MASS TIMBER HYBRID HOUSING IN DENVER
DESIGN OF CIRRUS

Presented by Chris Kendall, PE

Disclaimer: This presentation was developed by a third party and is not funded by WoodWorks or the Softwood Lumber Board.
OUTLINE

1. CONSTRUCTION TYPE IIIA FLOOR TO WALL INTERFACE COMPARISON
2. ACOUSTICS
3. STRUCTURAL DESIGN
4. CONSTRUCTION DETAILS
5. ADVANTAGES OF MASS TIMBER HYBRID RELATIVE TO STANDARD LIGHT FRAME
6. OPPORTUNITIES FOR EXPANDED SERVICES
Cirrus
Multi Unit Residential
232,000 square feet
Type III-A Wood Construction
Over 200,000 square feet of Type I-A concrete
Architect: Katerra & Davis Partnership
Structural Engineer: KL&A
General Contractor: Katerra
Mass Timber Supplier: Katerra
292 Residential Units
Building encompasses 2 courtyards
Includes rooftop amenity
Multiple two-story spaces including fitness and club room
Building separation joint above podium
## CONSTRUCTION TYPE

### TABLE 601
FIRE-RESISTANCE RATING REQUIREMENTS FOR BUILDING ELEMENTS (HOURS)

<table>
<thead>
<tr>
<th>BUILDING ELEMENT</th>
<th>TYPE I</th>
<th>TYPE II</th>
<th>TYPE III</th>
<th>TYPE IV</th>
<th>TYPE V</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
<td>B</td>
<td>A</td>
<td>B</td>
<td>HT</td>
</tr>
<tr>
<td>Primary structural frame (see Section 202)</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>2&lt;sup&gt;a&lt;/sup&gt;&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;</td>
<td>0</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Bearing walls</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior&lt;sup&gt;c&lt;/sup&gt;,&lt;sup&gt;f&lt;/sup&gt;</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Interior</td>
<td>3&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1</td>
<td>0</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Nonbearing walls and partitions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exterior</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Interior&lt;sup&gt;d&lt;/sup&gt;</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0&lt;sup&gt;d&lt;/sup&gt;</td>
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<tr>
<td>Nonbearing walls and partitions</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floor construction and associated secondary members</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1&lt;sup&gt;e&lt;/sup&gt;</td>
</tr>
<tr>
<td>(see Section 202)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roof construction and associated secondary members</td>
<td>1&lt;sup&gt;f&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;&lt;sup&gt;c&lt;/sup&gt;</td>
<td>0&lt;sup&gt;c&lt;/sup&gt;</td>
<td>1&lt;sup&gt;b&lt;/sup&gt;&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

For SI: 1 foot = 304.8 mm.

a. Roof supports: Fire-resistance ratings of primary structural frame and bearing walls are permitted to be reduced by 1 hour where supporting a roof only.

b. Except in Group F-1, H, M and S-1 occupancies, fire protection of structural members in roof construction shall not be required, including protection of primary structural frame members, roof framing and decking where every part of the roof construction is 20 feet or more above any floor immediately below. Fire-retardant-treated wood members shall be allowed to be used for such unprotected members.

c. In all occupancies, heavy timber complying with Section 2304.11 shall be allowed where a 1-hour or less fire-resistance rating is required.

d. Not less than the fire-resistance rating required by other sections of this code.

e. Not less than the fire-resistance rating based on fire separation distance (see Table 602).

f. Not less than the fire-resistance rating as referenced in Section 704.10.
WOOD WALLS IN TYPE III CONSTRUCTION

602.3 Type III. Type III construction is that type of construction in which the exterior walls are of noncombustible materials and the interior building elements are of any material permitted by this code. Fire-retardant-treated wood framing and sheathing complying with Section 2303.2 shall be permitted within exterior wall assemblies of a 2-hour rating or less.
CEMENTITIOUS OR GYPCRETE T O P P I N G S L A B  R E :  P L A N
A C O U S T I C  M A T  R E :  A R C H
C L T  P A N E L  R E :  P L A N

T / C L T
R E :  P L A N

(2) 2x R I M  B O A R D ,  R I P  T O  D E P T H
(3) 0.120"x3" N A I L  @  4" O C
F R T  2x  E X T E R I O R  W A L L
R E :  P L A N
G Y P  R E :  A R C H

