Everything Municipal Concrete

June 8, 2021

CONCRETE ONTARIO

ONTARIO GOOD ROADS ASSN. 1894

MUNICIPAL ENGINEERS ASSOCIATION

Presenters

Amin Mneina, MSc. EIT.

Member Services Coordinator

MEA / OGRA

Alen Keri, P.Eng.

Director of Technical Services

Concrete Ontario

Bart Kanters, P.Eng., MBA

President

Concrete Ontario

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Housekeeping

GoToWebinar

- Approximately a 60-minute webinar with Q & A at the end
  - Stick around until the end to play a Kahoot for $200 in prizes
- All participants are muted
- Questions? Use the GoToWebinar ‘Questions’ Pane
- Webinar will be recorded and posted on the Concrete Ontario website along with a PDF copy of the presentation
- https://www.rmcao.org/publications/webinar-presentations/

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Agenda

- OGRA Municipal Concrete Liaison Committee Overview
- Latest OPSS Concrete Standard Updates
- New Municipal Exterior Flatwork Certification Program
- Low Carbon Concrete
- Kahoot! for Amazon E-gift Cards

2012
Municipal Concrete Liaison Committee

Concrete Ontario, Cement Association of Canada and the Ontario Good Roads Association agree that there are benefits to working together to resolve any current or future concrete related issues. Therefore the 3 associations have decided to form a municipal/industry liaison committee.

ONTARIO STANDARDS
OPS
MUNICIPAL-PROVINCIAL

ST MARYS CBM

THE MILLER GROUP

Dufferin Concrete
A CRH COMPANY

AMICO
PROPERTIES | INFRASTRUCTURE | DESIGN BUILD

Thorncrete CONSTRUCTION LTD.

