Concrete Steps to Net Zero:

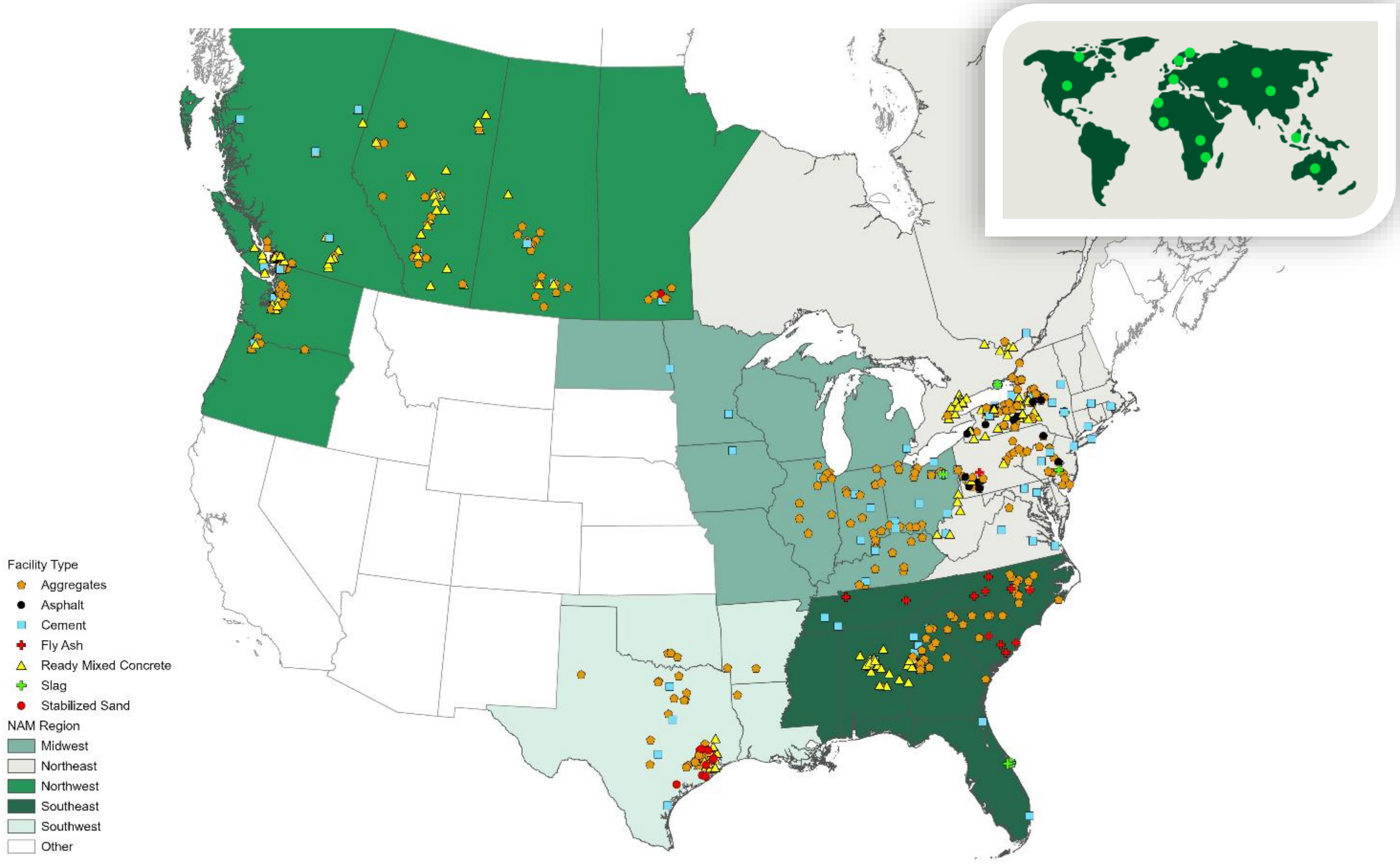
Practical Strategies for Low Carbon Construction

Concrete Innovations

15.10.2025

Heidelberg Materials

Heidelberg Materials North America Business



Leading positions in: cement, aggregates, and ready-mixed concrete

>450 locations

Heidelberg Materials is evolving our portfolio, products and services—providing the materials to build the future.

Cement

10 plants

Aggregates

>205 facilities

Concrete

~200 plants

Asphalt

~20 plants

Our industry-leading concrete promises

10mt

cumulative CO_2 reduction through CCUS by 2030

400kg CO_2/t cementitious material as average across the whole portfolio in 2030[1]

47% emission reduction[2] across the cementitious materials portfolio by 2030

50% of our revenue will be generated from sustainable products by 2030

Corporate carbon footprint reduction in line with SBTi 1.5°C path by 2030

[1] Scope 1, 2 acc. to GCCA; [2] Reference year 1990 with an average of 750 kg CO2/t of cementitious material

Policy Outlook | Embodied carbon policies shifting North America to compliance-driven action

