




KL&A
Engineers & Builders

TRACKING CARBON THROUGH DESIGN: FROM EARLY-STAGE CARBON ACCOUNTING TO WHOLE BUILDING LIFE CYCLE ASSESSMENT

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

- 
- RETURN TO FORM LCA CASE STUDY
 - RETURN TO FORM vs PLATTE 15 LCA CASE STUDIES
 - EMBODIED CARBON QUANTIFICATION AT EARLY DESIGN

OUTLINE

Multifamily / Retail

Type IV-B Construction, IBC 2018 with Denver Amendments

12 Story

No below grade

L1: Drilled Piers + Concrete Slab on Grade

L2-L4: Concrete Slabs

L5 - Roof: Mass Timber

Concrete Cores

20' x 20' Grid

RETURN TO FORM

Denver, Colorado

Multifamily / Retail

Type IV-B Construction, IBC 2018 with Denver Amendments

12 Story

No below grade

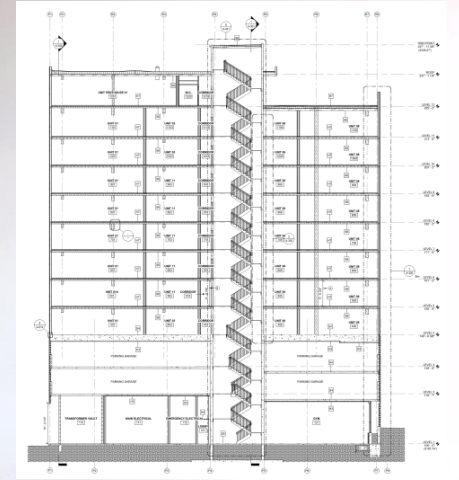
L1: Drilled Piers + Concrete Slab on Grade

L2-L4: Concrete Slabs

L5 - Roof: Mass Timber

Concrete Cores

20' x 20' Grid



RETURN TO FORM

Denver, Colorado



RETURN TO FORM

Structural LCA (Preliminary Results)

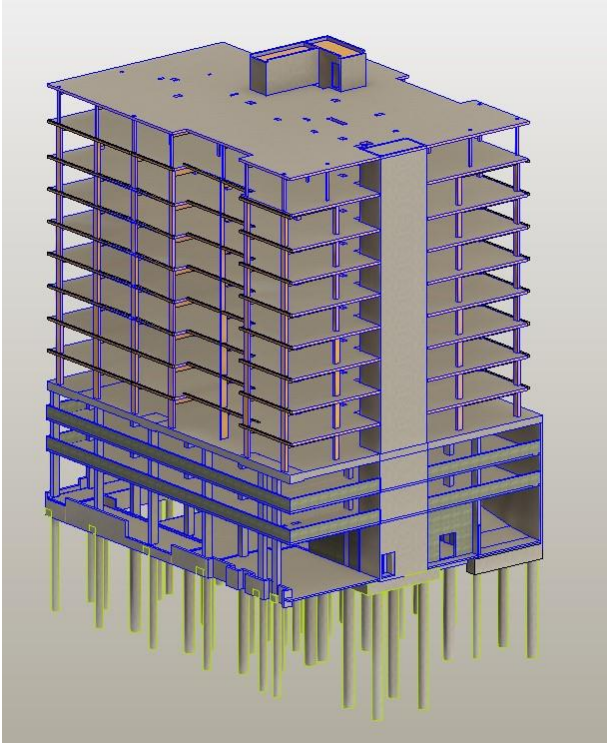


LIFE CYCLE STAGES

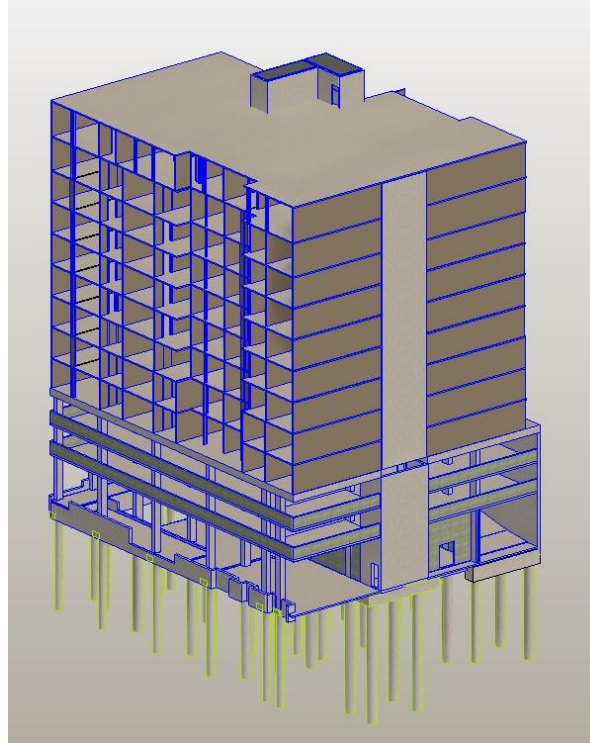
Product			Construction		Use							End-of-Life				Module D		
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Raw material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste Processing	Disposal	Reuse	Recycling	Energy Recovery

CRADLE TO GATE →

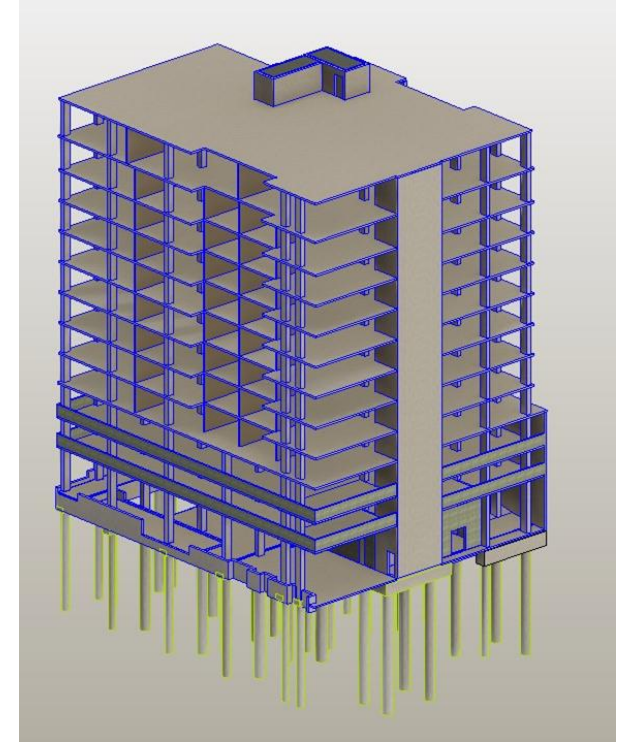
CRADLE TO GRAVE →



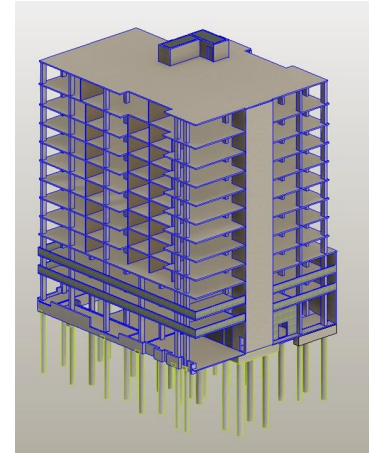
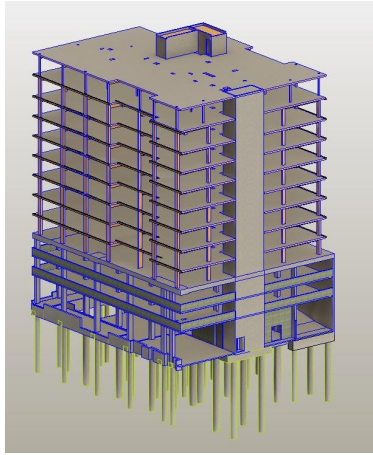
MASS TIMBER
(AS DESIGNED)



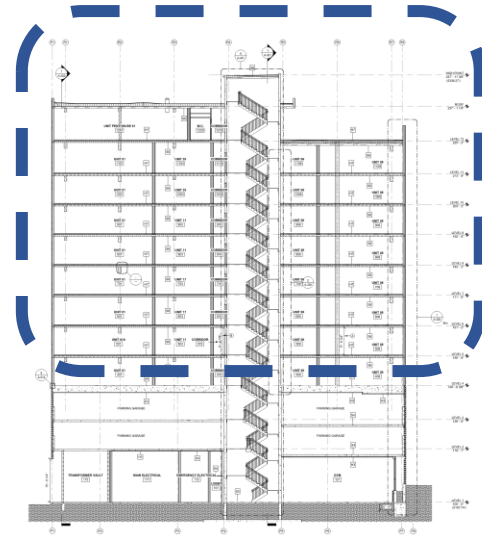
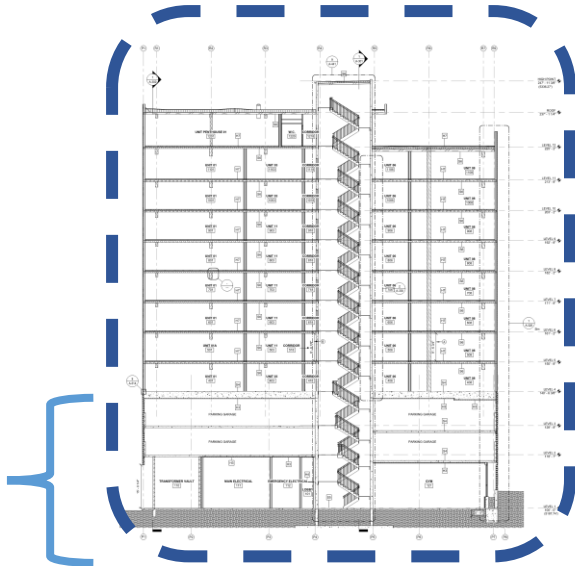
STEEL
(CFS & DECK)