DiCRETE

TOMLINSON
FOUNDED ON STRENGTH GUIDED BY VISION

ORILLIA

KINGSTON

DURHAM REGION

VAUGHAN

CITY OF Thunder Bay
Superior by Nature

wsp

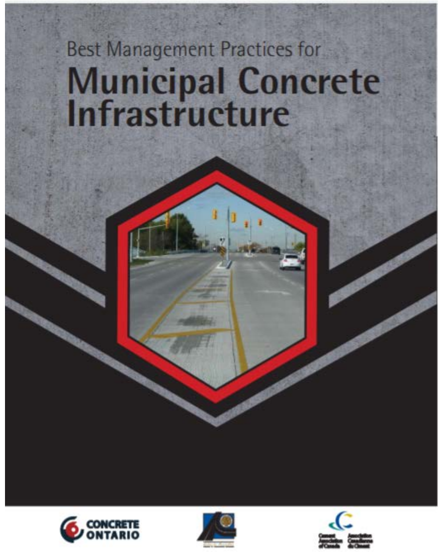
Englobe

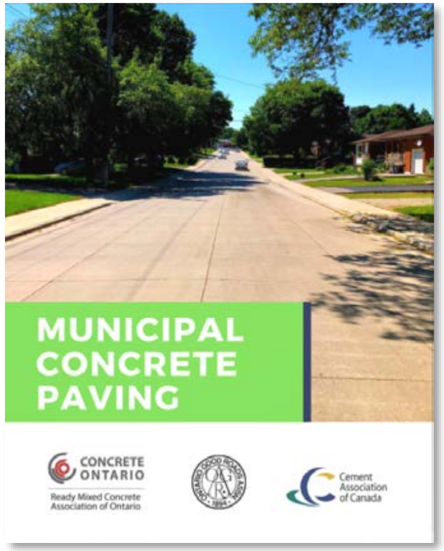
BRIDGE CHECK CANADA

OCPA

Ryerson University

Committee Highlights

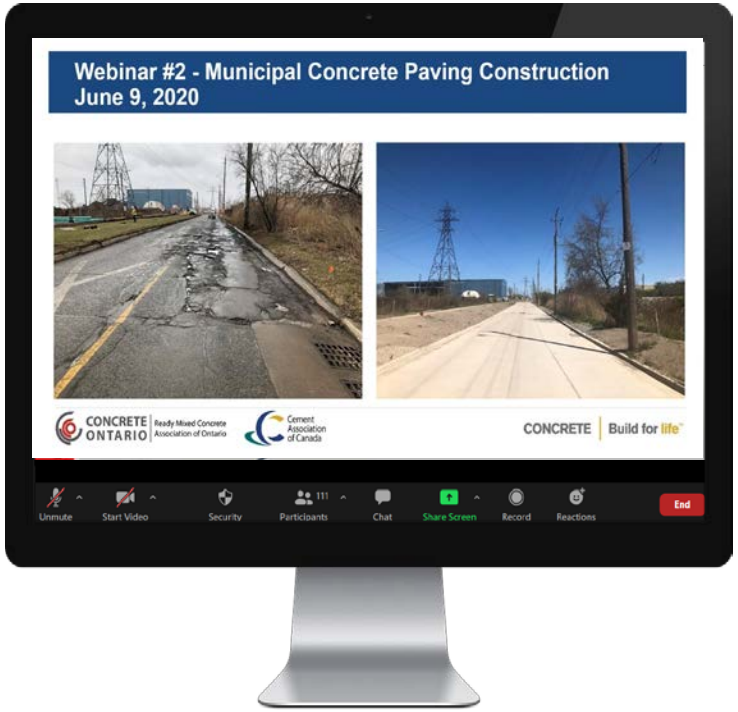




Best Practices Guides (Explore "Handouts section)

Municipal Concrete Award

Municipal Concrete Paving Webinar Series



2020 Municipal Concrete Award

Purpose

Promote and recognize the successful collaboration between municipalities and Concrete producers for excellence and innovation in Municipal Concrete projects in Ontario

Judging Criteria

- Conformance to specifications based on testing
- Visual appearance
- Workmanship
- Innovation
- Other considerations (work window, traffic, interaction with public, etc.)

2019 Winner - 7-3 Fire Station

2020 Winner - Reconstruction of Pedestrian Access Dorengate Drive & Islington Avenue

$327,109.75

86+ cubic metres of concrete

67 tonnes of granular fill installed

12 concrete foundations

11 suspended concrete slabs

VAUGHAN

Pine Valley

- 3rd annual Municipal Concrete Award submission deadline is **December 17, 2021**
- Winner to be recognized at the annual OGRA Convention in February 2022.

- Visit: https://www.ogra.org/images/MPAward_Images/2021/2021%20MCA%20Application.pdf for more information.

- Brochure is available in the "Handouts" section on the right side of your screen.

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Latest OPSS Concrete Standard Updates

- **OPSS.MUNI 350 (Nov. ‘21) – Construction specification for concrete pavement and concrete base**
  - **Fully revised specification (Last update was in 1998)**
- **OPSS.MUNI 351 (Nov. ‘19) – Construction specification for concrete sidewalk**
  - Introduction of the ACI Flatwork Certification requirement
  - 30MPa updated to 32MPa Class C-2
  - **Update coming in Nov. ’21 (Addition of Municipal Exterior Flatwork Certification)**
- **OPSS.MUNI 353 (Nov. ‘19) – Concrete specification for concrete curb and gutter systems**
  - Introduction of the ACI Flatwork Certification requirement
  - 30MPa updated to 32MPa Class C-2
  - **Update coming in Nov. ’21 (Addition of Municipal Exterior Flatwork Certification)**
- **OPSS.MUNI 1350 (Nov. ‘19) – Material specification for concrete – Materials and production**
  - Full adoption of Portland-limestone cement

Challenges
Surface durability

MUNICIPAL EXTERIOR FLATWORK CERTIFICATION

Challenges

Uniform support & proper joint construction

Challenges

Public

Challenges
Salt usage

MUNICIPAL
EXTERIOR
FLATWORK
CERTIFICATION

Concrete does last!

MUNICIPAL
EXTERIOR
FLATWORK
CERTIFICATION

Industry Support

Program Overview

MUNICIPAL EXTERIOR FLATWORK CERTIFICATION

- Provide a comprehensive overview of Municipal best practices and specifications specifically regarding Ontario Municipal concrete flatwork applications (Sidewalks, curbs, gutters and pavements)
- Educate contractors and inspectors
- Gather and spread knowledge about individual Municipal practices
- Minimize deficiencies in the field

Program Recognition

OPSS.MUNI 350, 351 & 353 (November '21)

MUNICIPAL EXTERIOR FLATWORK CERTIFICATION

Definition:

Municipal Exterior Flatwork Certification means the certification issued by Ready Mixed Concrete Association of Ontario (RMCAO), after **demonstrating knowledge** to place, consolidate, finish, edge, joint, cure and protect concrete flatwork.

