



Experienced. Innovative. Trusted.

CODE UNLIMITED, LLC

Block 29: Center for Health and Healing Fire Protection of HSS member

Client Name: Hoffman Construction

Client Address: 805 SW Broadway #2100, Portland, OR 97205

Date: 2/19/2018

PROJECT OVERVIEW

Hoffman Construction is building the OHSU Block 29 project in Portland, OR. The Type IA building is fully protected by automatic sprinklers, fire and smoke detection, and a fire alarm system. A two-hour fire rated shaft wall assembly is required to protect the elevator hoistway.

Code Unlimited has been asked to provide analysis for the fire protection of HSS type members within the shaft enclosure to ensure they will provide 2-hour fire protection as required per Oregon Structural Specialty Code.

APPLICABLE CODE

2014 Oregon Structural Specialty Code (OSSC)

2014 Oregon Fire Code (OFC)

APPROACH

- The proposed member assembly has been analyzed in accordance with 2014 OSSC §703.3 Alternative Methods for Determining Fire Resistance.
- The proposed member assembly is compared to listed assemblies, UL X790 and X521.

PROPOSED DESIGN

The proposed members consist of 6 x 6 x 3/8 and 14 x 6 x 5/8 HSS sections utilized as a support of the elevator rails. (see Fig. 1A through 1H, Fig. 2A, and Fig. 2B). These members are supporting elevator hoistway rails and are part of the shaft wall fire barrier.

Per 2014 OSSC 707.5, continuity of the shaft enclosure barrier shall be maintained for 2 Hrs to match the required fire-resistance rating of the shaft wall.

It is assumed that the member will be exposed to fire either side (not simultaneously) and the assembly will require continuous protection from all sides exposed to heat. The members can potentially be exposed to fire from one of two paths, Path #1 and Path #2 as shown in Fig. 2A and Fig. 2B.