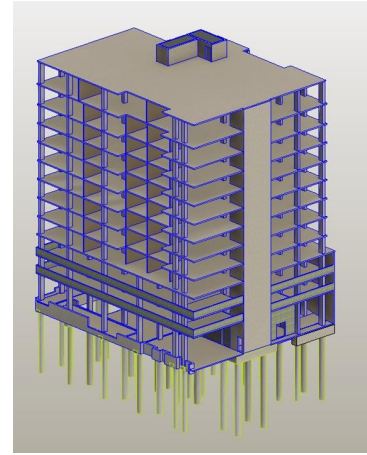
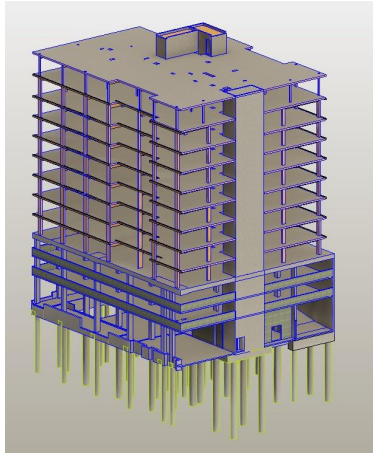
PT CONCRETE



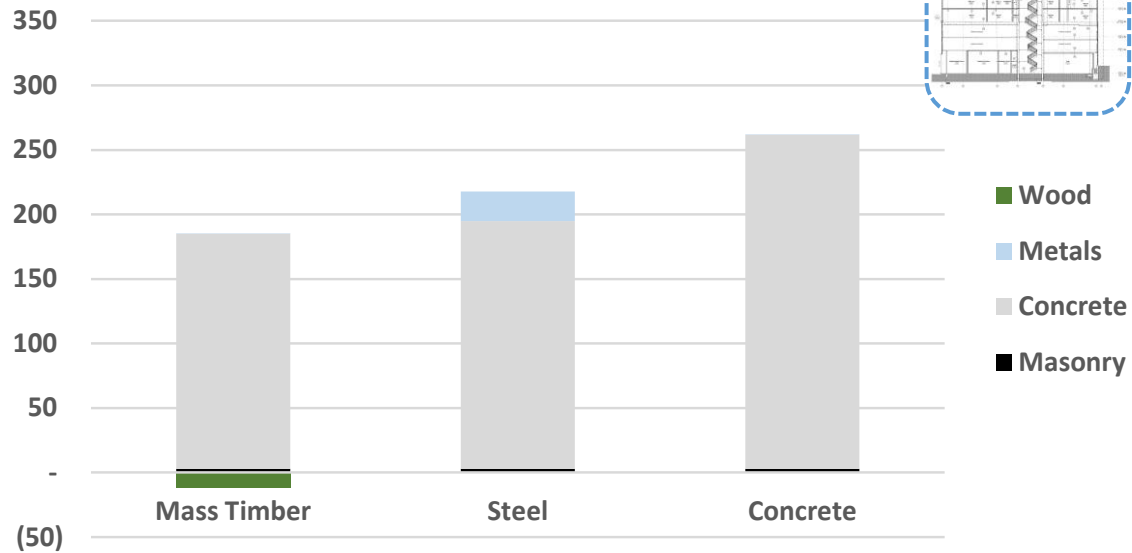
The GWP is
dominated
by this piece



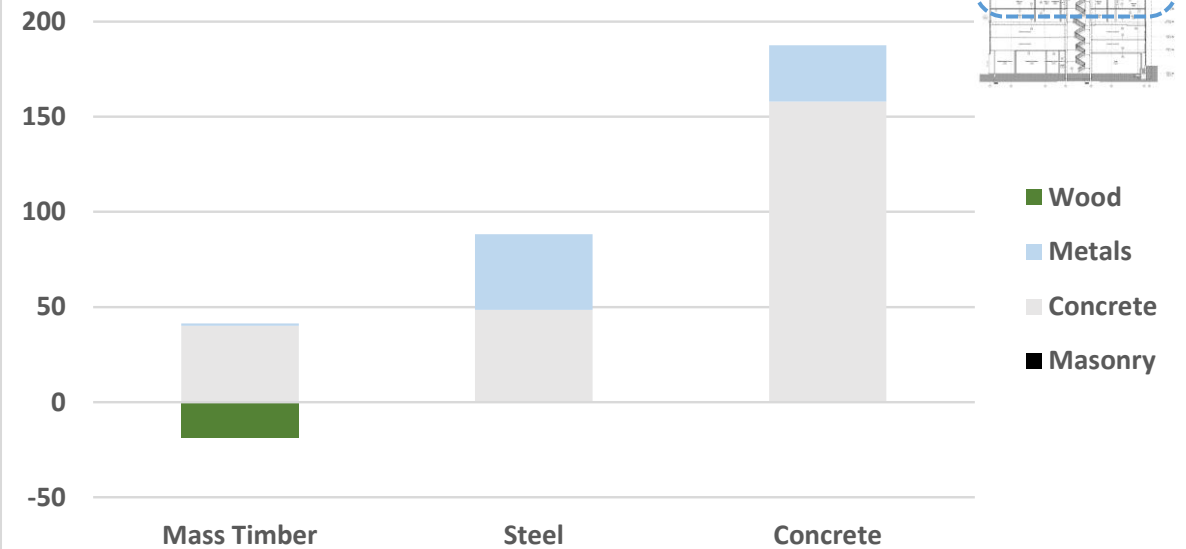
Floor assembly,
(including topping)
framing, columns,
bearing walls

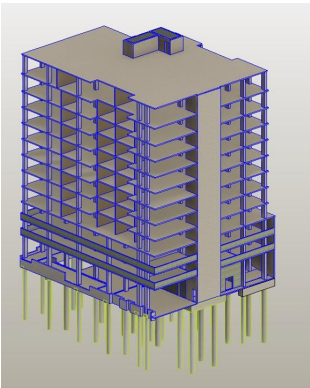
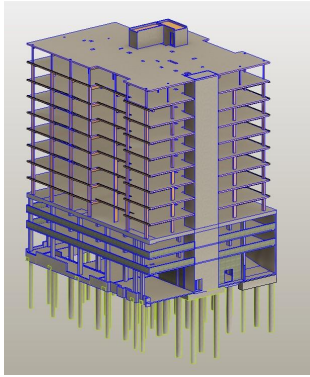


Total GWP/M² Per Building System

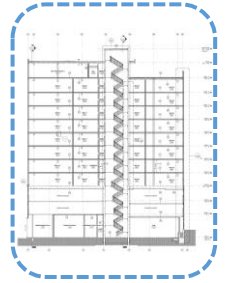
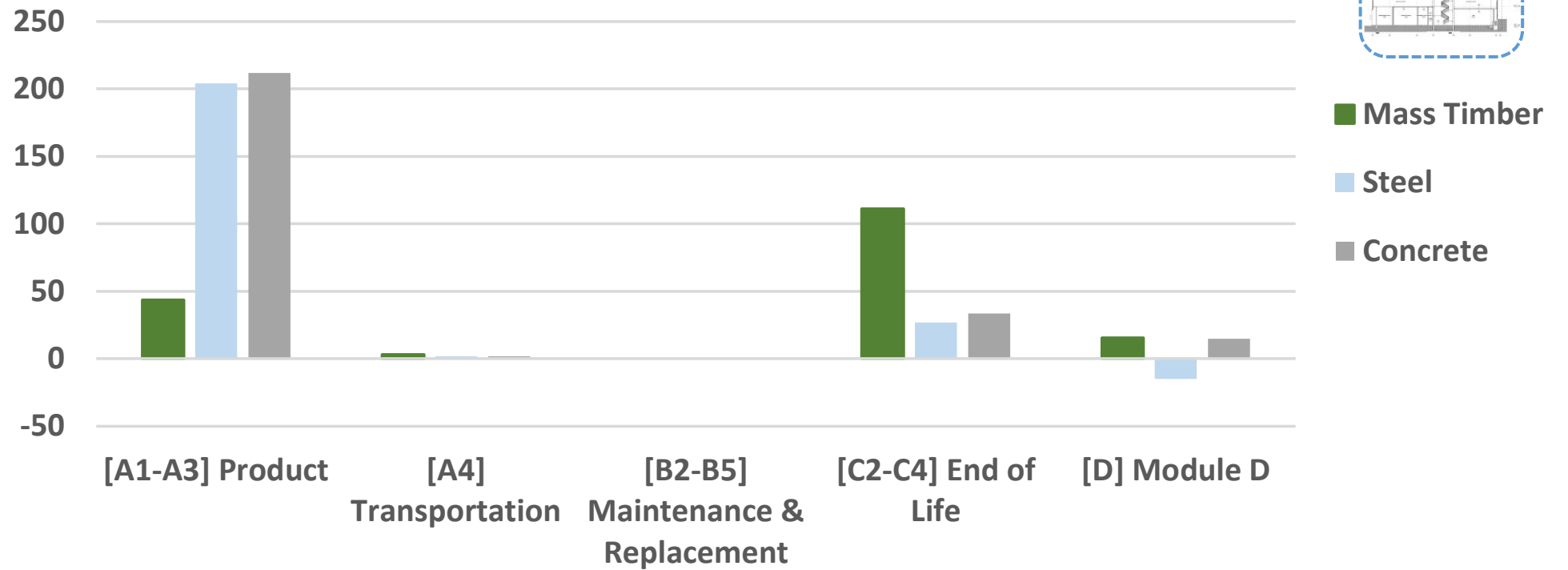


