FIRE SAFETY AND CODE CHALLENGES FOR MASS TIMBER IN CURTAIN WALL SYSTEMS

Facade Tectonics 2020 WORLD CONGRESS LOS ANGELES

Negotiating codes for a sustainable design

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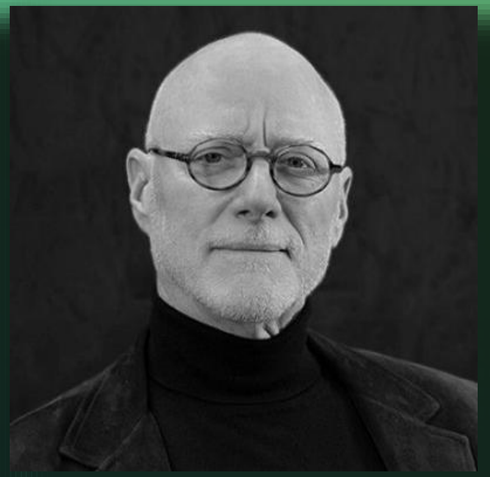

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Introduction

Why wood Curtain Wall?

New York set to ban glass skyscrapers in bid to tackle climate change

Mayor hopes new rules will cut greenhouse emissions by 30 per cent

Chiara Giordano | Tuesday 23 April 2019 12:05 |

- Recent regulations in major cities including New York and Boston call for net zero in the near future– curtain wall facades under scrutiny
- New enclosure U values are hard to achieve with conventional curtain wall--

Image: Independent

Los Angeles | March 25-26, 2020

Image: Luuk Kramer

Introduction

Why wood Curtain Wall?

- **New approaches to Curtain Wall**
- taking advantage of its benefits of installation and performance,
- but with better effective insulation and less embodied energy are required.
- **Wood mullions offer sustainability advantages over aluminum**

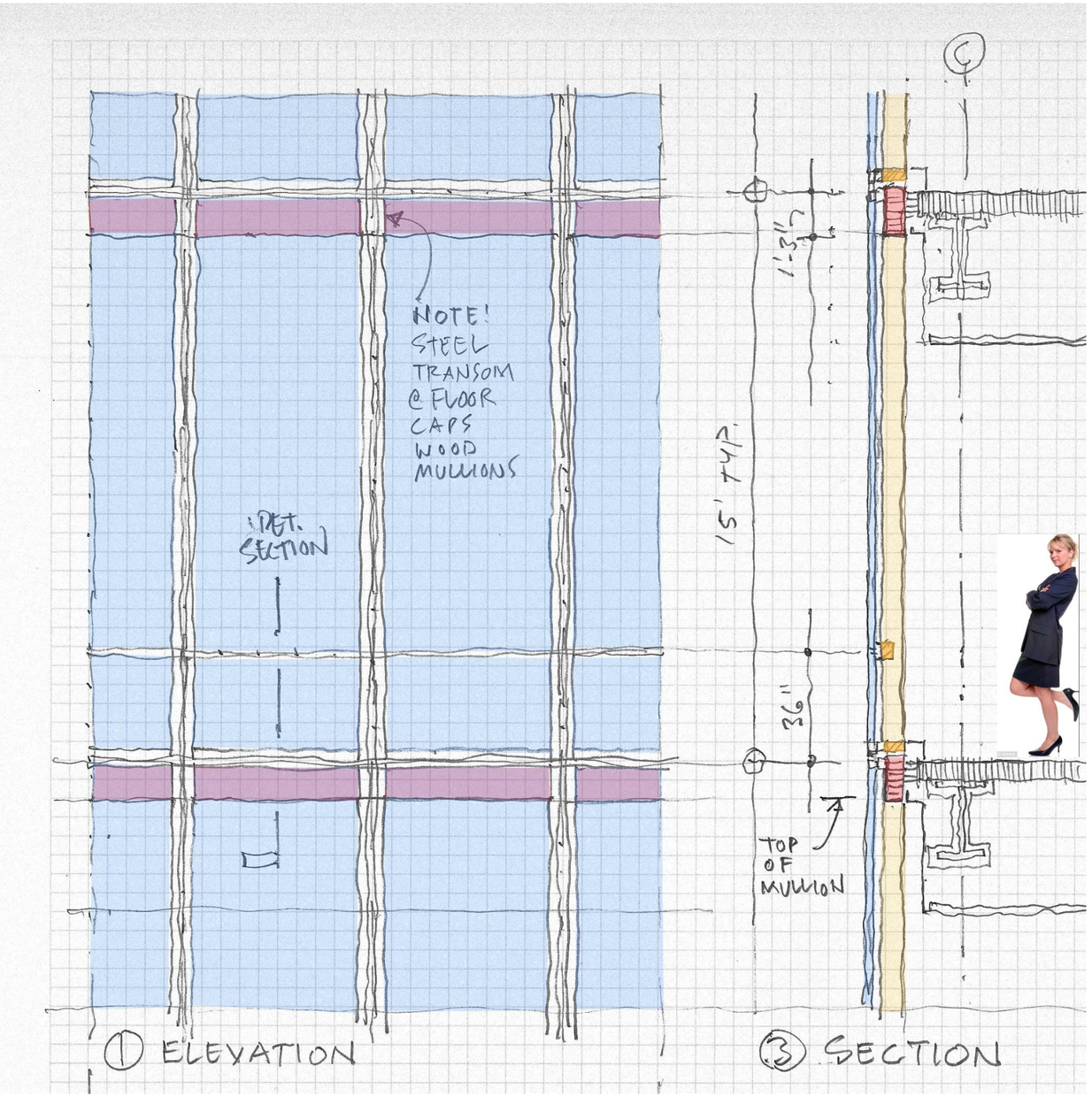


Image: J. Neary

Introduction

- Desire for views and daylight critical to occupant wellness motivates continued use of the floor-to-ceiling fenestration façade
- Can be combined with opaque areas
- But eliminating curtain wall entirely seems unlikely anytime soon

While the Codes require “noncombustible exterior wall construction” in Type I and II buildings, there is potentially a code compliant path to use **mass timber** as part of a curtain or window wall within a medium or high-rise building

Why Mass Timber ?