City of Edmonton
Embodied Carbon Assessment Policy
June 2021

City of Langford Low Carbon Concrete Policy June 2022

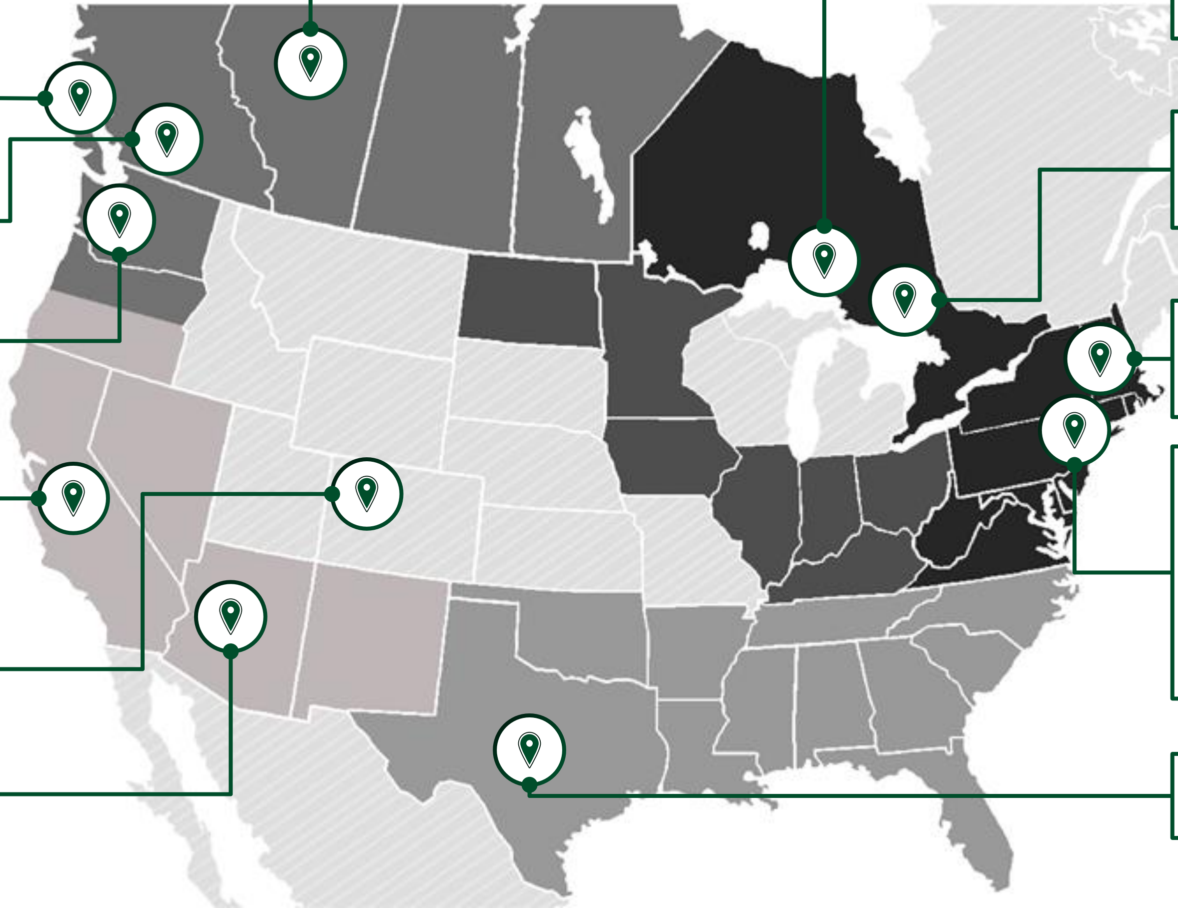
City of Vancouver
Climate Emergency Action Plan
November 2020

City of Portland Low Carbon Concrete Initiative 2019

State of California
Assembly Bill 2246 for building sector to achieve 40% GHG reduction by 2035, 2024
Buy Clean California Act, 2017
Caltrans EPD Implementation Project

"Global Warming Potential For Public Project Materials"/"Buy Clean Colorado", 2021

Phoenix's Climate Action Plan



Treasury Board of Canada Low Carbon Concrete Policy
2023

Ontario Ministry of Transportation OPSS 1350
November 2019

New York State
Low Embodied Carbon Concrete Leadership Act

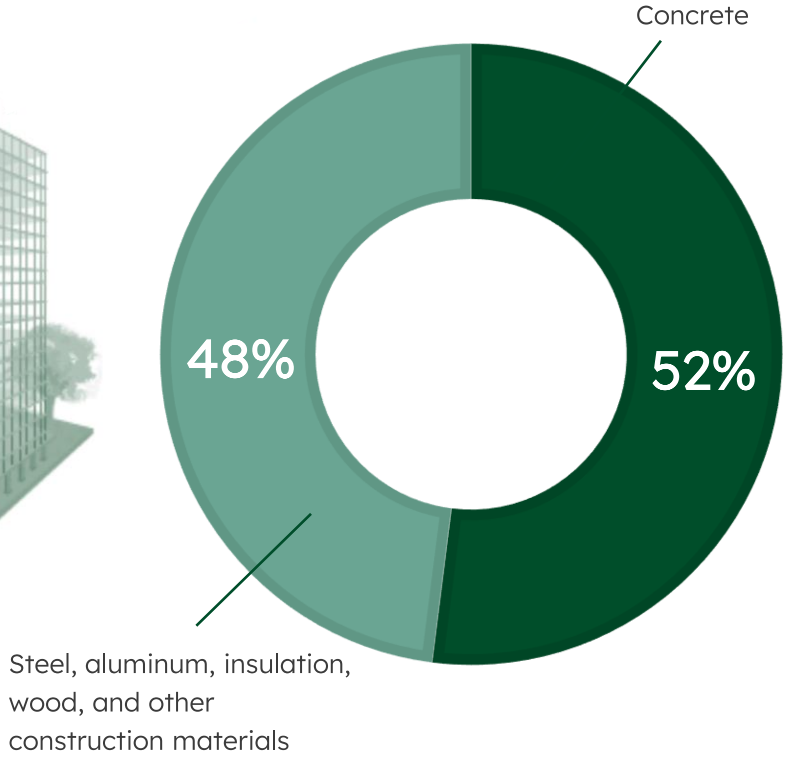
US Federal Policies:
FHWA Sustainable Pavements Program
The CLEAN Future Act (proposed)
GSA Advice Letter
Catalyzing America's Clean Energy Economy Through Federal Sustainability

City of Austin Climate Equity Action Plan

Source: Carbon leadership forum policy toolkit

Embodied Carbon in the Build Environment

CO_2 of Materials in a Building (%)

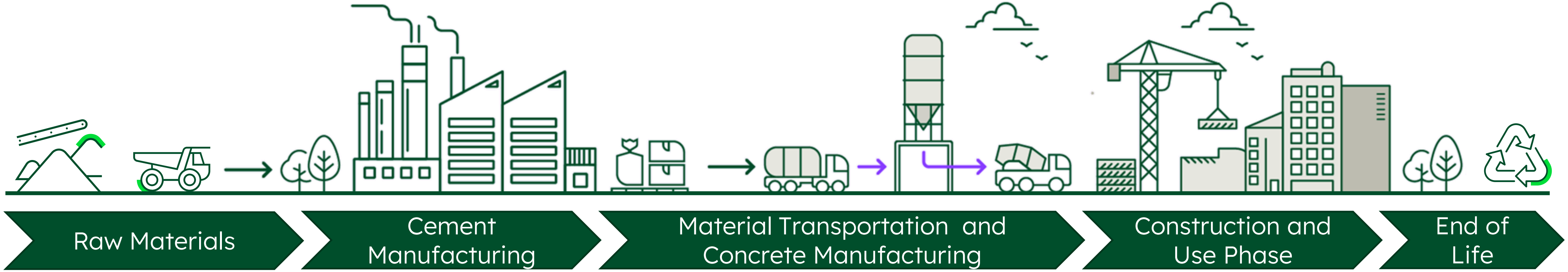


Concrete can represent ~ 50% of a building's total greenhouse gas emissions related to the manufacture, transport, install, maintenance and disposal of building materials.

Growing policy emphasis on embodied carbon reduction includes emphasis on concrete as a result.

