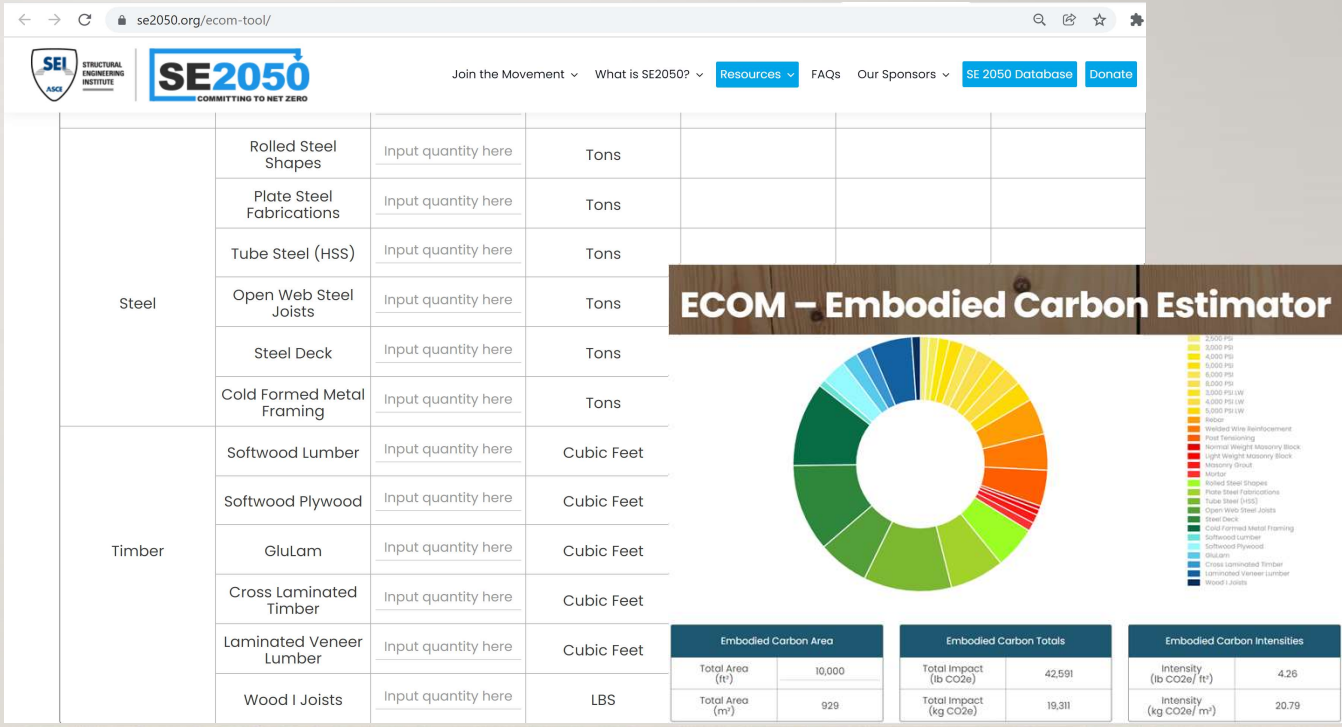
BACKGROUND WORK BEHIND ENGINEERED MODULAR BLOCKS COMPARISON

A CASE STUDY OF EMBODIED CARBON ESTIMATION WITH MODULAR ARCHETYPES

STRUCTURAL ENGINEERS 2050 COMMITMENT PROGRAM

ECOM stands for Embodied Carbon Order of Magnitude

"The underlying data has been gathered from publicly available industry-wide Environmental Product Declarations (EPD's) that are applicable to North America. In most cases they are the EPD's produced by the applicable trade organization and constitute Life-Cycle Assessment modules A1 to A3."



HIGH LOD 3D MODEL AS A SOURCE OF DATA FOR EMBODIED CARBON ESTIMATION

- ✓ Early-stage design data assessment.
- ✓ Visual comparison between construction types.
- ✓ Estimation of materials quantity based on a fabrication data.
- ✓ Cross platform data exchange.

cadwork® wood

CONSTRUCTION MATERIALS MAPPING

- Embodied Carbon Order of Magnitude (ECOM)

Environmental Product Declarations (EPD's) data-based set of materials commonly used construction materials.

