Development Services

From Concept to Construction

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APPEAL SUMMARY

Status: Decision Rendered - Reconsideration of ID 18938

Appeal ID: 18966	**Project Address:** 1075 NW 16th Ave
Hearing Date: 2/6/19	**Appellant Name:** Tom Jaleski
Case No.: B-019	**Appellant Phone:** 971-238-5266
Appeal Type: Building	**Plans Examiner/Inspector:** Corey Stanley
Project Type: commercial	**Stories:** 6 **Occupancy:** A-3, B, R-2, & S-2 **Construction Type:** III-A OVER I-A
Building/Business Name: Derby Slabtown Apartments	**Fire Sprinklers:** Yes - Throughout
Appeal Involves: Reconsideration of appeal	**LUR or Permit Application No.:**
Plan Submitted Option: pdf [File 1]	**Proposed use:** Apartments

APPEAL INFORMATION SHEET

Appeal item 1

Code Section	§703.3, §704.3
Requires	703.3 Alternative methods for determining fire resistance. The application of any of the alternative methods listed in this section shall be based on the fire exposure and acceptance criteria specified in ASTM E 119 or UL 263. The required fire resistance of a building element, component or assembly shall be permitted to be established by any of the following methods or procedures: Engineering analysis based on a comparison of building element, component or assemblies designs having fire-resistance ratings as determined by the test procedures set forth in ASTM E 119 or UL 263. 704.3 Protection of the primary structural frame other than columns. Members of the primary structural frame other than columns that are required to have protection to achieve a fire-resistance rating and support more than two floors or one floor and roof, or support a load-bearing wall or a nonload-bearing wall more than two stories high, shall be provided individual encasement protection by protecting them on all sides for the full length, including connections to other structural members, with materials having the required fire-resistance rating. Exception: Individual encasement protection on all sides shall be permitted on all exposed sides provided the extent of protection is in accordance with the required fire-resistance rating, as determined in Section 703.
Proposed Design	The proposed design assemblies are steel support members installed against mezzanine concrete floor. Two similar conditions are analyzed (L-3x3x ¼ and C6x13), located at the level 01-Mezz of the building.

The C-member is exposed on all 3 sides, while the L-member, only the bottom side. They will be protected equally with 2-hr fire resistance rated per 2014 OSSC §704.3.

Reason for alternative The proposed fire proofing application uses an analysis from an Oregon registered Fire Protection Engineer to provide equivalent life safety and fire protection for the requirements of the assemblies.

The proposed assembly members protected by SFRM coating with a minimum thickness as identified in the EJ#1 (see attachment – EJ#1) will provide protection for a 2-hr rating based on the comparison to the UL test data and our analysis. The complete fire proofing as detailed in the EJ will provide a conservative level protection for the members. The proposed protection will meet the minimum 2-hr fire resistance rating per the OSSC for this application. Therefore, we urge you to approve this appeal.

"Reconsideration Text"
Evaluated protection thickness has been compared to a thinner beam member and additional SFRM protection has been provided as a conservative measure. See revised EJ.

APPEAL DECISION

Alternate 2 hour fire rated steel support member assembly with engineering analysis: Granted as proposed.

The Administrative Appeal Board finds that the information submitted by the appellant demonstrates that the approved modifications or alternate methods are consistent with the intent of the code; do not lessen health, safety, accessibility, life, fire safety or structural requirements; and that special conditions unique to this project make strict application of those code sections impractical.

Pursuant to City Code Chapter 24.10, you may appeal this decision to the Building Code Board of Appeal within 180 calendar days of the date this decision is published. For information on the appeals process and costs, including forms, appeal fee, payment methods and fee waivers, go to www.portlandoregon.gov/bds/appealsinfo, call (503) 823-7300 or come in to the Development Services Center.

CODE UNLIMITED, LLC

Engineering Judgement Letter

Derby Slabtown Apartments - EJ #1

Fire Protection-Steel Structural Members

Client Name: Koz Development

Client Address: 1830 Bickford Ave, Suite 201 Snohomish, WA 98290

Date: 2/3/2019

Table of Contents

1 PROJECT OVERVIEW

The Derby Slabtown Apartments is a new building in Portland, Oregon. Some of the proposed building systems do not meet a tested fire resistive assembly requirement. Code Unlimited has been asked to provide an analysis and engineering judgement letter for these conditions.