Concrete Carbon Lifecycle

Despite representing only 10-15% of the concrete mix, cement contributes 80-85% of the total carbon footprint

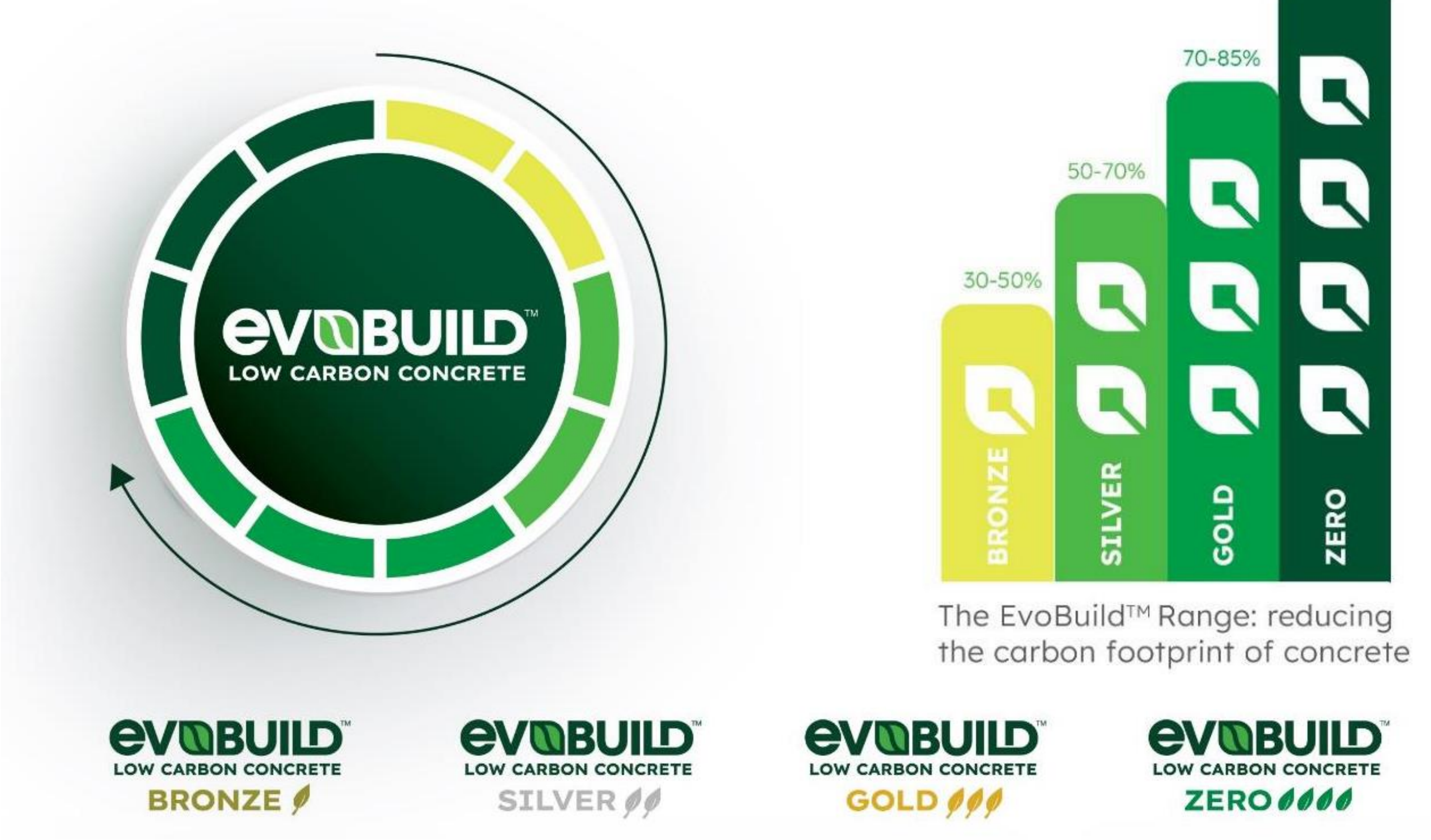


1

Understanding low carbon concrete

EvoBuild™ Low Carbon Concrete

Dial up the green. Dial down the CO_2.



EvoBuild Bronze (30-50%), Silver (50-70%), Gold (70-85%) savings levels are measured against 2021 CLF Material Baseline Report.

A Science-Based Approach to Lowering the Embodied Carbon of Concrete

Low carbon concretes can utilize a combination of carbon reduction levers to reduce overall CO2. These include, but are not limited to:

- Aggregate gradations
- Admixtures
- Secondary cementitious materials (SCMs)
- Cement type
- Days to strength maturity

- Digital solutions

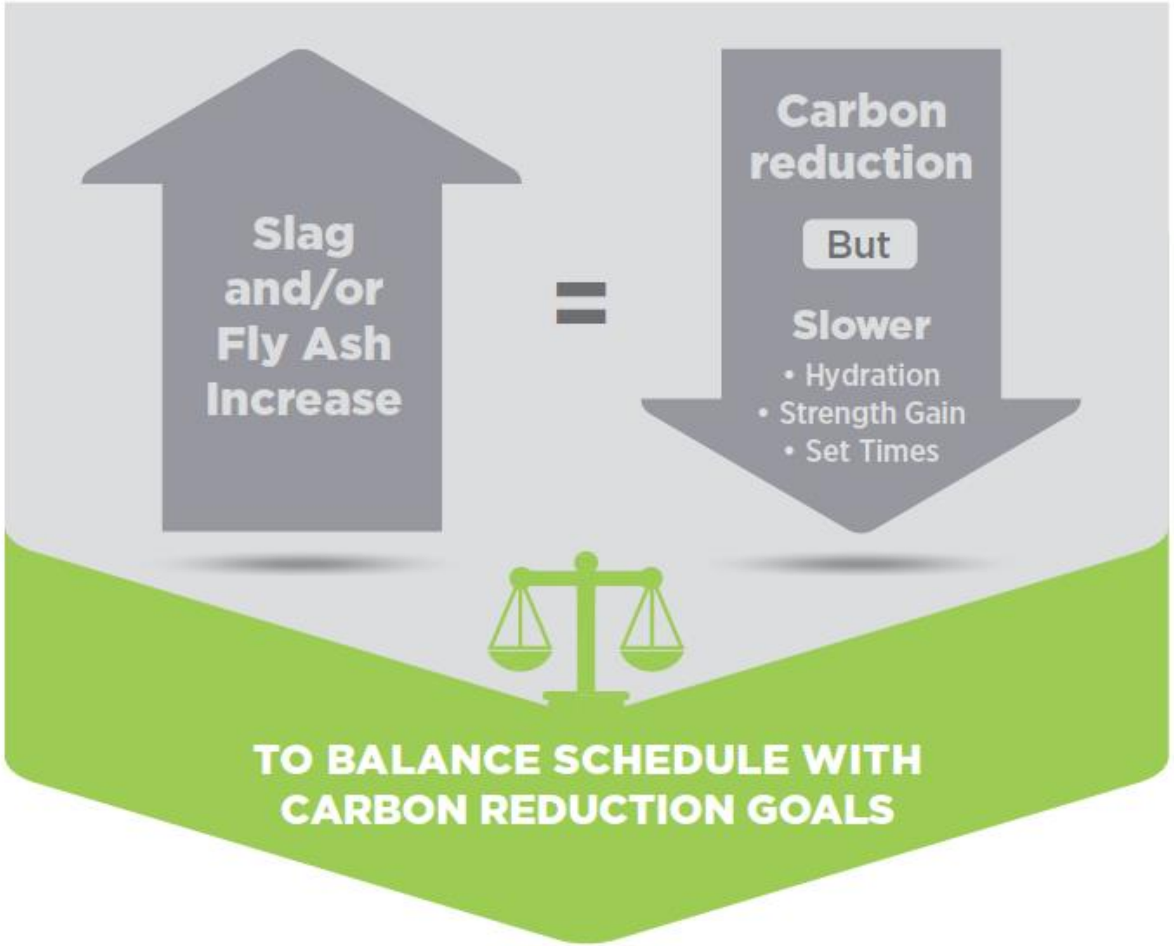
Advanced mix design optimization through chemical and materials engineering