-The Embodied Carbon in Construction Calculator (EC3) tool

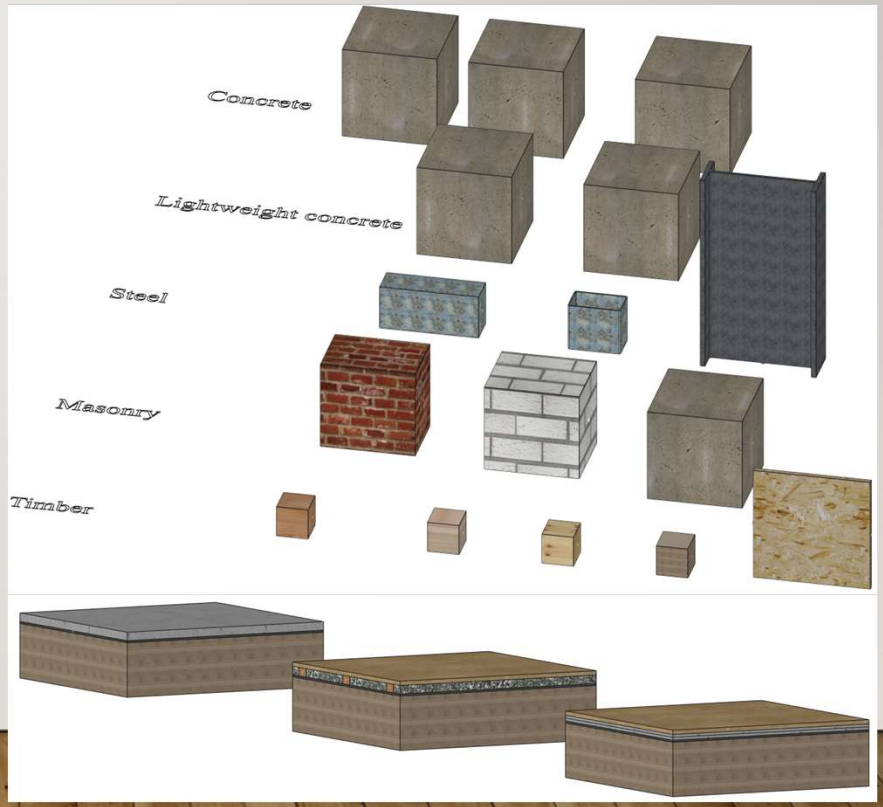
The Embodied Carbon in Construction Calculator (EC3) tool.

-QWEB Floor Assembly Calculator 2022

The tool for assessment of the environmental impact of the Floor assembly variations.

-Construction Specification Institute CSI Master Format

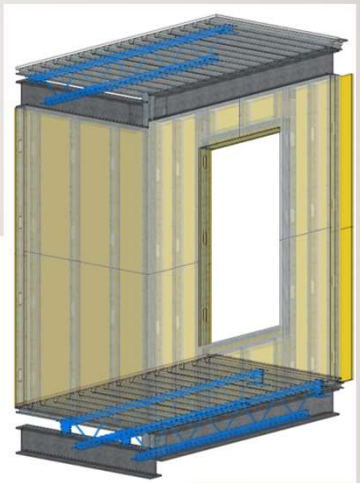
The Transparency Catalog of products with EPD data is organized with standard categories.