The proposed 6 story building of III-A over I-A construction contains groups A-3, B, R-2, & S-2 occupancies. The building is protected by automatic fire sprinkler and fire alarm systems throughout. The support members located at the mezzanine are not part of a UL listed assembly. Since they are part of primary structural members, they are required to be 2-hr fire resistance rated per 2014 OSSC §704.3.
Code Unlimited has been asked to provide analysis for the fire resistance rating of the assemblies to ensure they will provide 2-hour fire resistance as required per OSSC.

2 APPLICABLE CODES, STANDARDS, AND GUIDES

2014 Oregon Structural Specialty Code

3 APPROACH

- The proposed assembly has been analyzed in accordance with 2014 OSSC §703.3 **Alternative Methods for Determining Fire Resistance**.
- Portions of the tested assembly are modified to suit the unique design condition. The modification is analyzed for equivalency using published fire test data and acceptable fire science principles.

4 PROPOSED DESIGN

The proposed design assemblies are steel support members installed against a mezzanine concrete floor. Two similar conditions are analyzed (L-3x3x ¼ and C6x13(W/L2x2x¼), located at the level 01-Mezz of the building (see fig 1).
The C-member is exposed on all 3 sides with an L2x2x ¼ adjacent. The L3x3x ¼ -member, is exposed on the bottom side only. They will be protected equally with 2-hr fire resistance rated per 2014 OSSC §704.3.

The member C6x13 is detailed in fig 2, while the L3x3x ¼ is shown in fig. 3.