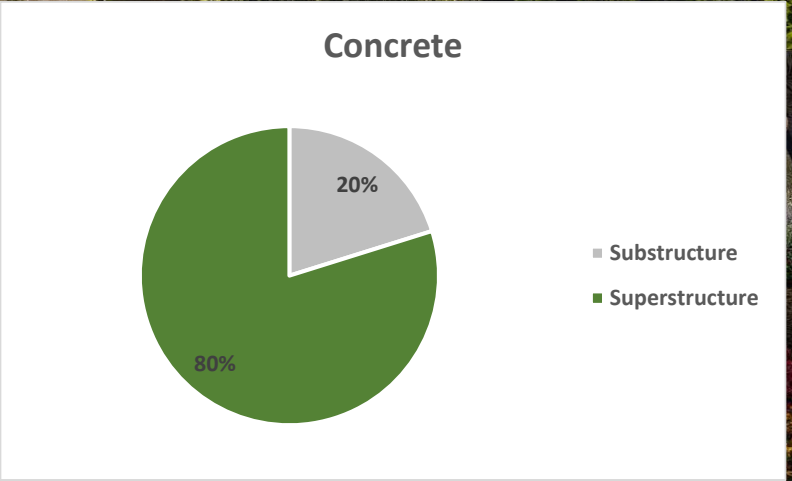
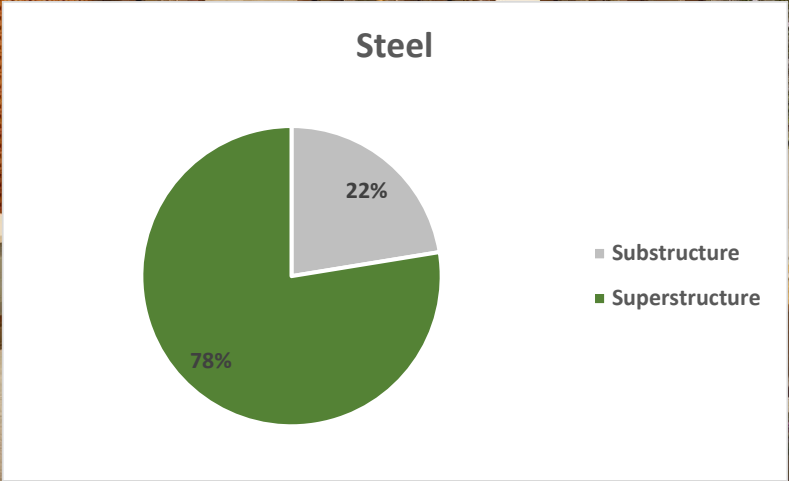
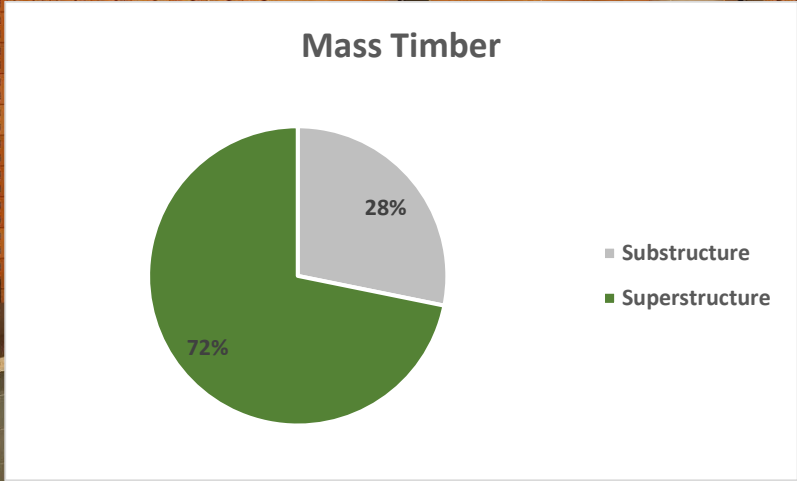
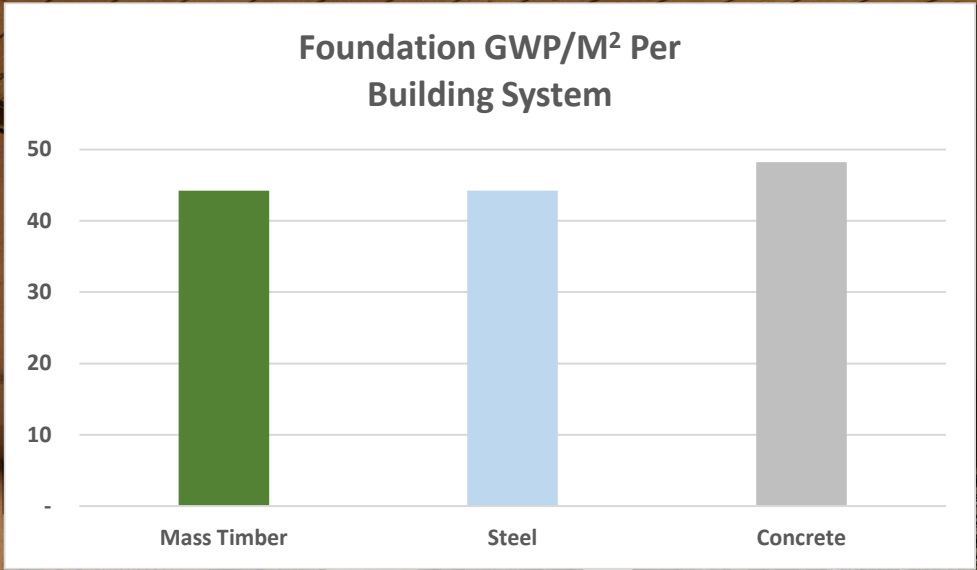
Total GWP/M² Above Podium Slab Per Building System



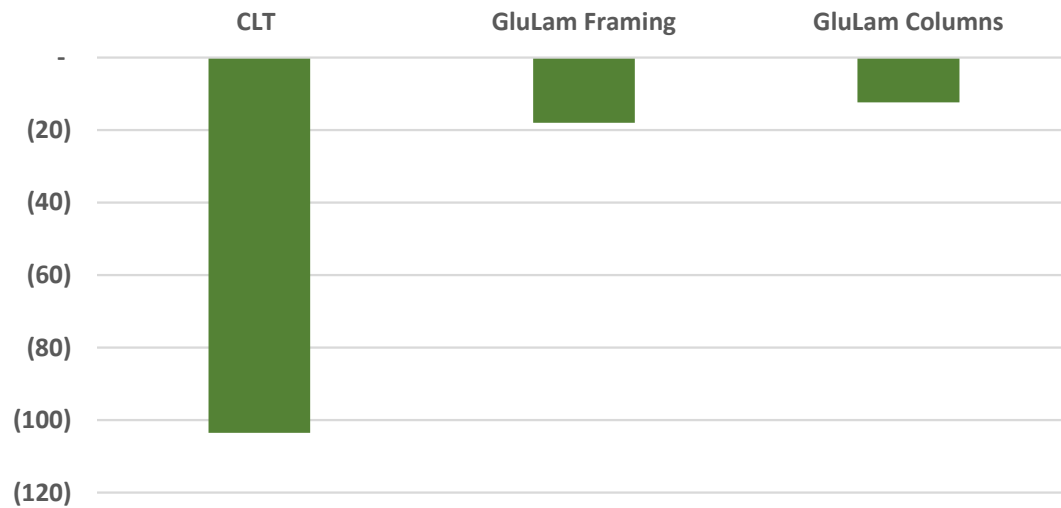


Total GWP/M² Per Life Cycle Stage





Maximum Stored Biogenic Carbon Potential



1738 Metric Ton of CO₂eq

= 4.3 Million Miles Driven by Standard Vehicle

= 240 First Class Roundtrip Flights from Denver to London

= 335 Homes' Electricity Use for 1 Year

= 5 Minutes for US and Canadian Forests to Grow

Office / Retail

Type III-B over IA Construction, IBC 2015

P2: Concrete Mat Slab Foundation

P1, L1: Concrete Slabs

L2: Concrete Podium Slab

L3- Roof: Mass Timber

Concrete Cores

30' x 30' Grid

Platte Fifteen Life Cycle Assessment



Authors
KL&A Engineers and Builders
Adolfson & Peterson

THINK
WOOD.