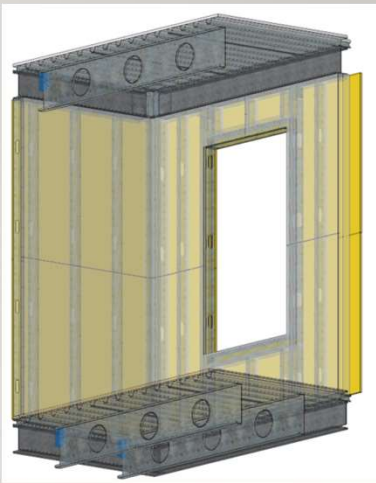


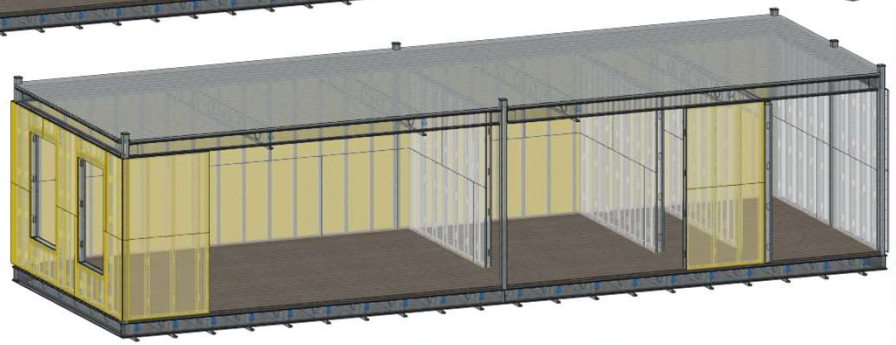
STACKABLE MODULES WITH DIFFERENT MATERIAL OPTIONS: COMPARING WITH STEEL

Module size and materials:

- 8'-0 x 40'-0" and 14'-0" x 40'-0" modules, both 9'10 ½" in height.
- Structural elements engineered for stackable module up to 3 levels of residential housing.
- W beams, HSS columns, studs and joists modelled with industry-standard properties.



