/16"	(306.4)
B3117SL-16 to 20	16"	(400)	4 1/4"	(107.9)	12 3/8"	(314.3)	10"	(254.0)	6 1/2"	(165.1)	13 5/8"	(346.1)
	18"	(450)	4 1/4"	(107.9)	12 3/8"	(314.3)	10"	(254.0)	6 1/2"	(165.1)	14 11/16"	(373.1)
	20"	(500)	4 1/4"	(107.9)	12 3/8"	(314.3)	10"	(254.0)	6 1/2"	(165.1)	15 11/16"	(398.5)
B3117SL-24	24"	(600)	4 3/8"	(111.1)	13 1/2"	(342.9)	10"	(254.0)	6 1/2"	(165.1)	17 11/16"	(449.3)
B3117SL-30	30"	(750)	5 1/8"	(130.2)	17"	(431.8)	10 3/4"	(273.0)	8"	(203.2)	21 3/4"	(552.4)
B3117SL-36 to 42	36"	(900)	5 3/4"	(146.0)	20"	(508.0)	12"	(304.8)	9"	(203.2)	25 5/16"	(642.9)
	42"	(1050)	5 3/4"	(146.0)	20"	(508.0)	12"	(304.8)	9"	(203.2)	28 5/16"	(719.1)

Part No.	Dia. F in.	Dia. F (mm)	Dia. G in.	Dia. G (mm)	H in.	H (mm)	J in.	J (mm)	Design Load Lbs.	Design Load (kN)	Approx. Wt./100 Lbs.	Approx. Wt./100 (kg)
B3117SL-2 to 3 1/2	1/2"	(12.7)	1"	(25.4)	3 7/16"	(87.3)	6 3/8"	(161.9)	390	(1.73)	508	(230.4)
B3117SL-4 to 6	1/2"	(12.7)	1"	(25.4)	4 11/16"	(119.1)	7 7/8"	(200.0)	950	(4.22)	631	(286.2)
B3117SL-8 to 10	5/8"	(15.9)	1"	(25.4)	7"	(177.8)	4"	(101.6)	2100	(9.34)	1271	(576.5)
B3117SL-12 to 14	3/4"	(19.0)	1"	(25.4)	9 1/16"	(230.2)	5 3/4"	(146.0)	3075	(13.68)	1994	(904.5)
B3117SL-16 to 20	13/16"	(20.6)	1"	(25.4)	10 1/4"	(260.3)	6 3/4"	(171.4)	4980	(22.15)	3423	(1552.7)
B3117SL-24	13/16"	(20.6)	1"	(25.4)	11 3/8"	(288.9)	7 1/2"	(190.5)	6100	(27.13)	4710	(2136.4)
B3117SL-30	1 1/16"	(27.0)	1"	(25.4)	14 1/4"	(361.9)	10"	(254.0)	7500	(33.36)	7132	(3235.1)
B3117SL-36 to 42	1 3/16"	(30.2)	1"	(25.4)	17"	(431.8)	12"	(304.8)	12000	(53.37)	10386	(4711.1)

B3118SL Adjustable Roller Stand with Base Plate (TOLCO Fig.328)

Size Range: 2" (50mm) thru 30" (750mm)

Material: Cast Iron Roller and Steel Base

Function: Designed to support pipe where movement may occur due to thermal expansion. Set screws allow for vertical adjustment. When used with insulated pipe, see B3160-B3165 pipe covering protection saddle charts for proper sizing on pages 155 thru 160.

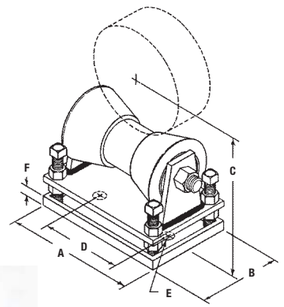
Approvals: Conforms to Federal Specification WW-H-171E & A-A-1192A, Type 47 and Manufacturers Standardization Society ANSI/MSS SP-69 & SP-58, Type 46.

Finish: Plain, Available in Electro-Galvanized and HDG finish or Stainless Steel material

Order by: Part number and finish.

Notes: If using D.I. pipe refer to page 298 for sizing. Non-metallic rollers with stainless steel stand and hardware are available for most sizes (B3118SLNM-Pipe Size). Contact B-Line Engineering for more information. Not for continuous cycling applications.

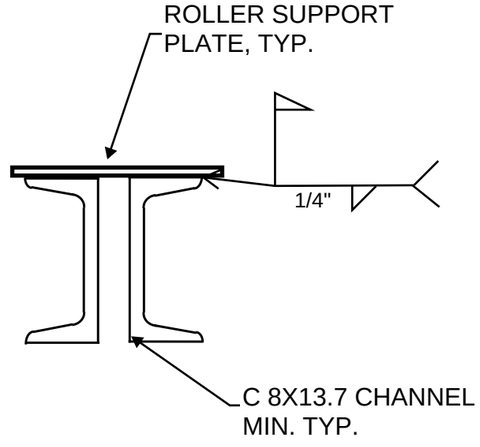
C
Center of pipe to bottom of base plate.
D
Center to center of mounting holes in bottom plate.
E Dia.
Mounting holes in bottom plate.



Part No.	Pipe Size in.	Pipe Size (mm)	A in.	A (mm)	B in.	B (mm)	Minimum C in.	Minimum C (mm)	Maximum C in.	Maximum C (mm)	D in.	D (mm)
B3118SL-2 to 3 1/2	2"	(50)	6 7/8"	(174.6)	6"	(152.4)	4 3/4"	(120.6)	5 5/8"	(142.9)	3 7/8"	(98.4)
	2 1/2"	(65)	6 7/8"	(174.6)	6"	(152.4)	5"	(127.0)	5 7/8"	(142.9)	3 7/8"	(98.4)
	3"	(80)	6 7/8"	(174.6)	6"	(152.4)	5 5/16"	(134.9)	6 3/16"	(157.2)	3 7/8"	(98.4)
	3 1/2"	(90)	6 7/8"	(174.6)	6"	(152.4)	5 9/16"	(141.3)	6 7/16"	(163.5)	3 7/8"	(98.4)
B3118SL-4 to 6	4"	(100)	8 1/8"	(206.4)	6"	(152.4)	6 3/16"	(157.2)	7 7/16"	(188.9)	5 1/8"	(130.2)
	5"	(125)	8 1/8"	(206.4)	6"	(152.4)	6 3/4"	(171.4)	8"	(203.2)	5 1/8"	(130.2)
	6"	(150)	8 1/8"	(206.4)	6"	(152.4)	7 1/4"	(184.1)	8 1/2"	(215.9)	5 1/8"	(130.2)
B3118SL-8 to 10	8"	(200)	10 5/8"	(269.9)	8"	(203.2)	10 1/8"	(257.2)	11 11/16"	(296.9)	7 3/8"	(187.3)
	10"	(250)	10 5/8"	(269.9)	8"	(203.2)	11 3/16"	(284.2)	12 3/4"	(323.8)	7 3/8"	(187.3)
B3118SL-12 to 14	12"	(300)	13"	(330.2)	8"	(203.2)	12 3/4"	(323.8)	14 1/8"	(358.8)	9 1/2"	(241.3)
	14"	(350)	13"	(330.2)	8"	(203.2)	13 3/8"	(339.7)	14 3/8"	(365.1)	9 1/2"	(241.3)
B3118SL-16 to 20	16"	(400)	14 5/8"	(371.5)	10"	(254.0)	15 3/8"	(390.5)	17 1/4"	(438.1)	11 1/8"	(282.6)
	18"	(450)	14 5/8"	(371.5)	10"	(254.0)	16 3/8"	(415.9)	18 1/4"	(463.5)	11 1/8"	(282.6)
	20"	(500)	14 5/8"	(371.5)	10"	(254.0)	17 3/8"	(441.3)	19 1/4"	(488.9)	11 1/8"	(282.6)
B3118SL-24	24"	(600)	15 3/4"	(400.0)	10"	(254.0)	19 1/4"	(488.9)	21 1/4"	(539.7)	12 1/4"	(311.1)
B3118SL-30	30"	(750)	19 1/4"	(488.9)	10 1/2"	(266.7)	24 7/16"	(620.7)	26 11/16"	(677.9)	15 3/4"	(400.0)

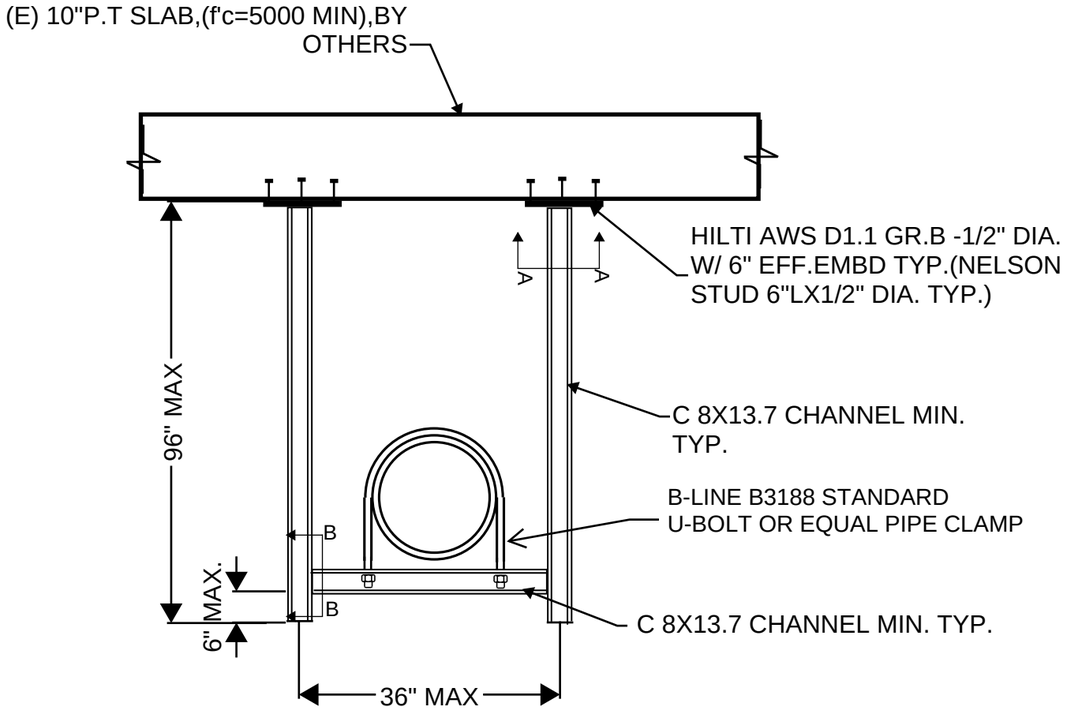
Part No.	E in.	E (mm)	F in.	F (mm)	Design Load Lbs.	Design Load (kN)	Approx. Wt./100 Lbs.	Approx. Wt./100 (kg)
B3118SL-2 to 3 1/2	1"	(25.4)	1"	(25.4)	390	(1.73)	1100	(498.9)
B3118SL-4 to 6	1"	(25.4)	1"	(25.4)	950	(4.22)	1310	(594.2)
B3118SL-8 to 10	1"	(25.4)	1 1/8"	(28.6)	2100	(9.34)	2725	(1236.0)
B3118SL-12 to 14	1"	(25.4)	1 1/8"	(28.6)	3075	(13.68)	3612	(1638.4)
B3118SL-16 to 20	1"	(25.4)	1 1/4"	(31.7)	4980	(22.15)	6384	(2895.8)
B3118SL-24	1"	(25.4)	1 3/8"	(34.9)	6100	(27.13)	8437	(3827.0)
B3118SL-30	1"	(25.4)	1 5/8"	(41.3)	7500	(33.36)	12528	(5682.7)

NOTES:
1) USE B117SL OR B118SL OR EQUAL TYP.

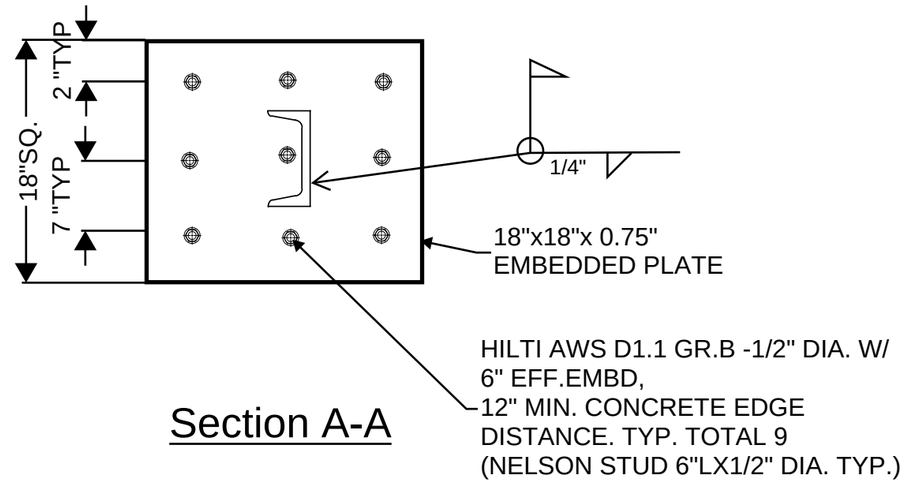


Section B-B

5 ROLLER STAND TO RIGID RACK ATTACHED
N.T.S.

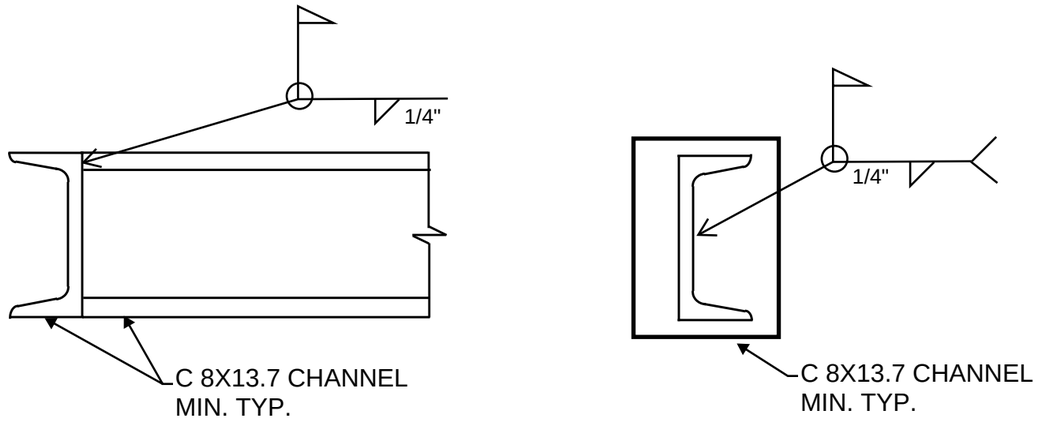


Elevation



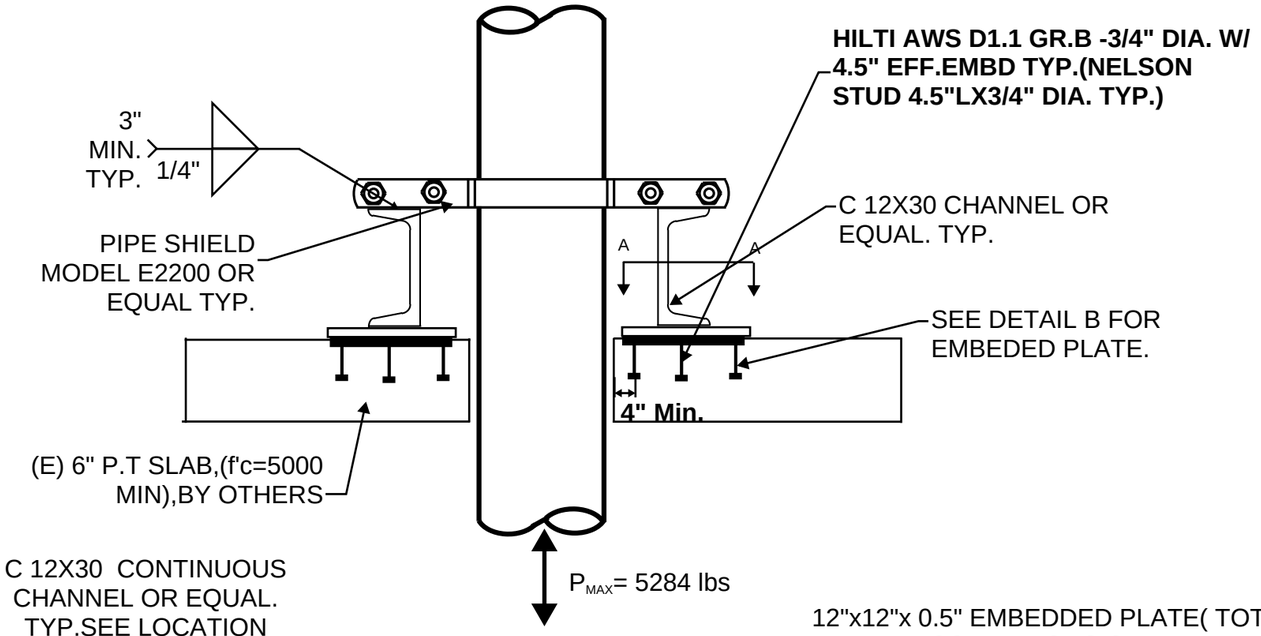
Section A-A

NOTES:
1) SUPPORT SPACING = 10**'-0" MAX**
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
3) DESIGN IS ONLY APPLICABLE FOR (1) 20" STEEL PIPE WITH 3" INSULATION (123 PLF MAX/PIPE) AND 506 LBS FOR 90 DEGREE FITTING(IF REQUIRED) .

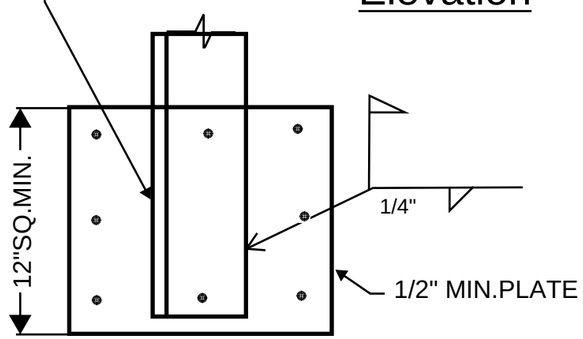


Section B-B

6 RIGID RACK -SUPPORT FOR 20" STEEL PIPE
N.T.S.

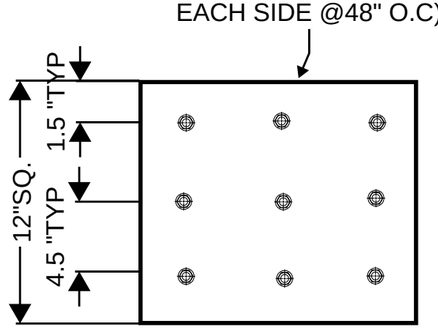


Elevation



Section A-A

12"x12"x 0.5" EMBEDDED PLATE(TOTAL
4 -PER CONTINUOUS CHANNEL-AT
EACH SIDE @48" O.C)



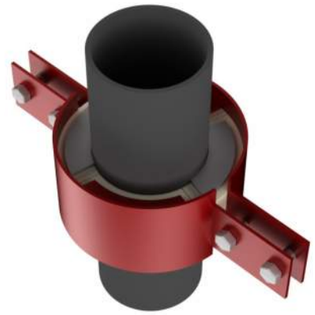
Detail B

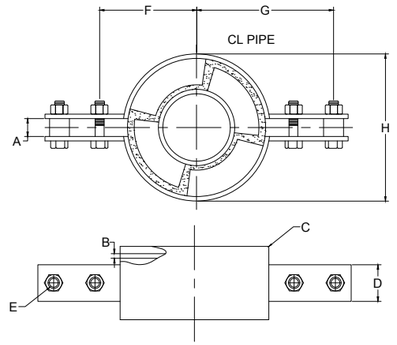
NOTES:

1) **BOLTS ON CLAMP ARE ONLY TO BE SNUG TIGHT AT ALL LEVELS, EXCEPT LEVEL 4, AND 8 SO THAT PIPE CAN SLIDE THRU CLAMP. LEVEL 4 AND 8, CLAMP IS TO BE TIGHTENED PER MANUFACTURER INSTRUCTION.**
2) **CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.**
3) DESIGN IS ONLY APPLICABLE FOR (3) 20" STEEL PIPE (123 PLF MAX/PIPE).
4) THE FIRST EMBEDDED PLATE ANCHORAGE EDGE DISTANCE HAS TO BE 7" MIN. FROM THE WALL.

A RISER SUPPORT ANCHOR DETAIL AT ALL LEVELS
N.T.S.

Model E2200, Model E2210,
Model E2220, Model E2230 *Insulated Pipe Riser Clamps for Upward or Downward Loads*





a) If thrust plate thickness "B" is greater than pipe wall thickness, consult factory.

b) One pair thrust plates supplied loose for field welding, top only.

Note: For higher load ratings, see: E2200. Available in all insulation thickness.

Pipe Size	Load lbs	A	B	C	D	E	Insul. Thk. = 1" F	G	H	Insul. Thk. = 2" F	G	H	Insul. Thk. = 3" F	G	H	Insul. Thk. = 4" F	G	H
2	750	0.63	0.38	0.38 x 3.00	1.50	0.625	3.94	6.19	5.38	5.00	7.25	7.5	6.00	8.25	9.5	7.06	9.31	11.63
2 1/2	900	0.63	0.38	0.38 x 3.00	1.50	0.625	4.19	6.44	5.88	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63
3	1200	0.63	0.38	0.38 x 3.00	1.50	0.625	4.47	6.72	6.44	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63
4	1800	0.63	0.38	0.38 x 3.00	1.50	0.625	5.00	7.25	7.5	6.00	8.25	9.5	7.06	9.31	11.63	8.06	10.31	13.63
5	2400	0.63	0.38	0.38 x 4.00	2.00	0.625	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63	8.69	10.94	14.88
6	3000	0.63	0.38	0.38 x 4.00	2.00	0.625	6.00	8.25	9.5	7.06	9.31	11.63	8.06	10.31	13.63	9.19	11.44	15.88
8	3900	0.63	0.50	0.50 x 4.00	2.00	0.625	7.31	9.81	11.88	8.31	10.81	13.88	9.44	11.94	16.13	10.44	12.94	18.13
10	4800	0.88	0.50	0.50 x 5.00	3.00	0.625	8.31	10.81	13.88	9.44	11.94	16.13	10.44	12.94	18.13	11.44	13.94	20.13
12	5100	0.88	0.50	0.50 x 5.00	3.00	0.625	9.44	11.94	16.13	10.44	12.94	18.13	11.44	13.94	20.13	12.44	14.94	22.13
14	6000	0.88	0.50	0.50 x 5.00	3.00	0.75	10.06	12.69	17.13	11.06	13.69	19.13	12.06	14.69	21.13	13.06	15.69	23.13
16	6900	0.88	0.50	0.50 x 6.00	4.00	0.75	11.06	13.69	19.13	12.06	14.69	21.13	13.06	15.69	23.13	14.06	16.69	25.13
18	7500	0.88	0.50	0.50 x 6.00	4.00	0.75	12.06	14.69	21.13	13.06	15.69	23.13	14.06	16.69	25.13	15.06	17.69	27.13
20	8100	0.88	0.50	0.50 x 6.00	4.00	0.75	13.06	15.69	23.13	14.06	16.69	25.13	15.06	17.69	27.13	16.06	18.69	29.13
24	8400	0.88	0.50	0.50 x 6.00	4.00	0.75	15.06	17.69	27.13	16.06	18.69	29.13	17.06	19.69	31.13	18.06	20.69	33.13

Application:

Model E2200 through E2230 is designed for use on:

- Hot water
- Cold water
- Chilled water
- Dual temperature
- Steam
- Air
- Gas
- Vacuum

Intended for installation on:

- Vertical runs of insulated pipe with upward and/or downward load.

Other:

- For handling downward loads only, see E1200

Temperature Range: +40°F to +1200°F
Note: Up to 1800°F available upon request.

Features:

- All pipe sizes
- Easy installation
- Positive stop - axially upward or downward
- May be supported from below or above
- Overlapping galvanized sheet metal jacket
- Insulating structural inserts for load transfer
- Other I.D.'s and/or O.D.'s Available on Request
- Eliminates condensation sweating on chilled water risers

Performance Test Results on File:
Available upon request.

Material Data:

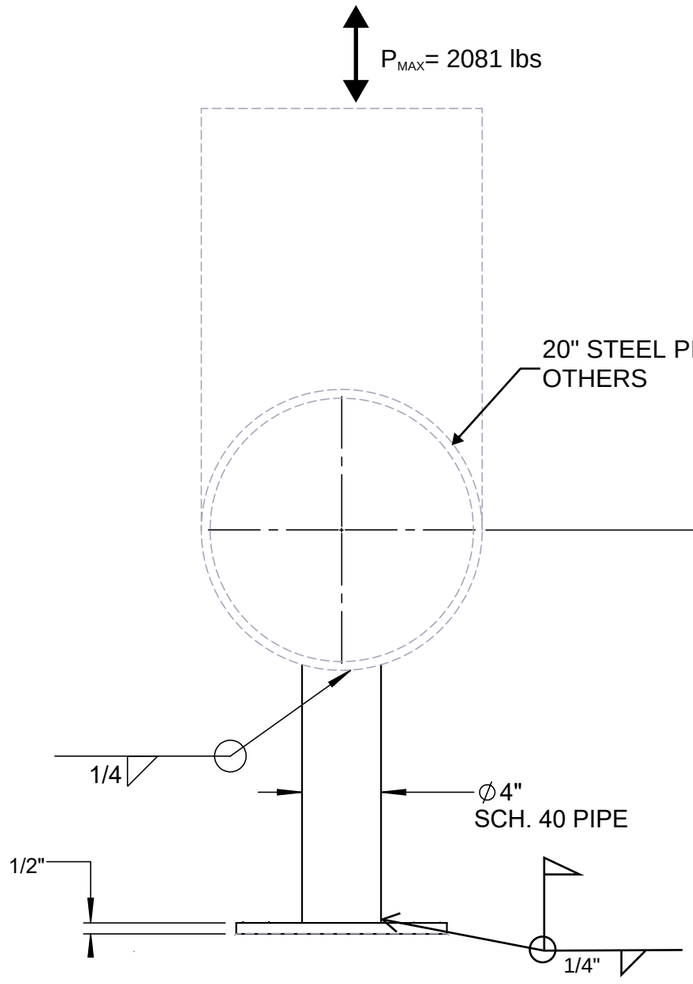
- **E2200 - E2230:** specification document: No. 209.
- **Steel Inner Thrust Plates**:

Model	ASTM	For Pipe Material
E2200	A36	Carbon-Steel
E2210	A387GR.11	Chrome-Moly
E2220	A515GR.70	Carbon Silicon
E2230	A304L	Stainless Steel

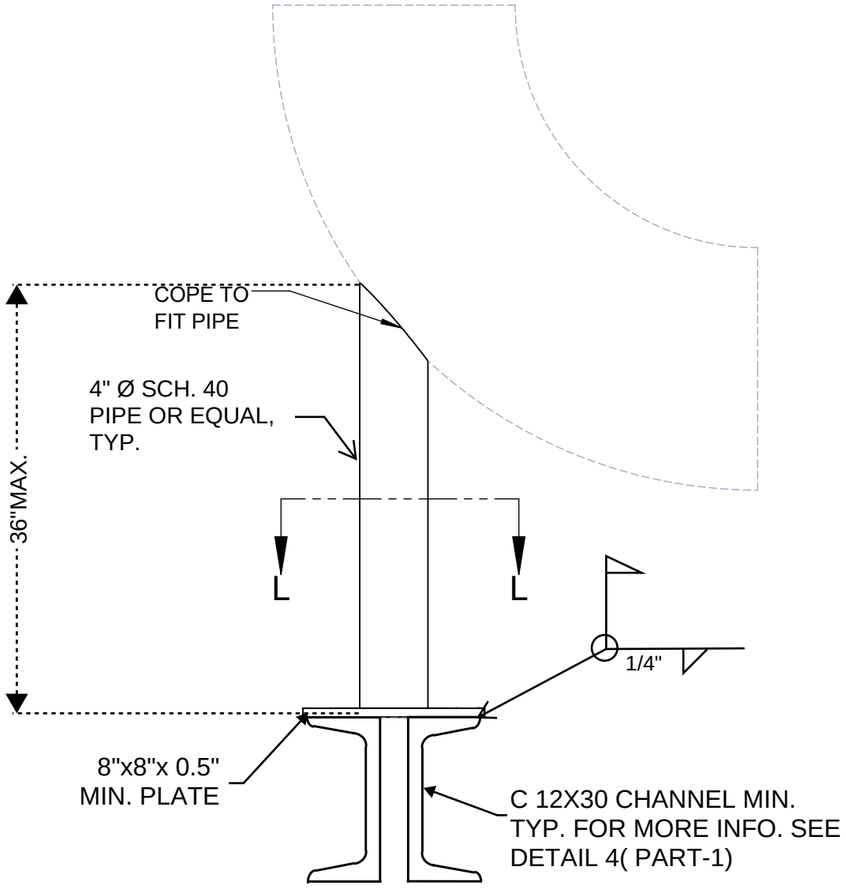
- Insulation: Calcium silicate asbestos-free, treated with water repellant.
- Jackets: Galvanized steel ASTM A-653.
- Glue: Industrial contact adhesive
- Structural Inserts: High-density calcium silicate asbestos free, treated with water repellant.
- Steel Straps/Base:Carbon steel ASTM A-36.
- Fasteners: ASTM A-307 plated.
- Coating: Primer coated or hot dipped galvanized
- Other coatings available upon request.

Formal submittal sheets available

www.pipeshields.com/e2200



Elevation



Side Elevation

NOTES:
1) LATERAL SUPPORT = 13'-0" MAX TRIBUTARY .
2) CONTRACTOR TO VERIFY ALL FINAL DIMENSIONS BEFORE CONSTRUCTION.
3) DESIGN IS ONLY APPLICABLE FOR (1) 20" STEEL PIPE (123 PLF MAX/PIPE).

B STANCHION PIPES SUPPORT
N.T.S.

SUPPORT-1
CONTROLS SUPPORT-2,2A AND 6
(DETAIL 1 , 2, 2A AND 6)

FORTRESS
Structural Engineering

Support 1(Worst Case)-Controls Support 2 AND 2A and 6

1. Seismic Design Criteria

Governing Code CBC 2016/ ASCE 7-10

$a_p := 2.5$ $R_p := 2.5$ (Table 13.6-1-Worst case)

$I_p := 1.5$ (Per S 0.01)

$S_{DS} := 0.634 = 0.634$ (Eq: 11.4-3)

$z := 18 \cdot ft$ (Location-Level 2)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Strength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p} \right)} \right) \cdot \left(1 + 2 \cdot \frac{z}{h} \right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$W1 := 3652 \ lbf = 3652 \ lbf$ (Filter Total weight-W/(2) Additional element=3652 lbs)

$W2 := 300 \ lbf = 300 \ lbf$ (Flange weight=150 /flange)

$W3 := 123 \ plf = 123 \ plf$ (20" steel pipe)

$b_1 := 10 \ ft$ (Max Tributary Dead Load on each support)

$W_{3t} := W3 \cdot b_1 = 1230 \ lbf$ (Weight on Support)

$W4 := 95 \ lbf = 95 \ lbf$ (Matraflex EX402000/EX302000-Worst case is 95 lbs))

$W_p := (0.5 \ (W1 + W2 + W_{3t})) + W4 = 2686 \ lbf$ (Total weight on each side Support of Filter: worst case)

$F_{pv1} := F_{pvc} \cdot W_p = 341 \ lbf$ (Vertical Seismic Load: Each support)

$F_{ph2} := F_{phc} \cdot W_p = 1375 \ lbf$ (Horizontal Seismic Load:)

$T := 190 \cdot lbf = 190 \ lbf$ (Horizontal Thermal Load max-worst case Both direction worst case)

$F_{ph} := T + F_{ph2} = 1565 \ lbf$ (Horizontal Force= Seismic+Thermal, as a worst case)

(As a worst case considered total horizontal force in both direction=Seismic +Thermal, anchorage calculated with over strength factor for total Horizontal Force)

(See Risa result)

Support 2(Case 1 Calculation Controls Case 2)

1. Seismic Design Criteria

Governing Code CBC 2016/ ASCE 7-10

$a_p := 2.5 \quad R_p := 2.5$ (Table 13.6-1-Worst case)

$I_p := 1.5$ (Per S 0.01)

$S_{DS} := 0.634 = 0.634$ (Eq: 11.4-3)

$z := 18 \cdot ft$ (Location-Level 2)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Stength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p} \right)} \right) \cdot \left(1 + 2 \cdot \frac{z}{h} \right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$W2 := 300 \ lbf = 300 \ lbf$ (Flange weight=150 /flange)

$W3 := 123 \ plf = 123 \ plf$ (20" steel pipe)

$W4 := 506 \ lbf = 506 \ lbf$ (90 degree fitting)

$b_1 := 10 \ ft$ (Max Tributary Dead Load on each support)

$W_{3t} := W3 \cdot b_1 = 1230 \ lbf$ (Weight on Support)

$W5 := 95 \ lbf = 95 \ lbf$ (Matraflex EX402000/EX302000-Worst case is 95 lbs))

$W_p := 1.1 \ (W2 + W_{3t} + W4 + W5) = 2344 \ lbf$ (Total weight on one Support of Filter: worst case)

$F_{pv1} := F_{pvc} \cdot W_p = 297 \ lbf$ (Vertical Seismic Load: Each support)

$F_{ph2} := F_{phc} \cdot W_p = 1200 \ lbf$ (Horizontal Seismic Load:)

$T := 190 \cdot lbf = 190 \ lbf$ (Horizontal Thermal Load max-worst case Both direction)

$F_{ph} := T + F_{ph2} = 1390 \ lbf$ (Horizontal Force Seismic+Thermal)

(As a worst case considered total horizontal force in both direction=Seismic +Thermal, anchorage calculated with over strength factor for total Horizontal Force)

(See support 1 Risa result as a worst case)

FORTRESS
Structural Engineering

Support 2A -(2) 20" Pipes(Case 1 Calculation Controls Case 2A)

1. Seismic Design Criteria

Governing Code CBC 2016/ ASCE 7-10

$a_p := 2.5$ $R_p := 2.5$ (Table 13.6-1-Worst case)

$I_p := 1.5$ (Per S 0.01)

$S_{DS} := 0.634 = 0.634$ (Eq: 11.4-3)

$z := 18 \cdot ft$ (Location-Level 2)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Stength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p} \right)} \right) \cdot \left(1 + 2 \cdot \frac{z}{h} \right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$W2 := 300\ lbf = 300\ lbf$ (Flange weight=150 /flange)

$W3 := 2 \cdot 123\ plf = 246\ plf$ (20" steel pipe)

$W4 := 506\ lbf = 506\ lbf$ (90 degree fitting)

$W5 := 95\ lbf = 95\ lbf$ (Matraflex EX402000/EX302000-Worst case is 95 lbs))

$b_1 := 7\ ft$ (Max Tributary Dead Load on each support)

$W_{3t} := W3 \cdot b_1 = 1722\ lbf$ (Weight on Support)

$W_p := W2 + W_{3t} + W4 + W5 = 2623\ lbf$ (Total weight on one Support of Filter: worst case)

$F_{pv1} := F_{pvc} \cdot W_p = 333\ lbf$ (Vertical Seismic Load: Each support)

$F_{ph2} := F_{phc} \cdot W_p = 1343\ lbf$ (Horizontal Seismic Load:)

$T := 190 \cdot lbf = 190\ lbf$ (Horizontal Thermal Load max-worst case Both direction)

$F_{ph} := T + F_{ph2} = 1533\ lbf$ (Horizontal Force Seismic+Thermal)

(As a worst case considered total horizontal force in both direction=Seismic +Thermal, anchorage calculated with over strength factor for total Horizontal Force)

(See support 1 Risa result as a worst case)

Support 6(Worst Case)-Detail 6 _Calculation Controls By support 1

1. Seismic Design Criteria

Governing Code CBC 2016/ ASCE 7-10

$a_p := 2.5 \quad R_p := 2.5$ (Table 13.6-1-Worst case)

$I_p := 1.5$ (Per S 0.01)

$S_{DS} := 0.634 = 0.634$ (Eq: 11.4-3)

$z := 18 \cdot ft$ (Location-Level 2)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Stength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p} \right)} \right) \cdot \left(1 + 2 \cdot \frac{z}{h} \right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$W1 := 123 \ plf = 123 \ plf$ (20" steel pipe)

$W2 := 506 \ lbf = 506 \ lbf$ (90 degree fitting)

$b_1 := 10 \ ft$ (Max Tributary Dead Load on each support)

$W_{1t} := W1 \cdot b_1 = 1230 \ lbf$ (Weight on Support)

$W5 := 95 \ lbf = 95 \ lbf$ (Matraflex EX402000/EX302000-Worst case is 95 lbs))

$W_p := 1.02 \ (W2 + W_{1t} + W5) = 1868 \ lbf$ (Total weight on one Support of Filter: worst case)

$F_{pv1} := F_{pvc} \cdot W_p = 237 \ lbf$ (Vertical Seismic Load: Each support)

$F_{ph2} := F_{phc} \cdot W_p = 956 \ lbf$ (Horizontal Seismic Load:)

$T := 244 \cdot lbf = 244 \ lbf$ (**Horizontal Thermal Load max-worst case Both direction**)

$T1 := T + F_{ph2} = 1200 \ lbf$ (Horizontal Force Seismic+Thermal)

(As a worst case considered total horizontal force in both direction=Seismic +Thermal, anchorage calculated with over strength factor for total Horizontal Force)

(See support 1 Risa result as a worst case)

3. Check B3188 Standard U-bolt

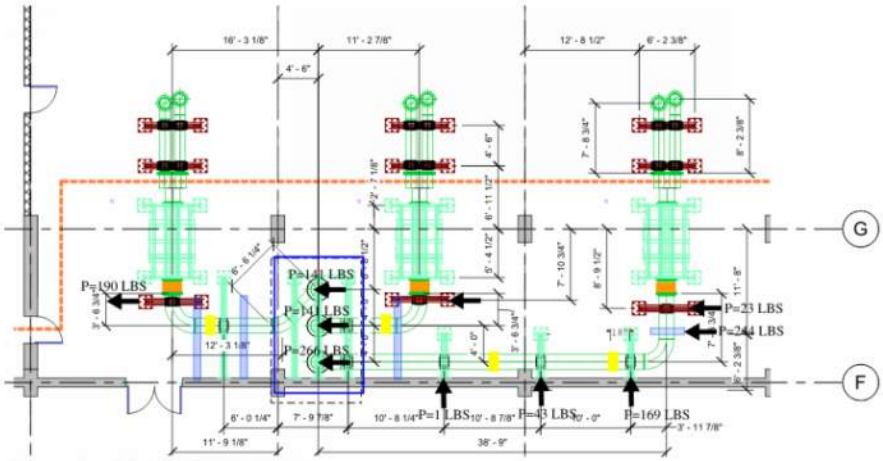
$P_d := T1 = 1200 \ lbf$ (Axial demand on brace)

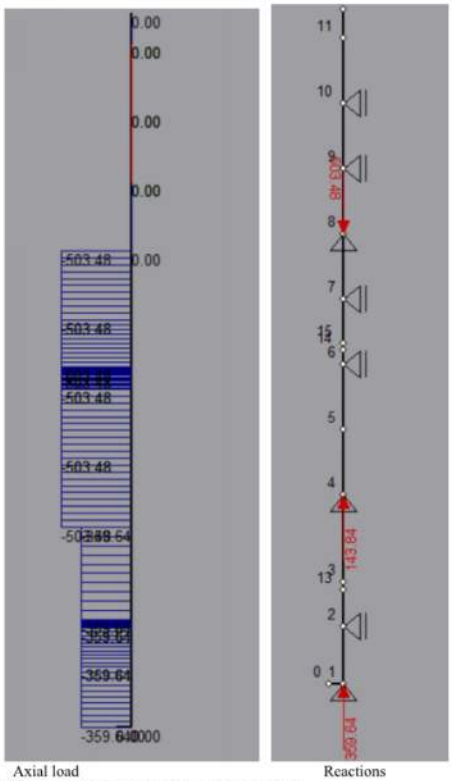
$P_c := 2490 \ lbf$ (Axial capacity: See Appendix)

$$DC := \frac{P_d}{P_c} = 0.48$$ (<1.0 OK, D/C Ratio)

Thermal load on each support: (see Thermal Calc for More info.)

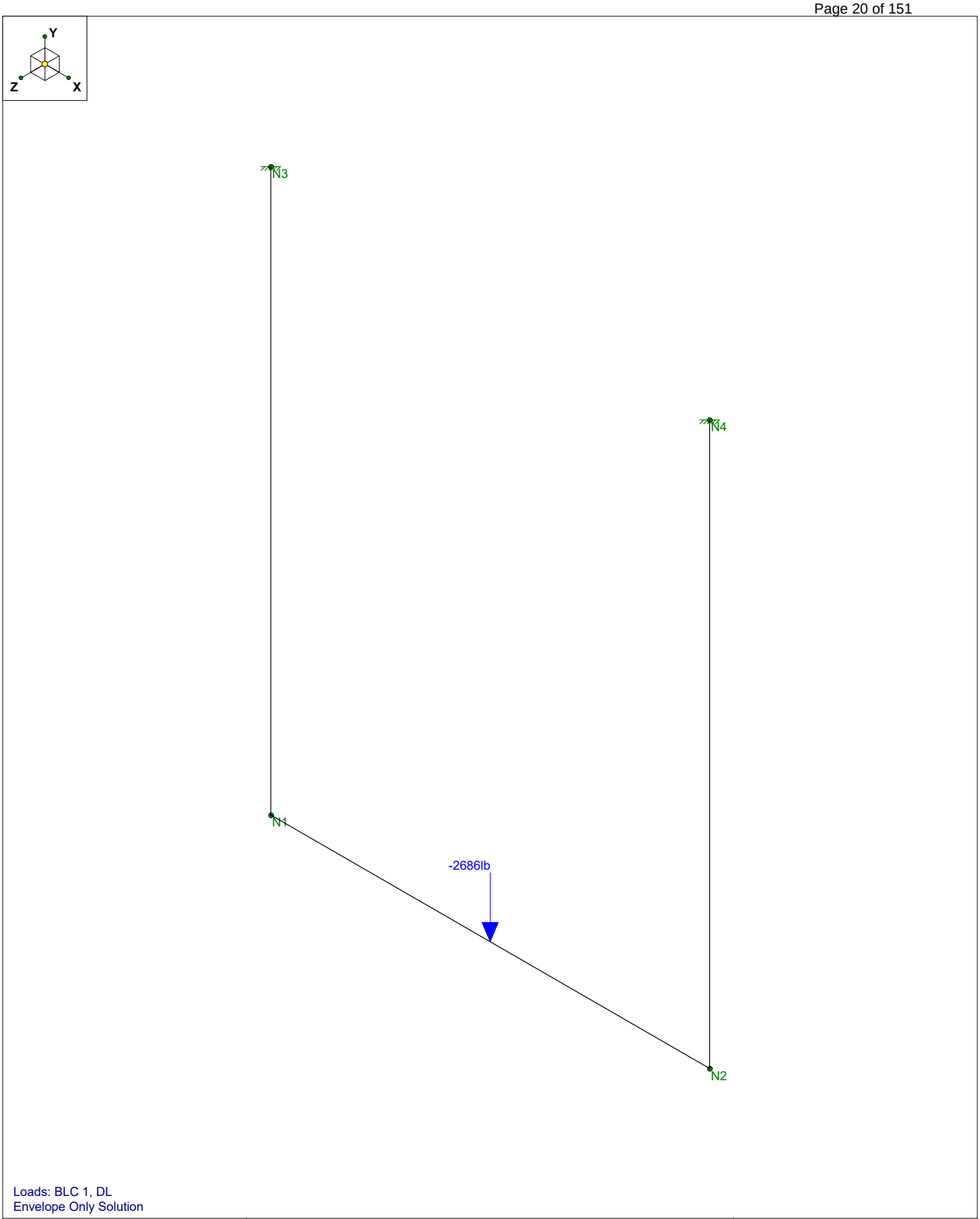
1- Location of the Bellows and the lateral support reaction is shown below:





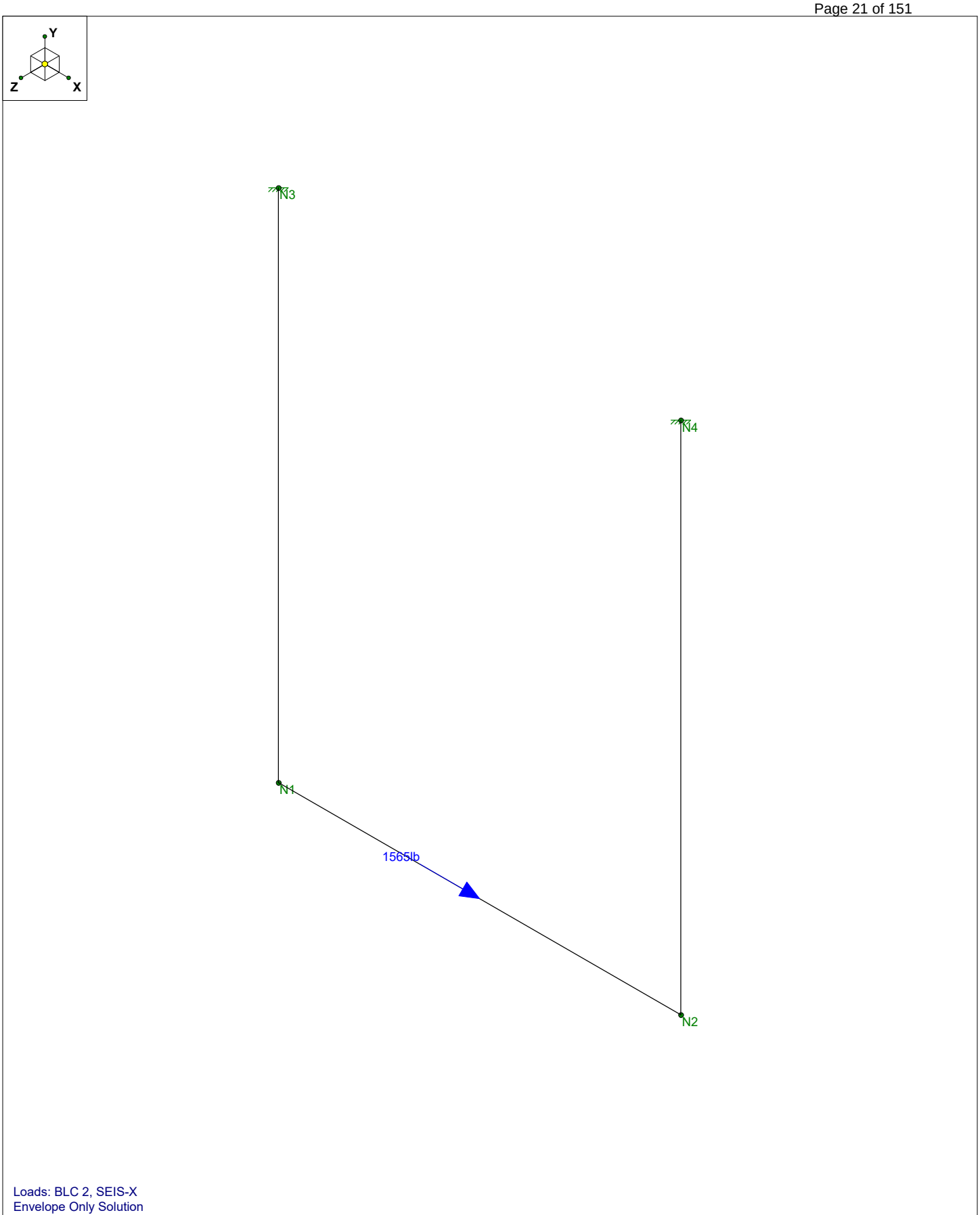
Axial load Reactions

Weight of the pipe=(47)'*123 = 5781 @ node 8
Support Reaction on the top (node #8)= 503.48 lbs + 5781 (Weight of the pipe.)= 5284.48 lbs
Weight of the pipe=(32)'*123 = 3936 @ node 4
Support Reaction on the top (node #4)= 143.84 lbs + 3936 (Weight of the pipe.)= 4079.84 lbs
Weight of the pipe=(14)'*123 = 1722 @ node 1
Support Reaction on the top (node #1)= 359.64 lbs + 1722 (Weight of the pipe.)= 2081.64 lbs



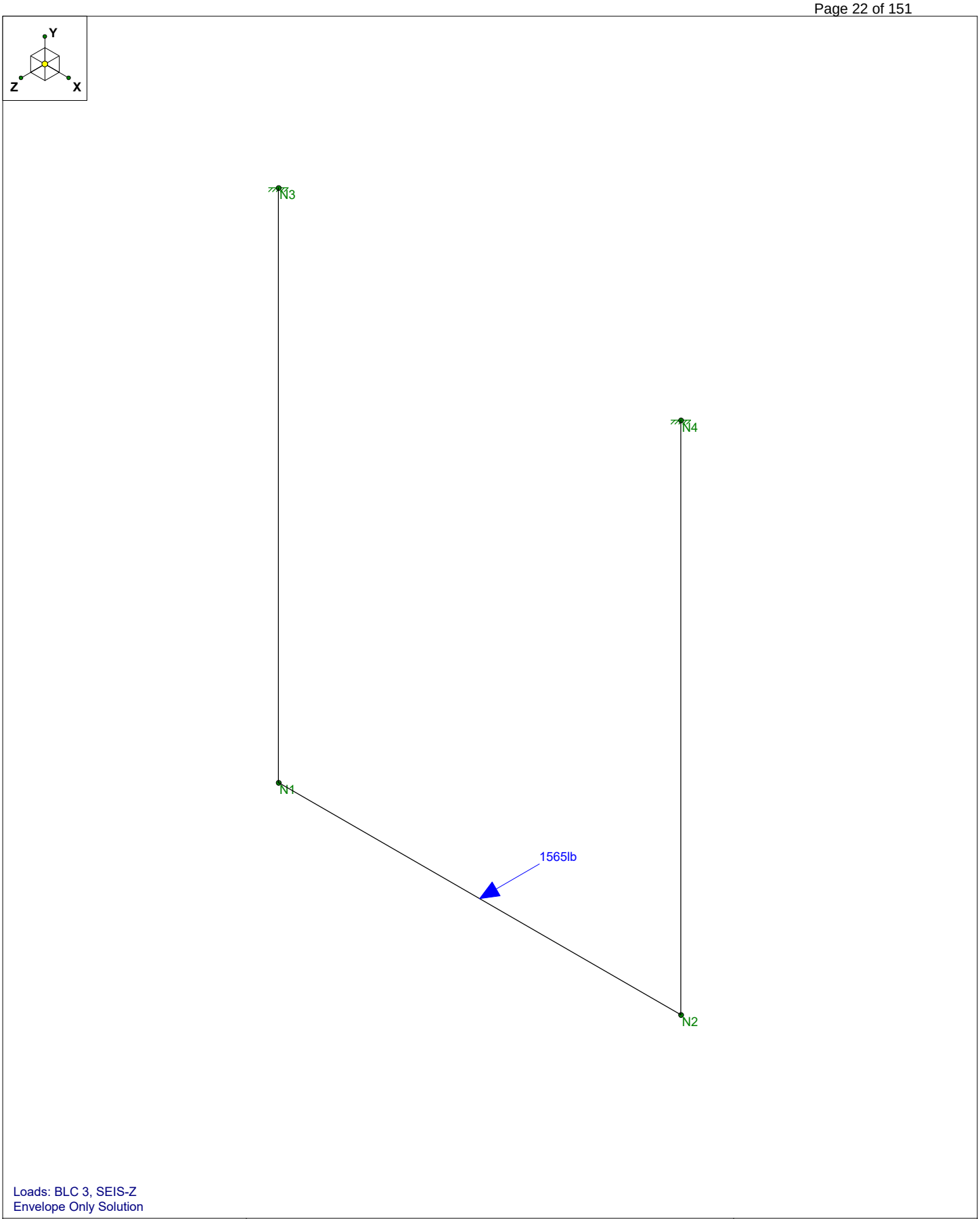
Loads: BLC 1, DL
Envelope Only Solution

Fortress Structural Engine...	Rigid Frame	SK - 1
KJ		May 26, 2020 at 8:58 AM
20118		20118 - Costco Generator Exhaust...