351.04.02 Submission Requirements

Prior to starting the work, documentation shall be submitted, verifying that the Contractor's representative of the placing crew shall be on site and shall have the certification as **specified in Contract Documents**.

Designer Action/Considerations

Certification such as **Municipal Exterior Flatwork Certification**, or ACI Flatwork Certification, or approved equivalent. (351.04.02)

ONTARIO PROVINCIAL STANDARD SPECIFICATION

OPSS.MUNI 351
NOVEMBER 2019

CONSTRUCTION SPECIFICATION FOR CONCRETE SIDEWALK

TABLE OF CONTENTS

351.01 SCOPE

This specification covers the requirements for the construction of concrete sidewalks.

351.01.01 Specification Significance and Use

This specification is written as a municipal-oriented specification. Municipal-oriented specifications are developed to reflect the administration, testing, and payment policies, procedures, and practices of many municipalities in Ontario.

Use of this specification or any other specification shall be as specified in the Contract Documents.

November 2019 Page 1 of 10 OPSS.MUNI 351

Program Promotion

MUNICIPAL EXTERIOR FLATWORK CERTIFICATION

- In talks with City of Ottawa, Thunder Bay and LiUNA 183
- Numerous contractors interested in taking the course already

Program Promotion

MUNICIPAL
EXTERIOR
FLATWORK
CERTIFICATION

MUNICIPAL
ENGINEERS
ASSOCIATION

MEA 2021 Virtual CONFERENCE & AGM

Week of November 22, 2021

Low Carbon Concrete | Reductions that can be made today

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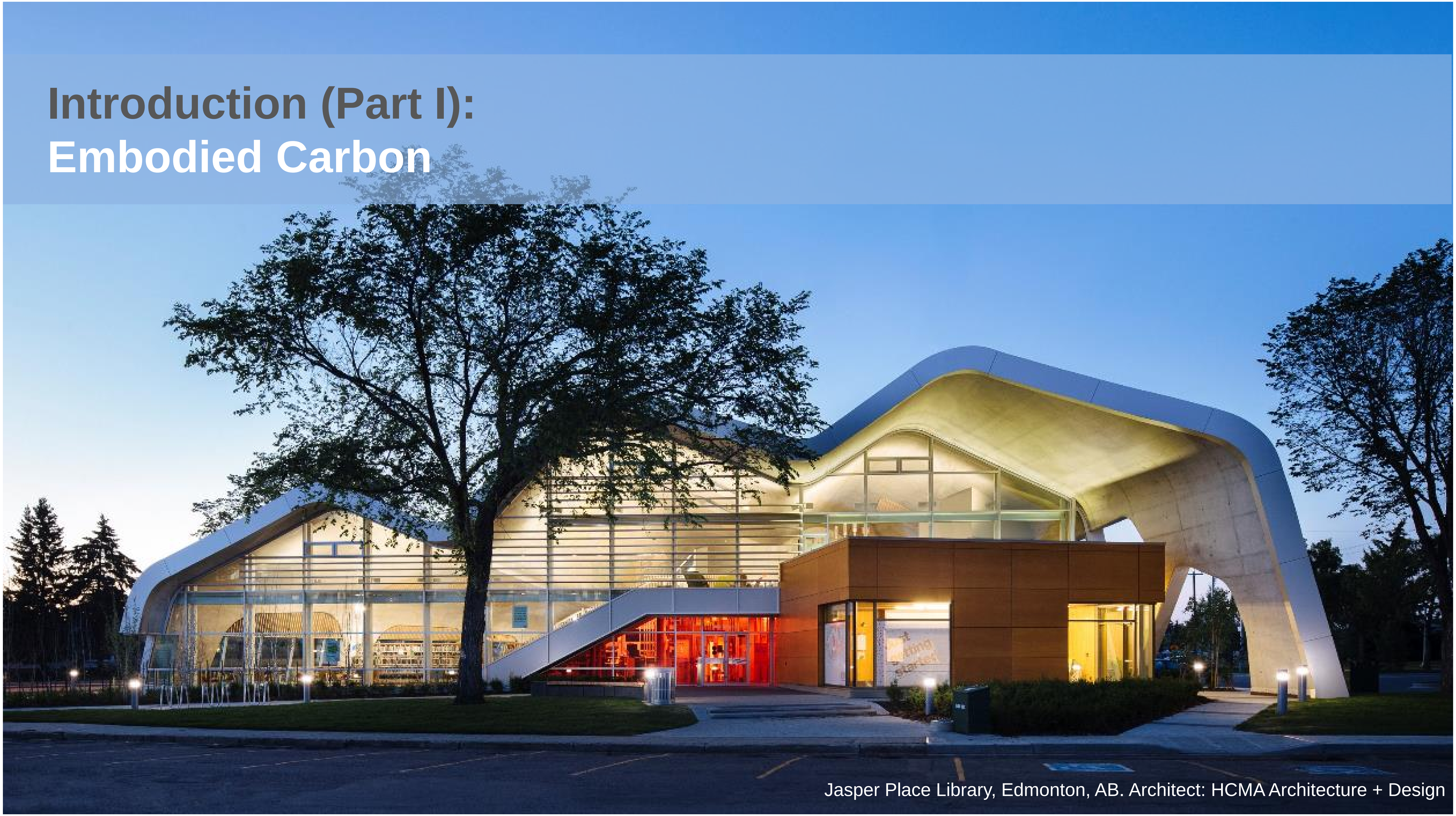
Agenda