PLATTE FIFTEEN

Denver, Colorado

Office / Retail

Type III-B over IA Construction, IBC 2015

P2: Concrete Mat Slab Foundation

P1, L1: Concrete Slabs

L2: Concrete Podium Slab

L3- Roof: Mass Timber

Concrete Cores

30' x 30' Grid



PLATTE FIFTEEN

Denver, Colorado



Multifamily / Retail

Type IV-B Construction, IBC 2018 + Denver Mods

12 Story

No below grade

L1: Drilled Piers + Concrete Slab on Grade

L2-L4: Concrete Slabs

L5 - Roof: Mass Timber

Concrete Cores

20' x 20' Grid



Office / Retail

Type III-B over IA Construction, IBC 2015

7 Story

P2: Concrete Mat Slab Foundation

P1, L1: Concrete Slabs

L2: Concrete Podium Slab

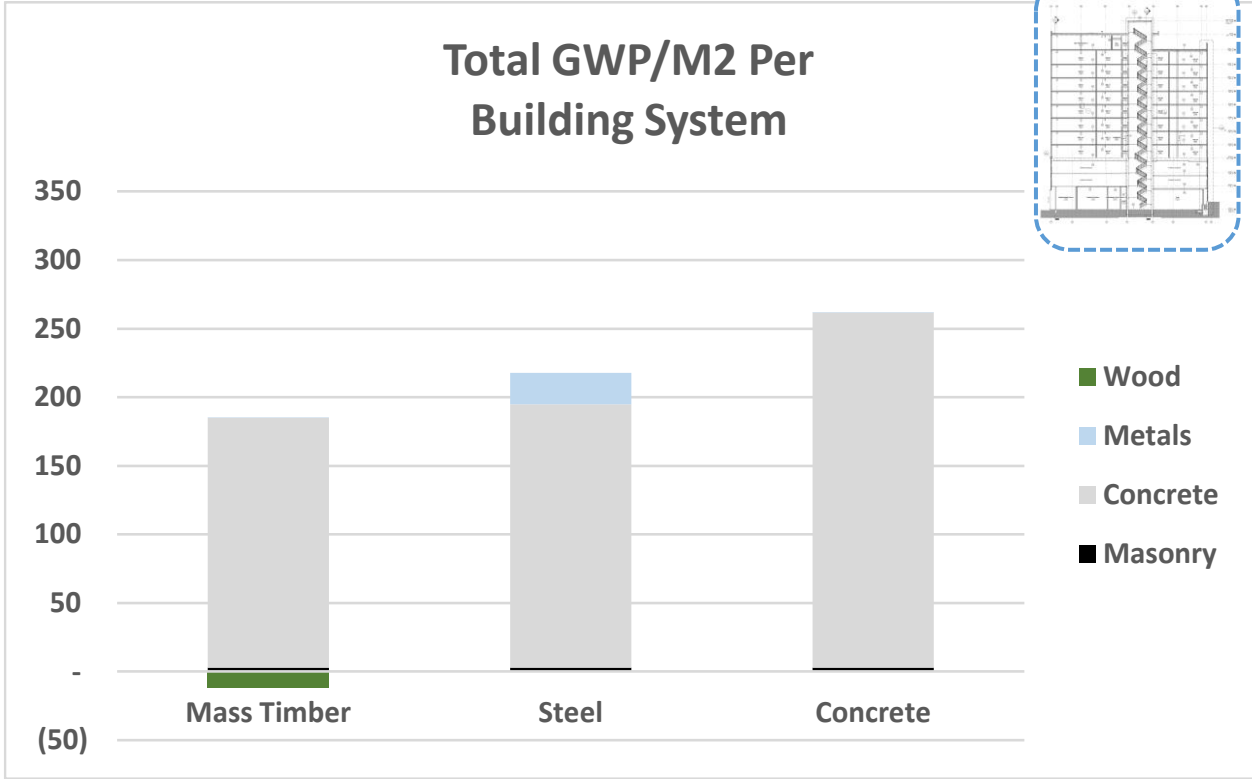
L3- Roof: Mass Timber

Concrete Cores

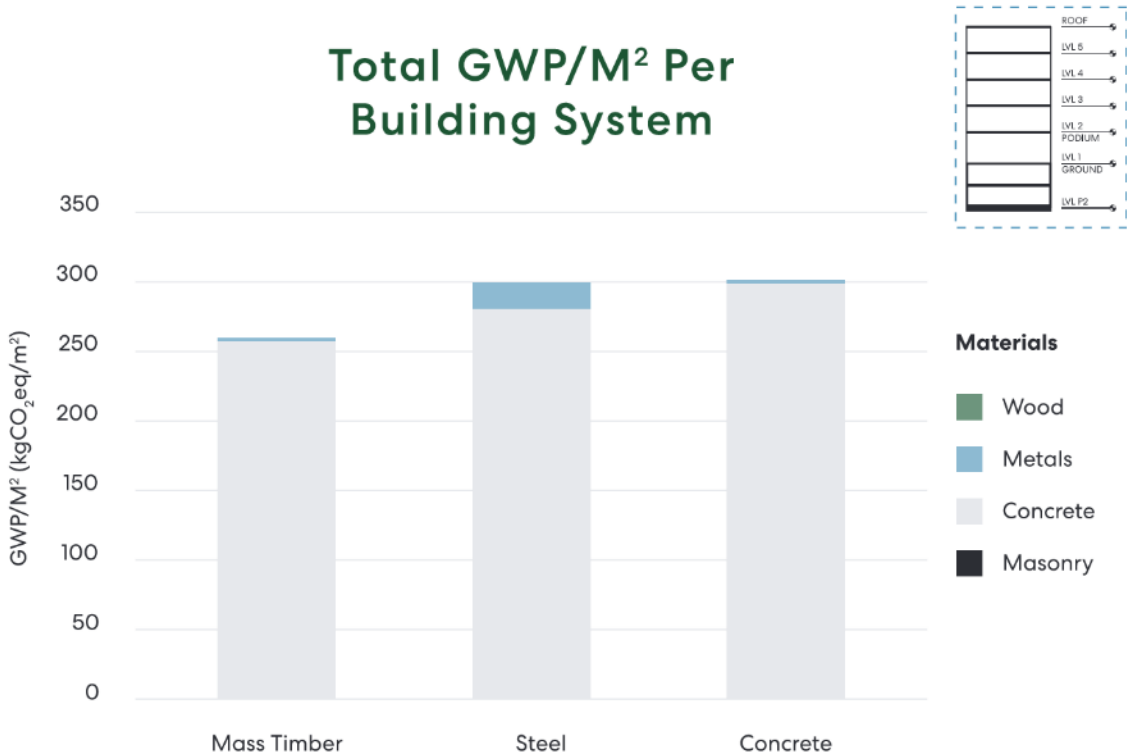
30' x 30' Grid

RETURN TO FORM & PLATTE FIFTEEN

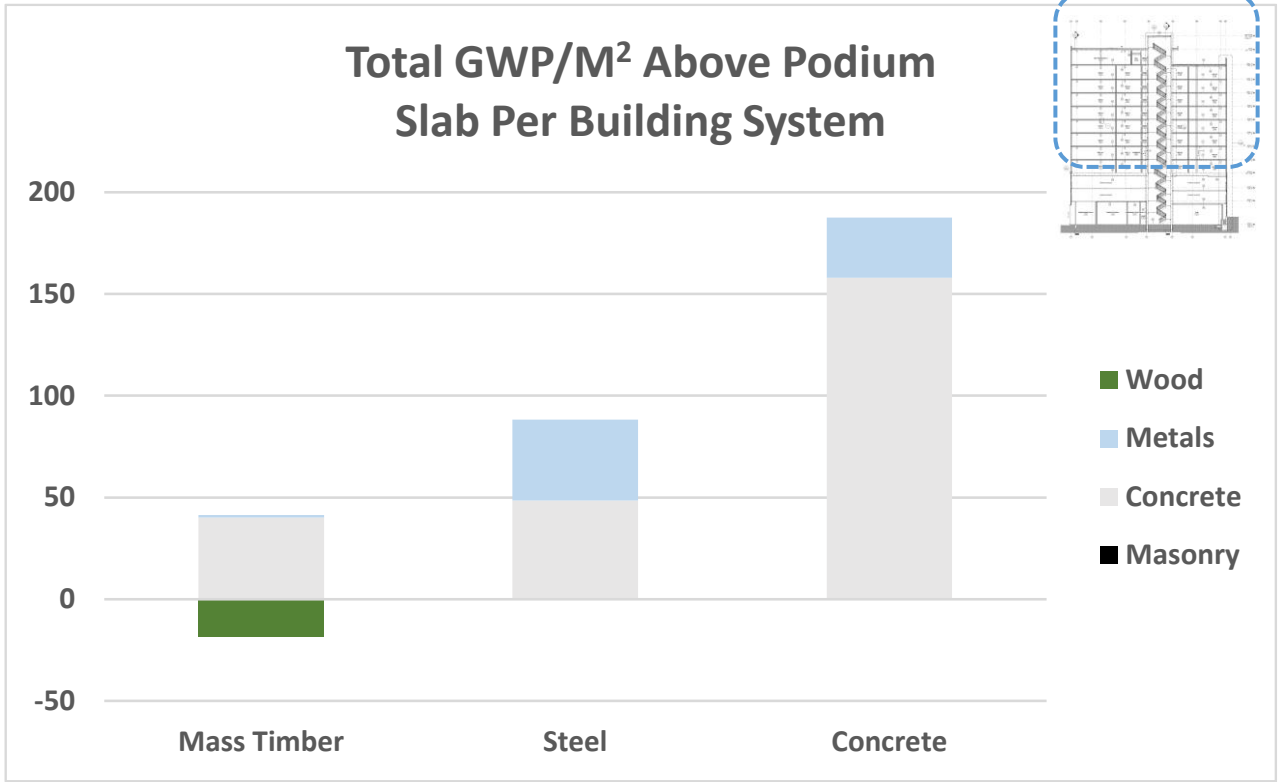
Total GWP/M2 Per Building System



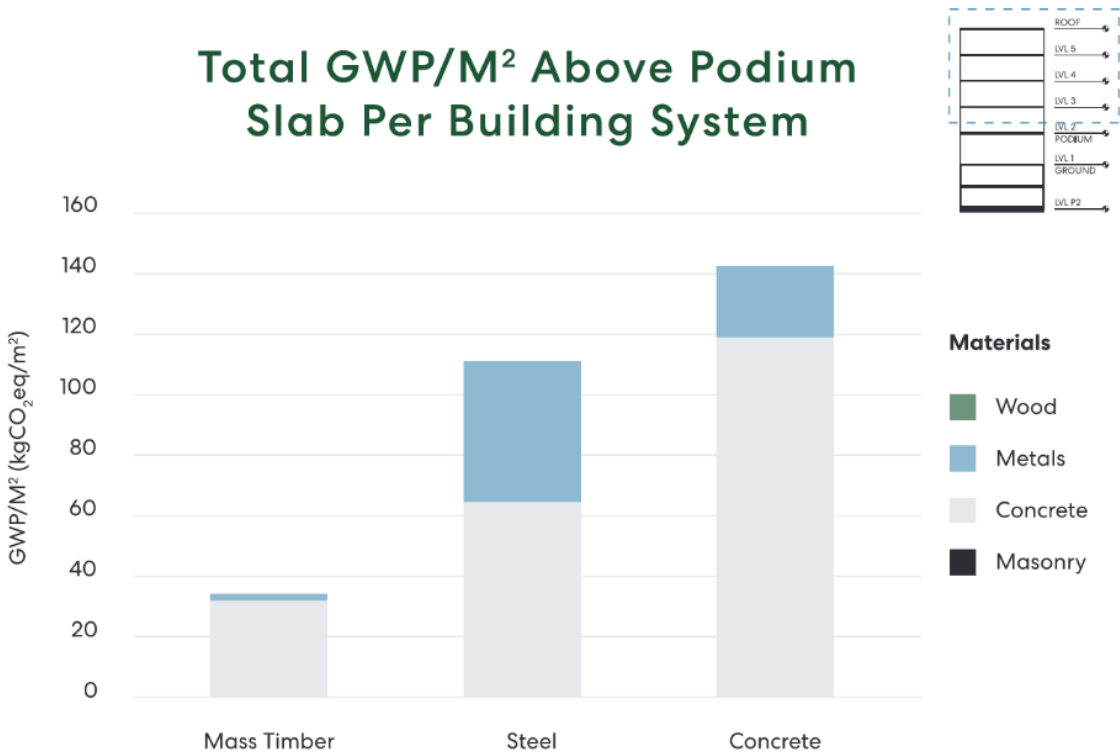
Total GWP/M² Per Building System

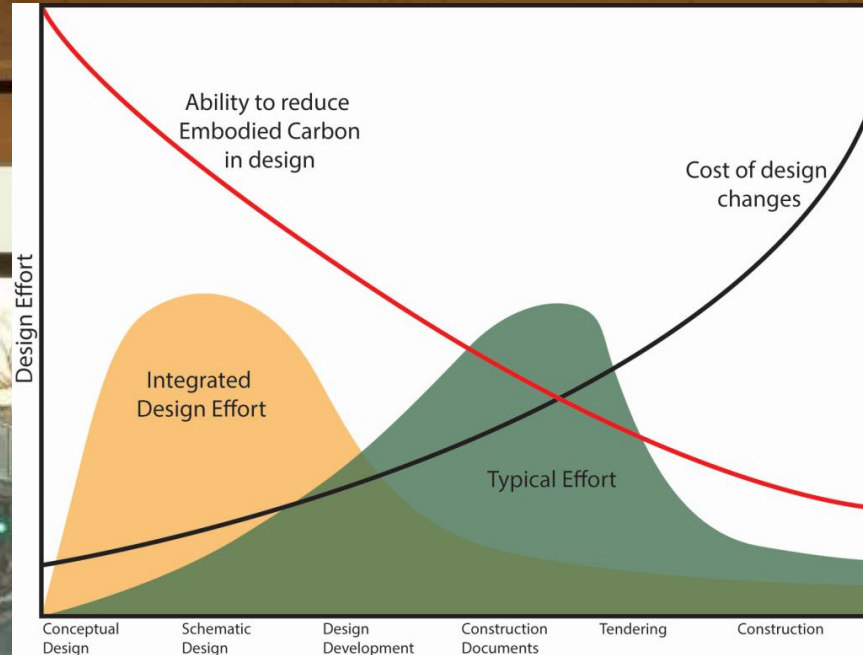


Total GWP/M² Above Podium Slab Per Building System



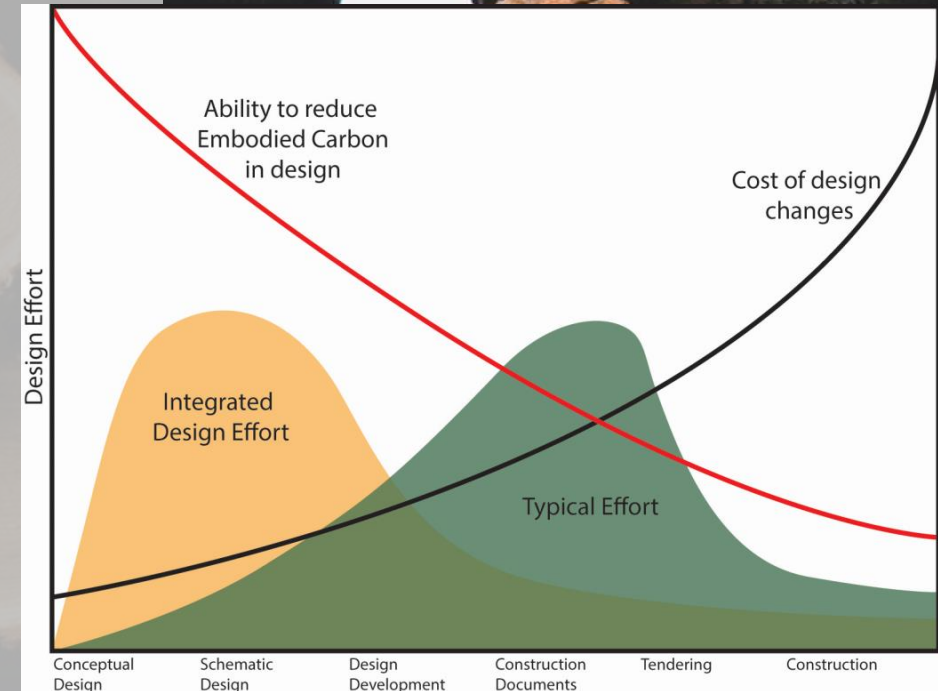
Total GWP/M² Above Podium Slab Per Building System





CONCEPTUAL DESIGN & CARBON QUANTIFICATION

- SYSTEM & MATERIAL COMPARISONS
- BAY LAYOUT COMPARISONS
- DEVELOP BASELINE
- IDENTIFY HOT SPOTS
- DEVELOP REDUCTION STRATEGIES

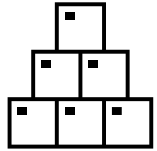


CONCEPTUAL DESIGN & CARBON QUANTIFICATION



LIFE CYCLE STAGES

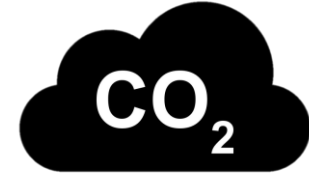
Product			Construction		Use							End-of-Life				Module D		
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D1	D2	D3
