

Comparing Carbon Footprints of Steel and Timber Systems Equitably

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CTBUH 2022
Steel-Timber Conference

THE HYBRID DILEMMA

Comparing Carbon Footprints - Steel, Concrete, and Timber

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and Urban Habitat





STEEL

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CONCRETE

Concrete Batch Tickets & EPD's

(Upstream sourcing disclosure beyond industry averages is greatly improving)



Hanley Wood Ready Mixed Concrete
 5600 N. River Rd.
 Rosemont, IL 60018
 773-824-2400

Driver's Information
 Mileage: Return 48156 Start: 4:15 P
 Time Left Plant: 2:45 Arrived Job: 2:05
 End Hour: 3:55 Left Job: 4:05
 Arrived Plant: 4:25

IMPORTANT TERMS AND CONDITIONS
 Customer will receive concrete per order and this contract is not to be used for any other purpose. This contract is void if the concrete is not used for the purpose specified. The customer will be responsible for the cost of any rework or damage to the concrete. The customer will be responsible for the cost of any rework or damage to the concrete. The customer will be responsible for the cost of any rework or damage to the concrete.

INSPECTED, APPROVED AND RECEIVED BY:
 Joe Conrath (Signature)
 (Date)

NOTICE: Driver will not add water unless customer is in writing. Driver will not add water unless customer is in writing.

ENVIRONMENTAL PRODUCT DECLARATION
 Mix: S86001 • Ivine Plant

SOLD TO: Ken W. Concrete Construction
 2706 Concrete Lane
 Chicago, IL 60675

SHIP TO: Joe Conrath, Plant
 603 East. Waco St.
 Chicago, IL 60623

DATE: 02/08/14
CUST. ACCT. #: 600745
TRUCK #: 0308

2.00 yd 4012 4000 gal #12 WINTER DELIVERY DELT. LOAD CHARGE TOTAL COST

2.00 yd 35.0 yd

4.5 min

COMPANY
 National Ready Mix
 15621 Ventura Boulevard, Suite 475
 Encino, CA 91436

PLANT
 Ivine Plant
 16322 Construction Circle East
 Irvine, CA 92606

EPD PROGRAM OPERATOR
 ASTM International
 100 Barr Harbor Drive
 West Conshohocken, PA 19428

DATE OF ISSUE
 11/29/2021 (valid for 5 years until 11/29/2026)

NATIONAL READY MIX
 ENVIRONMENTAL PRODUCT DECLARATION
 Mix: S86001 • Ivine Plant

ENVIRONMENTAL IMPACTS

Declared Product:
 Mix: S86001 • Ivine Plant
 Description: AUGER CAST PILE
 Compressive strength: 5000 PSI at 28 days

Declared Unit: 1 m³ of concrete

Global Warming Potential (kg CO ₂ e)	407
Acidification Potential (kg SO ₂ e)	1.19
Eutrophication Potential (kg N-e)	0.17
Photochemical Oxidation Potential (kg O ₃ e)	29.3
Abiotic Depletion, fossil (kg Si-e)	1.11E-4
Abiotic Depletion, fossil (MJ)	2.621
Total Waste Disposal (kg)	2.59
Consumption of Freshwater (m ³)	3.25

Product Components: natural aggregate (ASTM C33), Portland cement (ASTM C150), fly ash (ASTM C916), admixture (ASTM C494), batch water (ASTM C1102)

Additional detail and impacts are reported on page three of this EPD

ISO 21930:2017 Sustainability in Building Construction— Environmental Declaration of Building Products: serves as the core PCR for Concrete, NSF International, February 2019 series as the sub-category PCR

Sub-category PCR review was conducted by Thomas P. Gloria • Industrial Ecology Consultants

Independent verification of the declaration, according to ISO 14025:2006: Internal external

Third party verifier Thomas P. Gloria (t.gloria@industrial-ecology.com) • Industrial Ecology Consultants

For additional explanatory material
 Manufacture Representative: John Halverson (jhalverson@natrem.com)
 Software Tool: CustomCLARITY Suite, EPD Generator • Verification
 LCA & EPD Developer: Climate Earth (support@climateearth.com)

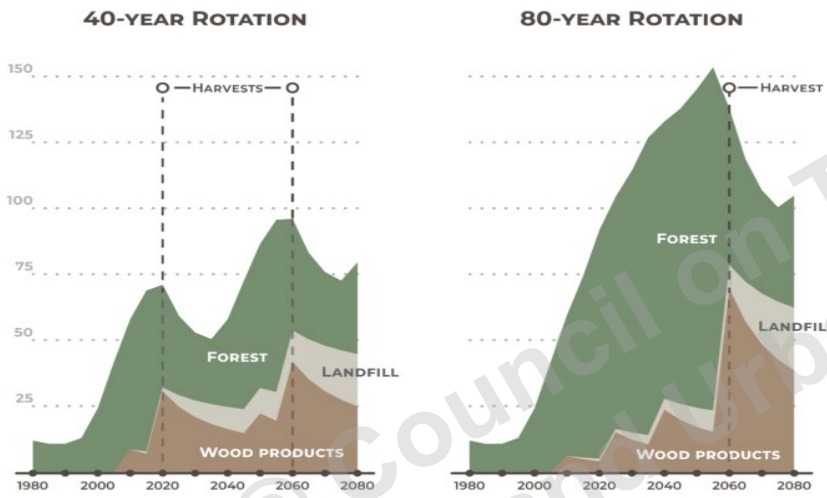


WOOD

Wood & EPD's

(Upstream sourcing isn't differentiated across North America, all impacts are reported as carbon neutral)