**EJ BEAM
LOCATIONS**

Fire Rating of HSS Member

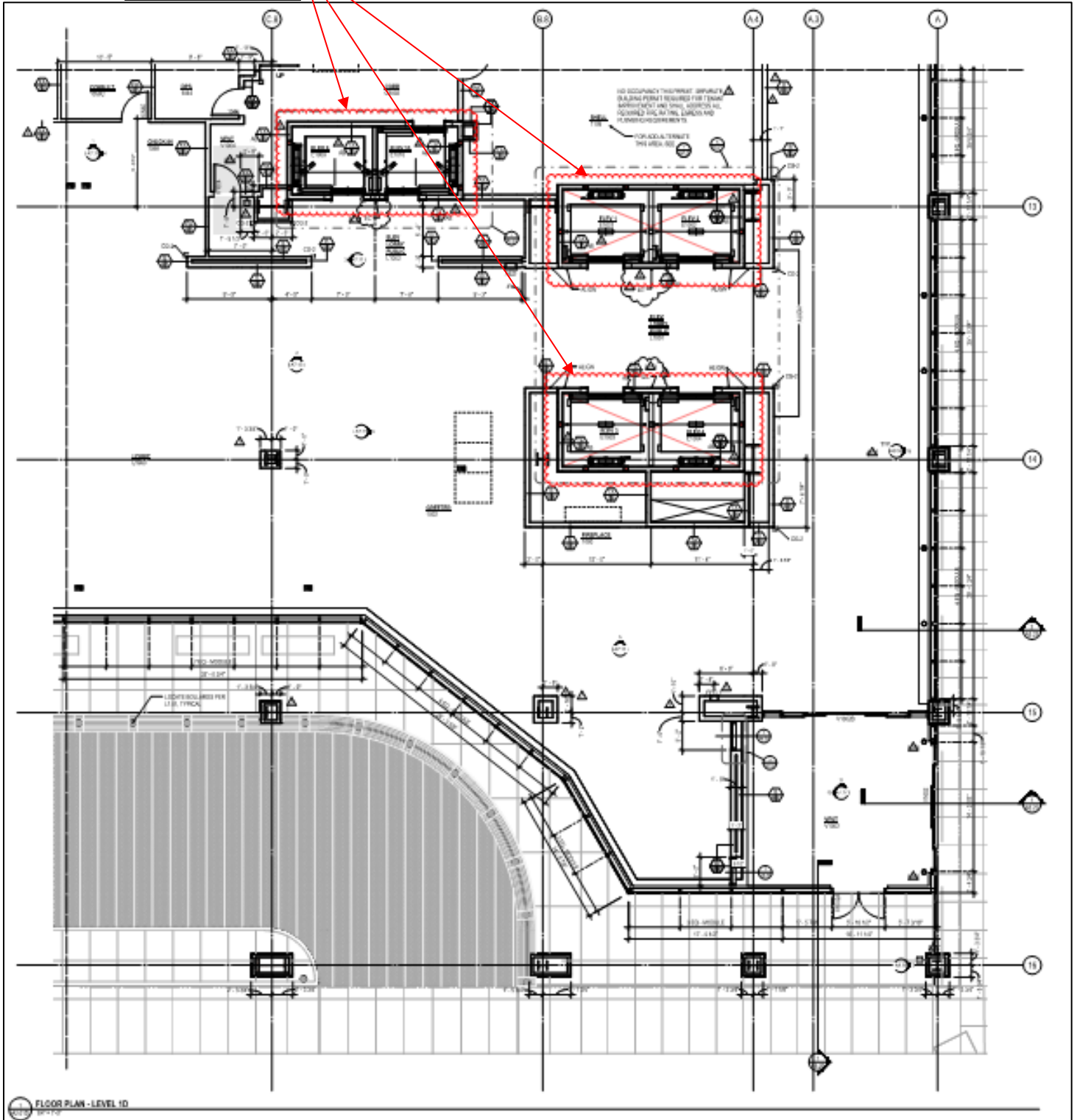


Fig. 1A: HSS Member Locations on Level 1D

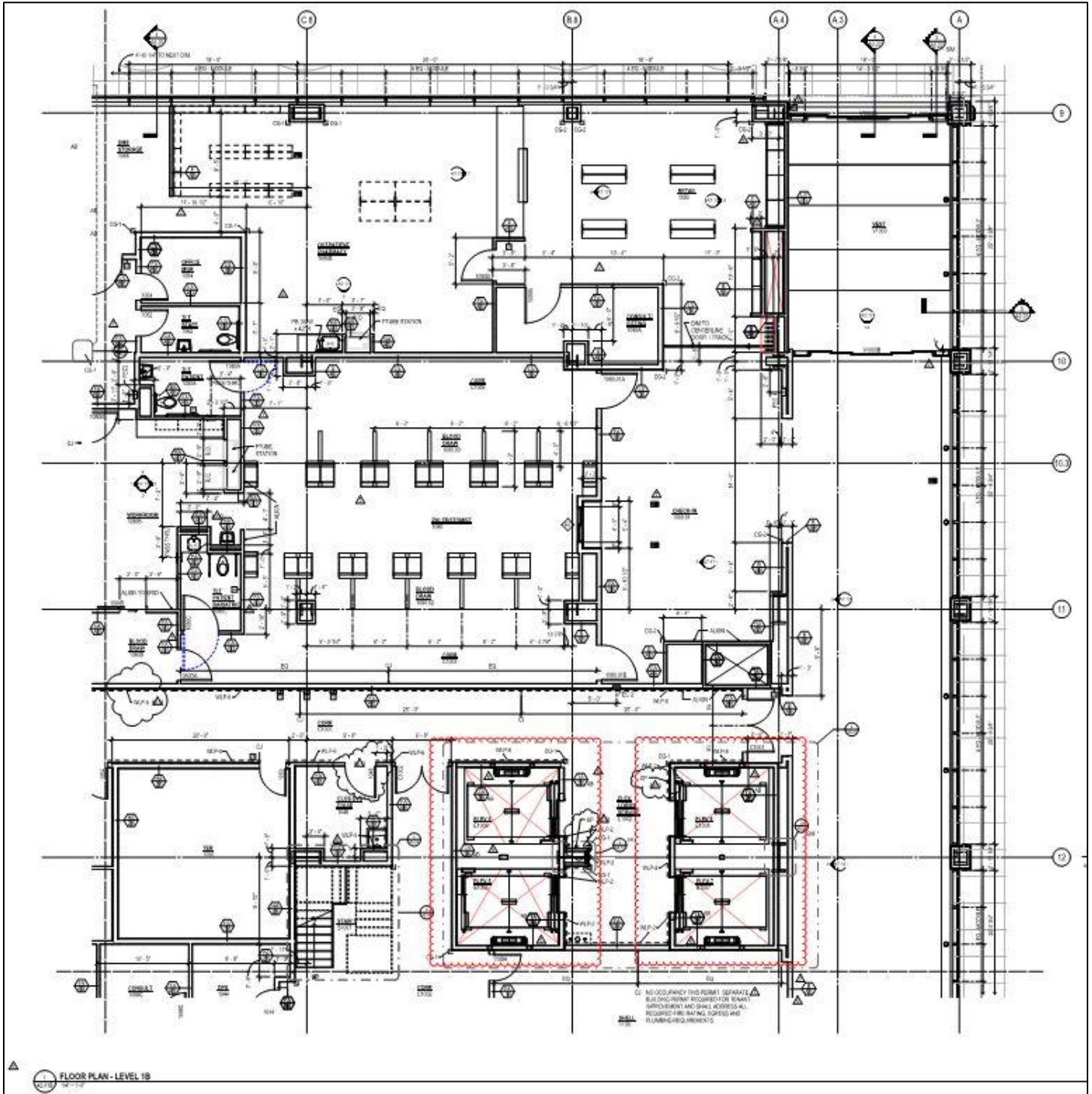


Fig. 1B: HSS Member Locations on Level 1B