Raw material supply	Transport	Manufacturing	Transport	Construction/Installation	Use	Maintenance	Repair	Replacement	Refurbishment	Operational Energy Use	Operational Water Use	Deconstruction	Transport	Waste Processing	Disposal	Reuse	Recycling	Energy Recovery
CRADLE TO GATE																		
CRADLE TO GRAVE																		



**FUNCTIONAL
MATERIAL
QUANTITIES**



**MATERIAL/PRODUCT
LEVEL LCA
(EPD, LCI)**



**A1-A3
GWP IMPACT**

CONCEPTUAL DESIGN & CARBON QUANTIFICATION

- +1/-1 BIOGENIC CARBON
- A1-A3 vs A-C, A-D
- “MAXIMUM BIOGENIC CARBON POTENTIAL”
- DESIGN FOR DECONSTRUCTION & RECOVERY



BIOGENIC CARBON

SYSTEM COMPARISON				
TYPE	IV-HT	IV-HT	IV-HT	IV-C
BAY	20'x32'	30'x30'	30'x32'	20'x32'

SYSTEM COMPARISON				
TYPE	IV-HT	IV-HT	IV-HT	IV-C
TOTAL PER SYSTEM				
TYPE	IV-HT	IV-HT	IV-HT	IV-C
BAY	20'x32'	30'x30'	30'x32'	20'x32'
TIMBER VOLUME (FT ³ /FT ²)	0.747	0.782	0.790	0.895
CONC VOLUME (FT ³ /FT ²)	0.286	0.286	0.286	0.286
GYPCRETE VOLUME (FT ³ /FT ²)	0.071	0.071	0.071	0.071
TIMBER GWP (Crade-to-Gate, kgCO ₂ eq/FT ²)	2.538	2.651	2.677	3.035
CONC GWP (Crade-to-Gate, kgCO ₂ eq/FT ²)	3.611	3.611	3.611	3.611
GYPCRETE GWP (Crade-to-Gate, kgCO ₂ eq/FT ²)	0.559	0.559	0.559	0.559
GWP (Crade-to-Gate, kgCO ₂ eq/FT ²)	6.708	6.820	6.847	7.205
GWP (Crade-to-Gate, kgCO ₂ eq/M ²)	72.175	73.385	73.669	77.523
SEQUESTRATION POTENTIAL (kgCO ₂ eq/FT ²)	-19.698	-20.668	-20.896	-23.638
SEQUESTRATION POTENTIAL (kgCO ₂ eq/M ²)	-211.950	-222.390	-224.836	-254.347
TIMBER VOLUME CHANGE	Baseline	4.61%	5.69%	19.74%
GWP CHANGE	Baseline	1.68%	2.07%	7.41%
SEQUESTRATION POTENTIAL CHANGE	Baseline	4.93%	6.08%	20.00%
CONCRETE	-	-	-	-
GYPCRETE TOPPING	-	-	-	-

