ALTERNATIVE SOLUTION

William Griffin Community Recreation Center

woodWORKS!

HDR | CEI

GHL CONSULTANTS LTD

rjc Read Jones Christoffersen Consulting Engineers

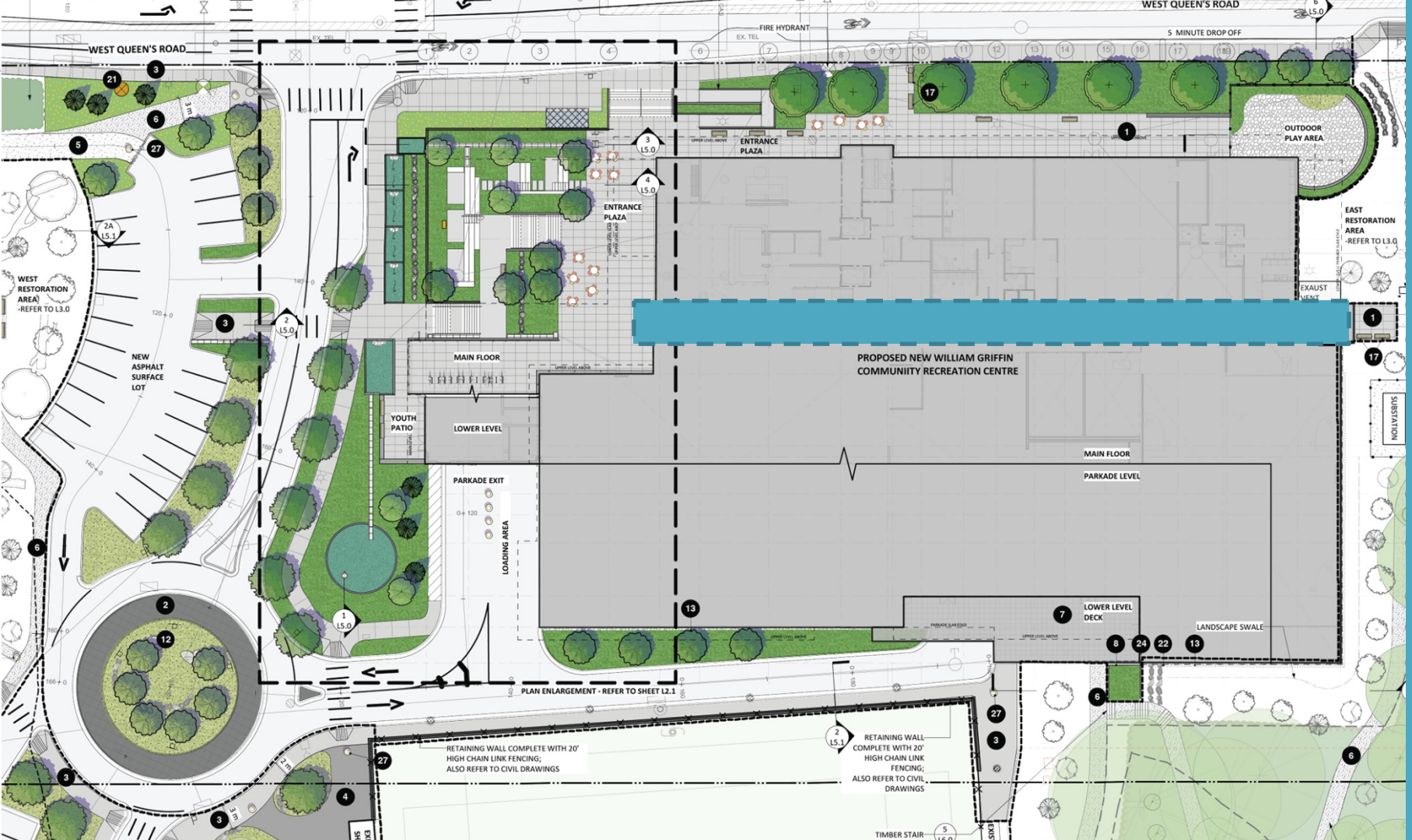
NORTH VANCOUVER DISTRICT

01 Project Overview

02 Building & Occupancy Classification

03 Alternative Solution Strategies
(Pre and Post Flashover)

William Griffin project overview


WEST QUEEN'S ROAD
WEST QUEEN'S ROAD
FIRE HYDRANT
EX. TEL
5 MINUTE DROP OFF
ENTRANCE PLAZA
ENTRANCE PLAZA
OUTDOOR PLAY AREA