Tons of carbon stored per acre (1980-2080)



ENVIRONMENTAL PRODUCT DECLARATION



North American Softwood Lumber
North American Structural and Architectural Wood Products



According to ISO 14025,
EN 15884 and ISO 21930:2017

3.1. Life Cycle Impact Assessment Results

Table 9. Impact Assessment Results for 1 m³ of North American Softwood Lumber

TRACI v4.1	Total	A1	A2	A3
GWP ₁₀₀ (kg CO ₂ eq)	63.12	1		
GWP ₁₀₀ (inc. biogenic carbon) (kg CO ₂ eq)	63.12	0.06		
ODP (kg CFC11 eq)	2.86E-09	1		
AP (kg SO ₂ eq)	0.52			
EP (kg N eq)	0.25			
POCP (kg C ₂ H ₄ eq)	13.68			
ADP _{min} (MJ LHV)	833.37	14		
Total for biogenic (MJ LHV)	101.61	2		

*A1 Results for GWP₁₀₀; include downstream emissions that occur in upstream product A2 and C2004 S0

3.2. Life Cycle Inventory Results

Table 10. Resource Use for 1 m³ of North American Softwood Lumber

Resource	Total	A1
RP _{0%} (MJ LHV)	2,390.53	
RP _{10%} (MJ LHV)	10,959.10	10.95
NR _{10%} (MJ LHV)	1,009.14	11
NR _{0%} (MJ LHV)	0.00	
SM (kg)	0.00	
RSP (MJ LHV)	405.72	
NRSP (MJ LHV)	0.00	
RE (MJ LHV)	0.00	
FW (m ³)	0.44	

Table 11. Output Flows and Waste Categories for 1 m³ of North American Softwood Lumber

Resource	Total	A1
HW _{0%} (kg)	2.1E-03	0.0E
NHW _{0%} (kg)	5.05	1
HL _{RR} (m ³)	2.7E-06	1.5E
LL _{RR} (m ³)	3.5E-03	2.4E
CRU (kg)	0.00	0
MR (kg)	0.00	0
MR _R (kg)	0.00	0
EE (MJ LHV)	0.00	0

ENVIRONMENTAL PRODUCT DECLARATION NORTH AMERICAN SOFTWOOD LUMBER

AMERICAN WOOD COUNCIL
CANADIAN WOOD COUNCIL



The American Wood Council (AWC) and the Canadian Wood Council (CWC) are pleased to present this Environmental Product Declaration (EPD) for North American softwood lumber. The EPD includes Life Cycle Assessment (LCA) results for all processes up to the point that planed and dry lumber is packaged and ready for shipment at the manufacturing plant. The underlying LCA and the EPD were developed in compliance with ISO 14025:2006 and ISO 21930:2017 and have been verified under the UK Environmental EPD program.

The AWC and CWC represent wood product manufacturers across North America. The North American forest product industry is a global leader of sustainably sourced wood products. This EPD reflects years of research and numerous sustainability initiatives on behalf of our members to continually improve the environmental footprint of North American wood products. We are pleased to present this document to show our progress.

Please follow our sustainability initiatives at www.awc.org and www.cwc.ca.



Mass Timber Sourcing Disclosure (Questionnaire)

(Disclosure that rewards those “doing better”)