Self Leveling Underlayment EPD - Gypsum Lime Plaster (Tally)

Total System GWP is reported assuming Concrete with 20% Fly Ash. Total GWP can be reduced by 17-19% if Concrete with 50% Fly Ash is used

Table 1: Structural and Embodied Carbon System Comparison Results

CONCEPTUAL DESIGN SYSTEM COMPARISON

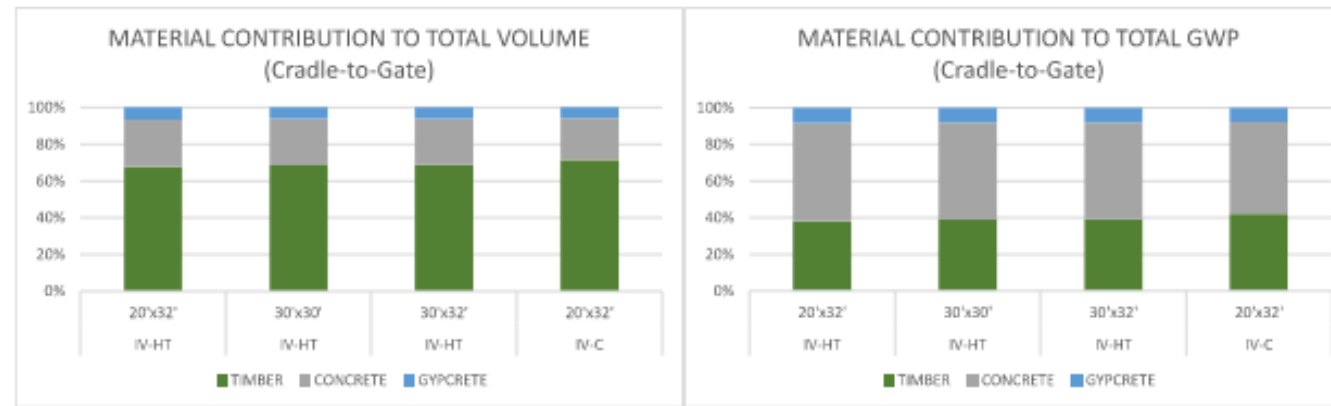


Figure 3: Volume versus GWP Material Contributions

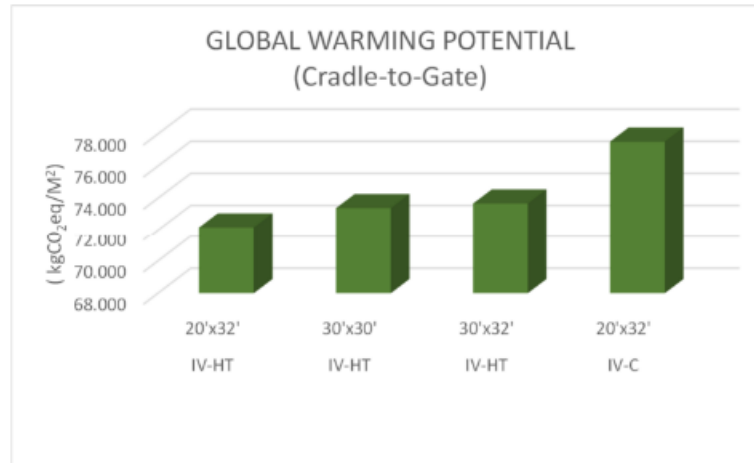


Figure 2: Total GWP System Comparison

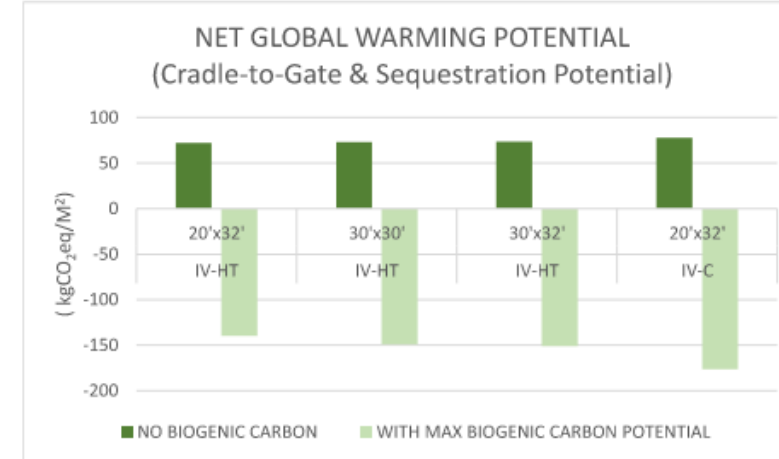