EAST RESTORATION AREA -REFER TO L3.0
WEST RESTORATION AREA -REFER TO L3.0
NEW ASPHALT SURFACE LOT
MAIN FLOOR
YOUTH PATIO
LOWER LEVEL
PROPOSED NEW WILLIAM GRIFFIN COMMUNIITY RECREATION CENTRE
MAIN FLOOR
PARKADE LEVEL
PARKADE EXIT
LOADING AREA
LOWER LEVEL DECK
LANDSCAPE SWALE
SUBSTATION
PLAN ENLARGEMENT - REFER TO SHEET L2.1
RETAINING WALL COMPLETE WITH 20' HIGH CHAIN LINK FENCING; ALSO REFER TO CIVIL DRAWINGS
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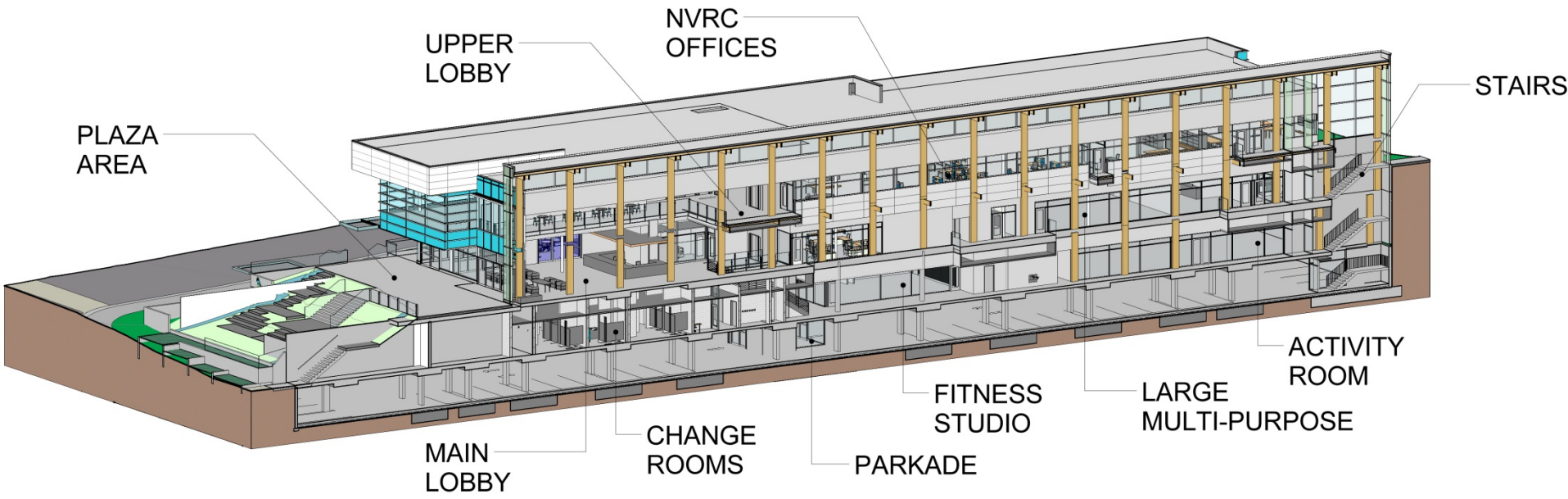
TIMBER STAIR