1. APPENDIX: MASS TIMBER SUBCONTRACTOR RFP FOREST SOURCING DISCLOSURE QUESTIONNAIRE (3/29/2022)	
<p>Responses to this questionnaire are to be collected by the project general contractor, accompanying the subcontractor bid submissions for the sourcing of a minimum of 90% of the structural mass timber to be used on the project. This information will be evaluated by the owner and/or the owners designated representatives (who may include a forestry consultant hired on behalf of the owner).</p> <p>The questions are to assist in a comparative and competitive bid evaluation of the climate smart and ecological impact characteristics of the sourced timber. Chain of custody for the material shall be agreed to be provided, traceable back to the source forest(s) of origin. Documented third party verification of the chain of custody will be valued higher than self-declaration from the winning bidder at the time of material delivery to the owner, to verify to accuracy of the data provided.</p> <p>Subcontractor bids should include a baseline bid that is performance characteristics identified within the design and considered along with comparative subcontractor submitted climate smart and ecologically sensitive sourcing information include an alternative bid to the base bid which provides a sensitive material sourcing than the base bid. Provide any on a separate line item.</p> <p>Each subcontractor's bid cost and climate smart and ecological performance characteristics identified within the design and considered along with comparative subcontractor submitted climate smart and ecologically sensitive sourcing information include an alternative bid to the base bid which provides a sensitive material sourcing than the base bid. Provide any on a separate line item.</p> <p>Please share documentation for responses to the below questions likely prior to harvesting of the source logs for the project, of sourcing that will be committed to for the project, subject to the site. Sourcing substitutions may occur, subject to reviewers designated representatives, with the substitution information original bid submission for its climate smart and ecological</p>	
<ol style="list-style-type: none">1) Is the timber being proposed for use on the project from operation, and/or is the material traceable to the source forest?2) If source forest material certification is being provided, this material certification (FSC, SFI, PEFC, other)?3) Can a third party developed source forest(s) specific re on the forest landscape(s) divided by the timber output consider a window of initial planting to final harvest, w than one forest is involved and segregation is not prov involved, using averaged yearly data for all of the mat project is acceptable.	<ol style="list-style-type: none">4) Additionally, please provide written answers and documentation for the following questions:<ol style="list-style-type: none">a. What practices do the forest managers use to mitigate the impacts of climate change and increase resiliency for the forest ecosystems?b. Please characterize the silviculture used on the source forest(s) and share documentation of the source forest(s) forest management plan. Include stream buffers, the controls to protect soils and biodiversity, the controls to protect the habitat for any rare, threatened, or endangered plant or animal species that occur on the source forestlands, and the controls to prevent excessive soil erosion.c. What are the rotation lengths between final harvests at the source forest(s)? Do the forest managers use pre-commercial or commercial thinning to enhance forest quality?d. Confirm that no rare old-growth or forest conversion harvesting from prime, not previously logged forest lands will be included within the sourced material (unless such sourcing is from an ecologically restorative forest management plan that is attempting to maintain the values associated with the stand (e.g., removal of non-native species, conduct controlled burning, and thinning from below where restoration is appropriate).e. Please share documentation of the material sourcing control from the source forest(s) to the material delivery to the site. This shall include satellite photo images less than 5 years old, with GIS polygons identified, for the source forest(s) showing the forest management unit(s) where timber has been harvested for the project, and the year when harvesting has occurred.f. Has the source forest(s) been used to generate independently verified forest carbon credits? If so, please describe and provide documentation of the credit restrictions.g. What other characteristics do the source forest land(s) include that make their management climate smart and why?

The Impact of GWP Questions at Bidding

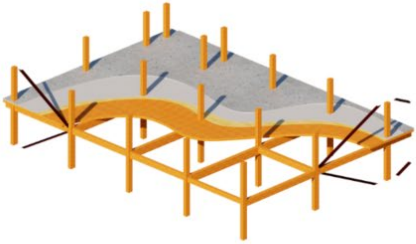
5000 psi Ready-Mix Concretes in Seattle

**+/-20%
Reduction!**

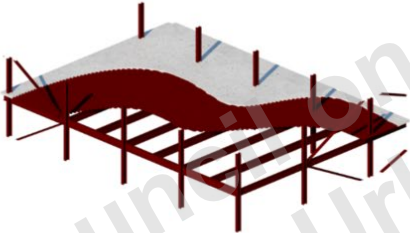
Average GWP,
kgCO₂e/m³



Floor System Case Study



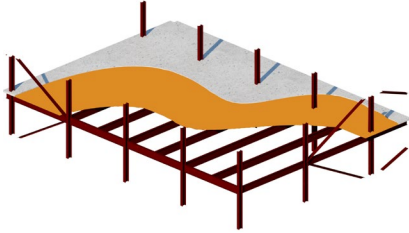
MASS TIMBER



STEEL (COMPOSITE)



