Press Blocks EJ#3
Engineering Judgment Report
Fire Rating of Steel Beams Protected with Intumescent Coating

Client Name: Craig Figgins
Technical Sales Representative
Carboline Company
Client Address: 11211 NW 38th AVE
Vancouver, WA. 98685
Date: 2/26/2020

Table of Contents

1 PROJECT OVERVIEW

The Press Blocks Half Block Office is an existing mixed-use project being developed in Portland, Oregon. It is eight stories of Type I-A construction with fire sprinkler protection throughout.

Code Unlimited is addressing the concerns of the project regarding the IFRM protection of steel roof beams. The design includes the following structural member: W10x12 Beam. Code Unlimited has been asked to provide an Engineering Judgment (EJ) letter for the IFRM application thickness when compared to ASTM E119/UL listed designs.

2 APPLICABLE CODES, STANDARDS, AND GUIDES

2019 Oregon Structural Specialty Code (OSSC).

2019 Oregon Fire Code (OFC)

3 DISCUSSION

3.1 Approach

- The proposed beam assembly has been analyzed in accordance with 2019 OSSC §703.3 Alternative Methods for Determining Fire Resistance.
- The beam assembly is compared side-by-side to a rated assembly tested by Underwriters Laboratories (UL), Designs N645 and Y642.

4 PROPOSED DESIGN

Steel beams frame the roof system and are protected by intumescent coating (IFRM) where they are visible from the floor. One-hour fire ratings are required for these beams where they are supporting the roof. By incorporating the column design and comparing the data for similar size tested beans it can be shown that with a 26% decrease of intumescent coating from the column protection requirements will achieve the same 1-hour fire rating for a beam. The following beam size and rating requirement is proposed to frame the roof:

- W10x12, -1-HOUR

Intumescent coating will be applied to the beams in accordance with UL design thickness required to achieve a 1-hour fire-rating as required by OSSC

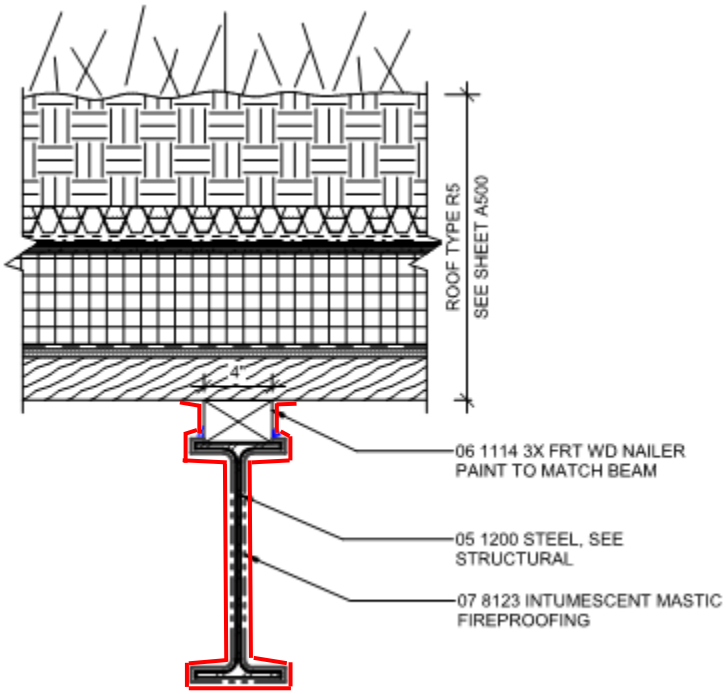


Figure 1: Proposed design (typ). Intumescent fireproofing is shown with a minimum <u>1/2" overlap onto the roof decking</u>