Sustainability

Low carbon footprint
possible local material
lightweight solutions
renewable resource

Aesthetics

Structure = finish
biophilia & natural patterns
market differentiator

Speed

Pre-fabrication of engineered wood
composite & hybrid solutions
speed on site

Reduced Embodied Carbon

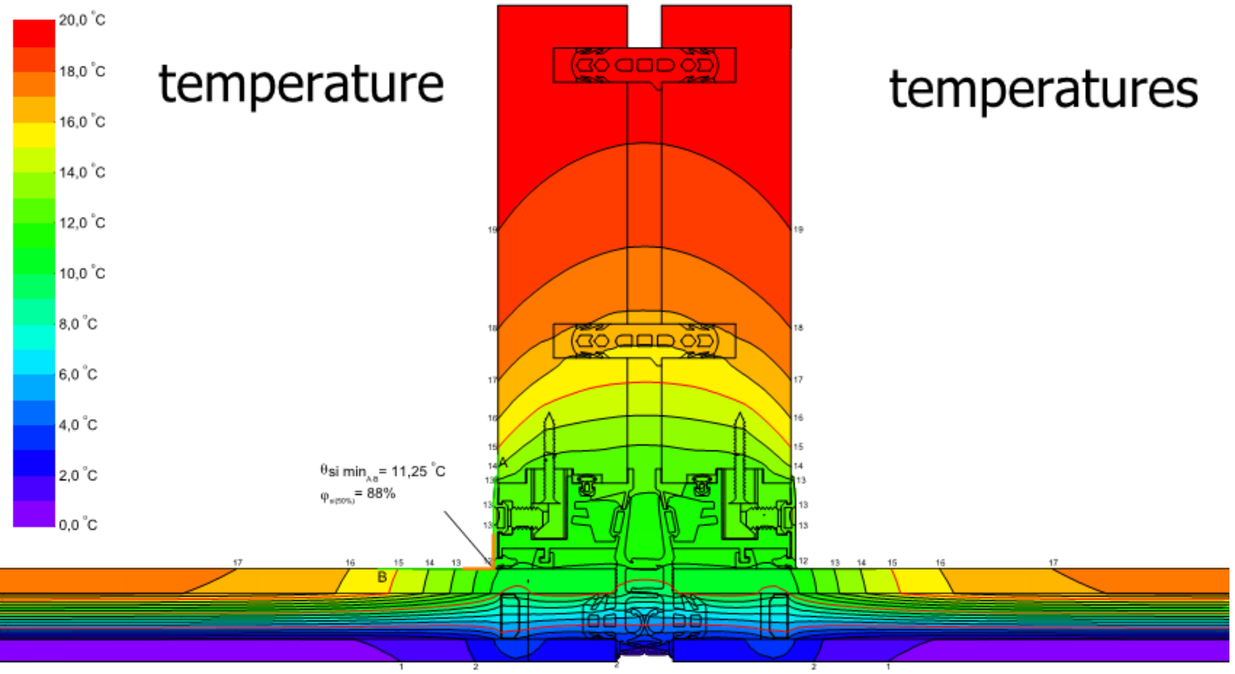
- 1 ton of fabricated glulam timber represents 0.9 tons of embodied C02
- 1 ton of aluminum extrusions represents 8 to 9 tons of embodied CO2 (ICE, U. Of Bath)
- Weight per foot of mullions approximately the same

Image: Luuk Kramer

U Value

Typical unitized aluminum curtain wall system with double glazing including low-e coating and argon has an overall U value of around 0.35 to 0.40

Image: WIDC



The equivalent system with timber mullions has a U value of approximately 0.25

(value for “Woody” system by Stramandinoli/ Giuguaro)

Image: Stramandinoli

Use of Timber

Building codes are changing and embracing the use of mass timber as part of the structural system

- 2021 International Building Code is allowing mass timber for high-rise buildings up to 18 stories