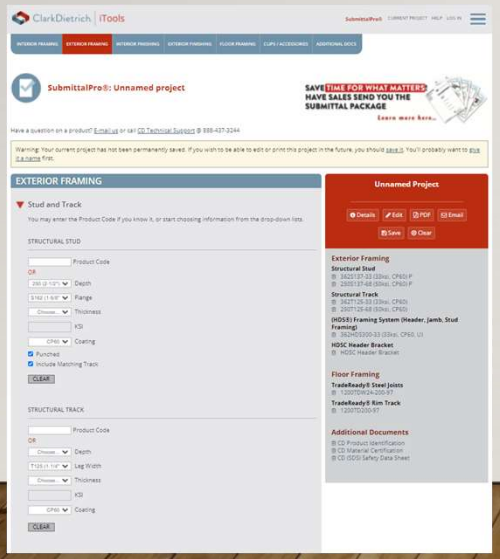


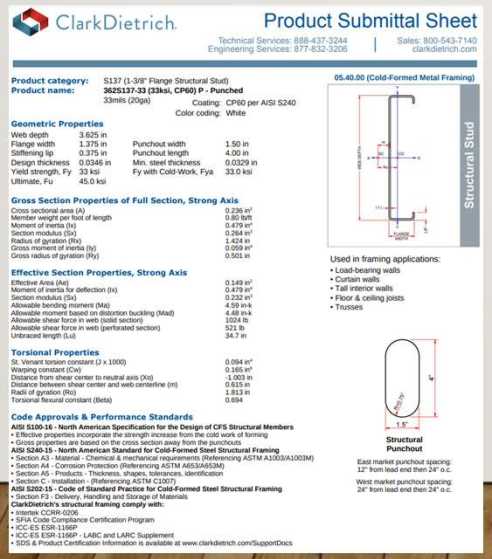


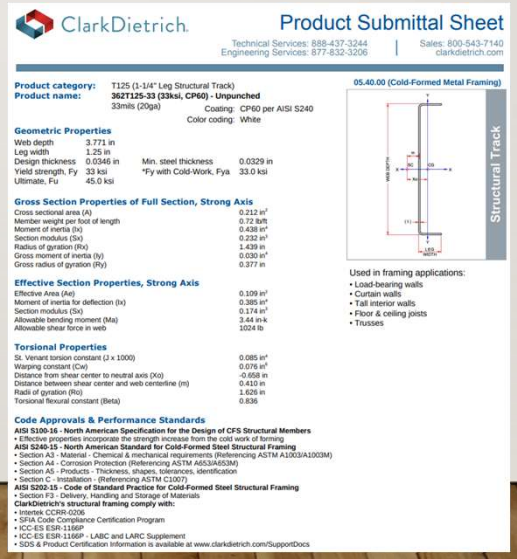
LIGHT FRAME WALLS

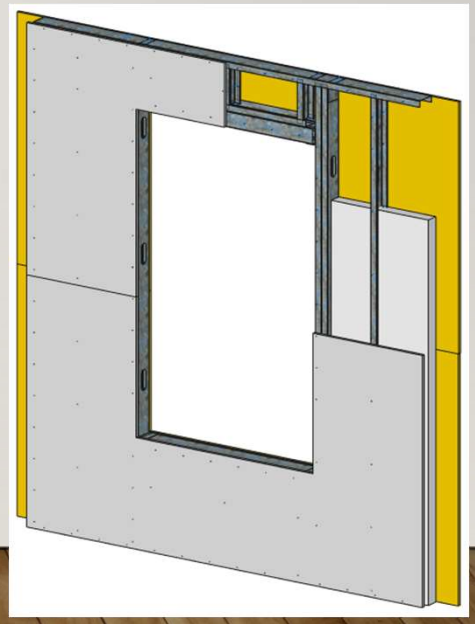
The studs and associated components for exterior and interior walls were identified by online iTools by ClarkDietrich.

- 3 5/8” wide studs typically and 2 ½” wide studs for partition wall only.
- 1/2” polyurethane foam insulation.
- 5/8” DensGlass exterior sheathing and Gypsum standard board interior sheathing (4’-0” x 8’-0”).