5 ASSEMBLY ANALYSIS

IFRM will be applied to the beams in accordance with UL N645 with the thickness required to achieve a 1-hour rating. The proposed design is compared to UL N645 shown in Fig.2 and analyzed in Graph below (Fig. 3b). Limited Testing is provided for the proposed Carboline intumescent coating, however by evaluating test data with slightly larger beams, it can be shown that incorporating the column design test will provide a conservative protection basis. It can be shown that a decrease of 26% thickness from the column design application would protect the beam for an equivalent 1-hour fire rating. The comparison table below details how the ratio of protection thicknesses corresponds between UL tests N645 and Y642. N645 (beam design) has limited testing for beams and no testing below a W/D ratio of 0.67, while the project is utilizing beams with W/D ratios of 0.4 (W10x12). When calculated against a Y642 tests for a similar sized steel column, the intumescent thickness for the W10x12 protection would 26% thicker than required for a beam. (Fig. 3a)

Note: Primer (Carboline Rustbond) shall be continuous around the entire beam and continuing over the wood blocking and overlapping 1" onto the roof decking. Primer (Carboline Carbocrylic 3359-DTM) is listed as an approved topcoat.

Design No. N645

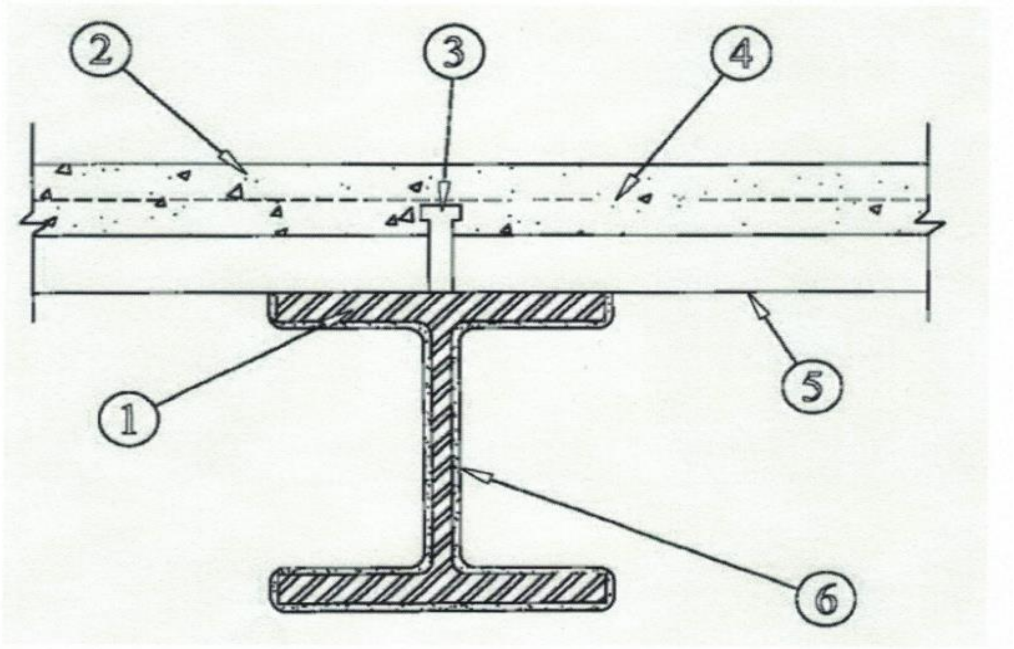
August 18, 2017

Restrained Beam Ratings — 1, 1-1/2, 2, 3 and 4 Hr (See Item 6)

Unrestrained Beam Ratings — 1, 1-1/2, 2 and 3 Hr (See Item 6)

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

*** 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 Beam —** Wide flange steel beams with the minimum sizes shown in the tables below. Beams shall be free of dirt, loose scale and oil. Beams shall be primed with 0.003 in. dry film thickness of modified alkyd, epoxy, organic zinc or inorganic zinc based primer.

2. **Normal Weight or lightweight Concrete —** Compressive strength 3000 psi. For normal weight concrete either carbonate or siliceous aggregate may be used. Unit weight 148 lbs/cu ft for normal weight concrete and 110 lbs/cu ft for lightweight concrete.

3. **Shear Connector—(Optional) —** Studs, 3/4 in. diam headed type or equivalent per AISC specifications welded to the top flange of beam through the steel floor units.

4. **Welded Wire Fabric —** 6x6-10/10 SWG.