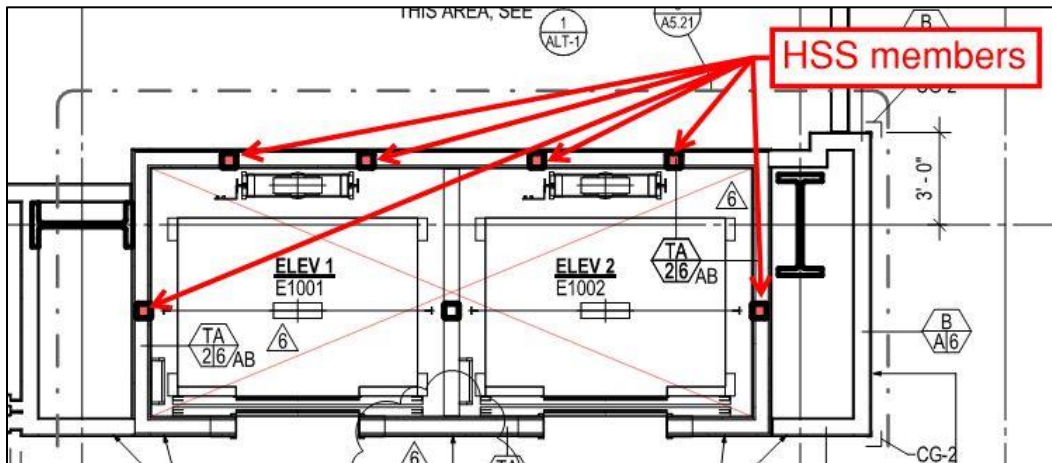


Fig. 1C: HSS Members at Elevators 1 and 2

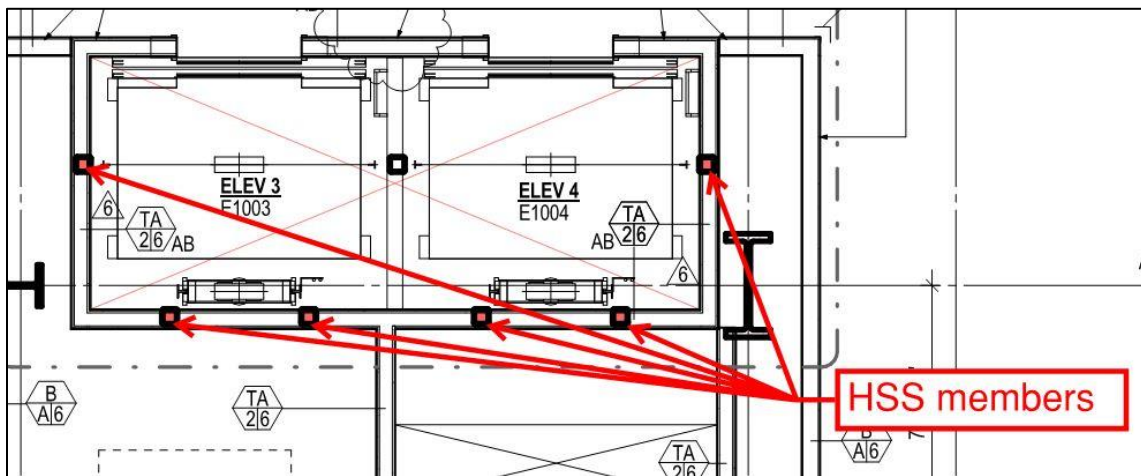


Fig. 1D: HSS Members at Elevators 3 and 4.

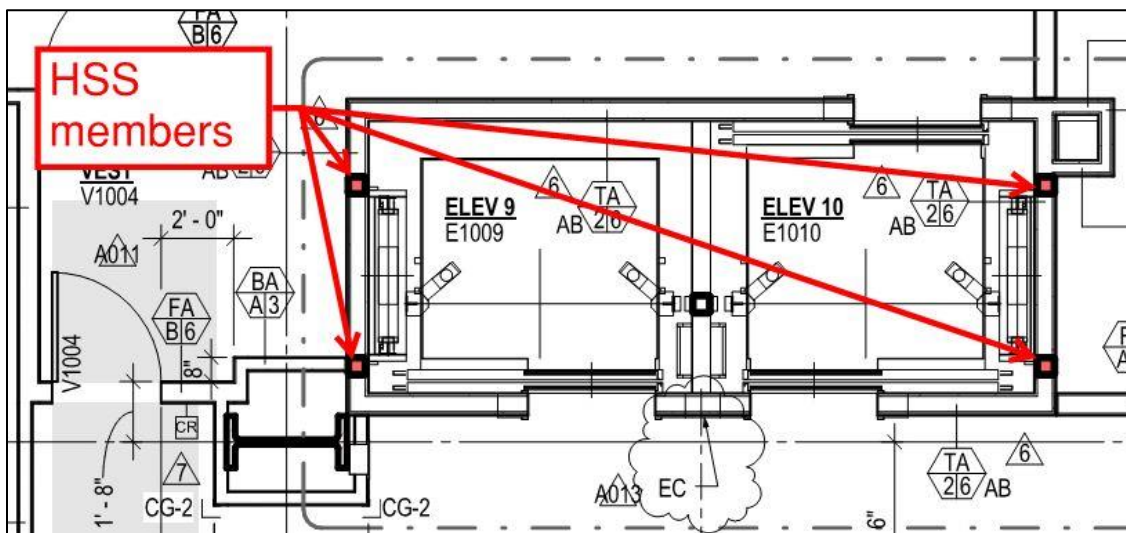


Fig. 1E: HSS Members at Elevators 9 and 10.