TYPE IIIA FLOOR TO WALL INTERFACE:
CLT SPANNING PARALLEL TO WALL
TYPE IIIA FLOOR TO WALL INTERFACE: WOOD JOISTS
TYPE IIIA FLOOR TO WALL INTERFACE:
WOOD TRUSSES PARALLEL TO WALL

TYPE IIIA FLOOR TO WALL INTERFACE:
WOOD TRUSSES BEARING ON WALL
ACOUSTICS CIRRUS FLOOR ASSEMBLY

TYPICAL CLT FLOOR

FIRE RATING: 1
IIC RATING: 50
STC RATING: 51-52
ASSY LISTING: IBC 703.3

NOTES:
CLT MANUFACTURED TO APA/PRG 320. FIRE RESISTANCE DEMONSTRATED THROUGH ASTM E 119 FIRE TEST PER IBC SECTION 703.3.
ASSEMBLY AS SHOWN DEPICTS THICKNESS FOR BROADLOOM CARPET FLOOR FINISH WITH CARPET PAD

FINISH FLOOR PER UNIT PLANS
FINISH FLOOR UNDERLAYMENT, PER UNIT PLANS
2" CEMENTITIOUS TOPPING
3/4" SOUND CONTROL MAT

(5) LAYERS CLT PER STRUCTURAL

APPENDIX:
IIC NOTES: TO COMPLY WITH IBC IIC REQUIREMENTS, PROVIDE THE FOLLOWING, OR APPROVED EQUAL:

- FINISH FLOOR: 3.5 MM MARMOLEUM SHEET TILE OR 4 MM ARMSTRONG NATURAL CREATIONS LUXURY VINYL TILE OR OTHER 4MM THICK CUSHIONED-VINYL TILE
- FINISH FLOOR UNDERLAYMENT: 2-MM UNDERLAYMENT: ARMSTRONG QUIETCOMFORT OR PLITEQ GENIEMAT RST02 OR ECORE QTSQ
- 2 INCH CEMENTITIOUS TOPPING MAXXON GYP-CRETE
- 10 MM SOUND CONTROL MAT MAXXON ENKASONIC HP OVER
- CLT PER STRUCTURAL

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### Table 1 Continued: CLT Floor Assemblies with Concrete/Gypsum Topping, Ceiling Side Exposed