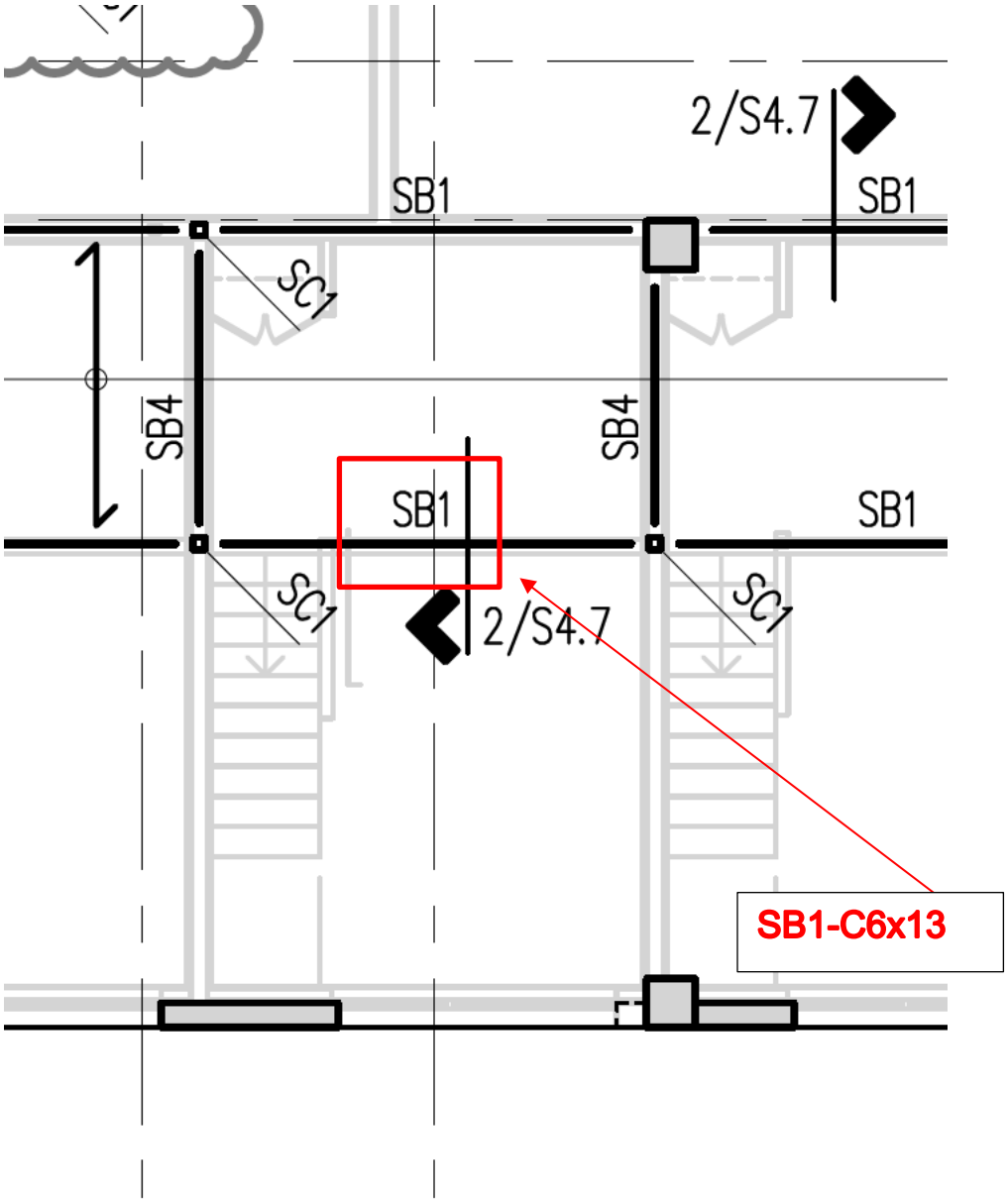


Figure 1: *Location of C6x13 steel members at level 01.*

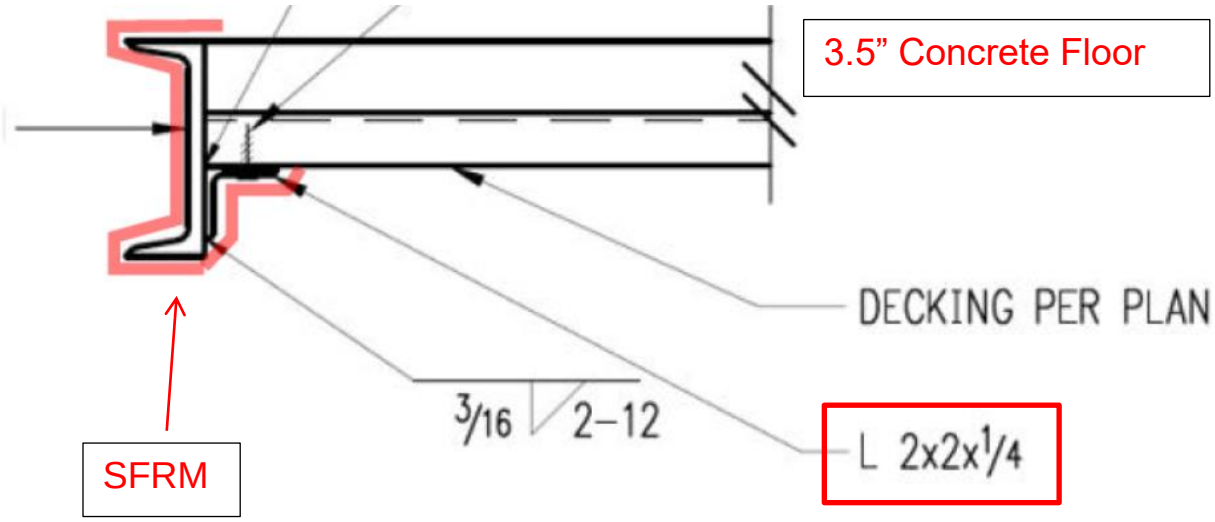


Figure 2: *C6x13 Member*

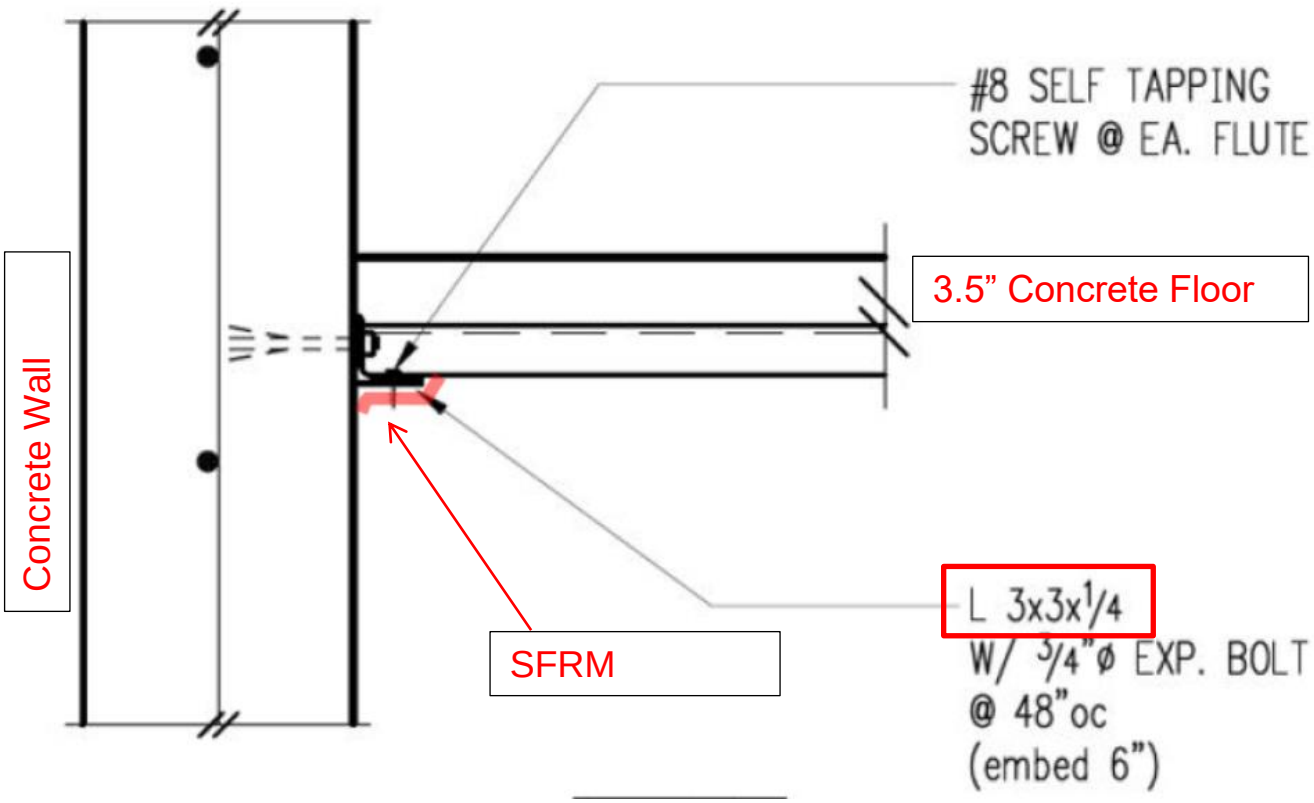


Figure 3: *L 3x3 x¼ Support*

5 ASSEMBLY ANALYSIS

The proposed structural members are supporting the mezzanine floor in the Type 1A portion of the building and are required to be protected for a 2-hr rating per OSSC, Table 601. The concrete deck will act as a sink to transfer heat from the exposed members. The UL tested design assembly to be used for comparison to a loaded (restrained) beam assembly supporting a concrete floor.

The proposed assembly of C6x13 is a primary structural member. It is compared to the W8x28 member used in the UL test assembly D759 as shown in figure 4.