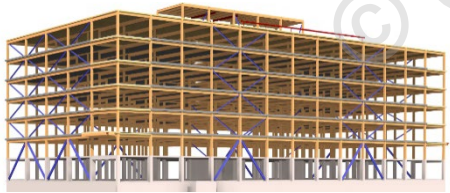
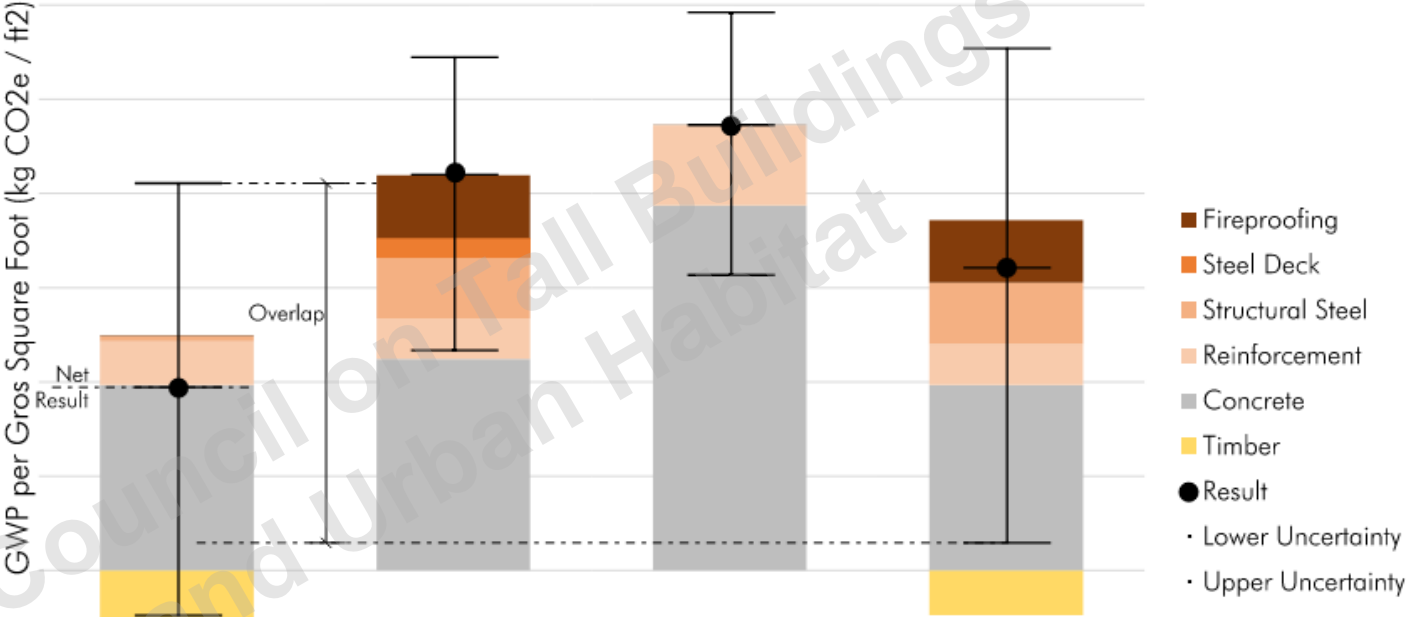
POST-TENSIONED CONCRETE



HYBRID TIMBER/STEEL/CONC

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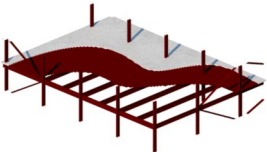
Floor System Case Study



BUILDING CONSIDERED IN FLOOR STUDY



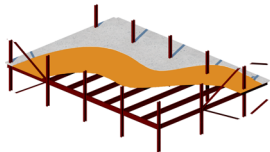
MASS TIMBER



STEEL (COMPOSITE)

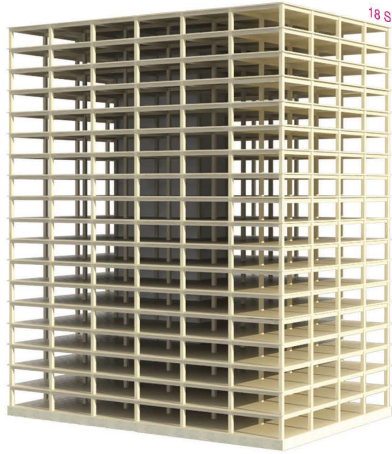


POST-TENSIONED CONCRETE

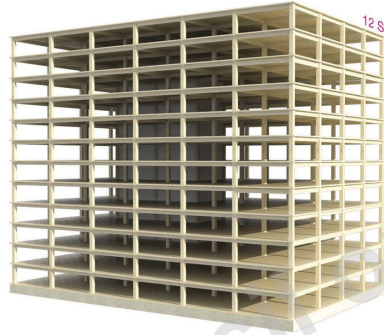


HYBRID TIMBER/STEEL/CONC

New Building Types – IBC 2021



18 S



12 S



9 S

18 STORIES
BUILDING HEIGHT 270'
ALLOWABLE BUILDING AREA 972,000 SF
AVERAGE AREA PER STORY 54,000SF

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

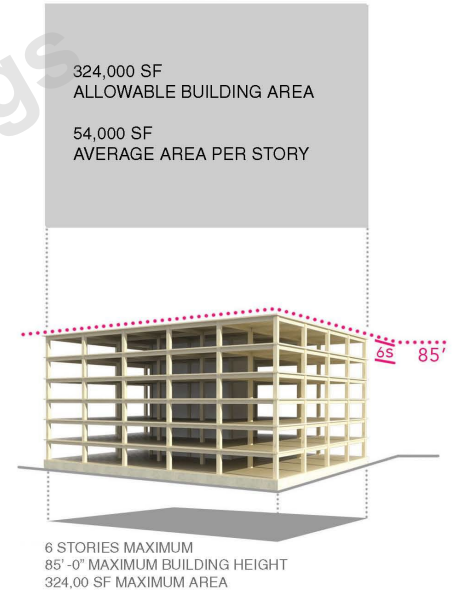
9 STORIES
BUILDING HEIGHT 85'
ALLOWABLE BUILDING AREA 405,000 SF
AVERAGE AREA PER STORY 45,000 SF