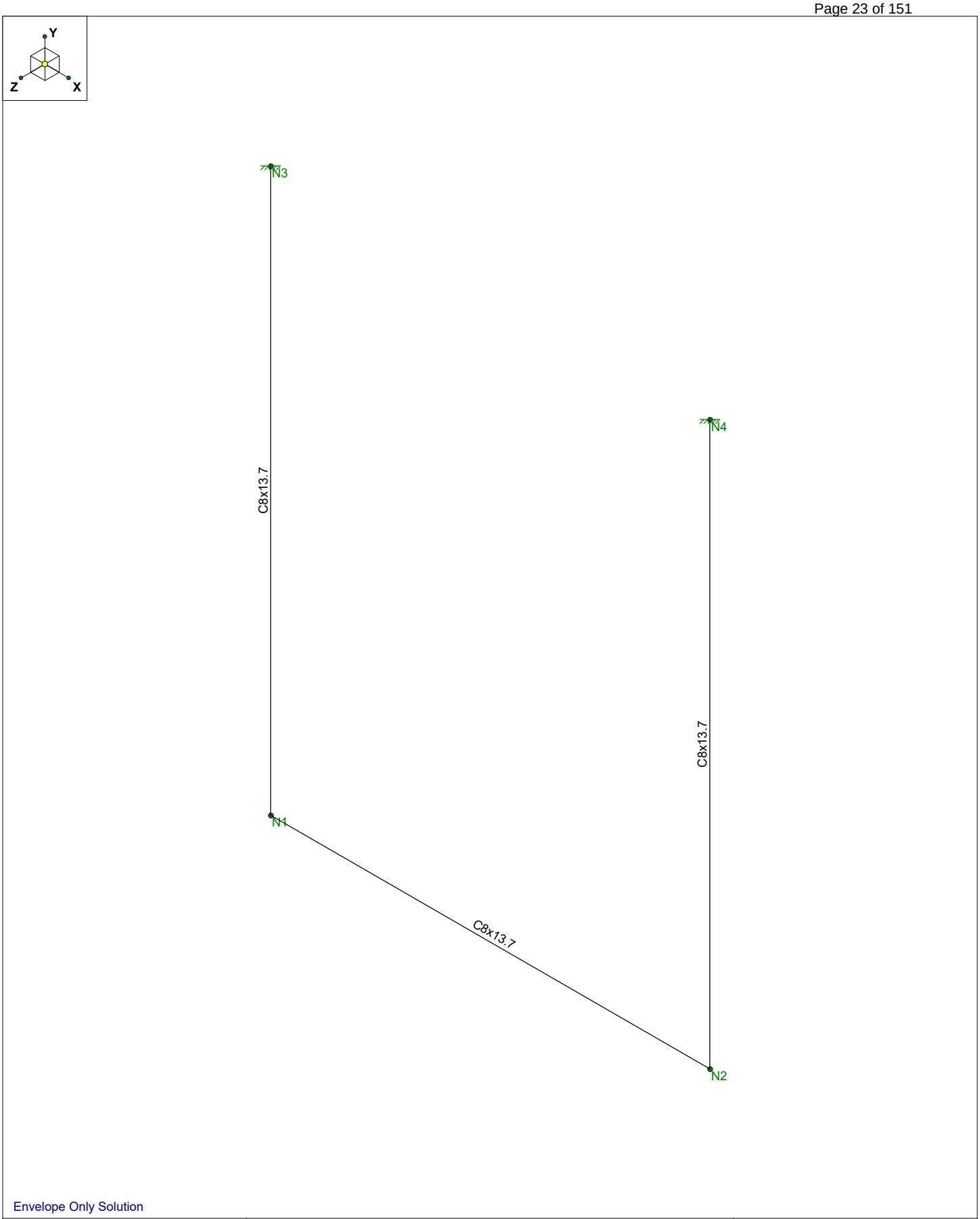
Loads: BLC 2, SEIS-X
Envelope Only Solution

Fortress Structural Engine...	Rigid Frame	SK - 1
KJ		July 28, 2020 at 12:16 PM
20118		20118 - Costco Generator Exhaust...



Loads: BLC 3, SEIS-Z
Envelope Only Solution

Fortress Structural Engine...	Rigid Frame	SK - 2
KJ		July 28, 2020 at 12:18 PM
20118		20118 - Costco Generator Exhaust...



Envelope Only Solution

Fortress Structural Engine...	Rigid Frame	SK - 4
KJ		Apr 8, 2020 at 6:56 PM
20118		20118 - Costco Generator Exhaust...

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): LRFD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 14th(360-10): LRFD
Cold Formed Steel Code	AISI NAS-04: ASD
Wood Code	AWC NDS-12: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-11
Masonry Code	ACI 530-11: ASD
Aluminum Code	AA ADM1-10: ASD - Building
	AISC 14th(360-10): LRFD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-10
Seismic Base Elevation (ft)	Not Entered
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	.634
SDS	.634
S1	.951
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	2.5
Om X	2.5
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
2	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
3	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.4	65	1.3
8	S316	29000	11154	.3	.65	.49	30	1.5	58	1.2

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	6.25	0	0	0	
3	N3	0	8	0	0	
4	N4	6.25	8	0	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1						
2	N2						
3	N3	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
4	N4	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2			Beam	Beam	Tube	A36 Gr.36	Typical
2	M2	N1	N3		270	Post	Column	Channel	A36 Gr.36	Typical
3	M3	N2	N4		90	Post	Column	Channel	A36 Gr.36	Typical

Member Point Loads (BLC 1 : DL)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Y	-2686	3.125

Member Point Loads (BLC 2 : SEIS-X)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	X	1565	3.125

Member Point Loads (BLC 3 : SEIS-Z)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Z	1565	3.125

Basic Load Cases

	BLC Descript...	Category	X Gra..	Y Gra..	Z Gra...	Joint	Point	Distri...	Area(...	Surfa...
1	DL	DL		-1			1			
2	SEIS-X	ELX					1			
3	SEIS-Z	ELZ					1			

Load Combinations

	Description	S...	PDelta	S...	B...	Fac..	B...	Fac...	BLC	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac...
1	Deflection 1	Yes	Y		DL	1																		
2	Deflection 2	Yes	Y		LL	1																		
3	Deflection 3	Yes	Y		DL	1	LL	1																
4	IBC 16-1	Yes	Y		DL	1.4																		
5	IBC 16-2 (a)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
6	IBC 16-5 (a)	Yes	Y		DL	1.2	S...	.2	ELX	1	LL	.5	LLS	1										
7	IBC 16-5 (b)	Yes	Y		DL	1.2	S...	.2	ELZ	1	LL	.5	LLS	1										
8	IBC 16-5 (c)	Yes	Y		DL	1.2	S...	.2	ELX	-1	LL	.5	LLS	1										
9	IBC 16-5 (d)	Yes	Y		DL	1.2	S...	.2	ELZ	-1	LL	.5	LLS	1										
10	IBC 16-7 (a)	Yes	Y		DL	.9	S...	-.2	ELX	1														
11	IBC 16-7 (b)	Yes	Y		DL	.9	S...	-.2	ELZ	1														
12	IBC 16-7 (c)	Yes	Y		DL	.9	S...	-.2	ELX	-1														
13	IBC 16-7 (d)	Yes	Y		DL	.9	S...	-.2	ELZ	-1														
14	IBC 16-5 (os-a)	Yes	Y		DL	1.2	S...	.2	Om*E...	1	LL	.5	LLS	1										
15	IBC 16-5 (os-b)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	1	LL	.5	LLS	1										
16	IBC 16-5 (os-c)	Yes	Y		DL	1.2	S...	.2	Om*E...	-1	LL	.5	LLS	1										
17	IBC 16-5 (os-d)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	-1	LL	.5	LLS	1										
18	IBC 16-7 (os-a)	Yes	Y		DL	.9	S...	-.2	Om*E...	1														
19	IBC 16-7 (os-b)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	1														
20	IBC 16-7 (os-c)	Yes	Y		DL	.9	S...	-.2	Om*E...	-1														
21	IBC 16-7 (os-d)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	-1														

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation [...	LC	Y Rotation [...	LC	Z Rotation [...	LC
1	N1	max	1.63	10	0	2	.278	11	4.287e-03	13	1.508e-02	9	0	2
2		min	-1.63	12	-.003	6	-.278	13	-4.287e-03	11	-1.508e-02	7	-2.037e-03	8
3	N2	max	1.63	10	0	2	.278	11	4.287e-03	13	1.508e-02	7	2.037e-03	6
4		min	-1.63	12	-.003	8	-.278	13	-4.287e-03	11	-1.508e-02	9	0	2
5	N3	max	0	6	0	2	0	7	0	13	0	9	0	10
6		min	0	12	0	6	0	9	0	11	0	7	0	12
7	N4	max	0	10	0	2	0	7	0	13	0	7	0	10
8		min	0	8	0	8	0	9	0	11	0	9	0	12

Member Suggested Shapes

	Section Set/Member	Current Shape	Suggested Shape	Controlling Member	Controlling Criteria	Use Suggested?
1	Beam	C8x13.7	HSS4x2.5x4	M1	Strength	Yes
2	Post	C8x13.7	C8x11.5	M2	Strength	Yes

Envelope AISC 14th(360-10): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Che...	Loc[ft]	Dir	...	phi*P...	phi*P...	phi*M...	phi*M.....		Eqn
1	M1	C8x13.7	.839	3.125	7	.059	6.25	y	8	5954...	130572	4411...	356400	...	H1-1b
2	M2	C8x13.7	.870	0	6	.064	4	y	11	3725...	130572	4411...	2663...	1	H1-1b
3	M3	C8x13.7	.870	0	8	.064	4	y	11	3725...	130572	4411...	2663...	1	H1-1b

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
1	M1	1	max	746.902	12	2793.676	6	782.5	9	0	1	493.221	7	37911....	6
2			min	-831.197	6	0	2	-782.5	7	0	1	-493.221	9	-35202....	12
3		2	max	746.902	12	2765.246	6	782.5	9	0	1	14178.654	13	0	2
4			min	-831.197	6	0	2	-782.5	7	0	1	-14178.654	11	-50013....	8
5		3	max	746.902	10	0	2	782.5	7	0	1	28850.529	13	0	2
6			min	-831.197	8	-2736.8...	8	-782.5	9	0	1	-28850.529	11	-69414....	4
7		4	max	746.902	10	0	2	782.5	7	0	1	14178.654	9	0	2
8			min	-831.197	8	-2765.2...	8	-782.5	9	0	1	-14178.654	7	-50013....	6
9		5	max	746.902	10	0	2	782.5	7	0	1	493.221	7	37911....	8
10			min	-831.197	8	-2793.6...	8	-782.5	9	0	1	-493.221	9	-35202....	10
11	M2	1	max	0	2	779.264	13	744.473	12	493.221	9	37911.508	6	0	1
12			min	-2793.6...	6	-779.264	11	-783.466	6	-493.221	7	-35202.462	12	0	1
13		2	max	0	2	779.264	13	744.473	12	493.221	9	19108.323	6	18702....	11
14			min	-2830.0...	6	-779.264	11	-783.466	6	-493.221	7	-17335.122	12	-18702....	13
15		3	max	0	2	779.264	13	744.473	12	493.221	9	748.133	8	37404....	11
16			min	-2866.4...	6	-779.264	11	-783.466	6	-493.221	7	0	2	-37404....	13
17		4	max	0	2	779.264	13	744.473	12	493.221	9	18399.558	12	56107....	11
18			min	-2902.8...	6	-779.264	11	-783.466	6	-493.221	7	-18703.646	10	-56107....	13
19		5	max	0	2	779.264	13	744.473	12	493.221	9	36266.898	12	74809....	11
20			min	-2939.2...	6	-779.264	11	-783.466	6	-493.221	7	-37488.875	10	-74809....	13
21	M3	1	max	0	2	779.264	11	744.473	10	493.221	7	37911.508	8	0	1
22			min	-2793.6...	8	-779.264	13	-783.466	8	-493.221	9	-35202.462	10	0	1
23		2	max	0	2	779.264	11	744.473	10	493.221	7	19108.323	8	18702....	13
24			min	-2830.0...	8	-779.264	13	-783.466	8	-493.221	9	-17335.122	10	-18702....	11

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
25		3	max	0	2	779.264	11	744.473	10	493.221	7	748.133	6	37404....	13
26			min	-2866.4...	8	-779.264	13	-783.466	8	-493.221	9	0	2	-37404....	11
27		4	max	0	2	779.264	11	744.473	10	493.221	7	18399.558	10	56107....	13
28			min	-2902.8...	8	-779.264	13	-783.466	8	-493.221	9	-18703.646	12	-56107....	11
29		5	max	0	2	779.264	11	744.473	10	493.221	7	36266.898	10	74809....	13
30			min	-2939.2...	8	-779.264	13	-783.466	8	-493.221	9	-37488.875	12	-74809....	11

Joint Reactions (By Combination)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	1	N3	-24.736	1495.559	0	0	0	-790.397
2	1	N4	24.736	1495.559	0	0	0	790.397
3	1	Totals:	0	2991.119	0			
4	1	COG (ft):	X: 3.125	Y: .293	Z: 0			
5	2	N3	0	0	0	0	0	0
6	2	N4	0	0	0	0	0	0
7	2	Totals:	0	0	0			
8	2	COG (ft):	NC	NC	NC			
9	3	N3	-24.736	1495.559	0	0	0	-790.397
10	3	N4	24.736	1495.559	0	0	0	790.397
11	3	Totals:	0	2991.119	0			
12	3	COG (ft):	X: 3.125	Y: .293	Z: 0			
13	4	N3	-34.63	2093.783	0	0	0	-1106.556
14	4	N4	34.63	2093.783	0	0	0	1106.556
15	4	Totals:	0	4187.566	0			
16	4	COG (ft):	X: 3.125	Y: .293	Z: 0			
17	5	N3	-29.683	1794.671	0	0	0	-948.477
18	5	N4	29.683	1794.671	0	0	0	948.477
19	5	Totals:	0	3589.342	0			
20	5	COG (ft):	X: 3.125	Y: .293	Z: 0			
21	6	N3	-831.197	2939.232	0	0	0	-37301.235
22	6	N4	-733.803	1029.385	0	0	0	-35204.12
23	6	Totals:	-1565	3968.616	0			
24	6	COG (ft):	X: 3.125	Y: .293	Z: 0			
25	7	N3	-32.819	1984.308	-782.5	74590.711	493.221	-1048.699
26	7	N4	32.819	1984.308	-782.5	74590.711	-493.221	1048.699
27	7	Totals:	0	3968.616	-1565			
28	7	COG (ft):	X: 3.125	Y: .293	Z: 0			
29	8	N3	733.803	1029.385	0	0	0	35204.12
30	8	N4	831.197	2939.232	0	0	0	37301.235
31	8	Totals:	1565	3968.616	0			
32	8	COG (ft):	X: 3.125	Y: .293	Z: 0			
33	9	N3	-32.819	1984.308	782.5	-74590.711	-493.221	-1048.699
34	9	N4	32.819	1984.308	782.5	-74590.711	493.221	1048.699
35	9	Totals:	0	3968.616	1565			
36	9	COG (ft):	X: 3.125	Y: .293	Z: 0			
37	10	N3	-818.098	2127.759	0	0	0	-37488.875
38	10	N4	-746.902	184.974	0	0	0	-36266.898
39	10	Totals:	-1565	2312.733	0			
40	10	COG (ft):	X: 3.125	Y: .293	Z: 0			
41	11	N3	-19.126	1156.366	-782.5	74809.349	493.221	-611.135

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
42	11	N4	19.126	1156.366	-782.5	74809.349	-493.221	611.135
43	11	Totals:	0	2312.733	-1565			
44	11	COG (ft):	X: 3.125	Y: .293	Z: 0			
45	12	N3	746.902	184.974	0	0	0	36266.898
46	12	N4	818.098	2127.759	0	0	0	37488.875
47	12	Totals:	1565	2312.733	0			
48	12	COG (ft):	X: 3.125	Y: .293	Z: 0			
49	13	N3	-19.126	1156.366	782.5	-74809.349	-493.221	-611.135
50	13	N4	19.126	1156.366	782.5	-74809.349	493.221	611.135
51	13	Totals:	0	2312.733	1565			
52	13	COG (ft):	X: 3.125	Y: .293	Z: 0			

Joint Reactions - Overstrength

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	14	N3	-2088.683	4371.421	0	0	0	-91672.286
2	14	N4	-1823.817	-402.805	0	0	0	-89576.661
3	14	Totals:	-3912.5	3968.616	0			
4	14	COG (ft):	X: 3.125	Y: .293	Z: 0			
5	15	N3	-32.819	1984.308	-1956.25	186476.776	1233.053	-1048.699
6	15	N4	32.819	1984.308	-1956.25	186476.776	-1233.053	1048.699
7	15	Totals:	0	3968.616	-3912.5			
8	15	COG (ft):	X: 3.125	Y: .293	Z: 0			
9	16	N3	1823.817	-402.805	0	0	0	89576.661
10	16	N4	2088.683	4371.421	0	0	0	91672.286
11	16	Totals:	3912.5	3968.616	0			
12	16	COG (ft):	X: 3.125	Y: .293	Z: 0			
13	17	N3	-32.819	1984.308	1956.25	-186476.776	-1233.053	-1048.699
14	17	N4	32.819	1984.308	1956.25	-186476.776	1233.053	1048.699
15	17	Totals:	0	3968.616	3912.5			
16	17	COG (ft):	X: 3.125	Y: .293	Z: 0			
17	18	N3	-2078.326	3584.843	0	0	0	-92804.98
18	18	N4	-1834.174	-1272.11	0	0	0	-91584.542
19	18	Totals:	-3912.5	2312.733	0			
20	18	COG (ft):	X: 3.125	Y: .293	Z: 0			
21	19	N3	-19.126	1156.366	-1956.25	187023.373	1233.053	-611.135
22	19	N4	19.126	1156.366	-1956.25	187023.373	-1233.053	611.135
23	19	Totals:	0	2312.733	-3912.5			
24	19	COG (ft):	X: 3.125	Y: .293	Z: 0			
25	20	N3	1834.174	-1272.11	0	0	0	91584.542
26	20	N4	2078.326	3584.843	0	0	0	92804.98
27	20	Totals:	3912.5	2312.733	0			
28	20	COG (ft):	X: 3.125	Y: .293	Z: 0			
29	21	N3	-19.126	1156.366	1956.25	-187023.373	-1233.053	-611.135
30	21	N4	19.126	1156.366	1956.25	-187023.373	1233.053	611.135
31	21	Totals:	0	2312.733	3912.5			
32	21	COG (ft):	X: 3.125	Y: .293	Z: 0			

Envelope Joint Reactions - Overstrength

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-in]	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N3	max	1834.174	20	4371.421	14	1956.25	17	187023.373	19	1233.053	15	91584.542	20
2		min	-2088.683	14	-1272.11	20	-1956.25	15	-187023.373	21	-1233.053	17	-92804.98	18
3	N4	max	2088.683	16	4371.421	16	1956.25	17	187023.373	19	1233.053	17	92804.98	20
4		min	-1834.174	18	-1272.11	18	-1956.25	15	-187023.373	21	-1233.053	15	-91584.542	18
5	Totals:	max	3912.5	20	3968.616	14	3912.5	17						
6		min	-3912.5	18	2312.733	19	-3912.5	15						

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb...	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N3	max	746.902	12	2939.232	6	782.5	9	74809....	11	493.221	7	36266.898	12
2		min	-831.1...	6	0	2	-782.5	7	-74809...	13	-493.221	9	-37488.875	10
3	N4	max	831.197	8	2939.232	8	782.5	9	74809....	11	493.221	9	37488.875	12
4		min	-746.9...	10	0	2	-782.5	7	-74809...	13	-493.221	7	-36266.898	10
5	Totals:	max	1565	12	4187.566	4	1565	9						
6		min	-1565	10	0	2	-1565	7						

Hilti PROFIS Engineering 3.0.62

www.hilti.com

Company:	Fortress Structural Engineering	Page:	1
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	20118- support 1_07-28-20	Date:	7/28/2020
Fastening point:			

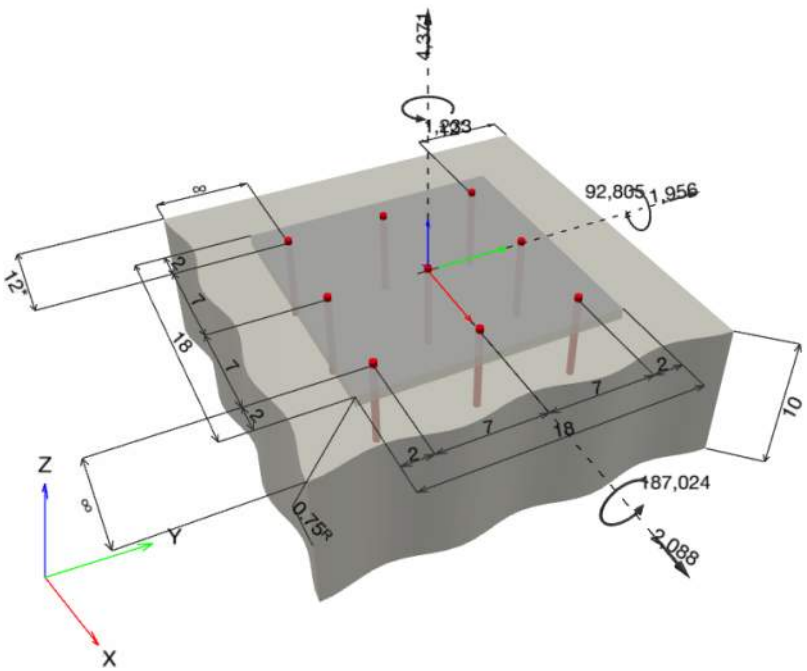
Specifier's comments:

1 Input data

Anchor type and diameter:	**AWS D1.1 GR. B 1/2**
Item number:	not available
Effective embedment depth:	h_{ef} = 6.000 in.
Material:	
Proof:	Design Method ACI 318-14 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate[R] :	l_x x l_y x t = 18.000 in. x 18.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 10.000 in.
Reinforcement:	tension: condition B, shear: condition B; edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



Hilti PROFIS Engineering 3.0.62

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Company:	Fortress Structural Engineering	Page:	2
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	20118- support 1_07-28-20	Date:	7/28/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 4,371; V_x = 2,088; V_y = 1,956; M_x = 187,024; M_y = 92,805; M_z = 1,233;	yes	63

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Design:	20118- support 1_07-28-20	Date:	7/28/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	18,325	29,193	63 / -	OK
Shear	Concrete edge failure in direction y+	2,861	18,708	- / 16	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.628	0.153	5/3	51	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Company:	Fortress Structural Engineering	Page:	4
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	20118- support 1_07-28-20	Date:	7/28/2020
Fastening point:			

4 Remarks; Your Cooperation Duties

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SUPPORT-3
(DETAIL 3)

Support 3 - Wall Calc (2-20"pipe for 10' tributary)

1. Seismic Design Criteria

Governing Code CBC 2016/ ASCE 7-10

$a_p := 2.5 \quad R_p := 2.5$ (Table 13.6-1-Worst case)

$I_p := 1.5$ (Per S 0.01)

$S_{DS} := 0.634 = 0.634$ (Eq: 11.4-3)

$z := 18 \cdot ft$ (Location-Level 2)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Strength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p} \right)} \right) \cdot \left(1 + 2 \cdot \frac{z}{h} \right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$W2 := 300 \ lbf = 300 \ lbf$ (Flange weight=150 /flange)

$W3 := 2 \cdot 123 \ plf = 246 \ plf$ (20" steel pipe with 3" insulation)

$W_3 := 1.0 \cdot W3 = 246 \ plf$ (Weight w/ appurtenances)

$b_1 := 10 \ ft$ (Max Tributary Dead Load on each support)

$W_{3t} := W_3 \cdot b_1 = 2460 \ lbf$ (Weight on Support)

$W4 := 506 \ lbf = 506 \ lbf$ (90 degree fitting)

$W5 := 95 \ lbf = 95 \ lbf$ (Matraflex EX402000/EX302000-Worst case is 95 lbs))

$W_p := \left(W2 + W_{3t} + W4 + W5 \right) = 3361 \ lbf$ (Total weight on Support: worst case)

$F_{pv1} := F_{pvc} \cdot W_p = 426 \ lbf$ (Vertical Seismic Load: Each support)

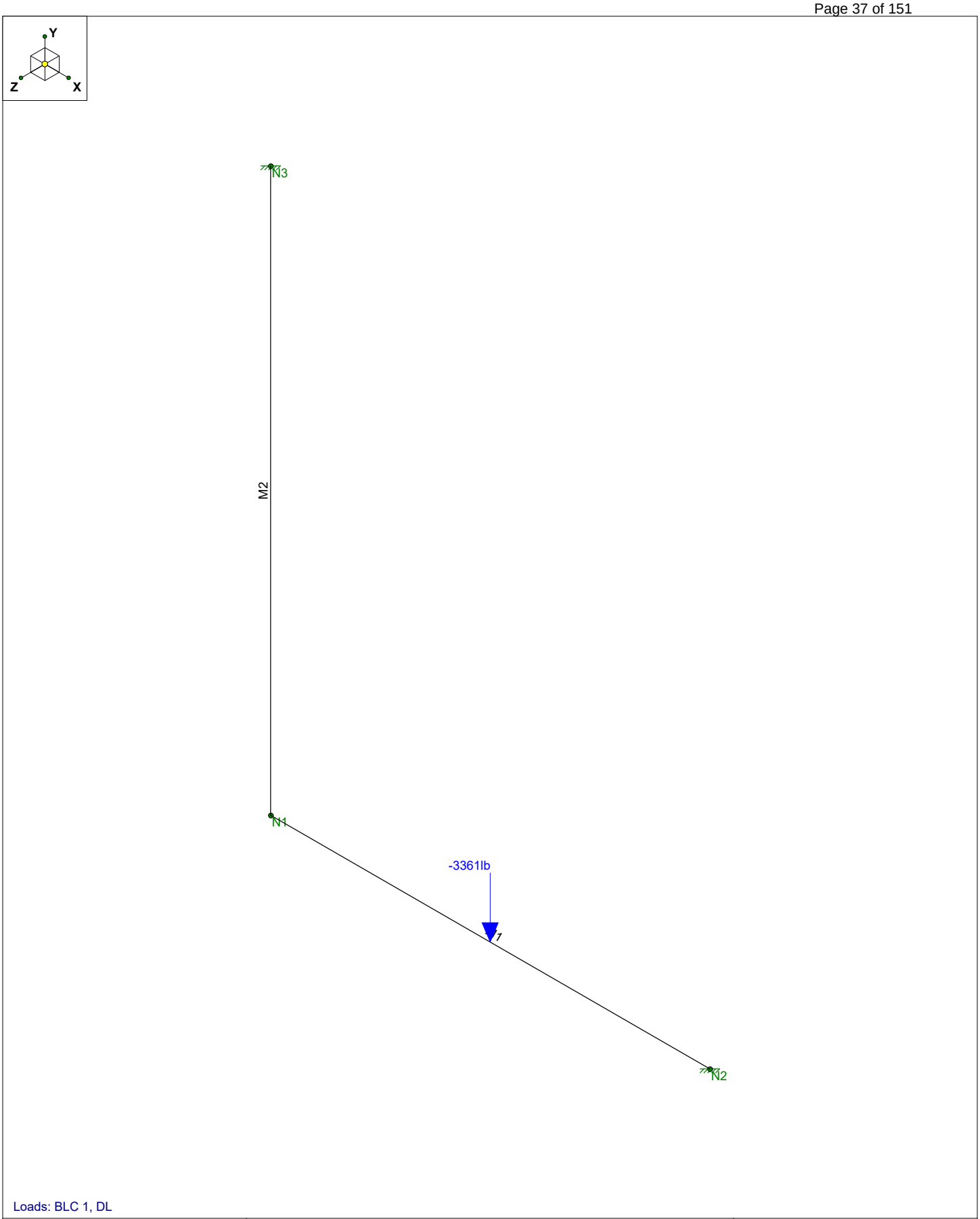
$F_{ph2} := F_{phc} \cdot W_p = 1721 \ lbf$ (Horizontal Seismic Load:)

$T := 169 \cdot lbf = 169 \ lbf$ (Horizontal Thermal Load max-worst case Both direction)

$F_{ph} := T + F_{ph2} = 1890 \ lbf$ (Horizontal Force Seismic+Thermal)

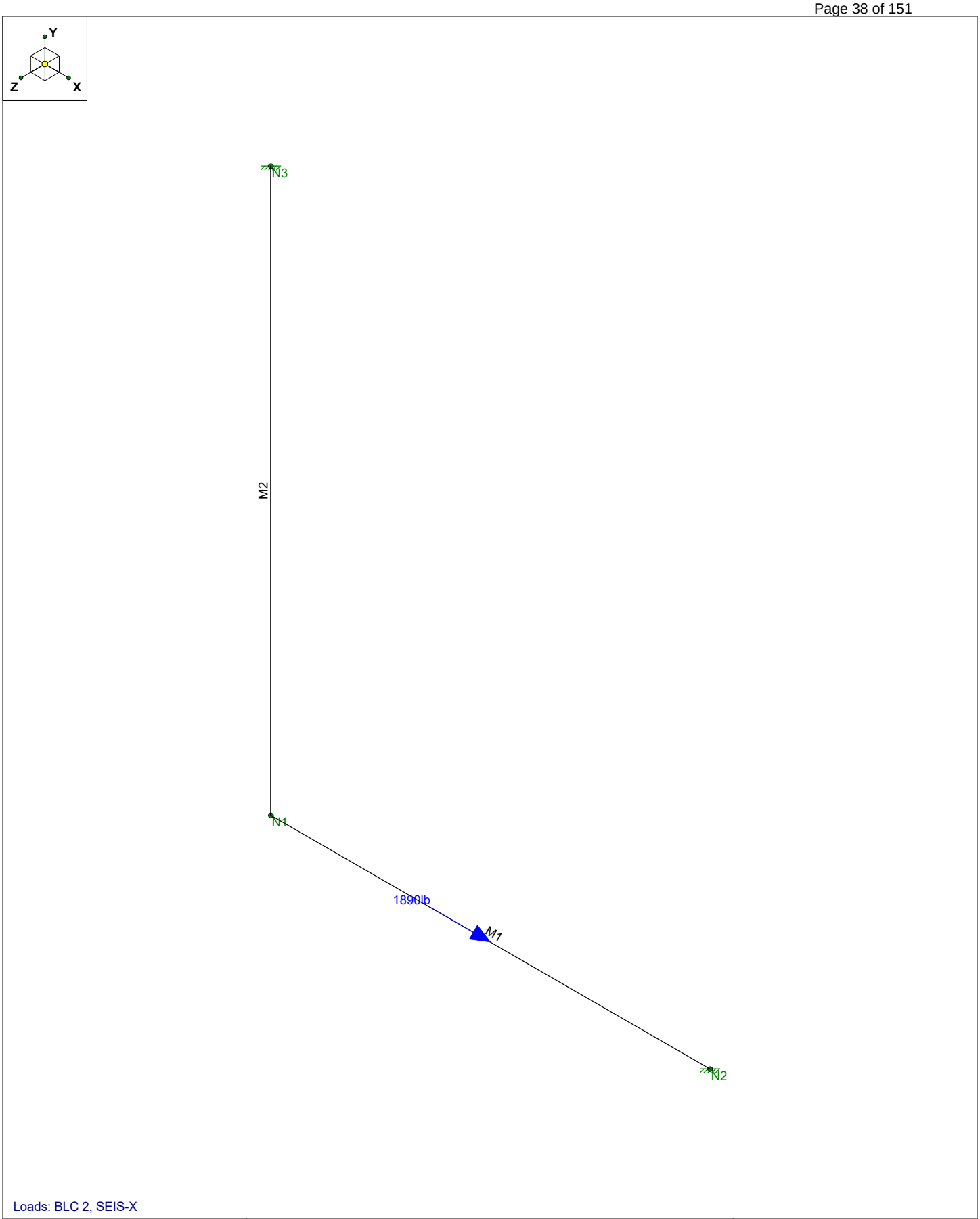
(As a worst case considered total horizontal force as a seismic load and calculated Anchorage with over strength factor)

(See Risa result)



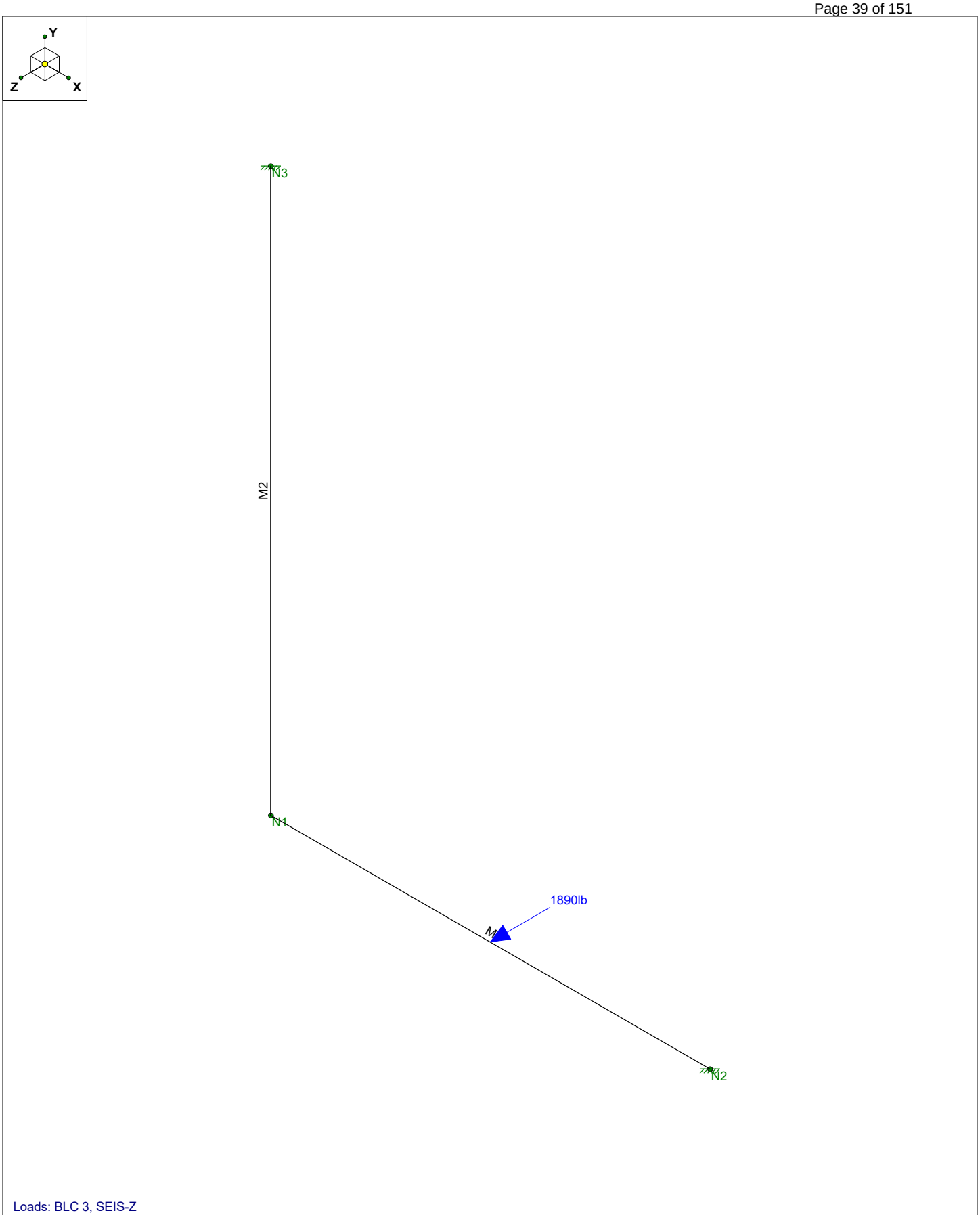
Loads: BLC 1, DL

Fortress Structural Engine...	Rigid Frame	SK - 1
KJ		July 28, 2020 at 1:17 PM
20118		20118 - Costco Generator Exhaust...



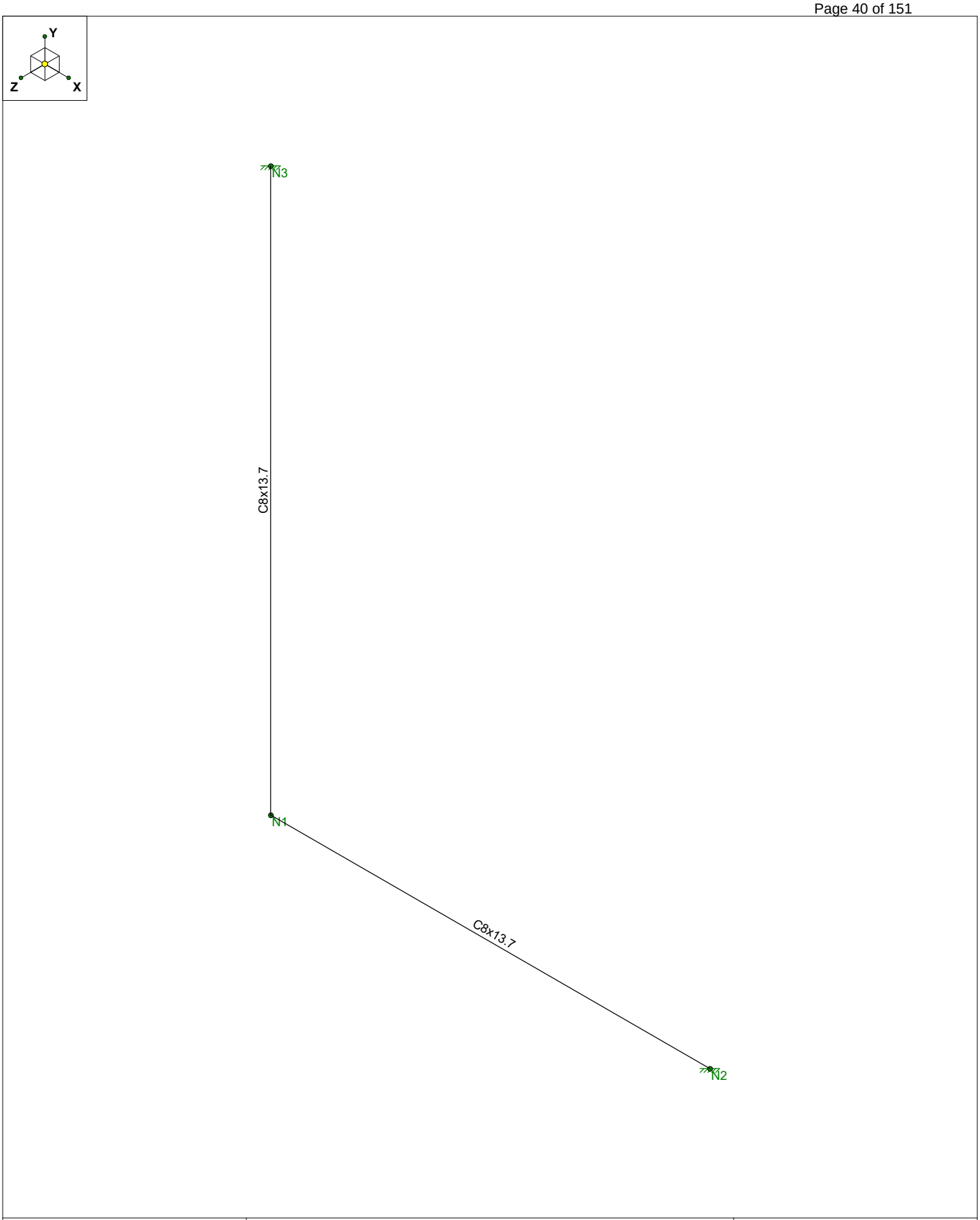
Loads: BLC 2, SEIS-X

Fortress Structural Engine...	Rigid Frame	SK - 2
KJ		July 28, 2020 at 1:17 PM
20118		20118 - Costco Generator Exhaust...



Loads: BLC 3, SEIS-Z

Fortress Structural Engine...	Rigid Frame	SK - 3
KJ		July 28, 2020 at 1:18 PM
20118		20118 - Costco Generator Exhaust...



Fortress Structural Engine...	Rigid Frame	SK - 4
KJ		July 28, 2020 at 1:19 PM
20118		20118 - Costco Generator Exhaust...

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): LRFD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 14th(360-10): LRFD
Cold Formed Steel Code	AISI NAS-04: ASD
Wood Code	AWC NDS-12: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-11
Masonry Code	ACI 530-11: ASD
Aluminum Code	AA ADM1-10: ASD - Building
	AISC 14th(360-10): LRFD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-10
Seismic Base Elevation (ft)	Not Entered
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	.634
SDS	.634
S1	.951
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	2.5
Om X	2.5
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
2	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
3	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.4	65	1.3
8	S316	29000	11154	.3	.65	.49	30	1.5	58	1.2

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	6.25	0	0	0	
3	N3	0	8	0	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1						
2	N2	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
3	N3	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2			Beam	Beam	Channel	A36 Gr.36	Typical
2	M2	N1	N3		90	Post	Column	Channel	A36 Gr.36	Typical

Member Point Loads (BLC 1 : DL)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Y	-3361	3.125

Member Point Loads (BLC 2 : SEIS-X)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	X	1890	3.125

Member Point Loads (BLC 3 : SEIS-Z)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Z	1890	3.125

Basic Load Cases

	BLC Descript...	Category	X Gra..	Y Gra..	Z Gra...	Joint	Point	Distri...	Area(...	Surfa...
1	DL	DL		-1			1			
2	SEIS-X	ELX					1			
3	SEIS-Z	ELZ					1			

Load Combinations

	Description	S...	PDelta	S...	B...	Fac..	B...	Fac...	BLC	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac..	B...	Fac...
1	Deflection 1	Yes	Y		DL	1																		
2	Deflection 2	Yes	Y		LL	1																		
3	Deflection 3	Yes	Y		DL	1	LL	1																
4	IBC 16-1	Yes	Y		DL	1.4																		
5	IBC 16-2 (a)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
6	IBC 16-5 (a)	Yes	Y		DL	1.2	S...	.2	ELX	1	LL	.5	LLS	1										
7	IBC 16-5 (b)	Yes	Y		DL	1.2	S...	.2	ELZ	1	LL	.5	LLS	1										
8	IBC 16-5 (c)	Yes	Y		DL	1.2	S...	.2	ELX	-1	LL	.5	LLS	1										
9	IBC 16-5 (d)	Yes	Y		DL	1.2	S...	.2	ELZ	-1	LL	.5	LLS	1										
10	IBC 16-7 (a)	Yes	Y		DL	.9	S...	-.2	ELX	1														
11	IBC 16-7 (b)	Yes	Y		DL	.9	S...	-.2	ELZ	1														
12	IBC 16-7 (c)	Yes	Y		DL	.9	S...	-.2	ELX	-1														
13	IBC 16-7 (d)	Yes	Y		DL	.9	S...	-.2	ELZ	-1														
14	IBC 16-5 (os-a)	Yes	Y		DL	1.2	S...	.2	Om*E...	1	LL	.5	LLS	1										
15	IBC 16-5 (os-b)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	1	LL	.5	LLS	1										
16	IBC 16-5 (os-c)	Yes	Y		DL	1.2	S...	.2	Om*E...	-1	LL	.5	LLS	1										
17	IBC 16-5 (os-d)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	-1	LL	.5	LLS	1										
18	IBC 16-7 (os-a)	Yes	Y		DL	.9	S...	-.2	Om*E...	1														
19	IBC 16-7 (os-b)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	1														
20	IBC 16-7 (os-c)	Yes	Y		DL	.9	S...	-.2	Om*E...	-1														
21	IBC 16-7 (os-d)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	-1														

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation [...	LC	Y Rotation [...	LC	Z Rotation [...	LC
1	N1	max	0	10	0	2	.193	11	2.979e-03	13	5.505e-03	9	0	2
2		min	0	8	-.002	4	-.193	13	-2.979e-03	11	-5.505e-03	7	-9.956e-04	4
3	N2	max	0	10	0	2	0	11	0	13	0	11	0	4
4		min	0	8	0	4	0	13	0	11	0	13	0	2
5	N3	max	0	4	0	2	0	7	0	13	0	9	0	4
6		min	0	2	0	4	0	9	0	11	0	7	0	2

Member Suggested Shapes

	Section Set/Member	Current Shape	Suggested Shape	Controlling Member	Controlling Criteria	Use Suggested?
1	Beam	C8x13.7	C8x11.5	M1	Strength	Yes
2	Post	C8x13.7	C4x4.5	M2	Strength	Yes

Envelope AISC 14th(360-10): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Che...	Loc[ft]	Dir	...	phi*P...	phi*P...	phi*M...	phi*M.....	Eqn
1	M1	C8x13.7	.870	6.25	7	.077	3.385	y	9	5954...	130572	4411...	356400	...	H1-1b
2	M2	C8x13.7	.184	8	7	.029	4	y	7	3725...	130572	4411...	356400	...	H1-1b

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
1	M1	1	max	0	2	1551.733	4	546.324	9	144.038	13	180.076	7	1459.452	4
2			min	-22.786	4	0	2	-546.324	7	-144.038	11	-180.076	9	0	2
3		2	max	0	2	1521.735	4	546.324	9	144.038	13	10063.499	9	0	2
4			min	-22.786	4	0	2	-546.324	7	-144.038	11	-10063.499	7	-27354....	4
5		3	max	1877.056	10	0	2	1343.788	11	144.038	13	20307.073	9	0	2
6			min	-1911.23	8	-3213.6...	4	-1343.7...	13	-144.038	11	-20307.073	7	-55605....	4
7		4	max	1877.056	10	0	2	1343.788	11	144.038	13	4892.862	11	4931.785	4
8			min	-1911.23	8	-3243.66	4	-1343.7...	13	-144.038	11	-4892.862	13	0	2
9		5	max	1877.056	10	0	2	1343.788	11	144.038	13	30088.881	11	66031.64	4
10			min	-1911.23	8	-3273.6...	4	-1343.7...	13	-144.038	11	-30088.881	13	0	2
11	M2	1	max	0	2	544.364	11	22.786	4	180.076	9	0	2	144.038	11
12			min	-1551.7...	4	-544.364	13	0	2	-180.076	7	-1459.452	4	-144.038	13
13		2	max	0	2	544.364	11	22.786	4	180.076	9	0	2	12920....	13
14			min	-1590.1...	4	-544.364	13	0	2	-180.076	7	-912.58	4	-12920....	11
15		3	max	0	2	544.364	11	22.786	4	180.076	9	0	2	25985....	13
16			min	-1628.5...	4	-544.364	13	0	2	-180.076	7	-365.708	4	-25985....	11
17		4	max	0	2	544.364	11	22.786	4	180.076	9	181.164	4	39050....	13
18			min	-1666.9...	4	-544.364	13	0	2	-180.076	7	0	2	-39050....	11
19		5	max	0	2	544.364	11	22.786	4	180.076	9	728.036	4	52114....	13
20			min	-1705.32	4	-544.364	13	0	2	-180.076	7	0	2	-52114....	11

Joint Reactions

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	1	N2	16.276	2338.327	0	0	0	-47165.457
2	1	N3	-16.276	1218.086	0	0	0	-520.026
3	1	Totals:	0	3556.413	0			

Joint Reactions (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
4	1	COG (ft):	X: 3.029	Y: .123	Z: 0			
5	2	N2	0	0	0	0	0	0
6	2	N3	0	0	0	0	0	0
7	2	Totals:	0	0	0			
8	2	COG (ft):	NC	NC	NC			
9	3	N2	16.276	2338.327	0	0	0	-47165.457
10	3	N3	-16.276	1218.086	0	0	0	-520.026
11	3	Totals:	0	3556.413	0			
12	3	COG (ft):	X: 3.029	Y: .123	Z: 0			
13	4	N2	22.786	3273.658	0	0	0	-66031.64
14	4	N3	-22.786	1705.32	0	0	0	-728.036
15	4	Totals:	0	4978.978	0			
16	4	COG (ft):	X: 3.029	Y: .123	Z: 0			
17	5	N2	19.531	2805.993	0	0	0	-56598.548
18	5	N3	-19.531	1461.703	0	0	0	-624.031
19	5	Totals:	0	4267.696	0			
20	5	COG (ft):	X: 3.029	Y: .123	Z: 0			
21	6	N2	-1868.041	3102.146	0	0	0	-62571.394
22	6	N3	-21.959	1616.503	0	0	0	-707.024
23	6	Totals:	-1890	4718.649	0			
24	6	COG (ft):	X: 3.029	Y: .123	Z: 0			
25	7	N2	21.595	3102.493	-1343.732	143.721	-30080.778	-62579.128
26	7	N3	-21.595	1616.156	-546.268	52000.516	180.076	-689.97
27	7	Totals:	0	4718.649	-1890			
28	7	COG (ft):	X: 3.029	Y: .123	Z: 0			
29	8	N2	1911.23	3102.839	0	0	0	-62586.863
30	8	N3	-21.23	1615.81	0	0	0	-672.916
31	8	Totals:	1890	4718.649	0			
32	8	COG (ft):	X: 3.029	Y: .123	Z: 0			
33	9	N2	21.595	3102.493	1343.732	-143.721	30080.778	-62579.128
34	9	N3	-21.595	1616.156	546.268	-52000.516	-180.076	-689.97
35	9	Totals:	0	4718.649	1890			
36	9	COG (ft):	X: 3.029	Y: .123	Z: 0			
37	10	N2	-1877.056	1807.656	0	0	0	-36460.593
38	10	N3	-12.944	942.162	0	0	0	-419.138
39	10	Totals:	-1890	2749.819	0			
40	10	COG (ft):	X: 3.029	Y: .123	Z: 0			
41	11	N2	12.584	1807.995	-1343.82	144.038	-30088.881	-36468.331
42	11	N3	-12.584	941.824	-546.18	52114.905	179.803	-402.084
43	11	Totals:	0	2749.819	-1890			
44	11	COG (ft):	X: 3.029	Y: .123	Z: 0			
45	12	N2	1902.225	1808.333	0	0	0	-36476.07
46	12	N3	-12.225	941.486	0	0	0	-385.029
47	12	Totals:	1890	2749.819	0			
48	12	COG (ft):	X: 3.029	Y: .123	Z: 0			
49	13	N2	12.584	1807.995	1343.82	-144.038	30088.881	-36468.331
50	13	N3	-12.584	941.824	546.18	-52114.905	-179.803	-402.084
51	13	Totals:	0	2749.819	1890			
52	13	COG (ft):	X: 3.029	Y: .123	Z: 0			