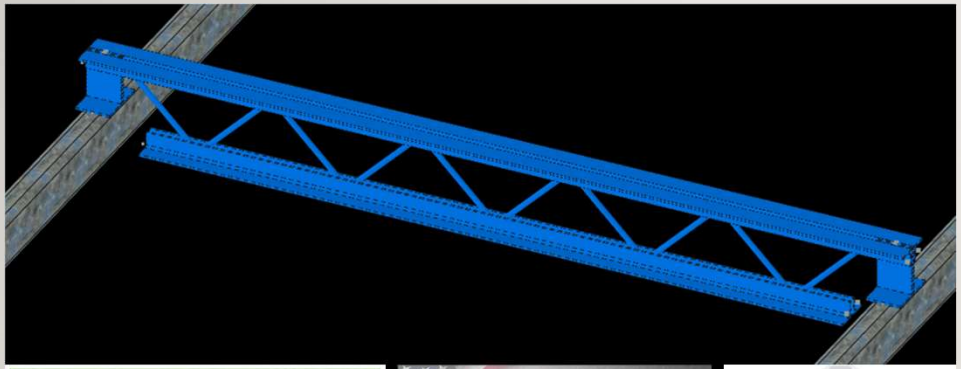


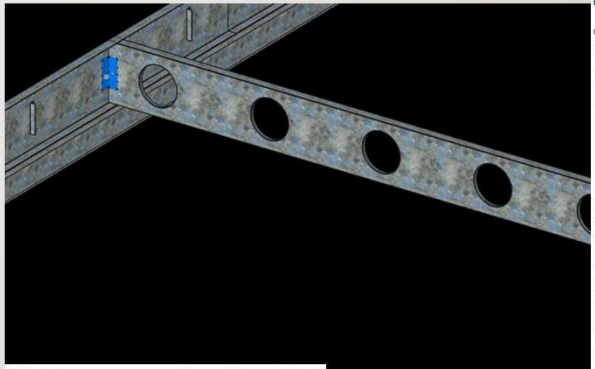


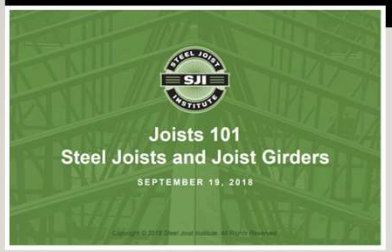


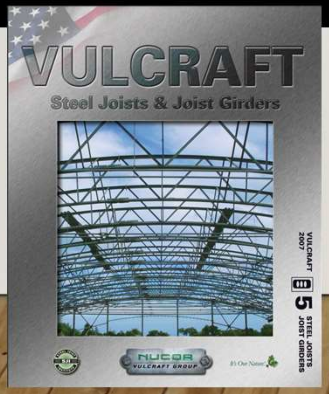
FLOOR AND CEILING

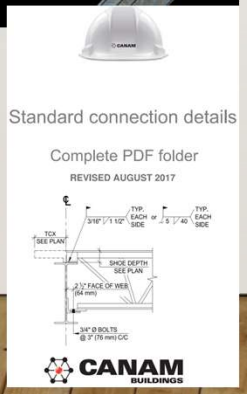
Structural performance of the floor and ceiling provided by variations of traditional open web steel joists 10K1 and trade-ready light gauge steel joists by ClarkDietrich. Steel deck complete with acoustic mat, insulation and timber finish floor.