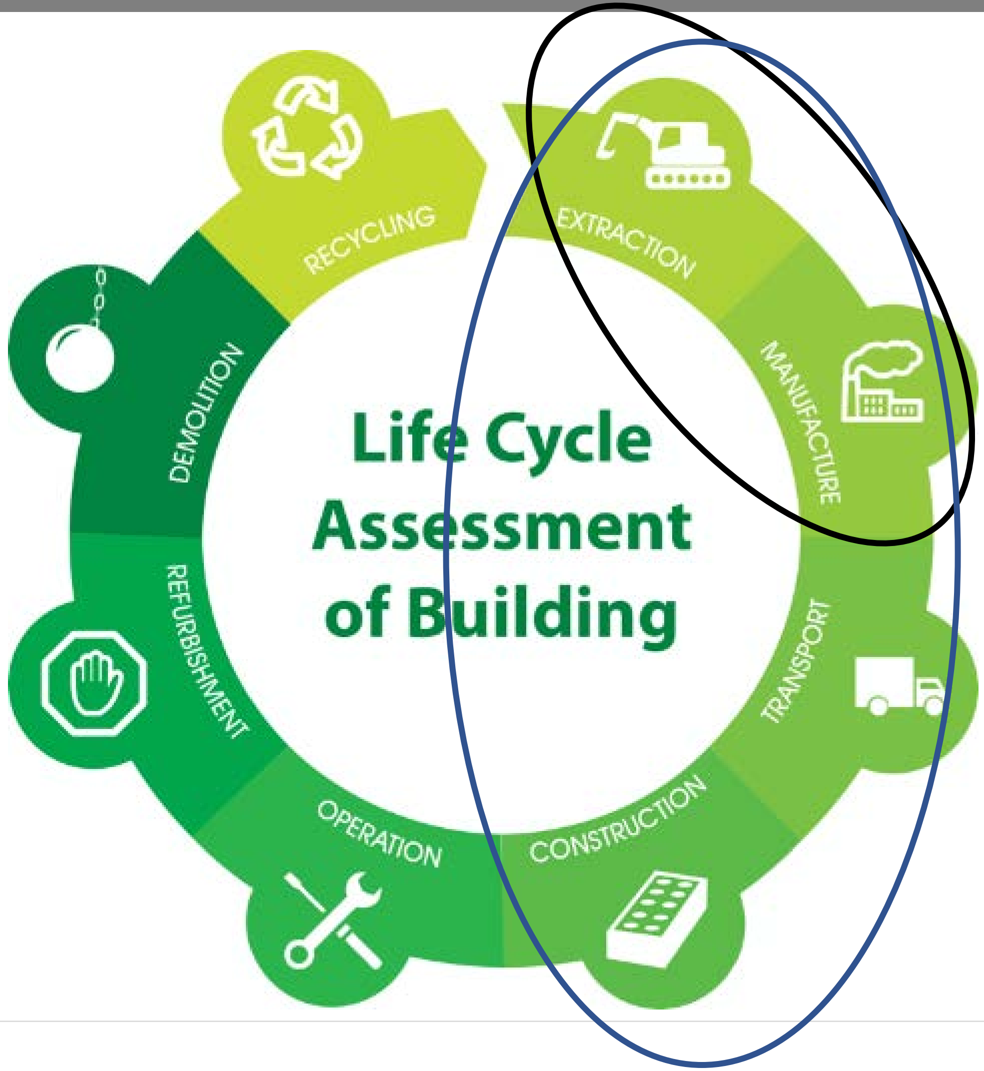
- **Introduction**
  - What is “embodied carbon” and why is it important?
  - What is the construction industry doing about embodied carbon?
  - What is the relationship between cement, concrete and GHG emissions?
- **Decarbonizing concrete**
  - How are cement and concrete made?
  - What is the industry doing to reduce GHG emissions?
  - Is the future of concrete carbon neutral?
  - What is your role in reducing concrete’s embodied carbon?