Joint Reactions - Overstrength

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	14	N2	-4702.494	3101.626	0	0	0	-62559.793
2	14	N3	-22.506	1617.022	0	0	0	-732.606
3	14	Totals:	-4725	4718.649	0			
4	14	COG (ft):	X: 3.029	Y: .123	Z: 0			
5	15	N2	21.595	3102.493	-3359.329	359.304	-75201.945	-62579.128
6	15	N3	-21.595	1616.156	-1365.671	130001.29	450.189	-689.97
7	15	Totals:	0	4718.649	-4725			
8	15	COG (ft):	X: 3.029	Y: .123	Z: 0			
9	16	N2	4745.684	3103.359	0	0	0	-62598.464
10	16	N3	-20.684	1615.29	0	0	0	-647.334
11	16	Totals:	4725	4718.649	0			
12	16	COG (ft):	X: 3.029	Y: .123	Z: 0			
13	17	N2	21.595	3102.493	3359.329	-359.304	75201.945	-62579.128
14	17	N3	-21.595	1616.156	1365.671	-130001.29	-450.189	-689.97
15	17	Totals:	0	4718.649	4725			
16	17	COG (ft):	X: 3.029	Y: .123	Z: 0			
17	18	N2	-4711.517	1807.149	0	0	0	-36448.986
18	18	N3	-13.483	942.67	0	0	0	-444.72
19	18	Totals:	-4725	2749.819	0			
20	18	COG (ft):	X: 3.029	Y: .123	Z: 0			
21	19	N2	12.584	1807.995	-3359.551	360.094	-75222.202	-36468.331
22	19	N3	-12.584	941.824	-1365.449	130287.262	449.508	-402.084
23	19	Totals:	0	2749.819	-4725			
24	19	COG (ft):	X: 3.029	Y: .123	Z: 0			
25	20	N2	4736.686	1808.84	0	0	0	-36487.677
26	20	N3	-11.686	940.978	0	0	0	-359.447
27	20	Totals:	4725	2749.819	0			
28	20	COG (ft):	X: 3.029	Y: .123	Z: 0			
29	21	N2	12.584	1807.995	3359.551	-360.094	75222.202	-36468.331
30	21	N3	-12.584	941.824	1365.449	-130287.262	-449.508	-402.084
31	21	Totals:	0	2749.819	4725			
32	21	COG (ft):	X: 3.029	Y: .123	Z: 0			

Envelope Joint Reactions - Overstrength

WALL connection

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-in]	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N2	max	4745.684	16	3103.359	16	3359.551	21	360.094	19	75222.202	21	-36448.986	18
2		min	-4711.517	18	1807.149	18	-3359.551	19	-360.094	21	-75222.202	19	-62598.464	16
3	N3	max	-11.686	20	1617.022	14	1365.671	17	130287.262	19	450.189	15	-359.447	20
4		min	-22.506	14	940.978	20	-1365.671	15	-130287.262	21	-450.189	17	-732.606	14
5	Totals:	max	4725	16	4718.649	14	4725	17						
6		min	4725	14	2749.819	19	-4725	15						

FOR CEILING, SUPPORT-1 ANCHORAGE CALC CONTOLS

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb...	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N2	max	1911.23	8	3273.658	4	1343.82	13	144.038	11	30088.881	13	0	2
2		min	-1877....	10	0	2	-1343....	11	-144.0...	13	-30088.881	11	-66031.64	4
3	N3	max	0	2	1705.32	4	546.268	9	52114....	11	180.076	7	0	2
4		min	-22.786	4	0	2	-546.2...	7	-52114..	13	-180.076	9	-728.036	4

Envelope Joint Reactions (Continued)

Joint			X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb...	LC	MY [lb-in]	LC	MZ [lb-in]	LC
5	Totals:	max	1890	8	4978.978	4	1890	9						
6		min	-1890	6	0	2	-1890	7						

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Company:	Fortress Structural Engineering	Page:	1
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	20118- wall- support 3-Embaded plate_07-28-20	Date:	7/28/2020
Fastening point:			

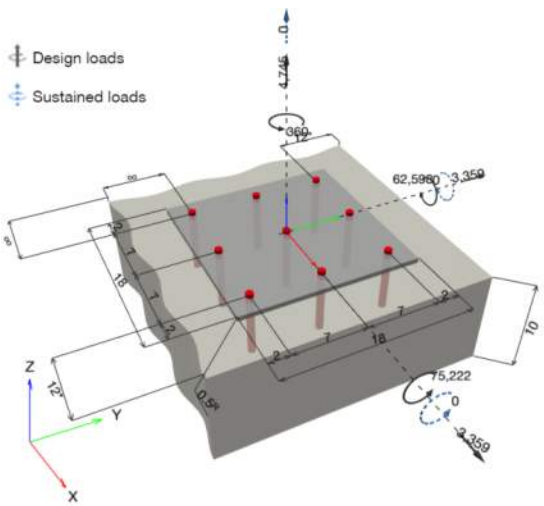
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 + HAS-V-36 (ASTM F1554 Gr.36) 3/4**
Item number:	2198029 HAS-V-36 3/4"x8" (element) / 2022793 HIT-HY 200-R (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 6.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM A 1554 Grade 36
Evaluation Service Report:	ESR-3187
Issued I Valid:	4/1/2020 | 3/1/2022
Proof:	Design Method ACI 318-14 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 18.000 in. x 18.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 10.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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Company:	Fortress Structural Engineering	Page:	2
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	20118- wall- support 3-Embaded plate_07-28-20	Date:	7/28/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 4,745; V_x = 3,359; V_y = 3,359; M_x = 75,222; M_y = 62,598; M_z = 360; N_{sus} = 0; $M_{x,sus}$ = 0; $M_{y,sus}$ = 0;	yes	61

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Company:	Fortress Structural Engineering	Page:	3
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Design:	20118- wall- support 3-Embaded plate_07-28-20	Date:	7/28/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	10,387	17,190	61 / -	OK
Shear	Concrete edge failure in direction x+	4,750	15,151	- / 32	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.609	0.314	5/3	59	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Fastening point:			

4 Remarks; Your Cooperation Duties

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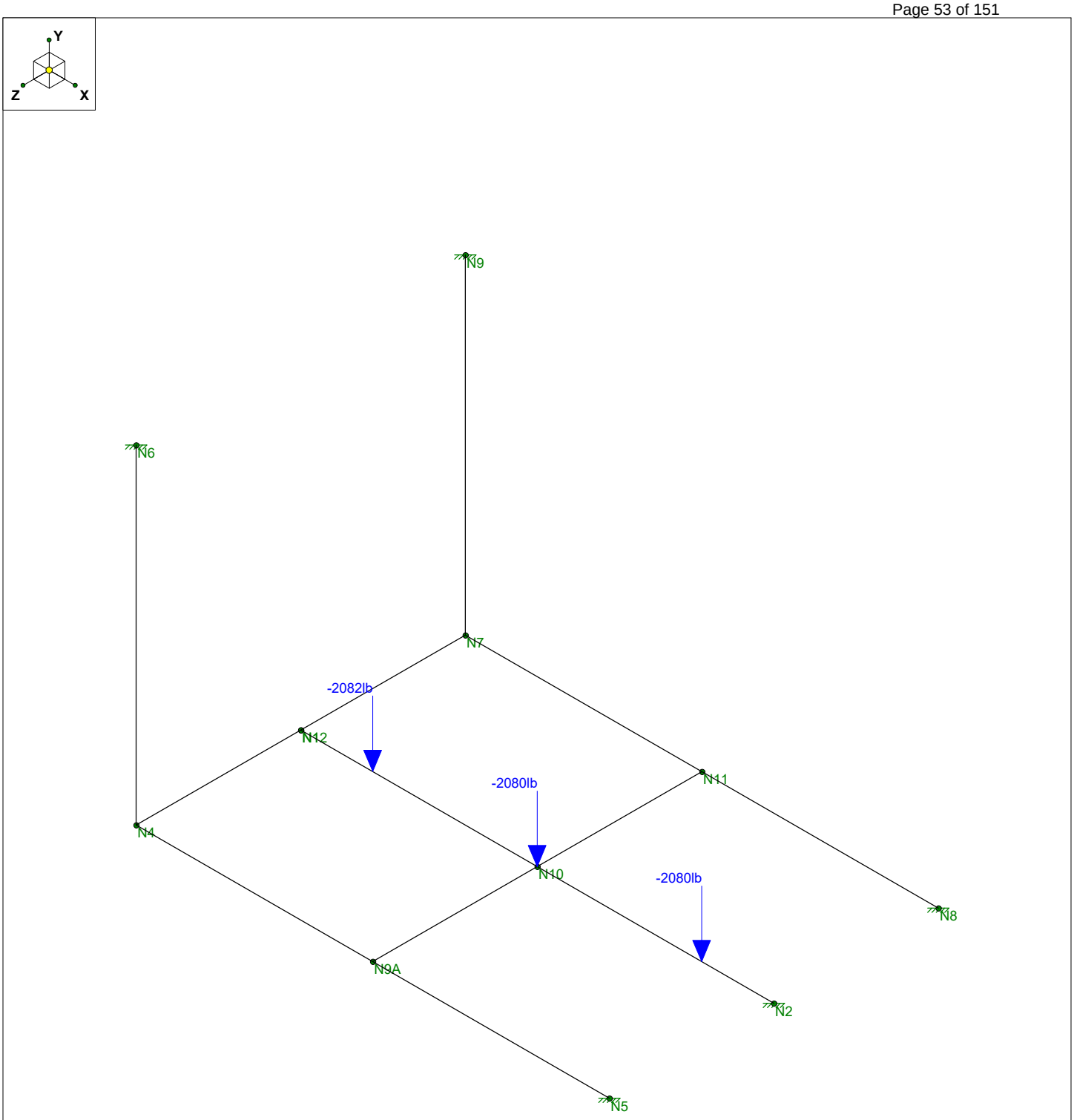
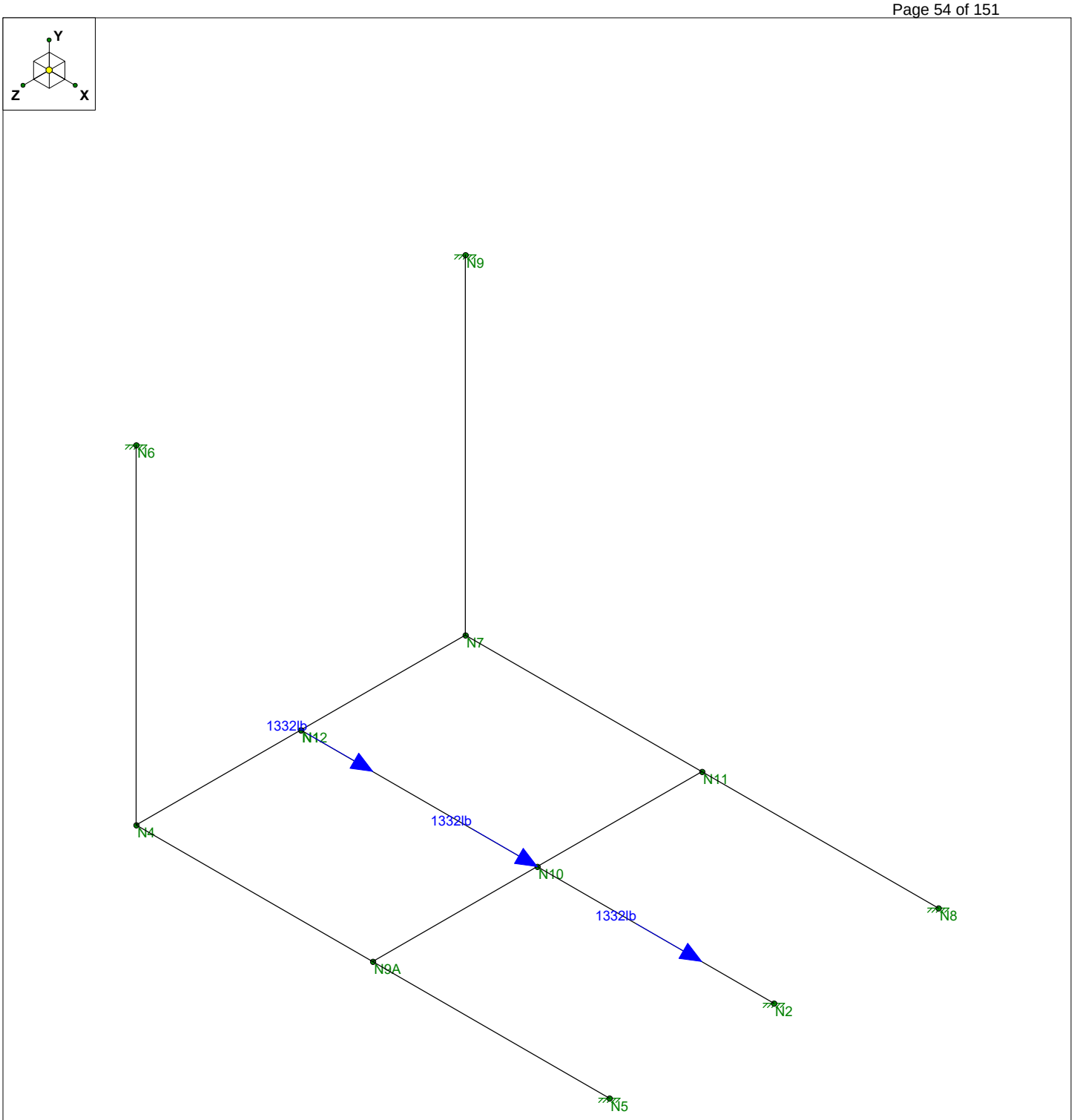
SUPPORT-4
(DETAIL 4)



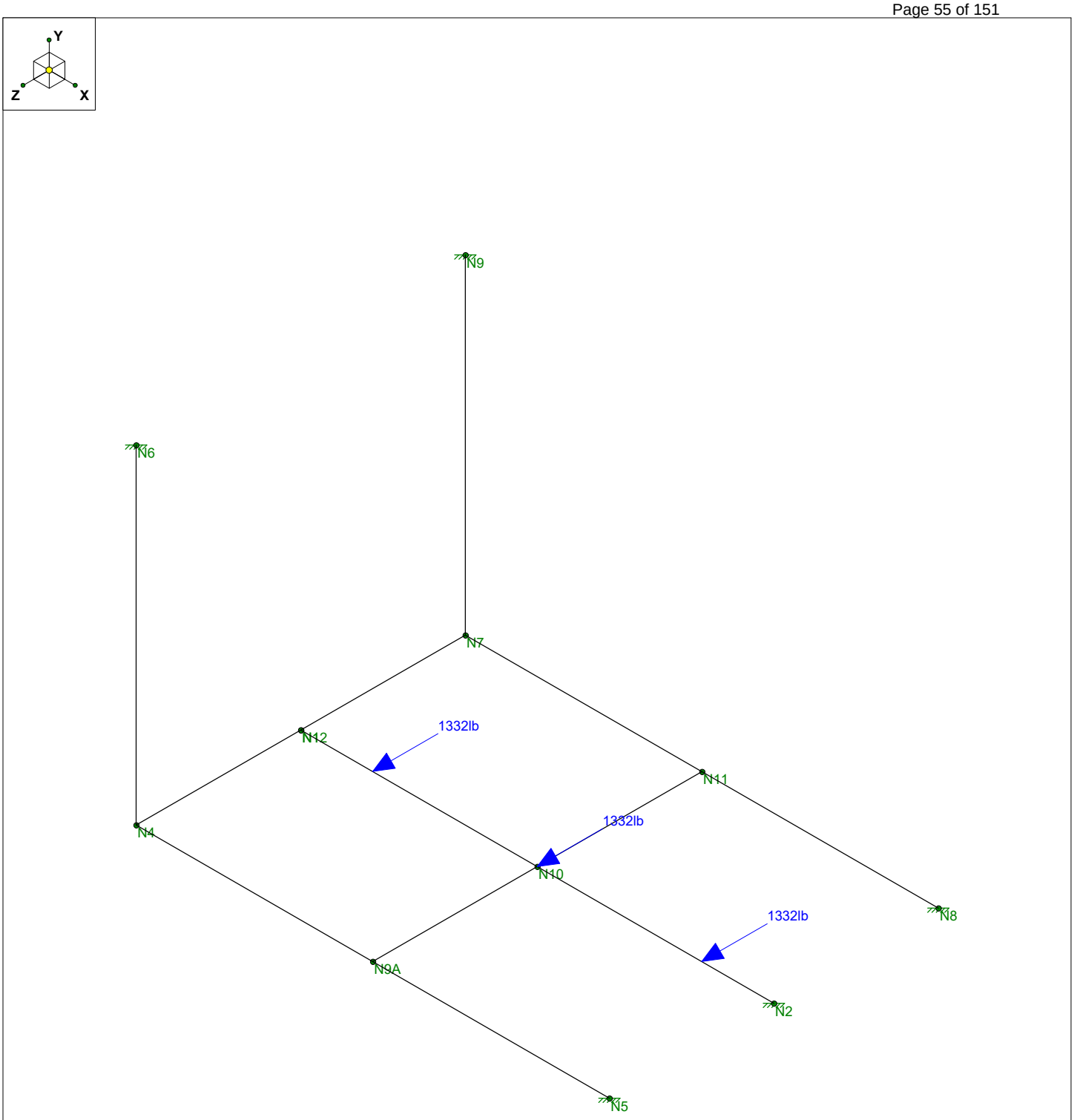
Loads: BLC 1, DL

Fortress Structural Engine...	Rigid Frame	SK - 1
KJ		July 28, 2020 at 2:26 PM
20118		20118 - Costco Generator Exhaust...



Loads: BLC 2, SEIS-X

Fortress Structural Engine...	Rigid Frame	SK - 2
KJ		July 28, 2020 at 2:28 PM
20118		20118 - Costco Generator Exhaust...



Loads: BLC 3, SEIS-Z

Fortress Structural Engine...	Rigid Frame	SK - 3
KJ		July 28, 2020 at 2:28 PM
20118		20118 - Costco Generator Exhaust...

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): LRFD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 14th(360-10): LRFD
Cold Formed Steel Code	AISI NAS-04: ASD
Wood Code	AWC NDS-12: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-11
Masonry Code	ACI 530-11: ASD
Aluminum Code	AA ADM1-10: ASD - Building
	AISC 14th(360-10): LRFD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-10
Seismic Base Elevation (ft)	Not Entered
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	.634
SDS	.634
S1	.951
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	2.5
Om X	2.5
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
2	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
3	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.4	65	1.3
8	S316	29000	11154	.3	.65	.49	30	1.5	58	1.2

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	11.5	0	0	0	
3	N4	0	0	4	0	
4	N5	11.5	0	4	0	
5	N6	0	8	4	0	
6	N7	0	0	-4	0	
7	N8	11.5	0	-4	0	
8	N9	0	8	-4	0	
9	N9A	5.75	0	4	0	
10	N10	5.75	0	0	0	
11	N11	5.75	0	-4	0	
12	N12	0	0	0	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1						
2	N2	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
3	N4						
4	N5	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
5	N6	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
6	N7						
7	N8	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
8	N9	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N2			Beam	Beam	Tube	A36 Gr.36	Typical
2	M3	N4	N5			Beam	Beam	Tube	A36 Gr.36	Typical
3	M4	N4	N6			Post	Column	Channel	A36 Gr.36	Typical
4	M5	N7	N8			Beam	Beam	Tube	A36 Gr.36	Typical
5	M6	N7	N9			Post	Column	Channel	A36 Gr.36	Typical
6	M7A	N4	N7			Beam	Beam	Tube	A36 Gr.36	Typical
7	M7	N9A	N10			Beam	Beam	Tube	A36 Gr.36	Typical
8	M8	N10	N11			Beam	Beam	Tube	A36 Gr.36	Typical

Member Point Loads (BLC 1 : DL)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Y	-2082	1.75
2	M1	Y	-2080	5.75
3	M1	Y	-2080	9.75

Member Point Loads (BLC 2 : SEIS-X)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	X	1332	1.75
2	M1	X	1332	5.75
3	M1	X	1332	9.75

Member Point Loads (BLC 3 : SEIS-Z)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Z	1332	1.75
2	M1	Z	1332	5.75
3	M1	Z	1332	9.75

Basic Load Cases

	BLC Descript...	Category	X Gra..	Y Gra..	Z Gra...	Joint	Point	Distri...	Area(...	Surfa...
1	DL	DL		-1			3			
2	SEIS-X	ELX					3			
3	SEIS-Z	ELZ					3			

Load Combinations

	Description	S...	PDelta	S...	B...	Fac...	B...	Fac...	BLC	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...
1	Deflection 1	Yes	Y		DL	1																		
2	Deflection 2	Yes	Y		LL	1																		
3	Deflection 3	Yes	Y		DL	1	LL	1																
4	IBC 16-1	Yes	Y		DL	1.4																		
5	IBC 16-2 (a)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
6	IBC 16-5 (a)	Yes	Y		DL	1.2	S...	.2	ELX	1	LL	.5	LLS	1										
7	IBC 16-5 (b)	Yes	Y		DL	1.2	S...	.2	ELZ	1	LL	.5	LLS	1										
8	IBC 16-5 (c)	Yes	Y		DL	1.2	S...	.2	ELX	-1	LL	.5	LLS	1										
9	IBC 16-5 (d)	Yes	Y		DL	1.2	S...	.2	ELZ	-1	LL	.5	LLS	1										
10	IBC 16-7 (a)	Yes	Y		DL	.9	S...	-.2	ELX	1														
11	IBC 16-7 (b)	Yes	Y		DL	.9	S...	-.2	ELZ	1														
12	IBC 16-7 (c)	Yes	Y		DL	.9	S...	-.2	ELX	-1														
13	IBC 16-7 (d)	Yes	Y		DL	.9	S...	-.2	ELZ	-1														
14	IBC 16-5 (os-a)	Yes	Y		DL	1.2	S...	.2	Om*E...	1	LL	.5	LLS	1										
15	IBC 16-5 (os-b)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	1	LL	.5	LLS	1										
16	IBC 16-5 (os-c)	Yes	Y		DL	1.2	S...	.2	Om*E...	-1	LL	.5	LLS	1										
17	IBC 16-5 (os-d)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	-1	LL	.5	LLS	1										
18	IBC 16-7 (os-a)	Yes	Y		DL	.9	S...	-.2	Om*E...	1														
19	IBC 16-7 (os-b)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	1														
20	IBC 16-7 (os-c)	Yes	Y		DL	.9	S...	-.2	Om*E...	-1														
21	IBC 16-7 (os-d)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	-1														

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation [...	LC	Y Rotation [...	LC	Z Rotation [...	LC
1	N1	max	.001	10	0	2	.321	11	5.313e-03	9	0	2	2.998e-03	9
2		min	-.001	8	-.257	9	-.423	9	0	2	-4.3e-04	7	0	2
3	N2	max	0	10	0	2	0	11	0	9	0	11	0	4
4		min	0	8	0	7	0	9	0	11	0	9	0	2
5	N4	max	0	11	0	2	.253	7	2.725e-03	13	1.693e-03	9	0	2
6		min	0	9	-.001	9	-.213	13	-4.576e-03	7	-1.724e-04	11	-2.881e-04	9
7	N5	max	0	11	0	2	0	11	0	2	0	11	0	9
8		min	0	9	0	9	0	9	0	9	0	9	0	2
9	N6	max	0	9	0	2	0	11	0	9	0	9	0	9
10		min	0	2	0	9	0	9	0	11	0	11	0	2
11	N7	max	0	13	0	2	.321	11	5.362e-03	9	6.266e-04	11	0	2
12		min	0	7	-.001	7	-.423	9	0	2	-1.028e-03	9	-2.725e-04	9
13	N8	max	0	13	0	2	0	11	0	9	0	11	0	9
14		min	0	7	0	9	0	9	0	2	0	9	0	2
15	N9	max	0	9	0	2	0	7	0	13	0	11	0	9
16		min	0	2	0	7	0	13	0	7	0	9	0	2
17	N9A	max	0	11	0	2	.221	11	0	2	1.386e-03	7	7.571e-05	9
18		min	0	9	-.023	9	-.252	9	-1.157e-03	9	-1.27e-03	13	0	2
19	N10	max	0	10	0	2	.221	11	6.776e-06	9	1.022e-03	11	2.017e-03	9
20		min	-.001	8	-.063	9	-.252	9	-9.279e-07	11	-1.38e-03	9	0	2
21	N11	max	0	13	0	2	.221	11	1.174e-03	9	1.735e-03	11	7.141e-05	9
22		min	0	7	-.022	9	-.252	9	0	2	-2.254e-03	9	0	2
23	N12	max	.008	11	.13	13	.253	7	2.715e-03	13	1.693e-03	9	0	2
24		min	-.082	9	-.221	7	-.213	13	-4.592e-03	7	-1.724e-04	11	-2.881e-04	9

Member Suggested Shapes

	Section Set/Member	Current Shape	Suggested Shape	Controlling Member	Controlling Criteria	Use Suggested?
1	Beam	C12x30	HSS4.5x4.5x4	M1	Strength	Yes
2	Post	C12x30	C9x13.4	M4	Strength	Yes

Envelope AISC 14th(360-10): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Che...	Loc[ft]	Dir	...	phi*P...	phi*P...	phi*M...	phi*M.....	Eqn
1	M1	C12x30	.546	11.5	9	.057	5.75	y	9	6073...	285444	1063...	1.024.....	H1-1b
2	M3	C12x30	.402	11.5	9	.038	5.75	y	9	6073...	285444	1063...	1.095.....	H1-1b
3	M4	C12x30	.124	8	9	.013	4	y	9	1238...	285444	1063...	1.095.....	H1-1b
4	M5	C12x30	.372	11.5	9	.043	5.75	y	9	6073...	285444	1063...	1.095.....	H1-1b
5	M6	C12x30	.403	0	7	.014	4	z	7	1238...	285444	1063...	1.095.....	H1-1b
6	M7A	C12x30	.143	8	9	.035	4	z	9	1238...	285444	1063...	1.095.....	H1-1b
7	M7	C12x30	.349	4	9	.048	3.792	y	9	2316...	285444	1063...	1.095.....	H1-1b
8	M8	C12x30	.393	0	9	.047	.208	y	9	2316...	285444	1063...	1.095.....	H1-1b

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
1	M1	1	max	89.197	11	763.98	7	575.045	13	1068.024	9	6197.691	9	0	2
2			min	-349.159	9	-294.558	13	-767.007	7	0	2	0	2	-1158.21	9
3		2	max	1233.571	10	0	2	616.149	11	1068.024	9	6422.683	13	43951....	9
4			min	-1494.0...	8	-3046.1...	9	-805.464	9	0	2	-6590.263	7	0	2
5		3	max	2476.997	10	0	2	616.149	11	1068.024	9	21987.43	9	151016...	9
6			min	-2934.4...	8	-3160.5...	9	-805.464	9	0	2	-19907.653	11	0	2
7		4	max	2476.997	10	1370.501	9	504.656	11	1.364	9	2038.457	13	100384...	9
8			min	-2934.4...	8	0	2	-582.816	9	-.187	11	-2663.201	7	0	2
9		5	max	3808.997	10	0	2	1836.656	11	1.364	9	42885.611	11	116999...	4
10			min	-4266.4...	8	-2362.1...	7	-1914.8...	9	-.187	11	-46198.902	9	0	2
11	M3	1	max	0	2	1836.076	9	154.539	9	694.993	13	30.533	11	40897....	9
12			min	-617.043	9	0	2	-77.487	11	-739.713	7	-299.732	9	0	2
13		2	max	0	2	1721.721	9	154.539	9	694.993	13	5031.874	9	0	2
14			min	-617.043	9	0	2	-77.487	11	-739.713	7	-2642.752	11	-20474....	9
15		3	max	459.913	11	0	2	748.391	11	694.993	13	28898.902	9	0	2
16			min	-1404.8...	9	-2281.3...	9	-899.037	9	-739.713	7	-23473.584	11	-77900....	9
17		4	max	459.913	11	0	2	748.391	11	0	2	2386.484	7	3466.608	9
18			min	-1404.8...	9	-2395.7...	9	-899.037	9	-232.926	9	-2185.73	13	0	2
19		5	max	459.913	11	0	2	748.391	11	0	2	28165.398	11	88091....	9
20			min	-1404.8...	9	-2510.0...	9	-899.037	9	-232.926	9	-33134.652	9	0	2
21	M4	1	max	0	2	0	2	74.974	11	299.732	9	4495.409	9	0	2
22			min	-1995.3...	9	-617.058	9	-150.523	9	-30.533	11	0	2	-40897....	9
23		2	max	0	2	0	2	74.974	11	299.732	9	4370.346	7	0	2
24			min	-2074.9...	9	-617.058	9	-150.523	9	-30.533	11	-225.598	13	-26088....	9
25		3	max	0	2	0	2	74.974	11	299.732	9	5661.963	7	0	2
26			min	-2154.4...	9	-617.058	9	-150.523	9	-30.533	11	-3371.406	13	-11278....	9
27		4	max	0	2	0	2	74.974	11	299.732	9	6953.58	7	3543.361	4
28			min	-2234.0...	9	-617.058	9	-150.523	9	-30.533	11	-6517.215	13	0	2
29		5	max	0	2	0	2	74.974	11	299.732	9	8689.552	11	18339....	9
30			min	-2313.5...	9	-617.058	9	-150.523	9	-30.533	11	-9954.786	9	0	2
31	M5	1	max	0	2	1828.1	9	76.923	11	842.969	9	10743.68	9	41708....	9
32			min	-487.626	7	0	2	-250.219	9	0	2	-4562.709	11	0	2

Envelope Member Section Forces (Continued)

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
33		2	max	0	2	1713.746	9	76.923	11	842.969	9	2111.108	9	0	2
34			min	-487.626	7	0	2	-250.219	9	0	2	-1908.875	11	-19388....	9
35		3	max	914.68	13	0	2	693.361	11	842.969	9	21920.035	9	0	2
36			min	-1244.8...	7	-2235.0...	9	-747.85	9	0	2	-20933.378	11	-76539....	9
37		4	max	914.68	13	0	2	693.361	11	236.232	9	2987.57	11	3231.871	9
38			min	-1244.8...	7	-2349.4...	9	-747.85	9	0	2	-3880.783	9	0	2
39		5	max	914.68	13	0	2	693.361	11	236.232	9	26908.518	11	86259....	9
40			min	-1244.8...	7	-2463.7...	9	-747.85	9	0	2	-29681.6	9	0	2
41	M6	1	max	0	2	0	2	728.338	7	110.954	11	13100.08	13	0	2
42			min	-2367.3...	7	-622.57	9	-364.219	13	-182.027	9	-39134.4	7	-40550....	9
43		2	max	0	2	0	2	728.338	7	110.954	11	4358.819	13	0	2
44			min	-2446.9...	7	-622.57	9	-364.219	13	-182.027	9	-21654.278	7	-25608.8	9
45		3	max	0	2	0	2	728.338	7	110.954	11	0	2	0	2
46			min	-2526.4...	7	-622.57	9	-364.219	13	-182.027	9	-6634.246	9	-10667....	9
47		4	max	0	2	0	2	728.338	7	110.954	11	13305.966	7	4274.544	9
48			min	-2606.0...	7	-622.57	9	-364.219	13	-182.027	9	-13123.703	13	0	2
49		5	max	0	2	0	2	728.338	7	110.954	11	30786.088	7	19216....	9
50			min	-2685.5...	7	-622.57	9	-364.219	13	-182.027	9	-21864.964	13	0	2
51	M7A	1	max	0	1	167.879	4	0	1	0	1	0	1	4029.107	4
52			min	0	1	0	2	0	1	0	1	0	1	0	2
53		2	max	0	1	83.94	4	0	1	0	1	0	1	1007.277	4
54			min	0	1	0	2	0	1	0	1	0	1	0	2
55		3	max	574.418	13	293.081	13	349.153	9	0	2	0	2	0	2
56			min	-767.03	7	-761.29	7	-89.206	11	-1158.21	9	-6197.691	9	-1068.0...	9
57		4	max	574.418	13	246.723	13	349.153	9	0	2	2213.955	13	18498....	7
58			min	-767.03	7	-840.841	7	-89.206	11	-1158.21	9	-2347.819	7	-7171.5...	13
59		5	max	574.418	13	200.364	13	349.153	9	0	2	10561.653	9	39633....	7
60			min	-767.03	7	-920.392	7	-89.206	11	-1158.21	9	-4451.755	11	-12536....	13
61	M7	1	max	824.316	11	3888.521	9	787.791	9	687.474	9	18157.546	11	909.893	9
62			min	-1059.1...	9	0	2	-721.446	11	0	2	-18535.423	9	-638.3	11
63		2	max	824.316	11	3848.746	9	787.791	9	687.474	9	9538.887	7	0	2
64			min	-1059.1...	9	0	2	-721.446	11	0	2	-9222.627	13	-45513....	9
65		3	max	824.316	11	3808.97	9	787.791	9	687.474	9	1140.048	7	0	2
66			min	-1059.1...	9	0	2	-721.446	11	0	2	0	2	-91460	9
67		4	max	824.316	11	3769.195	9	787.791	9	687.474	9	9825.037	9	0	2
68			min	-1059.1...	9	0	2	-721.446	11	0	2	-7814.522	11	-13692...	9
69		5	max	824.316	11	3729.419	9	787.791	9	687.474	9	19278.523	9	0	2
70			min	-1059.1...	9	0	2	-721.446	11	0	2	-16471.879	11	-18192...	9
71	M8	1	max	525.399	13	0	2	1094.953	9	0	2	18147.887	11	0	2
72			min	-650.062	7	-3675.6...	9	-829.713	11	-689.001	9	-24116.241	9	-18085...	9
73		2	max	525.399	13	0	2	1094.953	9	0	2	8191.331	11	0	2
74			min	-650.062	7	-3715.3...	9	-829.713	11	-689.001	9	-10976.806	9	-13650...	9
75		3	max	525.399	13	0	2	1094.953	9	0	2	2162.629	9	0	2
76			min	-650.062	7	-3755.1...	9	-829.713	11	-689.001	9	-1765.225	11	-91684....	9
77		4	max	525.399	13	0	2	1094.953	9	0	2	15302.064	9	0	2
78			min	-650.062	7	-3794.9...	9	-829.713	11	-689.001	9	-11721.78	11	-46384....	9
79		5	max	525.399	13	0	2	1094.953	9	0	2	28441.499	9	0	2
80			min	-650.062	7	-3834.7...	9	-829.713	11	-689.001	9	-21678.336	11	-606.737	9

Joint Reactions

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	1	N2	218.109	1457.114	38.254	-.559	1612.872	-83573.156
2	1	N5	451.548	1689.679	72.194	156.096	2387.115	-59062.878
3	1	N6	-418.319	1599.59	36.196	-649.711	-125.139	-12571.035
4	1	N8	159.814	1672.272	26.725	-156.964	1349.974	-58448.834
5	1	N9	-411.153	1816.914	-173.369	4290.934	33.924	-12468.016
6	1	Totals:	0	8235.568	0			
7	1	COG (ft):	X: 5.247	Y: .233	Z: 0			
8	2	N2	0	0	0	0	0	0
9	2	N5	0	0	0	0	0	0
10	2	N6	0	0	0	0	0	0
11	2	N8	0	0	0	0	0	0
12	2	N9	0	0	0	0	0	0
13	2	Totals:	0	0	0			
14	2	COG (ft):	NC	NC	NC			
15	3	N2	218.109	1457.114	38.254	-.559	1612.872	-83573.156
16	3	N5	451.548	1689.679	72.194	156.096	2387.115	-59062.878
17	3	N6	-418.319	1599.59	36.196	-649.711	-125.139	-12571.035
18	3	N8	159.814	1672.272	26.725	-156.964	1349.974	-58448.834
19	3	N9	-411.153	1816.914	-173.369	4290.934	33.924	-12468.016
20	3	Totals:	0	8235.568	0			
21	3	COG (ft):	X: 5.247	Y: .233	Z: 0			
22	4	N2	304.648	2040.388	53.514	-.782	2254.81	-116999.662
23	4	N5	632.137	2365.347	100.887	218.511	3334.829	-82678.634
24	4	N6	-585.576	2239.285	50.588	-916.946	-174.439	-17597.402
25	4	N8	224.331	2340.964	37.382	-219.725	1887.12	-81819.925
26	4	N9	-575.541	2543.812	-242.371	6014.979	47.398	-17452.811
27	4	Totals:	0	11529.796	0			
28	4	COG (ft):	X: 5.247	Y: .233	Z: 0			
29	5	N2	261.429	1748.72	45.888	-.67	1934.072	-100286.605
30	5	N5	541.845	2027.527	86.553	187.305	2861.478	-70871.424
31	5	N6	-501.953	1919.447	43.398	-782.815	-149.842	-15084.364
32	5	N8	192.03	2006.634	32.056	-188.346	1618.751	-70134.98
33	5	N9	-493.352	2180.353	-207.895	5152.411	40.667	-14960.585
34	5	Totals:	0	9882.682	0			
35	5	COG (ft):	X: 5.247	Y: .233	Z: 0			
36	6	N2	-3688.816	1930.911	50.668	-.741	2166.23	-110899.669
37	6	N5	591.565	2242.13	93.608	207.13	3123.467	-78372.447
38	6	N6	-555.156	2122.579	48.421	-907.266	-163.978	-16685.332
39	6	N8	202.082	2218.973	38.297	-208.285	1862.833	-77556.76
40	6	N9	-545.676	2412.359	-230.995	5756.984	41.081	-16550.752
41	6	Totals:	-3996	10926.952	0			
42	6	COG (ft):	X: 5.247	Y: .233	Z: 0			
43	7	N2	-76.442	2362.092	-1813.411	-.121	-41925.598	-108743.068
44	7	N5	-206.818	1973.637	-707.005	181.325	-26800.143	-68648.546
45	7	N6	-493.086	1931.402	-58.492	8245.196	-33.434	-15021.261
46	7	N8	1244.886	1974.245	-681.055	-180.324	-26105.324	-68849.081
47	7	N9	-468.539	2685.576	-736.037	30786.088	-91.855	-13871.771
48	7	Totals:	0	10926.952	-3996			
49	7	COG (ft):	X: 5.247	Y: .233	Z: 0			
50	8	N2	4266.485	1936.35	50.769	-.741	2108.934	-110865.79
51	8	N5	606.619	2241.286	97.683	207.05	3200.098	-78342.237

Joint Reactions (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
52	8	N6	-554.787	2121.874	47.496	-828.264	-166.92	-16669.992
53	8	N8	222.929	2218.232	32.576	-208.197	1715.271	-77529.974
54	8	N9	-545.246	2409.209	-228.524	5641.407	48.789	-16530.623
55	8	Totals:	3996	10926.952	0			
56	8	COG (ft):	X: 5.247	Y: .233	Z: 0			
57	9	N2	656.332	1504.198	1917.213	-1.364	46198.902	-113029.724
58	9	N5	1404.828	2510.553	904.162	232.926	33134.652	-88091.937
59	9	N6	-617.043	2313.577	155.005	-9954.786	-299.732	-18339.807
60	9	N8	-821.543	2463.516	744.851	-236.232	29681.6	-86259.757
61	9	N9	-622.573	2135.108	274.769	-19404.896	182.027	-19216.216
62	9	Totals:	0	10926.952	3996			
63	9	COG (ft):	X: 5.247	Y: .233	Z: 0			
64	10	N2	-3808.997	1125.361	29.804	-.433	1272.127	-64626.314
65	10	N5	341.385	1306.493	53.709	120.693	1804.804	-45669.06
66	10	N6	-323.535	1236.87	28.456	-538.447	-95.475	-9724.785
67	10	N8	113.172	1292.997	23.439	-121.368	1114.46	-45192.664
68	10	N9	-318.025	1406.021	-135.408	3375.751	22.37	-9647.463
69	10	Totals:	-3996	6367.741	0			
70	10	COG (ft):	X: 5.247	Y: .233	Z: 0			
71	11	N2	-197.457	1555.64	-1836.022	.187	-42885.611	-62478.827
72	11	N5	-459.913	1038.279	-746.917	94.912	-28165.398	-35951.288
73	11	N6	-261.535	1045.85	-77.399	8689.552	30.533	-8063.742
74	11	N8	1159.779	1048.292	-697.08	-93.425	-26908.518	-36490.555
75	11	N9	-240.875	1679.68	-638.582	28478.515	-110.954	-6966.465
76	11	Totals:	0	6367.741	-3996			
77	11	COG (ft):	X: 5.247	Y: .233	Z: 0			
78	12	N2	4146.711	1127.653	29.371	-.432	1224.201	-64612.935
79	12	N5	356.908	1306.553	58.052	120.709	1891.238	-45671.624
80	12	N6	-323.397	1236.823	27.573	-461.658	-98.518	-9716.34
81	12	N8	133.606	1293.139	17.913	-121.376	975.095	-45197.87
82	12	N9	-317.827	1403.573	-132.91	3255.048	30.146	-9634.567
83	12	Totals:	3996	6367.741	0			
84	12	COG (ft):	X: 5.247	Y: .233	Z: 0			
85	13	N2	537.417	696.4	1897.567	-1.054	45379.943	-66767.85
86	13	N5	1158.016	1575.543	864.583	146.562	31872.511	-55415.24
87	13	N6	-385.584	1428.369	134.032	-9663.023	-226.85	-11383.146
88	13	N8	-914.68	1538.401	731.31	-149.394	28996.147	-53922.146
89	13	N9	-395.169	1129.029	368.508	-21864.964	163.775	-12322.2
90	13	Totals:	0	6367.741	3996			
91	13	COG (ft):	X: 5.247	Y: .233	Z: 0			

Joint Reactions - Overstrength

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	14	N2	-9655.33	1926.831	50.568	-.742	2209.774	-110925.082
2	14	N5	580.279	2242.762	90.563	207.189	3066.428	-78395.061
3	14	N6	-555.432	2123.107	49.117	-966.673	-161.773	-16696.825
4	14	N8	186.48	2219.527	42.605	-208.351	1974.072	-77576.81
5	14	N9	-545.998	2414.725	-232.853	5843.891	35.291	-16565.805
6	14	Totals:	-9990	10926.952	0			
7	14	COG (ft):	X: 5.247	Y: .233	Z: 0			

Joint Reactions - Overstrength (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
8	15	N2	-620.236	3002.966	-4605.254	.804	-108023.602	-105547.363
9	15	N5	-1416.027	1572.975	-1899.974	142.812	-71722.248	-54133.515
10	15	N6	-400.606	1646.148	-217.048	21963.688	160.298	-12547.395
11	15	N8	2790.382	1608.745	-1769.01	-138.589	-67949.996	-55848.931
12	15	N9	-353.513	3096.118	-1498.713	68384.836	-296.483	-9880.699
13	15	Totals:	0	10926.952	-9990			
14	15	COG (ft):	X: 5.247	Y: .233	Z: 0			
15	16	N2	10232.922	1940.43	50.82	-.74	2066.528	-110840.384
16	16	N5	617.914	2240.652	100.751	206.991	3258.003	-78319.538
17	16	N6	-554.509	2121.345	46.803	-769.166	-169.127	-16658.475
18	16	N8	238.597	2217.676	28.302	-208.131	1605.163	-77509.848
19	16	N9	-544.922	2406.85	-226.676	5554.948	54.562	-16515.482
20	16	Totals:	9990	10926.952	0			
21	16	COG (ft):	X: 5.247	Y: .233	Z: 0			
22	17	N2	1211.719	858.23	4721.418	-2.304	112288.082	-116263.93
23	17	N5	2613.116	2915.273	2127.943	271.812	78115.05	-102742.244
24	17	N6	-710.501	2601.59	316.695	-23536.887	-505.407	-20843.8
25	17	N8	-2375.734	2831.926	1795.684	-278.357	71517.649	-99375.827
26	17	N9	-738.601	1719.933	1028.26	-57093.357	388.23	-23241.9
27	17	Totals:	0	10926.952	9990			
28	17	COG (ft):	X: 5.247	Y: .233	Z: 0			
29	18	N2	-9775.818	1123.649	30.11	-.433	1308.539	-64636.326
30	18	N5	329.745	1306.444	50.46	120.681	1740.314	-45667.016
31	18	N6	-323.637	1236.902	29.119	-596.164	-93.193	-9731.091
32	18	N8	97.882	1292.887	27.598	-121.362	1219.457	-45188.649
33	18	N9	-318.171	1407.86	-137.288	3466.569	16.53	-9657.072
34	18	Totals:	-9990	6367.741	0			
35	18	COG (ft):	X: 5.247	Y: .233	Z: 0			
36	19	N2	-742.766	2197.521	-4630.069	1.11	-109089.725	-59281.57
37	19	N5	-1673.866	637.36	-1940.03	56.361	-73164.585	-21420.934
38	19	N6	-168.988	760.34	-234.387	22523.973	217.458	-5589.274
39	19	N8	2711.274	682.168	-1787.02	-51.644	-68841.736	-23474.848
40	19	N9	-125.655	2090.353	-1398.494	66191.483	-316.211	-2966.979
41	19	Totals:	0	6367.741	-9990			
42	19	COG (ft):	X: 5.247	Y: .233	Z: 0			
43	20	N2	10113.452	1129.378	29.029	-.432	1188.718	-64602.879
44	20	N5	368.552	1306.596	61.317	120.72	1956.395	-45673.428
45	20	N6	-323.293	1236.785	26.912	-404.191	-100.802	-9709.979
46	20	N8	148.967	1293.243	13.783	-121.382	871.04	-45201.665
47	20	N9	-317.677	1401.739	-131.042	3164.811	35.97	-9624.835
48	20	Totals:	9990	6367.741	0			
49	20	COG (ft):	X: 5.247	Y: .233	Z: 0			
50	21	N2	1094.442	49.419	4704.015	-1.993	111574.51	-70004.054
51	21	N5	2370.975	1980.525	2088.719	185.487	76930.486	-70081.029
52	21	N6	-479.111	1716.642	294.195	-23357.871	-425.976	-13887.818
53	21	N8	-2474.915	1907.442	1783.883	-191.567	70920.195	-67054.01
54	21	N9	-511.392	713.712	1119.188	-59667.9	370.616	-16356.396
55	21	Totals:	0	6367.741	9990			
56	21	COG (ft):	X: 5.247	Y: .233	Z: 0			

Company : Fortress Structural Engineers
Designer : KJ
Job Number : 20118
Model Name : Rigid Frame

for wall anchorage

Envelope Joint Reactions - Overstrength

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-in]	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N2	max	10232.922	16	3002.966	15	4721.418	17	1.11	19	112288.082	17	-59281.57	19
2		min	-9775.818	18	49.419	21	-4630.069	19	-2.304	17	-109089.725	19	-116263.93	17
3	N5	max	2613.116	17	2915.273	17	2127.943	17	271.812	17	78115.05	17	-21420.934	19
4		min	-1673.866	19	637.36	19	-1940.03	19	56.361	19	-73164.585	19	-102742.244	17
5	N6	max	-168.988	19	2601.59	17	316.695	17	22523.973	19	217.458	19	-5589.274	19
6		min	-710.501	17	760.34	19	-234.387	19	-23536.887	17	-505.407	17	-20843.8	17
7	N8	max	2790.382	15	2831.926	17	1795.684	17	-51.644	19	71517.649	17	-23474.848	19
8		min	-2474.915	21	682.168	19	-1787.02	19	-278.357	17	-68841.736	19	-99375.827	17
9	N9	max	-125.655	19	3096.118	15	1119.188	21	68384.836	15	388.23	17	-2966.979	19
10		min	-738.601	17	713.712	21	-1498.713	15	-59667.9	21	-316.211	19	-23241.9	17
11	Totals:	max	9990	16	10926.952	15	9990	21						
12		min	-9990	18	6367.741	21	-9990	15						

worst of N6 and n9 for ceiling anchorage

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb...	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N2	max	4266.4...	8	2362.092	7	1917.2...	9	.187	11	46198.902	9	0	2
2		min	-3808....	10	0	2	-1836....	11	-1.364	9	-42885.611	11	-116999.662	4
3	N5	max	1404.8...	9	2510.553	9	904.162	9	232.926	9	33134.652	9	0	2
4		min	-459.9...	11	0	2	-746.9...	11	0	2	-28165.398	11	-88091.937	9
5	N6	max	0	2	2313.577	9	155.005	9	8689.5...	11	30.533	11	0	2
6		min	-617.0...	9	0	2	-77.399	11	-9954....	9	-299.732	9	-18339.807	9
7	N8	max	1244.8...	7	2463.516	9	744.851	9	0	2	29681.6	9	0	2
8		min	-914.68	13	0	2	-697.08	11	-236.2...	9	-26908.518	11	-86259.757	9
9	N9	max	0	2	2685.576	7	368.508	13	30786....	7	182.027	9	0	2
10		min	-622.5...	9	0	2	-736.0...	7	-21864...	13	-110.954	11	-19216.216	9
11	Totals:	max	3996	12	11529.796	4	3996	13						
12		min	-3996	6	0	2	-3996	7						

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Company:	Fortress Structural Engineering	Page:	1
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	07-28-20_ 20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

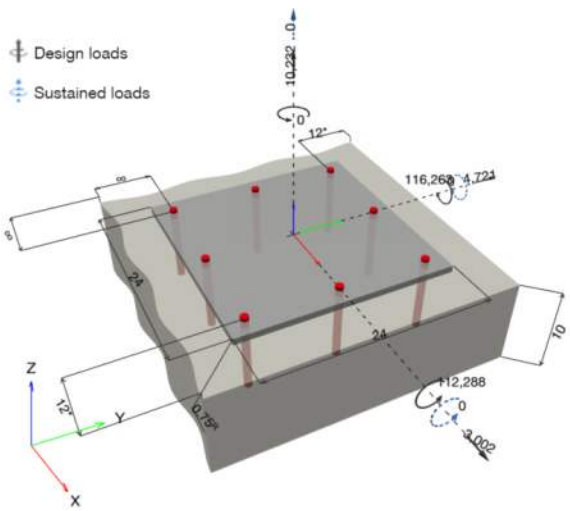
Specifier's comments:

1 Input data

Anchor type and diameter:	**HIT-HY 200 + HAS-V-36 (ASTM F1554 Gr.36) 7/8**
Item number:	not available (element) / 2022793 HIT-HY 200-R (adhesive)
Effective embedment depth:	$h_{ef,act}$ = 8.000 in. ($h_{ef,limit}$ = - in.)
Material:	ASTM A 1554 Grade 36
Evaluation Service Report:	ESR-3187
Issued I Valid:	4/1/2020 | 3/1/2022
Proof:	Design Method ACI 318-14 / Chem
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate[R]:	l_x x l_y x t = 24.000 in. x 24.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 10.000 in., Temp. short/long: 32/32 °F
Installation:	**hammer drilled hole, Installation condition: Dry**
Reinforcement:	tension: condition B, shear: condition B; no supplemental splitting reinforcement present edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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Design:	07-28-20_ 20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 10,232; V_x = 3,002; V_y = 4,721; M_x = 112,288; M_y = 116,263; M_z = 0; N_{sus} = 0; $M_{x,sus}$ = 0; $M_{y,sus}$ = 0;	yes	56

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Design:	07-28-20_ 20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	15,121	27,120	56 / -	OK
Shear	Concrete edge failure in direction x+	5,595	17,253	- / 33	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.558	0.324	5/3	54	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Design:	07-28-20_ 20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

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Design:	07-28-20_20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

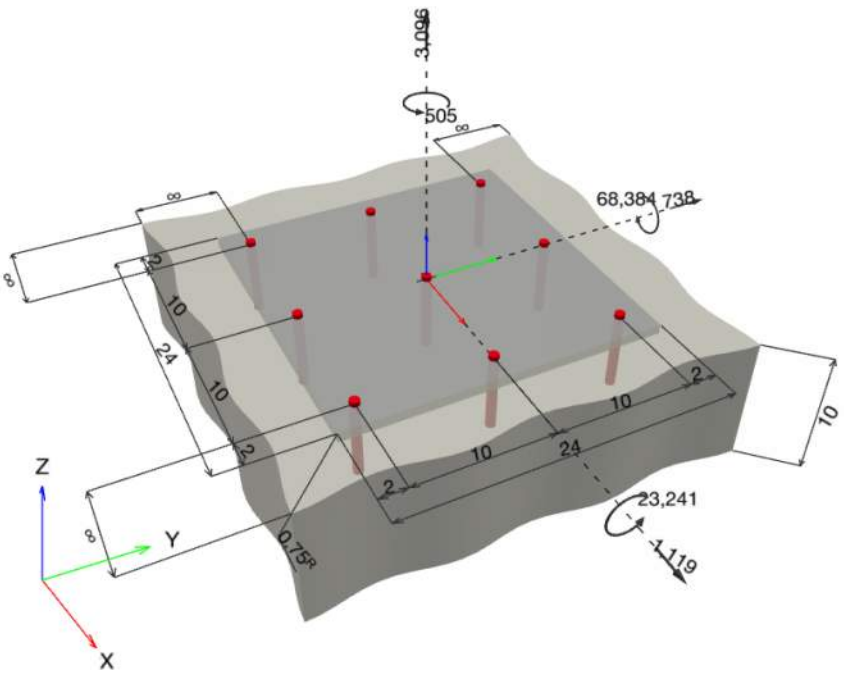
Specifier's comments:

1 Input data

Anchor type and diameter:	**AWS D1.1 GR. B 3/4**
Item number:	not available
Effective embedment depth:	h_{ef} = 6.000 in.
Material:	
Proof:	Design Method ACI 318-14 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.750 in.
Anchor plate[R] :	l_x x l_y x t = 24.000 in. x 24.000 in. x 0.750 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 10.000 in.
Reinforcement:	tension: condition B, shear: condition B; edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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Design:	07-28-20_20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 3,096; V_x = 1,119; V_y = 738; M_x = 23,241; M_y = 68,384; M_z = 505;	yes	17

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Design:	07-28-20_20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	5,913	34,806	17 / -	OK
Shear	Pryout Strength	1,340	146,981	- / 1	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.170	0.009	5/3	6	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Design:	07-28-20_20118_ steel support at level 1_support 4_	Date:	7/28/2020
Fastening point:			

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1. Check 1/4" Weld (C 12x30) to embeded plate-see forces at member(worst case Member M1-Support1)

$t_w := 0.707 \cdot \frac{1}{4}\ in$ (Thickness of weld)

$M_{dz} := 69414\ in \cdot lbf$ (Moment at z Dir.-M1)

$M_{dy} := 28820\ in \cdot lbf$ (Moment at y Dir.)

