Portland State UNIVERSITY

CONCRETE EMBODIED CARBON STUDY

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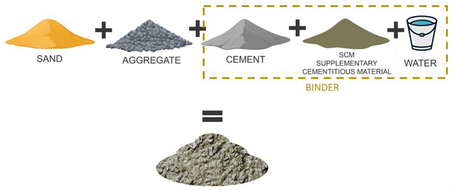
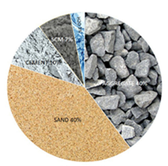
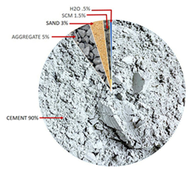
Abstract

Generally, in concrete, cement contains a significant amount of embodied carbon. For this reason, designers are looking for different mixtures and .sources for the replacement of cement in concrete. Which can provide the optimum strength by using a minimum amount of cement

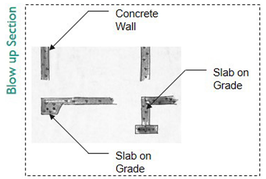


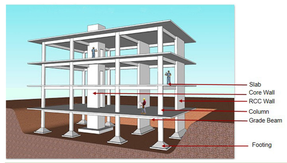


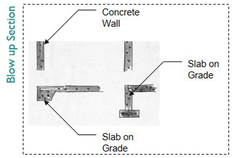
Components of Concrete by **WEIGHT**

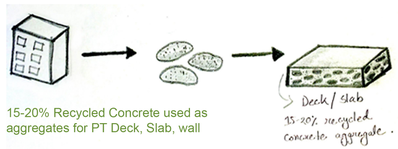


Components of Concrete by **EMBODIED CO2**







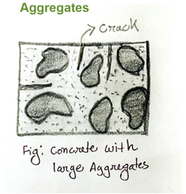


15-20% Recycled Concrete used as aggregates for PT Deck, Slab, wall

Not for footing and foundation

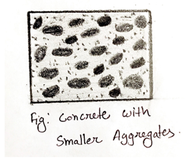
Variables in Concrete

Aggregates



Large Aggregates

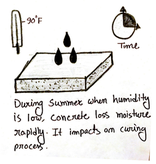
Less strength, Prone to cracking
Not suitable for smooth finishes, or curved structures.
Requires less amound of water

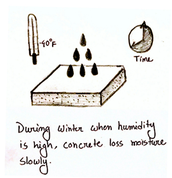


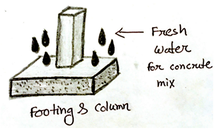
Small Aggregates

Stronger in comparison to the larger aggregates in the same amount of concrete.
Suitable for smooth finishes, curved structures
Requires more water

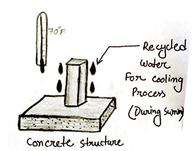
Seasons / Humidity







Freshwater used in the concrete mixture for construction. Recycled water does not use in the concrete mixture because it contains minerals that are harmful to concrete.



Recycled water used for the cooling process of the structure during summer time.

Methodology

Identify vendors

Identify baseline mixes and optimal mixes per concrete strength (Concrete location in)building

Compare vendors' mixes against each other based on their GWP

Push industry towards more transparency

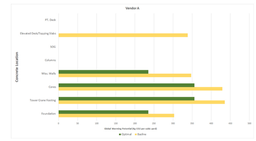
SCM: Supplementary Cementitious Material
EPD: Environment Product Declaration
GHG: Green House Gas
GWP: Global Warming Potential (KgCO2 per Cubic Yard)
LCA: Life Cycle Assessment
ASTM: The American Society for Testing and Materials
ACA: American Concrete Association

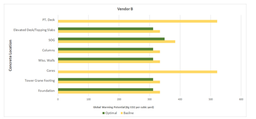
Results

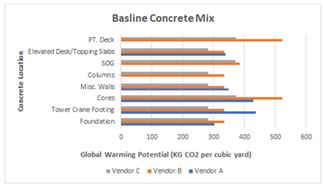
Vendor A							
Concrete		GWP (Kg CO2/Yard3)				Cure Days	% GWP to Baseline
PSI	Concrete Location	Basline	Mixture ID	Optimal	Mixture ID	Standard	
4000	Foundation	303		234.99		28	77.55
4000	Tower Crane Footing	435.57		355.75		28	81.67
6000	Cores	429.1		355.75		28	82.91
4000	Misc. Walls	347.2		234.99		28	67.68
4000	Columns					28	
5000	SOG					28	
4000	Elevated Desk/Topping Slabs	338.37				28	
6000	PT. Deck					28	