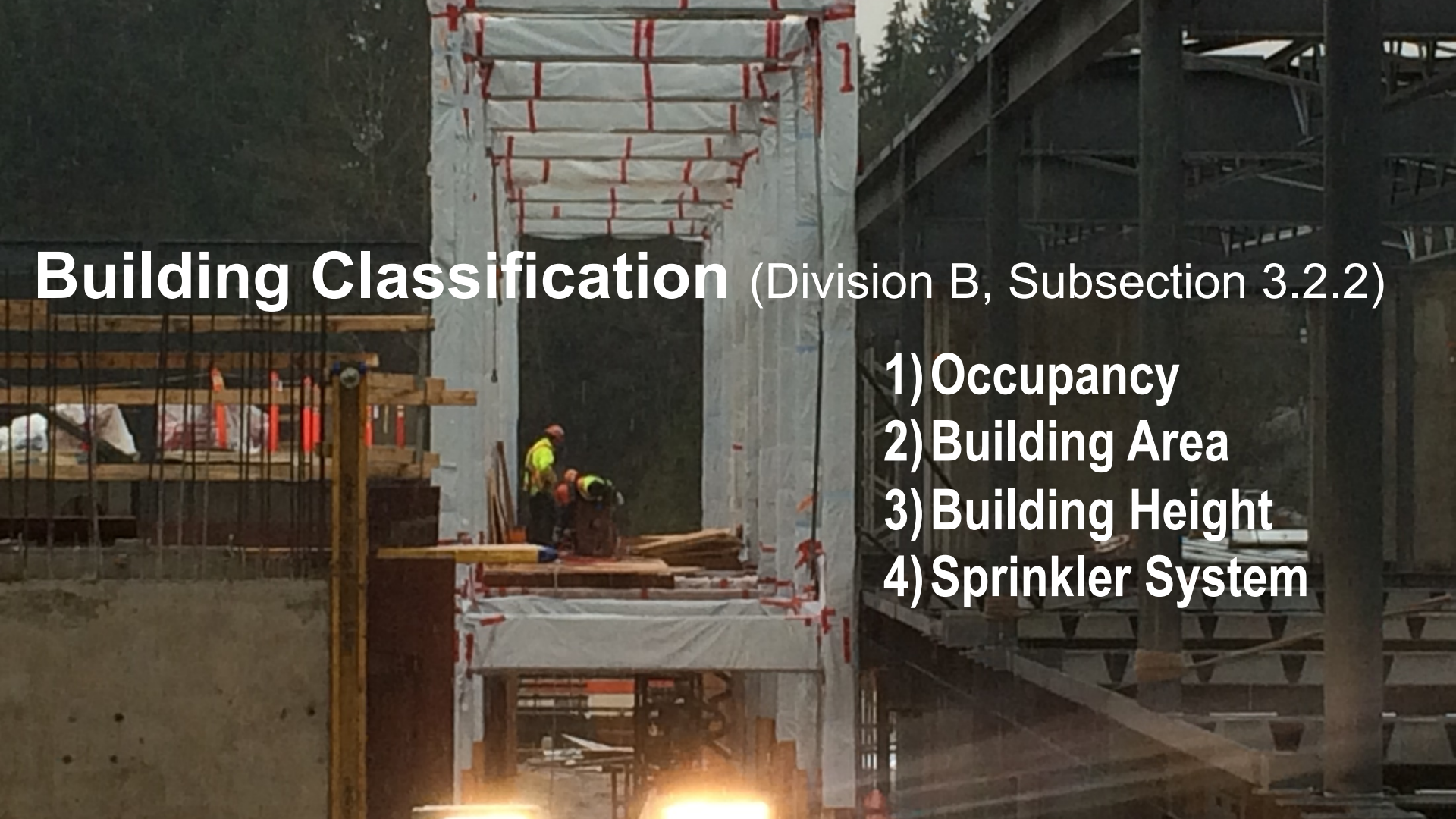
Mass Timber ‘Spine‘



Dec 22, 2015

April 26, 2016

May 10, 2016



Building Classification (Division B, Subsection 3.2.2)

1) **Occupancy**
2) **Building Area**
3) **Building Height**
4) **Sprinkler System**

Construction requirement

- Per Division B Part 3 required Article (i.e. 3.2.2.24) (base for Alternative Solution comparison)
  - Building Area — unlimited
  - Building Height — 6 storeys
  - Construction type — Non-combustible
  - Floor Assemblies — 1h fire resistance rating
  - Unoccupied Roof Assemblies — 0h fire rating

Functional Statement: to limit the severity and effects of fire or explosions so as to limit the risk of Injury OR Damage to the building due to fire or explosion impacting areas beyond its point of origin

Alternative Solution

Purpose : To demonstrate the proposed construction design will meet of exceed the level of performance attained by the Division B noncombustible design.