- Does not consider the use of timber on the exterior of a building

Image: Sindree Ellingsen

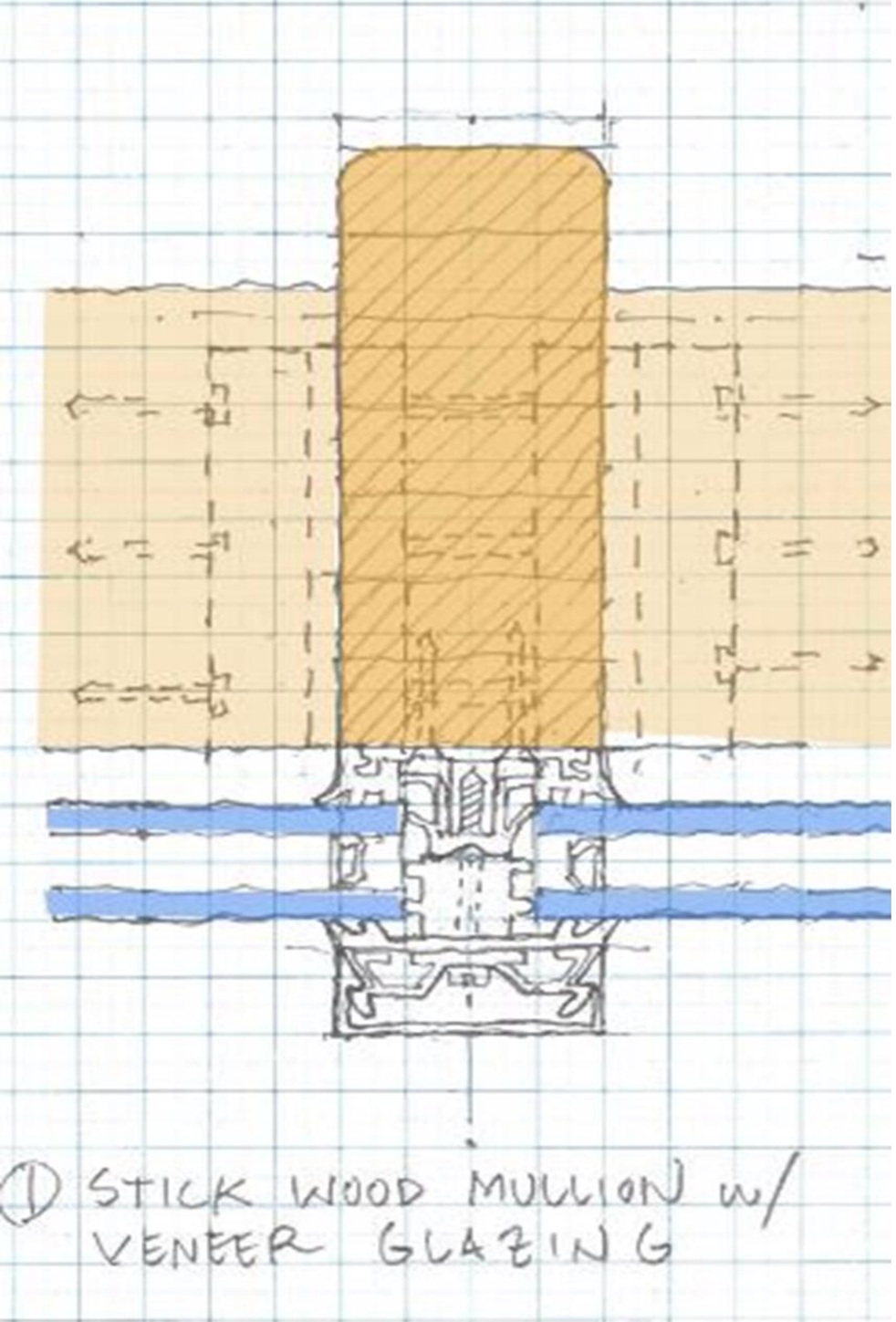


Image: John Neary

Use of Timber

- For Type I and II buildings, no combustible material is permitted on the exterior above 40’ (Section 1406.2.1.1)
- Exceptions for Fire Retardant Treated wood and Metal Composite Panel, both with severe limits.

Code Compliance?

The fundamental requirement that exterior walls of Type I and II buildings be constructed of non-combustible materials, the exceptions for minor quantities of water barriers and sealants etc. notwithstanding, leads most architects to assume that timber in quantity greater than the incidental blocking, allowed specifically in the exceptions of Chapter 6, is not permitted. But close reading of the code requirements and intent shows that if the timber is not exposed to the exterior, with a metal and glass enclosure on the outboard surface, and as long as the timber does not exceed the percentage of wall area allowed for window framing on the interior, timber complies with the requirements for a structural mullion component.

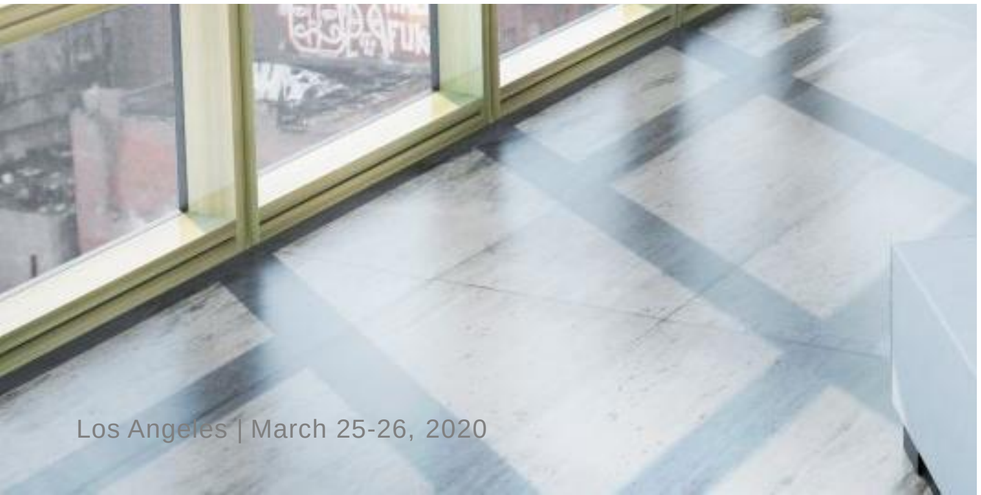


Image: G. Stramandinoli
"Woody" Window Wall

Image: Luuk Kramer

Flammability Classification

- Chapter 8 IBC permits the use of wood as part of the window frame, provided the wood elements used have a Class C flame spread classification (ASTM E 84)
- Total face area of window frame is 10% or less of the total wall area that it is attached to

NFPA 268, 285 & 286

Exterior and Interior of Exterior Walls

- These are tests intended for solid wall systems, not systems that are predominantly glazing.