Design No. D759

January 14, 2019

Restrained Assembly Rating — 1, 1-1/2, 2 and 3 Hr.

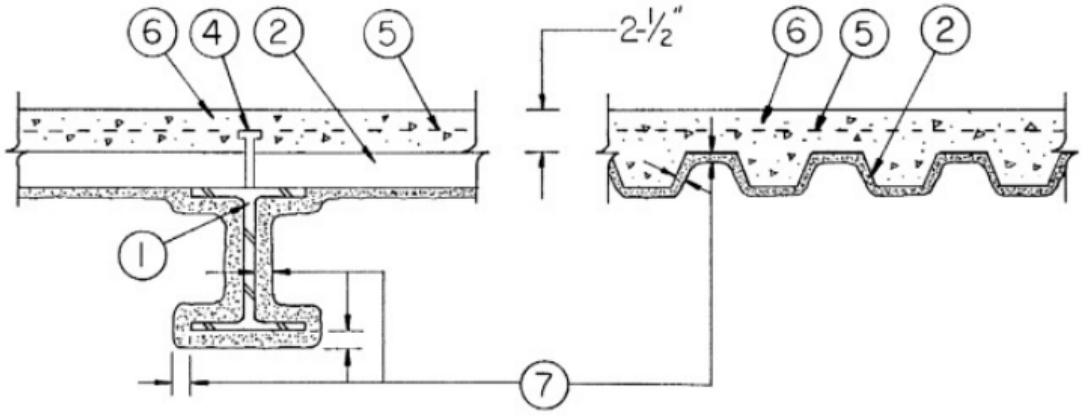
(See Items 2, 7, 7A, 9, 9A and 12).

Unrestrained Assembly Rating — 1, 1-1/2, 2 and 3 Hr.

(See Items 2, 7, 7A, 9, 9A and 12).

Unrestrained Beam Rating — 1, 1-1/2, 2, 3 Hr. (See Item 7 and 7A).

This design was evaluated using a load design method other than the Limit States Design Method (e.g., Working Stress Design Method). For jurisdictions employing the Limit States Design Method, such as Canada, a load restriction factor shall be used — See Guide BXUV or BXUV7



1. **Steel Beam** — W8x28 steel beam min size.