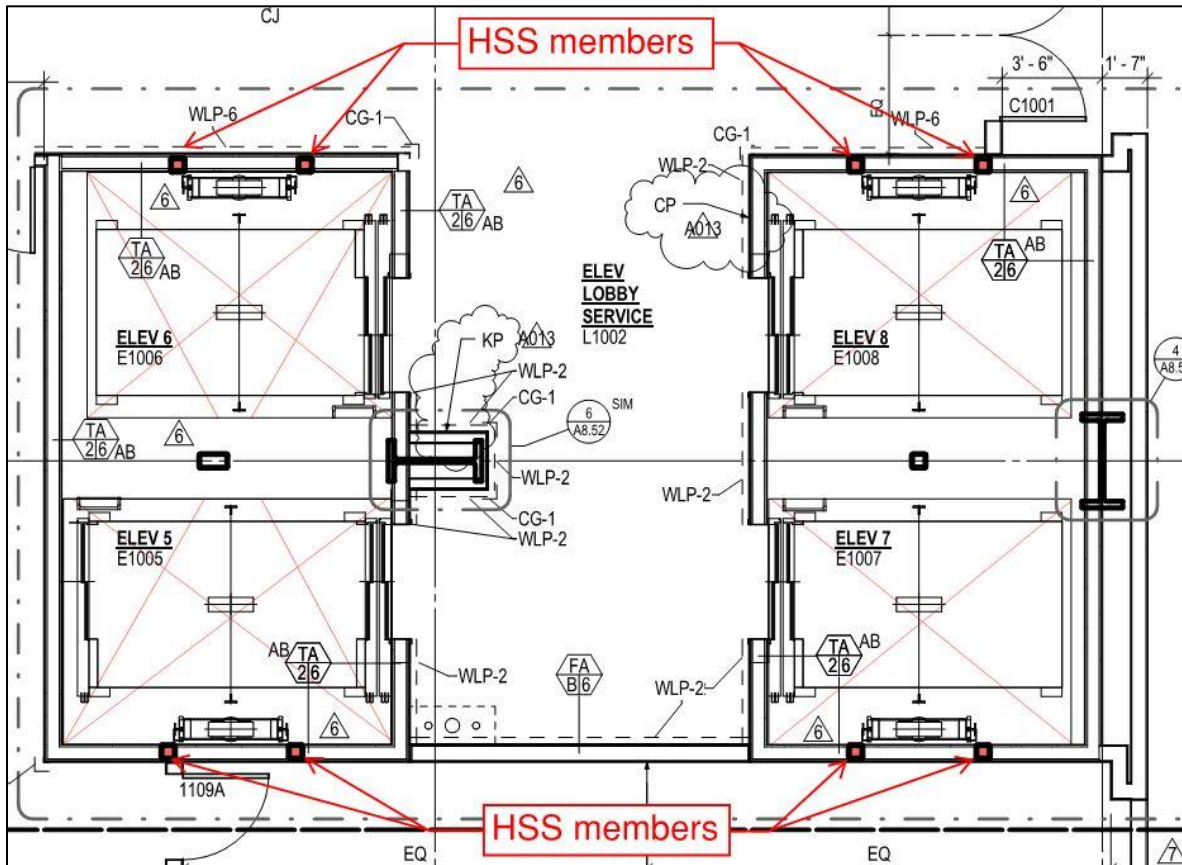


Fig. 1F: HSS Members at Elevators 5, 6, 7, and 8.

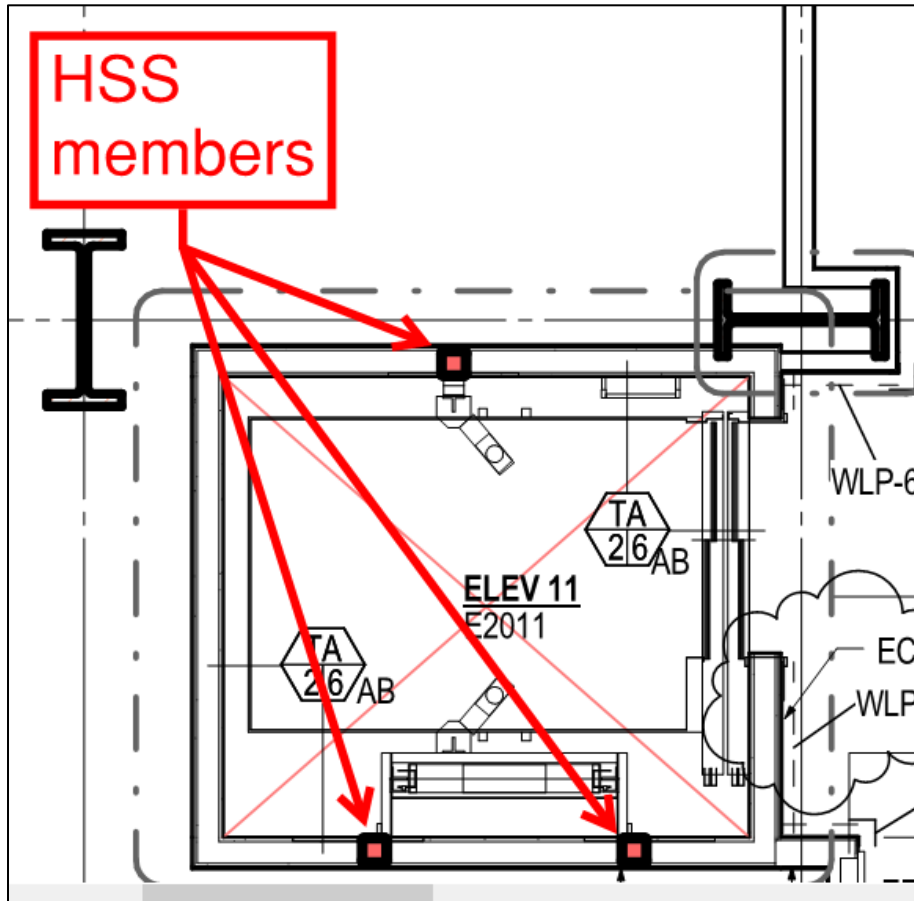


Fig. 1G: HSS Members at Elevator 11.

