Materials Matter

Lower Embodied Carbon at the Beginning of a Project Lifespan

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Project Overview

Our project involves compiling and comparing sustainable building materials and structural concepts to then use in building assemblies in various combinations. The assemblies will be optimized through testing and redesign, and compared on their performance data in comparison to their sustainable characteristics. The end goal is to find the optimal combination of form, material, thermal performance, structural efficiency, and cost.

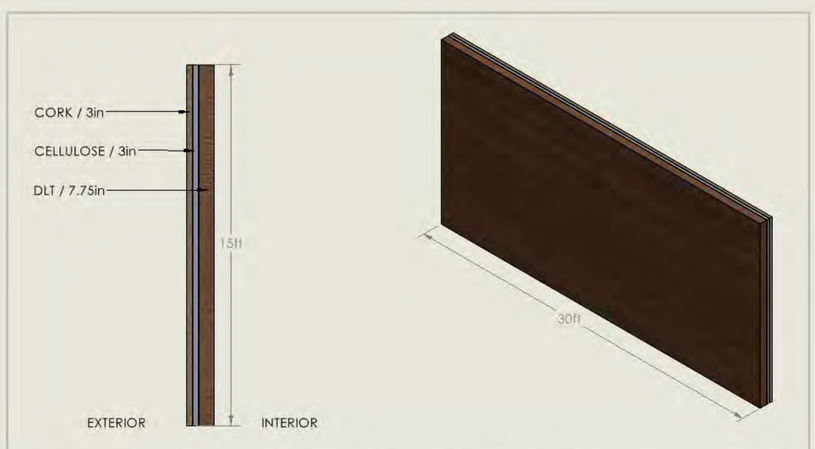
Design Method

- Research various building materials and find environmental product declarations for each material
- Design walls and roofs based off of R-30: a measure of how well a material resists heat (the higher the R-value, the better the insulating properties of the material are)
- Obtain the R-values and GWP (global warming potentials) of each material
- Design walls with various materials and calculate the overall R-value and GWP of the wall