- With no wood exposed on exterior, and with less than 10% of the interior surface area total, wood window frames/trim are permitted and these tests do not apply.

NFPA 268,

NFPA 285

NFPA 286

Image: Sindree Ellingsen

Code Compliance?

The issues to be addressed include:

- How is a window frame defined?
- Is a window frame part of an exterior wall?
- Is a window frame a structural element?

Image: G. Stramandinoli
“Woody” Window Wall

Code Compliance?

- The path for code compliance is difficult and fraught with potential misinterpretation and misunderstandings
- The use of glulam on the interior of a curtain wall glazing system for a high-rise building involves IBC Chapters 6, 7, 8, 14 and 23, showing the level of complexity of the problem

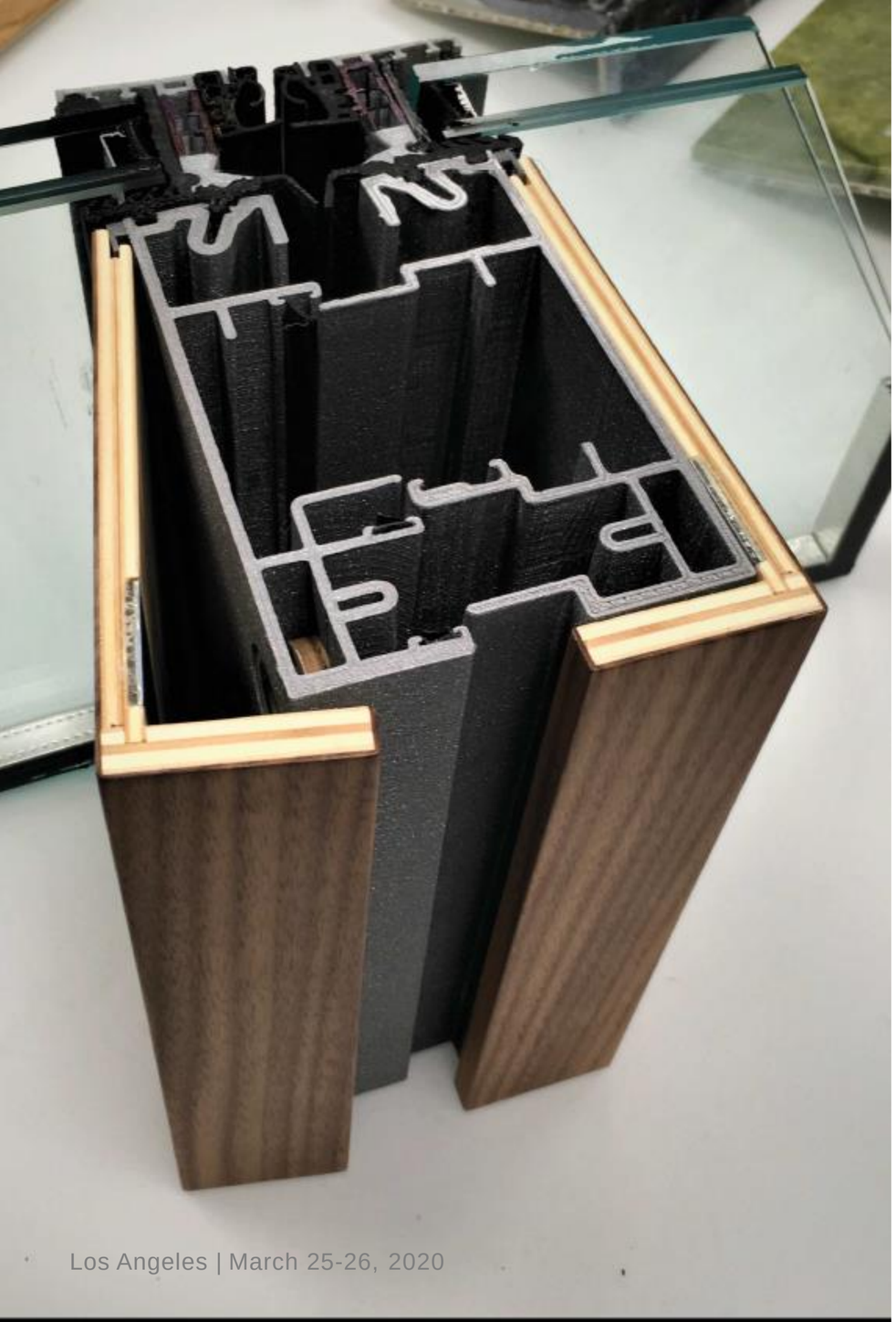
Image: Warren and Mahoney Architects

Fire Resistance

- When mass timber is exposed to fire it achieves a Fire Resistance through the insulating benefits of charring (inherent protection based on the section size)

- While not required, the inherent fire resistance of the glulam provides additional stability under fire conditions

