Block 8L

Column in 2 Hour Shaft Wall 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 IIB construction. The wood column at some locations is partially enclosed in a rated shaft wall which is required to have 2-hour fire protection since it is outside of the wall membrane.

Code Unlimited has been asked to provide analysis of the proposed column in shaft wall assembly to ensure that at least 2-hour fire-resistance rating will be provided to the column 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 column in shaft wall assembly shall be established as having 2 hour fire-resistance, as required by OSSC 714.
- 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 Design

MINIMUM (2) 2x WALL FRAMING BOTH SIDES

(2) LAYERS 5/8" TYPE 'X' GYPSUM

WD COLUMN
CALCULATED CHAR RATE:
C = 2.58 Btu/hr-ft
PER HOUR CHAR RATE DEPTH
CALCULATED AS SHOWN

NOTE:
1. COLUMN 2 HOUR RATED ASSEMBLY PROVIDED WITH COMBINATION GYPSUM AND CHARGE PIPE
Assembly Analysis

The proposed wall assembly was compared to UL BW-S-0016, tested for 2 hour fire resistive construction (pictured below).
<table>
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<tr>
<th>Element</th>
<th>BW-S-0016</th>
<th>Proposed Wall Assembly</th>
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</table>
| **1. Floor Assembly**         |           | 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.  
*(Provides floor assembly rating)* |
|                               |           | 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.  
*(Meets floor assembly requirement)* |
| **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)* |
|                               |           | 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. Column — __X__  
C. Gypsum Board (shaft side)— 2 layers 5/8" in. thick gypsum board liner panels.  
*(2 hour rating, see char analysis of column)* |
| **3. Fill, Void or Cavity Material-Sealant** |           | Max separation between top of floor and bottom of gypsum board is 1/2in. (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. |
|                               |           | Max separation between top of floor and bottom of gypsum board is 1/2in. (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. |

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<th>Fire Resistance</th>
<th>2-hour</th>
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**Char Analysis**

The cross-sectional area of the glulam column 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 column:

1. Exposed interior side of the column
2. Sides of column located in wall
3. Shaft side of column


1. Protection of the exposed side of column on the interior side analyzed by char rate calculations.
   a. 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 = 120 minutes (2 hour)
         - $c$ is char thickness in millimeters
      iii. Calculation:
         - $c = 2.58 \times 0.635 \times 120^{0.813}$
         - $c = 2.58 \times 76.2\times 3.16$
         - $c = 80.3\text{mm or } 3.16 \text{ inch}$

   2. Protection of the portion of column in wall is protected by:
      a. 2 layers of 5/8” gypsum wallboard Type ‘X’ provides 80 minutes (2 x 40 minutes) of
Block 8L Column in 2 Hour Shaft Wall Assembly Analysis

- Protection per OSSC 721.2.1.4(2).
  - (2) 2 x members provides 2 hour protection of column based on industry standard char rate of 1.5 inches per hour.
  - Fire Caulk protects joint at column /gypsum wallboard connection exceeding 2 hours.

3. Protection of the column on the shaft side analyzed by fire resistance analysis and char rate calculations.
   a. Protection of the column is protected by
      i. 2 layers of 6/8" gypsum wallboard Type ‘X’ provides 80 minutes (2 x 40 minutes) of protection per OSSC 721.2.1.4(2).
   b. Char rate analysis
      i. Base Formula: \( c = 2.58 \beta_n t^{0.813} \)
      ii. Values
          \( \beta_n \) is charring rate = 0.035 mm/m (1.5 in/hr)
          \( t \) is time = 40 minutes
          \( c \) is char thickness in millimeters
      iii. Calculation:
          \[ c = 2.58 \beta_n t^{0.813} \]
          \[ c = 2.58 (0.035)(40)^{0.813} \]
          \[ c = 32.9 \text{mm or 1.3 inch} \]

Based on the above analysis, a two hour fire exposure on the column in shaft wall will result in the loss of usable material (as shown in the shaded area of the drawings above). The unaffected area of the column in wall assembly exceeds the area required for the structural member.

Conclusions

The proposed column in shaft wall assembly will provide structural support for a 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 column in shaft wall assembly at Block 8L will meet the requirements for the installation.

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