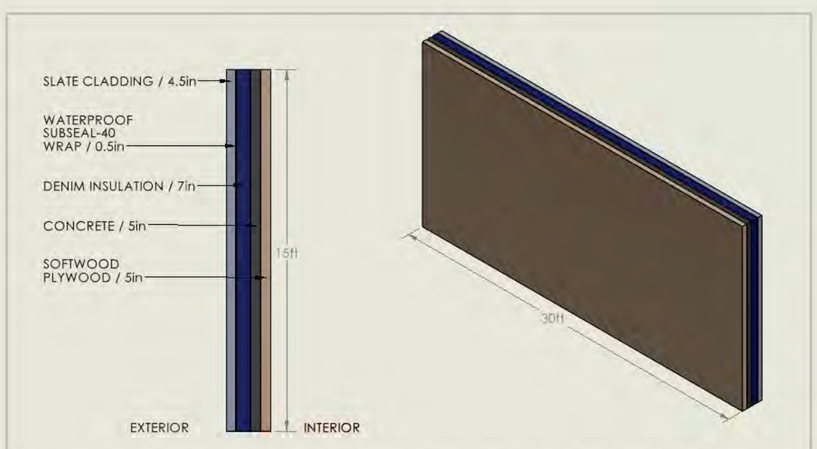
Materials List

296	Material Address of Origin	R-value/inch	GWP kgCO2e (A1-A3)	WDP/fw (A1-A3, m3)	Assembly Configuration	Characteristics	Toxicity Levels	A4 Information	EPD Link	PCR	construction spec	other notes
Wood - Structural												
Softwood Plywood	Oregon		1.20E+02			Roseburg FOrest Products, for formwork calculation			https://www.roseburg.com/wp-content/uploads/2021/01/EPD_-			
Thermopine (Wood)	Stockholm, Sweden	8	-5.42E+02	-7.54	panels/planks	thermally treated wood, enhanced stability, less substrate movement, less shrinkage/swelling	non-toxic	Timber grown, processed and treated in Scotland, transported to building site	https://epd-portal-api.azurewebsites.net/api/v1/EPDLibrary/Fil			
AWC North American Softwood Lumber	anywhere (can be CA)	negligible	63.12		beams and columns of all sizes	default wood studs and planes	non-toxic : pure wood	anywhere wood is sold NA	https://awc.org/wp-content/uploads/2021/11/AWC_EPD_NorthAmericanSoftwoodL	ISO		
Mass Ply Panels	141 14th St, Lyons, OR 97358	1.25	259.16	0.58	panel	prefabricated panels	no information, since it's phenol formaldehyde resin it may be toxic	since it's based in Oregon, it's relatively acessible for Califonia use	https://buildingtransparency.org/ec3/epds/ec3uywn4	FPInnovations PCR for North American Structural and	https://frereswood.co	
CLT	Conway, AR in US or in BC Canada		124.02	0.62	panels	panels, 2 way span		AR or BC Canada relatively close	Structurlam-Environmental-Product-Declaration-CLT.pdf		Technical Guide	Website for more technical design st
DLT	1929 Foy St., Abbotsford, BC	1.25	121.4	0.45	panel	prefabricated panels, all wood, can be used for wall/floor/ceiling, great for one-way spans, heavy timber	No other chemicals, VOCs, or metal nails	manufacturers are located right above Washignton state	https://drive.google.com/file/d/1IGtdWoKwgnnIrqOU6HKRyf2M		dlt_design_profile_qu	timbercrete compatible
Structural Bamboo	St. Louis, Missouri USA	0.72	need help reading specs, it says it	unable to estimate due to material	beams and columns of all sizes	laminated veneer bamboo (LVB/SEB), a composite of bamboo strand elements which are face-bonded to form finished	EQc2 Low emitting materials, no added formaldehyde	Fabricated in USA, but sourced from latin america through barge and rail	https://www.lamboo.us/_files/ugd/da42be_8564e311cbfd4539	LEED V-4 and BREEAM qualified, compliant to IBC.	ASTM International Standard: needs to be purchased :	although i don't have the loading table and modulus for this material, it's categorized with other
Glulam Beams	BC Canada		115.32	0.46	beam				Structurlam-Environ		STRUC-13694-U.S.-	

Sample Wall Assemblies



Cork, Cellulose, DLT Drawing	MATERIAL ASSEMBLY	THICKNESS (in)	GWP (kg CO2 eq)	R-VALUE (in)	EMBODIED H2O
	CORK PANEL	3	-630.7	10.8	
	CELLULOSE BATTING	3	1.2	11.4	
	DLT PANEL	7.75	999	9.7	
ASSEMBLY BY: TERESA HOANG TYPE: WALL DRAWN BY: KIANA S. DATE: 2/9/23					
	TOTAL	13.75	369.5	31.9	



Cladding, SubSeal, Denim Insulation, Concrete, Plywood Drawing	MATERIAL ASSEMBLY	THICKNESS (in)	GWP (kg CO2 eq)	R-VALUE (in)	EMBODIED H2O
	SLATE CLADDING	4.5	282.9	0	
	SUBSEAL-40	0.5	2.1	0	
	DENIM INSULATION	7	5.9	26.6	
ASSEMBLY BY: ETHAN WO TYPE: WALL DRAWN BY: KIANA S. DATE: 2/23/23	CONCRETE	5	1571.4	0.75	
	PLYWOOD	5	20.9	0	
	TOTAL	22	1883.2	27.35	

EPD Example

EPDs give valuable information about cradle-to-gate technology and resources used in production of the given material

Environmental performance

The environmental performance results include the indicators and disclaimers of EN 15804:2012+A2:2019/AC:2021. The PCR requires that several parameters be reported in the EPD, including resource use, waste categories and output flows. The estimated impact results are only relative statements, which do not indicate the endpoints of the impact categories, exceeding threshold values, safety margins and/or risks.

Indicator name and abbreviation	Unit	Module					
Core environmental impact indicators		**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
Climate Change - total	kg CO_2 eq.	3.18	0	2.04E-02	1.06E-02	1.08	8.04E-01
Climate Change - fossil	kg CO_2 eq.	4.74	0	2.04E-02	1.06E-02	5.17E-01	-1.91E-01
Climate Change - biogenic	kg CO_2 eq.	-1.56	0	0	0	5.64E-01	9.95E-01
Climate Change - LULUC	kg CO_2 eq.	8.54E-04	0	0	0	3.96E-06	0
GWP-GHG	kg CO_2 eq.	4.74	0	2.04E-02	1.06E-02	5.17E-01	-1.91E-01
Ozone depletion	kg CFC-11 eq.	1.69E-11	0	5.17E-13	2.98E-13	3.76E-13	-3.33E-12
Acidification	Mole of H+ eq.	5.27E-02	0	1.38E-04	1.20E-04	1.99E-03	-1.09E-02
Eutrophication, freshwater	kg P eq.	2.33E-04	0	5.68E-09	3.27E-09	5.88E-06	-1.96E-06
Eutrophication, marine	kg N eq.	1.74E-02	0	5.39E-05	5.27E-05	1.29E-03	-4.89E-03
Eutrophication, terrestrial	mol N eq.	1.80E-01	0	5.88E-04	5.76E-04	8.74E-03	-5.35E-02
Photochemical ozone formation	kg NMVOC eq.	4.34E-02	0	1.58E-04	1.71E-04	9.84E-04	-1.30E-02
Abiotic depletion potential, minerals & metals[2]	kg Sb eq.	1.84E-06	0	0	0	5.71E-09	0
Abiotic depletion potential, fossil resources[2]	MJ	59.25	0	5.60E-01	1.47E-01	4.82E-01	-4.1
Water use[2]	m^3 world eq. deprived	3.16E-01	0	0	0	-1.55E-02	-3.04E-02
Additional environmental impact indicators		**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
Particulate Matter emissions	Disease incidence	1.18E-06	0	4.41E-10	3.41E-10	3.61E-08	-2.98E-08
Ionizing radiation, human health[1]	kBq U235 eq.	1.38E-02	0	4.49E-21	2.59E-21	4.38E-04	-4.65E-20
Eco-toxicity (freshwater)[2]	CTUe	46.59	0	1.08	6.22E-01	8.88	-8.21
Human toxicity, cancer effects[2]	CTUh	2.56E-09	0	5.38E-12	4.00E-12	1.09E-10	-5.60E-10
Human toxicity, non-cancer effects[2]	CTUh	1.84E-07	0	5.05E-10	8.29E-10	2.57E-09	-1.18E-08
Land use related impacts/ Soil quality[2]	dimensionless	103.01	0	0	0	2.38E-02	0
Indicators describing resource use		**A1-A3**	**C1**	**C2**	**C3**	**C4**	**D**
Use of renewable primary energy as energy carrier	MJ	78.90	0	0	0	2.67E-02	0