<table>
<thead>
<tr>
<th>CLT Panel</th>
<th>Concrete/Gypsum Topping</th>
<th>Acoustical Mat Product Between CLT and Topping</th>
<th>Finish Floor</th>
<th>STC¹</th>
<th>IIC²</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.35&quot; (9 mm) closed-cell foam</td>
<td>None</td>
<td>None</td>
<td>49</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.35&quot; (9 mm) closed-cell foam</td>
<td>None</td>
<td>None</td>
<td>53</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.5&quot; wood fiberboard</td>
<td></td>
<td></td>
<td>52</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.75&quot; recycled fabric felt</td>
<td></td>
<td></td>
<td>59</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.5&quot; rubber nuggets on foil</td>
<td></td>
<td></td>
<td>53</td>
<td>46</td>
<td></td>
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<tr>
<td>1-1/2&quot; concrete</td>
<td>0.315&quot; (8 mm) shredded rubber mat</td>
<td></td>
<td></td>
<td>52</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.67&quot; (17 mm) shredded rubber mat</td>
<td></td>
<td></td>
<td>54</td>
<td>44</td>
<td></td>
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<tr>
<td>1-1/2&quot; concrete</td>
<td>0.39&quot; (10 mm) Tar Boards</td>
<td></td>
<td></td>
<td>54</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>Eng Wood on 2 mm closed cell foam</td>
<td></td>
<td></td>
<td>53</td>
<td>47</td>
<td>68</td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>16&quot; Insonomat</td>
<td></td>
<td></td>
<td>56</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>Eng Wood on 2 mm closed cell foam</td>
<td></td>
<td></td>
<td>55</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>0.35&quot; (9 mm) Owens Corning QuietZone closed cell foam</td>
<td></td>
<td></td>
<td>54</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>1-1/2&quot; concrete</td>
<td>Eng Wood on 2 mm closed cell foam</td>
<td></td>
<td></td>
<td>52</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>2&quot; Gyp-Crete®</td>
<td>Maxxon Acousti-Mat® 3/8 Premium</td>
<td>None</td>
<td></td>
<td>52</td>
<td>38</td>
<td>22</td>
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<tr>
<td>2&quot; Gyp-Crete®</td>
<td>Carpet</td>
<td></td>
<td></td>
<td>50</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>2&quot; Gyp-Crete®</td>
<td>LVT</td>
<td></td>
<td></td>
<td>52</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>2&quot; Gyp-Crete®</td>
<td>Linoleum sheet flooring</td>
<td></td>
<td></td>
<td>51</td>
<td>48</td>
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<tr>
<td>2&quot; Gyp-Crete®</td>
<td>Linoleum sheet flooring</td>
<td></td>
<td></td>
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<td>53</td>
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<tr>
<td>2&quot; Gyp-Crete®</td>
<td>LVT</td>
<td></td>
<td></td>
<td>52</td>
<td>51</td>
<td></td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>Pileeq GenieMat™ FF25</td>
<td>LVT on GenieMat RST05</td>
<td></td>
<td>53</td>
<td>51</td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>Eng Wood on GenieMat RST02</td>
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<td>2&quot; Levelrock® Brand 2500</td>
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<td></td>
<td>51¹</td>
<td>42²</td>
<td>62</td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>LVT</td>
<td></td>
<td></td>
<td>51¹</td>
<td>47²</td>
<td>63</td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>LVT Plus</td>
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<td>51¹</td>
<td>51¹</td>
<td>14</td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>Eng Wood</td>
<td></td>
<td></td>
<td>50²</td>
<td>48²</td>
<td>64</td>
</tr>
<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>Carpet + Pad</td>
<td></td>
<td></td>
<td>50²</td>
<td>66²</td>
<td>65</td>
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<tr>
<td>2&quot; Levelrock® Brand 2500</td>
<td>Ceramic Tile</td>
<td></td>
<td></td>
<td>52²</td>
<td>48²</td>
<td>66</td>
</tr>
</tbody>
</table>

¹ Acoustical value from design verification, ² Acoustical value from INL Core measurements.
1,190 CLT PANELS
AVG SIZES FOR PANELS OVER UNITS WERE 5’ 9”x30’
AVG SIZES FOR PANELS IN CORRIDOR WERE 9’ 9”x30’
LARGEST PANELS WERE 9’ 9”x39’ 11 7/8
OUR HEAVIEST PANELS WERE ALMOST 8000LBS
EFFICIENT USE OF CLT PRESS
Minimum Master Panel

Nominal = 40' or 60'
Squared = 40' - 3" or 60' - 3"
At Layup = 40' - 6" or 60' - 6"

EFFICIENT USE OF CLT PRESS
PANEL ORIENTATION
CONSTRUCTION DETAILS

WOOD WALL TO PODIUM DETAIL (NOT USED)
CONSTRUCTION DETAILS

PANEL DIAPHRAGM CONNECTIONS
WITH TRADITIONAL SPLINE
CONSTRUCTION DETAILS

PANEL DIAPHRAGM CONNECTIONS MADE USING WALL TOP AND BOTTOM PLATES
CONSTRUCTION DETAILS

PANEL CONNECTIONS TO STAY IN PLACE
CONCRETE FORM SYSTEM

CONC CORE WALL, RE: PLAN AND ELEVATION
CEMENTITIOUS OR GYPCRETE TOPPING SLAB RE: PLAN
ACOUSTIC MAT RE: ARCH
CLT PANEL RE: PLAN
T/SLAB

5/16"Ø x 5 1/2" ASSY KOMBI SCREWS Ø4"OC

L5x5x3/8, ATTACHMENT TO CORE WALL BY STAY-IN-PLACE FORM SYSTEM SUPPLIER
GRAVITY LOAD = 1140 PLF
LATERAL LOAD = 995 PLF
CONSTRUCTION DETAILS