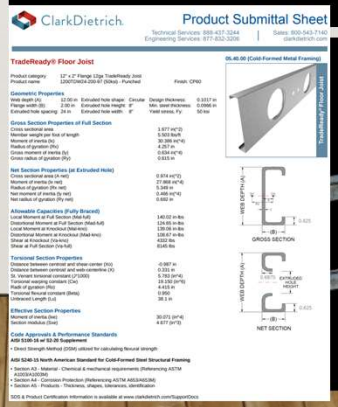


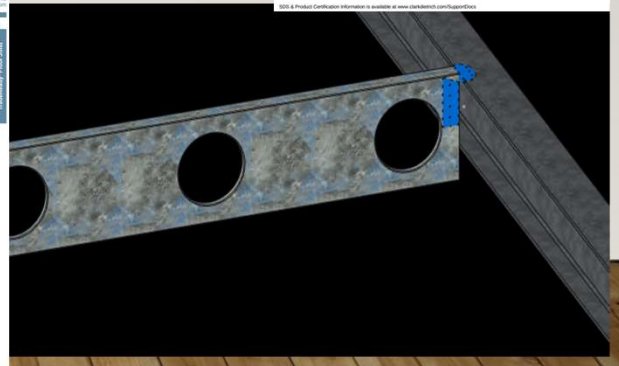








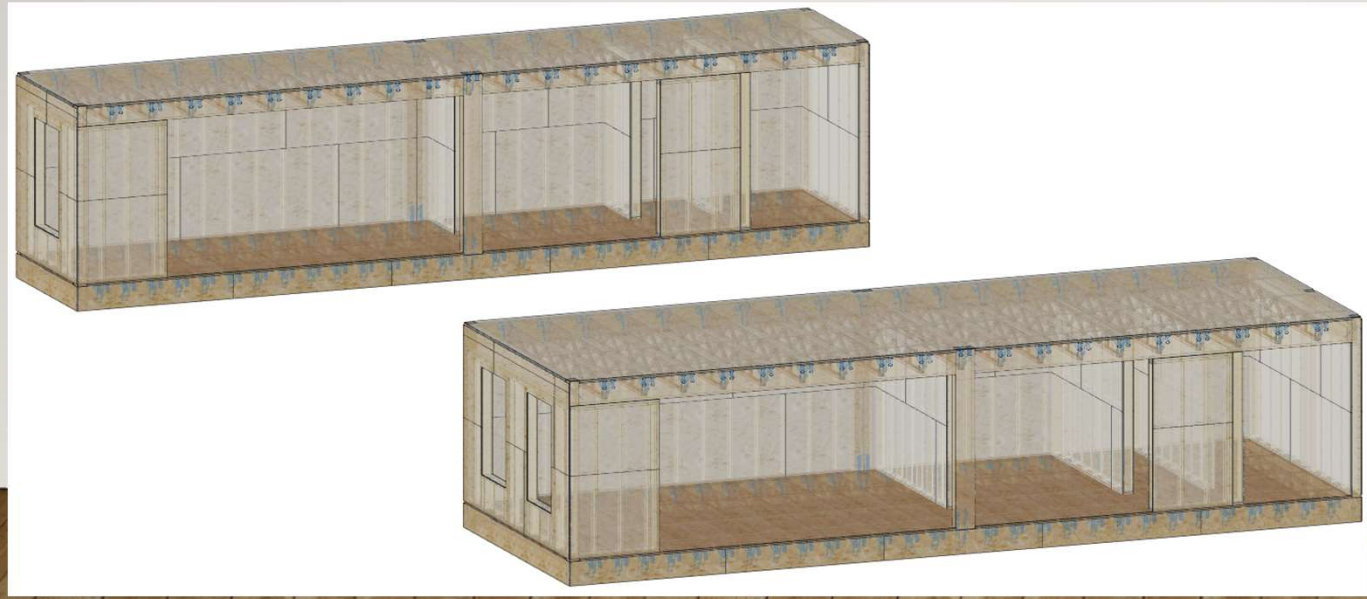


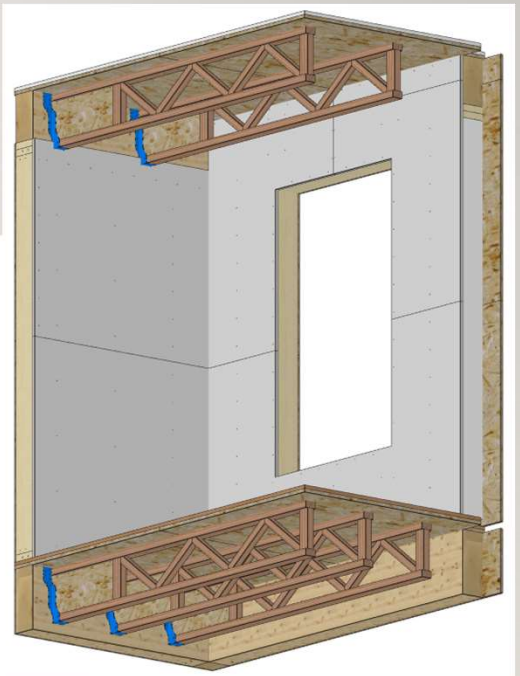


STACKABLE MODULE MADE OF TIMBER

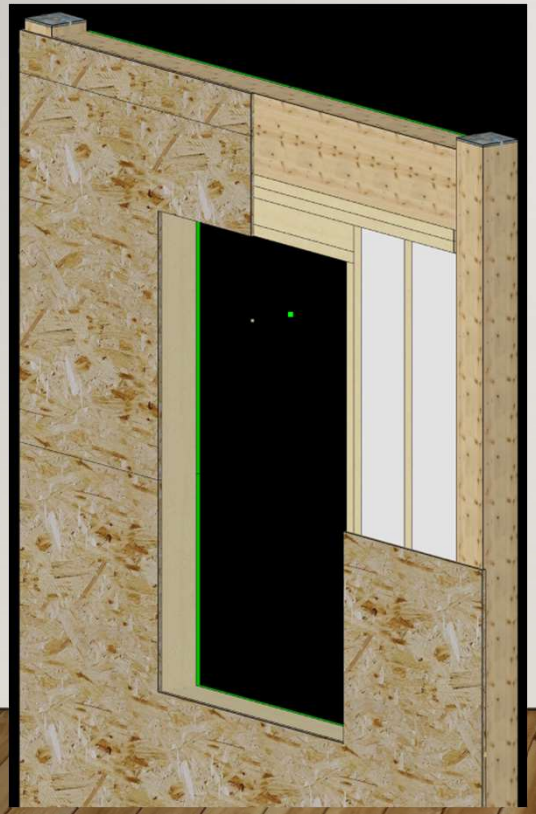
Module size and materials:

- 8'-0 x 40'-0" and 14'-0" x 40'-0" modules, both 9'10 ½" in height.
- Glulam columns and beams engineered for up to 3 levels of residential housing.
- All timber components and structurally required connections designed based on CSA standards.