Division B comparison summary

	Alternative Solution (Mass Timber Construction)	Division B Compliant (Article 3.2.2.24)
Structure	GLT floor and beams and columns (A portion of Upper Level floor and roof assemblies only; rest of the building construction is noncombustible or otherwise in compliance with Subsection 3.1.5)	Light steel frame
Interior Finishes	Gypsum board; exposed GLT floor; exposed glulam beams and columns	25mm thick wood wall paneling
Sprinkler System	NFPA 13 – Light Hazard Quick response	NFPA 13 - Light Hazard Quick response
Building Area	5453m^2	Any area
Building Height	3 storeys	6 storeys
Occupancy	Group A-2	Group A-2
Exiting	Cumulative exit capacity	Exit capacity based on occupant load on a floor by floor basis

Alternative Solution development was divided into 2 Parts:
(Part 1) Pre-Flashover fire stage &
(Part 2) Post-Flashover

Pre-Flashover and Combustible Construction

1) Fire Control / Suppression
2) Fire Detection
3) Evacuation
4) Emergency Response
5) Limit Spread of Fire

Table 1. Risk Analysis Summary – Pre-Flashover

	Alternative Solution GLT Mass Timber	Division B Light Steel Frame	Relative Performance
Fire control / suppression	NFPA 13 – Light Hazard; quick response	NFPA 13 – Light Hazard; quick response	AS / Division B equivalent
Fire detection	QR Sprinkler per NFPA 13; smoke and heat per CAN/ULC-S524 below mass timber roof and floor construction.	QR Sprinkler per NFPA 13, smoke and heat per BCBC 2012	AS better
Evacuation	Cumulative exiting	Exit capacity based on occupant load on a per floor basis (non-cumulative)	AS better
Emergency response	Fire access per BCBC. Multiple access points. Building area 5453m^2. 3 storeys. Mass timber exists in the 2 level portion relative to West Queens Rd	Fire access per BCBC. Multiple access points. Building area – no limit. 6 storeys	AS better
Limit spread of fire	Wall FSR 25; some areas will have wood paneling up to 25mm therefore FSR 150; GLT timber FSR 37.5; acoustic ceiling tile FSR 25. Ceiling height of 3.4m (floor to floor of 4.5m).	Wall FSR 150; Ceiling FSR 10% at 150, 90% at 25. Compartment height of min. 2.1m.	AS / Division B equivalent

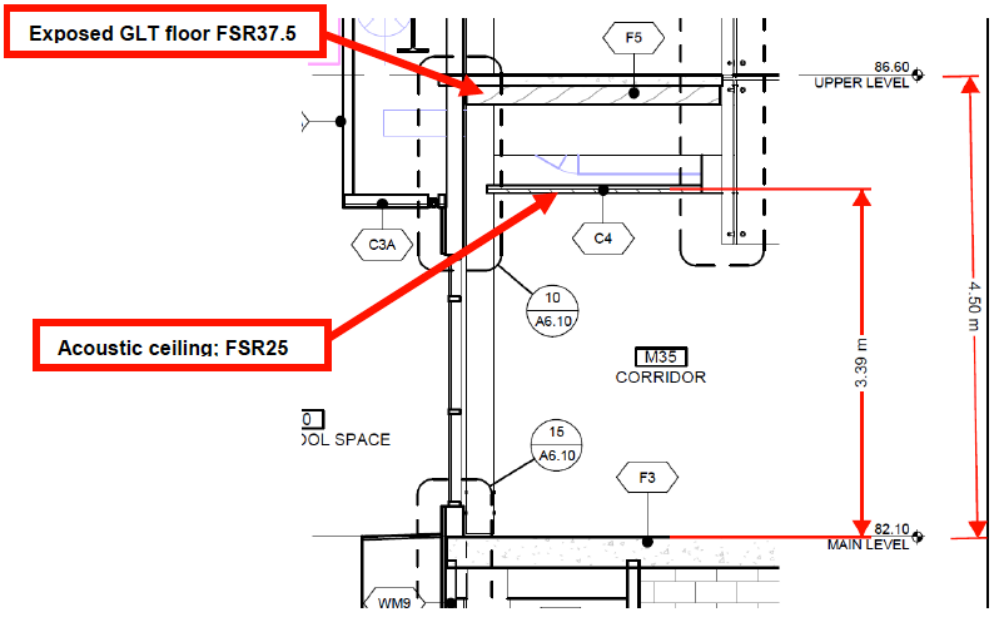


Table 8

Flame spread test results for 3-ply CLT specimens [65, 66]