Introduction (Part I):
Embodied Carbon



Jasper Place Library, Edmonton, AB. Architect: HCMA Architecture + Design

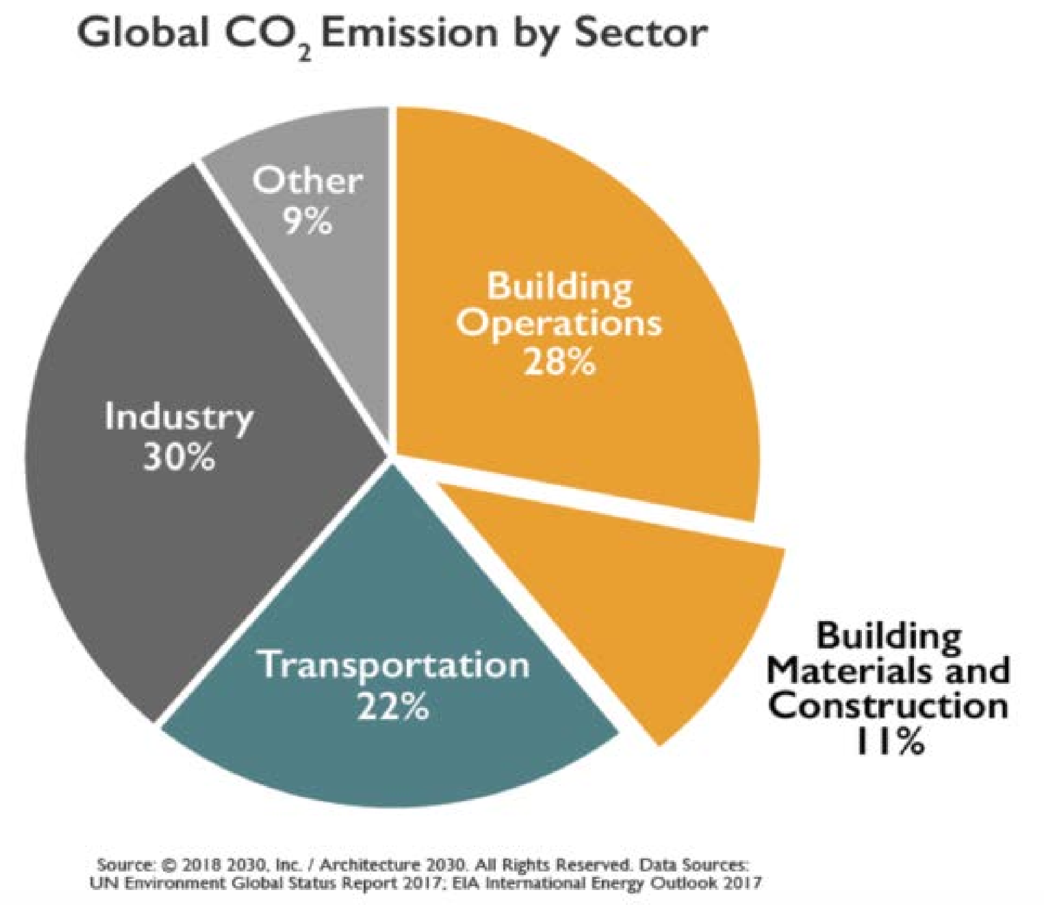
What is embodied carbon?