$V_{dx} := 831 \cdot lbf = 831\ lbf$ (shear at M1)

$V_{dy} := 2793 \cdot lbf = 2793\ lbf$ (shear at M1)

$V_{dz} := 782 \cdot lbf = 782\ lbf$ (shear at M1)

$M_d := M_{dz} + M_{dy} = 98234\ in \cdot lbf$ (Total Moment)

$V_d := V_{dx} + V_{dy} + V_{dz} = 4406\ lbf$ (Total shear)

$b := 2.34\ in \quad d := 8\ in$ (Dimensions of weld)

$S_w := \left(b \cdot d + \frac{d^2}{3}\right) \cdot t_w = 7.1\ in^3$ (Section modulus of weld)

$A_w := t_w \cdot (2 \cdot b + 2 \cdot d) = 3.7\ in^2$ (Area of weld)

Stress due to Moment:

$D_w := \frac{M_d}{S_w} = 14\ ksi$

Stress due to Shear:

$D_v := \frac{V_d}{A_w} = 1\ ksi$

Total stress:

$D_{wt} := \sqrt{D_w^{\,2} + D_v^{\,2}} = 14\ ksi$

$C_w := 0.75 \cdot 0.6 \cdot 70\ ksi = 32\ ksi$ (Weld)

$\frac{D_{wt}}{C_w} = 0.44$ (<1.0 OK, D/C Ratio)

RISER SUPPORT
(DETAIL A)

BY **KJ** DATE 5/26/20 ***Fortress*** JOB NO. **20118**

Costco Biolding-5 Garage **Support Riser** **Holaday-Parks,Inc**

GOVERNING CODES & DESIGN CRITERIA

International Building Code, 2015 edition

ASCE 7-10 Minimum Design Loads for Buildings and Other Structures

Seismic Coefficients

Elements of Structures and Nonstructural Components and Equipment

Seismic Design Category	**E**	**(Per Plans, S0.01)**
Site Class	**F**	
Importance Factor	**1.50**	

	Vib.	Stl/Cu	--	
Component Importance Factor: Ip =	1.50	1.50		(Per Plans, S0.01)
Component Amplification Factor: ap =	2.50	2.50		(Table 13.6-1)
Component Amplification Factor: Rp =	2.50	6.00		(Table 13.6-1)
S_{DS} =	0.634			(Eq 11.4-3)

Lateral Force (Section 13.3): **Strength Design**

	Ip = 1.0	Ip = 1.5	
Horizontal Lower Limit: Fph =(0.3 SDS Ip)*Wp	**0.190**	**0.285**	Eq. 13.3-3
Upper Limit: Fph = (1.6 SDS Ip)*Wp	**1.014**	**1.522**	Eq. 13.3-2
Vertical Fpv = +/- 0.2*SDS*Wp	**0.127**	**0.127**	Eq. 12.4-4
Fph =(0.4 ap SDS)*(1+2z / h) / (Rp / Ip) Wp			Eq. 13.3-1

			Vib.		Stl/Cu		--	
	z	h	Eq. 13.3-1	Fph	Eq. 13.3-1	Fph	Eq. 13.3-1	Fph
Level 1	0.0	104.0	0.380	**0.380**	0.159	**0.190**		
Level 2	18.0	104.0	0.512	**0.512**	0.213	**0.213**		
Level 3	27.0	104.0	0.578	**0.578**	0.241	**0.241**		
Level 4	36.0	104.0	0.644	**0.644**	0.268	**0.268**		
Level 5	45.0	104.0	0.710	**0.710**	0.296	**0.296**		
Level 6	54.0	104.0	0.775	**0.775**	0.323	**0.323**		
Level 7	63.0	104.0	0.841	**0.841**	0.351	**0.351**		
Level 8	72.0	104.0	0.907	**0.907**	0.378	**0.378**		
Level 9	81.0	104.0	0.973	**0.973**	0.405	**0.405**		
Level 10	90.0	104.0	1.039	**1.014**	0.433	**0.433**		
Roof	104.0	104.0	1.141	**1.014**	0.476	**0.476**		

BY **KJ** DATE 7/28/20 ***Fortress*** JOB NO. **20118**

Costco Biolding-5 Garage **Bracing Riser** **Holaday-Parks,Inc**

20" Steel Pipe **Case 2** **Level 10**

Wp = 123.0 plf **6" Min. Concrete**

Fph = 1.014 *Wp **Slab**

Fpv = 0.127 *Wp (Worst case)

Tr =	20	ft	(Max tributary load For 10th Floor)
P = Fph =	2495	lbs	(Total load per angle: Seismic)
P_2 = Fph/2 =	**1248**	lbs	(Seismic force on one side-per pipe)
T (Dead and Thermal)=	**2852**	lbs	**(5703 lbs/2, For themal and dead load see Thermal)**

(latest Forces as Per thermal is 5284 lbs at level 8, which is less then original design)

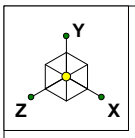
See Risa calculation.

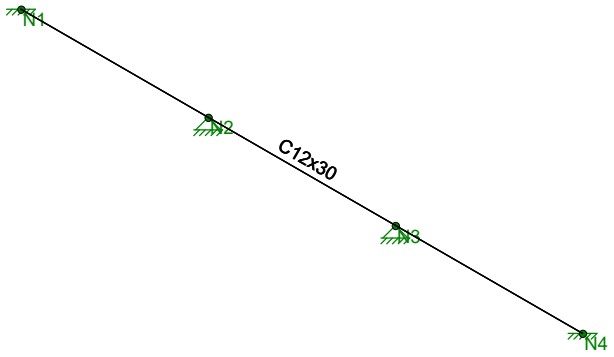
Check Welding

tw =	0.25	in	(Weld size)
lw =	3.0	in	(Weld length)
Aw = tw*lw =	0.75	in^2	(Area of weld)
Vc = 0.75*0.6*70ksi*Aw =	23625	lbs	(Weld capacity)
V Dead=	5703	lbs	(thermal and dead load at 10th floor)
Vd = Fph =	2495	lbs	(Shear demand)
D/C = (V_d/V_c) =	**0.35**		**<=1.0 OK**

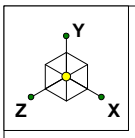
Check Riser Clamp Capacity

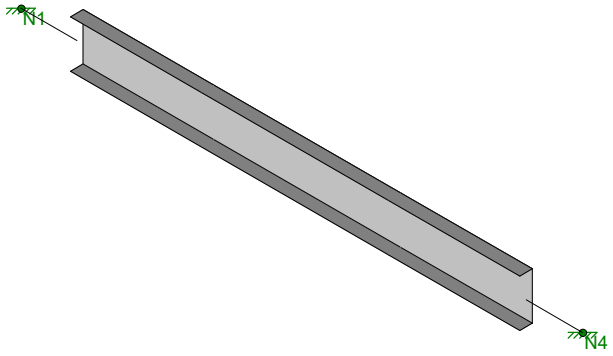
Pd =	5703	lbs	(Point load From Thermal calculation-Worst case whole load)
Pc =	8100	lbs	(See cutsheet in Appendix)
D/C = (P_d/P_c) =	**0.70**		**<=1.0 OK**



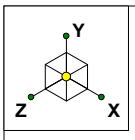


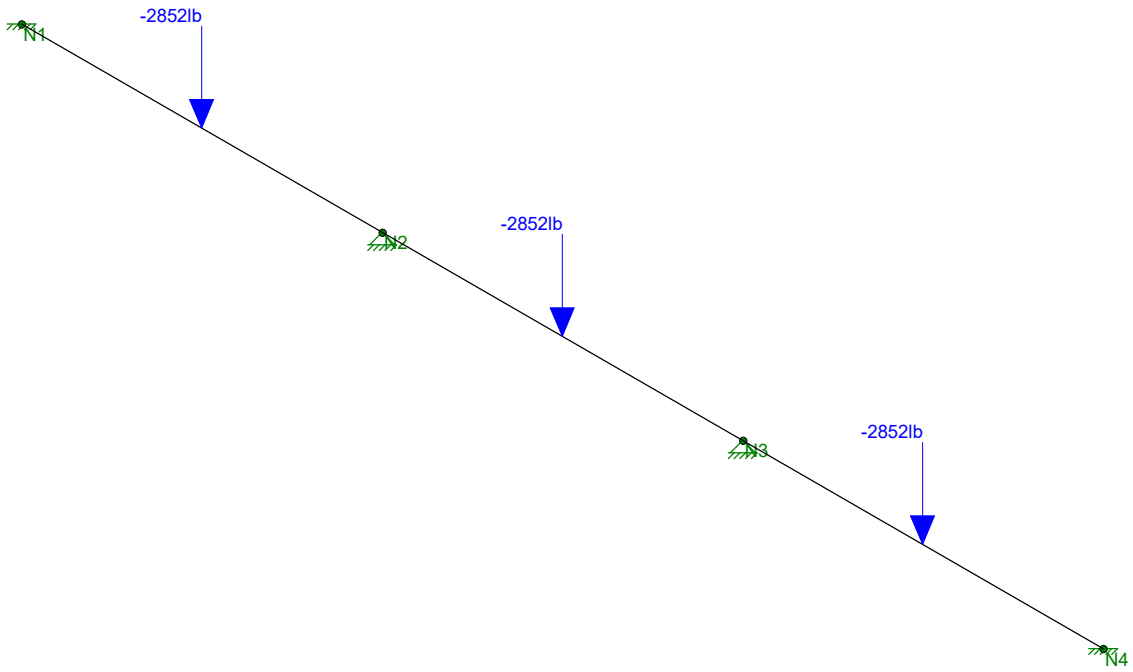
Fortress Structural Engine...	Rigid Frame	SK - 4
KJ		Apr 29, 2020 at 3:56 PM
20118		20118 - Costco Generator Exhaust...





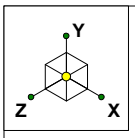
Fortress Structural Engine...	Rigid Frame	SK - 5
KJ		Apr 29, 2020 at 4:01 PM
20118		20118 - Costco Generator Exhaust...

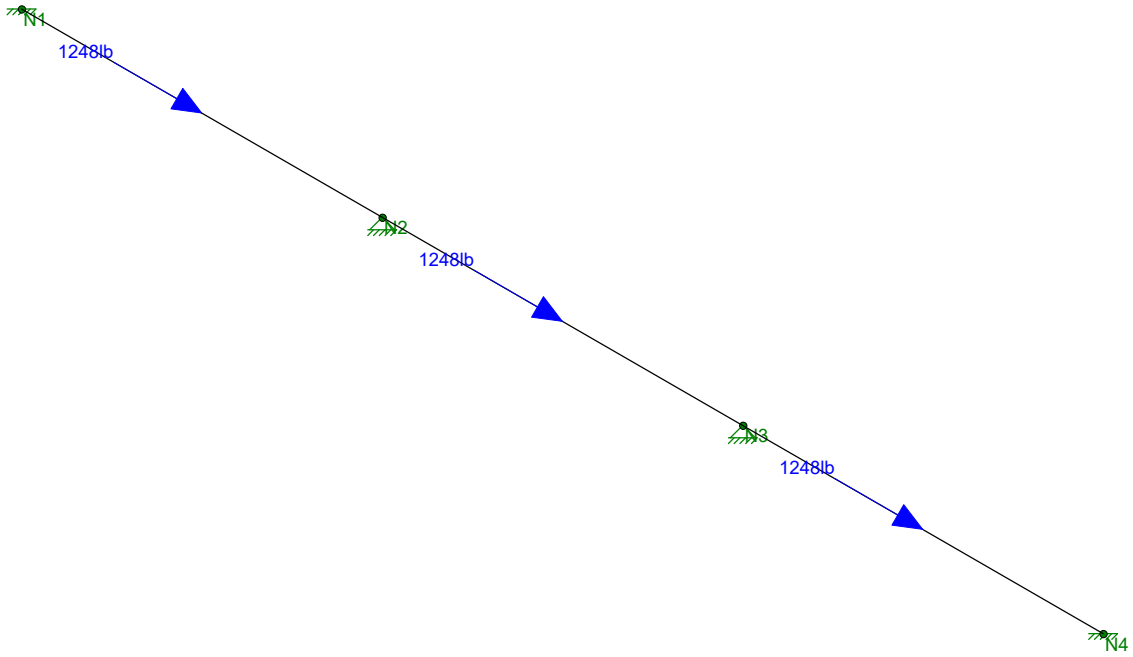




Loads: BLC 1, DL

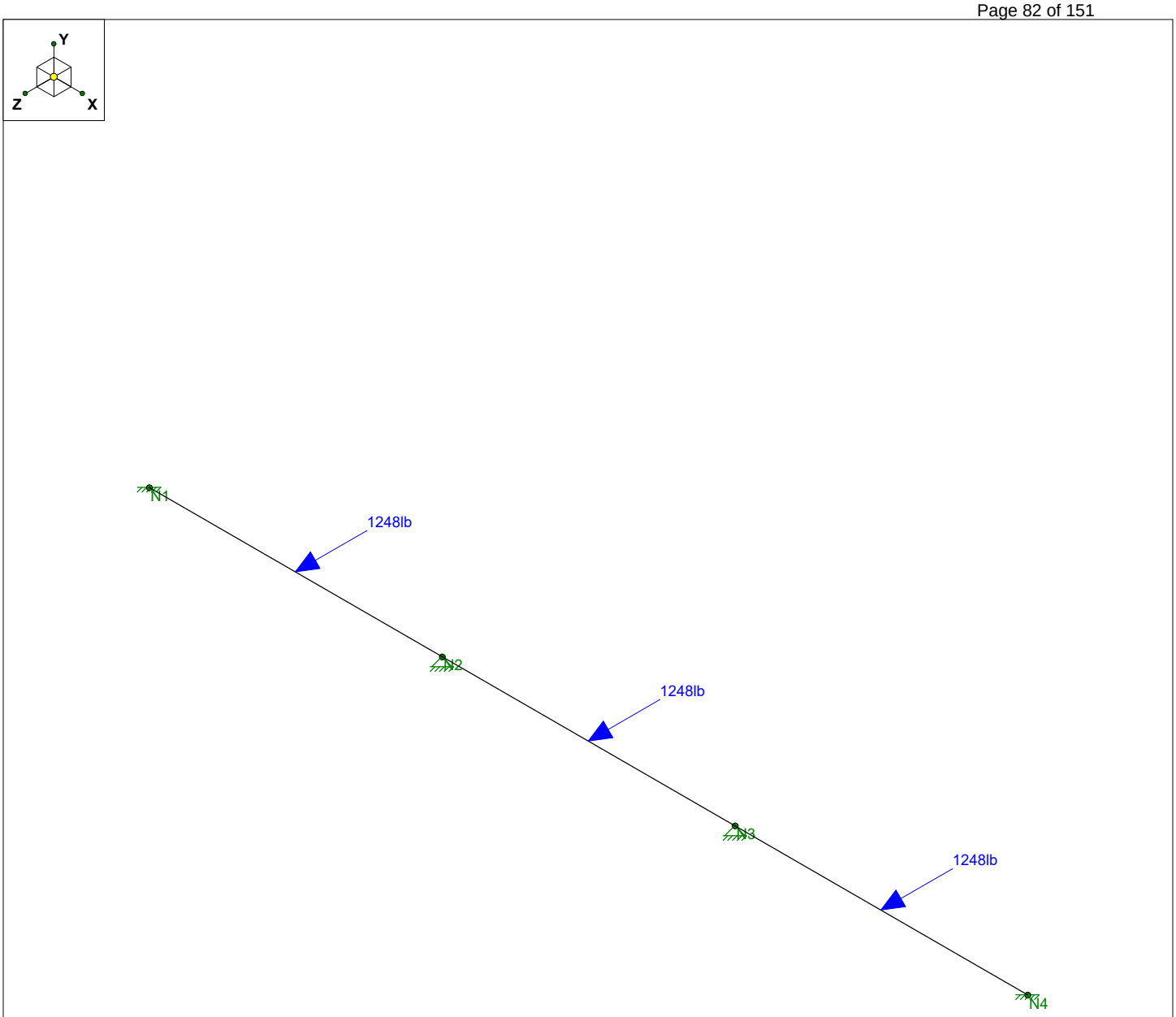
Fortress Structural Engine...	Rigid Frame	SK - 1
KJ		May 26, 2020 at 11:11 AM
20118		20118 - Costco Generator Exhaust...





Loads: BLC 2, SEIS-X

Fortress Structural Engine...	Rigid Frame	SK - 2
KJ		May 26, 2020 at 11:12 AM
20118		20118 - Costco Generator Exhaust...



Loads: BLC 3, SEIS-Z

Fortress Structural Engine...	Rigid Frame	SK - 3
KJ		May 26, 2020 at 11:12 AM
20118		20118 - Costco Generator Exhaust...

(Global) Model Settings

Display Sections for Member Calcs	5
Max Internal Sections for Member Calcs	97
Include Shear Deformation?	Yes
Increase Nailing Capacity for Wind?	Yes
Include Warping?	Yes
Trans Load Btwn Intersecting Wood Wall?	Yes
Area Load Mesh (in^2)	144
Merge Tolerance (in)	.12
P-Delta Analysis Tolerance	0.50%
Include P-Delta for Walls?	Yes
Automatically Iterate Stiffness for Walls?	Yes
Max Iterations for Wall Stiffness	3
Gravity Acceleration (ft/sec^2)	32.2
Wall Mesh Size (in)	12
Eigensolution Convergence Tol. (1.E-)	4
Vertical Axis	Y
Global Member Orientation Plane	XZ
Static Solver	Sparse Accelerated
Dynamic Solver	Accelerated Solver

Hot Rolled Steel Code	AISC 14th(360-10): LRFD
Adjust Stiffness?	Yes(Iterative)
RISAConnection Code	AISC 14th(360-10): LRFD
Cold Formed Steel Code	AISI NAS-04: ASD
Wood Code	AWC NDS-12: ASD
Wood Temperature	< 100F
Concrete Code	ACI 318-11
Masonry Code	ACI 530-11: ASD
Aluminum Code	AA ADM1-10: ASD - Building
	AISC 14th(360-10): LRFD

Number of Shear Regions	4
Region Spacing Increment (in)	4
Biaxial Column Method	Exact Integration
Parme Beta Factor (PCA)	.65
Concrete Stress Block	Rectangular
Use Cracked Sections?	Yes
Use Cracked Sections Slab?	No
Bad Framing Warnings?	No
Unused Force Warnings?	Yes
Min 1 Bar Diam. Spacing?	No
Concrete Rebar Set	REBAR_SET_ASTMA615
Min % Steel for Column	1
Max % Steel for Column	8

(Global) Model Settings, Continued

Seismic Code	ASCE 7-10
Seismic Base Elevation (ft)	Not Entered
Add Base Weight?	Yes
Ct X	.02
Ct Z	.02
T X (sec)	Not Entered
T Z (sec)	Not Entered
R X	3
R Z	3
Ct Exp. X	.75
Ct Exp. Z	.75
SD1	.634
SDS	.634
S1	.951
TL (sec)	5
Risk Cat	I or II
Drift Cat	Other
Om Z	2.5
Om X	2.5
Cd Z	4
Cd X	4
Rho Z	1
Rho X	1

Hot Rolled Steel Properties

	Label	E [ksi]	G [ksi]	Nu	Therm (\1E5 F)	Density[...	Yield[ksi]	Ry	Fu[ksi]	Rt
1	A36 Gr.36	29000	11154	.3	.65	.49	36	1.5	58	1.2
2	A572 Gr.50	29000	11154	.3	.65	.49	50	1.1	65	1.1
3	A992	29000	11154	.3	.65	.49	50	1.1	65	1.1
4	A500 Gr.B RND	29000	11154	.3	.65	.527	42	1.4	58	1.3
5	A500 Gr.B Rect	29000	11154	.3	.65	.527	46	1.4	58	1.3
6	A53 Gr.B	29000	11154	.3	.65	.49	35	1.6	60	1.2
7	A1085	29000	11154	.3	.65	.49	50	1.4	65	1.3
8	S316	29000	11154	.3	.65	.49	30	1.5	58	1.2

Joint Coordinates and Temperatures

	Label	X [ft]	Y [ft]	Z [ft]	Temp [F]	Detach From Diap...
1	N1	0	0	0	0	
2	N2	4	0	0	0	
3	N3	8	0	0	0	
4	N4	12	0	0	0	

Joint Boundary Conditions

	Joint Label	X [k/in]	Y [k/in]	Z [k/in]	X Rot.[k-ft/rad]	Y Rot.[k-ft/rad]	Z Rot.[k-ft/rad]
1	N1	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction
2	N2	Reaction	Reaction	Reaction			
3	N3	Reaction	Reaction	Reaction			
4	N4	Reaction	Reaction	Reaction	Reaction	Reaction	Reaction

Member Primary Data

	Label	I Joint	J Joint	K Joint	Rotate(deg)	Section/Shape	Type	Design List	Material	Design Rules
1	M1	N1	N4			Beam	Beam	Channel	A36 Gr.36	Typical

Member Point Loads (BLC 1 : DL)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Y	-2852	2
2	M1	Y	-2852	6
3	M1	Y	-2852	10

Member Point Loads (BLC 2 : SEIS-X)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	X	1248	2
2	M1	X	1248	6
3	M1	X	1248	10

Member Point Loads (BLC 3 : SEIS-Z)

	Member Label	Direction	Magnitude[lb,lb-in]	Location[ft,%]
1	M1	Z	1248	2
2	M1	Z	1248	6
3	M1	Z	1248	10

Basic Load Cases

	BLC Descript...	Category	X Gra..	Y Gra..	Z Gra...	Joint	Point	Distri...	Area(...	Surfa...
1	DL	DL		-1			3			
2	SEIS-X	ELX					3			
3	SEIS-Z	ELZ					3			

Load Combinations

	Description	S...	PDelta	S...	B...	Fac...	B...	Fac...	BLC	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...
1	Deflection 1	Yes	Y		DL	1																		
2	Deflection 2	Yes	Y		LL	1																		
3	Deflection 3	Yes	Y		DL	1	LL	1																
4	IBC 16-1	Yes	Y		DL	1.4																		
5	IBC 16-2 (a)	Yes	Y		DL	1.2	LL	1.6	LLS	1.6														
6	IBC 16-5 (a)	Yes	Y		DL	1.2	S...	.2	ELX	1	LL	.5	LLS	1										
7	IBC 16-5 (b)	Yes	Y		DL	1.2	S...	.2	ELZ	1	LL	.5	LLS	1										
8	IBC 16-5 (c)	Yes	Y		DL	1.2	S...	.2	ELX	-1	LL	.5	LLS	1										
9	IBC 16-5 (d)	Yes	Y		DL	1.2	S...	.2	ELZ	-1	LL	.5	LLS	1										
10	IBC 16-7 (a)	Yes	Y		DL	.9	S...	-.2	ELX	1														
11	IBC 16-7 (b)	Yes	Y		DL	.9	S...	-.2	ELZ	1														
12	IBC 16-7 (c)	Yes	Y		DL	.9	S...	-.2	ELX	-1														
13	IBC 16-7 (d)	Yes	Y		DL	.9	S...	-.2	ELZ	-1														
14	IBC 16-5 (os-a)	Yes	Y		DL	1.2	S...	.2	Om*E...	1	LL	.5	LLS	1										
15	IBC 16-5 (os-b)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	1	LL	.5	LLS	1										
16	IBC 16-5 (os-c)	Yes	Y		DL	1.2	S...	.2	Om*E...	-1	LL	.5	LLS	1										
17	IBC 16-5 (os-d)	Yes	Y		DL	1.2	S...	.2	Om*ELZ	-1	LL	.5	LLS	1										

Load Combinations (Continued)

	Description	S...	PDelta	S...	B...	Fac...	B...	Fac...	BLC	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...	B...	Fac...
18	IBC 16-7 (os-a)	Yes	Y		DL	.9	S...	-.2	Om*E...	1														
19	IBC 16-7 (os-b)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	1														
20	IBC 16-7 (os-c)	Yes	Y		DL	.9	S...	-.2	Om*E...	-1														
21	IBC 16-7 (os-d)	Yes	Y		DL	.9	S...	-.2	Om*ELZ	-1														

Envelope Joint Displacements

	Joint		X [in]	LC	Y [in]	LC	Z [in]	LC	X Rotation [...	LC	Y Rotation [...	LC	Z Rotation [...	LC
1	N1	max	0	6	0	2	0	7	0	1	0	9	0	2
2		min	0	8	0	4	0	9	0	1	0	7	0	4
3	N2	max	0	6	0	2	0	7	0	1	0	7	0	6
4		min	0	8	0	4	0	9	0	1	0	9	0	2
5	N3	max	0	6	0	2	0	7	0	1	0	9	0	6
6		min	0	8	0	4	0	9	0	1	0	7	0	1
7	N4	max	0	6	0	2	0	7	0	1	0	7	0	4
8		min	0	8	0	4	0	9	0	1	0	9	0	2

Member Suggested Shapes

	Section Set/Member	Current Shape	Suggested Shape	Controlling Member	Controlling Criteria	Use Suggested?
1	Beam	C12x30	C12x20.7	M1	Strength	Yes

Envelope AISC 14th(360-10): LRFD Steel Code Checks

	Member	Shape	Code Check	Loc[ft]	LC	Shear Che...	Loc[ft]	Dir	...	phi*P...	phi*P...	phi*M...	phi*M.....		Eqn
1	M1	C12x30	.092	8	7	.017	4	y	4	5578...	285444	1063...	1.095...	...	H1-1b

Envelope Member Section Forces

	Member	Sec		Axial[lb]	LC	y Shear...	LC	z Shear...	LC	Torque[...	LC	y-y Moment[lb-in]	LC	z-z Mo...	LC
1	M1	1	max	624	8	2080.34	4	624	9	0	1	7488	7	24628....	4
2			min	-624	6	0	2	-624	7	0	1	-7488	9	0	2
3		2	max	624	6	0	2	624	7	0	1	0	1	0	2
4			min	-624	8	-2038.37	4	-624	9	0	1	0	1	-83.94	4
5		3	max	624	6	0	2	624	7	0	1	7488	9	0	2
6			min	-624	8	-1996.4	4	-624	9	0	1	-7488	7	-24292....	4
7		4	max	624	8	2038.37	4	624	9	0	1	0	1	0	2
8			min	-624	6	0	2	-624	7	0	1	0	1	-83.94	4
9		5	max	624	6	0	2	624	7	0	1	7488	7	24628....	4
10			min	-624	8	-2080.34	4	-624	9	0	1	-7488	9	0	2

Joint Reactions (By Combination)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	1	N1	0	1485.957	0	0	0	17591.656
2	1	N2	0	2971.914	0	0	0	0
3	1	N3	0	2971.914	0	0	0	0
4	1	N4	0	1485.957	0	0	0	-17591.656
5	1	Totals:	0	8915.742	0			

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
6	1	COG (ft):	X: 6	Y: 0	Z: 0			
7	2	N1	0	0	0	0	0	0
8	2	N2	0	0	0	0	0	0
9	2	N3	0	0	0	0	0	0
10	2	N4	0	0	0	0	0	0
11	2	Totals:	0	0	0			
12	2	COG (ft):	NC	NC	NC			
13	3	N1	0	1485.957	0	0	0	17591.656
14	3	N2	0	2971.914	0	0	0	0
15	3	N3	0	2971.914	0	0	0	0
16	3	N4	0	1485.957	0	0	0	-17591.656
17	3	Totals:	0	8915.742	0			
18	3	COG (ft):	X: 6	Y: 0	Z: 0			
19	4	N1	0	2080.34	0	0	0	24628.318
20	4	N2	0	4160.679	0	0	0	0
21	4	N3	0	4160.679	0	0	0	0
22	4	N4	0	2080.34	0	0	0	-24628.318
23	4	Totals:	0	12482.038	0			
24	4	COG (ft):	X: 6	Y: 0	Z: 0			
25	5	N1	0	1783.148	0	0	0	21109.987
26	5	N2	0	3566.297	0	0	0	0
27	5	N3	0	3566.297	0	0	0	0
28	5	N4	0	1783.148	0	0	0	-21109.987
29	5	Totals:	0	10698.89	0			
30	5	COG (ft):	X: 6	Y: 0	Z: 0			
31	6	N1	-624	1971.568	0	0	0	23340.609
32	6	N2	-1248	3943.135	0	0	0	0
33	6	N3	-1248	3943.135	0	0	0	0
34	6	N4	-624	1971.568	0	0	0	-23340.609
35	6	Totals:	-3744	11829.406	0			
36	6	COG (ft):	X: 6	Y: 0	Z: 0			
37	7	N1	0	1971.568	-624	0	7488	23340.609
38	7	N2	0	3943.135	-1248	0	0	0
39	7	N3	0	3943.135	-1248	0	0	0
40	7	N4	0	1971.568	-624	0	-7488	-23340.609
41	7	Totals:	0	11829.406	-3744			
42	7	COG (ft):	X: 6	Y: 0	Z: 0			
43	8	N1	624	1971.568	0	0	0	23340.609
44	8	N2	1248	3943.135	0	0	0	0
45	8	N3	1248	3943.135	0	0	0	0
46	8	N4	624	1971.568	0	0	0	-23340.609
47	8	Totals:	3744	11829.406	0			
48	8	COG (ft):	X: 6	Y: 0	Z: 0			
49	9	N1	0	1971.568	624	0	-7488	23340.609
50	9	N2	0	3943.135	1248	0	0	0
51	9	N3	0	3943.135	1248	0	0	0
52	9	N4	0	1971.568	624	0	7488	-23340.609
53	9	Totals:	0	11829.406	3744			
54	9	COG (ft):	X: 6	Y: 0	Z: 0			
55	10	N1	-624	1148.942	0	0	0	13601.868
56	10	N2	-1248	2297.884	0	0	0	0
57	10	N3	-1248	2297.884	0	0	0	0

Joint Reactions (By Combination) (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
58	10	N4	-624	1148.942	0	0	0	-13601.868
59	10	Totals:	-3744	6893.651	0			
60	10	COG (ft):	X: 6	Y: 0	Z: 0			
61	11	N1	0	1148.942	-624	0	7488	13601.868
62	11	N2	0	2297.884	-1248	0	0	0
63	11	N3	0	2297.884	-1248	0	0	0
64	11	N4	0	1148.942	-624	0	-7488	-13601.868
65	11	Totals:	0	6893.651	-3744			
66	11	COG (ft):	X: 6	Y: 0	Z: 0			
67	12	N1	624	1148.942	0	0	0	13601.868
68	12	N2	1248	2297.884	0	0	0	0
69	12	N3	1248	2297.884	0	0	0	0
70	12	N4	624	1148.942	0	0	0	-13601.868
71	12	Totals:	3744	6893.651	0			
72	12	COG (ft):	X: 6	Y: 0	Z: 0			
73	13	N1	0	1148.942	624	0	-7488	13601.868
74	13	N2	0	2297.884	1248	0	0	0
75	13	N3	0	2297.884	1248	0	0	0
76	13	N4	0	1148.942	624	0	7488	-13601.868
77	13	Totals:	0	6893.651	3744			
78	13	COG (ft):	X: 6	Y: 0	Z: 0			

Joint Reactions - Overstrength

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
1	14	N1	-1560	1971.568	0	0	0	23340.609
2	14	N2	-3120	3943.135	0	0	0	0
3	14	N3	-3120	3943.135	0	0	0	0
4	14	N4	-1560	1971.568	0	0	0	-23340.609
5	14	Totals:	-9360	11829.406	0			
6	14	COG (ft):	X: 6	Y: 0	Z: 0			
7	15	N1	0	1971.568	-1560	0	18720	23340.609
8	15	N2	0	3943.135	-3120	0	0	0
9	15	N3	0	3943.135	-3120	0	0	0
10	15	N4	0	1971.568	-1560	0	-18720	-23340.609
11	15	Totals:	0	11829.406	-9360			
12	15	COG (ft):	X: 6	Y: 0	Z: 0			
13	16	N1	1560	1971.568	0	0	0	23340.609
14	16	N2	3120	3943.135	0	0	0	0
15	16	N3	3120	3943.135	0	0	0	0
16	16	N4	1560	1971.568	0	0	0	-23340.609
17	16	Totals:	9360	11829.406	0			
18	16	COG (ft):	X: 6	Y: 0	Z: 0			
19	17	N1	0	1971.568	1560	0	-18720	23340.609
20	17	N2	0	3943.135	3120	0	0	0
21	17	N3	0	3943.135	3120	0	0	0
22	17	N4	0	1971.568	1560	0	18720	-23340.609
23	17	Totals:	0	11829.406	9360			
24	17	COG (ft):	X: 6	Y: 0	Z: 0			
25	18	N1	-1560	1148.942	0	0	0	13601.868
26	18	N2	-3120	2297.884	0	0	0	0

Joint Reactions - Overstrength (Continued)

	LC	Joint Label	X [lb]	Y [lb]	Z [lb]	MX [lb-in]	MY [lb-in]	MZ [lb-in]
27	18	N3	-3120	2297.884	0	0	0	0
28	18	N4	-1560	1148.942	0	0	0	-13601.868
29	18	Totals:	-9360	6893.651	0			
30	18	COG (ft):	X: 6	Y: 0	Z: 0			
31	19	N1	0	1148.942	-1560	0	18720	13601.868
32	19	N2	0	2297.884	-3120	0	0	0
33	19	N3	0	2297.884	-3120	0	0	0
34	19	N4	0	1148.942	-1560	0	-18720	-13601.868
35	19	Totals:	0	6893.651	-9360			
36	19	COG (ft):	X: 6	Y: 0	Z: 0			
37	20	N1	1560	1148.942	0	0	0	13601.868
38	20	N2	3120	2297.884	0	0	0	0
39	20	N3	3120	2297.884	0	0	0	0
40	20	N4	1560	1148.942	0	0	0	-13601.868
41	20	Totals:	9360	6893.651	0			
42	20	COG (ft):	X: 6	Y: 0	Z: 0			
43	21	N1	0	1148.942	1560	0	-18720	13601.868
44	21	N2	0	2297.884	3120	0	0	0
45	21	N3	0	2297.884	3120	0	0	0
46	21	N4	0	1148.942	1560	0	18720	-13601.868
47	21	Totals:	0	6893.651	9360			
48	21	COG (ft):	X: 6	Y: 0	Z: 0			

Envelope Joint Reactions - Overstrength

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-in]	LC	MY [lb-in]	LC	MZ [lb-in]	LC
1	N1	max	1560	16	1971.568	14	1560	17	0	14	18720	15	23340.609	14
2		min	-1560	14	1148.942	18	-1560	15	0	14	-18720	17	13601.868	18
3	N2	max	3120	16	3943.135	14	3120	17	0	14	0	14	0	14
4		min	-3120	14	2297.884	18	-3120	15	0	14	0	14	0	14
5	N3	max	3120	16	3943.135	14	3120	17	0	14	0	14	0	14
6		min	-3120	14	2297.884	18	-3120	15	0	14	0	14	0	14
7	N4	max	1560	16	1971.568	14	1560	17	0	14	18720	17	-13601.868	18
8		min	-1560	14	1148.942	18	-1560	15	0	14	-18720	15	-23340.609	14
9	Totals:	max	9360	16	11829.406	14	9360	17						
10		min	-9360	14	6893.651	18	-9360	15						

Envelope Joint Reactions

	Joint		X [lb]	LC	Y [lb]	LC	Z [lb]	LC	MX [lb-..]	LC	MY [lb-..]	LC	MZ [lb-in]	LC
1	N1	max	624	8	2080.34	4	624	9	0	1	7488	7	24628.318	4
2		min	-624	6	0	2	-624	7	0	1	-7488	9	0	2
3	N2	max	1248	8	4160.679	4	1248	9	0	1	0	1	0	1
4		min	-1248	6	0	2	-1248	7	0	1	0	1	0	1
5	N3	max	1248	8	4160.679	4	1248	9	0	1	0	1	0	1
6		min	-1248	6	0	2	-1248	7	0	1	0	1	0	1
7	N4	max	624	8	2080.34	4	624	9	0	1	7488	9	0	2
8		min	-624	6	0	2	-624	7	0	1	-7488	7	-24628.318	4
9	Totals:	max	3744	8	12482.038	4	3744	9						
10		min	-3744	6	0	2	-3744	7						

Company:	Fortress Structural Engineering	Page:	1
Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	end support _N1 - Option 2- EMBEDED PLATE FOR	Date:	5/26/2020
Fastening point:			

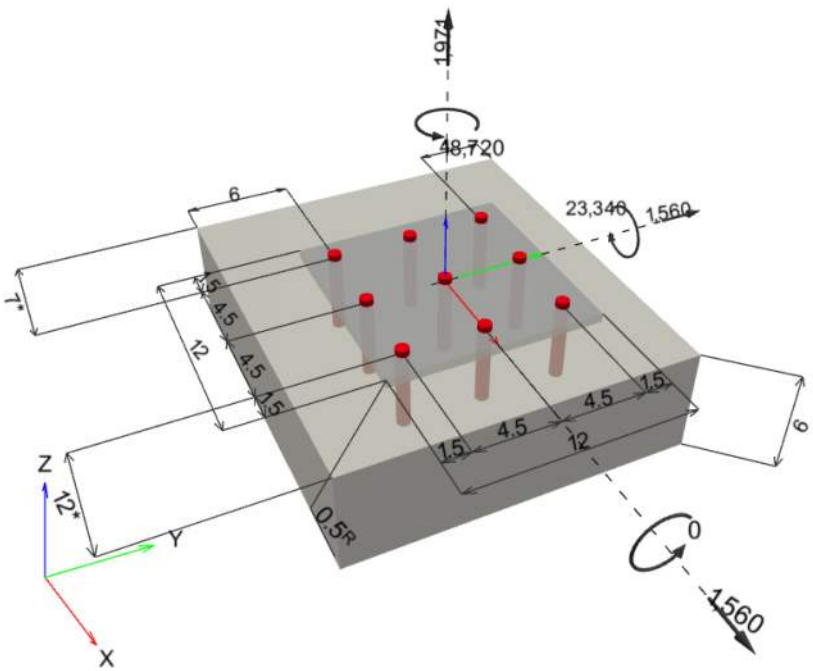
Specifier's comments:

1 Input data

Anchor type and diameter:	**AWS D1.1 GR. B 3/4**
Item number:	not available
Effective embedment depth:	h_{ef} = 4.500 in.
Material:	
Proof:	Design Method ACI 318-14 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 12.000 in. x 12.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 6.000 in.
Reinforcement:	tension: condition B, shear: condition B; edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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Design:	end support _N1 - Option 2- EMBEDED PLATE FOR	Date:	5/26/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 1,971; V_x = 1,560; V_y = 1,560; M_x = 0; M_y = 23,340; M_z = 18,720;	yes	91

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Design:	end support _N1 - Option 2- EMBEDED PLATE FOR	Date:	5/26/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	4,042	12,300	33 / -	OK
Shear	Concrete edge failure in direction x+	2,942	3,502	- / 84	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.329	0.840	5/3	91	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Design:	end support _N1 - Option 2- EMBEDED PLATE FOR	Date:	5/26/2020
Fastening point:			

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Design:	Riser_end support _N2-N3 - Option 2- EMBEDED PL	Date:	5/26/2020
Fastening point:			

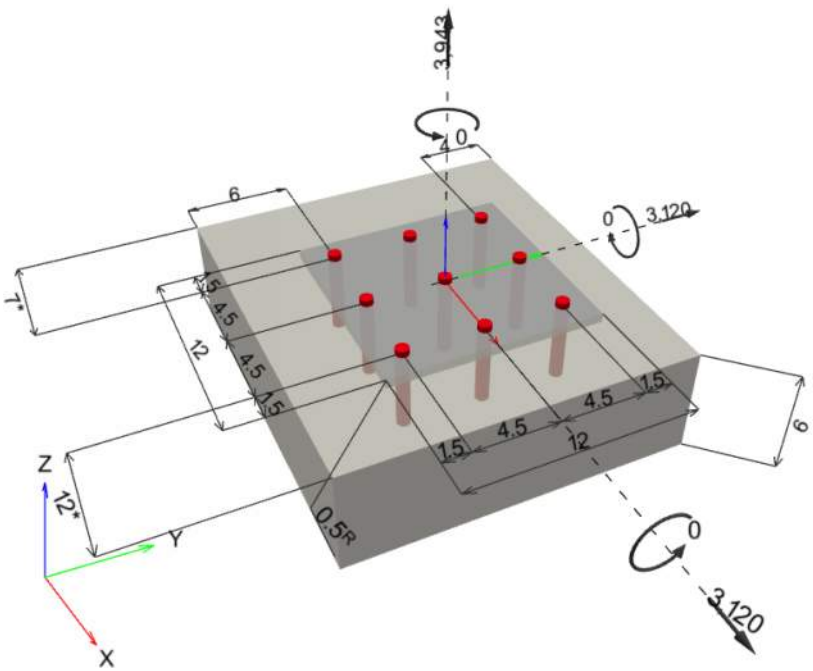
Specifier's comments:

1 Input data

Anchor type and diameter:	**AWS D1.1 GR. B 3/4**
Item number:	not available
Effective embedment depth:	h_{ef} = 4.500 in.
Material:	
Proof:	Design Method ACI 318-14 / CIP
Stand-off installation:	e_b = 0.000 in. (no stand-off); t = 0.500 in.
Anchor plate[R] :	l_x x l_y x t = 12.000 in. x 12.000 in. x 0.500 in.; (Recommended plate thickness: not calculated)
Profile:	no profile
Base material:	cracked concrete, 5000, f_c' = 5,000 psi; h = 6.000 in.
Reinforcement:	tension: condition B, shear: condition B; edge reinforcement: none or < No. 4 bar
Seismic loads (cat. C, D, E, or F)	Tension load: yes (17.2.3.4.3 (d)) Shear load: yes (17.2.3.5.3 (c))

[R] - The anchor calculation is based on a rigid anchor plate assumption.

Geometry [in.] & Loading [lb, in.lb]



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Design:	Riser_end support _N2-N3 - Option 2- EMBEDED PL	Date:	5/26/2020
Fastening point:			

1.1 Design results

Case	Description	Forces [lb] / Moments [in.lb]	Seismic	Max. Util. Anchor [%]
1	Combination 1	N = 3,943; V_x = 3,120; V_y = 3,120; M_x = 0; M_y = 0; M_z = 0;	yes	93

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Design:	Riser_end support _N2-N3 - Option 2- EMBEDED PL	Date:	5/26/2020
Fastening point:			

2 Proof I Utilization (Governing Cases)

		Design values [lb]		Utilization	
Loading	**Proof**	**Load**	**Capacity**	**β_N / β_V [%]**	**Status**
Tension	Concrete Breakout Failure	3,943	17,512	23 / -	OK
Shear	Concrete edge failure in direction x+	4,412	4,895	- / 91	OK

Loading	**β_N**	**β_V**	**ζ**	**Utilization $\beta_{N,V}$ [%]**	**Status**
Combined tension and shear loads	0.225	0.901	5/3	93	OK

3 Warnings

- Please consider all details and hints/warnings given in the detailed report!

Fastening meets the design criteria!