Figure 5: Net GWP with and without the potential offsets of Biogenic Carbon

CONCEPTUAL DESIGN SYSTEM COMPARISON

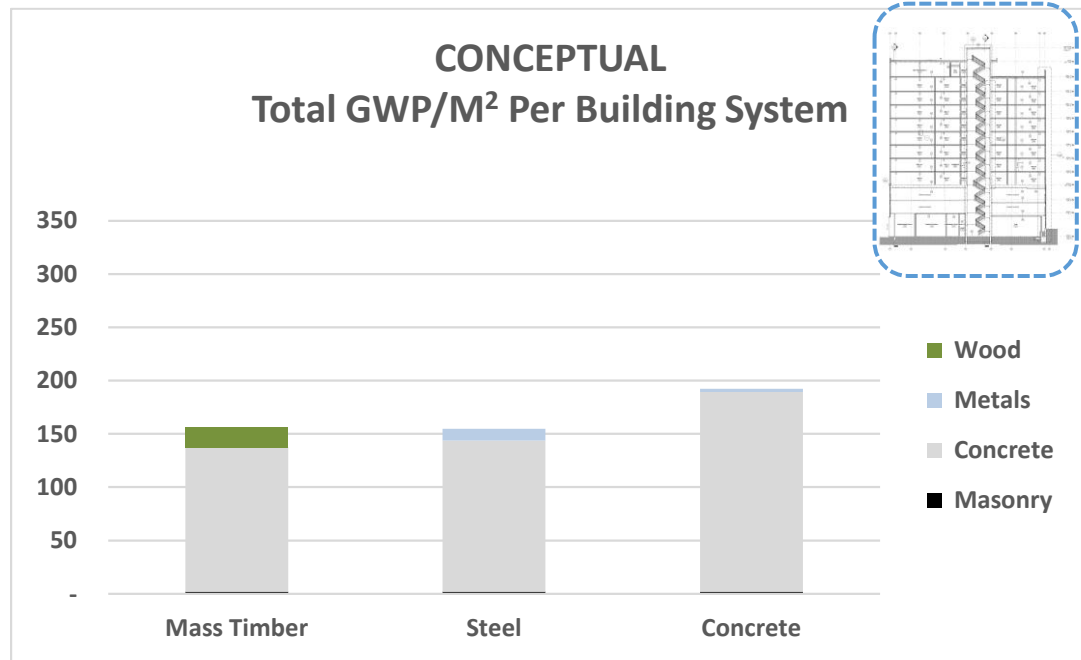


RETURN TO FORM

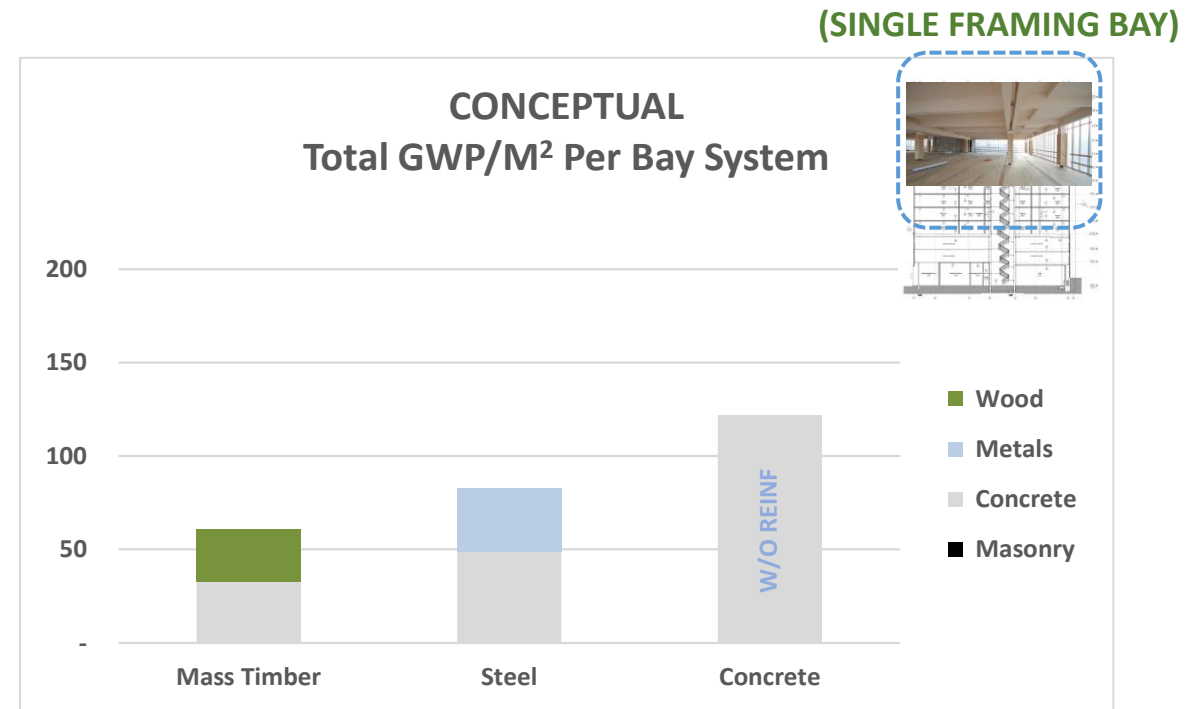
EARLY EMBODIED CARBON QUANTIFICATION

Photo by Aleksandar Radovanovic on Unsplash

RETURN TO FORM



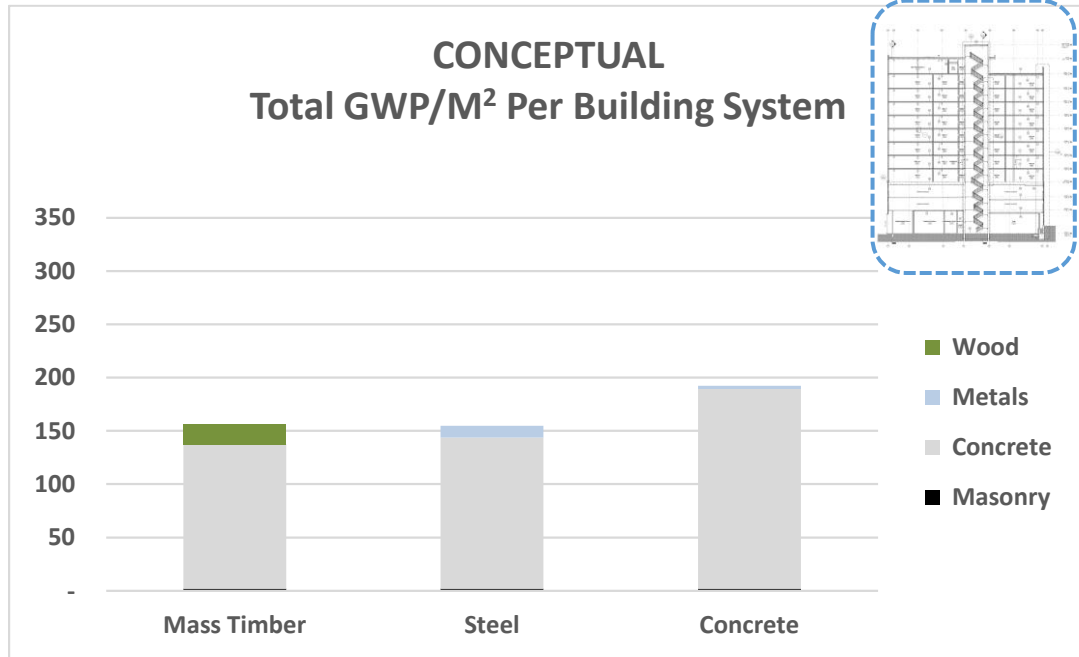
(WITHOUT BIOGENIC CARBON)



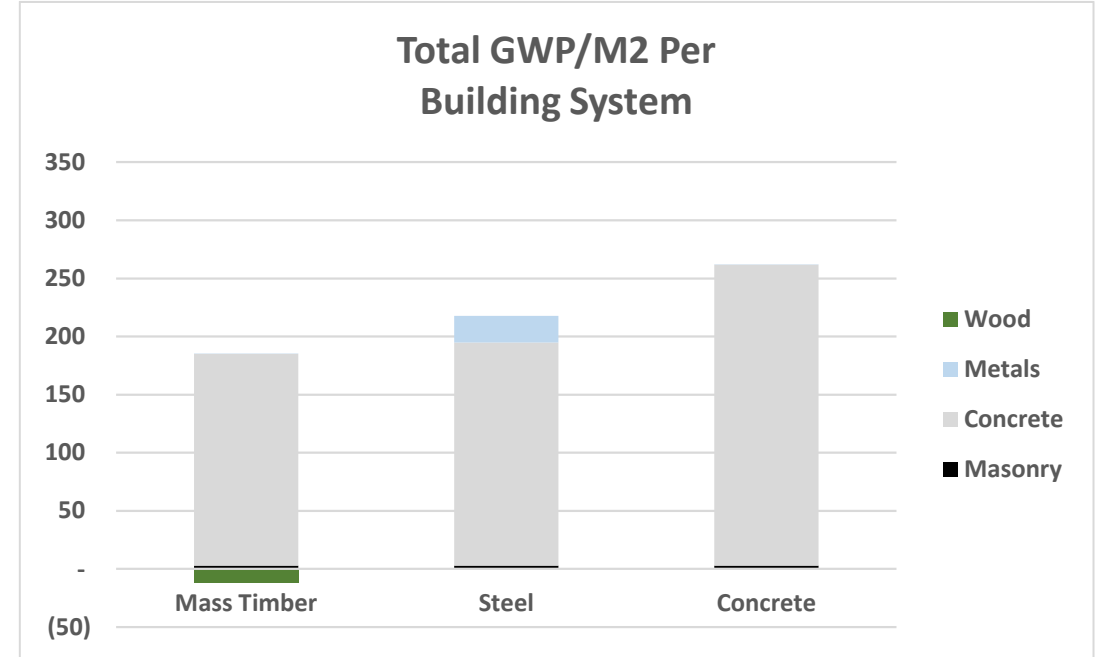
(WITHOUT BIOGENIC CARBON)

EARLY DESIGN

RETURN TO FORM



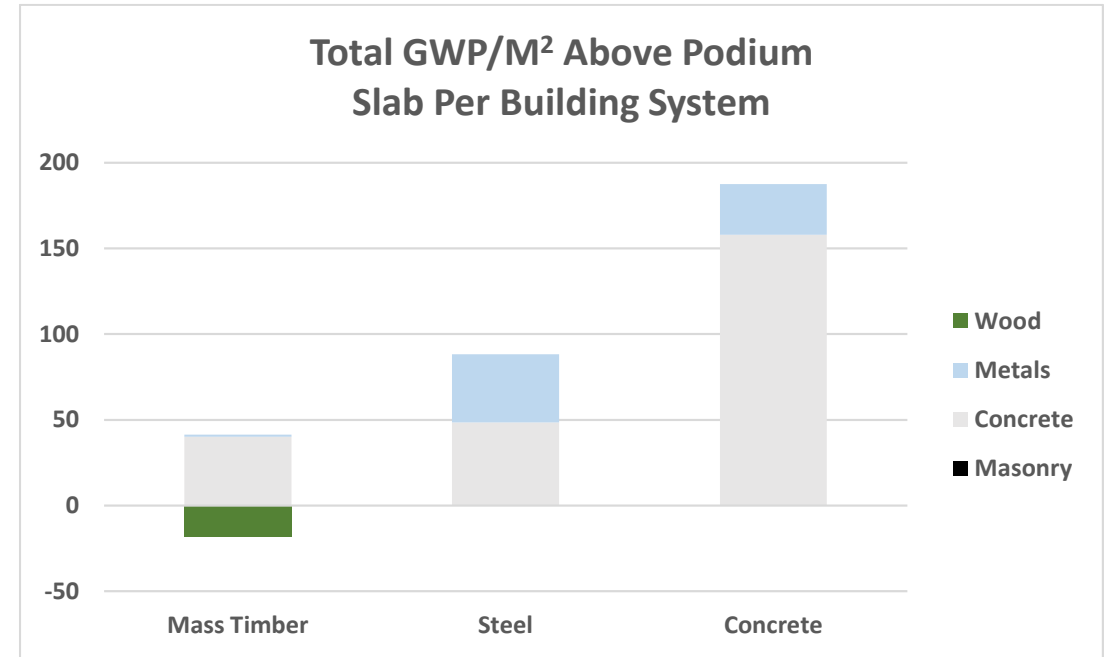
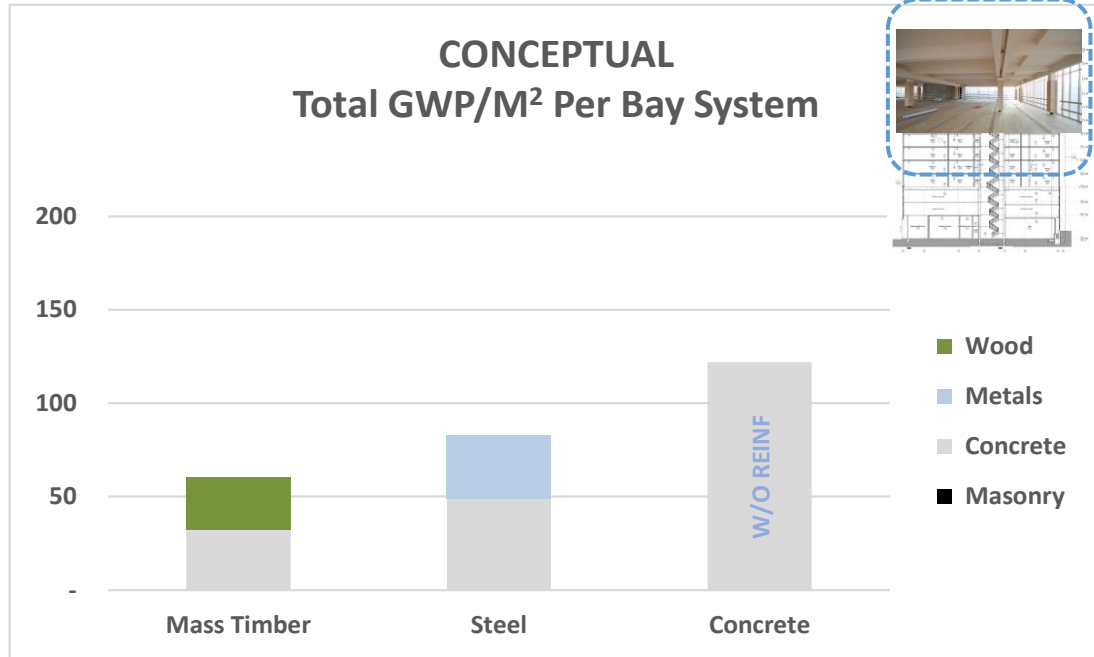
(WITHOUT BIOGENIC CARBON)



