Block 8L

Beam at 2 Hour Rated Shaft Wall at Floor/Ceiling Assembly Analysis

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Project Overview

Ankrom Moisan Architects is designing Block 8L in the city of Portland, Oregon. The building is a Type IIIB construction. The wood beam at some locations is partially enclosed in a rated shaft wall which is required to have 2-hour fire protection.

Code Unlimited has been asked to provide analysis of the proposed beam in shaft wall assembly to ensure that at least 2-hour structural stability will be provided to the beam as required by code.

Applicable Codes

2014 Oregon Structural Specialty Code (OSSC)
2014 Oregon Fire Code (OFC)

Approach

- The existing wall assembly has been analyzed in accordance with OSSC §703.3 Alternative Methods for Determining Fire Resistance.
- The beam in shaft wall assembly shall be established as having 2 hour fire-resistance, as required by OSSC 708.
- A more detailed analysis of the assembly follows this section. Each analysis consists of a graphical and tabular comparison of assemblies, followed by a narrative of notable assembly differences and an explanation of fire resistance equivalency.
Proposed Designs
Assembly Analysis

The proposed wall assembly was compared to UL BW-S-0016, tested for 2 hour fire resistive construction (pictured below).

<table>
<thead>
<tr>
<th>Element</th>
<th>BW-S-0016</th>
<th>Proposed Wall Assembly</th>
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</thead>
<tbody>
<tr>
<td>1. Floor Assembly</td>
<td>Min 4-1/2 in. thick reinforced lightweight or normal weight structural concrete. Floor may also be constructed of any min 6 in. thick UL Classified hollow-core Precast Concrete Units. <em>(Provides floor assembly rating)</em></td>
<td>Min 4-1/2 in. thick reinforced lightweight or normal weight structural concrete. Floor may also be constructed of any min 6 in. thick UL Classified hollow-core Precast Concrete Units. <em>(Meets floor assembly requirement)</em></td>
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2. Shaft Wall Assembly

A. **Steel Floor Runner** — "J"-shaped runners, min 2-1/2 in. (64 mm) deep, with unequal legs of 1 in. (25 mm) and 2 in. (51 mm), fabricated from min 24 MSG galv steel. Runners positioned with short leg toward finished side of wall. Runners attached to structural supports with steel fasteners located not greater than 2 in. (51 mm) from ends and not greater than 24 in. (610 mm) OC.

B. **Studs** — "C-H", "E" (back-to-back) or "C-T"-shaped studs, min 2-1/2 in. (64 mm) deep, fabricated from min 25 MSG galv steel. Cut to lengths 3/8 to 1/2 in. (10 to 13 mm) less than floor-to-ceiling height and spaced 24 in. (610 mm) OC.

C. **Gypsum Board** — 1 in. thick gypsum liner panels and 1/2 in., 5/8 in. or 3/4 in. (13, 16 or 19 mm) thick gypsum panels installed as specified in the individual U400 or V400 Series shaft wall designs in the UL Fire Resistance Directory.

(Provides 2 hour rating)

3. Fill, Void or Cavity Material-Sealant

Max separation between top of floor and bottom of gypsum board is 1/2 in. (13 mm). Min 1/2 in. (13 mm) thickness of fill material installed on finish side of the wall between the bottom of the gypsum board and the top of the concrete floor.

Fire Resistance

2-hour

Char Analysis

The cross-sectional area of the glulam beam unimpaired by fire exceeds the cross-sectional area required to provide structural support based on structural engineering analysis.
An analysis was performed at the following three locations of the beam:

1. Exposed side of beam above ceiling
2. Shaft side of beam
3. Bottom of beam/Wall header


1. Protection of exposed above ceiling analyzed by fire resistance analysis and char rate calculations.
   a. 1 layers of 5/8" gypsum Type ‘X’ provides 40 minutes of fire rating (OSSC 722.2.1.4(a))
   b. Char rate analysis
      i. Base Formula: \( c = 2.58 \beta_n t^{0.813} \)
      ii. Values
         \( \beta_n \) is charring rate = 0.635mm/m (1.5 in/hr)
         \( t \) is time = 120min – 40 min (5/8”gyp) = 80 minutes (1.33 hour)
         \( c \) is char thickness in millimeters
      iii. Calculation:
         \( c = 2.58 \beta_n t^{0.813} \)
         \( c = 2.58 \times (0.635) \times (80)^{0.813} \)
         \( c = 57.8\text{mm or 2.3 inch} \)

2. Protection of beam at shaft side analyzed by fire resistance analysis and char rate calculations.
   a. 1 layers of 1” gypsum Type ‘X’ provides 50 minutes of fire rating (OSSC 722.2.1.4(a))
   b. Char rate analysis
      i. Base Formula: \( c = 2.58 \beta_n t^{0.813} \)
      ii. Values
$\beta_n$ is charring rate = 0.635mm/m (1.5 in/hr)

t is time = 120min - 50min (1"gyp) = 70 minutes (1.167 hour)

c is char thickness in millimeters

iii. Calculation:

\[ c = 2.58 \beta_n t^{0.813} \]
\[ c = 2.58 (0.635)(70)^{0.813} \]
\[ c = 51.8 \text{mm or 2 inch} \]

3. Protection of beam in-wall analyzed by fire resistance analysis.
   a. 1 layers of 1" gypsum Type 'X' provides 50 minutes of fire rating (OSSC 722.2.1.4(a))
   b. Char rate analysis
      i. Base Formula: \[ c = 2.58 \beta_n t^{0.813} \]
      ii. Values
         \[ \beta_n \text{ is charring rate} = 0.635\text{mm/m (1.5 in/hr)} \]
         \[ t \text{ is time} = 120\text{min - 50min (1"gyp)} = 70 \text{ minutes (1.167 hour)} \]
         \[ c \text{ is char thickness in millimeters} \]
      iii. Calculation:
         \[ c = 2.58 \beta_n t^{0.813} \]
         \[ c = 2.58 (0.635)(70)^{0.813} \]
         \[ c = 51.8 \text{mm or 2 inch} \]

Based on the above fire resistive rating and char depth analysis, it was determined that a two hour fire exposure will result in the loss of usable material (as shown in the shaded area of the drawings above) of the glulam beam.

The unaffected cross sectional area of the glulam beam is determined to be X and therefore exceeded the required amount set forth by the structural engineer.
Conclusions

The proposed beam in wall assembly provides structural stability for 2 hour fire duration and exceeds the minimum fire resistance requirements of a 2 hour fire rated UL BW-S-0016 assembly for exposure to fire.

Therefore it is our opinion that the proposed design for the beam in shaft wall assembly at Block 8L will provide at least 2-structural stability for the beam.

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