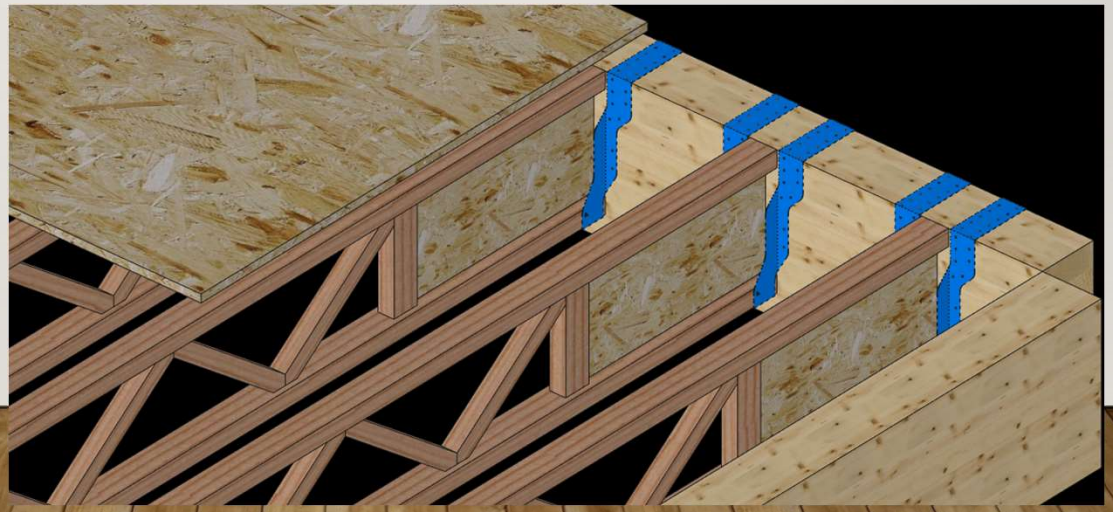




WALLS, FLOOR AND CEILING

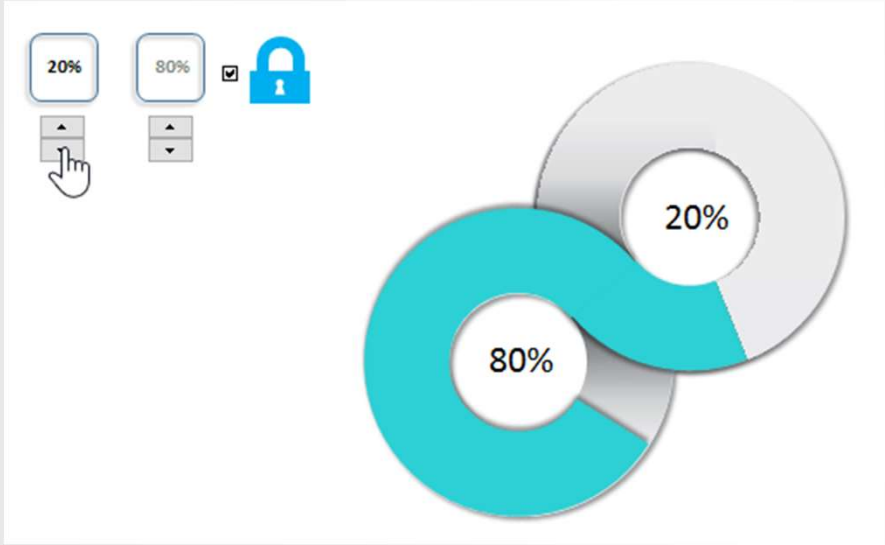


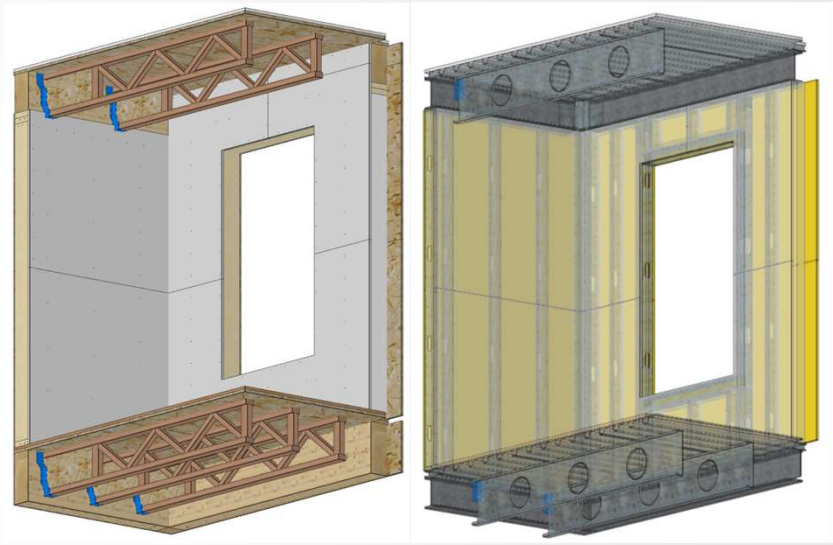
- The walls consist of glulam beams, 2x6 & 2x4 timber studs, insulation, standard OSB and Gypsum sheathing.
- Structural performance of the floor and ceiling provided by Triforce open web I-joists OJ314 and Simpson THAI322 connector.
- Floor and ceiling complete with layer of insulation, standard OSB sheathing and timber finish floor.



LIST OF MATERIALS AND PRODUCTS GENERATED OUT OF 3D MODEL

Material	Volume Real (Tot.)	Name	MasterSpec Section	CSI Division	OpenBIM Type	EC3 Category	SE 2050 Category	Fire Req: Total	Thermal Req: Total	Acoustic Req:Total	Unit of Manufacture
	[m³]										
3/8" acoustical underlayment	0.8	3/8" acoustical underlayment	0700 Thermal & Moisture Protection	Div 07- Thermal & Moisture Pro	IfcBuildingElementProxy	2 Thermal/Moisture Prot.	OtherFlooring	Not Assigned			
5/8-in. DensGlass	1.3	5/8-in. DensGlass	0618 Sheathing	Div 09- Finishes	IfcBuildingElementProxy	7 Gypsum Board		60 Minute			4x8 Sheet
Gyp-rock	2.7	GYP	0618 Sheathing	Div 09- Finishes	IfcBuildingElementProxy	7 Gypsum Board		Not Assigned			4x8 Sheet
INSULATION	1.5	INSULATION	0700 Thermal & Moisture Protection	Div 07- Thermal & Moisture Pro	IfcBuildingElementProxy	2 Thermal/Moisture Prot.		Not Assigned	Not Applicable	Not Applicable	