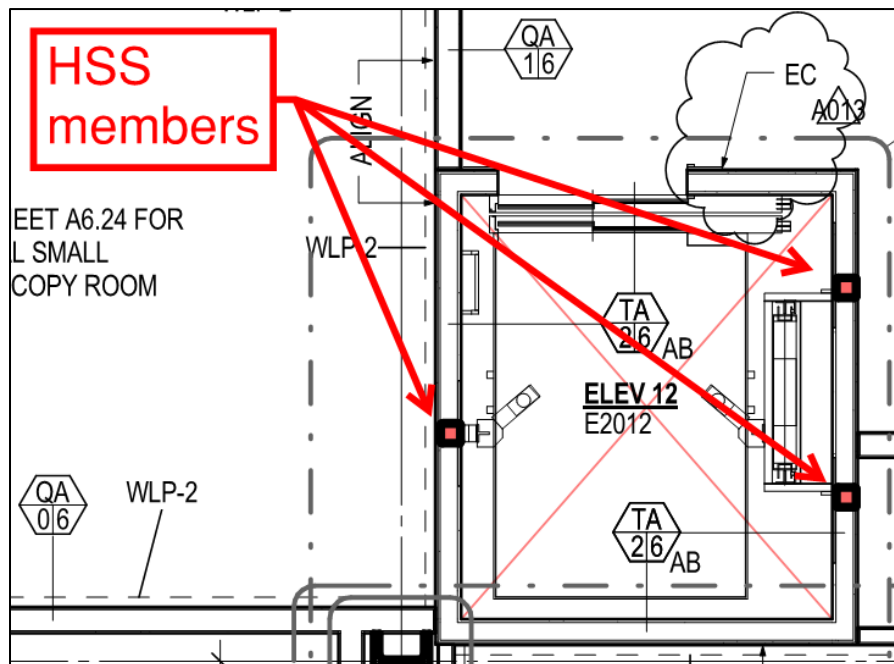
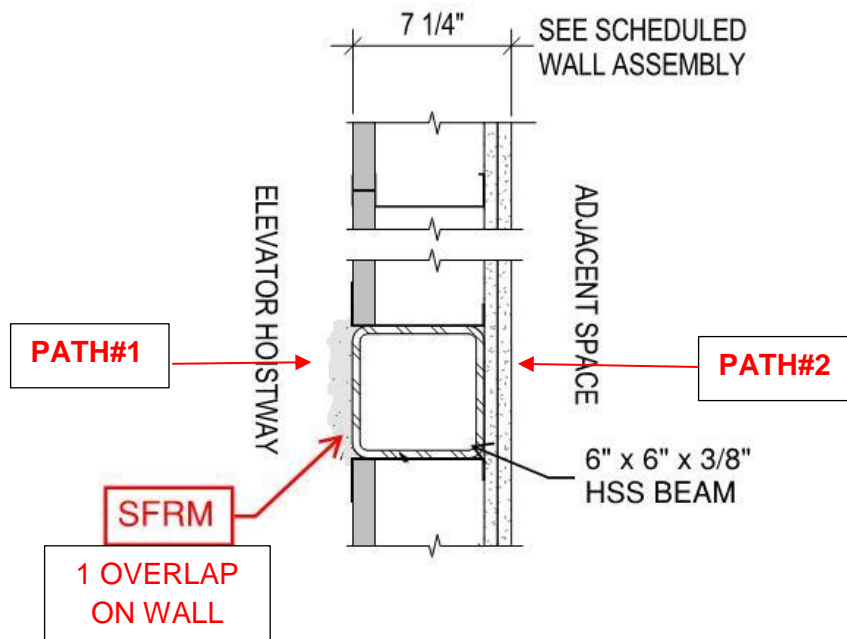


Fig. 1H: HSS Members at Elevator 12.

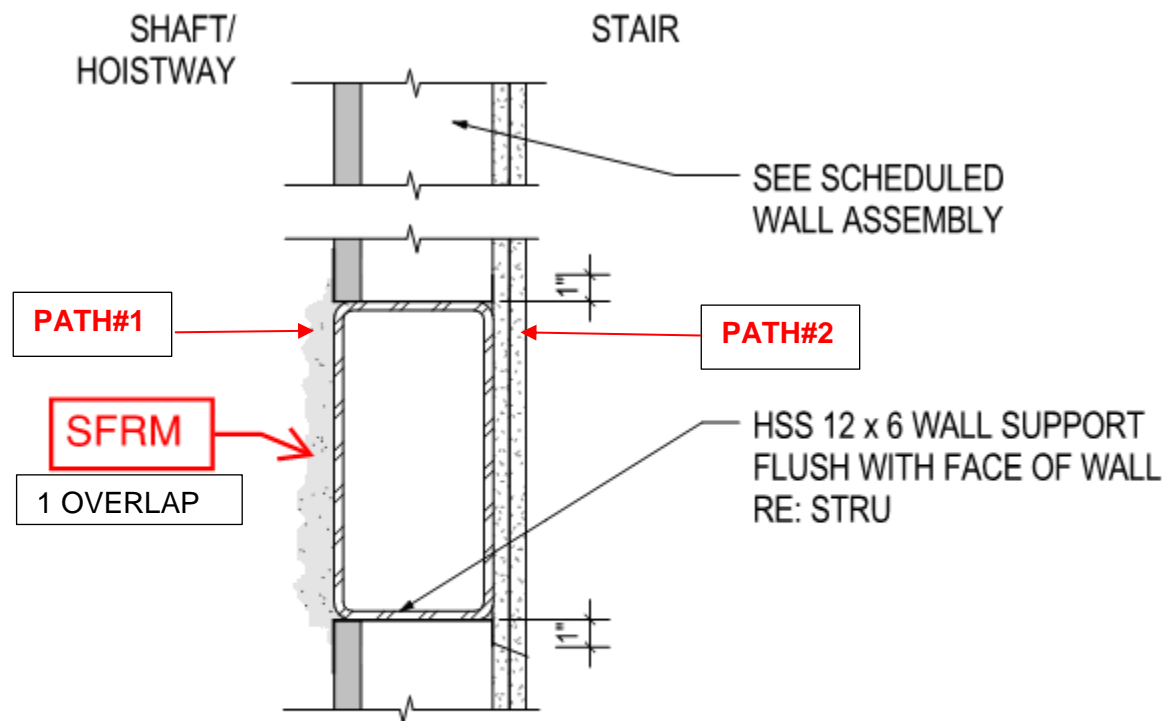


12
A8.50

PLAN DETAIL, HOISTWAY WALL

1 1/2" = 1'-0"