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Address:		Specifier:	Kavita Jivani
Phone I Fax:	408-841-4848 |	E-Mail:	kjivani@fortressse.com
Design:	Riser_end support _N2-N3 - Option 2- EMBEDED PL	Date:	5/26/2020
Fastening point:			

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STANCHION SUPPORT (DETAIL B)

Support B, 20" Pipe -Stanchion

1. Seismic Design Criteria

Governing Code IBC 2015/ ASCE 7-10

$a_p := 2.5$ $R_p := 2.5$ (Table 13.6-1, High Deform. Piping)

$I_p := 1.5$ (See Appendix)

$S_{DS} := 0.634 = 0.63$ (See Appendix)

$z := 18 \cdot ft$ (Location: Level 1)

$h := 104 \cdot ft$ (Height of structure above ground)

Horizontal Seismic Design Coefficients: Strength Design

$$F_{phc} := \left(\frac{0.4 \cdot a_p \cdot S_{DS}}{\left(\frac{R_p}{I_p}\right)}\right) \cdot \left(1 + 2 \cdot \frac{z}{h}\right) = 0.512$$ (Eq: 13.3-1) ***Controls***

$F_{phUc} := 1.6 \cdot S_{DS} \cdot I_p = 1.522$ (Eq: 13.3-2, Upper Limit)

$F_{phLc} := 0.3 \cdot S_{DS} \cdot I_p = 0.285$ (Eq: 13.3-3, Lower Limit)

Vertical Seismic Design Coefficients: Strength Design

$F_{pvc} := 0.2 \cdot S_{DS} = 0.127$ (Eq: 12.4-4)

2A. Design Loads

$OD_1 := 20\ in$ (Outside diameter of pipe)

$W := 123\ plf$ (See Appendix))

$b_1 := 13\ ft$ (Max tributary spacing of supports)

$W2 := W \cdot b_1 = 1599\ lbf$ (Weight on support)

$F_{ph} := F_{phc} \cdot W2 = 819\ lbf$ (Horizontal seismic load)

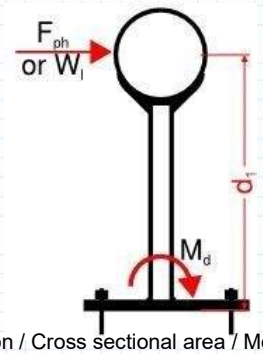
$F_{pv} := F_{pvc} \cdot W2 = 203\ lbf$ (Vertical seismic load)

$W_p := 2081 \cdot lbf = 2081\ lbf$ (See -thermal and dead load Calc)

2B. Wind Loads

(No wind load, Support indoor)

3. Check 4 in Dia Stl Post



$d_1 := 36\ in$ $F_y := 35\ ksi$ $z := 4.05\ in^3$ (See diagram / Yield Strength / Section Modulus)

$M_{d1} := F_{ph} \cdot d_1 = 29477\ lbf \cdot in$ (Moment Demand)

$M_c := 0.9 \cdot z \cdot F_y = 127575\ lbf \cdot in$ (Moment Capacity)

$DC := \frac{M_{d1}}{M_c} = 0.23$ (<1.0 OK, D/C Ratio)

Compression:

$P_{ad} := 1.2 \cdot W_p + F_{pv} = 2700\ lbf$ (Axial load on brace)

$K := 2.0$ $r := 1.51\ in$ $A_g := 2.97\ in^2$ $E := 29000 \cdot ksi$ (Effective length factor / Radius of gyration / Cross sectional area / Modulus of elasticity)

$KL_r := \frac{K \cdot d_1}{r} = 48$ **(< 200 OK)** $F_e := \frac{\pi^2 \cdot E}{(KL_r)^2} = 126\ ksi$ $EF_y := \frac{E}{F_y}$ $F_yF_e := \frac{F_y}{F_e}$

$KL_r \le 4.71 \cdot \sqrt{EF_y} = 1$ *or* $F_e > 0.44 \cdot F_y = 1$ $F_{cr1} := \left(0.658^{F_yF_e}\right) \cdot F_y = 31\ ksi$

$KL_r > 4.71 \cdot \sqrt{EF_y} = 0$ *or* $F_e < 0.44 \cdot F_y = 0$ $F_{cr2} := 0.877\ F_e = 110\ ksi$

(Equation: 0=Doesnt control, 1=controls)

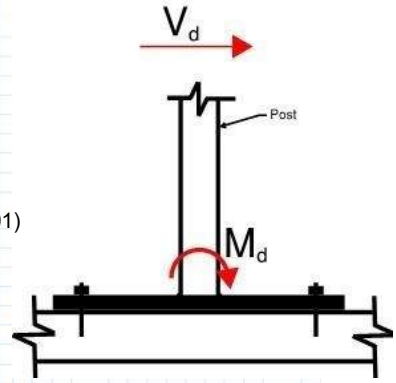
$P_{ac} := 0.9 \cdot F_{cr1} \cdot A_g = 83\ kip$ (Pipe support axial capacity)

$DC := \frac{P_{ad}}{P_{ac}} = 0.03$ (<1.0 OK, D/C Ratio)

Combined loading:

$$DC := \frac{P_{ad}}{2 \cdot P_{ac}} + \left(\frac{M_{d1}}{M_c}\right) = 0.25$$ (<1.0 OK, D/C Ratio, 14th AISC, Eq. H1-1b)

4. Check 1/4" Weld at Baseplate



$t_w := 0.707 \cdot \frac{1}{4}\ in$ (Thickness of weld)

$OD := 4.5\ in$ (Outside diameter of post)

$S_w := \pi \cdot \left(\frac{OD}{2}\right)^2 \cdot t_w = 2.8\ in^3$ (Section modulus of weld)

$S_p := 3.03\ in^3$ (Section modulus of post: 14th AISC, P. 1-101)

$A_w := t_w \cdot OD = 0.8\ in^2$ (Area of weld)

$A_p := 2.97\ in^2$ (Area of post: 14th AISC, P. 1-101)

Stress due to Moment:	Stress due to Shear:	Total stress:
$D_w := \frac{M_{d1}}{S_w} = 10\ ksi$	$D_v := \frac{F_{ph} + P_{ad}}{A_w} = 4\ ksi$	$D_{wt} := \sqrt{D_w^2 + D_v^2} = 11\ ksi$
$D_p := \frac{M_{d1}}{S_p} = 10\ ksi$	$D_v := \frac{F_{ph} + P_{ad}}{A_p} = 1\ ksi$	$D_{pt} := \sqrt{D_p^2 + D_v^2} = 10\ ksi$

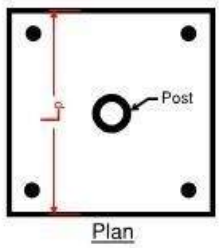
$C_w := 0.75 \cdot 0.6 \cdot 70\ ksi = 32\ ksi$ (Weld)

$C_p := 0.75 \cdot 35\ ksi = 26\ ksi$ (post)

$\frac{D_{wt}}{C_w} = 0.36$ (<1.0 OK, D/C Ratio)

$\frac{D_{pt}}{C_p} = 0.37$ (<1.0 OK, D/C Ratio)

5. Base Plate Design



$F_y := 36\ ksi$ (Yield strength of plate)

$t_p := 0.5\ in$ (Baseplate thickness)

$l_p := 8\ in$ (Baseplate length)

$OD := OD = 4.5\ in$ (Outside diameter of post)

$d_1 := 1.125\ in$ (Distance from edge of plate to C.L. of bolt holes)

$z := \frac{1}{4} \cdot l_p \cdot (t_p)^2 = 0.5\ in^3$ (Section modulus of plate)

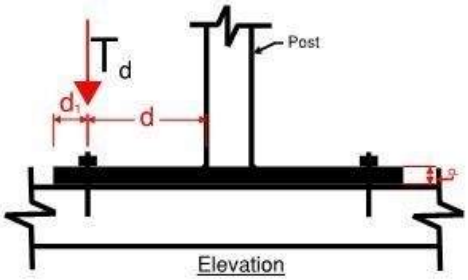
$T_d := P_{ad} = 2700\ lbf$ (Tension demand: From package 1)

$d := \frac{l_p - OD}{2} - d_1 = 0.625\ in$ (Lever arm distance: C.L. of bolt hole to face of post)

$M_d := T_d \cdot d = 1687\ in \cdot lbf$ (Moment demand)

$M_c := 0.9 \cdot z \cdot F_y = 16200\ in \cdot lbf$ (Moment capacity)

$DC := \frac{M_d}{M_c} = 0.10$ (<1.0 OK, D/C Ratio)



FORTRESS Structural Engineering

COSTCO WHOLESALE

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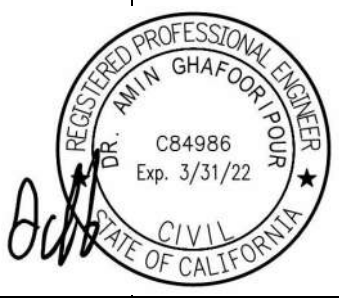
COSTCO BLDG-5 GARAGE

LEVEL 1 SOUTH
SUBMITTAL EXHAUST
ROUTING SUPPORT

STRUCTURAL CALCULATION NOTE FOR THE Thermal Expansion of the Generators' Exhaust Pipe

Ver.	Date	Description	Designed by	Verified by	Approved by
D6	7/16/2020	Changes the design temperature to 1000 degrees	Amin Ghafooripour, PhD		Marcus Oden
D5	4/30/2020	Adding new bellows to the muffler	Amin Ghafooripour, PhD		Marcus Oden
D4	4/26/2020	Issue for comment	Amin Ghafooripour, PhD		Marcus Oden
D3	4/14/2020	Issue for comment	Amin Ghafooripour, PhD		Marcus Oden
D2	4/8/2020	Issue for comment	Amin Ghafooripour, PhD		Marcus Oden
D1	4/6/2020	Issue for comment	Amin Ghafooripour, PhD		
D0	3/28/2020	Interim Report/ not completed yet Only for the review of the criteria	Amin Ghafooripour, PhD		



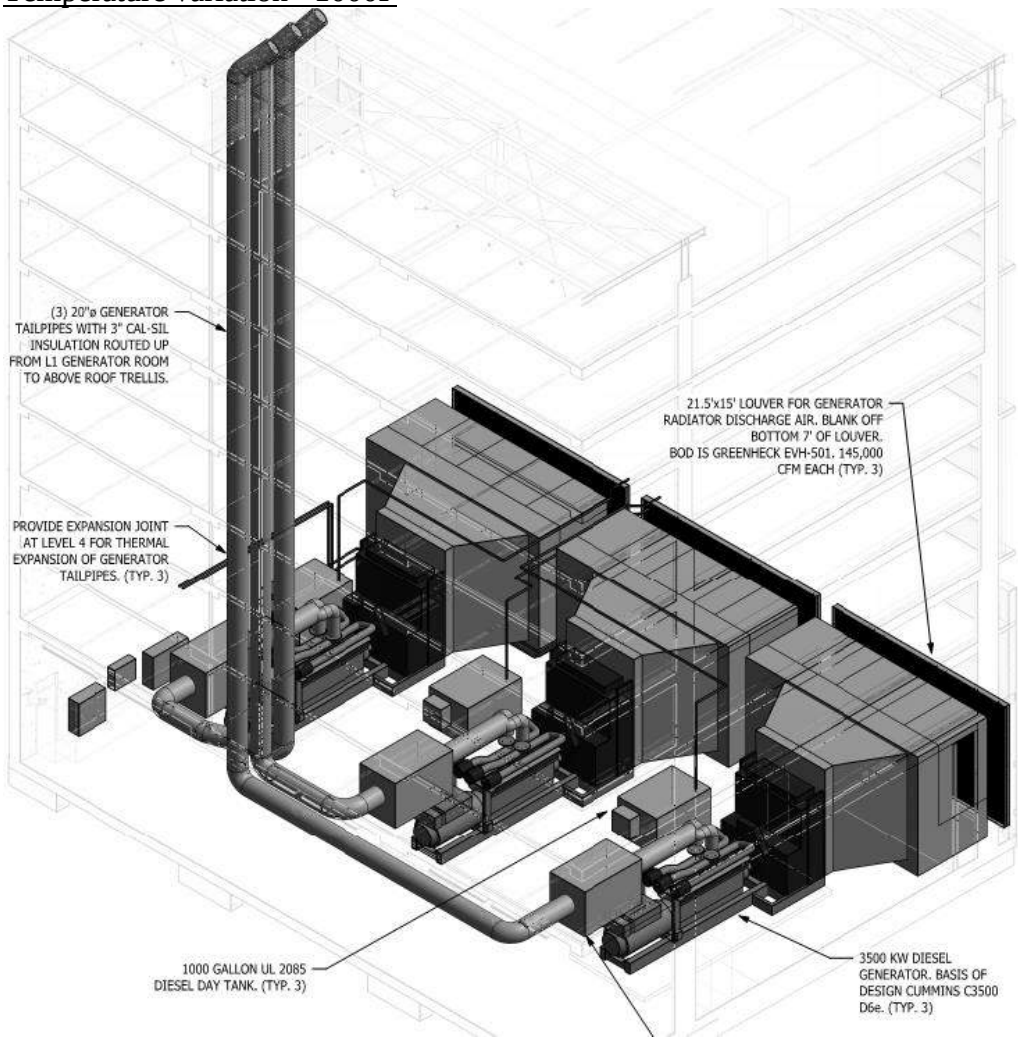
CONTENTS

1. BACKGROUND AND PURPOSE OF DOCUMENT

This calculation note presents the statutorily required design calculations for the “thermal analysis of Generator Exhaust pipe.”
Fortress Structural Engineering Inc. is in charge of this design. The contractor delivered all required dimensions, and the design calculations are conducted following the proposed drawings and given information.

Pipe materials and design temperature:

Temperature variation= 1000F



Pipe diameter= 20”
Schedule 40

RENOSA CORPORATION

MIRATECH

Proposal Number: REN-18-6719

Application & Performance Warranty Data

Project Information

Site Location:	Washington
Project Name:	Costco Bldg 5 - 3500KW's
Application:	Standby Power
Number Of Engines:	3
Operating Hours per Year:	50

Engine Specifications

Engine Manufacturer:	Cummins
Model Number:	QSK95-G9
EPA Engine Family:	JCEXL95.0AAA-006
Rated Speed:	1800 RPM
Type of Fuel:	Ultra-Low Sulfur Diesel (ULSD)
Type of Lube Oil:	1 wt% sulfated ash or less
Lube Oil Consumption:	0.1 % Fuel Consumption
Number of Exhaust Manifolds:	1

DOC/DPF System Specifications (LTR81-81-20-XR2)

Design Exhaust Flow Rate:	24,975 acfm (cfm)
Design Exhaust Temperature[1]:	914°F
System Pressure Loss:	15.0 inches of WC (Clean) (34.9 mBar)
Sound Attenuation:	Critical Grade
Minimum Regeneration Temperature[2]:	500°F (260°C)

As per the given information:

SUBMITTAL REVIEW COVERSHEET

RUSHING

- Structural engineer to verify basis for Temperature Variation = 200°F (shown on page 104 of 145 and page 116 of 145) that is utilized for thermal expansion calculations. Per generator submittal design exhaust temperature is equal to 914°F (see cutsheet from generator submittal on next page). Generator system is designed for continuous operations with onsite fuel storage for 24+ hours. Rushing would anticipate a temperature differential of approximately 1000°F based on calculations submitted for past projects.

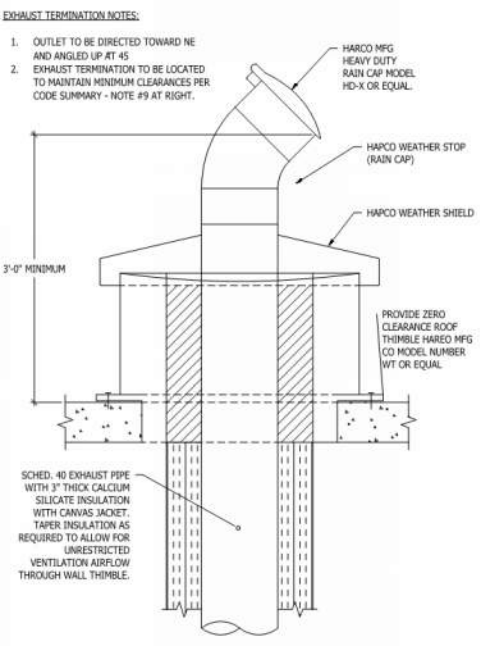


Table I-1 Allowable Stresses

Material	Spec. No.	Type or Grade	Class	P-No.	Notes	Factor *E* or *F*	Strengths Min. Tensile, ksi	Strengths Min. Yield, ksi	Max. Allowable Stress Value in Tension *SE*, ksi, for Metal Temperature, °F, Not Exceeding 0 to 100	150	200	250	300	350	400
Carbon Steel															
Seamless Pipe and Tube															
...	ASTM A53	A	S	1	...	1.00	48.0	30.0	13.7	13.7	13.7	13.7	13.7	13.7	13.7
...	ASTM A53	B	S	1	...	1.00	60.0	35.0	17.1	17.1	17.1	17.1	17.1	17.1	17.1
...	ASTM A106	A	...	1	...	1.00	48.0	30.0	13.7	13.7	13.7	13.7	13.7	13.7	13.7
...	ASTM A106	B	...	1	...	1.00	60.0	35.0	17.1	17.1	17.1	17.1	17.1	17.1	17.1
...	API 5L	A	...	1	(1)	1.00	48.0	30.0	13.7	13.7	13.7	13.7	13.7	13.7	13.7
...	API 5L	B	...	1	(1)	1.00	60.0	35.0	17.1	17.1	17.1	17.1	17.1	17.1	17.1
Butt Welded Pipe and Tube															
...	ASTM A53	...	F	1	(2)	0.60	48.0	30.0	8.2	8.2	8.2	8.2	8.2	8.2	8.2
...	API 5L	A25	...	1	(1)	0.60	45.0	25.0	7.7	7.7	7.7	7.7	7.7	7.7	7.7
Electric Resistance Welded Pipe and Tube															
...	ASTM A53	A	E	1	...	0.85	48.0	30.0	11.7	11.7	11.7	11.7	11.7	11.7	11.7
...	ASTM A53	B	E	1	...	0.85	60.0	35.0	14.6	14.6	14.6	14.6	14.6	14.6	14.6
...	ASTM A135	A	...	1	...	0.85	48.0	30.0	11.7	11.7	11.7	11.7	11.7	11.7	11.7

Capacity of the pipe at the temperature of 1000 F:

The material is A53 with Fy=35000 psi. The relation between the temperature and modulus of elasticity and yield point is shown in the following reference:

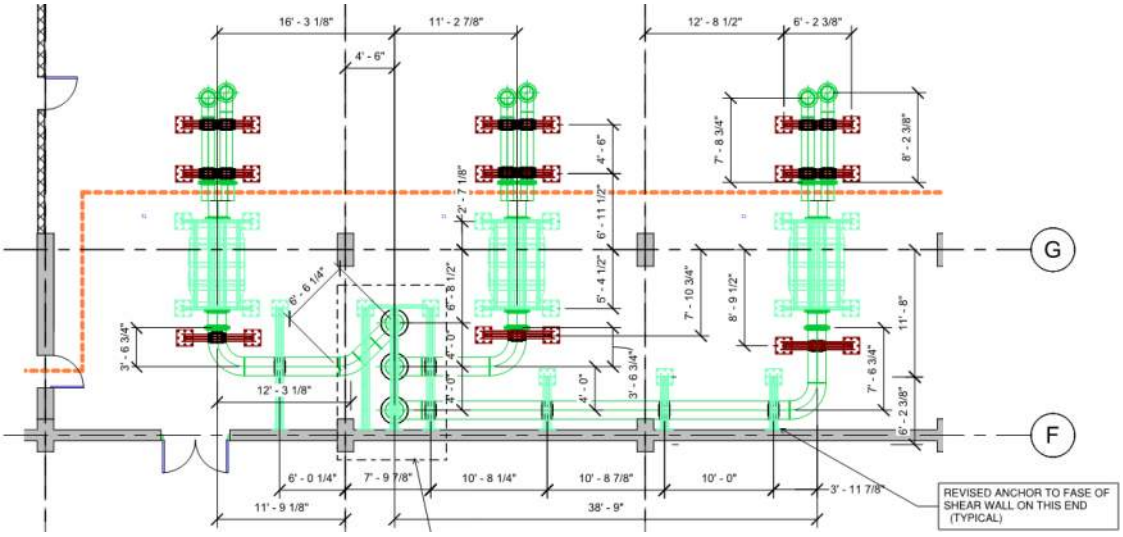
X.6 STEEL PROPERTIES AT ELEVATED TEMPERATURES

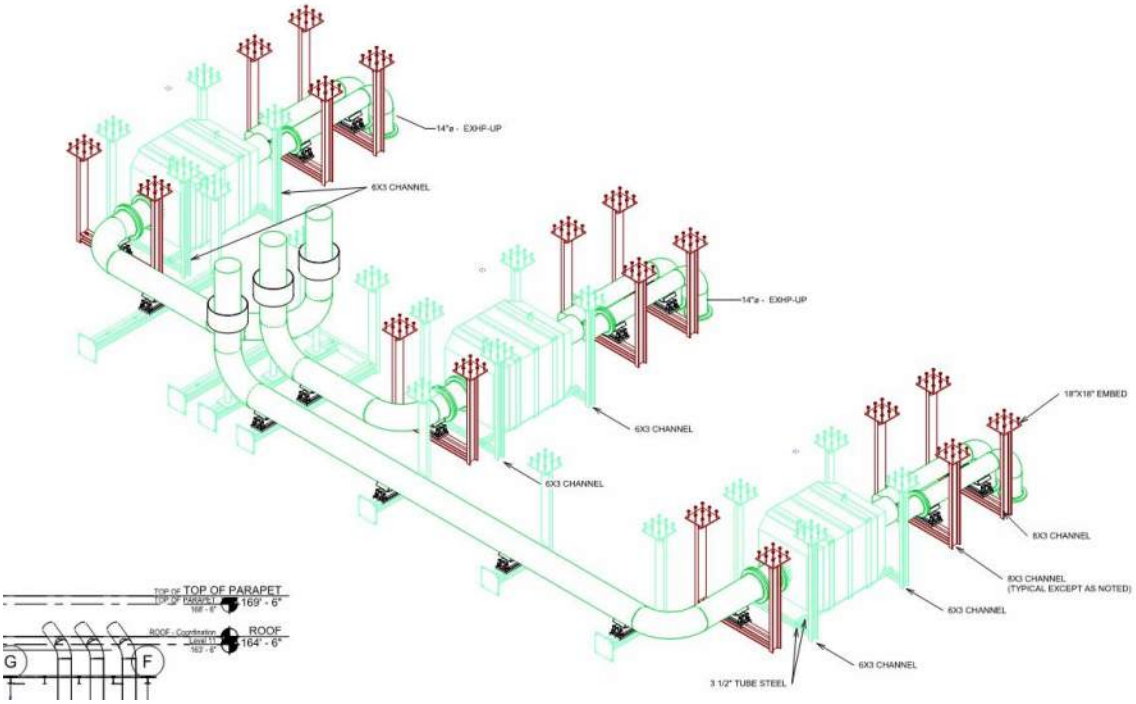
Steel properties, like those of other conventional construction materials, degrade with increases in temperature. The influence of elevated temperatures on the modulus of elasticity (E_m) and the yield strength (F_{ym}) of steel is presented in Table X.1 as a ratio of the value at the elevated temperature to the value at 68 °F (20 °C)[7].

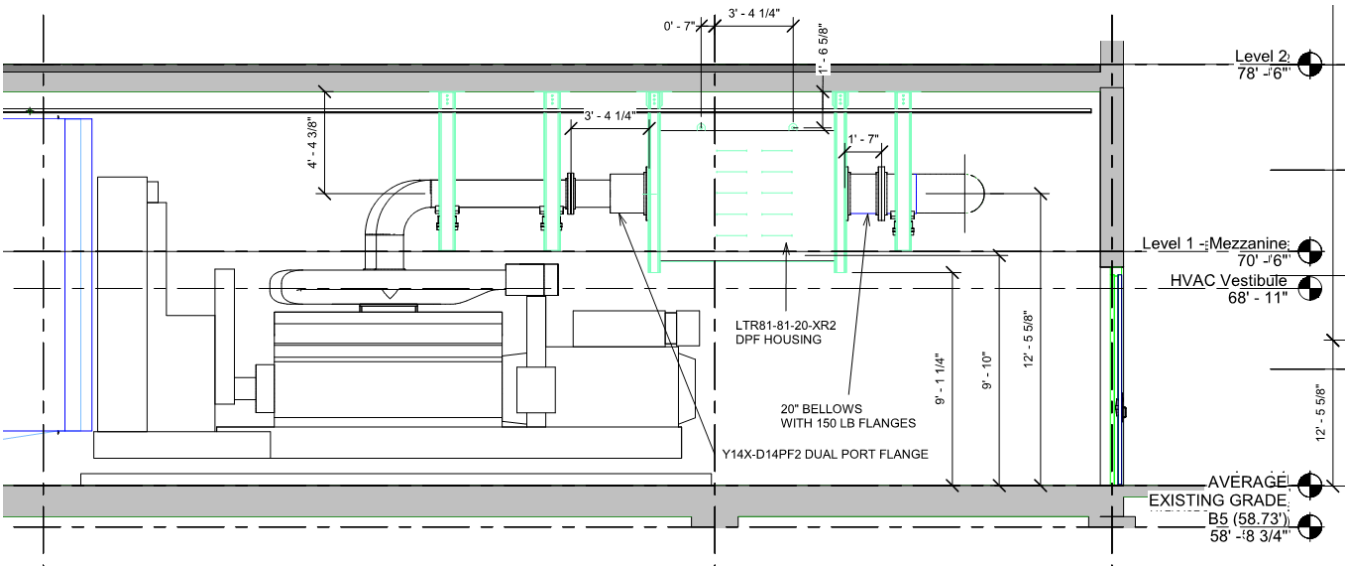
Table X.1 Steel Modulus of Elasticity and Yield Strength Reduction at Elevated Temperatures

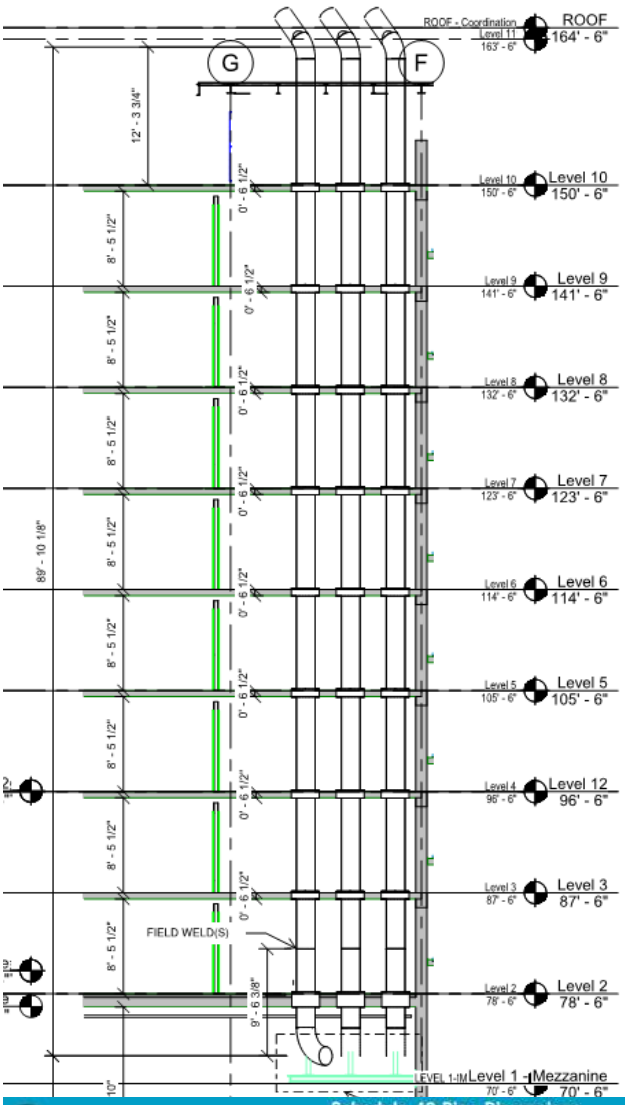
Steel Temperature °F [°C]	E_m/E	F_{ym}/F_y
68 [20]	1.00	1.00
200 [93]	1.00	1.00
400 [204]	0.90	1.00
600 [316]	0.78	1.00
750 [399]	0.70	1.00
800 [427]	0.67	0.94
1,000 [538]	0.49	0.66
1,200 [649]	0.22	0.35
1,400 [760]	0.11	0.16
1,600 [871]	0.07	0.07
1,800 [982]	0.05	0.04
2,000 [1,090]	0.02	0.02
2,200 [1,200]	0.00	0.00

For the maximum temperature of 1000F (538 C) a reduction factor of 0.66 is expected.
So, Fy@1000F= 0.66*14600=9636 psi




14"ø - EXHP-UP
6X3 CHANNEL
14"ø - EXHP-UP
6X3 CHANNEL
6X3 CHANNEL
18"X18" EMBED
8X3 CHANNEL
8X3 CHANNEL
(TYPICAL EXCEPT AS NOTED)
6X3 CHANNEL
6X3 CHANNEL
3 1/2" TUBE STEEL
TOP OF PARAPET
169' - 6"
ROOF
164' - 6"
G
F


0' - 7"
3' - 4 1/4"
1' - 6 5/8"
3' - 4 1/4"
4' - 4 3/8"
1' - 7"
Level 2
78' - 6"
Level 1 - Mezzanine
70' - 6"
HVAC Vestibule
68' - 11"
LTR81-81-20-XR2
DPF HOUSING
20" BELLOWS
WITH 150 LB FLANGES
Y14X-D14PF2 DUAL PORT FLANGE
9' - 1 1/4"
9' - 10"
12' - 5 5/8"
12' - 5 5/8"
AVERAGE
EXISTING GRADE
B5 (58.73')
58' - 8 3/4"



Schedule 40 Pipe Dimensions

Size Inches	Diameters: External Inches	Diameters: Internal Inches	Nominal Thickness Inches	Transverse Areas: External Sq. Ins.	Transverse Areas: Internal Sq. Ins.	Transverse Areas: Metal Sq. Ins.	Length of Pipe per Sq. Foot of: External Surface Feet	Length of Pipe per Sq. Foot of: Internal Surface Feet	Cubic Feet per Foot of Pipe	Weight per Foot Pounds	Number Threads per Inch of Screw
1/8	.405	.269	.068	.129	.057	.072	9.431	14.199	.00039	.244	27
1/4	.540	.364	.088	.229	.104	.125	7.073	10.493	.00072	.424	18
3/8	.675	.493	.091	.358	.191	.167	5.658	7.747	.00133	.567	18
1/2	.840	.622	.109	.554	.304	.250	4.547	6.141	.00211	.850	14
3/4	1.050	.824	.113	.866	.533	.333	3.637	4.635	.00370	1.130	14
1	1.315	1.049	.133	1.358	.864	.494	2.904	3.641	.00600	1.678	11½
1¼	1.660	1.380	.140	2.164	1.495	.669	2.301	2.767	.01039	2.272	11½
1½	1.900	1.610	.145	2.835	2.036	.799	2.010	2.372	.01414	2.717	11½
2	2.375	2.067	.154	4.430	3.355	1.075	1.608	1.847	.02330	3.652	11½
2½	2.875	2.469	.203	6.492	4.788	1.704	1.328	1.547	.03325	5.793	8
3	3.500	3.068	.216	9.621	7.393	2.228	1.091	1.245	.05134	7.575	8
3½	4.000	3.548	.226	12.56	9.886	2.680	.954	1.076	.06866	9.109	8
4	4.500	4.026	.237	15.90	12.73	3.174	.848	.948	.08840	10.790	8
5	5.563	5.047	.258	24.30	20.00	4.300	.686	.756	.1389	14.61	8
6	6.625	6.065	.280	34.47	28.89	5.581	.576	.629	.2006	18.97	8
8	8.625	7.981	.322	58.42	50.02	8.399	.442	.478	.3552	28.55	8
10	10.750	10.020	.365	90.76	78.85	11.90	.355	.381	.5476	40.48	8
12	12.750	11.938	.406	127.64	111.9	15.74	.299	.318	.7763	53.6	
14	14.000	13.125	.437	153.94	135.3	18.64	.272	.280	.9354	63.0	
16	16.000	15.000	.500	201.05	176.7	24.35	.238	.254	1.223	78.0	
18	18.000	16.874	.563	254.85	224.0	30.85	.212	.226	1.555	105.0	
20	20.000	18.814	.593	314.15	278.0	36.15	.191	.203	1.926	123.0	
24	24.000	22.626	.687	452.40	402.1	50.30	.159	.169	2.793	171.0	

2. CRITERIA OF THE THERMAL EXPANSION EVALUATION

As per the given information, the following criteria shall be considered:

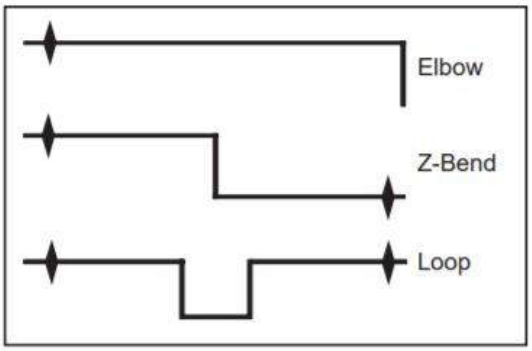
1- The lateral force on the pipe support is estimated based on the pipe expansion.
2- Thermal expansion is considered shall be estimated for the vertical riser.
3- The maximum expansion of each line is related to the amount of the bending moment of the perpendicular line. The excess bending moment in the perpendicular line should not exceed the capacity of the pipe.
4- In the straight lines, where the pipe clamps were considered, the amount of expansion shall be less than the threshold of the excess stresses in the pipe hangers.
5- Seismic braces are not in the scope of work.
6- Design temperature variation is given equal to 1000F (according to Rushing company suggestion and experiences)
7- Thermal expansion coefficient= 0.0000065

EXPANSION CALCULATIONS AND LOOP SIZING

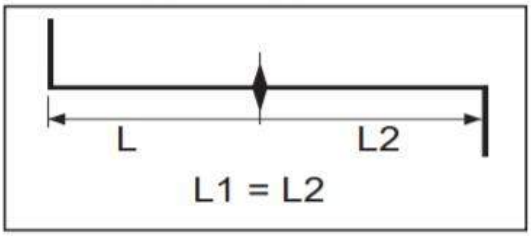
In a bonded system, the carrier pipe, foam insulation, and outer protective jacket are joined together forming one cohesive unit that expands and contracts together. Thermal expansion of the carrier pipe during operation is therefore transferred to the polyurethane foam and outer jacket. These movements are naturally restricted to a certain extent by the friction between the soil and jacket. In extreme cases, the force of friction can become so great that free expansion cannot occur and the unit becomes "fixed" into place. In such a case, the opposing force from thermal expansion can place impermissibly high stresses in the carrier pipe. Therefore, free expansion must be allowed to occur, but expansion must ultimately be compensated for through system design. The most common method is the inclusion of expansion elbows, loops, or z-bends.

Thermal expansion will occur between all fixed points in the piping system. If the system has the same covering height, natural fixed points will occur in the center of a line section between two expansion elbows. Unequal covering will cause the fixed point to be displaced due to varying frictional forces, and if there is any doubt, the fixed point should be set with an anchor. In all cases, this fixed point should be considered when calculating expansion.

EXPANSION COMPENSATION

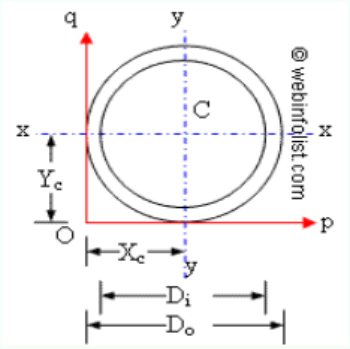


NATURAL FIXED POINT



2.1 THERMAL ANALYSIS OF PIPES FOR THE FEASIBILITY OF A PIPE SYSTEM WITHOUT THERMAL EXPANSIONS

To find the maximum allowable length of each line between loops and the bends, we need to find the moment capacity of the pipes and then relate it to the amount of the expansion.



Calculator for Moment of Inertia of Hollow circular section

This calculator gives the values of moment of inertia as well as the values of section modulus about x-axis and y-axis of the section. Section modulus helps in determining the strength of the beam. Please enter the "Input Values" in the form given below and click "Calculate". You should enter all the values in same units and this calculator will provide the "Output Results" in the corresponding units (unit^2 , unit^3 , unit^4 etc.). You can also vist Instructions for Moment of Inertia Calculator

Input Values

Outer Diameter of section (unit):	20
Inner Diameter of section (unit):	18.81

Please make sure that all the values are positive and the outer diameter is bigger than the inner diameter

Reset Calculate

Output Results

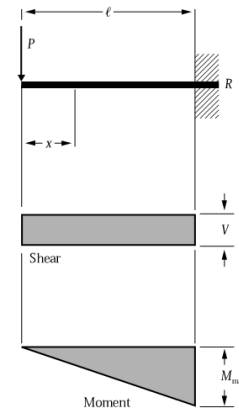
Area of section (unit^2):	36.272750238
Position of centroid - Xc (unit):	10
Position of centroid - Yc (unit):	10
Moment of Inertia Ixx (unit^4):	1708.9364450
Moment of Inertia Iyy (unit^4):	1708.9364450
Section Modulus Zxx (unit^3):	170.8936445
Section Modulus Zyy (unit^3):	170.8936445
Radius of gyration rxx (unit):	6.863927902
Radius of gyration ryy (unit):	6.863927902

Resistive bending moment of the pipe at 1000F with Fy= 9636 psi= Mr=9636*170.89/12=137.2 kip-ft

Check the effect of the elbow and the side of the loop.

The connection at an elbow is similar to the model of a cantilever beam,

Figure 13 Cantilever Beam – Concentrated Load at Free End



$R = V \quad = P$

M_{max} (at fixed end) $\quad = P\ell$

$M_x \quad = Px$

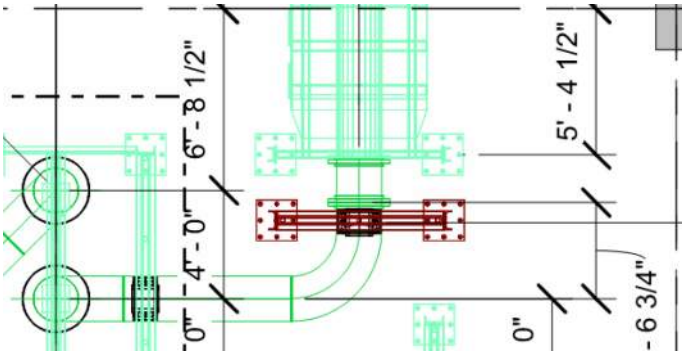
Δ_{max} (at free end) $\quad = \frac{P\ell^3}{3EI}$

$\Delta_x \quad = \frac{P}{6EI}(2\ell^3 - 3\ell^2 x + x^3)$

The goal is to find the relation between the maximum possible of the straight length to the maximum reasonable length of the perpendicular pipe.

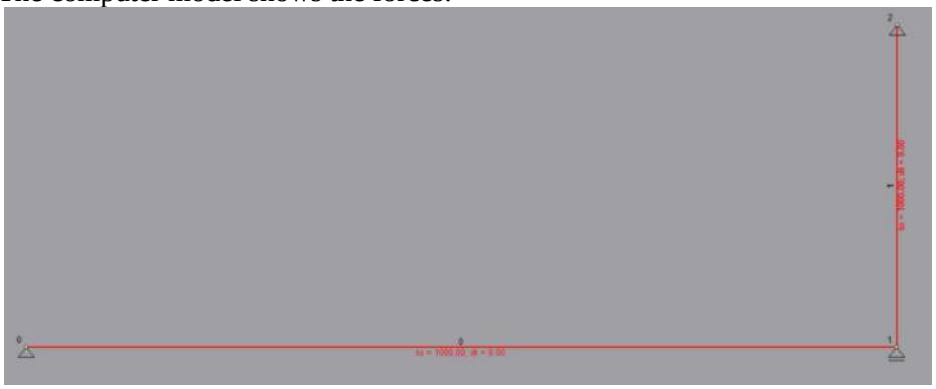
To find this relation, we analyzed different models of the exhaust pipes with a computer to understand the internal forces:

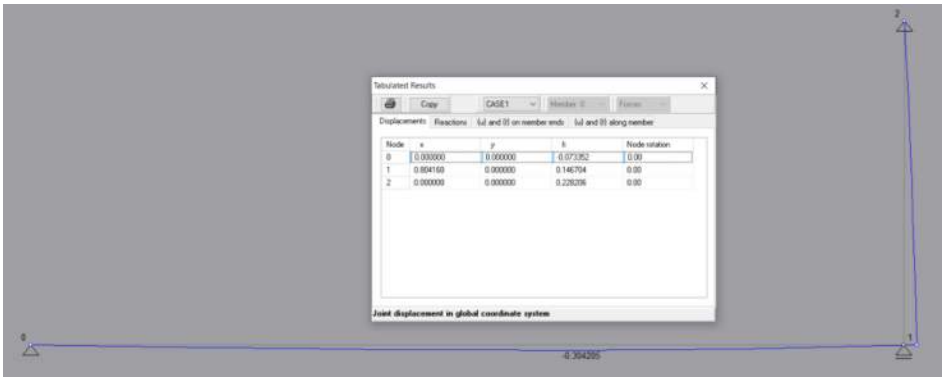
Case 1, short exhaust length

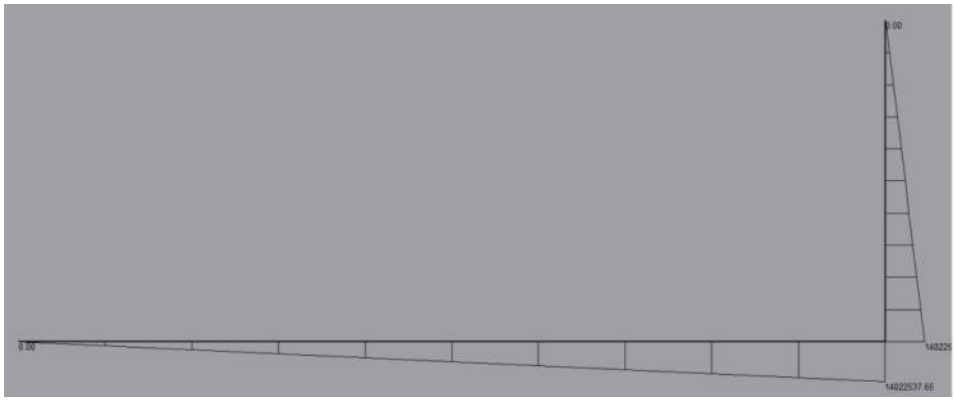


The length of the elbow is short, and because of the high moment of Inertia that increases the stiffness, the moment at the elbow and thus the lateral force of the support is more than the standard thresholds, so w need use thermal expansion.

The computer model shows the forces:

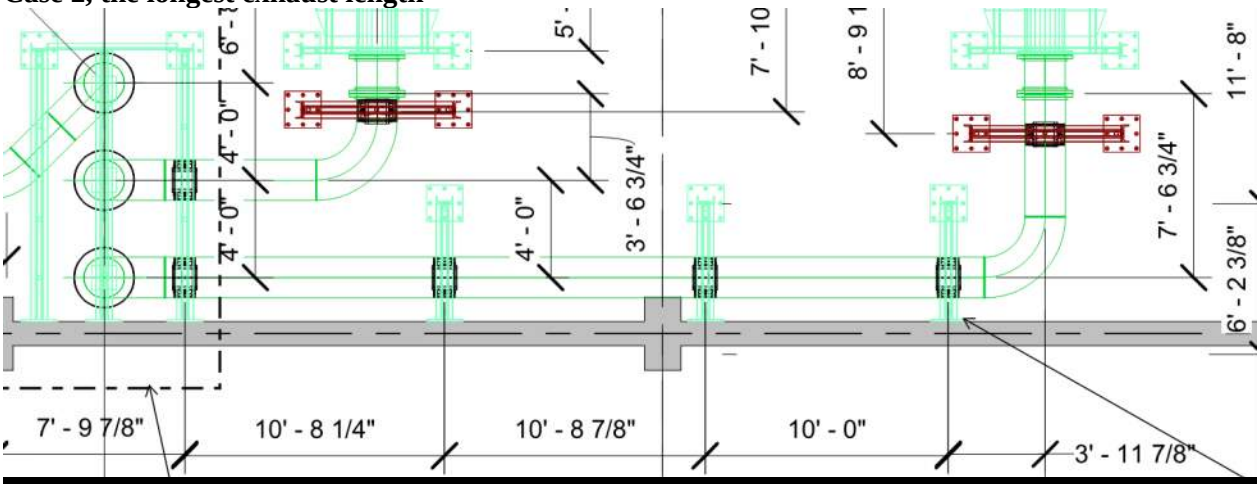


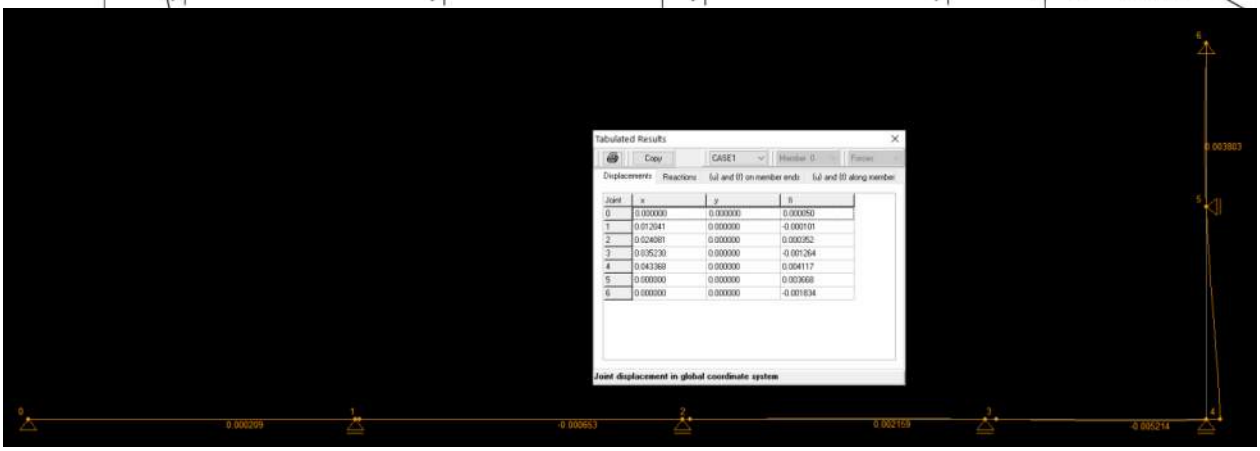


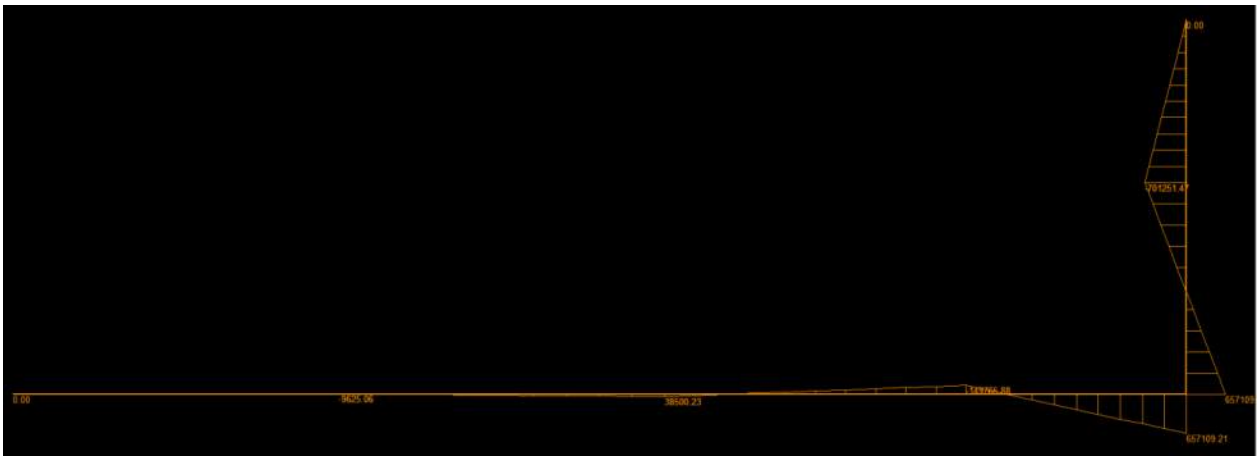


M= 14022537 lb-ft, Fb= M/170.89*12= 984671.09 >> 9636= capacity @1000 F

Case 2, the longest exhaust length







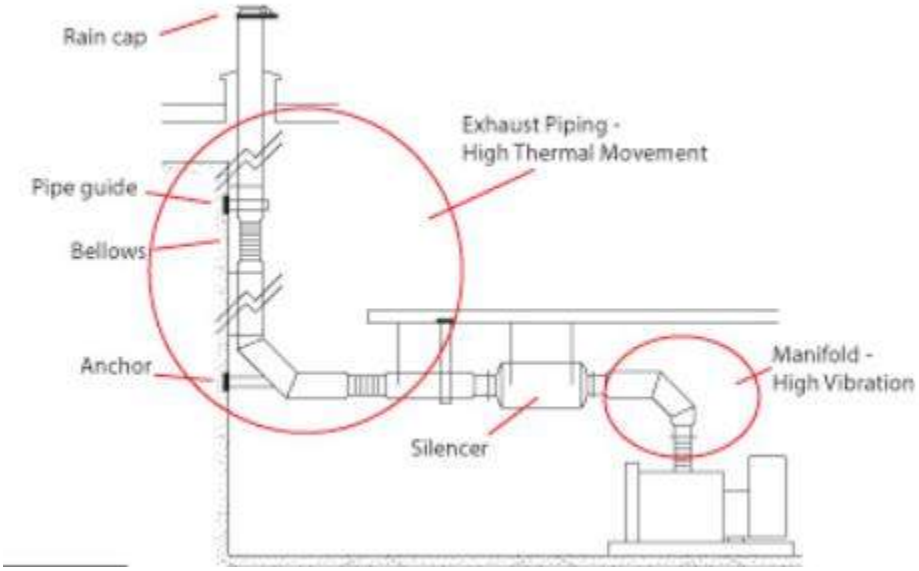
M= 657109 lb-ft, Fb= M/170.89*12= 46142 >> 9636= capacity @1000F

Conclusion: As per the above analysis, it is not feasible to use the elbows to release the thermal stresses, and based on this investigation, we need to use the thermal expansion.

2.2 DESIGN OF THE THERMAL EXPANSION SYSTEM

Every emergency generator application includes an exhaust system designed to route exhaust gases out of the engine room. These exhaust systems consist of piping, elbows, and, very importantly, flexible sections that must be used to account for the engine's vibration, and also for the pipe growth experienced as the engine runs and the exhaust gases quickly rise to 800°F and more. If the exhaust piping where to be installed rigidly, you can be sure that cracks will develop at the weakest point, usually at the engine's outlet flanges, or at silencer inlet/outlet connections. Having a flexible connector between the engine and the silencer seems to be well understood.

A typical generator system shall be designed with the following features:

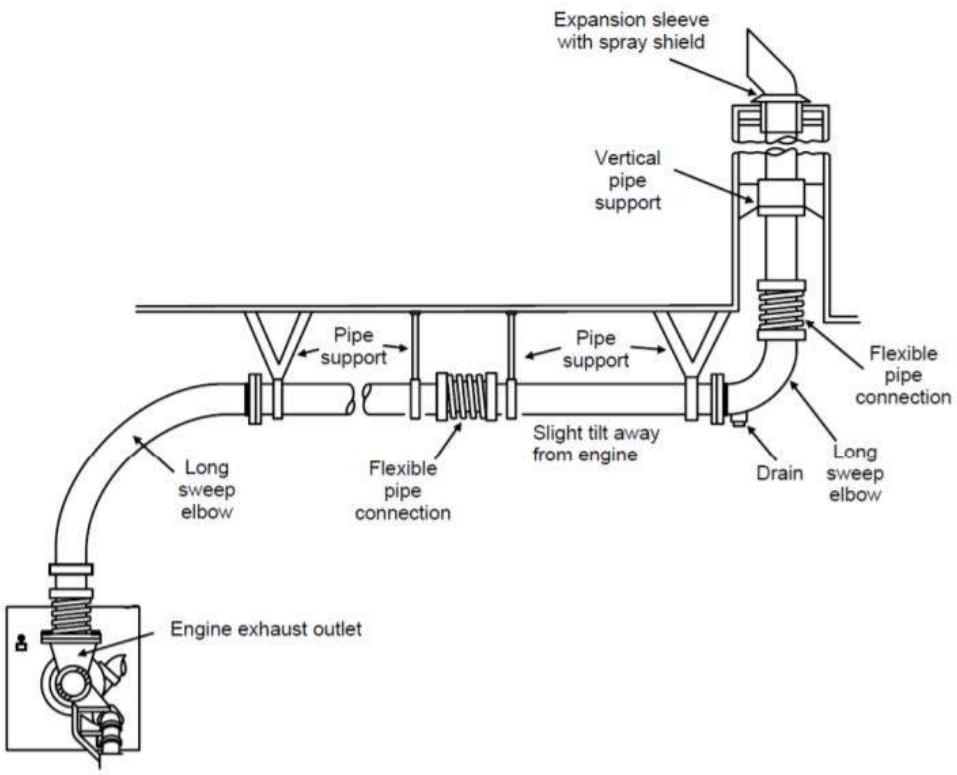


Assumptions:

1- The silencer is not rigidly mounted to the engine
2- Between the silencer and the engine, exhaust flex shall be used in accordance with the generator guidelines.
3- The design of the flexible connection is not in the scope of work and contractor to follow the vendors specs. To install the flex between engine and silencer. See also the note below:

Note on the Flex:
In most cases, the exhaust piping seems to rely on the flexible connector to absorb all movements in the piping system. The flexible connector is not designed for this, and the consequences are almost always evident in premature gas leaks due to cracked flanges in the flexible connector. Flexible connectors are intended to absorb or isolate high frequency, low amplitude engine vibration (fast but small movements) from the rest of the exhaust piping. They are NOT designed to compensate for or absorb pipe expansion, nor are they designed to "make up" for major mis-alignments in the exhaust piping. If the flexible connector between the engine and the silencer seems compressed or "s-shaped" in its idle state, it is not installed correctly. Flexible connectors are made up of flexible hose, which is typically constructed of a single ply of relatively small corrugations that allow the material to move with vibration. The corrugations aren't designed to compress; over time the flex will fail if it is operated under compression.