CLT Assembly	Flame Spread Rating	Smoke Developed Classification
SPF – E1 Stress grade (min. 105 mm)	35	40
SPF – V2 Stress grade (min. 99 mm)	40	30

Post-Flashover and Mass Timber

1) Fire Resistance Ratings & Building performance utilizing Mass Timber (CAN/ULC –S101)
2) Charring of Mass Timber

Table 2. Risk Analysis Summary – Post-Flashover

	Alternative Solution Mass Timber	Division B Light Steel Frame
Building area	5453m^2	No limit
Building height	3 storeys	6 storeys
Floor fire-resistance rating per CAN/ULC-S101	1h	1h
Load-bearing assembly fire-resistance rating per CAN/ULC-S101	1h	1h
Means of achieving fire-resistance rating	Charring – inherent mass of timber	Reliance on gypsum board – some assemblies can achieve 1h based on single layer 15.9mm Type X GWB

2 Storey “Timber Spine” (Upper level and Roof)

- 265x608 Glulam columns @ 5m O.C

<u>Upper Level</u>

- 100mm conc topping on 175mm thk GLT Panels
- 265x494 Glulam beams

<u>Roof Level</u>

- 136mm thk GLT Panels
- 2-130x380 Glulam beams

- Architect and client wish to explore an alternate solution option through use of mass timber
- Objective is to meet/exceed Division B for non Combustible design
- Achieved through the fire resistance properties of mass timber during post flashover, principal of charring
- Charring occurs as wood burns and forms a protective, insulating layer for the unburned material
- How to determine the fire rating?

Design Criteria to achieve a 1hr fire resistance rating:

$$U_{fire} \leq \Phi \, f \, R_{fire}$$

Where

U_{fire} = the design action from the applied load at the time of the fire, which can be taken to be:

=1.0D+0.5L for non-storage, non-equipment areas, or

=1.0D+1.0L for storage and equipment areas

Φ_{fire} = the strength reduction factor for the timber material, which can be taken to be:

=1.0 based on the low probability that a structurally significant fire will develop currently with weakness in the material

R_{fire} = the nominal load capacity at the time of the fire, which is required to be calculated based on a reduction in the member's section factor due to charring

What does this mean?!

The structural capacity of the columns, beams and panels need to be still sufficient :

- Under a dead and ½ live load, load combination (in our case a 45% reduction in gravity load)
- After 1hr
- With reduced section sizes (i.e size of members have been reduced due to burning away of their material)

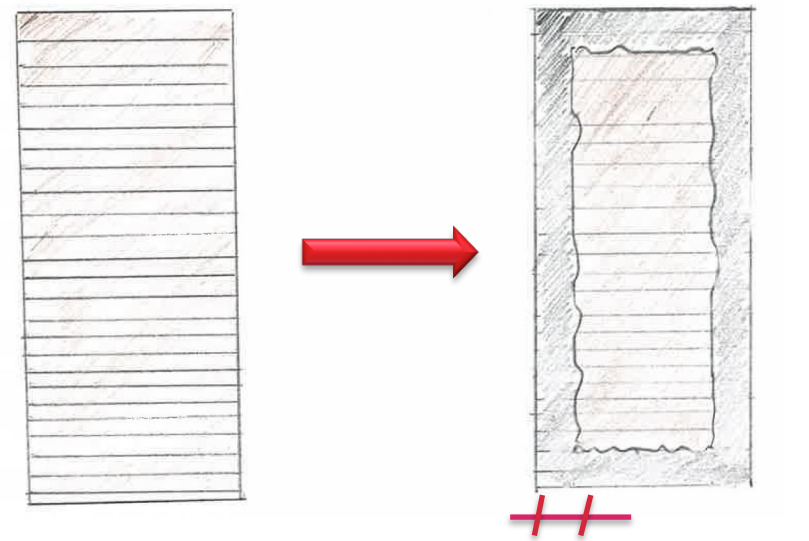
To determine reduction in member size and calculate new capacity of members:

- Char rate provided by Code Consultant (based on draft CSA 086)
- Glulam beams and columns = 0.7mm/min + 7mm zero strength layer
- GLT Floor = 0.65mm/min + 7mm zero strength layer

Column Example:

Fire on x4 sides

Char depth= (0.7mm/min x 60mins) + 7mm = 49mm



265x608 167x510

- Check capacity of revised section size for required load conditions
- Size members accordingly