Fig.2A. Proposed Member 6 x 6 x 3/8 (Worst Case)



13
A8.50

SECTION DETAIL, SHAFT WALL (SIM)

1 1/2" = 1'-0"

Fig.2B. Proposed Member 14 x 6 x 5/8

MEMBER EQUIVALENCY ANALYSIS

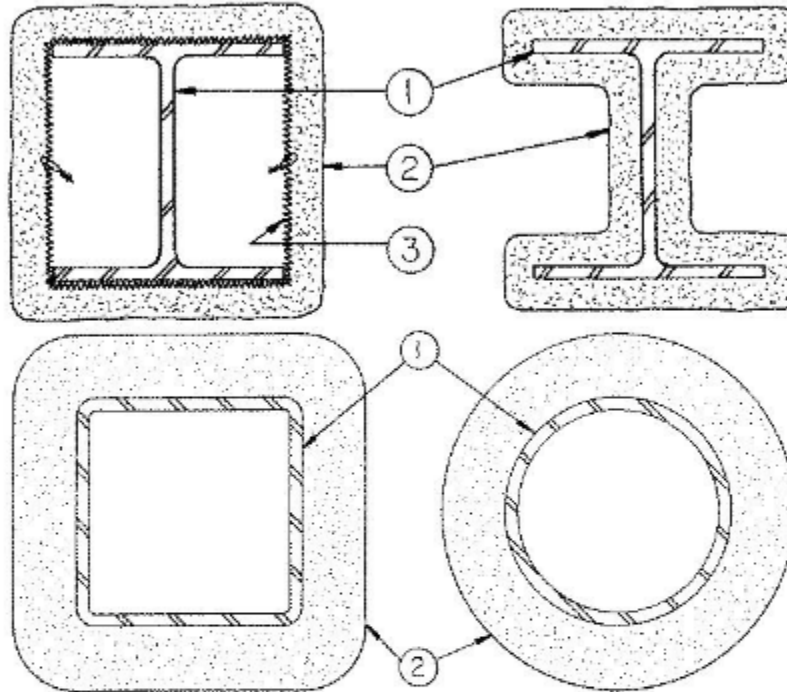
The proposed assembly of HSS 6 x 6 x 3/8 and 14 x 6 x 5/8 are supporting members for elevator rails. They are compared to the W14x233 member used in the Underwriters Laboratories (UL) test member assembly X790 shown in Fig. 3 (Path#1). For Path#2, the required membrane protection will be evaluated against UL Test X521. The key member property under consideration is the W/D ratio. The W/D ratio is the ratio of a structural element's weight, per lineal foot, to the length of the heated perimeter. A higher W/D ratio represents a greater thermal capacity for the member, and thus, a greater resistance to failure when exposed to fire. The W/D ratios of the proposed assemblies and the test assembly are compared in Table 2.

Design No. X790

November 17, 2014

Ratings — 1, 1-1/2, 2, 3 and 4 Hr.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.



1. **Steel Column, Steel Pipe or Steel Tube** — Wide flange steel column (W) or steel circular pipe (SP) or steel square or rectangular tube (ST), min sizes as shown in the tables below.

2. **Spray-Applied Fire Resistive Materials*** — Applied by mixing with water and spraying in one or more coats to the thicknesses shown below, to steel surfaces which are clean and free of dirt, loose scale, and oil. Min average and min individual density of 15 and 14 pcf, for Types 300, 300AC, 300ES, 300HS, 300N, 3000, 3000ES and SB. For Types 400AC and 400ES min average and min individual density of 22 and 19 pcf, respectively. For method of density determination, see Design Information Section, Sprayed Material.

The min thickness of Spray-Applied Fire Resistive Materials required for various fire resistance ratings of contour sprayed or boxed wide flange columns are shown in the table below:

Column Size	W/D	Min Thkns In.				
		1 Hr	1-1/2 Hr	2 Hr	3 Hr	4 Hr
W6x9	0.33	15/16	1-1/4	1-9/16	2-1/8	2-11/16
W6x12	0.43	13/16	1-1/8	1-7/16	2	2-9/16
W6x16	0.57	11/16	1	1-5/16	1-7/8	2-3/8
W8x28	0.68	5/8	15/16	1-1/4	1-13/16	2-5/16
W10x49	0.83	9/16	13/16	1-1/8	1-5/8	2-1/8
W12x106	1.46	3/8	9/16	13/16	1-1/4	1-11/16
W14x233	2.52	1/4	3/8	1/2	7/8	1-3/16

