41st Annual State Construction Conference

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Advancements in Heavy Timber Construction: Design & Construction

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WoodWorks – Wood Products Council
MASS TIMBER DESIGN

DESIGN TOPICS

• CONSTRUCTION TYPES
• FIRE RESISTANCE
• MEP DETAILING
• LATERAL FRAMING
• CONNECTIONS
• CONSTRUCTION PROCESS
Q: Of the 5 construction types, which ones can mass timber be used in?

A: All 5!
IBC defines 5 construction types: I, II, III, IV and V. A building must be classified as one of these.

**Construction Types I & II:** All elements required to be non-combustible materials.

However, there are exceptions including several for mass timber.
ALL WOOD FRAMED BUILDING OPTIONS:

**TYPE III**
Exterior walls non-combustible (may be FRTW)
Interior elements any allowed by code, including mass timber

**TYPE V**
All building elements are any allowed by code, including mass timber

Types III and V are subdivided to A (protected) and B (unprotected)

**TYPE IV (HEAVY TIMBER)**
Exterior walls non-combustible (may be FRTW or CLT)
Interior elements qualify as heavy timber (min. sizes, no concealed spaces)
Where does the code allow MT to be used?

- **Type IB & II**: Roof Decking
Portland International Jetport

- LEED Gold
- Completed 2012

Design Team: Gensler, Oest Associates
Photo Credit: DeStafano & Chamberlain, Inc, Robert Benson Photography

Construction Type IB
Exposed Timber Roof Decking and Framing
Where does the code allow MT to be used?

• **Type III**: Interior elements (floors, roofs, partitions/shafts) and exterior walls if FRT
ICE BLOCK I
SACRAMENTO, CA

ICE BLOCK I, RMW ARCHITECTURE & INTERIORS, BUEHLER ENGINEERING, BERNARD ANDRÉ PHOTOGRAPHY
U OF ARKANSAS STUDENT DORMS
FAYETTVILLE, AR
(2) - 5 STORY BUILDINGS
TOTAL OVER 200,000 SF
368 RESIDENTIAL ROOMS

IMAGE CREDIT: MODUS STUDIO/LEERS WEINZAPFEL ARCHITECTS
Where does the code allow mass timber to be used?

- **Type IV**: Any interior elements & roofs if meets min. size; exterior walls if FRT. No concealed spaces permitted.
T3 MINNEAPOLIS
MINNEAPOLIS, MN

IMAGE CREDIT: EMA PETER
Where does the code allow MT to be used?

- **Type V**: Interior elements, roofs & exterior walls
COMMON GROUND HIGH SCHOOL
NEW HAVEN, CT

- 15,000 SF CLASSROOM & MULTI-PURPOSE SPACE ADDITION
- CLT & GLULAM FRAMING SCHEME
- TYPE VB CONSTRUCTION

PHOTO CREDIT: DAVID SUNDBERG AND GRAY ORGANSCHI ARCHITECTURE
Type III: 6 stories

Allowable mass timber building size for group B occupancy with NFPA 13 Sprinkler

Type IV: 6 stories

Type V: 4 stories
Mass timber design

Fire resistance

COMPARATIVE STRENGTH LOSS OF WOOD VERSUS STEEL

WOOD

25% loss @
30 minutes

STEEL

50% loss
1020°F

90% loss @
30 minutes
1380°F

TIME (MINUTES)

Results from test sponsored by National Forest Products
Association at the Southwest Research Institute

SOURCE: AITC
Mass timber design

Fire resistance

Similar to heavy timber, mass timber products have inherent fire resistance properties.

Source: AWC’s TR 10
Construction type selection dictates prescriptive fire resistance requirements:

- Type IV Construction (minimum sizes)
- **Other than type IV**: Demonstrated fire resistance:
  - IBC 703.3 allows several options, including:
    - ASTM E119 assembly test
    - Calculations per IBC 722 → NDS Chapter 16
FOR EXPOSED WOOD MEMBERS: IBC 722.1 REFERENCES AWC’S NDS CHAPTER 16 (AWC’S TR 10 IS A DESIGN AID TO NDS CHAPTER 16)
Mass timber fire design methods:

NDS Chapter 16 Char Calculations vs. ASTM E119 Tested Assembly

- NDS Chpt 16 calcs check structural integrity
- ASTM E119 checks structural integrity, thermal separation (elevated temp. on unexposed side) and burn through (ignition of cotton waste at gaps)
- Reasonable to assume other assembly components such as concrete topping aid in other 2 criteria

Source: UL L901
Due to exposed mass timber structure and finish, unique MEP accommodation solutions are required. If using Type IV construction, no concealed spaces are allowed.
MASS TIMBER PRODUCTS

EXPOSED MEP
MEP ITEMS LEFT EXPOSED, USUALLY ON CEILING SIDE OF FLOOR ASSEMBLY
Mass timber products

Accommodating MEP

Raised access floor
Installed on top of floor structure
Provides 2” to 18” of plenum space for MEP

Photo Credit: KK Law, Courtesy: naturally:wood

Photo Credit: Woodworks
WOOD INNOVATION DESIGN CENTER

PHOTO CREDIT: ED WHITE

PRINCE GEORGE, BC
Inlaid wood ceiling panels cover MEP between CLT panels.
LATERAL CORE RESISTING SYSTEM:

- Commonly used with glazing/curtain walls
- May use rigid or semi-rigid (if used with frames at exterior) analysis

LIGHT FRAME SHEARWALLS:

- Typical for 1-5 stories
- Typically assume flexible diaphragm
- Need ample wall at perimeter
CENTRAL CORE: CONCRETE SHEARWALLS

PHOTO CREDIT: STRUCTURECRAFT BUILDERS
Mass timber design

Central Core: Mass timber shearwalls

Photo Credit: Alex Schreyer
MASS TIMBER DESIGN

LATERAL FRAMING SYSTEMS

EXTERIOR STEEL MOMENT FRAME

PHOTO CREDIT: WOODWORKS
MASS TIMBER DESIGN

LATERAL FRAMING SYSTEMS

Proprietary rigid/semi-rigid frames

Photo credit: Komatsu/Japan

Photo: Andreas Sauter, Tim Clay Photography
CONNECTION DESIGN CONSIDERATIONS:

- Structural Capacity
- Shrinkage
- Fire
- Constructability
- Aesthetics
- Cost

PHOTO CREDIT: ALEX SCHREYER
Mass timber design connections

Long self tapping screws used extensively throughout mass timber construction.
Mass timber design connections

Beam to beam connections

Photo Credit: Alex Schreyer

Photo Credit: Myticon
MASS TIMBER DESIGN

BEAM TO COLUMN CONNECTIONS
COLUMN TO FOUNDATION CONNECTIONS
MASS TIMBER DESIGN

CONNECTIONS

PANEL TO PANEL CONNECTIONS – SURFACE SPLINE
Mass timber design

Connections

Panel to beam connections

Photo Credit: MYICON
SOURCING, CONSTRUCTION & COST CONSIDERATIONS
Mass timber products

Working with Mass Timber: Know Your Supply Chain

- Manufacturers - Different species, grades and maximum panel/beam sizes
- Trucking logistics and cost
- Manufacturers have specific CNC capabilities
- 3rd party fabricators can have additional CNC capabilities
DEFINE & COMMUNICATE THE DELIVERABLES YOU NEED FROM THE SUPPLIER:

- SHOP DRAWINGS
- SHOP DRAWINGS WITH ENGINEERING STAMP
- ENGINEERED DRAWINGS AND CALCULATIONS (E.G. AS A DEFERRED SUBMITTAL)
WHAT DOES A MASS TIMBER CONSTRUCTION PROCESS LOOK LIKE?

VERY SIMILAR TO A PRECAST CONCRETE OR STRUCTURAL STEEL PROJECT

- SHOP DRAWINGS
- ERECTION DRAWINGS
- PREFABRICATED MEMBERS AND CONNECTIONS
» Current Prescriptive Code Limit - 6 stories or 85 feet

» Over 6 Stories - Alternate Means and Methods Request (AMMR) through performance based design

» Based on the 1910 Heights and Areas Act
New Building Types

18 STORIES
BUILDING HEIGHT 270’
ALLOWABLE BUILDING AREA 1,072,000 SF
AVERAGE AREA PER STORY 54,000 SF

12 STORIES
BUILDING HEIGHT 180 FT
ALLOWABLE BUILDING AREA 648,000 SF
AVERAGE AREA PER STORY 54,000 SF

9 STORIES
BUILDING HEIGHT 85’
ALLOWABLE BUILDING AREA 405,000 SF
AVERAGE AREA PER STORY 45,000 SF

6 STORIES MAXIMUM
85’-0” MAXIMUM BUILDING HEIGHT
324,000 SF MAXIMUM AREA

324,000 SF
ALLOWABLE BUILDING AREA
54,000 SF
AVERAGE AREA PER STORY

TYPE IV-A
IBC 2021

TYPE IV-B

TYPE IV-C

TYPE IV- HT
IBC 2015

BUSINESS OCCUPANCY [GROUP B]

*BUILDING FLOOR-TO-FLOOR HEIGHTS ARE SHOWN AT 12’-0” FOR ALL EXAMPLES FOR CLARITY IN COMPARISON BETWEEN 2015 TO 2021 IBC CODES.
INTRO, CLEVELAND

9 Stories | 115 ft
8 Timber Over 1 Podium

512,000 SF
297 Apartments, Mixed-Use

Photo: Harbor Bay Real Estate Advisors, Purple Film | Architect: Hartshorne Plunkard Architecture
INTRO, CLEVELAND

9 Stories | 115 ft
8 Timber Over 1 Podium

Type IV-B
Variance to expose ~50% ceilings

Photo: Harbor Bay Real Estate Advisors, Image Fiction | Architect: Hartshorne Plunkard Architecture
ASCENT, MILWAUKEE

493,000 SF
259 APARTMENTS, MIXED-USE

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
ASCENT, MILWAUKEE
Tallest Mass Timber Building in the World

Photo: CD Smith Construction | Architect: Korb & Associates Architects
ASCENT, MILWAUKEE

25 STORIES
19 TIMBER OVER 6 PODIUM, 284 FT

Photo: Korb & Associates Architects | Architect: Korb & Associates Architects
Sources & Works Cited

1. LEVER Architecture: https://leverarchitecture.com/projects/albina_yard
10. CLT Handbook: https://www.thinkwood.com/clthandbook
Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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