BUILDING FIRE SEPARATION JOINT

- CLT PANEL (ref. plan)
- 1" Shaftliner Board
- CLT Panel (ref. plan)
- Metal H-Stud
- Aluminum breakaway clip @ 5'-0" OC Max
- Attach Vert Leg to H Stud
- Attach Horizontal Leg to Sill
- WALL

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CONSTRUCTION DETAILS

WOOD STUD, WHERE OCCURS RE: PLAN
COUNTERSINK CARRIAGE BOLTS

2x NAILER W/ 1/2" ø CARRIAGE BOLTS @ 24" OC STAGGERED

1/2"

CEMENTITIOUS OR GYPCRETE
TOPPING SLAB RE: PLAN

ACOUSTIC MAT RE: ARCH

CLT PANEL RE: PLAN

T/CLT
RE: PLAN

L6x4x5/16x CONT NS&FS, FASTEN
TO CLT W/ 5/16" øx5 1/2" ASSY
KOMBI SCREWS @ 12" OC

STEEL BEAM RE: PLAN

CLT TO UPTURNED STEEL BEAM
MASS TIMBER HYBRID BENEFITS

SPEED
1. 230,000 SQUARE FEET OF WOOD CONSTRUCTION FRAMED IN 17 WEEKS (13,640 SQUARE FEET PER WEEK)
2. 7 WEEKS FASTER THAN ORIGINALLY SCHEDULED AND 11-12 WEEKS FASTER THAN STICK BUILT ON SITE

SAFETY
1. FACTORY BUILT WOOD WALLS AND CLT SAVE AT LEAST 50% OF LABOR ON SITE
2. SHEATHING AND TRUSSES ARE TWO OF THE MORE DANGEROUS ACTIVITIES IN WOOD FRAMING AND ARE ELIMINATED WITH WALL PANELS AND CLT

REDUCED WASTE
1. FRAMING WASTE IS REDUCED ON SITE AND IS LIMITED TO TEMPORARY BRACING AND GUARDRAILS WHICH ARE REUSED ON MULTIPLE FLOORS
MASS TIMBER HYBRID

1. REDUCED FLOOR STRUCTURE DEPTH FOR SIMILAR SPANS
2. INCREASED SPEED OF CONSTRUCTION OVER STANDARD LIGHT FRAME
3. IMPROVED SAFETY
4. SIMPLIFIED FLOOR TO WALL INTERFACE
5. EXPOSED CLT PROVIDES UNIQUE AESTHETIC

STANDARD LIGHT FRAME

1. MORE CONVENTIONAL
2. LESS COORDINATION REQUIRED
3. SIMPLE FIELD MODIFICATION IF NEEDED
4. LESS EXPENSIVE ON A MATERIAL BASIS
EXPANDED SERVICES

NOTE:
1. ANGLE $\alpha = 60^\circ$ MAX
2. ANGLE $\beta = 30^\circ$ MAX AT EACH ANCHOR
3. A COMPENSATOR DEVICE MUST BE USED TO EQUALLY DISTRIBUTE LOAD TO ALL (4) CABLES.
4. RE: 4/S-100 FOR LOCATIONS OF RIGGING ATTACHMENTS. RIGGING ATTACHMENTS TO BE
   MYTON YOKE 5T W/ (4) 1/2"x6 1/4" ASSY KOMBI SCREWS. REUSE SCREWS ONCE.

<table>
<thead>
<tr>
<th>LENGTH</th>
<th>A</th>
<th>WIDTH</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10'</td>
<td>2'0&quot;</td>
<td>&lt; 6'</td>
<td>1'0&quot;</td>
</tr>
<tr>
<td>&lt; 15'</td>
<td>3'0&quot;</td>
<td>&lt; 7'</td>
<td>2'0&quot;</td>
</tr>
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<td>&lt; 20'</td>
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<td>&lt; 25'</td>
<td>6'0&quot;</td>
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<tr>
<td>&lt; 30'</td>
<td>7'6&quot;</td>
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<td>&lt; 35'</td>
<td>9'0&quot;</td>
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<tr>
<td>&lt; 40'</td>
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<tr>
<td>&lt; 50'</td>
<td>12'6&quot;</td>
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</table>
THANK YOU!

Chris Kendall (EOR)
ckendall@klaa.com