Fig.3. UL X790. Proposed SFRM thickness for 2-hour rating highlighted in red

IMPERIAL				
SIZE (in. x lb./ft.)	Column		Beam	
	W/D	Heated Perimeter (in.)	W/D	Heated Perimeter (in.)
W 14 x 808	7.28	111	8.75	92.3
x 730	6.76	108	8.08	90.4
x 665	6.21	107	7.49	88.8
x 605	5.82	104	6.96	86.9
x 550	5.34	103	6.43	85.6
x 500	4.95	101	5.95	84.0
x 455	4.59	99.1	5.53	82.3
x 426	4.32	98.5	5.21	81.8
x 398	4.09	97.3	4.93	80.7
x 370	3.84	96.4	4.63	79.9
x 342	3.58	95.5	4.32	79.1
x 311	3.30	94.3	3.98	78.1
x 283	3.03	93.4	3.66	77.3
x 257	2.78	92.5	3.36	76.5
x 233	2.55	91.5	3.08	75.6
x 211	2.32	91.0	2.81	75.2

W14x233

IMPERIAL				
SIZE (in. x lb./ft.)	Column		Beam	
	W/D	Heated Perimeter (in.)	W/D	Heated Perimeter (in.)
W 8 x 28	0.688	40.7	0.819	34.2

W12x233

IMPERIAL						
SIZE (in. x in. x in.)	COLUMN			BEAM		
	A/P	W/D	Heated Perimeter (in.)	A/P	W/D	Heated Perimeter (in.)
6 x 6 x 01.625	0.533	1.81	22.0	0.640	2.17	18.3
x 0.500	0.435	1.48	22.4	0.533	1.81	18.3
x 0.375	0.332	1.13	22.8	0.416	1.42	18.2
x 0.313	0.279	0.95	23.0	0.354	1.20	18.2
x 0.250	0.226	0.77	23.2	0.289	0.98	18.1
x 0.188	0.170	0.58	23.4	0.220	0.75	18.1
x 0.125	0.114	0.39	23.6	0.149	0.51	18.1

HSS 6x6x3/8

IMPERIAL						
SIZE (in. x in. x in.)	COLUMN			BEAM*		
	A/P	W/D	Heated Perimeter (in.)	A/P	W/D	Heated Perimeter (in.)
14 x 10 x 0.500	0.450	1.53	46.4	0.546	1.86	38.3
x 0.375	0.341	1.16	46.8	0.418	1.42	38.2
x 0.313	0.285	0.97	47.0	0.351	1.19	38.2
x 0.250	0.229	0.78	47.2	0.284	0.97	38.1
14 x 6 x 0.625	0.553	1.88	38.0	0.612	2.08	34.3
x 0.500	0.447	1.52	38.4	0.501	1.70	34.3

HSS 14x6x5/8

Fig.4. W/D Ratios for W14x233, W12x233, HSS 6 x 6 x 3/8, HSS 14 x 6 x 5/8

In Table 1 below, the tested UL assembly is compared to the proposed assembly with a 6 x 6 x 3/8 HSS Member. This assembly is considered the worst case because the 6 x 6 x 3/8 Member has the lower W/D ratio, at 1.13 (4-Sided Exposure) versus 1.88 for the 14 x 6 x 5/8 HSS assembly.

Element	UL Assembly Design No. X790	Proposed Assembly
PATH#1		
1. Structural Material	Steel Member; W14x233 W/D = 2.52 (see Fig. 3)	HSS 6 x 6 x 3/8 Member (Worst Case) W/D = 4.82 (see Table 2)
2. Concrete type	Light weight; 110 pcf	Not included, 2-hour assembly provided on 3 sides
3. Shear Connector (optional)	Studs, 3/4 in. diam headed type. Welded to the flange of Member through the steel floor units	Not included
4. Welded Wire Fabric (optional)	6x6-10/10 SWG	Not included
5. SFRM	2 Hr fire protection – 1/2 inch	Proposed – 1/2 inch thickness
Fire-Resistance Rating	2-Hour	2-Hour (minimum)
	UL Assembly Design No. X521	Proposed Assembly
PATH#2		
Structural Material	Steel Member; W14x228 W/D = 3.00 (Approx) (see Fig. 4)	HSS 6 x 6 x 3/8 Member (Worst Case) W/D = 4.82 (see Table 2)
	Gypsum board assembly	2 Hr protection (Per UL X521- see Fig. 8)

Table 1. Assembly Comparison Table

The HSS Members have larger W/D ratios than the tested W Member. The 14 x 6 x 5/8 HSS Member has the largest W/D ratio, and 6 x 6 x 3/8 Member has the smaller ratio, but both exceed the W/D ratio of the tested assembly.

Additionally, we have compared the Members as proposed along with the UL tested configuration.

Member	Tabular W/D	Weight W (lb/ft)	Proposed Design Heated Perimeter D (inches)	Proposed Design Assembly W/D
HSS 6 x 6 x 0.375	1.13 (4 sides)	27.48	5.7 (1 Side)	4.82
HSS 14 x 6 x 0.625	1.16 (4 Sides)	76.33	13.3 (1 Long Side)	5.74