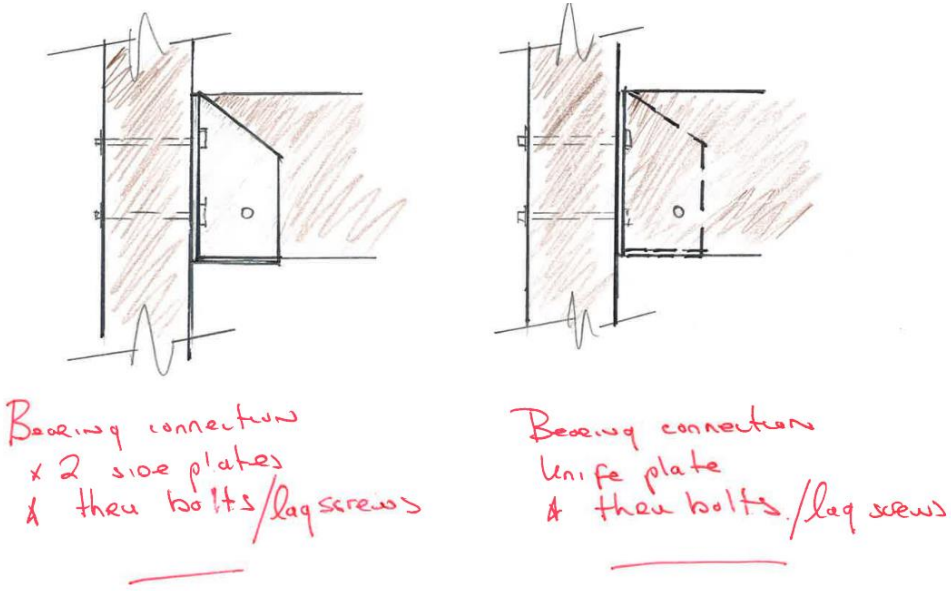
Connections

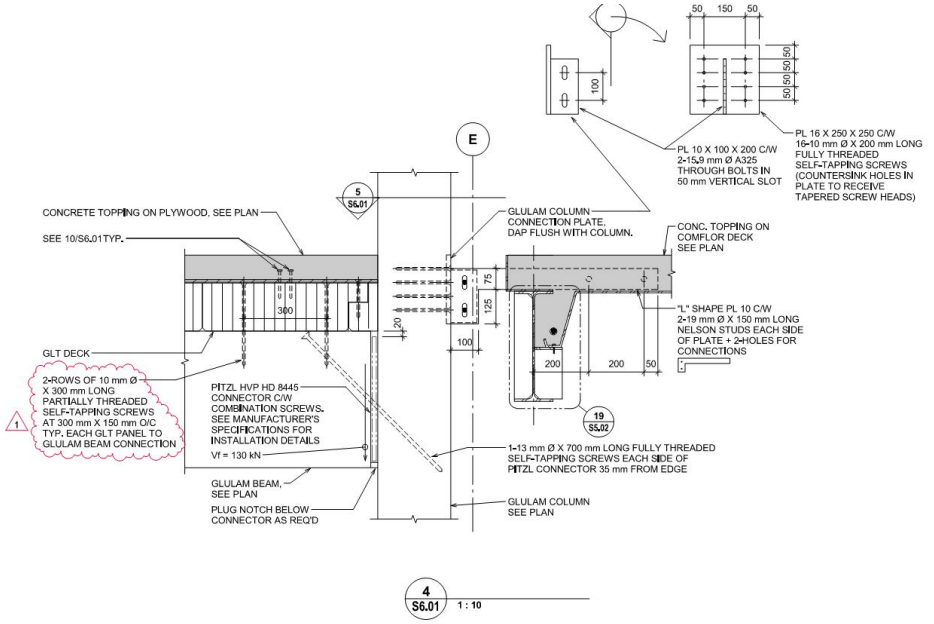
- A brief discussion

- Not explicitly addressed by Div B
- Require 1 hr rating
- Number of options
- Protection via:

    Intumescent coating

    Sprayed fire resistant material





- “Pitzl” connector used with combination screws @ 45 & 90 deg
- Housing fully dapped into end of beam
- Protection on x 3 sides
- Design accounts for loss of screws after 1hr
- Clean, simple, fast.....and architect liked it