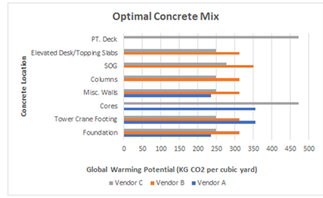
Vendor B							
Concrete		GWP (Kg CO2/Yard3)				Cure Days	% GWP to Baseline
PSI	Concrete Location	Basline	Mixture ID	Optimal	Mixture ID	Standard	
4000	Foundation	334.09	Mix 405C820A	311.16	Mix 06FF522N	28	93.14
4000	Tower Crane Footing	334.09	Mix 405C820A	311.16	Mix 06FF522N	28	93.14
6000	Cores	521.4	Mix 6500DS02			28	
4000	Misc. Walls	334.09	Mix 405C820A	311.16	Mix 06FF522N	28	93.14
4000	Columns	334.09	Mix 405C820A	311.16	Mix 06FF522N	28	93.14
5000	SOG	383.79	Mix 45VM329N	349.38	Mix 45ID422A	28	91.03
4000	Elevated Desk/Topping Slabs	334.09	Mix 405C820A	311.16	Mix 06FF522N	28	93.14
6000	PT. Deck	521.4	Mix 6500DS02			28	

Vendor C							
Concrete		GWP (Kg CO2/Yard3)				Cure Days	% GWP to Baseline
PSI	Concrete Location	Basline	Mixture ID	Optimal	Mixture ID	Standard	
4000	Foundation	281.25	2440N17200	249.27	2440N17F00	28	88.63
4000	Tower Crane Footing	281.25	2440N17200	249.27	2440N17F00	28	88.63
6000	Cores	371.26	2460N3R2PV	471.86	2460GARCS0	28	127.10
4000	Misc. Walls	281.25	2440N17200	249.27	2440N17F00	28	88.63
4000	Columns	281.25	2440N17200	249.27	2440N17F00	28	88.63
5000	SOG	369.66	2450N3V2S9	277.4	2450N15F00	28	75.04
4000	Elevated Desk/Topping Slabs	281.25	2440N17200	249.27	2440N17F00	28	88.63
6000	PT. Deck	371.26	2460N3R2PV	471.86	2460GARCS0	28	127.10



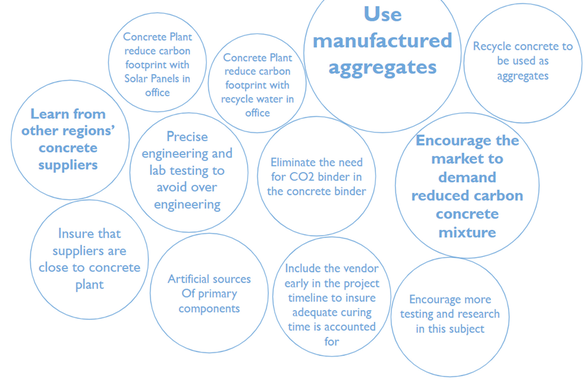






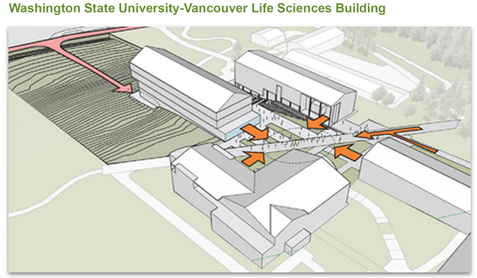
For foundation and misc. wall, Vendor A 's mixture has lower value of GWP. For the rest of the locations, Vendor C 's mixture emits least amount of carbon

Challenges and Recommendations



Client

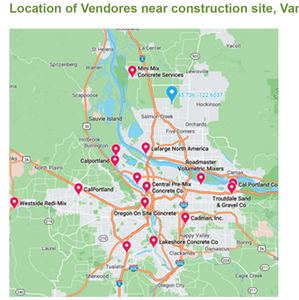
Washington State University-Vancouver Life Sciences Building



The project is a 60,000 sf new construction academic research building for Washington State University Vancouver. The building is currently in the programming phase and will include labs, offices, classrooms and other support spaces

The project will meet a minimum LEED Gold level of certification as set by WSU. In addition, SRG Partnership with Andersen Construction will be focusing on reducing embodied carbon on the project wherever possible, with a specific focus in the earliest stages on the selection and design of the structural system through quantifying the relative reduction in GWP

Location of Vendores near construction site, Vancouver, Wa



SRG