Image: Sindree Ellingsen



Possible Solutions

Innovative solution using a magnetic timber covering

Image: “Chameleon” system by Giugiaro

Possible Solutions

Timber kept interior to the glazing

Image: “Woody” system by Giugiaro

Possible Solutions

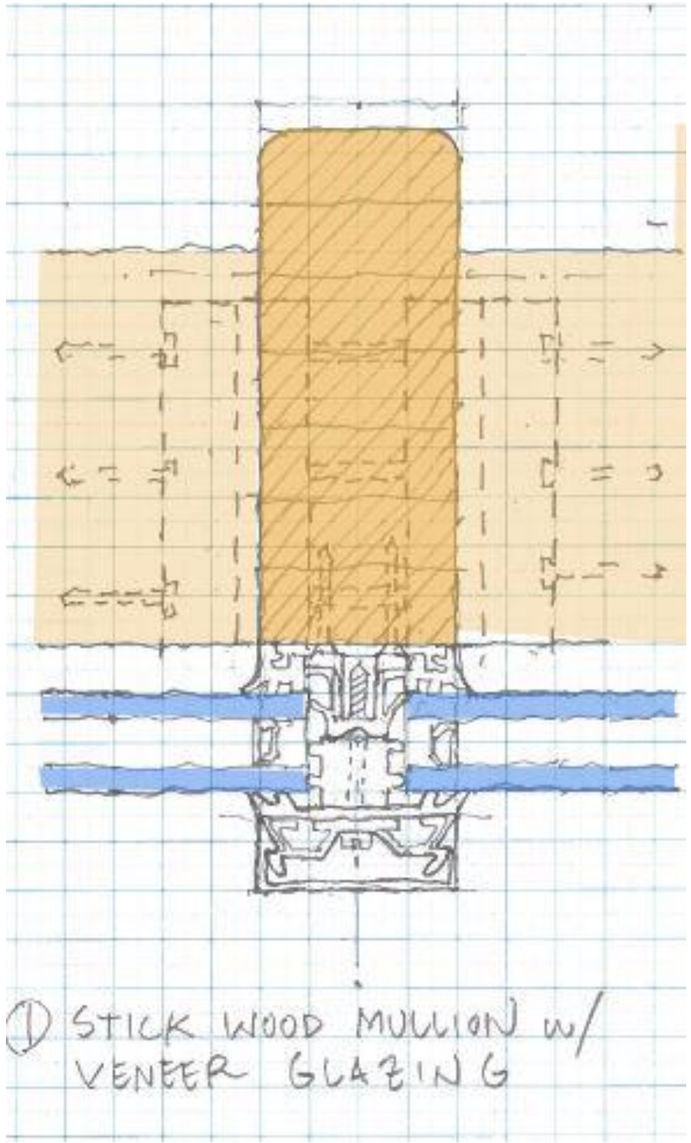
A curtain wall system incorporating timber mullions and transoms

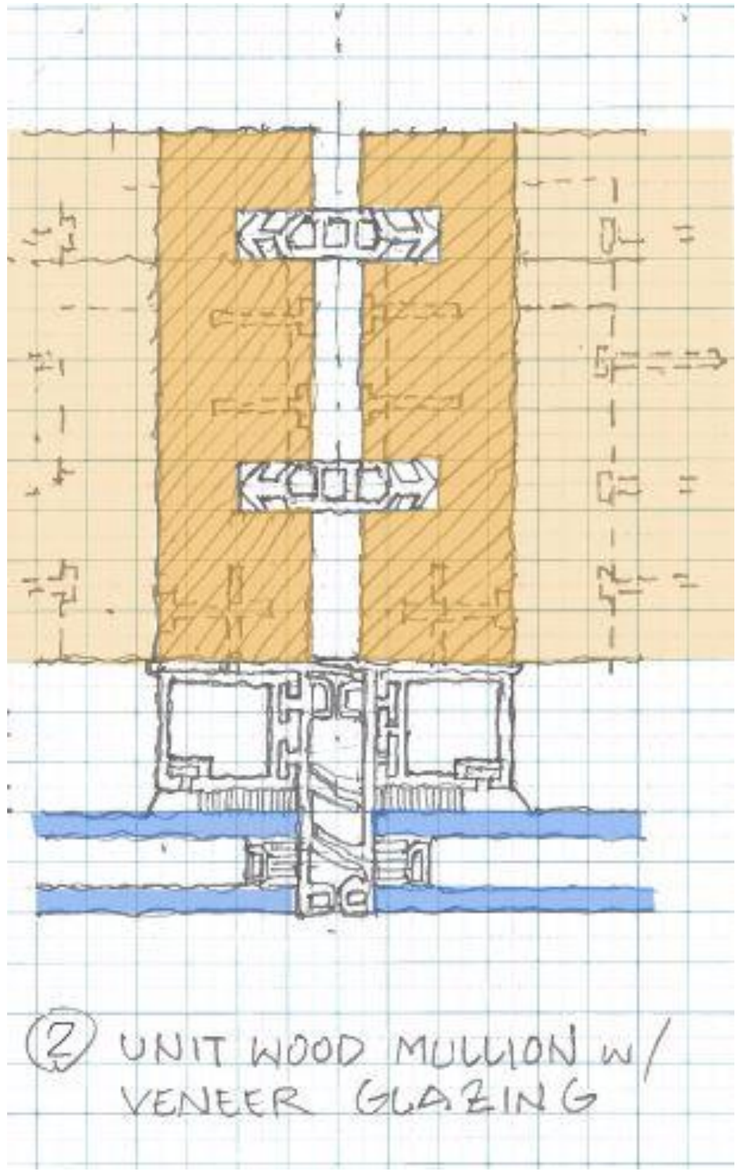
- Aluminum cassette glazing system holding weather-tight gasketing between units, receiving structurally glazed insulated glass units on the outboard face of the framing
- No timber exposed on the exterior surface of the enclosure

Image: J. Neary

Possible Solutions

- (left) Schematic of a typical stick mullion curtain wall system with glulam
- (right) Plan, Split Mullion