1A. **Steel Joist** — (Not Shown) Composite or noncomposite min 12k5 or min depth and weight shall be 12 in. and 7.1 lb/ft respectively. May be uncoated or provided with a shop coat of paint. Designed per S.J.I. specifications for a max design stress of 30, 000 psi (30 ksi). Welded or bolted to end supports. Top chords shall consist of two angles measuring 1-1/2 by 1-1/2 by 0.156 in. thick. Bottom chord shall consist of two round bars measuring 0.675 in. in diam. or two angles measuring 1 by 1 by 0.125 in. thick. The second web member at each end shall consist of a 0.654 in. diam round bar. All remaining web members, including the end web members, shall consist of 0.774 in. diam round bars. Bridging per S.J.I. specifications is required when noncomposite joists are used.

Note: Additional beams or joists from the N series designs may be substituted for the listed beam (item 1) or joist (item 1A) respectively. When joists are substituted, the restrained rating of the joist must be equal to or greater than the restrained rating of the assembly. Additional beam and joist substitution requirements are in the front of the Fire Resistance Directory - III. FLOOR-CEILINGS AND ROOF-CEILINGS, item 7 - Steel Joists or IV. BEAMS.

2. **Steel Floor And Form Units*** — 1-1/2, 2 or 3 in. deep galv units. Min gauges are 22 MSG for the fluted and 20/20 MSG for the cellular units. The units may be blended alternating one cellular unit to one or more fluted units.

3. **Joint Cover** — (Not Shown) — Burlap tape applied with a bituminous adhesive.

4. **Shear Connector Studs** — (Optional, Not Shown) — Studs, 3/4 in. diam, by 3 in. long for 1-1/2 in. deep form units to 5-1/4 in. deep for 3 in. units, headed type or equivalent per AISC specifications. Welded to top beam flange through steel form units.

5. **Welded Wire Fabric** — 6x6-W1.4xW1.4. When using steel joists, the min welded wire fabric should be 6x6-W2.9xW2.9.

5A. **Negative Reinforcement** — (Optional, Not Shown) Used in lieu of Item 5 and with Item 5B. For floor spans with concrete cast continuous over the supporting beams. Deformed bars designed to resist the support moments of the concrete slab in accordance with the latest ACI Building Code Specifications.

5B. **Fiber Reinforcement*** — (Not Shown) - Required with Item 5A. Any fiber reinforcement bearing the UL Classification Marking for Fire Resistance, Classified for use in lieu of welded wire fabric.

See **Fiber Reinforcement** (CBXQ) Category for names of manufacturers.

6. **Normal Weight Or Lightweight Concrete** — Normal weight concrete: carbonate or siliceous aggregate, 150 plus or minus 3 pcf unit weight, 3000 psi compressive strength, vibrated. Lightweight aggregate concrete: expanded shale, clay or slate aggregate by rotary-kiln method, 112 plus or minus 3 pcf unit weight, 3000 psi compressive strength, vibrated, 4 to 7 percent entrained air.

7. **Spray-Applied Fire Resistive Materials*** — Prepared by mixing with water. Spray-applied in one or more coats to beam surfaces to a min final thickness as shown in the table below. Beam surfaces must be clean and free of dirt, loose scale and oil. Crest areas of deck above the beams shall be filled with Spray-Applied Fire Resistive Materials. Min average and min individual density of 15 pcf and 14 pcf respectively for Types 300, 300 AC, 300ES, 300HS, 300N, 3000, 3000ES, and SB. For types 400, 400AC, and 400ES min average and min individual density of 22 pcf and 19 pcf respectively. Min average of 44 pcf with min individual value of 40 pcf for types M-II and TG. Min average density of 47 pcf, with min individual value of 43 pcf for Type M-II/P. For method of density determination, see Design Information Section, Sprayed Material. Use of Type PC Pre-coat is required on all cellular units. The Type PC Pre-coat shall be applied to cover approximately 70 percent of the flat plate surface. Thickness of the Type PC Pre-coat is included in the total thickness of the protection material.