Target concrete performance

Most efficient use of raw materials

Optimized for carbon reductions

Practical impacts of low carbon strategies using SCMs



Transparency and the Development of Environmental Product Declarations (EPDs)

Understanding carbon reduction levers is important but, having a way to uniformly measure a product's environmental impact is just as crucial.

EPDs offer that accounting, furthering the transparency behind sustainability claims.

The basis of past benchmarks and about 75% of LEED Still relevant but only part of the story

OPERATIONAL CARBON EMISSIONS

Things like water usage & energy efficiency

Newly introduced, third-party verified, and widely recognized

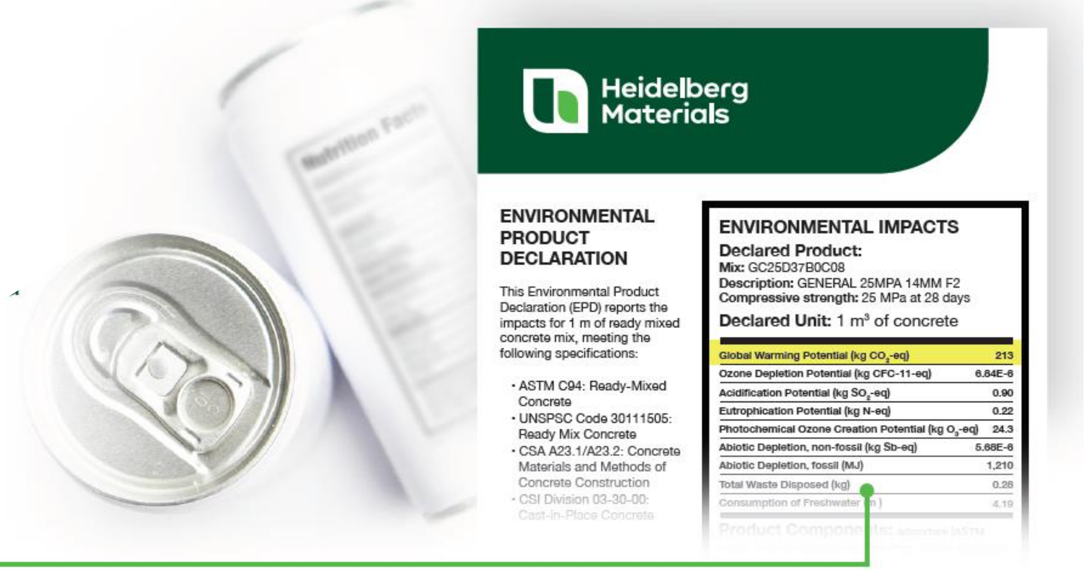
TRANSPARENCY

EPDs, like a nutrition label for materials, allow comparison based on environmental impact

At the center of Future-Facing Global Sustainability Commitments

EMBODIED CARBON EMISSIONS

Considers full life cycle of a product and full carbon footprint.



Similar to a "nutrition label," EPDs transparently communicate the environmental performance or impact of a product or material

Interpreting Concrete EPDs

ENVIRONMENTAL IMPACTS

Declared Product:
Mix EZ30D0XB2C60 • Mitchell Island Plant
Description: EZ FLOOR GENERAL 30 MPA 14MM NON AIR EVOBUILD BRONZE
Compressive strength: 30 MPa at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	**224**
Ozone Depletion Potential (kg CFC-11-eq)	**7.13E-6**
Acidification Potential (kg SO_2-eq)	**0.97**
Eutrophication Potential (kg N-eq)	**0.24**
Photochemical Ozone Creation Potential (kg O_3-eq)	**26.5**
Abiotic Depletion, non-fossil (kg Sb-eq)	**4.14**
Abiotic Depletion, fossil (MJ)	**1,310**
Total Waste Disposed (kg)	**0.38**
Consumption of Freshwater (m^3)	**4.13**

Product Components: admixture (ASTM C494), natural aggregate (ASTM C33), crushed aggregate (ASTM C33), portland limestone cement (ASTM 595), batch water (ASTM C1602), fly ash (ASTM C618)

DECLARATION OF ENVIRONMENTAL INDICATORS DERIVED FROM LCA

Impact Assessment	Unit	A1	A2	A3	Total
Global warming potential	kg CO_2-eq	208	10.1	5.42	224
Depletion potential of the stratospheric ozone layer (ODP)	kg CFC-11-eq	6.92E-6	3.99E-10	2.12E-7	7.13E-6
Eutrophication potential	kg N-eq	0.21	7.37E-3	0.02	0.24
Acidification potential of soil and water sources (AP)	kg SO_2-eq	0.80	0.13	0.04	0.97
Formation potential of tropospheric ozone (POCP)	kg O_3-eq	22.2	3.67	0.66	26.5

Product Stage		
extraction and upstream production	transport to factory	manufacturing
A1	A2	A3

A1: Disproportionately driven by cement (clinker) content

A2: Dependent on haul distances and mode of transport. How close are aggregate and cement resources?

A3: Dependent on energy sources – climate and electricity (hydroelectric or coal fired)?

2

Practical strategies for low carbon concrete

General strategies for reducing the carbon intensity of concrete elements

General Strategies

Less is more – in concrete buildings, most of the Embodied Carbon is located within the structure. Commitment to early concept optimization and lean detailed design is critical. In addition, a few fundamental yet simple strategies can lead to significant Embodied Carbon reductions.