Polyurethane spray foam	7.8	Polyurethane spray foam	0700 Thermal & Moisture Protection	Div 07- Thermal & Moisture Pro	IfcBuildingElementProxy	2 Thermal/Moisture Prot.		Not Assigned	Not Applicable	Not Applicable	
Rolled steel shape	0.5	W8x21	0510 Structural Steel	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Rolled Shapes	Not Assigned	Not Applicable	No Requirement	By Cross Section
Soft wood lumber	1.5	Softwood lumber	0900 Finishes	Div 09- Finishes	IfcBuildingElementProxy	3 Flooring	5 Timber: Softwood Plywood	Not Assigned	Not Applicable	Not Applicable	By Cross Section
Steel cold formed framing	0.2	ClarkDietrich-UJH-97 ClarkDietrich-SFIA-S-Column: 362S137-33	0500 Metals	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Cold Formed Framing	Not Assigned	Not Applicable	Not Applicable	Varies: Shop Built
Steel deck	0.2	Steel deck	0531 Steel Decking	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Deck	Not Assigned	Not Applicable	Not Applicable	3'x40'
Steel HSS	0.1	HSS3-1/2X3-1/2X3/16	0510 Structural Steel	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Tube Steel (HSS)	Not Assigned	Not Applicable	Not Applicable	By Cross Section
Steel plate	0.0	PLATE	0510 Structural Steel	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Plate Fabrications	Not Assigned	Not Applicable	No Requirement	By Cross Section
Steel rebar	0.0	#6x1 1/4 bugle head screw #10-16x5/8 HWH SD screw	0500 Metals	Div 05- Metals	IfcBuildingElementProxy	5 Steel	4 Steel: Rolled Shapes	Not Assigned	Not Applicable	Not Applicable	Ton/1958 lb CO2e;





THE END

YOUR QUESTIONS AND COMMENTS ARE WELCOME