Restrained Assembly Rating, Hr	Unrestrained Assembly Rating, Hr	Unrestrained Beam Rating, Hr	Min Thkns Spray Applied Fire Resistive Mtl In.				
			Deck Fluted	Deck Cellular	Beam (a)	Beam (b)	12K5 Joist
1+	1+	1	3/8	3/8	5/16	5/16	9/16++
1-1/2+	1-1/2+	1-1/2	3/8	3/8	1/2	9/16	1
2+	1+	1	3/8	3/8	5/16	5/16	1-3/8
2+	1-1/2+	1-1/2	3/8	3/8	1/2	9/16	1-3/8
2+	1-1/2+	2	3/8	3/8	11/16	13/16	1-3/8
2+	2+	2+	3/8	3/8	11/16	13/16	1-3/8
3+	1-1/2+	1-1/2	13/16	5/8	1/2	9/16	2-1/4
3+	2+	2+	13/16	5/8	11/16	13/16	2-1/4
3+	3+	3+	13/16	3/4	1-1/16	1-5/16	2-1/4

ISOLATEK INTERNATIONAL — Types 300, 300AC, 300ES, 300HS, 300N, SB, 400, 400AC, 400ES, 3000 or 3000ES; Types M-II, TG, and M-II/P

8. **Metal Lath** — (Optional, Not Shown) — 3/8 in. diamond mesh, expanded steel weighing 1.7 lb per sq yd, secured to one side of joist using No. 16 SWG steel tie wire located at the midheight of every other web.

8A. **Glass Fiber Mesh** — (Not Shown) — As an alternate to metal lath (Item 8), min 3/32 in. square mesh, coated fiberglass scrim fabric, weighing a min of 1.9 oz/sq yd, shall be attached to one side of each joist web member. The method of attachment must be sufficient to hold the mesh and fire protection material during application and curing of the material. An acceptable method of attaching the mesh is by embedding the mesh in min 1/4 in. long beads of hot melted glue. The beads of glue shall be spaced max 12 in. OC along the top chord of the joists. Another method of attachment is by the use of 1-1/4 in. long 1/2 in. wide hairpin clips formed from 0.064 in. diam steel wire, alternating from top to bottom of the joist web member.

9. **Trench Header** — (Bearing the UL Listing Mark) — (Optional, Not Shown) — Constructed of steel and provided with metal edge screeds. When the trench header is located near a support, the load carrying capacity of the span may be based on the allowable moment or shear stress of the floor units at the edge of the trench header away from the support or on the allowable composite moment or shear capacity of the slab at the center of the span, whichever governs.

Figure 4: *UL Design D759*

CHANNELS- C-SHAPES

METRIC					IMPERIAL				
	Column		Beam			Column		Beam	
SIZE (mm x kg/m)	M/D	Heated Perimeter (m)	M/D	Heated Perimeter (m)	SIZE (in. x lb./ft.)	W/D	Heated Perimeter (in.)	W/D	Heated Perimeter (in.)
C150 x 19	38.1	0.498	42.7	0.444	C6 x 13	0.657	19.8	0.739	17.6
x 16	32.5	0.492	36.2	0.441	x 10.5	0.544	19.3	0.607	17.3

http://www.adfire.com/media/1135/md-wd-table-june-7-2007.pdf

Figure 5A: *Heated Perimeter for C6x13*

ANGLES (4 sides exposed) continued...

METRIC			IMPERIAL		
	4 sided			4 sided	
SIZE (mm x mm x mm)	M/D	Heated Perimeter (m)	SIZE (in. x in. x in.)	W/D	Heated Perimeter (in.)
L51 x 51 x 9.5	33.7	0.204	L2 x 2 x 3/8	0.589	7.89
x 7.9	28.6	0.204	x 5/16	0.499	7.89
x 6.4	23.2	0.204	x 1/4	0.407	7.89

Figure 5B: *Heated Perimeter for L2x2x ¼*

N759

Unrestrained Beam

All-Fluted Deck
Lightweight and Normal Weight Concrete
CAFCO® FENDOLITE® M-II, TG & ISOLATEK® Type M-II, TG