EARLY DESIGN

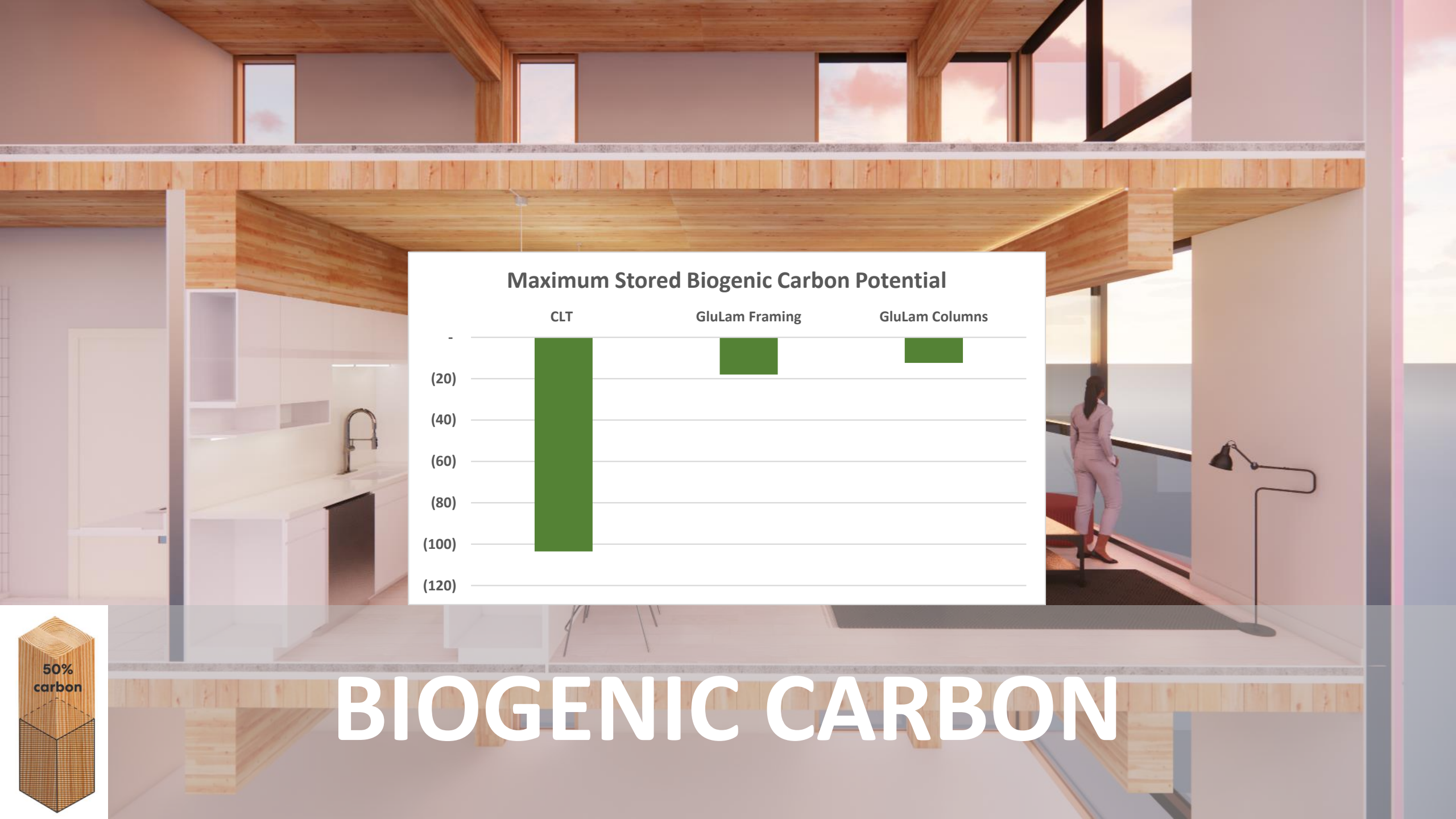
RETURN TO FORM

(SINGLE FRAMING BAY)

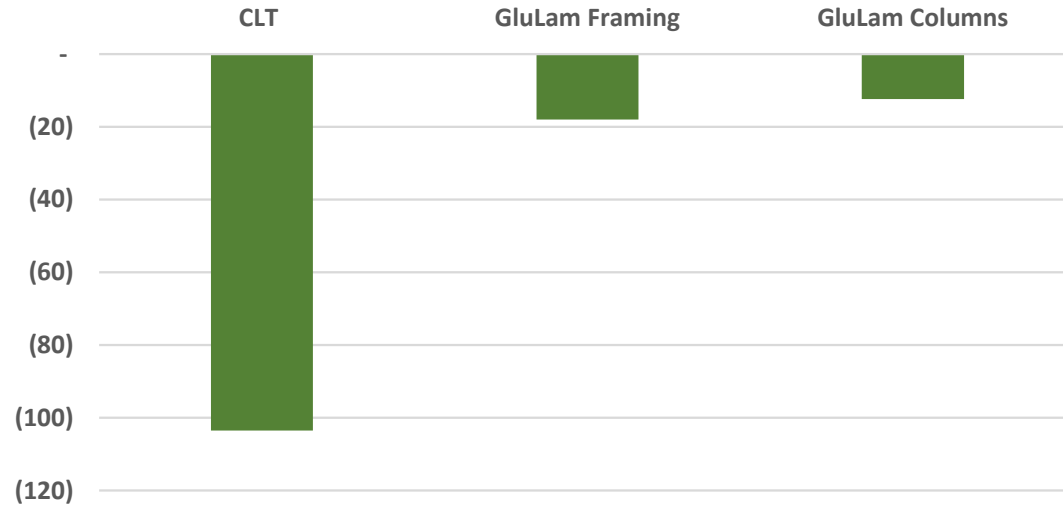


(WITHOUT BIOGENIC CARBON)

EARLY DESIGN



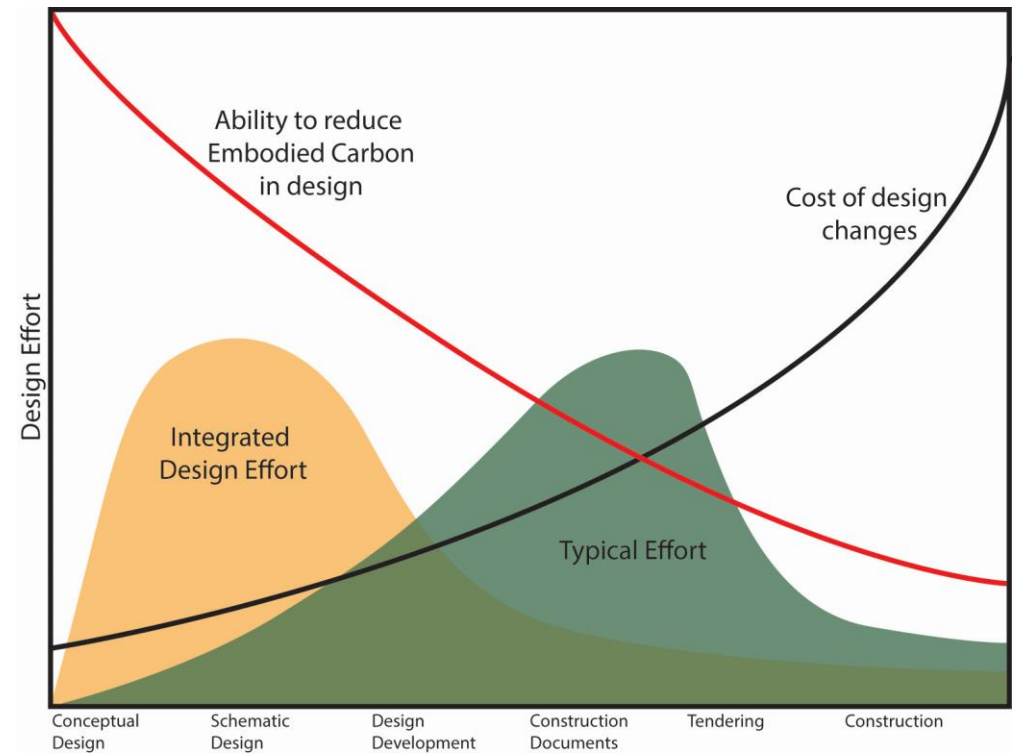
Maximum Stored Biogenic Carbon Potential



BIOGENIC CARBON



Photo Credit: JC Buck





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Engineers & Builders

THANK YOU

Alexis Feitel, PE, Team Carbon Unit Director & Structural Engineer afeitel@klaa.com

Photo Credit: JC Buck