5. **Steel Floor and Form Units —** 1-1/2, 2 or 3 in. deep fluted, cellular or corrugated units welded to beam. Fluted units shall be used with the 3 hour unrestrained and 4 hour restrained ratings.

6. **Mastic and Intumescent Coating* —** Coating spray, brush or trowel applied directly from containers to desired thickness. See table below for appropriate final dry thickness. Flutes above beam to be completely filled with mineral wool insulation having a minimum density of 6 lbs/cu ft or the top flange of the beam shall be protected with the same thickness of coating as required on the beam.

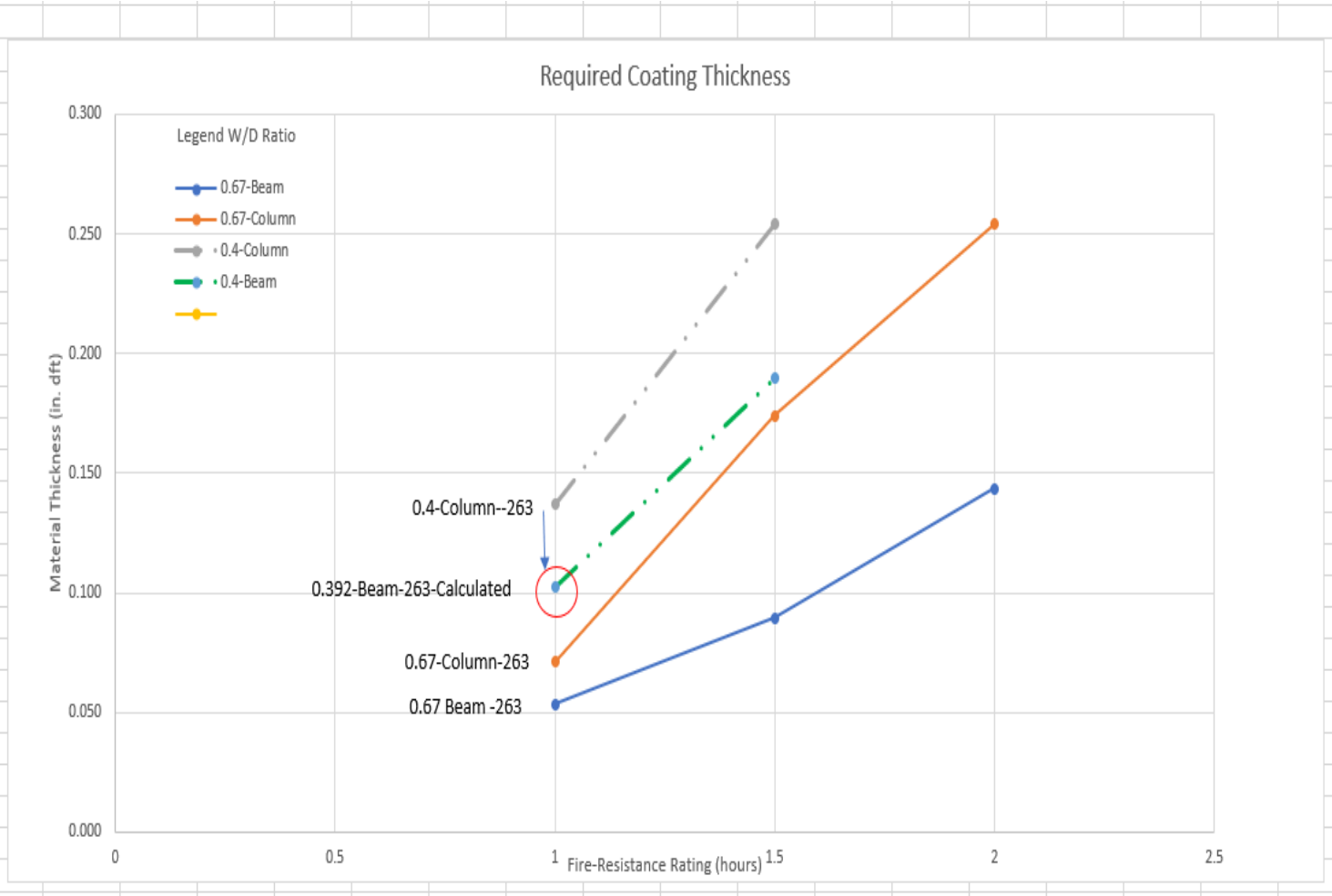
UNRESTRAINED BEAM RATINGS

STEEL SIZE	W/D	1 HR	1-1/2 HR	2 HR	3 HR
W6x16	0.67	0.053	0.089	0.143	NR
W8x21	0.67	0.053	0.089	0.143	NR
W18x35	0.67	0.053	0.089	0.143	NR
W6x20	0.68	0.053	0.089	0.143	NR
W12x30	0.69	0.053	0.089	0.143	NR
W8x24	0.7	0.053	0.089	0.143	NR

Figure 2: UL N645

	Beam W/D Ratio	Fire-Resistance Rating (hours)	Material thickness (in. dft)	Fire Test ASTM E-119 (UL Design No.)
Wide Flange	0.67-Beam	1	0.053	N645
	W6x16 Beam	1.5	0.089	N645
		2	0.143	N645
	W21x44-Column			
	0.67-Column	1	0.071	Y642
		1.5	0.174	Y642
		2	0.254	Y642
	0.4-Column	1	0.137	Y642
	W12x14-Column	1.5	0.254	Y642
	0.4-Beam	1	0.102	
	W10x12-Beam	1.5	0.189	Calculated
				Calculated

Figure 3a: Comparison Table-UL N645 vs Y642



BEAM W/D RATIO	FIRE-RESISTANCE RATING (HOURS)	MATERIAL THICKNESS (IN. DFT)
1. W6x16 Beam (0.67)	N645-1 Hr.	0.0534
2. W21x44-Column (0.67)	Y642-1 Hr.	0.071
3. W10x12-Beam (0.4)	Calculated 1 Hr.	0.102
4. W12x14-Column (0.4)	Y642-1 Hr.	0.137

Figure 3b: Comparison Table-UL N645 vs Y642

IMPERIAL				