TYPE IV-A

TYPE IV-B

TYPE IV-C

IBC 2021



TYPE IV- HT

IBC 2015

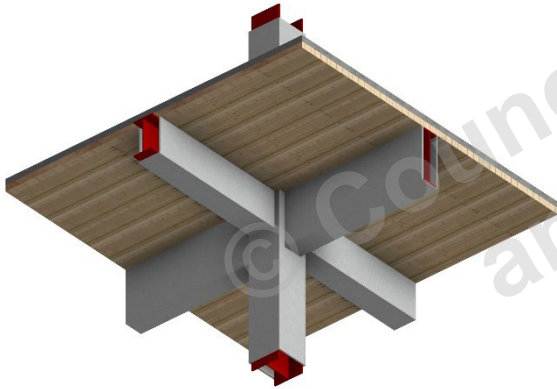
BUSINESS OCCUPANCY [GROUP B]

*BUILDING FLOOR-TO-FLOOR HEIGHTS ARE SHOWN AT 12'-0" FOR ALL EXAMPLES FOR CLARITY IN COMPARISON BETWEEN 2015 TO 2021 IBC CODES.

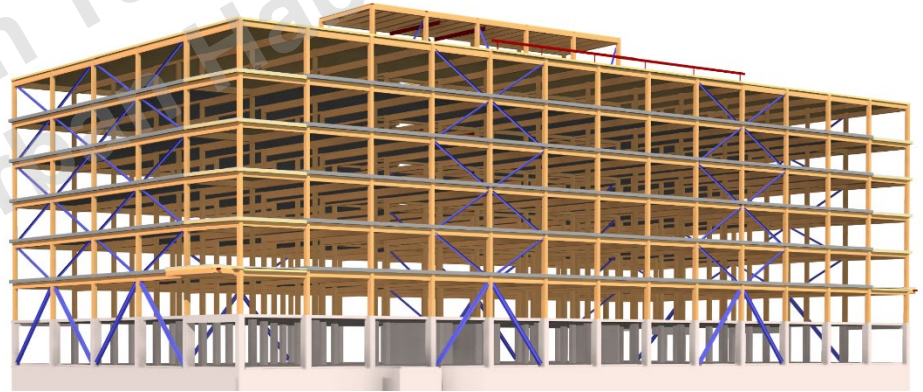
Full Structure Case Study



Mass Timber Floor Framing



Hybrid Floor Framing

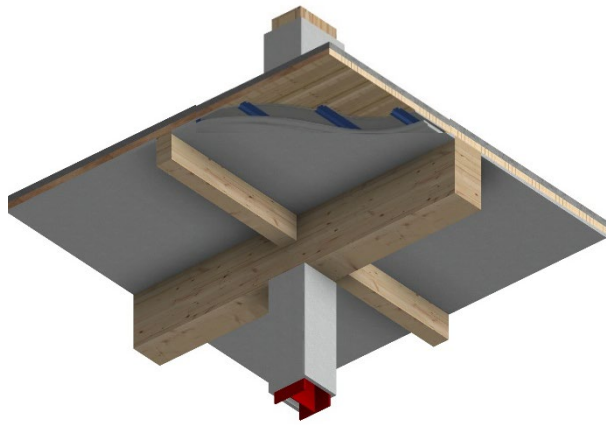


TYPE IV-HT

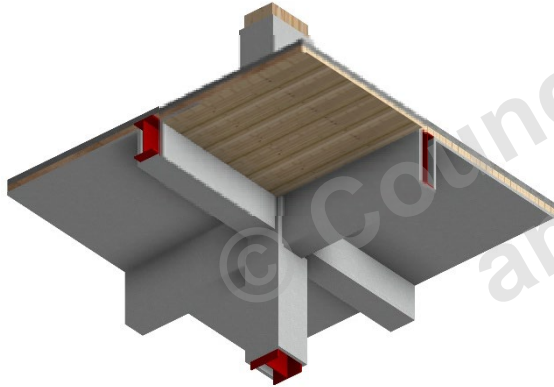
(TYPE IV-C not advantageous due to 85' limit...for this bldg.)

Mass timber surfaces exposed)