- Embodied Carbon of **Materials**
  - Extraction and manufacturing
- Embodied Carbon of **Infrastructure**
  - Materials + transportation, construction
  - (sometimes) end of life carbon impacts

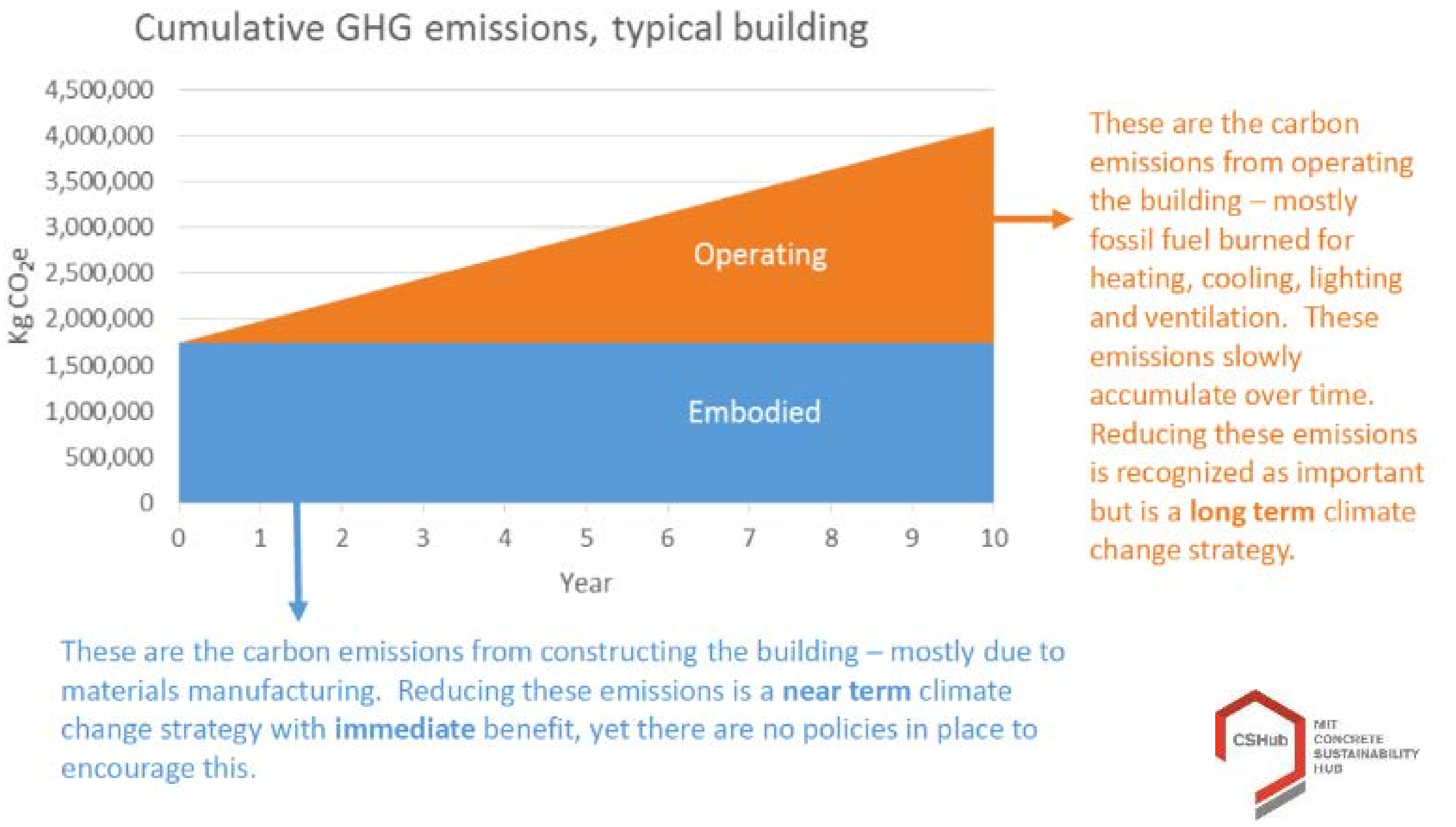
*i.e. **"upfront"** carbon*

Embodied carbon is a significant source of emissions