Conclusion on the Thermal system:
Therefore as per the standard design procedure, we need to design the Bellows (Expansion joint after the silencer for both horizontal and vertical directions as shown below:

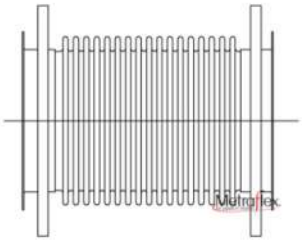


Note on the Bellows:

Bellows, or expansion joints, are much more flexible than flexible connectors. Bellows are designed to absorb pipe expansion. The corrugations are larger and, therefore, able to compress more. They are generally better able to handle lateral movement as well, so they can better tolerate pipe misalignment. Because they are more flexible, they can provide expansion absorption and vibration isolation in a shorter length than a flexible connector.

Products > Metal Expansion Joints

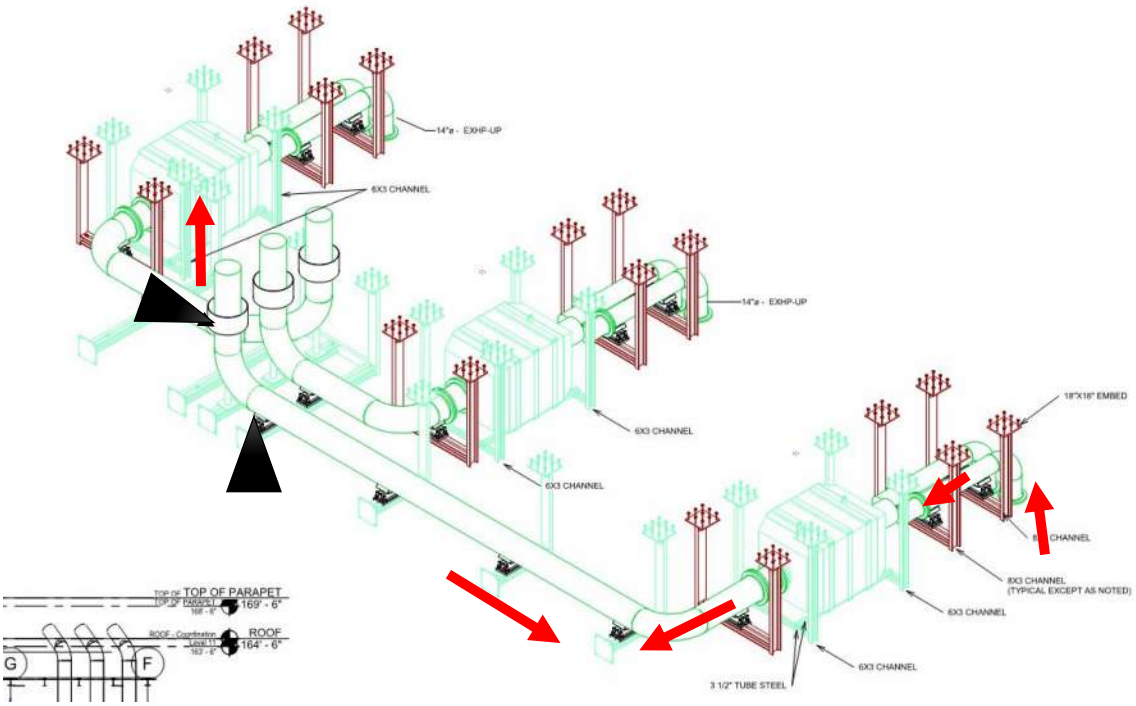
Exhaust Piping Expansion Joints for engine exhaust systems up to 1,200°F



PART NO	PIPE SIZE	ID (IN)	OAL (IN)	AXIAL COMP (IN)	LATERAL OFFSET (IN)	AXIAL SPRING RATE (LB/IN)	LATERAL SPRING RATE (LB/IN)	WEIGHT (LB)
EX300400	4	4.50	12.00	3	1	46	22	17
EX300500	5	5.56	12.00	3	1	66	47	20
EX300600	6	6.63	12.00	3	1	82	80	23
EX300800	8	8.61	12.00	3	1	103	165	31
EX301000	10	10.75	12.00	3	1	103	248	39
EX301200	12	12.75	12.00	3	0.875	121	405	55
EX301400	14	14.00	12.00	3	0.750	132	530	66
EX301600	16	16.00	12.00	3	0.625	150	777	77
EX301800	18	18.00	12.00	3	0.500	168	1092	80
EX302000	20	20.00	12.00	3	0.500	186	1480	93
EX302200	22	22.00	12.00	3	0.500	204	1952	97
EX302400	24	24.00	12.00	3	0.500	222	2513	124

For the EX302000 (20” pipe), the axial spring stiffness = 186 lb/in
Also the maximum expansion rate= 3”
Lateral stiffness= 1480 lb/in
Lateral offset=0.5”

Maximum horizontal length= 39’
Maximum vertical length = 150.5’-70.5’=80’



The direction of the thermal expansion is shown in the picture.

The maximum expected expansion in the horizontal lines= 3.04” > 3”, so we need to use (2) Bellows

Online Thermal Linear Expansion Calculator

468 L_0 - *initial length of object (m, inches)*

0.0000065 α - *linear expansion coefficient* (m/m^oC, in/in^oF)

0 t_0 - *initial temperature* (^oC, ^oF)

1000 t_1 - *final temperature* (^oC, ^oF)

Calculate! Reset!

www.engineeringtoolbox.com says

Change in Length of object - dL (m, inches) : 3.042

Final length of object - L1 (m, inches) : 471.042

The maximum expected expansion in the vertical riser= 6.24” > 3”, so we need (3) Bellows for the vertical riser

Online Thermal Linear Expansion Calculator

960 L_0 - *initial length of object (m, inches)*

0.0000065 α - *linear expansion coefficient* (m/m^oC, in/in^oF)

0 t_0 - *initial temperature* (^oC, ^oF)

1000 t_1 - *final temperature* (^oC, ^oF)

Calculate! Reset!

www.engineeringtoolbox.com says

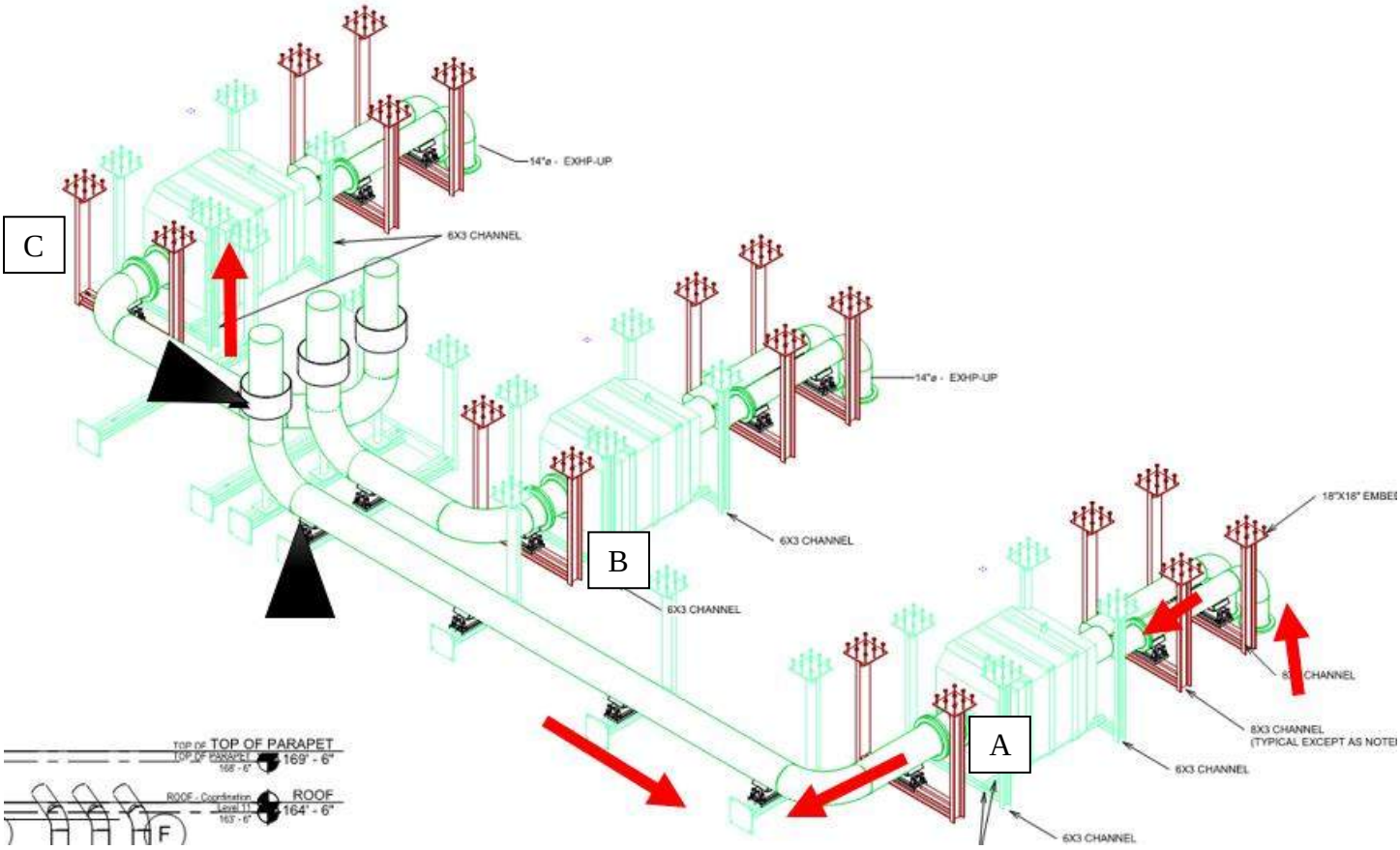
Change in Length of object - dL (m, inches) : 6.24

Final length of object - L1 (m, inches) : 966.24

So, the maximum thermal expansion of one bellow= 3” so we will use model EX302000.

3. ESTIMATION OF THE THERMAL FORCES ON THE STRUCTURAL SUPPORTS (HORIZONTAL PIPES)

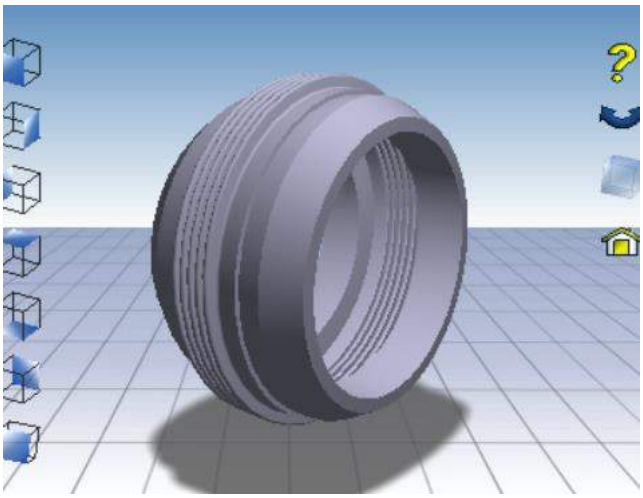
As per the below picture and the computer model results, we need to add thermal expansion between the vertical riser and the silencer for all three lines.



Therefore, the thermal expansion forces will be reduced, and thus the lateral pressure on the pipe supports A, B, and C.

3.1 ESTIMATION OF THE LATERAL LOAD ON SUPPORT A

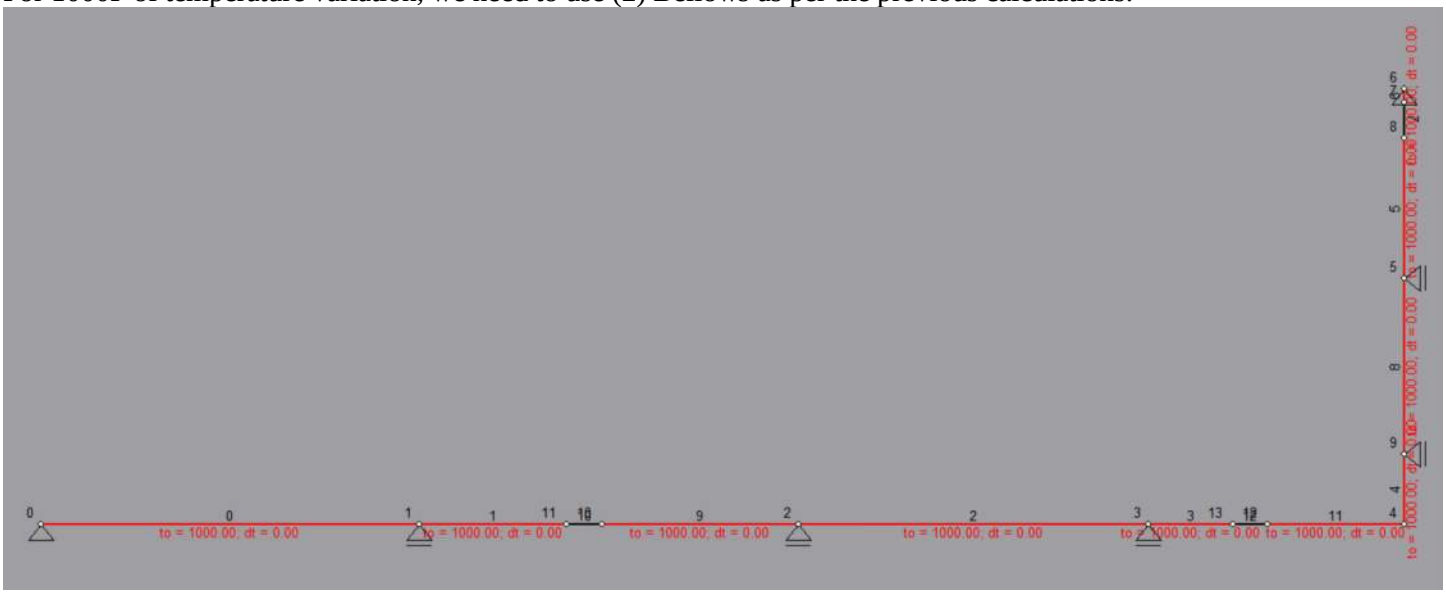
By adding a bellow (expansion joint), we can analyze the pipeline by adding the equivalent stiffness of the bellow to the pipeline. To simulate the stiffness, we can add an element with the unit length and create the equivalent stiffness of the expansion, as shown below:
F=K.D
D=PL/AE,
K for the axial element = AE/L, assuming 1' for the element, then K= A.E= 186 lb/in= 2232 lb/ft
Assuming the same E in the program= 4176000000, then the equivalent A= 0.00000053
Equivalent moment of Inertia can be estimated like a beam:
K=12EI/L^3, L=1'= 12EI = Lateral stiffness= 1480 lb/in= 17760 lb/ft
Assuming the same E in the program= 4176000000, then I= 0.000000354



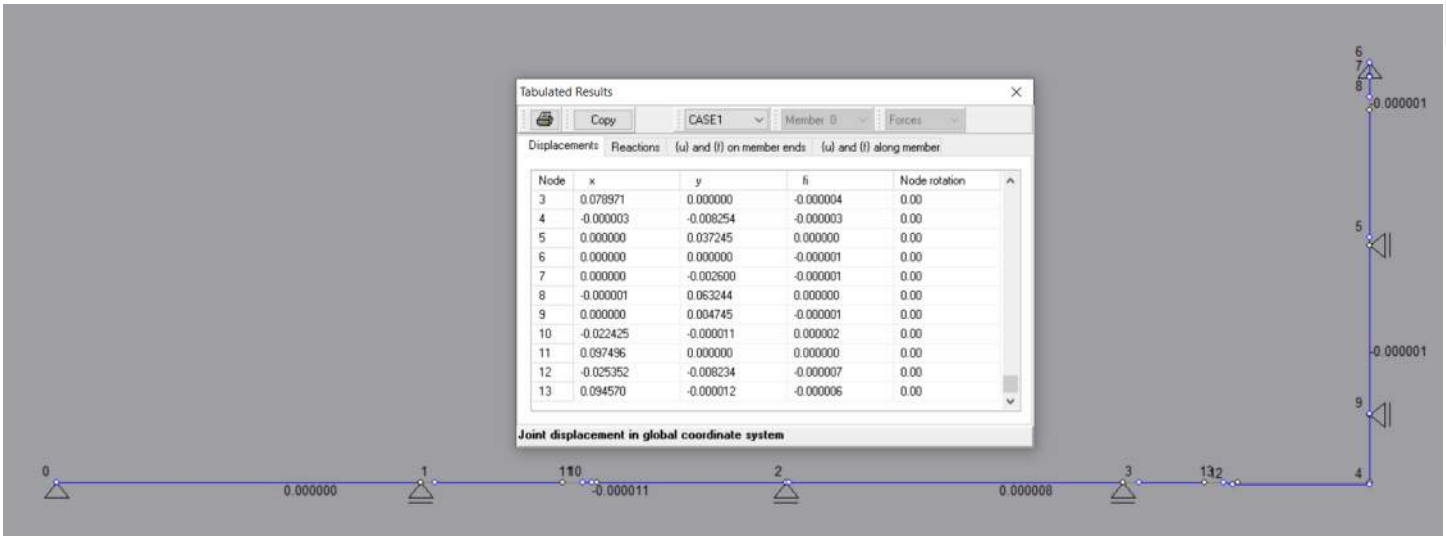
Specifications	
Nom size	20 in
Lateral Movement	1.000 in
OAL	12.000 in
Weight	47 lbs
Axial Spring Rate	102 lb·in
Lateral Spring Rate	568 lb·in
Bellows Material	Stainless Steel
END	WELD
End Material	Carbon Steel
Bellows ID	20.00 in
Pipe OD	20.00 in
Axial Movement	3 in

The corner support should be a free node, and the expansion should be installed between the elbow and the roller support.

For 1000F of temperature variation, we need to use (2) Bellows as per the previous calculations:

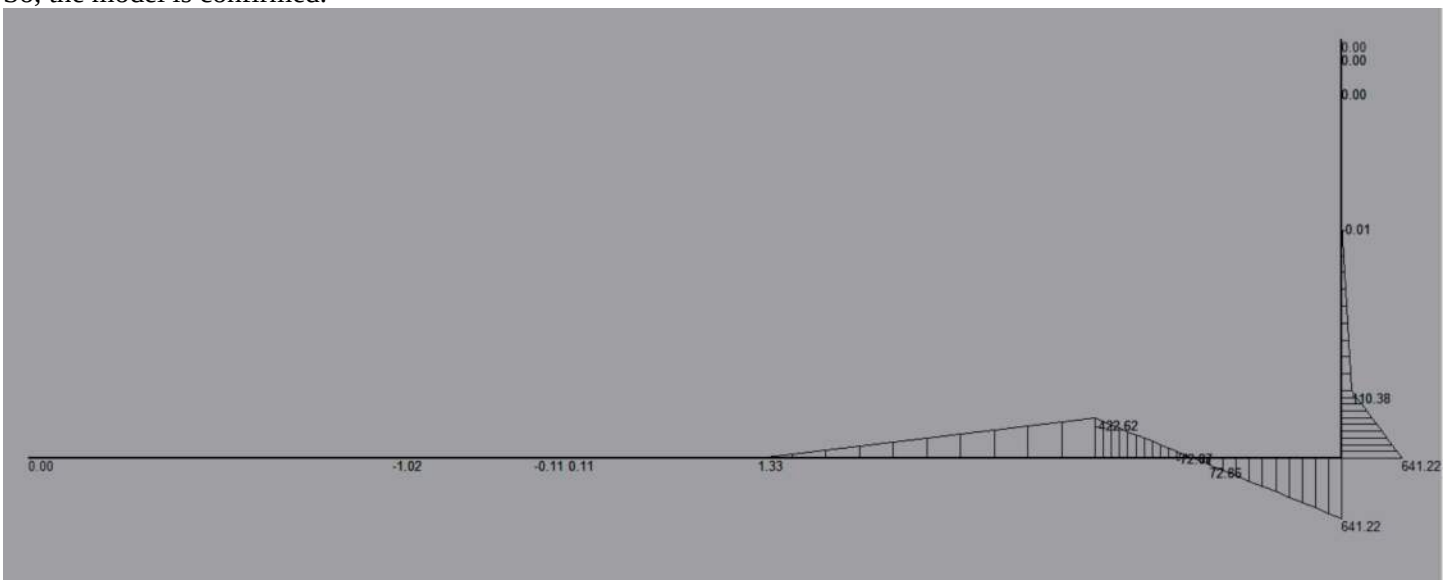


Thermal expansion= Element #10 and #12

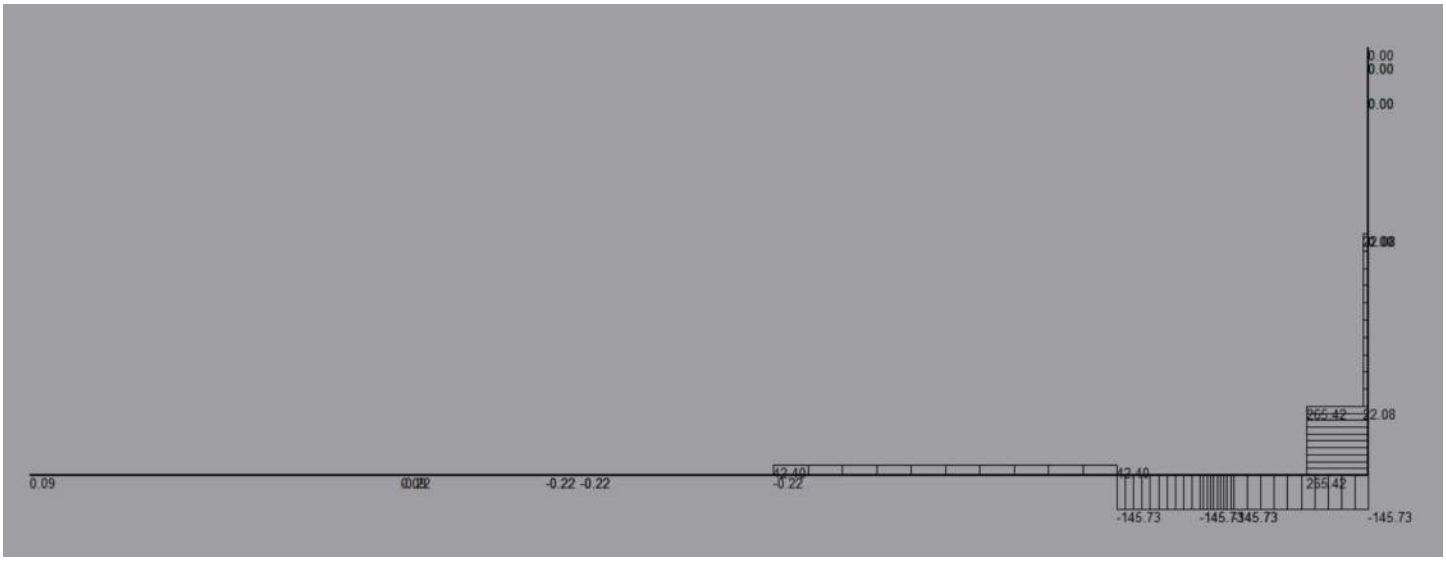


Lateral displacement (y direction)= 0.06'=0.72" < 3" OK to use one bellow in vertical direction
Node 13 longirudinal expansion (x-direction (node 12 &13))= 0.094'+0.025'=1.43" <3" for each bellows OK
Lateral offset of the Bellow (node #13)=0.008-0.000012=0.0081'= 0.09" < 0.5" (maximum allowed lateral offset of the Bellows) OK

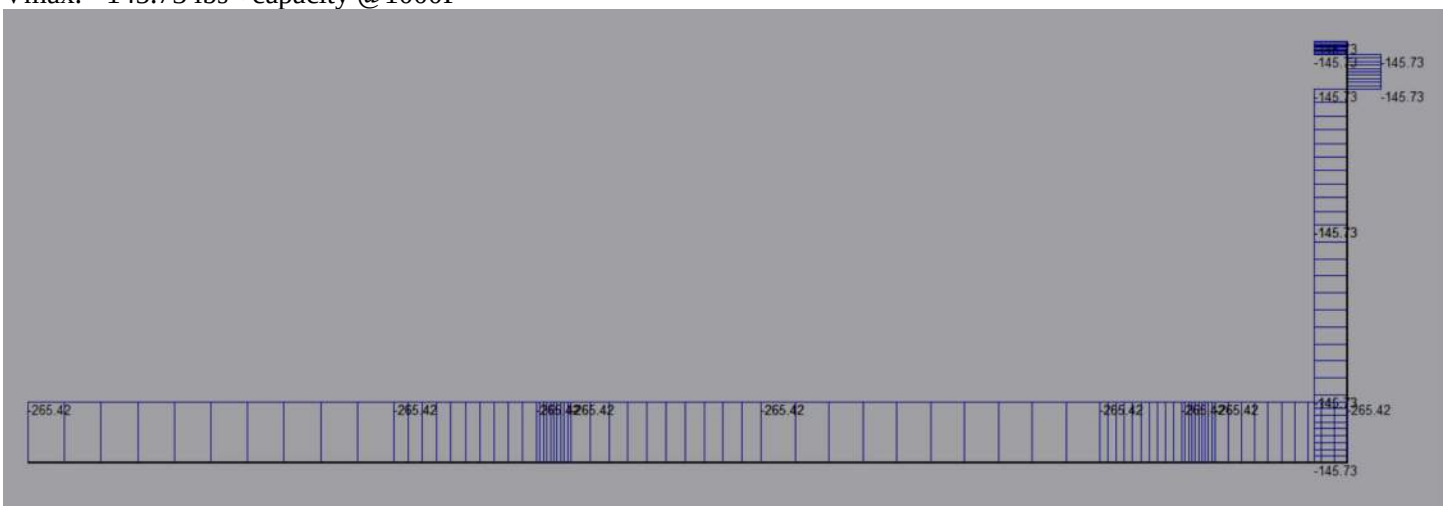
So, the model is confirmed.



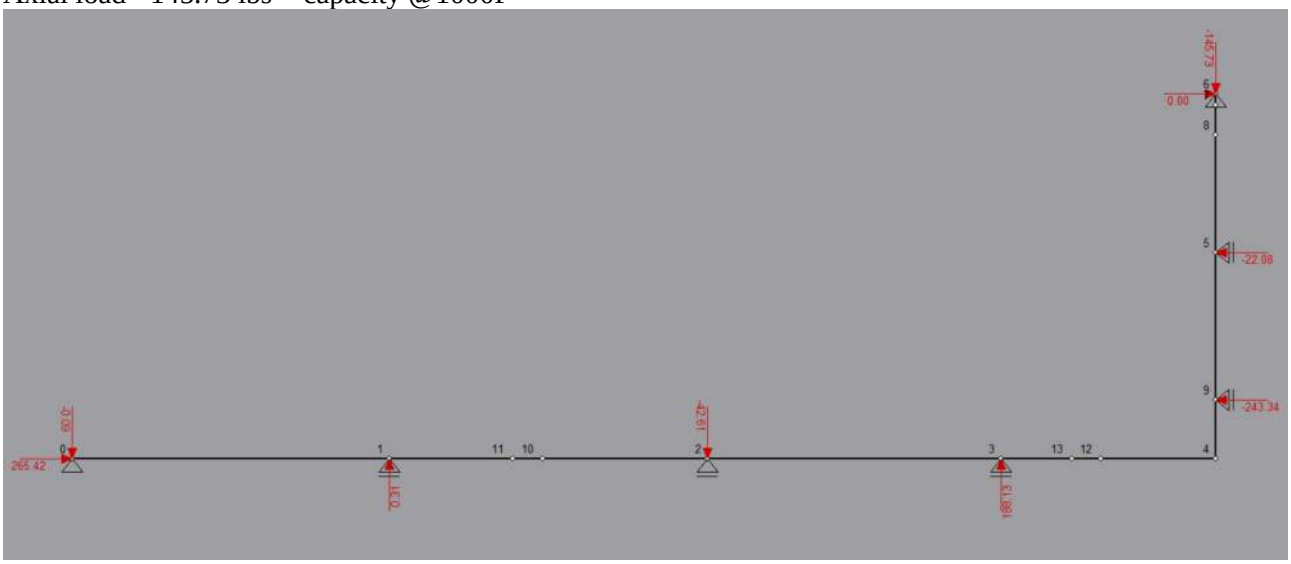
Mamx.= 641.22 lb-ft < 137.2 kip-ft @1000F OK



Vmax.= 145.73 lbs< capacity @1000F



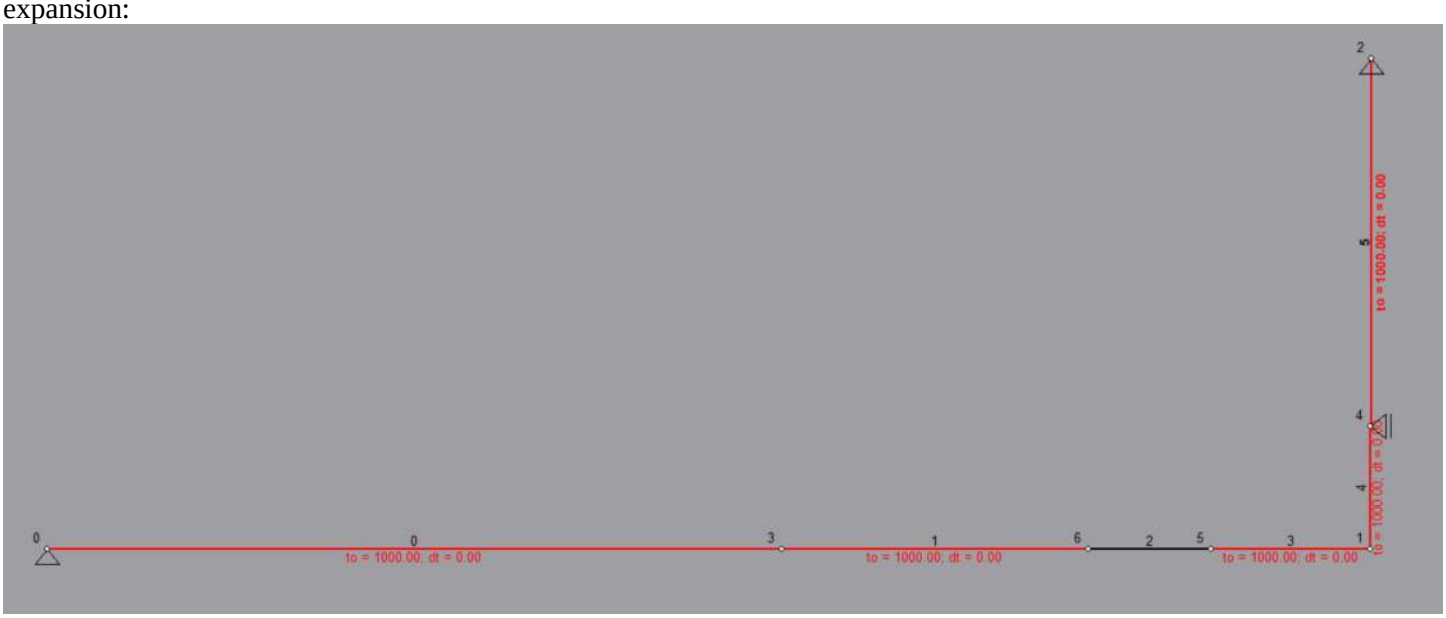
Axial load= 145.73 lbs < capacity @1000F



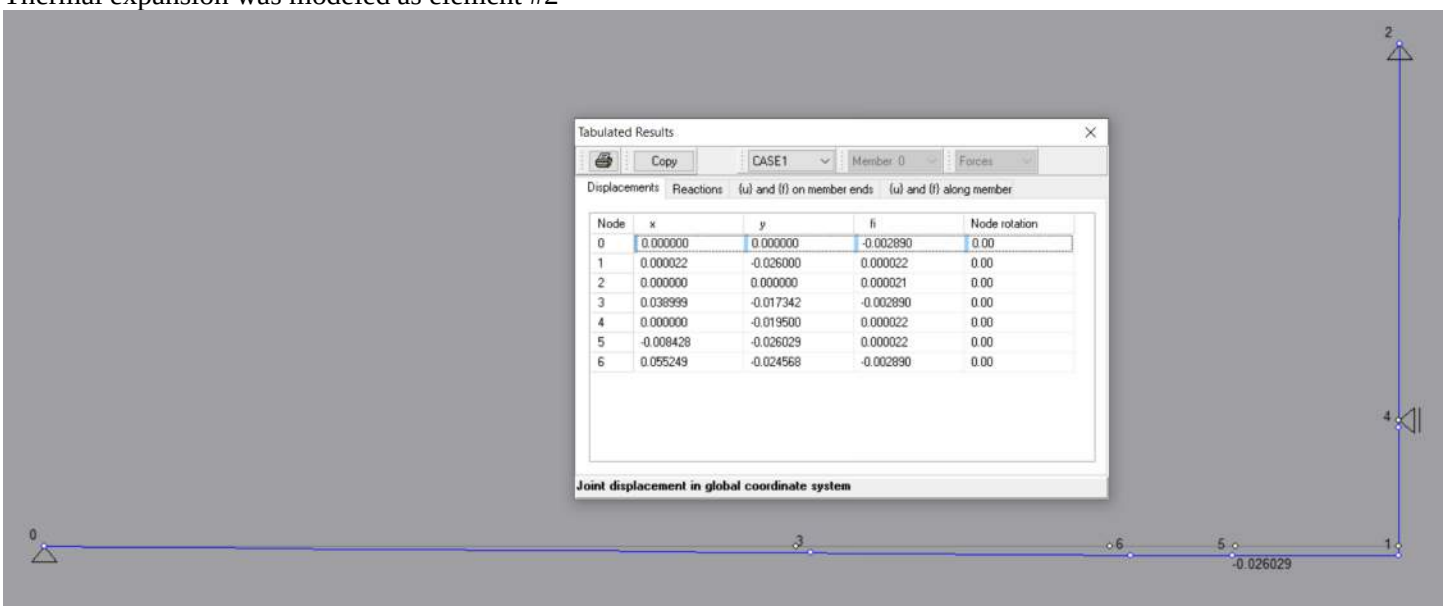
Reaction forces

3.2 ESTIMATION OF THE LATERAL LOAD ON SUPPORT B & C

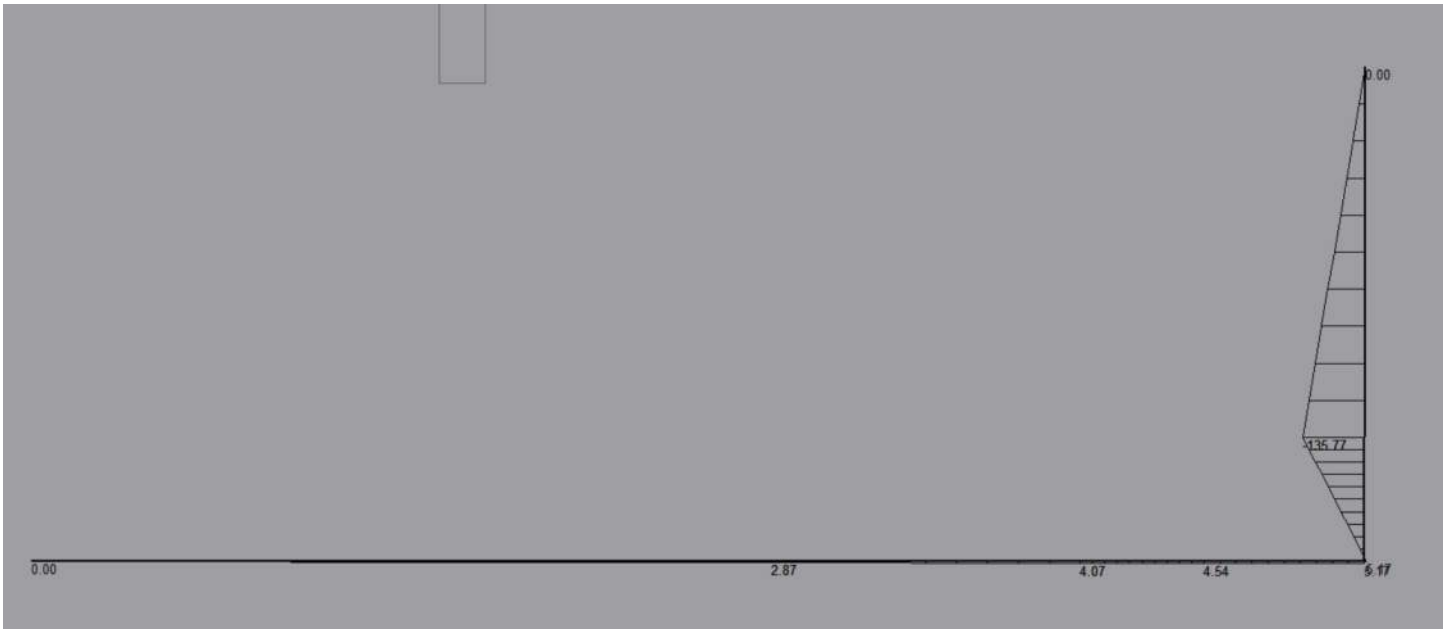
Using the same criteria for the support A, the below pictures shows the analysis results for the pipe with the thermal expansion:



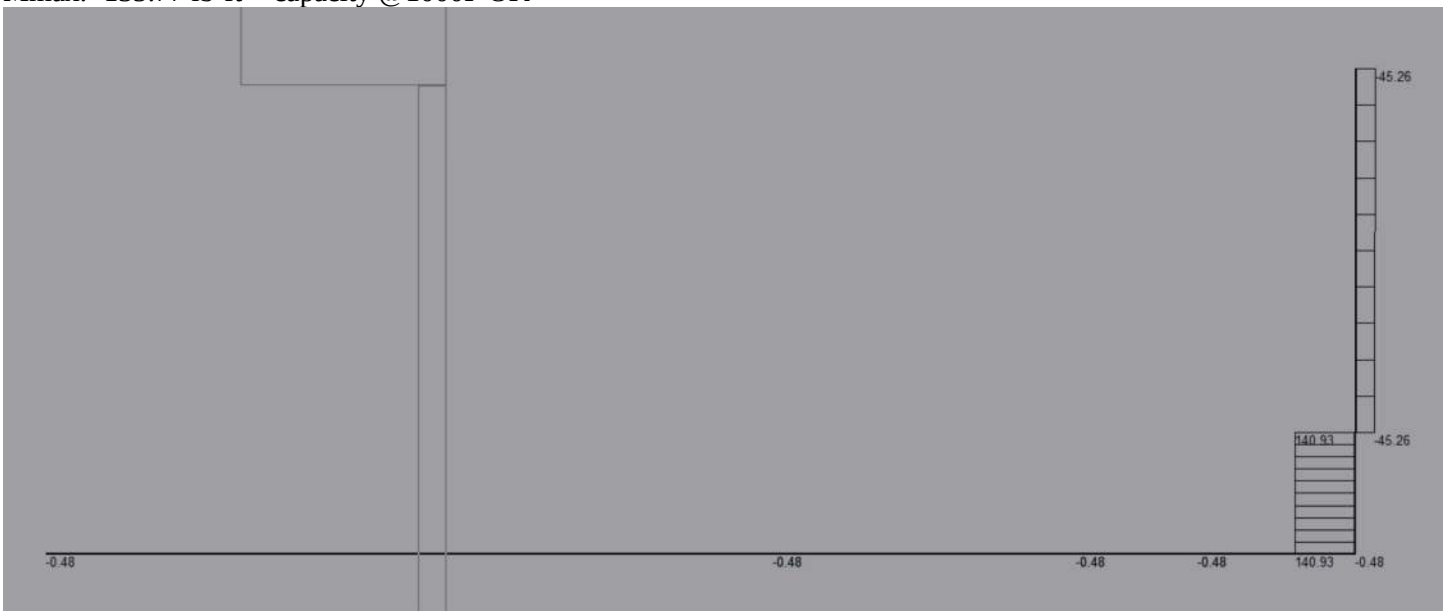
Thermal expansion was modeled as element #2



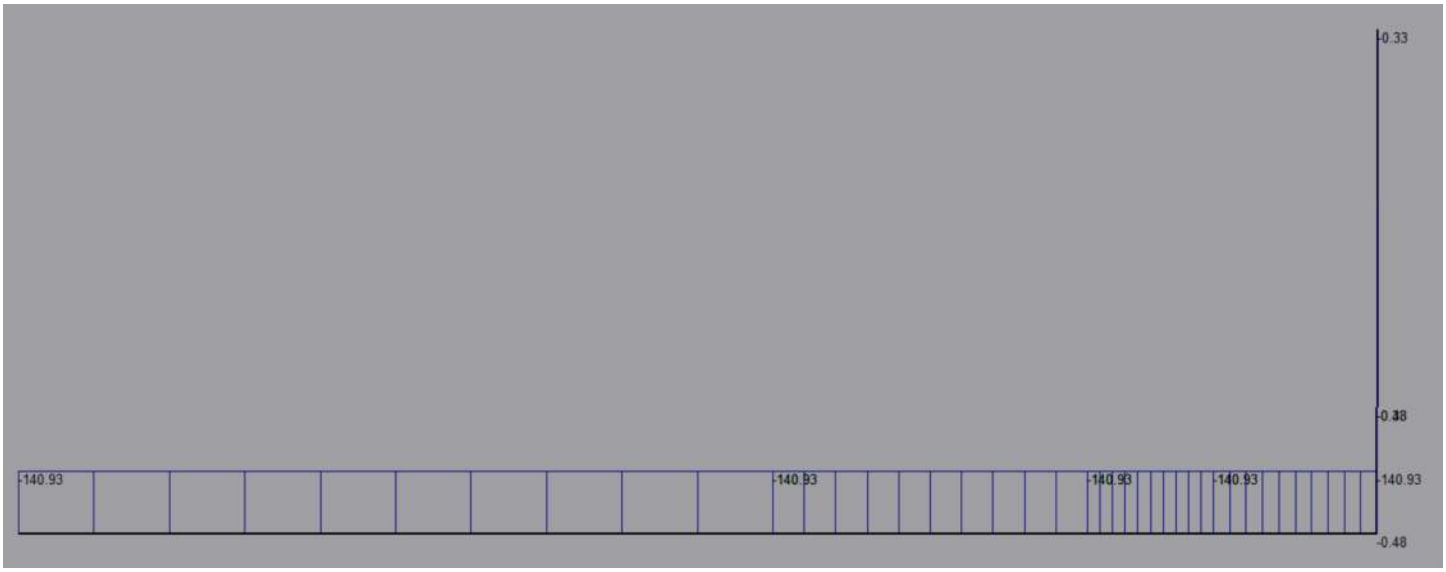
Node 5 lateral displacement (y direction)= 0.026'=0.3" < 0.5" OK
Node 6 longirudinal expansion (x-direction)=(node 5&6)0.022+0.0084=0.03'=0.36" <3" OK



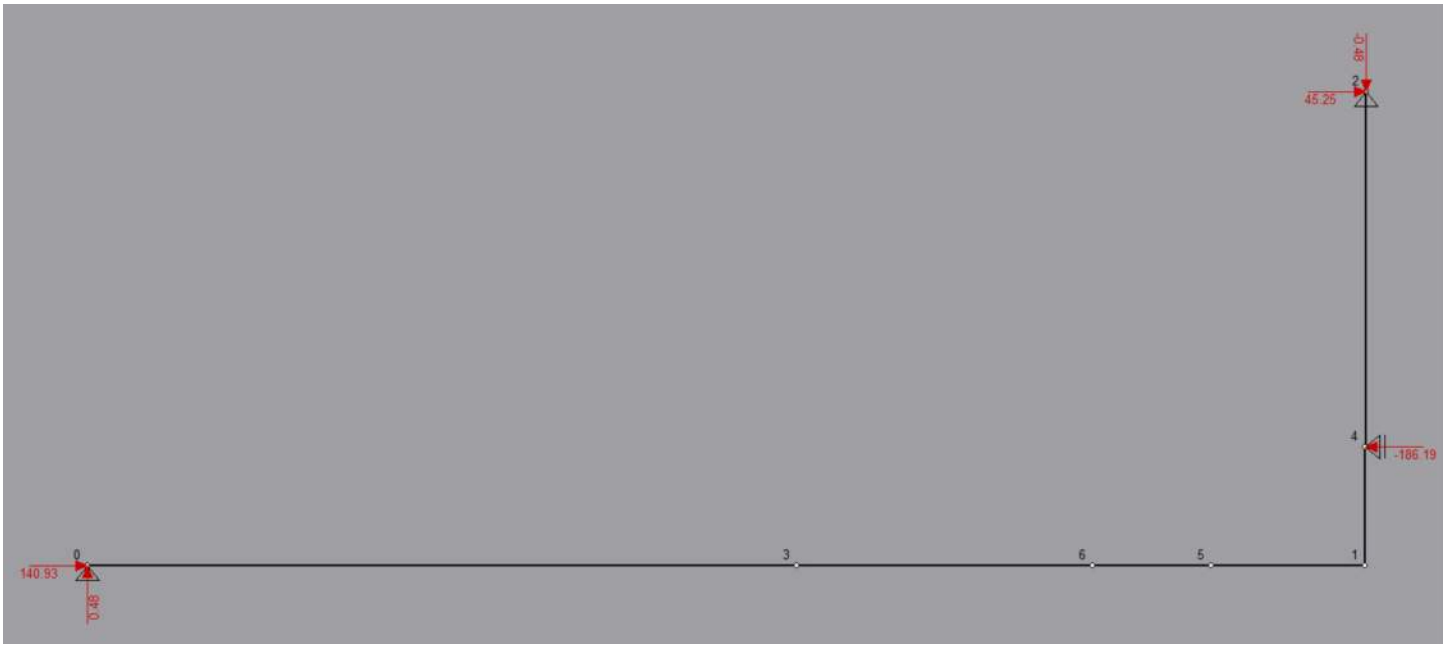
Mmax.=135.77 lb-ft < capacity @1000F OK



Vmax.= 141 lbs < capacity @1000F OK



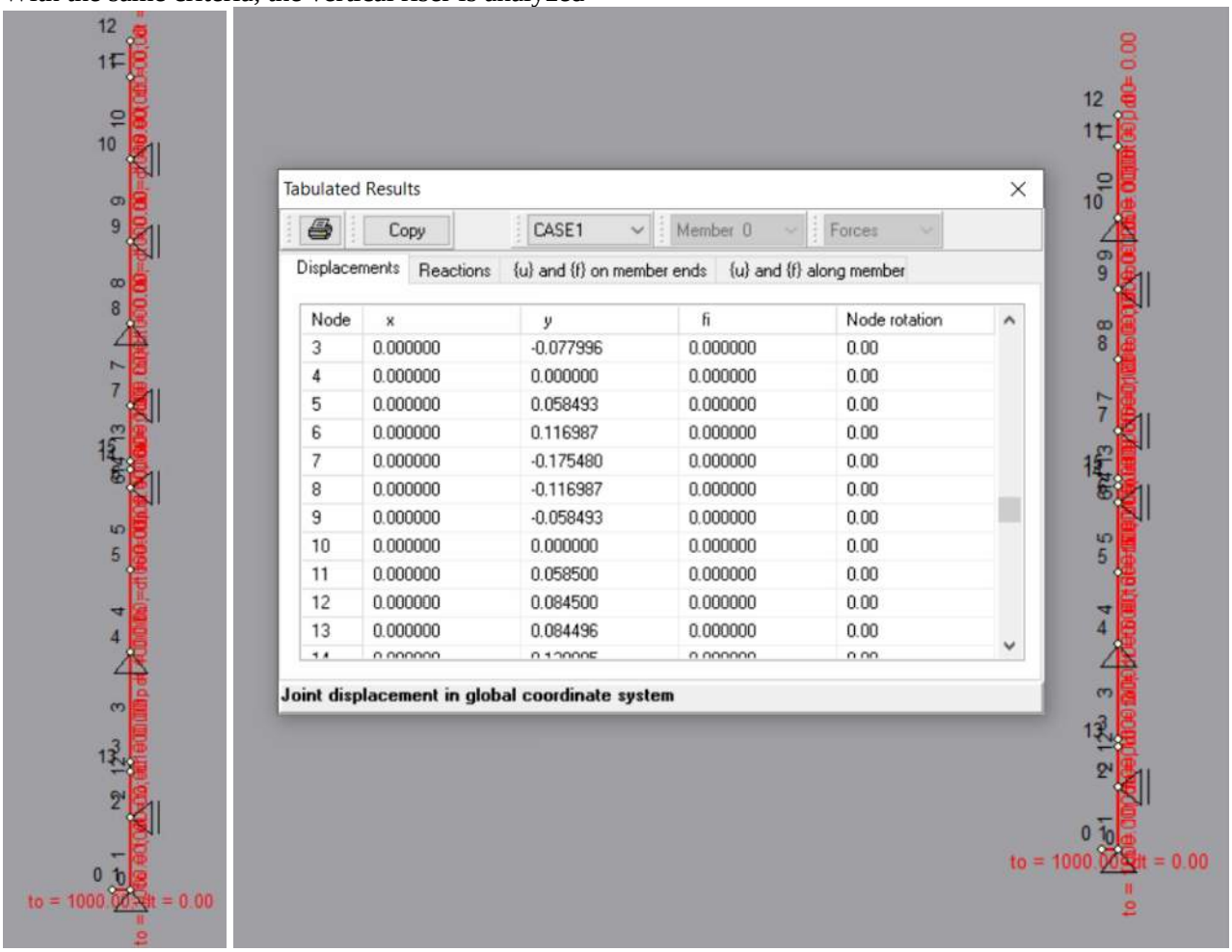
Axial= 141 lbs < capacity @ 1000F OK



Reactions

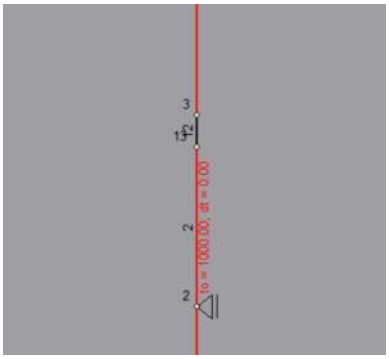
3.3 ESTIMATION OF THE SUPPORT REACTION IN THE VERTICAL RISERS

With the same criteria, the vertical riser is analyzed

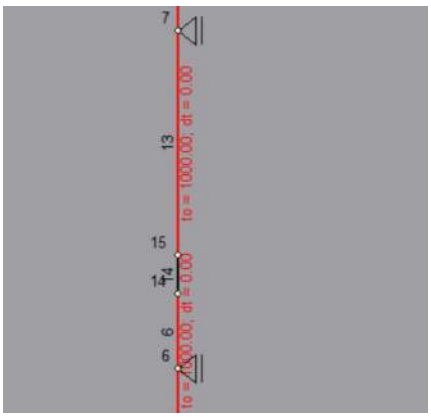


Node	x	y	fi	Node rotation
3	0.000000	-0.077996	0.000000	0.00
4	0.000000	0.000000	0.000000	0.00
5	0.000000	0.058493	0.000000	0.00
6	0.000000	0.116987	0.000000	0.00
7	0.000000	-0.175480	0.000000	0.00
8	0.000000	-0.116987	0.000000	0.00
9	0.000000	-0.058493	0.000000	0.00
10	0.000000	0.000000	0.000000	0.00
11	0.000000	0.058500	0.000000	0.00
12	0.000000	0.084500	0.000000	0.00
13	0.000000	0.084496	0.000000	0.00