Table 2. W/D Ratios

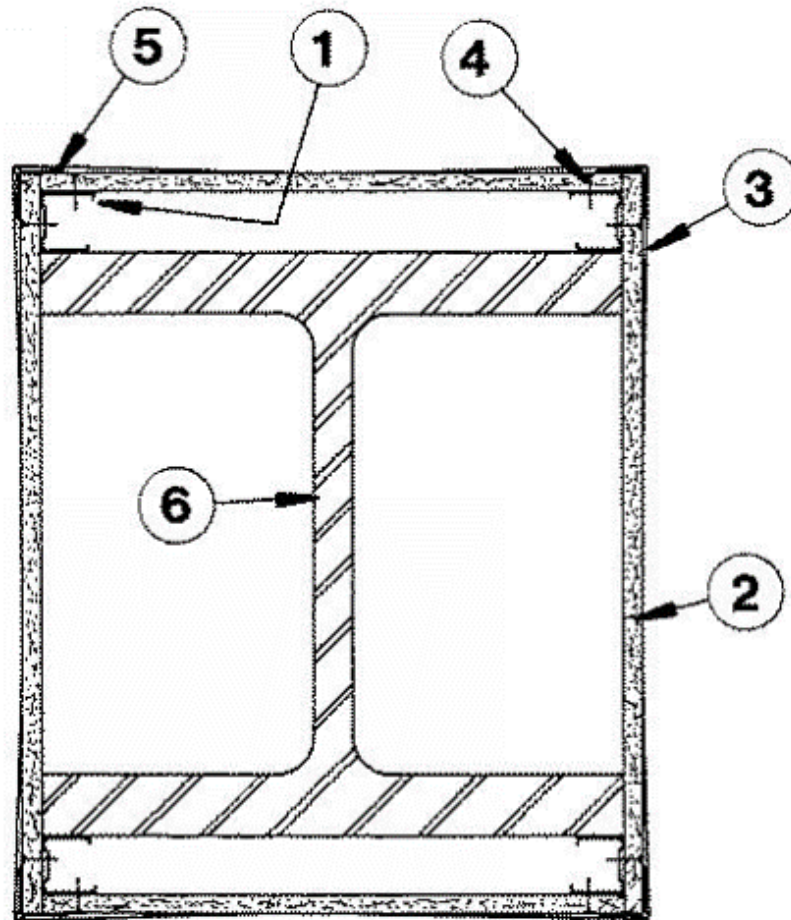
Note: When evaluated against the tested configuration. The HSS Member has a much larger W/D ratio than the tested Member.

Design No. X521

August 31, 2015

Rating — 2 Hr.

* Indicates such products shall bear the UL or cUL Certification Mark for jurisdictions employing the UL or cUL Certification (such as Canada), respectively.



1. **Steel Studs** — 1-5/8 in. wide with leg dimensions of 1-5/16 and 1-7/16 in. with a 1/4 in. folded flange in legs fabricated from 25 MSG galv steel. Steel stud cut 1/2 in. less in length than assembly height.

2. **Gypsum Board*** — 1/2 in. thick, one layer.

3. **Joint Compound** — Applied at corners to cover corner beads. As an option, nom 3/32 in. thick gypsum veneer plaster may be applied to the entire surface of Classified veneer baseboard.

4. **Screws** — 1 in. long self-drilling, self-tapping steel screws, spaced vertically 12 in. OC.

5. **Corner Beads** — 26 MSG galv steel, 1-1/4 in. legs attached to wallboard by crimping spaced 6 in. O.C.

6. **Steel Column** — Min. size of column W14 x 228, with outside dimensions of 16 by 15-7/8 in. with flange thickness of 1-11/16 in., a web thickness of 1-1/16 in., and a cross-sectional area of 67.06 sq in.

Figure 8: UL Design Number X521

EVALUATION DISCUSSION

While evaluating fire resistance requirement of members, different sized Members are compared against each other through a factor referred to as the W/D Ratio. The weight per unit length of a member is divided by the length of exposed heated perimeter area to determine the thermal capacity of a member. Lower W/D ratios correspond with thinner steel members that will be subject to earlier failure when heated, while higher W/D ratios correspond with greater fire resistance.

During the evaluation (Path#1), a UL test X790 was considered, but the test assembly has a concrete deck supported above the Member. The tested Member is heated on four sides. We proposed to compare HSS Member assembly with a fully loaded restrained Member assembly of UL X790. From the analysis above, we see that W/D ratios of the proposed assemblies greatly exceed the tested assembly (W8 x 28 Member), 4.82 for the 6 x 6 x 3/8 HSS vs 2.52 for the tested, and 5.74 for the 14 x 6 x 5/8 HSS vs 2.52. Therefore, the HSS Members have a higher thermal capacity when exposed to heat on one side. The SFRM coating required per the tested Member is 1/2" for a 2-hr fire resistance rating. This thickness of SFRM is a conservative level of protection of the HSS Members since they are exposed only on one side with a greater resultant W/D ratio than the minimum Member size used in UL X790.

The evaluation (Path#2), utilized a larger member for reference with UL test X521. The test assembly has four sides exposed to heat and only one layer of 1/2" Gyp-Board. The proposed assembly is superior, in that two layers of 5/8, Type X sheetrock are used and the W/D ratio is significantly larger.

CONCLUSION

We have reviewed the proposed member along with a Member UL test. The evaluation from X790 would require 1/2" of SFRM fire proofing with 1 inch of overlap onto the shaft wall for the HSS Members with the smallest W/D Ratio. All other HSS Members with larger W/D ratios will comply if protected with this applied SFRM thickness.

The proposed HSS Member protection is conservative as the Members are thicker and provide greater heat resistance than the UL tested assembly (W14x233). Therefore they require less added fire protection material than the tested member.

The shaft wall membrane will protect the Members in excess of the UL testing when evaluated against X521.

Therefore, as shown above, the proposed design for the HSS Members protected with SFRM on one side and protected by the shaft wall on the other three, will exceed the required 2 Hr rating as compared and detailed in this letter.



EXPIRES 12-31-18

Franklin Callfas
Principal/Fire Protection Engineer
Code Unlimited