ASTM Desig.	W/D	Metric Desig.	M/D	Hp/A	1-Hour	1-1/2 Hour	2-Hour	3-Hour	4-Hour
W12 x 336	4.85	W310 x 500	286.2	27.6	5/16	3/8	3/8	3/8	7/16
305	4.49	454	264.9	29.8	5/16	3/8	3/8	3/8	7/16
279	4.19	415	247.2	32.0	5/16	3/8	3/8	3/8	1/2
252	3.84	375	226.6	34.9	5/16	3/8	3/8	3/8	1/2
230	3.55	342	209.5	37.7	5/16	3/8	3/8	3/8	9/16
210	3.27	313	192.9	41.0	5/16	3/8	3/8	7/16	9/16
190	3	283	177.0	44.7	5/16	3/8	3/8	7/16	5/8
170	2.72	253	160.5	49.3	5/16	3/8	3/8	1/2	11/16
152	2.45	225	144.6	54.7	5/16	3/8	3/8	1/2	3/4
136	2.23	202	131.6	60.1	5/16	3/8	3/8	9/16	3/4
120	1.99	179	117.4	67.3	5/16	3/8	3/8	5/8	7/8
106	1.77	158	104.4	75.7	5/16	3/8	7/16	11/16	15/16
96	1.61	143	95.0	83.2	5/16	3/8	1/2	11/16	1
87	1.47	129	86.7	91.1	5/16	3/8	1/2	3/4	1-1/16
79	1.34	117	79.1	100.0	5/16	3/8	1/2	13/16	1-1/8
72	1.23	107	72.6	108.9	5/16	7/16	9/16	7/8	1-3/16
65	1.11	97	65.5	120.7	5/16	7/16	5/8	15/16	1-1/4
58	1.1	86	64.9	121.8	5/16	7/16	5/8	15/16	1-1/4
53	1.02	79	60.2	131.4	5/16	7/16	5/8	15/16	1-5/16
50	1.06	74	62.5	126.4	5/16	7/16	5/8	15/16	1-5/16
45	0.97	67	57.2	138.1	5/16	1/2	5/8	1	1-3/8
40	0.86	60	50.7	155.8	5/16	1/2	11/16	1-1/16	1-1/2
35	0.81	52	47.8	165.4	5/16	1/2	11/16	1-1/16	1-1/2
30	0.69	45	40.7	194.2	3/8	9/16	13/16	1-3/16	1-11/16
26	0.61	39	36.0	219.6	3/8	5/8	13/16	1-1/4	1-3/4
22	0.62	33	36.6	216.1	3/8	5/8	13/16	1-1/4	1-3/4
19	0.54	28	31.9	248.1	7/16	5/8	7/8	1-3/8	1-7/8
16	0.45	24	26.6	297.7	7/16	11/16	15/16	1-7/16	2-1/16
14	0.4	21	23.6	335.0	1/2	3/4	1	1-1/2	2-1/8

Figure 5C: *Protection Thickness for W12x14 Beam*

Designation Imperial (in x lb/ft)	Depth h (in)	Width w (in)	Web Thickness t_w (in)	Flange Thickness t_f (in)	Sectional Area (in^2)	Weight (lb_f/ft)	Static Parameters			
							Moment of Inertia		Elastic Section Modulus	
							I_x (in^4)	I_y (in^4)	S_x (in^3)	S_y (in^3)
W 12 x 16	11.99	3.990	0.22	0.265	4.7	16	103	2.8	17.1	1.4
W 12 x 14	11.91	3.970	0.2	0.225	4.2	14	88.6	2.4	14.9	1.2

Figure 5D: *Properties for W12x14 Beam*

Table 1: Comparison between Tested and Proposed assemblies

Element	UL Assembly Design No. N759	Proposed Assembly
1. Steel Beam	Steel Beam; W12x14 (W/D =0.4 – Beam-Fig. 5C)	C6x13 & L2x2x¼ Member (W/D=0.89) (see Fig 6) (Equivalent)
2. Steel Floor And Form Units	1-1/2, 2 or 3 in. deep galv units. Min gauges are 22 MSG for the fluted and 20/20 MSG for the cellular units. The units may be blended alternating one cellular unit to one or more fluted units.	1½"- B-36, 20 Ga Steel Decking. (Equivalent)
3. Joint.Cover	Burlap tape applied with a bituminous adhesive	N/A to evaluation
4. Shear Connector Studs (optional)	Optional	N/A to evaluation
5. Welded Wire Fabric	6x6-W1.4xW1.4. When using steel joists, the min welded wire fabric should be 6x6-W2.9xW2.9.	6x6-W1.4xW1.4. (Equivalent)
6. Normal Weight Or Lightweight Concrete	4" total, Normal weight concrete: carbonate or siliceous aggregate, 150 plus or minus 3 pcf unit weight, 3000 psi compressive strength, vibrated. Lightweight aggregate concrete: expanded shale, clay or slate aggregate by rotary-kiln method, 112 plus or minus 3 pcf unit weight, 3000 psi compressive strength, vibrated, 4 to 7 percent entrained air.	3.5" (total) Normal weight concrete: carbonate or siliceous aggregate, 150 plus or minus 3 pcf unit weight, 3000 psi compressive strength, vibrated. (0.5" thinner Concrete, see summary)
7. Spray-Applied Fire Resistive Materials	2 hr fire protection – 1" (Fig. 5C)	2 hr fire protection – **1-1/8"** (1" overspray onto Concrete) (Higher Protection)
Fire-Resistance Rating	**2-Hour**	**2-Hour (minimum)**

5.1 W/D Comparison to W-Beam

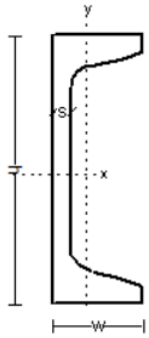
The proposed steel members have a higher inherent fire resistance than the tested W beam, while evaluated through the W/D comparison. We have compared the members as proposed, along with the UL tested configuration. See Fig. 6 below.