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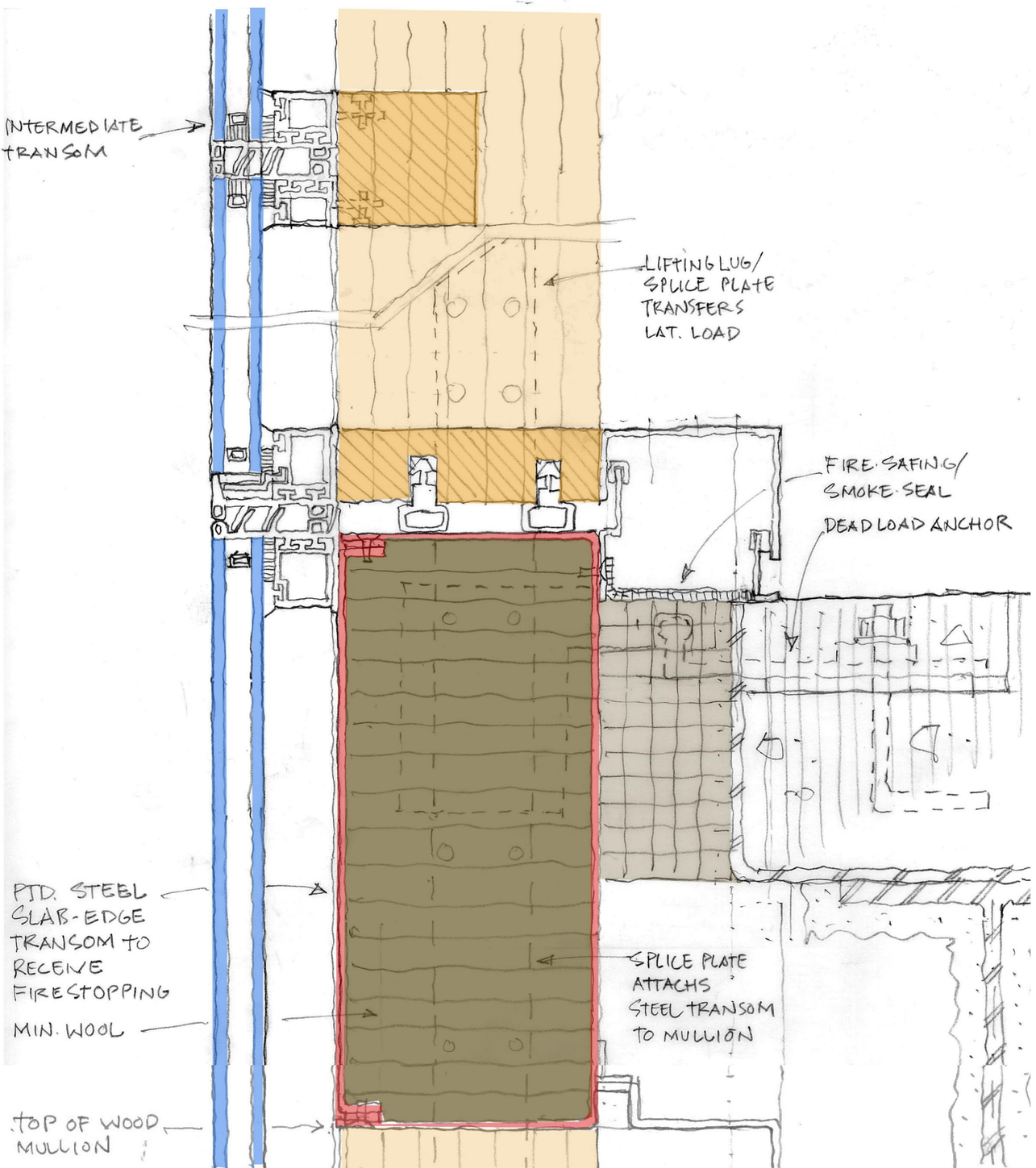
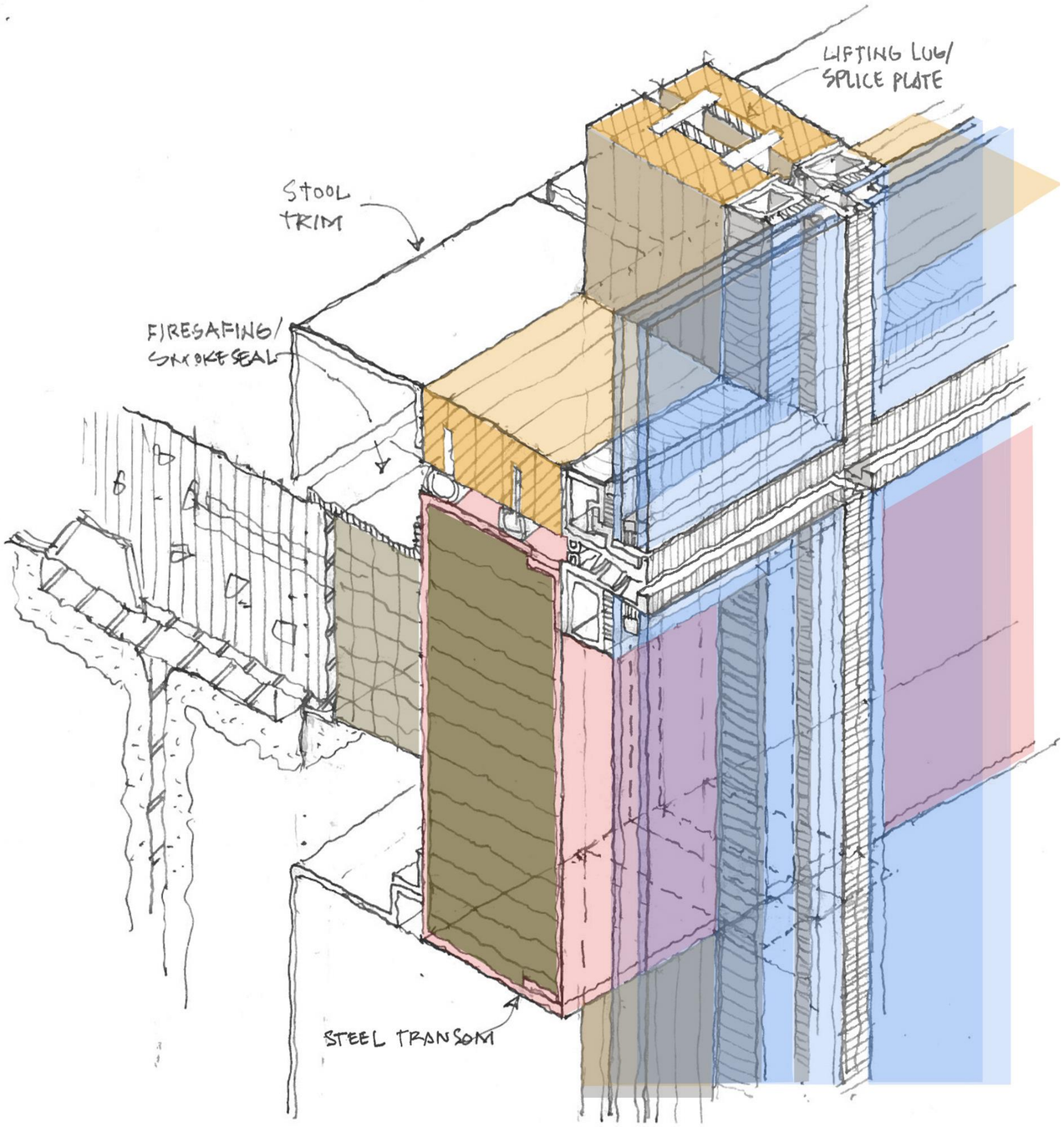