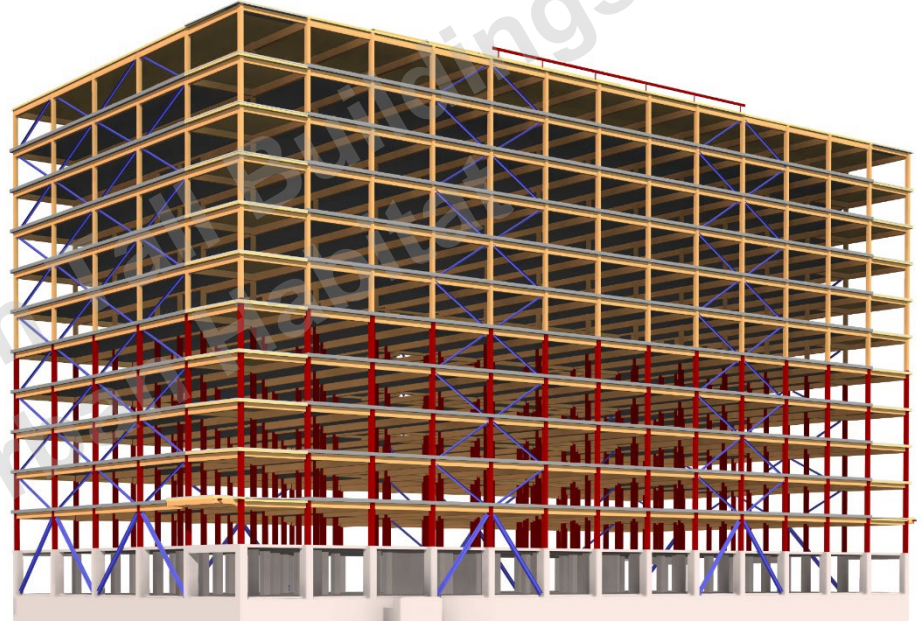
Full Structure Case Study



Mass Timber Floor Framing



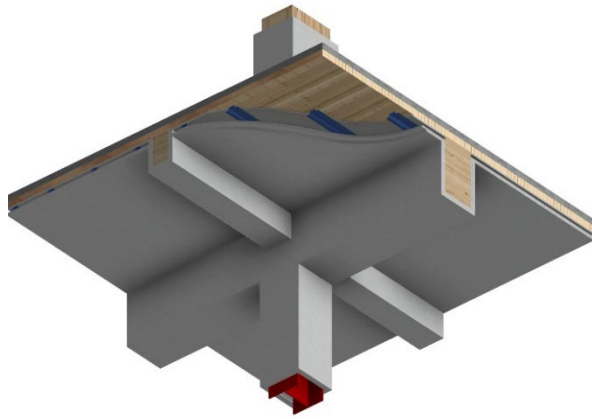
Hybrid Floor Framing



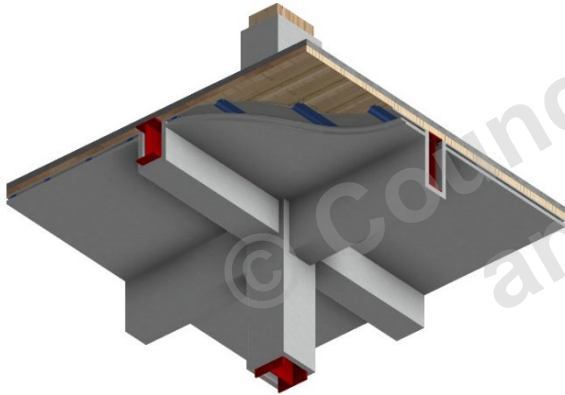
TYPE IV-B

(~20% of Ceiling or ~40% of Wall can be exposed)