Effective Heated Perimeter Heated- C6x13(W/L2x2x¼) - (19.8(fig.5)-(Concrete)-2") = (19.8-(3.5)-2)=14.3

Beam	Weight(lb/ft)	Perimeter D	W/D
W12 x 14	14	34.6 (3 Sides)	0.404
C6x13	13	14.3 (3.5 Sides)	
L2x2x ¼	3.2	3.95(fig. 5.5) (2 sides)	
(Combined C6x13, L2x2x ¼) (See Fig.2)	(16.2)	(18.25)	(0.89)
L3x3x ¼ (Fig. 3)	4.9	3.25 (1 Sides)	1.51

Fig.6. W/D ratios

When evaluated against the UL test. The proposed members have a larger W/D ratio than the tested beam.



Properties in imperial units of American Steel C Channels are indicated below.

Designation	Dimensions					Static Parameters			
						Moment of Inertia		Elastic Section Modulus	
Imperial (in x lb/ft)	Depth - h - (in) (mm)	With - w - (in) (mm)	Web Thickness - s - (in) (mm)	Sectional Area (in^2)	Weight (lb_f/ft)	I_x (in^4)	I_y (in^4)	S_x (in^3)	S_y (in^3)
C 6 x 13	6	2.157	0.437	3.83	13	17.4	1.05	5.80	0.64

Fig.7. Table for C-Channel member physical properties

6 SUMMARY

While evaluating fire resistance requirement of members, different sized beams 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 inherent fire resistance of a member. Lower W/D ratios correspond with thinner steel members that will be subject to earlier failure when heated.

During this evaluation, a UL test D759 was considered, the test assembly supports a concrete deck above the beam. The proposed C-Channel (combination) member is heated on three sides (Top, Bottom and a partial side). We proposed to compare C-Member (combined) assembly with a fully loaded, restrained W12x14 beam assembly of UL D759 (heated on lower 3 sides.)
During the complete evaluation, we also included the L3x3x¼. this L-member is concealed between the Concrete wall and the floor, with only the bottom face exposed.
From the analysis we see that W/D ratio of proposed assemblies greatly exceed the tested assembly (W12 x 14 beam)
0.89 vs 0.4 (+122%) for the C-Channel and 1.51 vs 0.4 (+277%) for the L-Member. Therefore, each member, as exposed to fire, has a much higher fire resistance. The SFRM required per the proposed members (Table 1) for 2-hr fire resistance rating will be used for each of these assemblies. One item to note, the concrete for the proposed assembly is 0.5" thinner than the tested assembly. This deficit is made up through the higher calculated member W/D ratios of the proposed members compared to the tested UL Design thickness. As a conservative measure, an additional 1/8" of SFRM has been added to provide superior protection.

The comparison is conservative, as the UL tested beams lower flange (exposed on all sides to heat) is 0.225 inches, this is thinner member than any portion of either proposed assembly steel. Additionally, the proposed members will be heated on a limited percentage of the perimeter and the concrete is adjacent to the member rather than above as in the UL test. The concrete will draw heat from the side of the steel member, theoretically lowering the temperature of the critical lower flange and thereby increasing the fire resistance time for the member failure under loading.

Note: Overspray of SFRM, 1" onto the concrete or a ¼" bead fire caulking at the interface (Top Surface) is required to ensure the steel is thoroughly protected.

7 CONCLUSION

We have reviewed the proposed members against a steel beam, ASTM E119- UL test. As listed above, the UL beam test used for comparison, exposed the beam to heat from below with a narrow concrete interface above. This provides a conservative approach for our evaluation as described in the summary.

The proposed protection is conservative as the members are heavier and provide greater resistance to heating than the lighter UL tested beam assembly (W12x14), exposed to heat on 3 sides..

The proposed assembly members protected by the SFRM with a minimum thickness as identified in this EJ will provide protection for a 2-hr rating based on the comparison to the UL testing and our analysis. The proposed protection will meet the minimum 2-hr fire resistance rating per the OSSC for this application.

Franklin Callfas
Principal/Fire Protection Engineer
Code Unlimited