Consider concrete with high compressive strength

- 40 MPa concrete is 60% stronger than 25 MPa concrete
- GWP increase is only 35%

Consider steel with high tensile strength

- 500 MPa steel is 25% stronger than 400 MPa steel
- Both have similar GWP

Minimize concrete volume by maximizing reinforcement ratio for flexural members

- Nearly 100% of steel used for producing reinforcing bars comes from recycled scrap, and more than 65% of all reinforcing bars are recycled
- Slab reinforced with 0.4% vs slab reinforced with 0.2% may be 40% thinner
- 32% GWP reduction

Maximize resistance utilization by maximizing number of element sizes

- Maximizing structural utilization (i.e. resistance/demand) of each element will minimize total material volumes
- GWP values are linearly dependent on material volumes

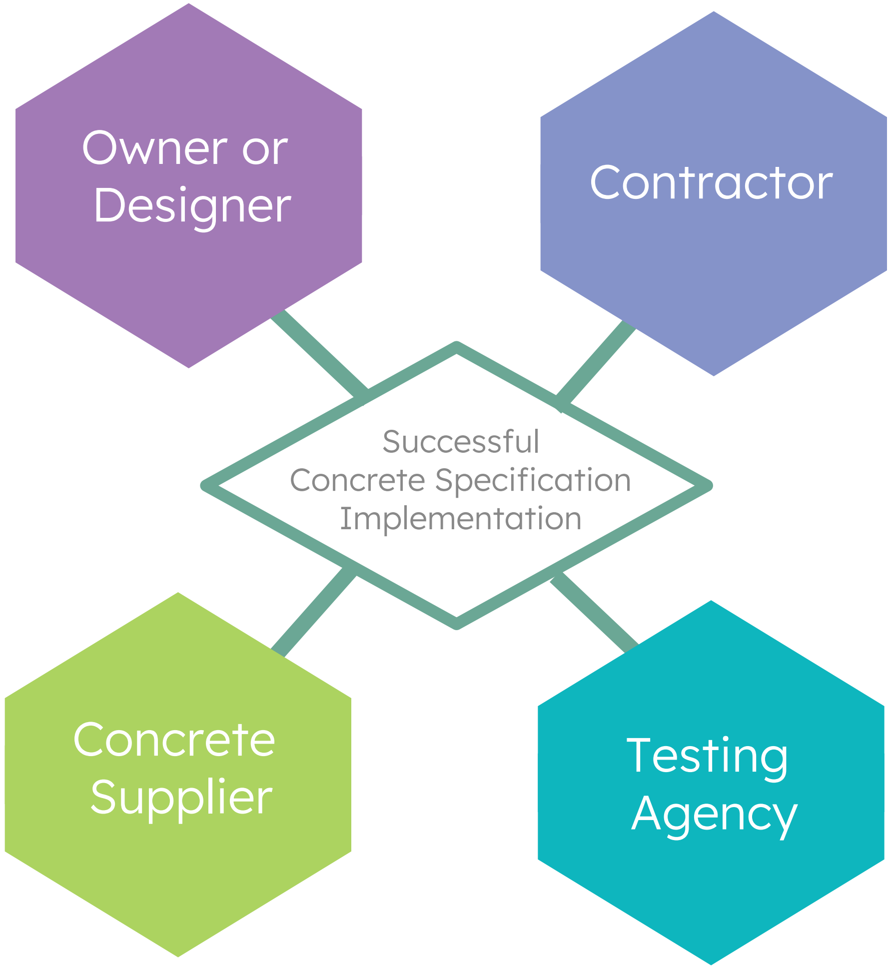
Round up sizing in concrete elements to nearest 25 mm vs higher increments

- Adapting 225mm thick slab vs 250mm thick slab
- 11% GWP reduction

Deeper beams are more efficient than wider beams

- 400 wide x 800 deep beam is as strong as 750 wide x 600 deep
- 40% GWP reduction

Embodied Carbon reductions listed above are examples of some specific cases, and may vary depending on actual conditions.



From: *A Pragmatic Approach to Lowering Embodied Carbon* – 2023, ZGF, Fast+Epp, Ellis Don, Lafarge

Specifying Low Carbon Concrete: Performance vs. Prescriptive Specifications

PRESCRIPTIVE

It is highly discouraged to specify any mix proportions, including material quantities (e.g., admixtures, aggregates, cementitious materials, and water), as the mix design becomes prescriptive, and the owner assumes full responsibility for the concrete performance.

Using prescriptive mix designs can not only negatively impact the performance of the concrete but can also very likely negatively impact the realization of carbon reduction goals on the project since the specifier will not be aware of the raw materials used by each individual concrete producer or plant.

PERFORMANCE

Performance-based specifications offer the specifier the ultimate peace of mind that the ready mixed producer is responsible for the performance of the concrete as delivered.

They also give the ready mixed producer flexibility in optimizing mix designs.

This flexibility becomes critically important when a ready mixed producer needs to use multiple CSA-approved approaches in designing mixes to meet a variety of requirements including strength, durability, constructability, and carbon/sustainability.

Performance-based specifications are critical to specifying low carbon concrete AND to achieving low carbon concrete.

Concrete Carbon Project Budgets Support Leading Policies and Best Practices

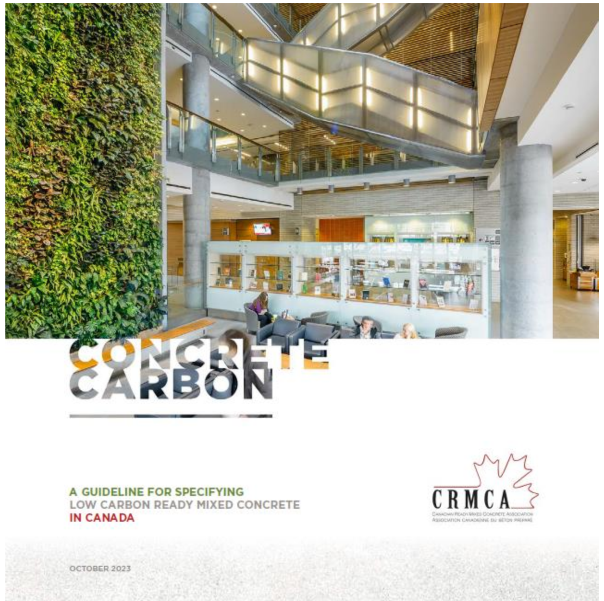
Guidelines, Policies or Standards that directly reference or are supported by concrete carbon project budgets include:

- Guideline to Specifying Low Carbon Ready Mixed Concrete in Canada, published by the Canadian Ready Mixed Concrete Association
- ACI 323-24: Low Carbon Concrete Code Requirements and Commentary — 15%
- Government of Canada Standard on Embodied Carbon in Construction (Treasury Board of Canada) — 10 -30%
- City of Langford Low Carbon Concrete Policy (Vancouver Island, Canada) — 13 - 17%

Additionally, carbon budget reporting support whole building lifecycle assessments (wbLCAs), which are required as part of regulations and green building rating systems, including:

- City of Vancouver Building Bylaw — Pending
- Toronto Green Standard
- LEED Green Building Rating System (Up to 6 credits) — 10 – 40% (whole building)
- Zero Carbon Building Standard (Canada)

CONCRETE CARBON PROJECT BUDGET (CCPB)



Benchmarks ideally informed by Regional Industry Average EPDs

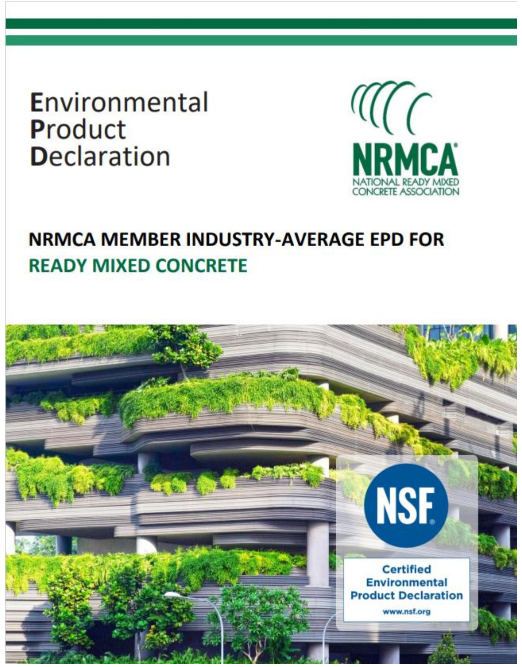
Carbon Budgets for Concrete

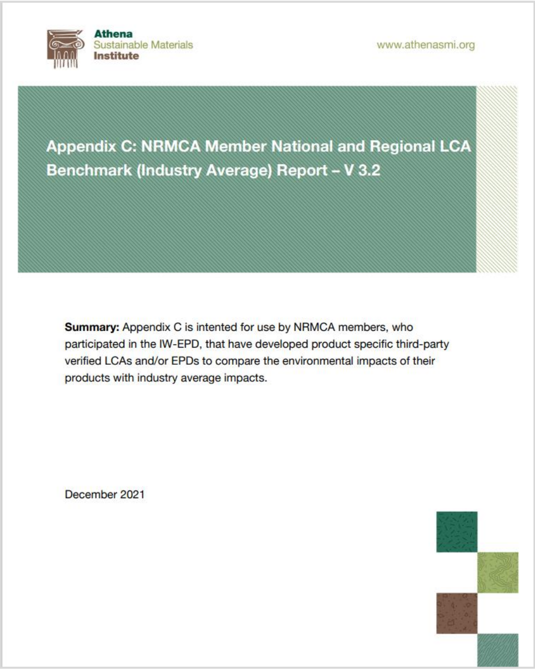
Application	Strength (psi)	Exposure Class	Maximum GWP (kg CO_2e/m^3)		Volume (m^3)	Total GWP (kg CO_2e)
Footings	3000	F0	261.38	X	500	130,690
Floors and Slabs	4000	C0	316.46	X	1,000	316,460
Columns	5000	C0	386.11	X	600	231,666
Exterior Concrete	4000	C2	316.46	X	300	94,938
					TOTAL	773,754

DON'T enforce limits at the individual mix level.

DO enforce limits at the project total level.

“Industry Average” Environmental Product Declaration Baseline





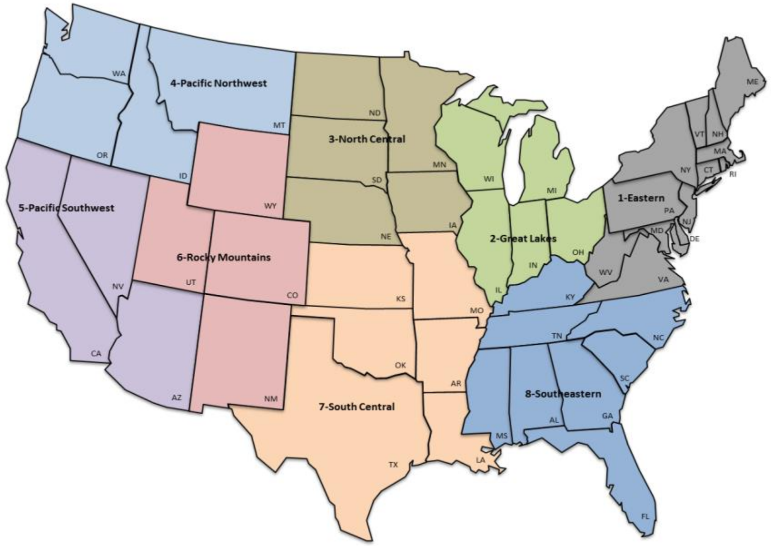


Table F5-Pacific Northwest LCA Results (per cubic meter)							
Strength	psi @28 days	2,500	3,000	4,000	5,000	6,000	8,000
Core Mandatory Impact Indicator							
GWP	kg CO2e	235.46	261.38	316.46	386.11	408.01	487.41
ODP	kg CFC11e	4.78E-06	6.80E-06	7.99E-06	9.47E-06	9.98E-06	1.17E-05
AP	kg SO2e	0.63	0.90	1.06	1.26	1.33	1.56
EP	kg Ne	0.22	0.32	0.38	0.46	0.48	0.57
SFP	kg O3e	14.49	20.64	24.25	28.76	30.27	35.45
ADPf	MJ, NCV	320.52	447.33	508.54	589.08	617.76	704.03
ADPe	kg Sbe	8.43E-05	1.14E-04	1.24E-04	1.35E-04	1.41E-04	1.53E-04

Product and Facility Specific Type III EPD

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Environmental Product Declaration (EPD)

Heidelberg Materials
Environmental Product Declaration
Mix G132E55C3 - Acheson

This cradle to gate Environmental Product Declaration (EPD) reports the impacts for one cubic meter of ready-mixed concrete, meeting the following product specifications:
ASTM C94 Standard Specification for Ready-Mixed Concrete.
CSA A23.1/A23.2: Concrete Materials and Methods of Concrete Construction
CSI Masterformat Division 03-30-00: Cast-in-Place Concrete.
UNSPSC Code 30111500: Ready Mix

PLANT
Acheson
200 Acheson Road
Spruce Grove, Alberta

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

DATE OF ISSUE
October 17, 2024

PERIOD OF VALIDITY
5 years; 4/9/2026

Environmental Impacts

Declared Product: G132E55C3C08

Description: 32MPa 5-8% Air HSLb 28d

Compressive Strength: 32 MPa @ 28 days

Declared Unit: 1 m3 of ready-mix concrete

		per m^3
Global Warming Potential	kg CO2e	269.41
Ozone Depletion	kg CFC11e	1.18E-05
Acidification	kg SO2e	1.15
Eutrophication	kg Ne	0.80
SFP (Smog)	kg O3e	33.39
Abiotic depletion potential for fossil resources	MJ, NCV	1889.30
Abiotic depletion potential for non-fossil mineral resources	kg Sbe	1.05

Product Components:
Crushed Coarse Aggregate (ASTM C33), Natural Fine Aggregate (ASTM C33), Portland Limestone Cement (ASTM C595), BatchWater (ASTM C1602), Water Reducer (ASTM C494), Water Reducer - High Range (ASTM C494), Other Admixture 1, Air Entrainer (ASTM C260), Fly Ash (processed)

ISO 21930:2017 Sustainability in Building Construction-Environmental Declaration of Building Products: serves as the core PCR for Concrete; NSF International, August 2021 serves as a subcategory PCR

Sub-category PCR review was conducted by
Thomas P. Gloria, Bill Stough, and Michael Overcash.