R Value and GWP Calculations

Assembly 1 - Wall

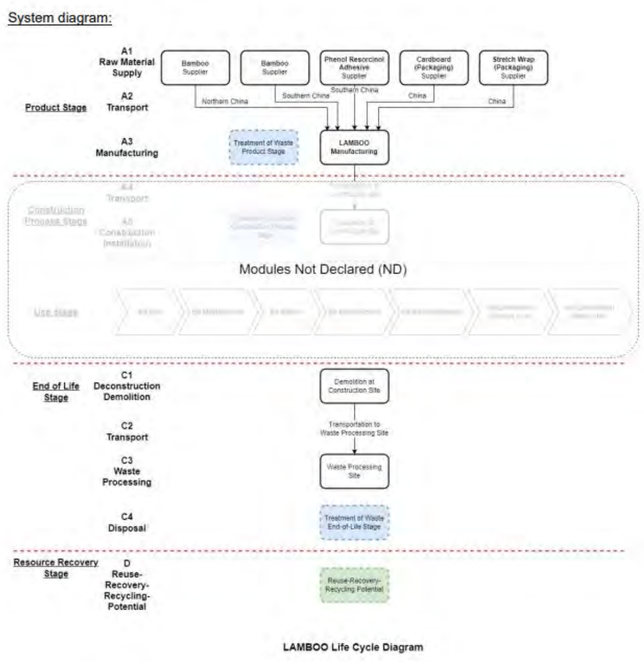
	Exterior	Waterproof		Interior	Formwork	
			Insulation			
	Panel	Wrap	Batting	Block	Panel	
Material	Slate Cladding	SubSeal-40	Denim Insulation	Concrete	Softwood Plywood	
Product Dimensions			comes in 3.5" sheets			
Length (ft)	30	30	30	30	30	
Height (ft)	15	15	15	15	15	
Thickness (in)	4.5	0.5	7	5	5	
R-value/in	0	0	3.8	0.15	0	
R-Value total	0	0	26.6	0.75	0	27.35
Volume Wall (m	4.778011074	0.5308901193	7.432461671	5.308901193	5.308901193	
GWP/m3	59.2	3.94	0.8	296	3.94	
GWP Total (kgC	282.8582556	2.09170707	5.945969337	1571.434753	20.9170707	1883.247756

Assembly 2 - Wall

	Exterior	Waterproof		Interior	
	Cladding		Insulation	Structural Panels	
	Panel	Wrap	Batting	Panel	
Material	Slate	SubSeal-40	Havelock Wool	Lamboo	
Product Dimensions					
Length (ft)	30	30	30	30	
Height (ft)	15	15	15	15	
Thickness (in)	4.5	0.5	7	7	
R-value/in	0	0	4.3	0.72	
R-Value total	0	0	30.1	5.04	35.14
Volume Wall (m	4.778011074	0.5308901193	7.432461671	7.432461671	
GWP/m3	59.2	3.94	2.63	3.18	
GWP Total (kgC	282.8582556	2.09170707	19.54737419	23.63522811	328.132565

Next Steps

- Calculate the load that our wall assemblies can withstand
- Design roof assemblies within the load parameters
- Calculate the embodied carbon for material transportation and add it into our GWP calculations
- Calculate the embodied water for each assembly
- Create the full assembly of a building using AutoCAD softwares



LAMBOO Life Cycle Diagram