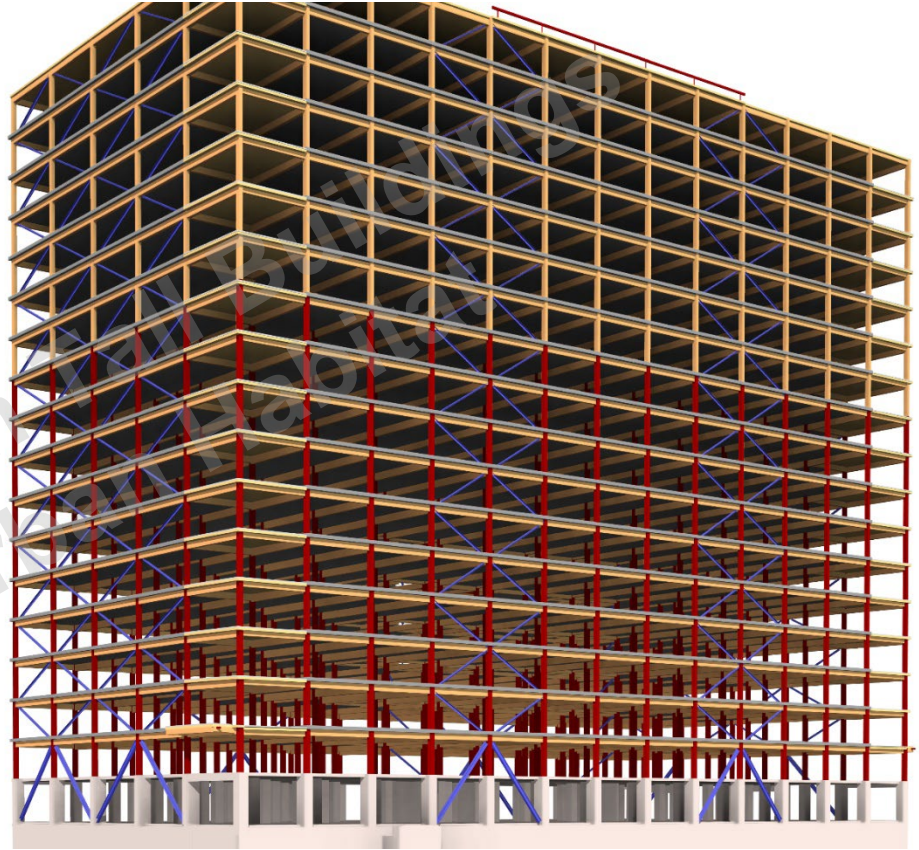
Full Structure Case Study



Mass Timber Floor Framing



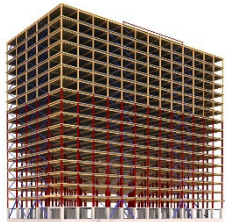
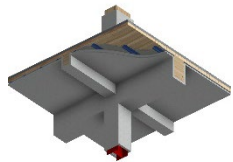
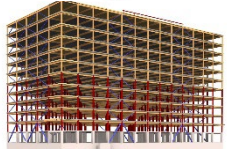
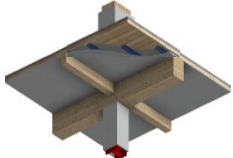
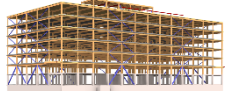
Hybrid Floor Framing



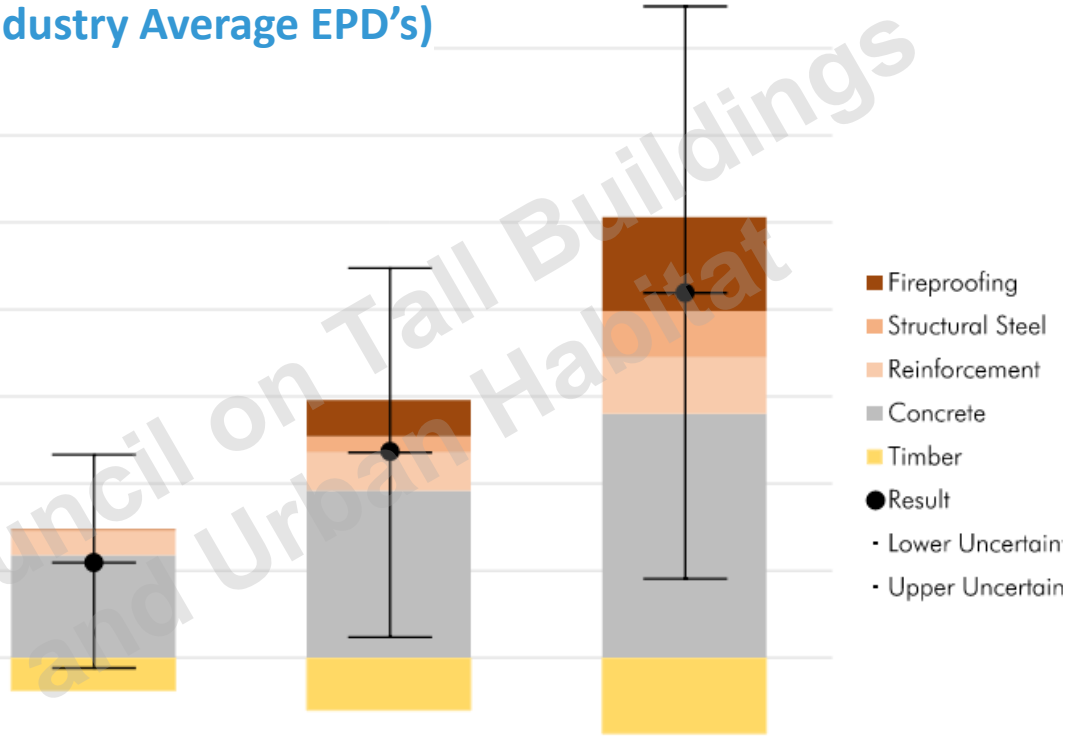
TYPE IV-A

(100% fire protection on all surfaces)

Full Structure GWP Comparison (Industry Average EPD's)



GWP (kg CO₂e)



TYPE IV-HT



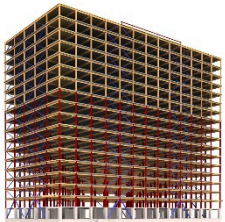
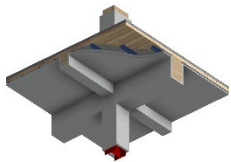
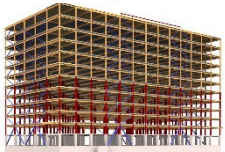
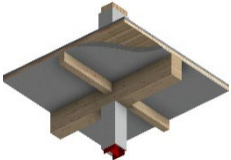
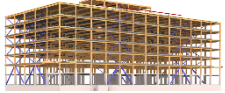
TYPE IV-B