	Column		Beam	
SIZE (in. x lb./ft.)	W/D	Heated Perimeter (in.)	W/D	Heated Perimeter (in.)
W 10 x 112	1.81	61.9	2.17	51.5
x 100	1.64	61.0	1.97	50.7
x 88	1.45	60.8	1.74	50.5
x 77	1.28	60.1	1.54	49.9
x 68	1.15	59.2	1.38	49.1
x 60	1.01	59.2	1.22	49.1
x 54	0.922	58.6	1.11	48.6
x 49	0.840	58.3	1.01	48.3
x 45	0.888	50.7	1.06	42.6
x 39	0.780	50.0	0.929	42.0
x 33	0.661	49.9	0.786	42.0
x 30	0.699	42.9	0.809	37.1
x 26	0.612	42.5	0.708	36.7
x 22	0.523	42.1	0.606	36.3
x 19	0.538	35.3	0.607	31.3
x 17	0.482	35.3	0.543	31.3
-	-	-	-	-
x 15	0.429	35.0	0.484	31.0
x 12	0.347	34.6	0.392	30.6

Figure 4. W/D Ratio table for W10x12 Beam

6 CONCLUSION

The proposed roof beam assembly (see **Attachment #1**) has been compared to UL listed designs UL N645 and Y642. The proposed beam assemblies will meet the required 1-hr fire resistance requirement if protected as calculated per Fig. 3a. As a conservative measure, in the absence of direct ASTM E119 testing for the beam design, it is recommended to apply the column design protection thickness (UL Y642), which is 26% thicker protection than calculated for N642 (beam design). Based on the review of the Carboline Thermosorb 263 UL test data provided in the tables and graph above, the Y642 thickness can be utilized for these beams (137 mil applied protection). The coating thickness shall continue over the wood blocking and onto the roof decking.

Therefore, the proposed design for the roof framing beam assembly, protected with Intumescent paint, will meet the 1-hr rating requirements prescribed by code as compared and detailed in this letter.

Franklin Callfas

Principal/Fire Protection Engineer

Code Unlimited