Independent verification of the declaration and data, according to ISO 21930:2017 and ISO 14025:2006.: ☐ internal ☒ external

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

For additional explanatory material:
Manufacture Representative: **Dan Crouch** (dan.crouch@heidelbergmaterials.com)
LCA and EPD Developer: **Athena Sustainable Materials Institute**

Disclaimer: EPDs are comparable only if they comply with this document, use the same sub-category PCR where applicable, include all relevant information modules and are based on equivalent scenarios with respect to the context of construction works.

This EPD was calculated using manufacturer specific cement data that represents 100% of the total cement used in this mix.

PLANT
Acheson
200 Acheson Road
Spruce Grove, Alberta

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

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Addressing specialty mixes

The carbon intensity of concrete mixes can be impacted significantly when special circumstances are considered, including:

- High early strength
- Specialty and high performance
    - Architectural
    - Low-shrinkage
    - Self-consolidating
    - Shotcrete
    - Specialized durability applications (i.e CXL)
- Cold weather concrete applications

Some concrete elements have specialized durability requirements beyond those defined by the typical exposure classes of CSA. These criteria can include exceptionally long service lives, more sophisticated testing such as direct abrasion resistance, salt scaling slabs, depth of chloride penetration, flexural strength, or resistance to other conditions such as abnormal temperatures or exposure to specific chemicals.

These requirements can necessitate the use of specialty materials or design considerations, and when it comes to integrating such criteria, it will serve the designer well to remain aware that anything driving a need for increased cement contents will increase the carbon impact of the concrete. Such design and testing can take considerable time and labour, and special requirements should be identified up front to ensure that the process can be completed and that mix designs are optimized for both performance and carbon intensity based on the results

Treasury Board of Canada – Low Carbon Concrete Standard

Cement Association of Canada

- Where specialized concrete mixes are required for **high early strength, high or ultra-high performance, and/or cold-weather applications, the baseline used for those mixes shall be 130% of the baseline mix** in the Regional Industry Average EPD for that strength class

Treasury Board of Canada Secretariat

CONCRETE CARBON PROJECT BUDGET (CCPB)

Application	Strength (psi)	Exposure Class	Maximum GWP (kg CO_2e/m^3)		Volume (m^3)	Total GWP (kg CO_2e)
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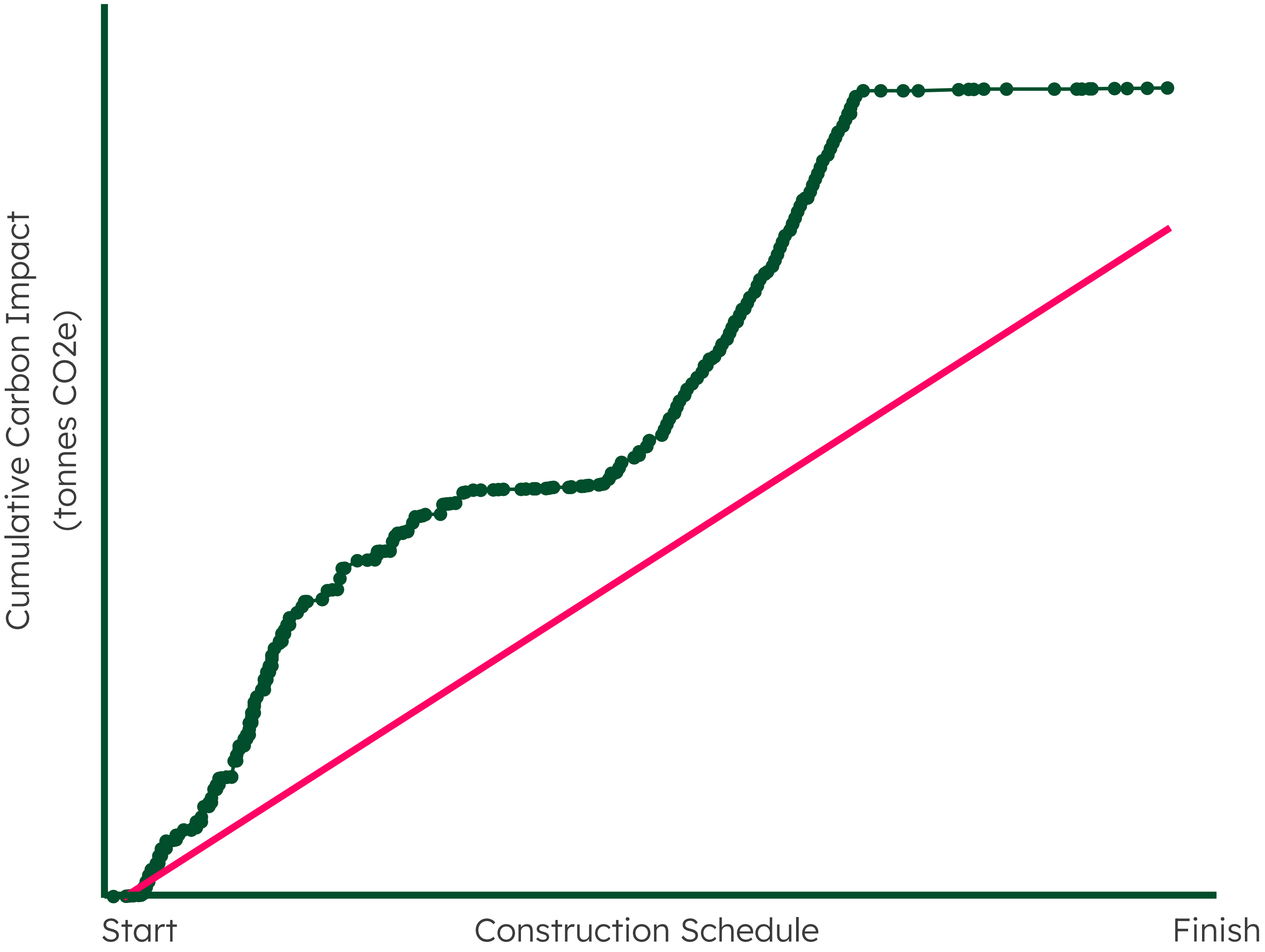
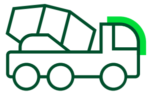
Floors and Slabs	4000	C0	316.46 x 1.3	X	1,000	411,398
Columns	5000	C0	386.11	X	600	231,666
Exterior Concrete	4000	C2	316.46	X	300	94,938
					TOTAL	868,692

You're doing it wrong (but that's okay)



Specifying Community (Architects, Engineers): Design the project and specify materials and systems to meet performance, aesthetic, and regulatory requirements. Have significant authority in selecting lower-carbon materials through design and specification choices.