Possible Solutions

- Section at Slab-edge, Unitized Wood Curtain Wall
- Insulated steel transom and slab-edge firestopping, similar to ‘zero-spandrel’ assemblies tested to ASTM E2307.

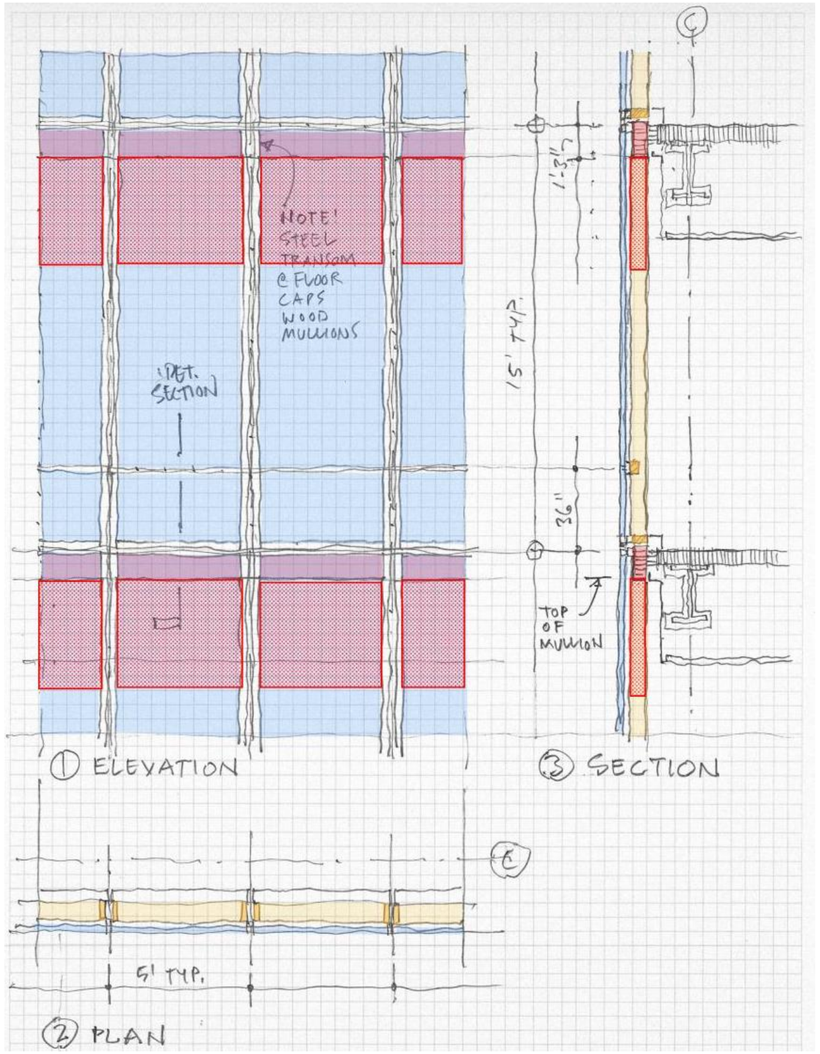
Image: J. Neary



Possible Solutions

- Cutaway View of Unitized Wood Curtain Wall at Insulated Steel Transom and Slab-Edge Firestopping
- Transom runs past the mullion which does not occupy the area of the firestopping assembly
- No wood is exposed to the exterior, which is clad in glass structurally glazed to aluminum cassette frames

Image: J. Neary



Possible Solutions

A curtain wall system incorporating timber mullions and transoms

- If a larger opaque spandrel area where the “Window Frame” definition is unsupportable is required, the non-combustible spandrel area with no mullions extending through it will be extended.
- Edge details to minimize thermal bridges and allow sealing of units would require further development.