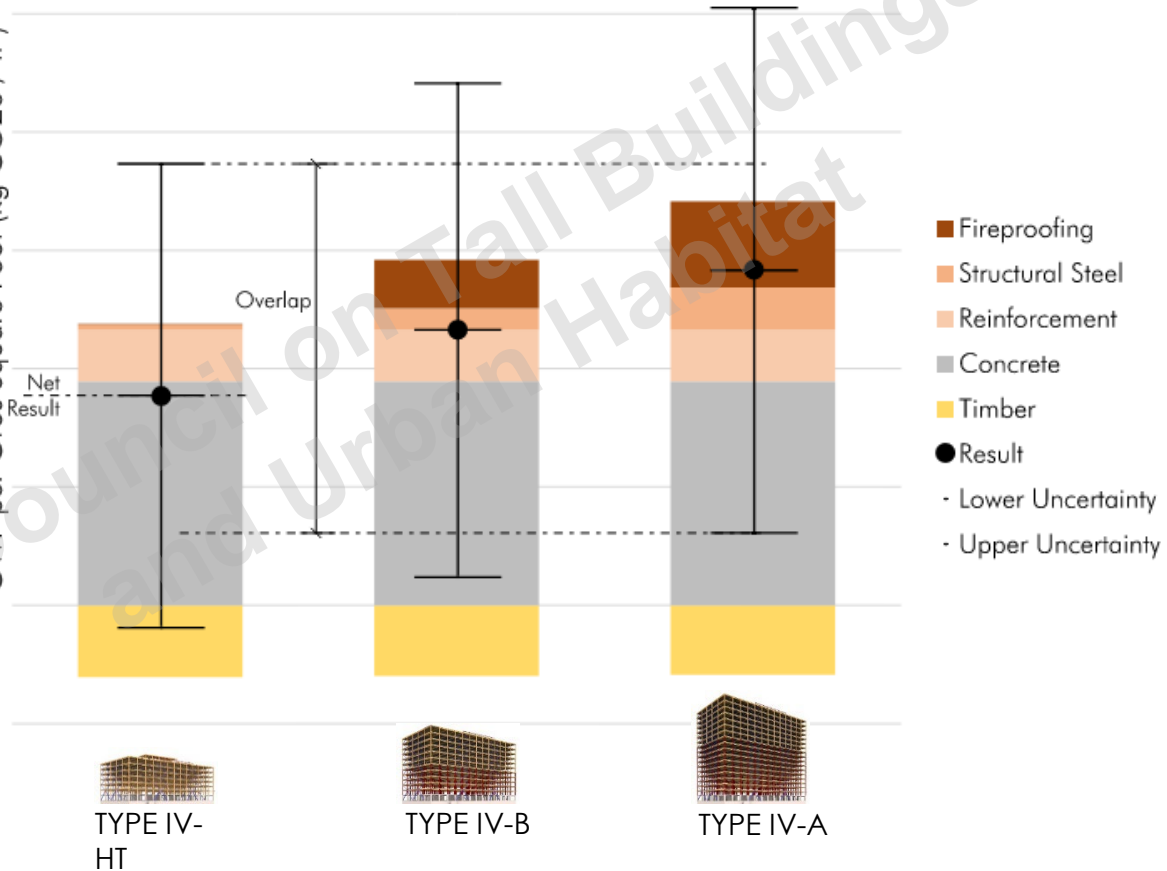
TYPE IV-A

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Per Square Foot GWP Comparison (Industry Average EPD's)



GWP per Gros Square Foot (kg CO2e / ft²)



Full Structure Case Study

Next Steps

<u>Southeast U.S.</u>				
IBC Designation	GWP (kg CO2e) by Structural System Material			
	Mass Timber	Steel (Composite)	PT Concrete	Hybrid Timber/Steel
Type IV-C	xxx	xxx	xxx	xxx
Type IV-B	xxx	xxx	xxx	xxx
Type IV-A	xxx	xxx	xxx	xxx

<u>Northeast U.S.</u>				
IBC Designation	GWP (kg CO2e) by Structural System Material			
	Mass Timber	Steel (Composite)	PT Concrete	Hybrid Timber/Steel
Type IV-C	xxx	xxx	xxx	xxx
Type IV-B	xxx	xxx	xxx	xxx
Type IV-A	xxx	xxx	xxx	xxx

<u>Pacific Northwest U.S.</u>				
IBC Designation	GWP (kg CO2e) by Structural System Material			
	Mass Timber	Steel (Composite)	PT Concrete	Hybrid Timber/Steel
Type IV-C	xxx	xxx	xxx	xxx
Type IV-B	xxx	xxx	xxx	xxx
Type IV-A	xxx	xxx	xxx	xxx

Expand study to include multiple building heights for each structural material across three geographical regions

Considering varying proportions of each material in hybrid schemes

Hybrid



USE MATERIALS WHERE THEY ARE MOST EFFICIENT AND
EACH DOES MORE THAN ONE JOB

LOWER COST & CONSERVATION OF RESOURCES

(Industry Average Data doesn't support making definitive carbon claims, you need to know where it comes from and how it was sourced...for all materials)