Bellow #1=Node 13&13 longirudinal expansion (y-direction)=0.077'+0.084'=0.161'=1.93" <3" OK



Bellow #2=Node 13&14 longirudinal expansion (y-direction)=0.097'+0.129'=0.226'=2.71" <3" OK



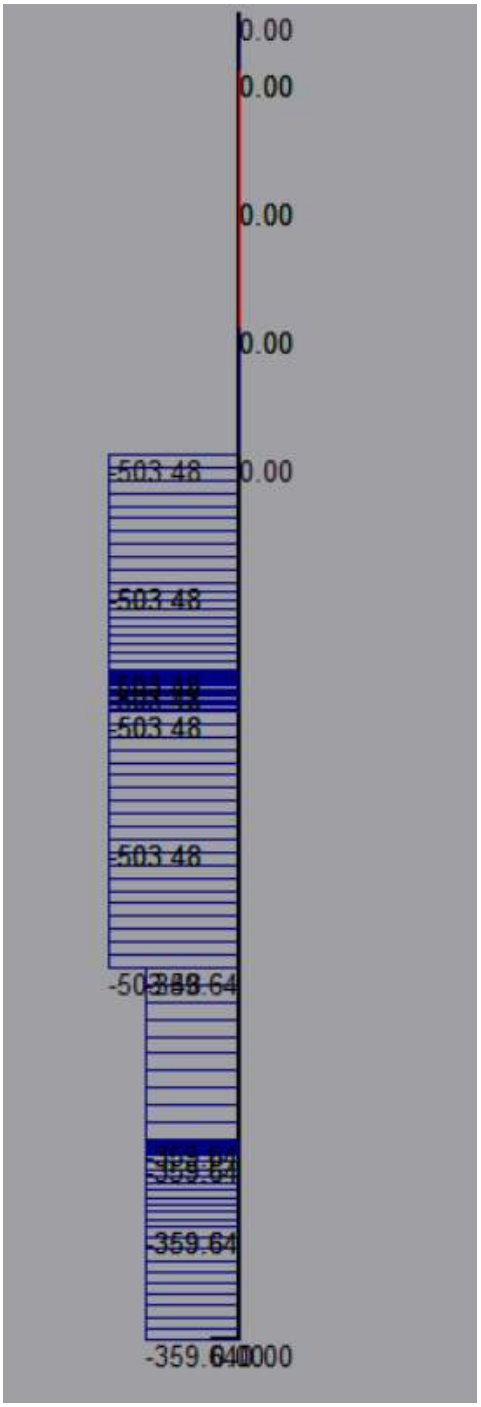
Tabulated Results

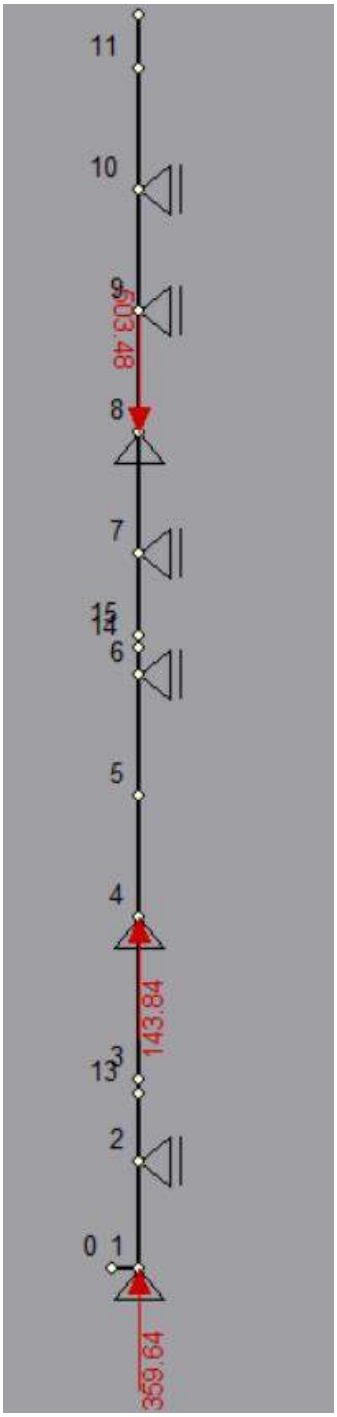
Copy | CASE1 | Member 0 | Forces

Displacements | Reactions | (u) and (f) on member ends | (u) and (f) along member

Node	x	y	fi	Node rotation
5	0.000000	0.058496	0.000000	0.00
6	0.000000	0.116991	0.000000	0.00
7	0.000000	-0.058496	0.000000	0.00
8	0.000000	0.000000	0.000000	0.00
9	0.000000	0.058500	0.000000	0.00
10	0.000000	0.117000	0.000000	0.00
11	0.000000	0.175500	0.000000	0.00
12	0.000000	0.201500	0.000000	0.00
13	0.000000	0.084496	0.000000	0.00
14	0.000000	0.129990	0.000000	0.00
15	0.000000	-0.097493	0.000000	0.00

Joint displacement in global coordinate system



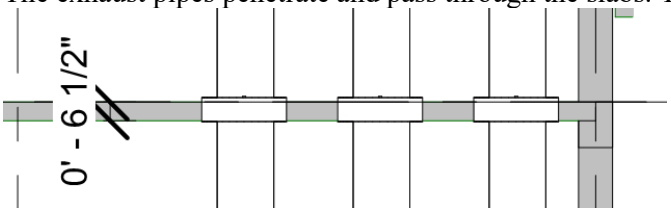


Axial load Reactions

Weight of the pipe=(47)'*123 = 5781 @ node 8
Support Reaction on the top (node #8)= 503.48 lbs + 5781 (Weight of the pipe.)= 5284.48 lbs
Weight of the pipe=(32)'*123 = 3936 @ node 4
Support Reaction on the top (node #4)= 143.84 lbs + 3936 (Weight of the pipe.)= 4079.84 lbs
Weight of the pipe=(14)'*123 = 1722 @ node 1
Support Reaction on the top (node #1)= 359.64 lbs + 1722 (Weight of the pipe.)= 2081.64 lbs

4. CHECK THE REQUIREMENTS FOR THE MINIMUM SPACING BETWEEN VERTICAL RISERS

The exhaust pipes penetrate and pass through the slabs. The thickness of the slab is equal to 6.5".

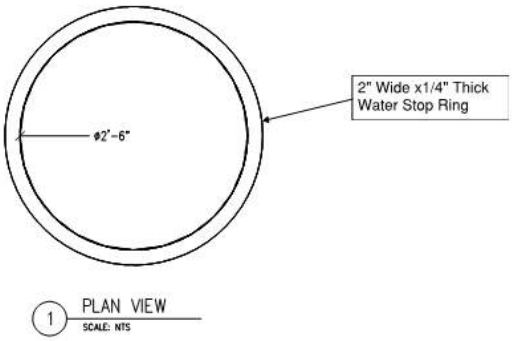


There is no vertical load on the slab at any level except at levels 4 and 8.

So, at all other levels, only the lateral seismic force and thermal load shall be applied on the slab as the bearing force. So, assuming 18" spacing between pipes, the maximum bearing capacity of the slab is equal to:
Area= 1.5*0.5= 0.75 sf
Stress = 0.35f'c= 0.35*3000=1050 psi
P=1050*0.75*144/1000= 113.4 kips

Check Shear force= $0.29\sqrt{f'c}$= 15.88 psi
Shear area=18*6*2=108*2=216 in^2
Vmax= 3430 lbs

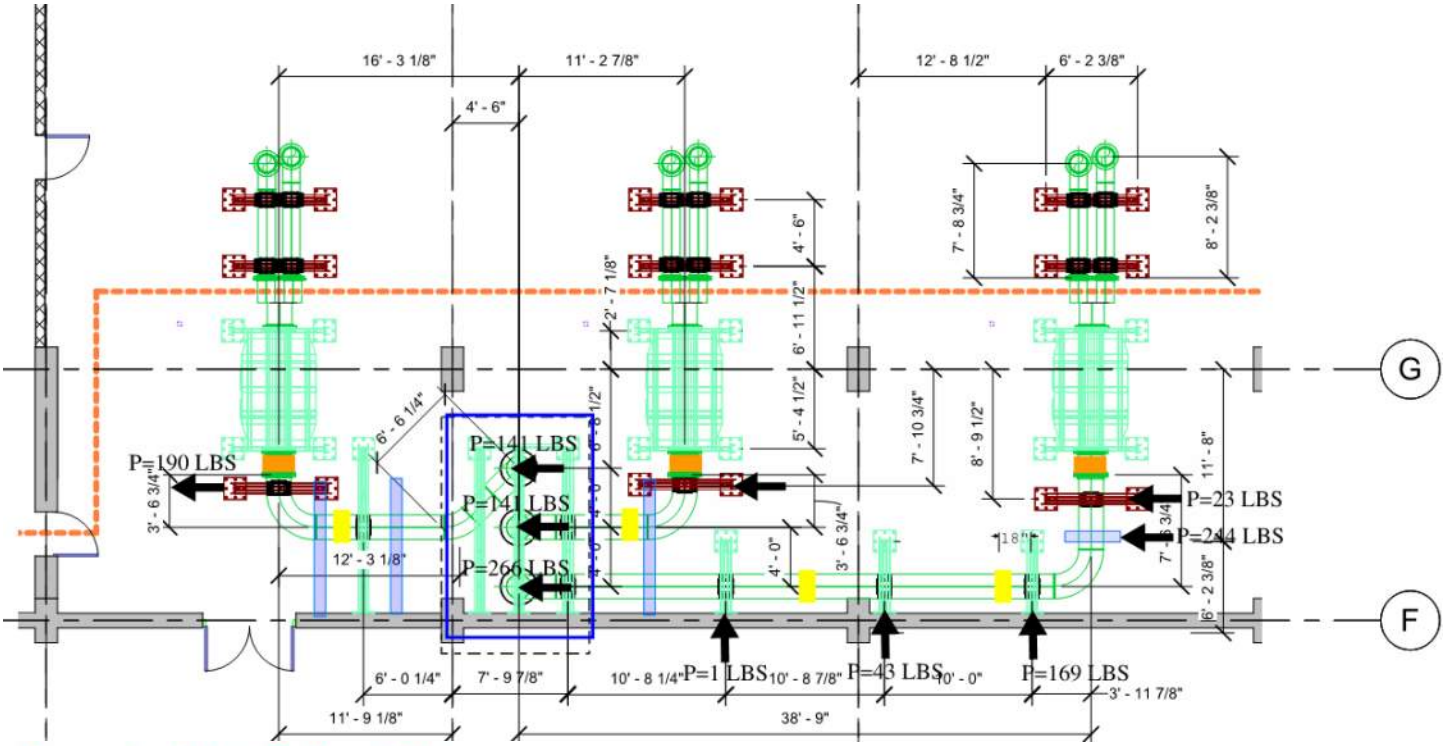
Based on the size of the sleeve and assuming the spacing of 18" between pipes:



Then, use 18" clear distance between pipes or 48" O.C.
Any lateral load from the pipe acting on the slab should be smaller than 3430 lbs.

5. CONCLUSION

1- Location of the Bellows and the lateral support reaction is shown below:



Expansion Joint (Bellows) Note:

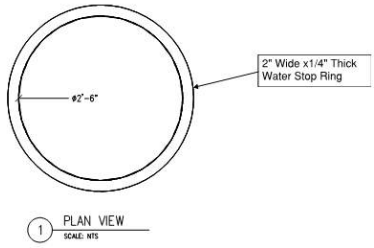
Type of Bellows:

Thermal Expansion
EX302000 (20" pipe), Metraflex
The axial spring stiffness = 186 lb/in; Lateral stiffness= 1480 lb/in
The maximum expansion rate= 3"

Bellows type between muffler and pipe

Thermal Expansion
EX402000 (20" pipe), Metraflex
The axial spring stiffness = 186 lb/in; Lateral stiffness= 1480 lb/in
The maximum expansion rate= 3"

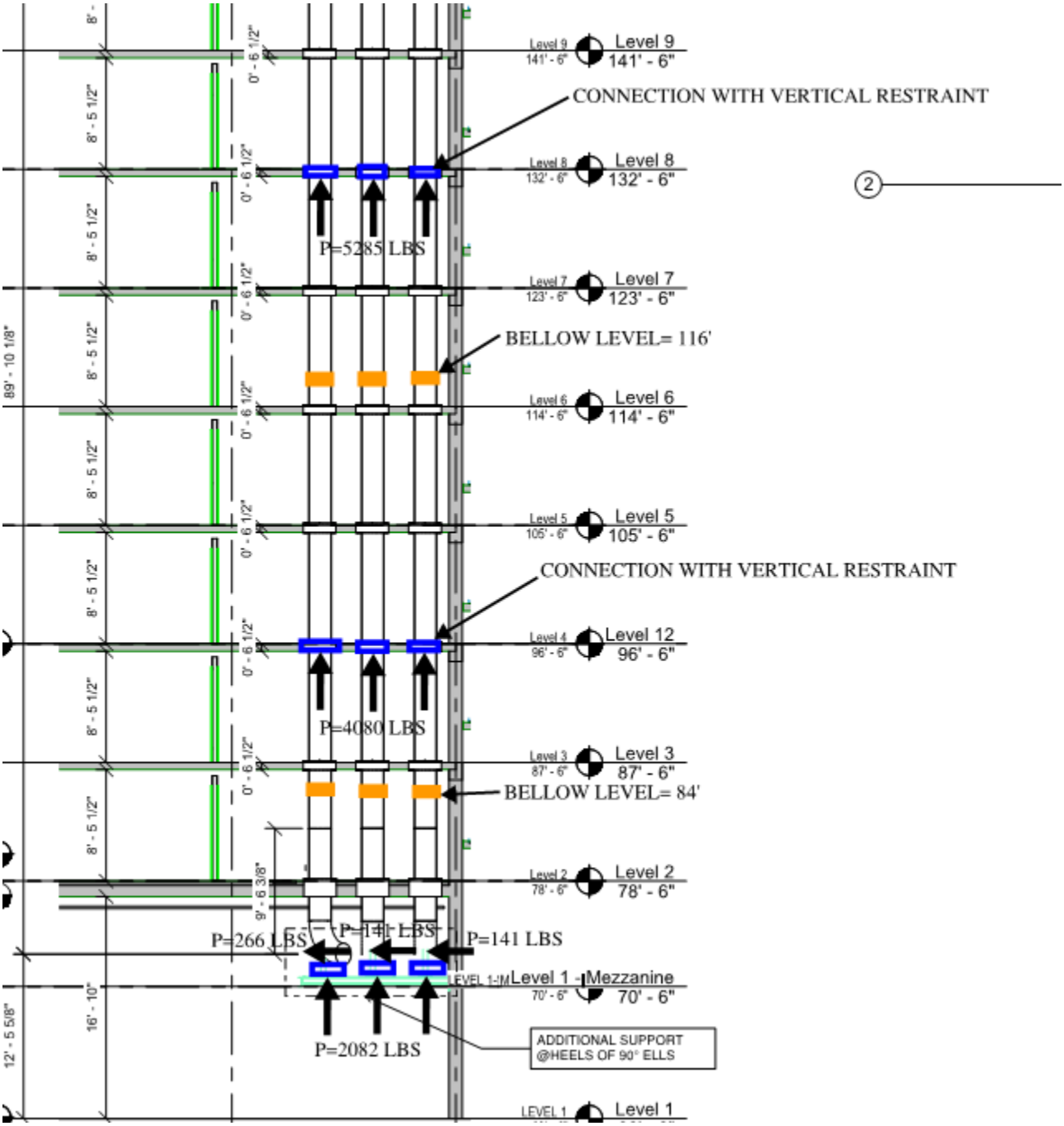
Spacing between exhaust pipes in the concrete slab:



Use 18” clear distance between pipes or 48” O.C.

Maximum possible lateral support reaction fore on each pipe: Pmax.= 3430 lbs.

SEOR should confirm the capacity of the slab. We did not evaluate the capacity of the superstructure.


Level 9
141' - 6"
CONNECTION WITH VERTICAL RESTRAINT
Level 8
132' - 6"
2
P=5285 LBS
Level 7
123' - 6"
BELLOW LEVEL= 116'
Level 6
114' - 6"
Level 5
105' - 6"
CONNECTION WITH VERTICAL RESTRAINT
Level 12
96' - 6"
P=4080 LBS
Level 3
87' - 6"
BELLOW LEVEL= 84'
Level 2
78' - 6"
P=266 LBS
P=141 LBS
P=141 LBS
Level 1 - Mezzanine
70' - 6"
P=2082 LBS
ADDITIONAL SUPPORT
@HEELS OF 90° ELLS
Level 1
89' - 10 1/8"
12' - 5 5/8"
16' - 10"
9' - 6 3/8"
8' - 5 1/2"
0' - 6 1/2"

Application & Performance Warranty Data

Project Information

Site Location:	Washington
Project Name:	Costco Bldg 5 - 3500KW's
Application:	Standby Power
Number Of Engines:	3
Operating Hours per Year:	50

Engine Specifications

Engine Manufacturer:	Cummins
Model Number:	QSK95-G9
EPA Engine Family:	JCEXL95.0AAA-006
Rated Speed:	1800 RPM
Type of Fuel:	Ultra-Low Sulfur Diesel (ULSD)
Type of Lube Oil:	1 wt% sulfated ash or less
Lube Oil Consumption:	0.1 % Fuel Consumption
Number of Exhaust Manifolds:	1

Engine Cycle Data

Load	Speed	Power	Exhaust Flow	Exhaust Temp.	Fuel Cons.	PM_{10}	O_2	H_2O
%		*bhp*	*acfm (cfm)*	*F*		*g/bhp-hr*	*%*	*%*
100	Rated	5,051	24,975	914		0.11	10	12

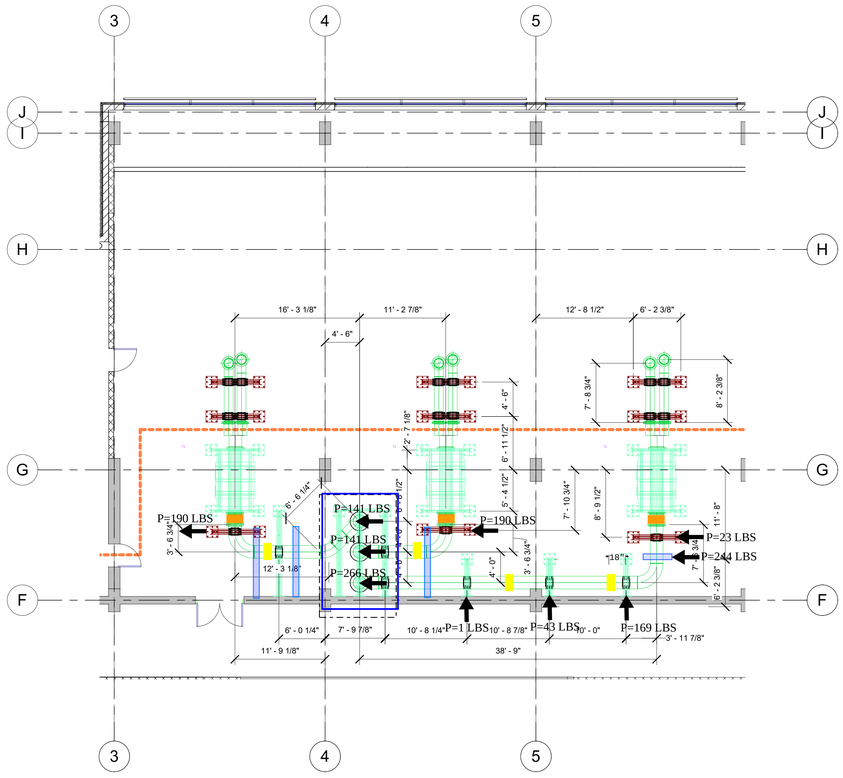
Emission Data (100% Load)

Emission	Raw Engine Emissions						Target Outlet Emissions						Calculated Reduction
	g/bhp-hr	*g/kW-hr*	*tons/yr*	*ppmvd @ 15% O_2*	*ppmvd*	*lb/MW-hr*	*g/bhp-hr*	*g/kW-hr*	*tons/yr*	*ppmvd @ 15% O_2*	*ppmvd*	*lb/MW-hr*	
PM_{10}	0.11	0.148	0.03	42	78	0.33	0.02	0.022	0	6	12	0.05	85%

System Specifications

DOC/DPF System Specifications (LTR81-81-20-XR2)

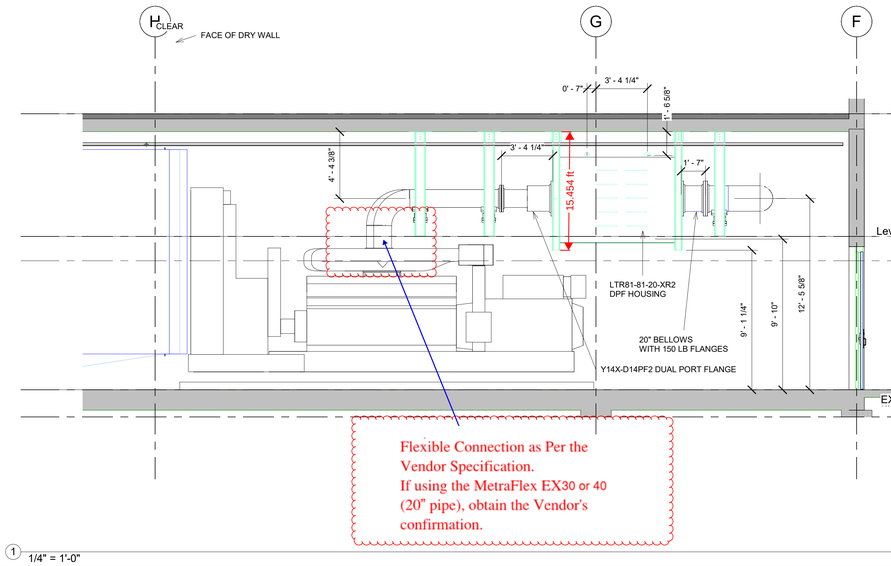
Design Exhaust Flow Rate:	24,975 acfm (cfm)
Design Exhaust Temperature[1]:	914°F
System Pressure Loss:	15.0 inches of WC (Clean) (34.9 mBar)
Sound Attenuation:	Critical Grade
Minimum Regeneration Temperature[2]:	500°F (260°C)



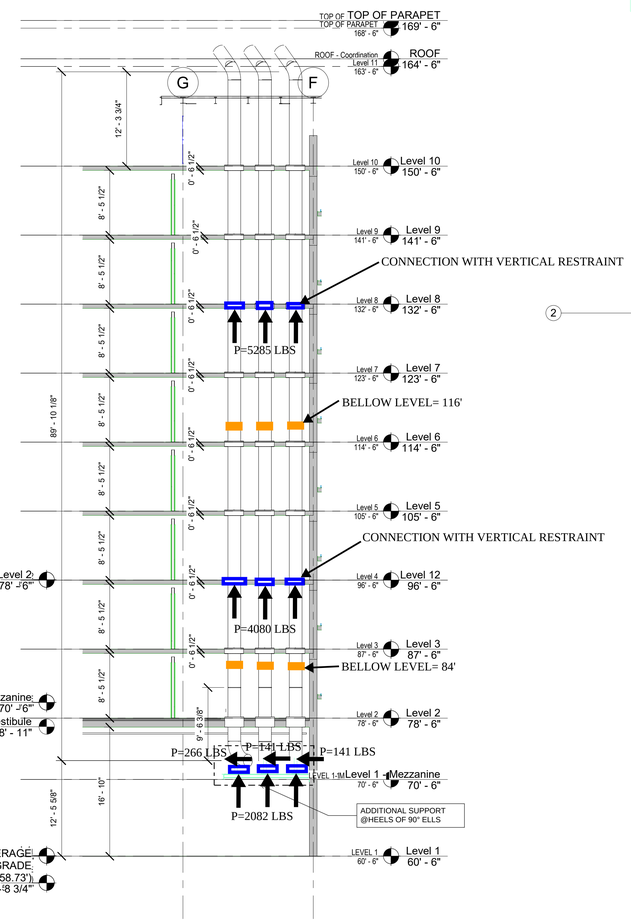
3 1/8" = 1'-0"

Note:
Expansion Bellows only shown on View 3 for horizontal pipe.
Bellows shown on View 4 for vertical pipe

Expansion Joint Bellow Legend
- Metraflex EX402000
- Metraflex EX302000

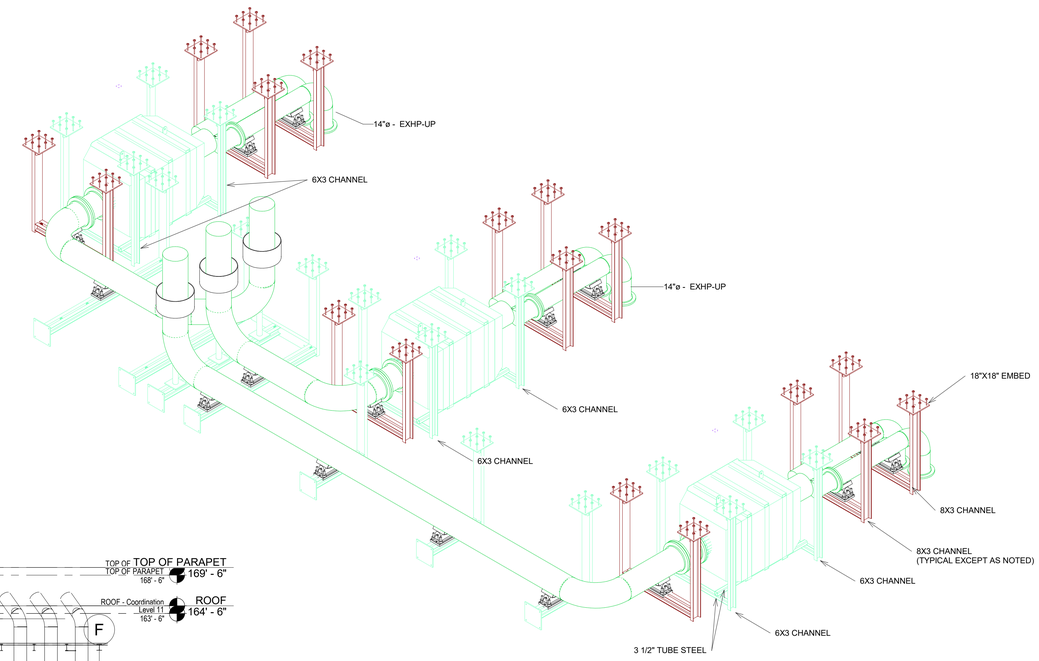


1 1/4" = 1'-0"



2

4 1/8" = 1'-0"



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SEATTLE, WA 98168 ● (206) 248-9700
WWW.HOLADAYPARKS.COM
WA LICENSE NUMBER: HOLADPI379N0

PROJECT

COSTCO BLDG-5 GARAGE

DESIGN TEAM

Designed by: Designer
Drawn by: Author
Approved by: Approver
Job Number:
Filename:

REGISTRATION

NOT APPROVED
FOR CONSTRUCTION
ISSUE NAME/DATE

SUBMITTAL

3/6/2020 3:41:05 PM

REVISIONS

No.	Date	By	Description
A	3/6/20	MH	SUBMITTAL

ONLY THERMAL ANALYSIS INCLUDING EXPANSION JOINTS (BELLOWS) TYPE, LOCATION, AND THE SUPPORT REACTIONS ARE COVERED IN THIS DRAWINGS UNDER THIS SIGNATURE.

SHEET TITLE

LEVEL 1 SOUTH
SUBMITTAL EXHAUST
ROUTING SUPPORT

SHEET NUMBER

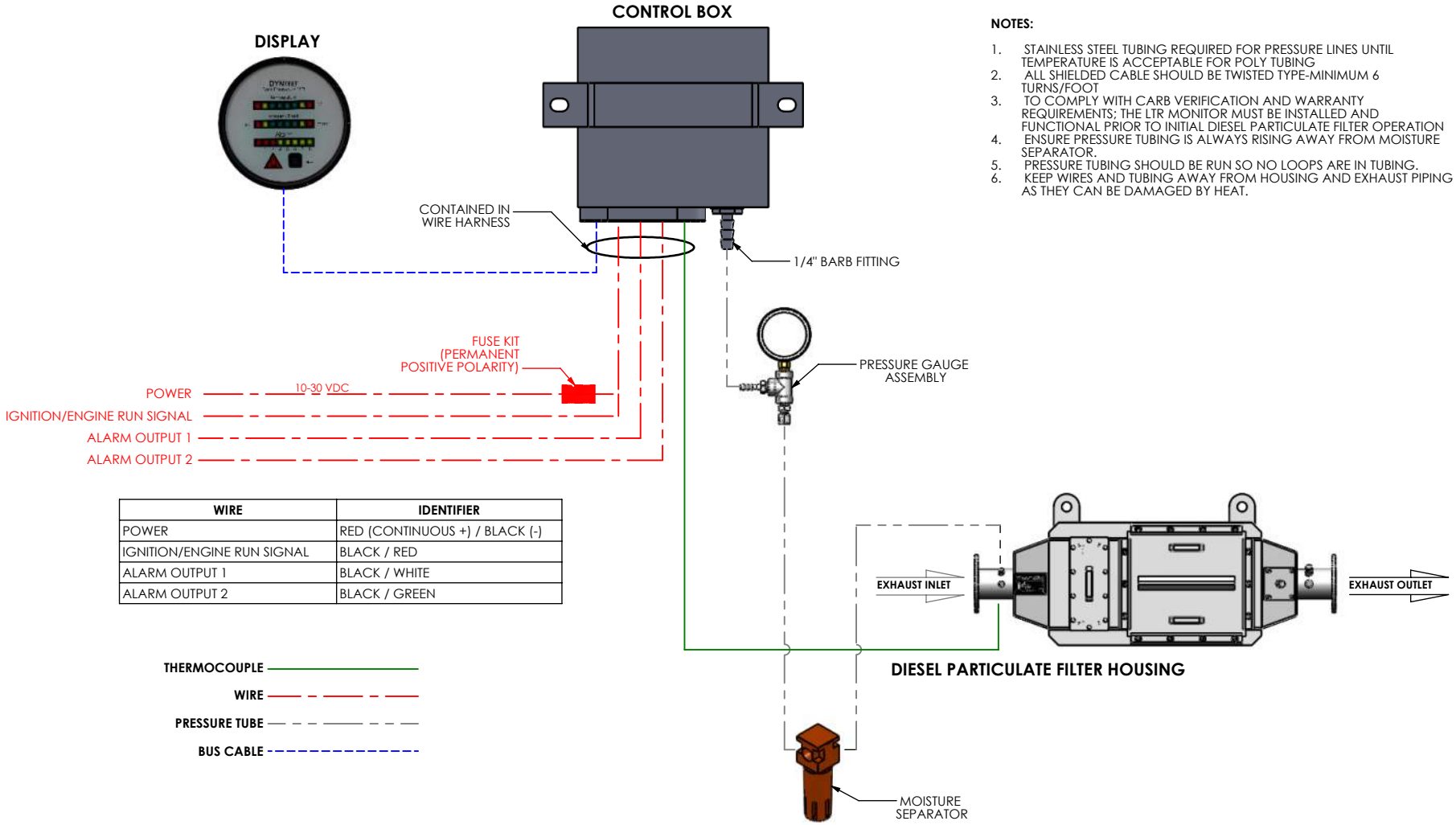
SMP4.01EXH

MIRATECH Scope of Supply & Equipment Details

	Model Number	Quantity
DPF Housing & Catalyst	**LTR81-81-20-XR2**	**1 / engine**
DPF Housing Kit	LTR81-20-HSG-0	1 / engine
DPF Housing	LTR81-20-HSG	1 / engine
• Material	Carbon Steel	
• Paint	Standard High Temperature Black Paint	
• Inlet Pipe Size & Connection	20 inch FF Flange, 150# ANSI standard bolt pattern	
• Outlet Pipe Size & Connection	20 inch FF Flange, 150# ANSI standard bolt pattern	
• Door Location	Right	
• Dimensions	63.875" H x 63.625" W x 100" L	
• Weight Without Catalyst	1,911 lbs	
• Weight Including Catalyst	3,348 lbs	
Tray Set	Tray Set-LTR81-300mm	1 / engine
Gasket	1303.0026	2 / engine
Gasket	LTR Expansion Mat	18 / engine
DPF Block	LTR-DPF-Filter-Block	81 / engine
Oxidation Catalyst	LTR81-RE-303-S2400x3250XR	2 / engine
Data Logger	DPF-DataLogger-Assembly	1 / engine
Nut, Bolt, and Gasket Set	NBG-LTR81	1 / engine

Customer Scope Of Supply

- Support Structure
- Attachment to Support Structure (Bolts, Nuts, Levels, etc.)
- Expansion Joints
- Exhaust Piping
- Inlet Pipe Bolts, Nuts, & Gasket
- Outlet Pipe Bolts, Nuts, & Gasket
- Insulation for Exhaust Piping
- Insulation for Housing
- Installation, Fabrication, and Installation of Mounting Frame for Particulate Filters



NOTES:

1. STAINLESS STEEL TUBING REQUIRED FOR PRESSURE LINES UNTIL TEMPERATURE IS ACCEPTABLE FOR POLY TUBING
2. ALL SHIELDED CABLE SHOULD BE TWISTED TYPE-MINIMUM 6 TURNS/FOOT
3. TO COMPLY WITH CARB VERIFICATION AND WARRANTY REQUIREMENTS; THE LTR MONITOR MUST BE INSTALLED AND FUNCTIONAL PRIOR TO INITIAL DIESEL PARTICULATE FILTER OPERATION
4. ENSURE PRESSURE TUBING IS ALWAYS RISING AWAY FROM MOISTURE SEPARATOR.
5. PRESSURE TUBING SHOULD BE RUN SO NO LOOPS ARE IN TUBING.
6. KEEP WIRES AND TUBING AWAY FROM HOUSING AND EXHAUST PIPING AS THEY CAN BE DAMAGED BY HEAT.

WIRE	IDENTIFIER
POWER	RED (CONTINUOUS +) / BLACK (-)
IGNITION/ENGINE RUN SIGNAL	BLACK / RED
ALARM OUTPUT 1	BLACK / WHITE
ALARM OUTPUT 2	BLACK / GREEN

THERMOCOUPLE

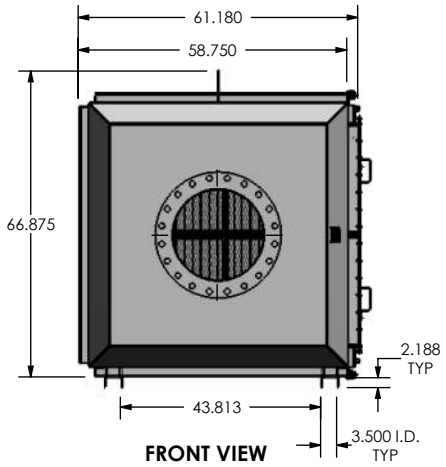
WIRE

PRESSURE TUBE

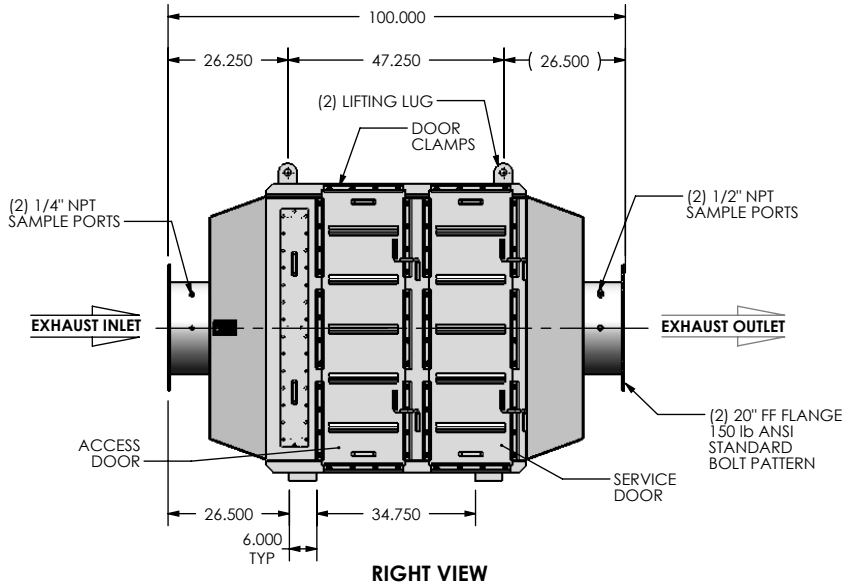
BUS CABLE

PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL**	DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED	MIRATECH
PROPOSAL NUMBER	THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRATECH CORPORATION. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRATECH CORPORATION IS PROHIBITED.	DO NOT SCALE DRAWING	**LTR-DPF DATALOGGER System Interconnect**
SALES ORDER NO.		DRAWN CLV / DATE 03/31/2014	DRAWING LTR-DPF DATALOGGER SI / REV 0
CUSTOMER P.O.		REVIEWED BY CDT / DATE 03/31/2014	SIZE A / NOT TO SCALE / SHEET 1 OF 1

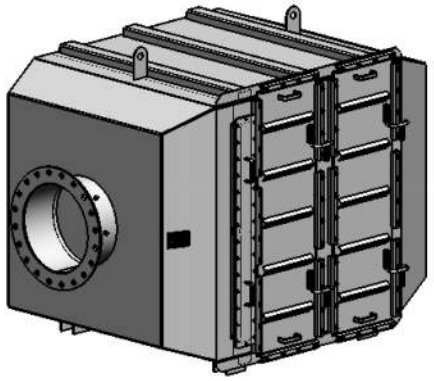
WEIGHTS (APPROXIMATE)	
EMPTY HOUSING	1911 lb
ONE (1) FULL DPF CATALYST LAYER	1437 lb
ONE (1) OXIDATION ELEMENT	152 lb
• HOUSING HAS CAPACITY FOR ONE(1) FULL DPF CATALYST LAYERS	
• HOUSING HAS CAPACITY FOR TWO(2) OXIDATION ELEMENT	

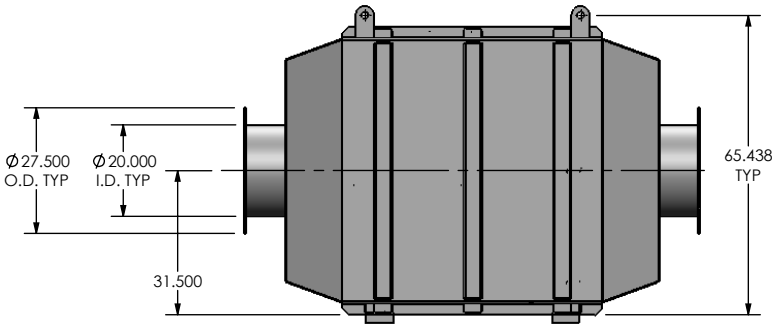


FRONT VIEW



RIGHT VIEW





LEFT VIEW

NOTES:

- ONLY USE LIFTING LUGS TO LIFT HOUSING
- ALLOW MINIMUM 50" CLEARANCE FROM DOOR FOR LOADING AND MAINTENANCE
- NO FORCES OR MOMENTS MAY BE APPLIED TO THE FLANGES
- MUST BE MOUNTED HORIZONTALLY (CUSTOM HOUSING REQUIRED TO MOUNT VERTICALLY)

MATERIAL CONSTRUCTION:

- CARBON STEEL

PAINT:

- HIGH TEMPERATURE BLACK (MIRATECH COATING SYSTEM 1)

PROJECT NAME	
PROPOSAL NUMBER	
SALES ORDER NO.	
CUSTOMER P.O.	

DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED

DO NOT SCALE DRAWING

DRAWN	CDT	DATE	03/31/2014	DRAWING	LTR81-20 SD	REV 0
REVIEWED BY	EQJ	DATE	03/31/2014	SIZE A	SCALE 1:42	SHEET 1 OF 1

MIRATECH

LTR81-20
Sales Drawing

REFERENCES

GENERAL NOTE

S0.1

GENERAL NOTE

THE FOLLOWING NOTES APPLY UNLESS NOTED OTHERWISE - ASTM'S NOTED ARE TO BE LATEST EDITION.

1. DESCRIPTION
   Building Name & Site Location - Costco Corporate Headquarters – (Issaquah, WA) Building 5
   Building Dept. – City of Issaquah

2. DESIGN CODE AND STANDARDS
   Applicable Code (Edition/Name) – 2015 International Building Code (IBC)
   Other documents referenced by these notes shall be the specific edition referenced by the building code specified above, or if not specified, shall be the latest edition.
   Code supplement & Date – ASCE 7-10

3. DESIGN LOADS

a.	I. Roof Live Load	See snow load / 20 psf (reducible per code)
	II. Parking Live Load	40 psf (Unreducible)
b.	Snow Load	Basic ground snow load – P_g = 25 psf Basic roof snow load – P_f = 25 psf Importance factor – I_S = 1.0, snow exposure factor – C_e = 1.0 Drifting snow is not required in the design.
c.	Seismic	Risk Category II S_s = 0.951, S_1 = 0951, Ie = 1.0, Site Class “F”, S_{DS} = 0.634, S_{D1} = 0.634 Seismic Design Category = E Resisting System(s) = Special Reinforced Concrete Shear Walls CS = 0.127, R = 5. Equivalent lateral force procedure was used. Mech. & Refrigeration unit loads will be picked up at the point of the units and transferred into the lateral system. Sprinkler lines will be braced to top of beam or slats by the sprinkler contractor.
d.	Wind Load	Risk Category II Basic wind speed (3 sec. gust) V_{ULT} = 110 mph, V_{ASD} = 85 mph Exposure B. K_{zt} = 1.0 IBC Load Cases per sec. 1605.2 or 1605.3.1 only K_d = 0.85 Importance factor 1.0. 2 psf of collateral loads was used in uplift design.
f.	Dead loads	Weight of structure. 113 PSF each floor approx.
g.	Special Loads	The following special loads are to be considered: Mechanical equipment on roof. Sprinkler lines, canopy & other reactions as noted on structural drawings.
h.	Future Rooftop Solar Panels	Included in design.
i.	Load Combinations	All Code required load combinations are to be used in the building design. Column reactions from these load combinations are to be given to the foundation engineer.

DEFERRED SUBMITTALS
STRUCTURAL COMPONENTS

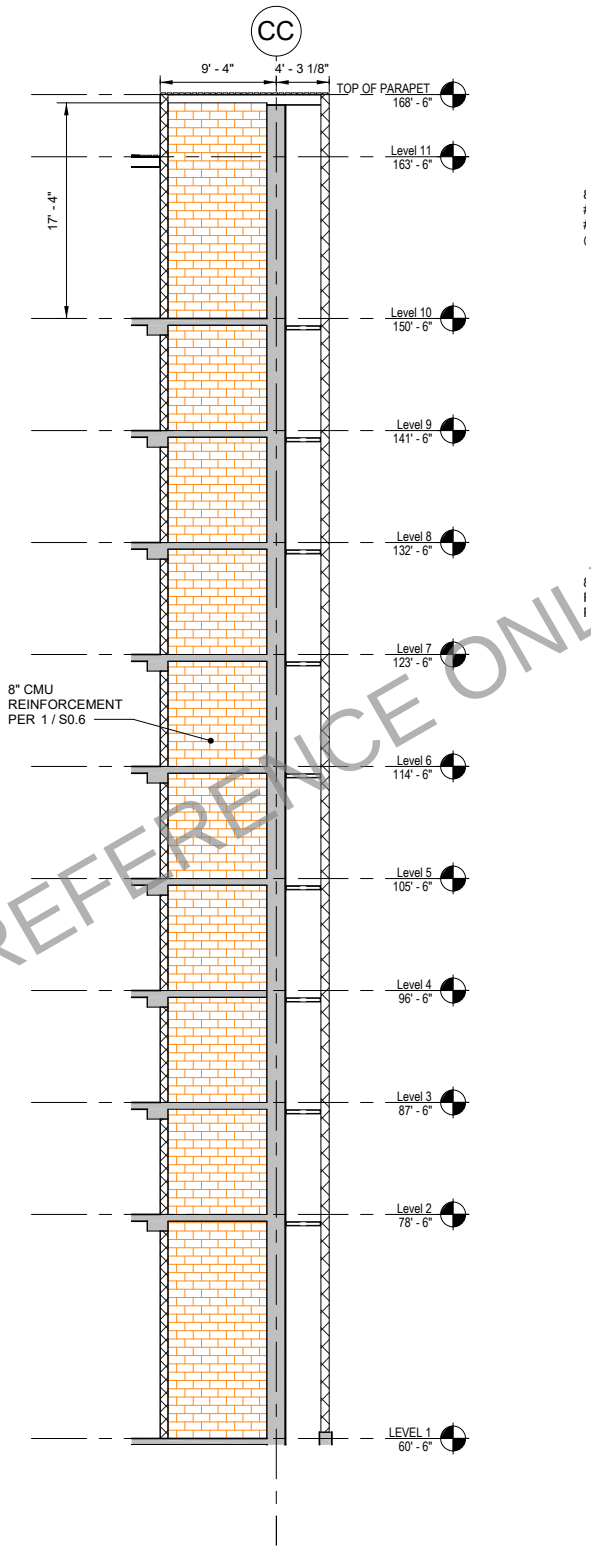
ITEM	REVIEWED BY		
	AOR	EOR	CITY OF ISSAQUAH DEVELOPMENT SERVICES DEPARTMENT (BUILDING)
a. STEEL STAIRS (NOT DETAILED ON STRUCTURAL DRAWINGS)		X	X
b. NON-STRUCTURAL LIGHT GAGE FRAMING	X		
c. ANCHORAGE FOR M.E.P. AND F.P. EQUIPMENT (HUNG OR FLOOR/WALL MOUNTED)		X	X
d. VENEER / FACADE / CLADDING SUPPORT SYSTEMS AND BRACING (NON-DETAILED ON STRUCTURAL DRAWINGS)	X	X	X
e. ELEVATORS AND ELEVATOR SUPPORT FRAMING		X	X
f. MECHANICAL ENCLOSURES AND THEIR ANCHORAGE (NON-DETAILED ON STRUCTURAL DRAWINGS)		X	X
h. ELMENTS THAT ARE PART OF THE DESIGNATED SEISMIC SYSTEM (Ip = 1.5) INCLUDING ANCHORAGE, BRACING REQUIREMENTS AND SHAKE TABLE CERTIFICATIONS OF ACTIVE MECHANICAL & ELECTRICAL EQUIPMENTS. THE FOLLOWING COMPONENTS ARE PART OF THE DESIGNATED SEISMIC SYSTEM: -EGRESS STAIRS -SMOKE CONTROL EQUIPMENT -GENERATORS AND OTHER ELECTRICAL EQUIPMENT SUCH AS SWITCH GEAR THAT IS REQUIRED FOR ENERGIZING ELEMENTS THAT ARE ON STAND-BY POWER OR EMERGENCY POWER. -DIESEL TANKS PROVIDING FUEL FOR GENERATORS -FIRE PUMPS -AUTOMATIC FIRE SPRINKLER SYSTEM	X	X	X

NOTES:

1. ALL CALCULATIONS PROVIDED SHALL MUST BEAR THE SEAL & SIGNATURE OF A REGISTERED ENGINEER LICENSED IN THE PROJECT STATE.
2. DEFERRED SUBMITTAL ITEMS SHALL NOT BE OTHERWISE CONSTRUCTED IN PLACE WITHOUT HAVING THE PLANS OR SHOP DRAWINGS REVIEWED AND APPROVED BY THE EOR AND THE BUILDING OFFICIAL.
3. DEFERRED SUBMITTAL DOCUMENTS (CALCULATIONS, DESIGN, DETAILING) ARE REQUIRED TO BE SUBMITTED TO THE REGISTERED DESIGN PROFESSIONAL(S) WHO ARE REQUIRED TO REVIEW THEM AND FORWARD THEM TO THE BUILDING OFFICIAL, NOTING THAT THE DEFERRED SUBMITTAL DOCUMENTS HAVE BEEN REVIEWED AND HAVE BEEN FOUND TO BE IN GENERAL CONFORMANCE TO THE DESIGN OF THE BUILDING.
4. DEFERRED SUBMITTAL ITEMS ARE REQUIRED TO BE REVIEWED /APPROVED BY THE REGISTERED DESIGN PROFESSIONAL(S) PRIOR TO SUBMITTAL TO THE CITY FOR REVIEW.
5. DEFERRED SUBMITAL ITEMS ARE NOT PERMITTED TO BE INSTALLED UNTIL THE DESIGN AND SUBMITTAL DOCUMENTS HAVE BEEN APPROVED BY THE BUILDING OFFICIAL.
6. AOR DENOTES ARCHITECT OF RECORD.
7. EOR DENOTES ENGINEER OF RECORD.
8. ACTIVE MECHANICAL AND ELECTRICAL EQUIPMENT THAT MUST REMAIN OPERABLE FOLLOWING THE DESIGN EARTHQUAKE GROUND MOTION ARE REQUIRED TO BE CERTIFIED BY THE MANUFACTURER AS OPERABLE WHEREBY ACTIVE PARTS OR ENERGIZED COMPONENTS SHALL BE CERTIFIED EXCLUSIVELY ON THE BASIS OF APPROVED SHAKE TABLE TESTING (13.2.5) OR EXPERIENCE DATA (13.2.6). EVIDENCE DEMONSTRATING COMPLIANCE WITH THIS REQUIREMENT IS REQUIRED TO BE SUBMITTED TO THE BUILDING OFFICIAL AFTER REVIEW AND ACCEPTANCE BY THE REGISTERED DESIGN PROFESSIONAL. THIS REQUIREMENT NEEDS TO BE CLEARLY STATED WITHIN THE DRAWING SET.