Image: J. Neary

Conclusions

- New energy code standards and related regulations require buildings to reduce energy consumption and embodied carbon
- Timber has emerged as a material of interest and is already being used in high-rise structural applications
- Innovative use of mass timber elements such as glulam for curtain and window wall mullions and transoms provides the potential for further embodied carbon reductions in mid and high rise buildings

Image: Luuk Kramer

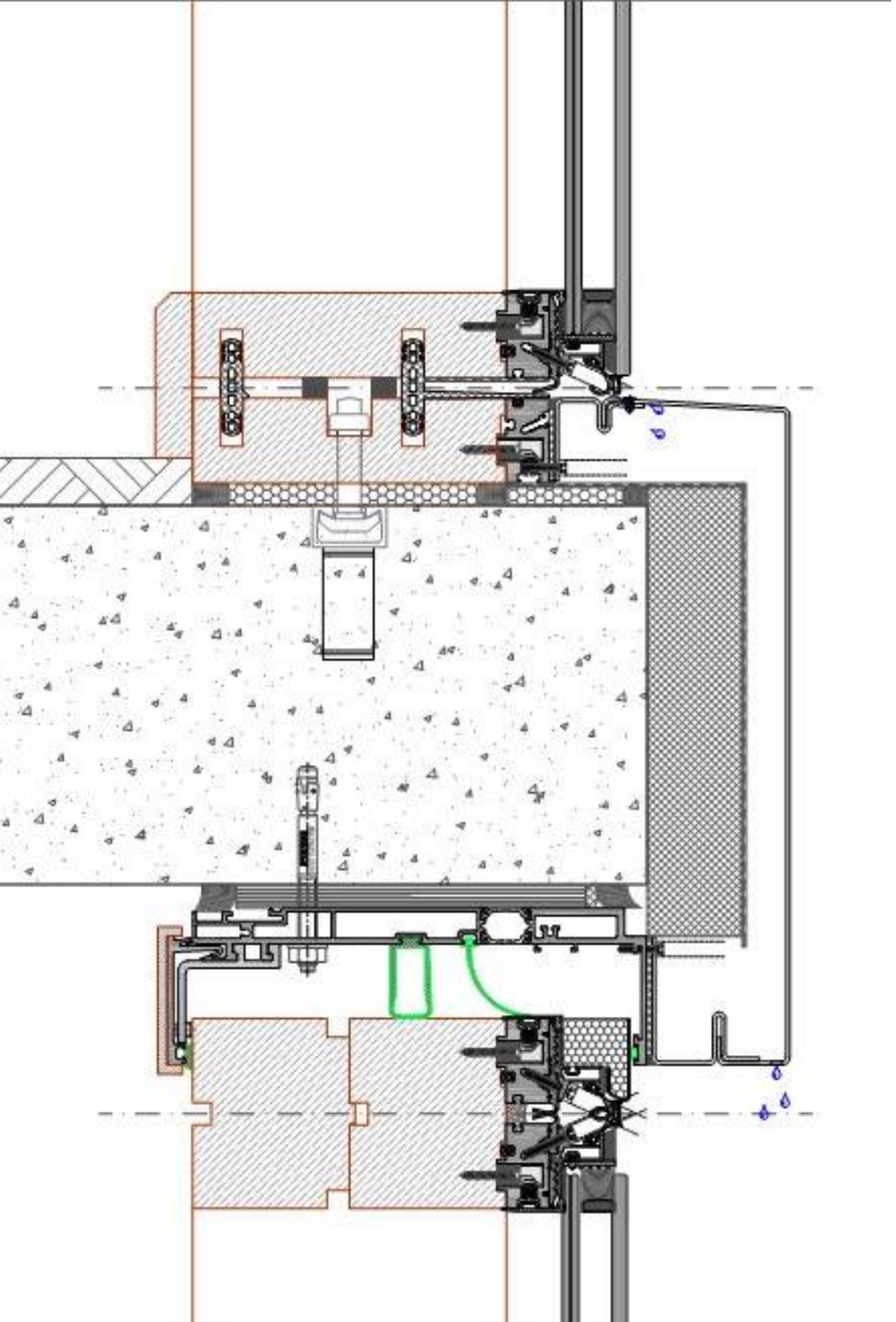


Image: Giugiaro

Conclusions

- The issue of fire remains a hurdle for the more ambitious use of timber in the building skin, with window wall systems offering an easier solution than a curtainwall system, given the fire sealing and limitations of combustibility at the slab edge

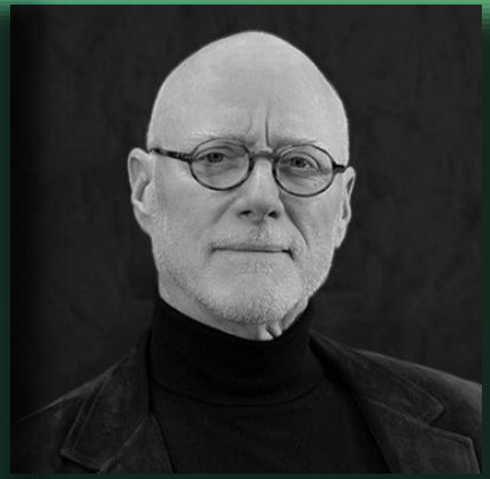
Conclusions

Using wood where it is most effective and combining it with aluminum or other materials appropriate for exterior glazing is a basis for a code compliant approach to incorporating wood mullions in Curtain Wall.

An important opportunity for future work is the continuing education of designers and building officials, who are often keenly interested in the use of mass timber but may not have the necessary understanding for implementation in the façade.

Image: Warren and Mahoney Architects

Continue the dialogue.



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