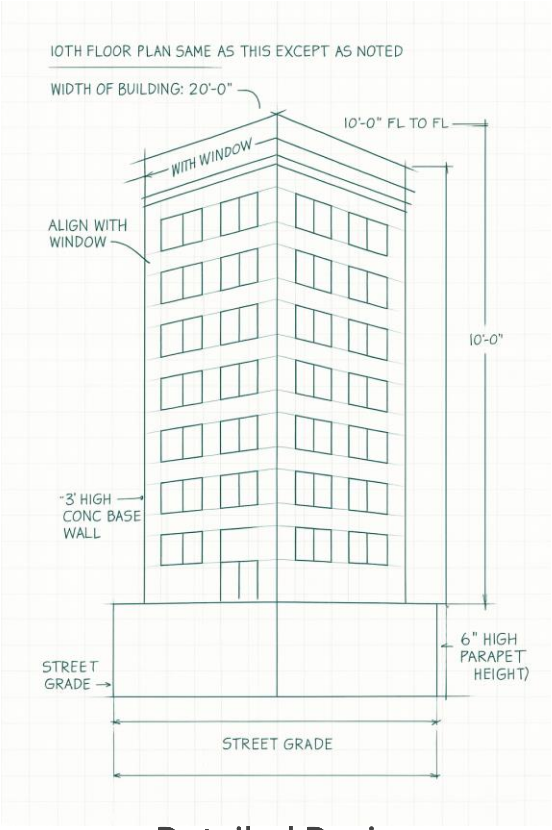


General Contractors: Oversee the entire construction process, coordinating subcontractors and managing timelines and budgets. Influence material procurement but usually defer to specifications from architects or owners.

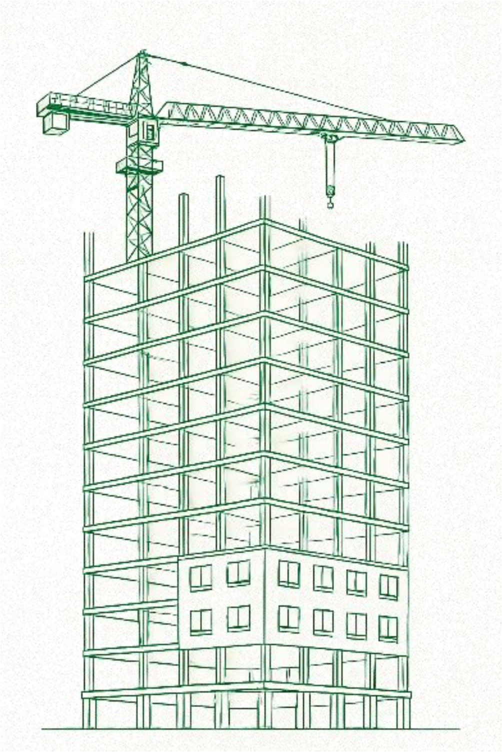
Concrete Producers: Provide finished construction materials to contractors and developers according to project specifications and applicable codes and standards. Can influence the carbon footprint of a project through the availability and promotion of lower-carbon material options.

Carbon Budgets are iterative!

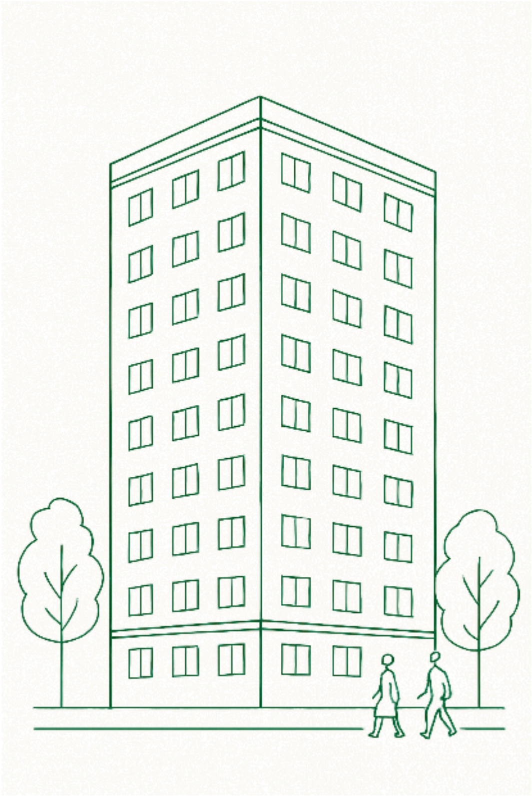
Conceptual Design



Detailed Design



Construction



Completion

Keys to success

Integrative Design Teams

As promoted by LEED, integrative design teams allow key stakeholders to align on project objectives, outlines tactics and alternatives, and communicate tradeoffs early in the design process, as well as along key project stages (Bid, Partial Completion, Substantial Completion).

Pump it up

Another aspect of concrete mixes that can impact GWP are workability considerations like pumping, finishability, and other desired properties that are difficult to outline in specifications. Have special conditions? Outline not just how you think they should be achieved, but why → knowing the underlying reasons can help our technical service teams deliver results while optimizing for carbon.

Don't sleep on schedule

Schedule is among the most impactful considerations for the GWP of concrete. Knowing which elements can delay set times and which require accelerated set times will significantly increase the accuracy of your carbon budgets. Work collaboratively with the general contractor and concrete producer to properly reflect schedule demands.

Leverage technology

From in-truck monitoring systems that help reduce waste and ensure quality concrete at point of delivery to maturity monitoring technology that provides in-situ insights into concrete strengths throughout the curing process, modern technology enables better insights and decision making. Work with your local concrete supplier to integrate into your project.

Don't lose sleep over data

Data is very important, but in the absence of key information, rely on best available information and best practices. Relevant, accurate benchmarks are great, but difficult to reflect to local geography for 100s of applications, each with project-specific considerations.

Conduct project review

Did the project achieve its goals? How far away were the results, and what are the reasons why? Can changes be made to make improvements, or do expectations need to change? Is everyone involved in the project aware so improvements can be made next time? ***Don't point fingers.***

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