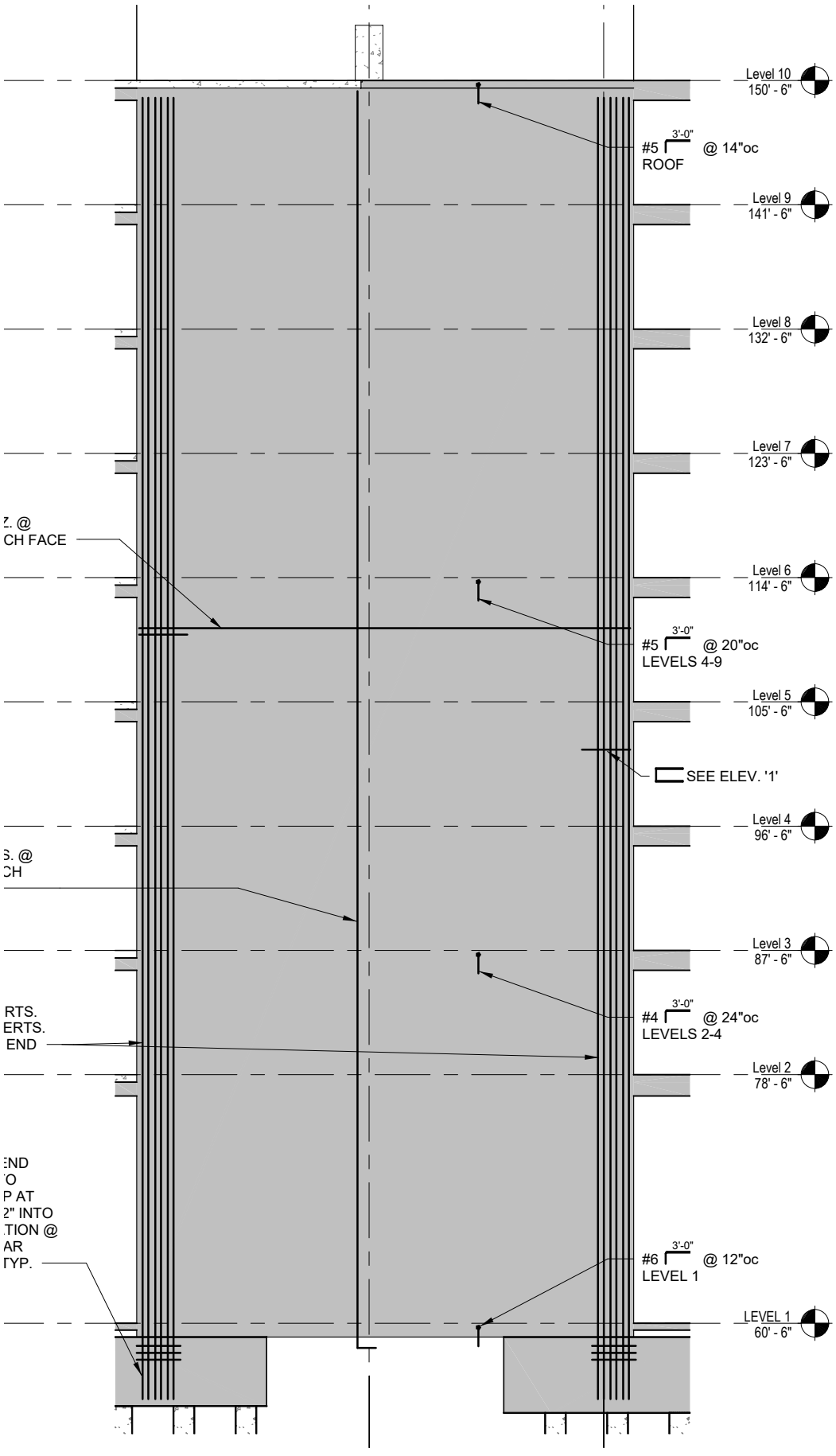
CONCRETE

CONCRETE										
STRUCTURAL ELEMENT	EXPOSURE CATEGORY / CLASS				CONCRETE F'c	MAX AGGREGATE ASTM C33	MAX W.C RATIO	SLUMP	MAX AIR CONTENT	NOTE
	(F)	(S)	(W)	(C)						
PILES	F0	S0	W1	C1	4000	3/4"	0.5	6"-10" MAX	2%	c
PILE CAPS AND GRADE BEAMS	F1	S0	W0	C0	4000	1"	0.55	6" MAX	2%	c
SLAB ON GRADE	F0	S0	W0	C0	4000	1 1/2"	0.49	5" ± 1"	2%	c
COLUMNS	F1	S0	W0	C1	5000	3/4"	0.52	5" MAX	2%	c
PT SLABS & BEAMS	F1	S0	W0	C0	5000	2.5 (1")	0.43	4" ± 1"	4%	a, b & d
SHEAR WALLS	F1	S0	W0	C1	5000	3/4"	0.52	5" MAX	2%	c
SLABS OVER STEEL DECK	F0	S0	W0	C0	3000	2.5 (1")	0.45	6" MAX	6%	c



11 SOUTH BUILDING ELEVATION ALONG GRID 'E'

1/8" = 1'-0"


Level 10
150' - 6"
#5 3'-0" @ 14"oc
ROOF
Level 9
141' - 6"
Level 8
132' - 6"
Level 7
123' - 6"
Z. @
CH FACE
Level 6
114' - 6"
#5 3'-0" @ 20"oc
LEVELS 4-9
Level 5
105' - 6"
SEE ELEV. '1'
Level 4
96' - 6"
S. @
CH
Level 3
87' - 6"
#4 3'-0" @ 24"oc
LEVELS 2-4
RTS.
ERTS.
END
Level 2
78' - 6"
END
O
P AT
2" INTO
TION @
AR
TYP.
#6 3'-0" @ 12"oc
LEVEL 1
LEVEL 1
60' - 6"

COSTCO WHOLESALE
755 Lake Dr, Issaquah
WA 98027

ENW STRUCTURAL ENGINEERS
Engineers Northwest Inc., P.S.
9725 Third Ave NE Suite 207 Seattle, WA 98115
Ph: (206)525-7560, Fax: (206)522-6698
www.engineersnw.com

1101 Second Ave, Ste 100
Seattle, WA 98101
206 962 6500
MG2.com
MG2

PR-B3 SET

09-25-2019

NOTES: (TYPICAL FOR PT SLAB AT THIS LEVEL)
1. SEE DWG S0.1 FOR GENERAL NOTES.
2. TOP OF SLAB ELEVATION & SLAB EDGE= PER ARCH
3. SLAB LIVE LOAD: 40 PSF
4. ALL N-S REINF. MARKED: "BOT" HOLD 3/4" CLR TO BOTTOM OF SLAB. PLACE E-W REINF. DIRECTLY ABOVE U.N.O. PER PLAN.
5. ALL N-S REINF. MARKED: "TOP" HOLD 1 1/2" CLR TO TOP OF SLAB. PLACE E-W REINF. DIRRECTLY BELOW U.N.O. PER PLAN.
6. REFER TO ALL APPLICABLE DETAILS AND SCHEDULE SHEET S0.4 FOR ADDITIONAL REINF. REQUIREMENT.
7. REFER TO P.T. PLANS FOR POST TENSIONING & ADDITIONAL REQUIREMENTS.
8. BEAMS TIES MARKED THUS: T1 REFER TO SCHEDULE ON SHEET S.04.

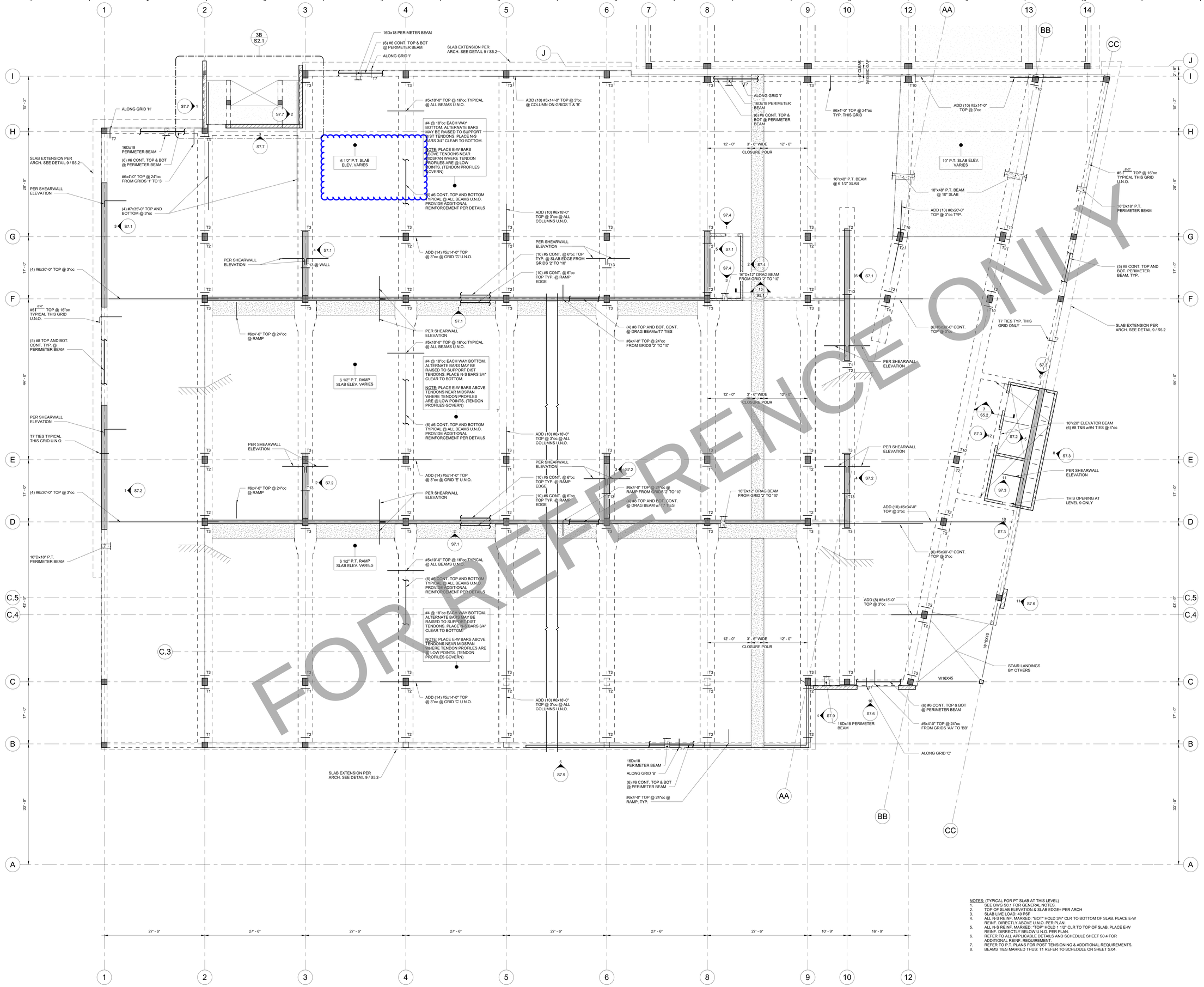
△	DATE	DESCRIPTION
4	05-21-19	BID
5	05-21-19	PR-02 EARLY FDN
6	05-31-19	BID SET ADDENDA "B"
7	06-07-19	BID SET ADDENDA "C"
8	06-17-19	BID SET ADDENDA "D"
9	06-17-19	PR-04 EARLY FDN
B.5	06-17-19	PILE PERMIT COMMENTS #05
10	06-24-19	PERMIT COMMENTS #03
S1	07-01-19	SKYBRIDGE COMMENTS #01
11	07-03-19	PR-05 EARLY FDN
12	07-15-19	PERMIT COMMENTS #05
13	07-26-19	POST BID ADDENDUM
14	08-02-19	ASI: CLASH DETECTION COORD.
S2	08-28-19	SKYBRIDGE COMMENTS #02
B1	09-06-19	PR-B1
S3	09-06-19	SKYBRIDGE COMMENTS #03
15	09-06-19	PR-06 EARLY FDN
B3	09-27-19	PR-B3
B-	xx-xx-xx	PR-B-

16038004
PM: C. RUIZ
DRAWN BY: C. HUH

REINFORCEMENT PLAN - LEVEL 2 - SOUTH

S1.2S

1 LEVEL 2 - SOUTH
1/8" = 1'-0"



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1 LEVEL 4-9 - SOUTH
1/8" = 1'-0"

COSTCO WHOLESALE
755 Lake Dr, Issaquah
WA 98027

ENW STRUCTURAL ENGINEERS
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9725 Third Ave NE Suite 207 Seattle, WA 98115
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www.engineersnw.com

1101 Second Ave, Ste 100
Seattle, WA 98101
206 962 6500
MG2.com
MG2

PR-B3 SET

09-25-2019

△	DATE	DESCRIPTION
F2	05-13-19	FDN CON PERMIT COMMENTS #2
4	05-21-19	BID
5	05-21-19	PR-02 EARLY FDN
6	05-31-19	BID SET ADDENDA "B"
7	06-07-19	BID SET ADDENDA "C"
8	06-17-19	BID SET ADDENDA "D"
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B.5	06-17-19	PILE PERMIT COMMENTS #05
10	06-24-19	PERMIT COMMENTS #03
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11	07-03-19	PR-05 EARLY FDN
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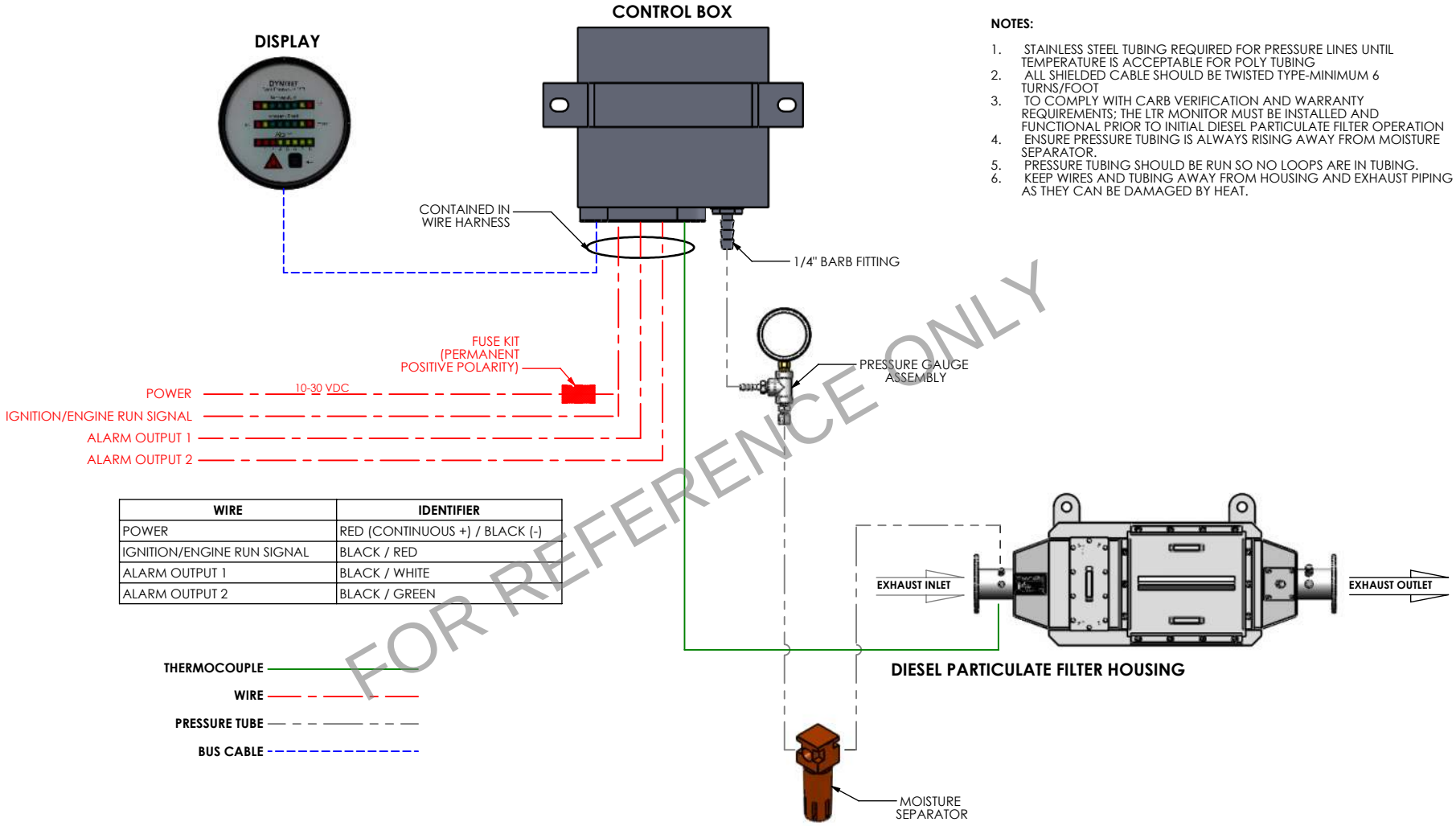
B1	09-06-19	PR-B1
S3	09-06-19	SKYBRIDGE COMMENTS #03
15	09-06-19	PR-06 EARLY FDN
B3	09-27-19	PR-B3

16038004
PM: C. RUIZ
DRAWN BY: C. HUH

REINFORCEMENT PLAN - LEVEL 4-9 - SOUTH

S1.4S

10/9/2019 2:53:57 PM C:\Users\cesarr\Desktop\REVIT\S-16038_PARKING GARAGE 5_R18_CESARR.rvt



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WIRE	IDENTIFIER
POWER	RED (CONTINUOUS +) / BLACK (-)
IGNITION/ENGINE RUN SIGNAL	BLACK / RED
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PROJECT NAME	**PROPRIETARY AND CONFIDENTIAL** THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRATECH CORPORATION. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRATECH CORPORATION IS PROHIBITED.	DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED	MIRATECH		
PROPOSAL NUMBER		DO NOT SCALE DRAWING	**LTR-DPF DATALOGGER System Interconnect**		
SALES ORDER NO.		DRAWN CLV / DATE 03/31/2014	DRAWING LTR-DPF DATALOGGER SI	REV 0	
CUSTOMER P.O.		REVIEWED BY CDT / DATE 03/31/2014	SIZE A / NOT TO SCALE		SHEET 1 OF 1

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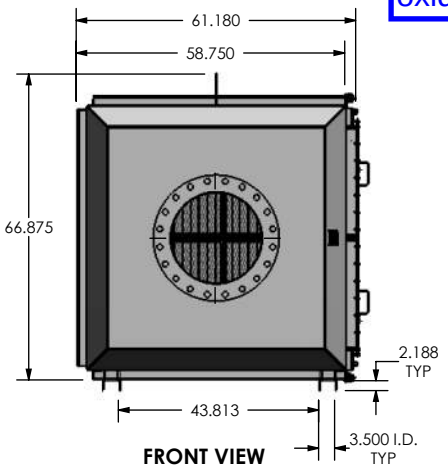
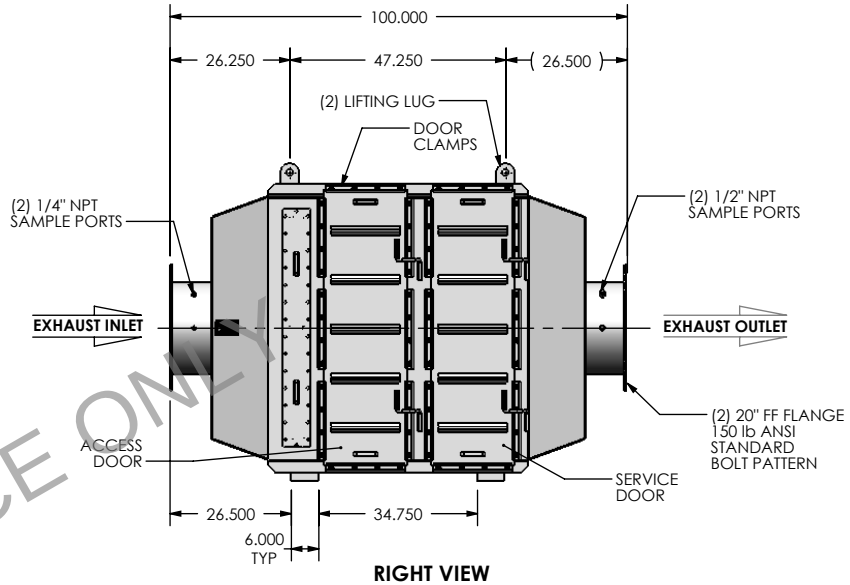
ONE (1) FULL DPF CATALYST LAYER	1437 lb
ONE (1) OXIDATION ELEMENT	152 lb
• HOUSING HAS CAPACITY FOR ONE(1) FULL DPF CATALYST LAYERS	
• HOUSING HAS CAPACITY FOR TWO(2) OXIDATION ELEMENT	

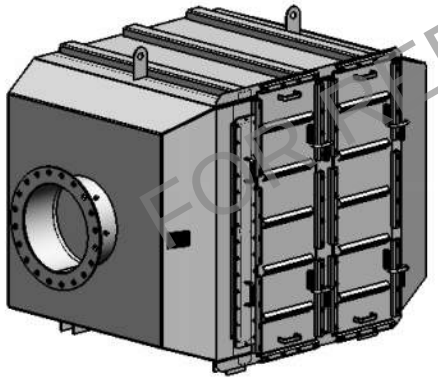
3652lbs max with (2) oxidation element

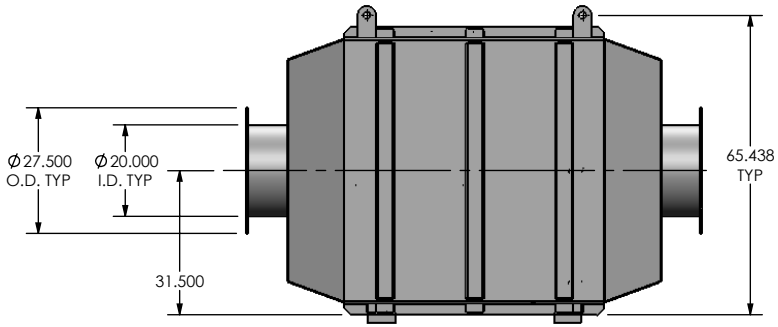


FRONT VIEW



RIGHT VIEW





LEFT VIEW

NOTES:

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- ALLOW MINIMUM 50" CLEARANCE FROM DOOR FOR LOADING AND MAINTENANCE
- NO FORCES OR MOMENTS MAY BE APPLIED TO THE FLANGES
- MUST BE MOUNTED HORIZONTALLY (CUSTOM HOUSING REQUIRED TO MOUNT VERTICALLY)

MATERIAL CONSTRUCTION:

- CARBON STEEL

PAINT:

- HIGH TEMPERATURE BLACK (MIRATECH COATING SYSTEM 1)

PROJECT NAME	
PROPOSAL NUMBER	
SALES ORDER NO.	
CUSTOMER P.O.	

DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED

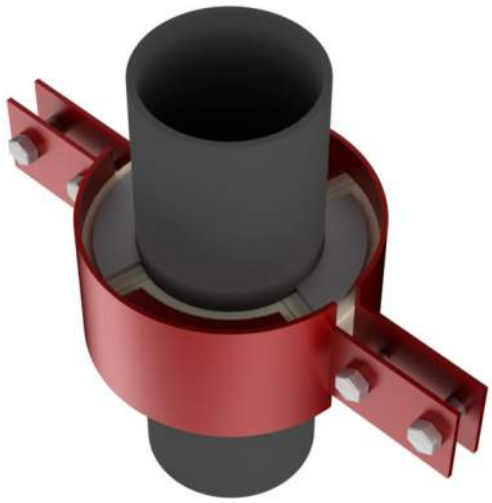
DO NOT SCALE DRAWING

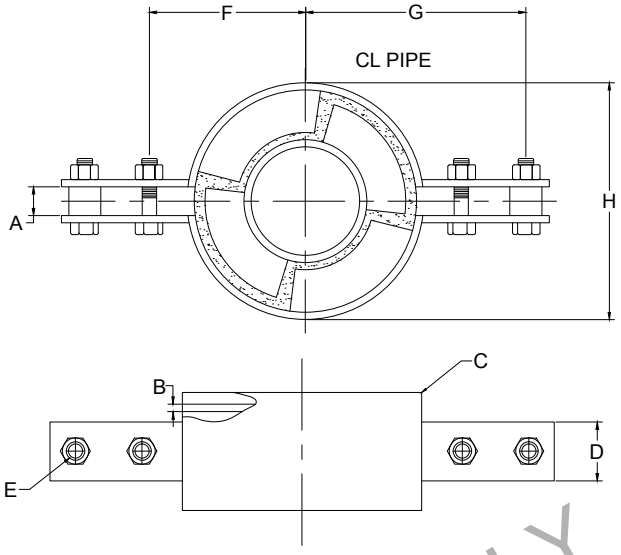
DRAWN	CDT	DATE	03/31/2014	DRAWING	LTR81-20 SD	REV 0
REVIEWED BY	EQJ	DATE	03/31/2014	SIZE A	SCALE 1:42	SHEET 1 OF 1

MIRATECH

LTR81-20
Sales Drawing

Insulated Pipe Riser Clamps for Upward or Downward Loads





a) If thrust plate thickness "B" is greater than pipe wall thickness, consult factory.

b) One pair thrust plates supplied loose for field welding, top only.

Note: For higher load ratings, see: E2200.
Available in all insulation thickness.

Pipe Size	Load lbs	A	B	C	D	E	Insul. Thk. = 1"			Insul. Thk. = 2"			Insul. Thk. = 3"			Insul. Thk. = 4"		
							F	G	H	F	G	H	F	G	H	F	G	H
2	750	0.63	0.38	0.38 x 3.00	1.50	0.625	3.94	6.19	5.38	5.00	7.25	7.5	6.00	8.25	9.5	7.06	9.31	11.63
2 1/2	900	0.63	0.38	0.38 x 3.00	1.50	0.625	4.19	6.44	5.88	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63
3	1200	0.63	0.38	0.38 x 3.00	1.50	0.625	4.47	6.72	6.44	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63
4	1800	0.63	0.38	0.38 x 3.00	1.50	0.625	5.00	7.25	7.5	6.00	8.25	9.5	7.06	9.31	11.63	8.06	10.31	13.63
5	2400	0.63	0.38	0.38 x 4.00	2.00	0.625	5.50	7.75	8.5	6.50	8.75	10.5	7.56	9.81	12.63	8.69	10.94	14.88
6	3000	0.63	0.38	0.38 x 4.00	2.00	0.625	6.00	8.25	9.5	7.06	9.31	11.63	8.06	10.31	13.63	9.19	11.44	15.88
8	3900	0.63	0.50	0.50 x 4.00	2.00	0.625	7.31	9.81	11.88	8.31	10.81	13.88	9.44	11.94	16.13	10.44	12.94	18.13
10	4800	0.88	0.50	0.50 x 5.00	3.00	0.625	8.31	10.81	13.88	9.44	11.94	16.13	10.44	12.94	18.13	11.44	13.94	20.13
12	5100	0.88	0.50	0.50 x 5.00	3.00	0.625	9.44	11.94	16.13	10.44	12.94	18.13	11.44	13.94	20.13	12.44	14.94	22.13
14	6000	0.88	0.50	0.50 x 5.00	3.00	0.75	10.06	12.69	17.13	11.06	13.69	19.13	12.06	14.69	21.13	13.06	15.69	23.13
16	6900	0.88	0.50	0.50 x 6.00	4.00	0.75	11.06	13.69	19.13	12.06	14.69	21.13	13.06	15.69	23.13	14.06	16.69	25.13
18	7500	0.88	0.50	0.50 x 6.00	4.00	0.75	12.06	14.69	21.13	13.06	15.69	23.13	14.06	16.69	25.13	15.06	17.69	27.13
20	8100	0.88	0.50	0.50 x 6.00	4.00	0.75	13.06	15.69	23.13	14.06	16.69	25.13	15.06	17.69	27.13	16.06	18.69	29.13
24	8400	0.88	0.50	0.50 x 6.00	4.00	0.75	15.06	17.69	27.13	16.06	18.69	29.13	17.06	19.69	31.13	18.06	20.69	33.13

Application:

Model E2200 through E2230 is designed for use on:

- Hot water
- Cold water
- Chilled water
- Dual temperature
- Steam
- Air
- Gas
- Vacuum

Intended for installation on:

- Vertical runs of insulated pipe with upward and/or downward load.

Other:

- For handling downward loads only, see E1200

Temperature Range: +40°F to +1200°F
Note: Up to 1800°F available upon request.

Features:

- All pipe sizes
- Easy installation
- Positive stop - axially upward or downward
- May be supported from below or above
- Overlapping galvanized sheet metal jacket
- Insulating structural inserts for load transfer
- Other I.D.'s and/or O.D.'s Available on Request
- Eliminates condensation sweating on chilled water risers

Performance Test Results on File:
Available upon request.

Material Data:

- **E2200 - E2230:** specification document: No. 209.
- **Steel Inner Thrust Plates**:

Model	ASTM	For Pipe Material
E2200	A36	Carbon-Steel
E2210	A387GR.11	Chrome-Moly
E2220	A515GR.70	Carbon Silicon
E2230	A304L	Stainless Steel

- Insulation: Calcium silicate asbestos-free, treated with water repellant.
- Jackets: Galvanized steel ASTM A-653.
- Glue: Industrial contact adhesive
- Structural Inserts: High-density calcium silicate asbestos free, treated with water repellant.
- Steel Straps/Base:Carbon steel ASTM A-36.
- Fasteners: ASTM A-307 plated.
- Coating: Primer coated or hot dipped galvanized
- Other coatings available upon request.

Formal submittal sheets available

Schedule 40 Pipe Dimensions

Size Inches	Diameters		Nominal Thickness Inches	Transverse Areas			Length of Pipe per Sq. Foot of		Cubic Feet per Foot of Pipe	Weight per Foot Pounds	Number Threads per Inch of Screw
	External Inches	Internal Inches		External Sq. Ins.	Internal Sq. Ins.	Metal Sq. Ins.	External Surface Feet	Internal Surface Feet			
1/8	.405	.269	.068	.129	.057	.072	9.431	14.199	.00039	.244	27
1/4	.540	.364	.088	.229	.104	.125	7.073	10.493	.00072	.424	18
3/8	.675	.493	.091	.358	.191	.167	5.658	7.747	.00133	.567	18
1/2	.840	.622	.109	.554	.304	.250	4.547	6.141	.00211	.850	14
3/4	1.050	.824	.113	.866	.533	.333	3.637	4.635	.00370	1.130	14
1	1.315	1.049	.133	1.358	.864	.494	2.904	3.641	.00600	1.678	11½
1¼	1.660	1.380	.140	2.164	1.495	.669	2.301	2.767	.01039	2.272	11½
1½	1.900	1.610	.145	2.835	2.036	.799	2.010	2.372	.01414	2.717	11½
2	2.375	2.067	.154	4.430	3.355	1.075	1.608	1.847	.02330	3.652	11½
2½	2.875	2.469	.203	6.492	4.788	1.704	1.328	1.547	.03325	5.793	8
3	3.500	3.068	.216	9.621	7.393	2.228	1.091	1.245	.05134	7.575	8
3½	4.000	3.548	.226	12.56	9.886	2.680	.954	1.076	.06866	9.109	8
4	4.500	4.026	.237	15.90	12.73	3.174	.848	.948	.08840	10.790	8
5	5.563	5.047	.258	24.30	20.00	4.300	.686	.756	.1389	14.61	8
6	6.625	6.065	.280	34.47	28.89	5.581	.576	.629	.2006	18.97	8
8	8.625	7.981	.322	58.42	50.02	8.399	.442	.478	.3552	28.55	8
10	10.750	10.020	.365	90.76	78.85	11.90	.355	.381	.5476	40.48	8
12	12.750	11.938	.406	127.64	111.9	15.74	.299	.318	.7763	53.6	
14	14.000	13.125	.437	153.94	135.3	18.64	.272	.280	.9354	63.0	
16	16.000	15.000	.500	201.06	176.7	24.35	.238	.254	1.223	78.0	
18	18.000	16.874	.563	254.65	224.0	30.65	.212	.226	1.555	105.0	
20	20.000	18.814	.593	314.15	278.0	36.15	.191	.203	1.926	123.0	
24	24.000	22.626	.687	452.40	402.1	50.30	.159	.169	2.793	171.0	

B3188 - Standard U-Bolt with 4 Hex Nuts (TOLCO Fig. 110)
B3188C - Standard Plastic Coated U-Bolt

Size Range: Size 1/2" (15mm) thru 30" (900mm) pipe

Material: Steel

Function: Recommended for support, anchor or guide of pipe.

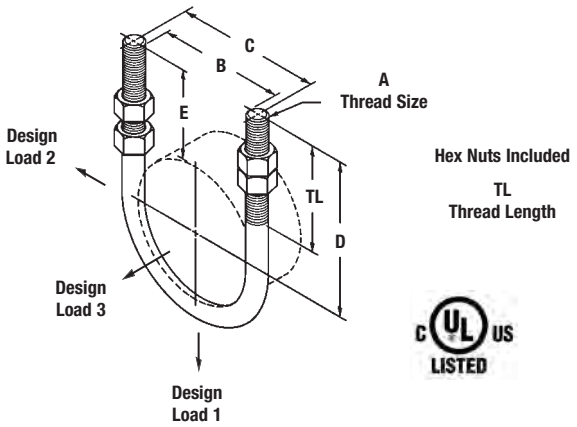
Approvals: Underwriters Laboratories Listed 3/4" (20mm) thru 12" (300mm). Conforms to Federal Specification WW-H-171E & A-A-1192A, Type 24 and Manufacturers Standardization Society ANSI/MSS SP-69 & SP-58, Type 24.

Maximum Temperature: 750°F (399°C)

Finish: Plain. Contact B-Line for alternative finishes and materials.

Order By: Part number and finish. U-bolt can be furnished with longer tangents "D" or with longer threads "E". Consult factory.

Note: When furnished in Hot-Dip Galvanized finish, oversize tapped hex nuts must be used.
B3188NS - Non-standard (NS) U-bolts are available upon request. Specify dimensions other than standard. B3188DI - For ductile iron pipe.



B3188C
Plastic Coated

Part No.	Pipe Size in.	Pipe Size (mm)	Thread Size	Thread Length TL in.	Thread Length TL (mm)	B in.	B (mm)
B3188-1/2	1/2"	(15)	1/4"-20	2 1/8"	(54.0)	15/16"	(23.8)
B3188-3/4	3/4"	(20)	1/4"-20	2 1/8"	(54.0)	1 1/8"	(28.6)
B3188-1	1"	(25)	1/4"-20	2 1/8"	(54.0)	1 3/8"	(34.9)
B3188-1 1/4	1 1/4"	(32)	3/8"-16	2 1/8"	(54.0)	1 11/16"	(42.9)
B3188-1 1/2	1 1/2"	(40)	3/8"-16	2 1/2"	(63.5)	2"	(50.8)
B3188-2	2"	(50)	3/8"-16	2 1/2"	(63.5)	2 7/16"	(61.9)
B3188-2 1/2	2 1/2"	(65)	1/2"-13	3"	(76.2)	2 15/16"	(74.6)
B3188-3	3"	(80)	1/2"-13	3"	(76.2)	3 9/16"	(90.5)
B3188-3 1/2	3 1/2"	(90)	1/2"-13	3"	(76.2)	4 1/16"	(103.2)
B3188-4	4"	(100)	1/2"-13	3"	(76.2)	4 9/16"	(115.9)
B3188-5	5"	(125)	1/2"-13	3"	(76.2)	5 21/32"	(143.6)
B3188-6	6"	(150)	5/8"-11	3 3/4"	(95.2)	6 3/4"	(171.4)
B3188-8	8"	(200)	5/8"-11	3 3/4"	(95.2)	8 3/4 "	(222.2)
B3188-10	10"	(250)	3/4"-10	4"	(101.6)	10 7/8"	(276.2)
B3188-12	12"	(300)	7/8"-9	4 1/4"	(107.9)	12 7/8"	(327.0)
B3188-14	14"	(350)	7/8"-9	4 1/4"	(107.9)	14 1/8"	(358.8)
B3188-16	16"	(400)	7/8"-9	4 1/4"	(107.9)	16 1/8"	(409.6)
B3188-18	18"	(450)	1"-8	4 3/4"	(120.6)	18 1/8"	(460.4)
B3188-20	20"	(500)	1"-8	4 3/4"	(120.6)	20 1/8"	(511.2)
B3188-24	24"	(600)	1"-8	4 3/4"	(120.6)	24 1/8"	(612.8)
B3188-30	30"	(750)	1"-8	4 3/4"	(120.6)	30 1/8"	(765.2)

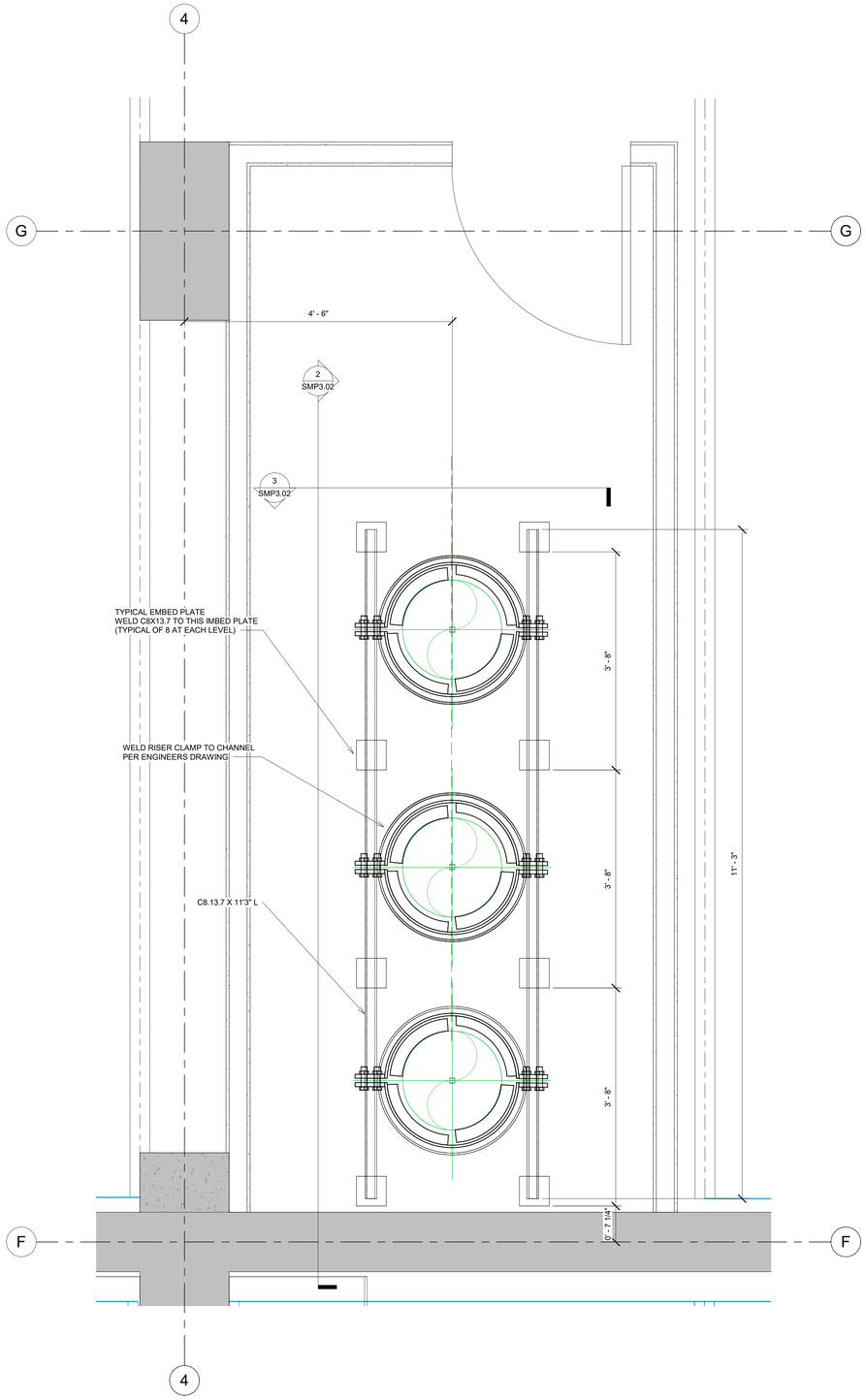
All dimensions in charts and on drawings are in inches. Dimensions shown in parentheses are in millimeters unless otherwise specified.

B3188 - Standard U-Bolt with 4 Hex Nuts (TOLCO Fig. 110) cont.

Part No.	C in.	C (mm)	Tangent D in.	Tangent D (mm)	E in.	E (mm)	Approx. Wt./100 Lbs.	Approx. Wt./100 (kg)
B3188-1/2	13/16"	(30.2)	23/4"	(69.8)	25/16"	(58.7)	10	(4.5)
B3188-3/4	13/8"	(34.9)	23/4"	(69.8)	27/32"	(56.3)	11	(5.0)
B3188-1	15/8"	(41.3)	23/4"	(69.8)	23/32"	(53.2)	11	(5.0)
B3188-1 1/4	23/32"	(53.2)	27/8"	(73.0)	21/32"	(51.6)	28	(12.7)
B3188-1 1/2	23/8"	(60.3)	3"	(76.2)	21/16"	(52.4)	29	(13.1)
B3188-2	213/16"	(71.4)	31/4"	(82.5)	21/16"	(52.4)	31	(14.0)
B3188-2 1/2	37/16"	(87.3)	33/4"	(95.2)	25/16"	(58.7)	72	(32.6)
B3188-3	41/16"	(103.2)	4"	(101.6)	21/4"	(57.1)	79	(35.8)
B3188-3 1/2	49/16"	(115.9)	41/4"	(107.9)	21/4"	(57.1)	84	(38.1)
B3188-4	51/16"	(128.6)	41/2"	(114.3)	21/4"	(57.1)	94	(42.6)
B3188-5	65/32"	(156.3)	5"	(127.0)	27/32"	(56.3)	104	(47.2)
B3188-6	73/8"	(187.3)	61/8"	(155.6)	213/16"	(71.4)	203	(92.1)
B3188-8	93/8"	(238.1)	71/8"	(181.0)	213/16"	(71.4)	241	(109.3)
B3188-10	115/8"	(295.3)	83/8"	(212.7)	3"	(76.2)	412	(186.9)
B3188-12	133/4"	(349.2)	95/8"	(244.5)	31/4"	(82.5)	661	(299.8)
B3188-14	15"	(381.0)	101/4"	(260.3)	31/4"	(82.5)	707	(320.7)
B3188-16	17"	(431.8)	111/4"	(285.7)	31/4"	(82.5)	782	(354.7)
B3188-18	191/8"	(485.8)	125/8"	(320.7)	35/8"	(92.1)	1344	(609.6)
B3188-20	211/8"	(536.6)	135/8"	(346.1)	35/8"	(92.1)	1458	(661.3)
B3188-24	251/8"	(638.2)	155/8"	(396.9)	35/8"	(92.1)	1687	(765.2)
B3188-30	311/8"	(790.6)	185/8"	(473.1)	35/8"	(92.1)	2030	(920.8)

Part No.	Design Load 1 650°F (343°C) Lbs.	Design Load 1 650°F (343°C) (kN)	Design Load 1 750°F (399°C) Lbs.	Design Load 1 750°F (399°C) (kN)	Design Load 2 650°F (343°C) Lbs.	Design Load 2 650°F (343°C) (kN)	Design Load 3 650°F (343°C) Lbs.	Design Load 3 650°F (343°C) (kN)
B3188-1/2	580	(2.58)	454	(2.02)	145	(0.64)	180	(0.80)
B3188-3/4	580	(2.58)	454	(2.02)	145	(0.64)	300	(1.33)
B3188-1	580	(2.58)	454	(2.02)	145	(0.64)	480	(2.13)
B3188-1 1/4	1460	(6.49)	1144	(5.09)	365	(1.62)	600	(2.67)
B3188-1 1/2	1460	(6.49)	1144	(5.09)	365	(1.62)	600	(2.67)
B3188-2	1460	(6.49)	1144	(5.09)	365	(1.62)	720	(3.20)
B3188-2 1/2	2700	(12.01)	2114	(9.40)	675	(3.00)	720	(3.20)
B3188-3	2700	(12.01)	2114	(9.40)	675	(3.00)	900	(4.00)
B3188-3 1/2	2700	(12.01)	2114	(9.40)	675	(3.00)	900	(4.00)
B3188-4	2700	(12.01)	2114	(9.40)	675	(3.00)	900	(4.00)
B3188-5	2700	(12.01)	2114	(9.40)	675	(3.00)	1080	(4.80)
B3188-6	4320	(19.21)	3382	(15.04)	1080	(4.80)	1080	(4.80)
B3188-8	4320	(19.21)	3382	(15.04)	1080	(4.80)	--	--
B3188-10	6460	(28.73)	5060	(22.50)	1615	(7.18)	--	--
B3188-12	9960	(44.30)	7016	(31.21)	2490	(11.07)	--	--
B3188-14	9960	(44.30)	7016	(31.21)	2490	(11.07)	--	--
B3188-16	9960	(44.30)	7016	(31.21)	2490	(11.07)	--	--
B3188-18	11800	(52.48)	9240	(41.10)	--	--	--	--
B3188-20	11800	(52.48)	9240	(41.10)	--	--	--	--
B3188-24	11800	(52.48)	9240	(41.10)	--	--	--	--
B3188-30	11800	(52.48)	9240	(41.10)	--	--	--	--

All dimensions in charts and on drawings are in inches. Dimensions shown in parentheses are in millimeters unless otherwise specified.



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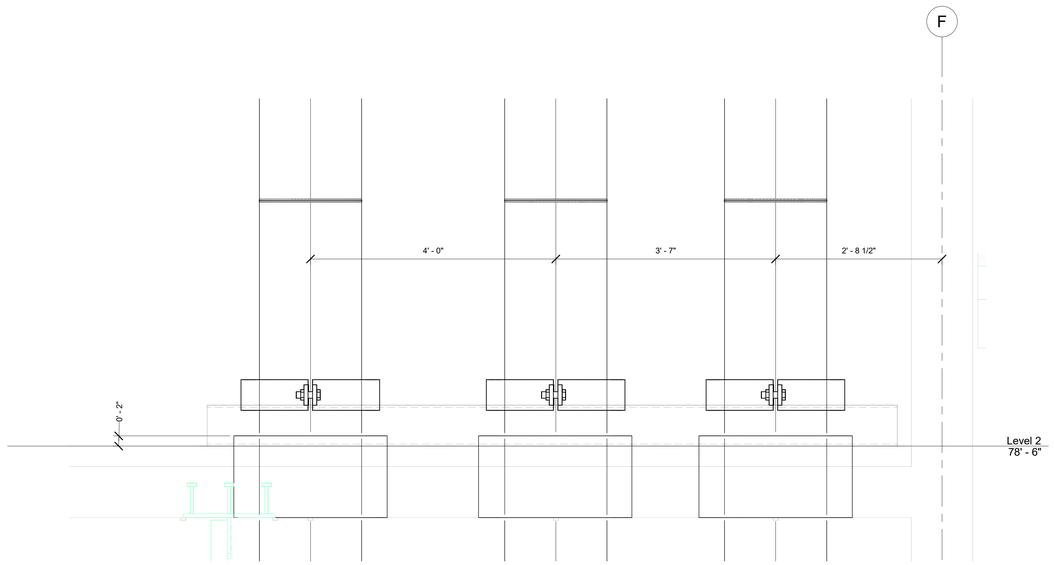

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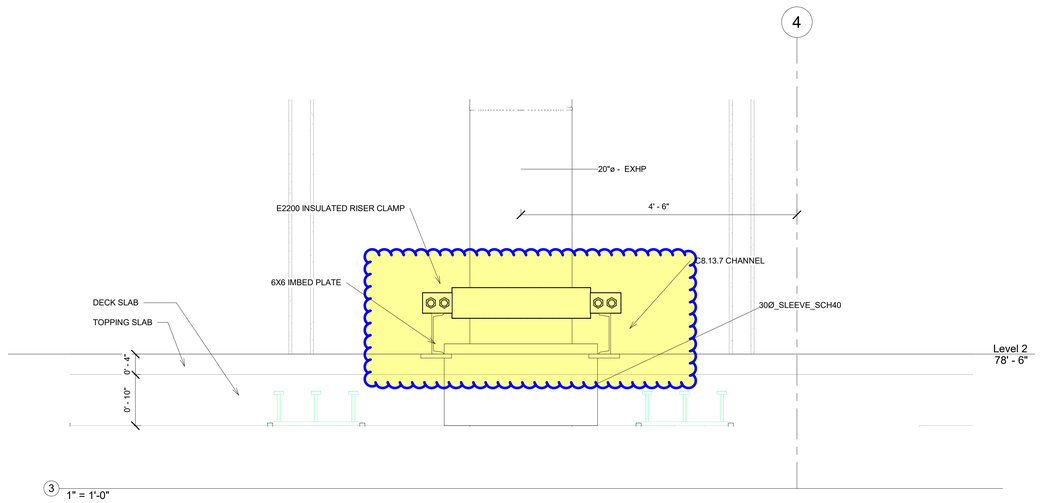

3 1" = 1'-0"

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DESIGN TEAM

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Drawn by: Author
Approved by: Approver
Job Number:
Filename:

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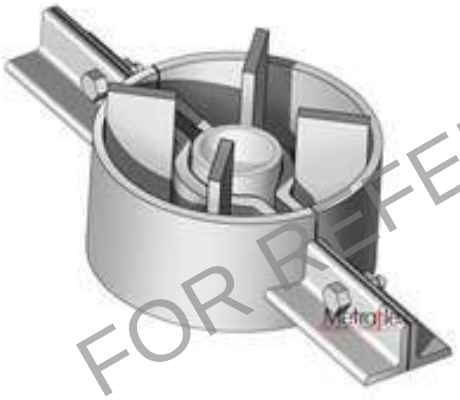

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