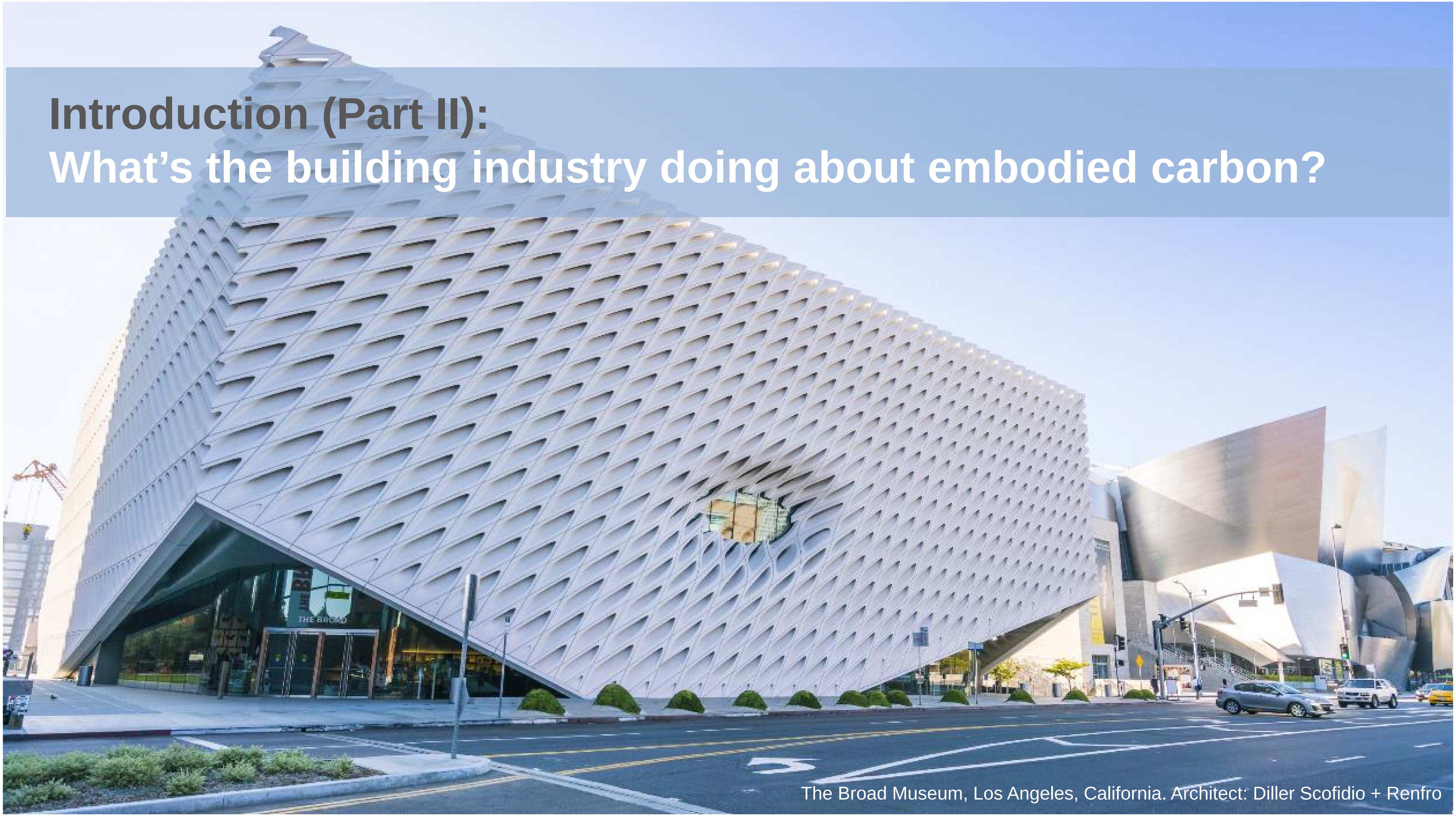


- **Transportation is #3** at 22% of global GHG emissions
- Building Operations and Building Materials and Construction are about 40% of global GHG emissions

Timing of emissions (“radiative forcing”) give reductions in embodied carbon added climate mitigation value



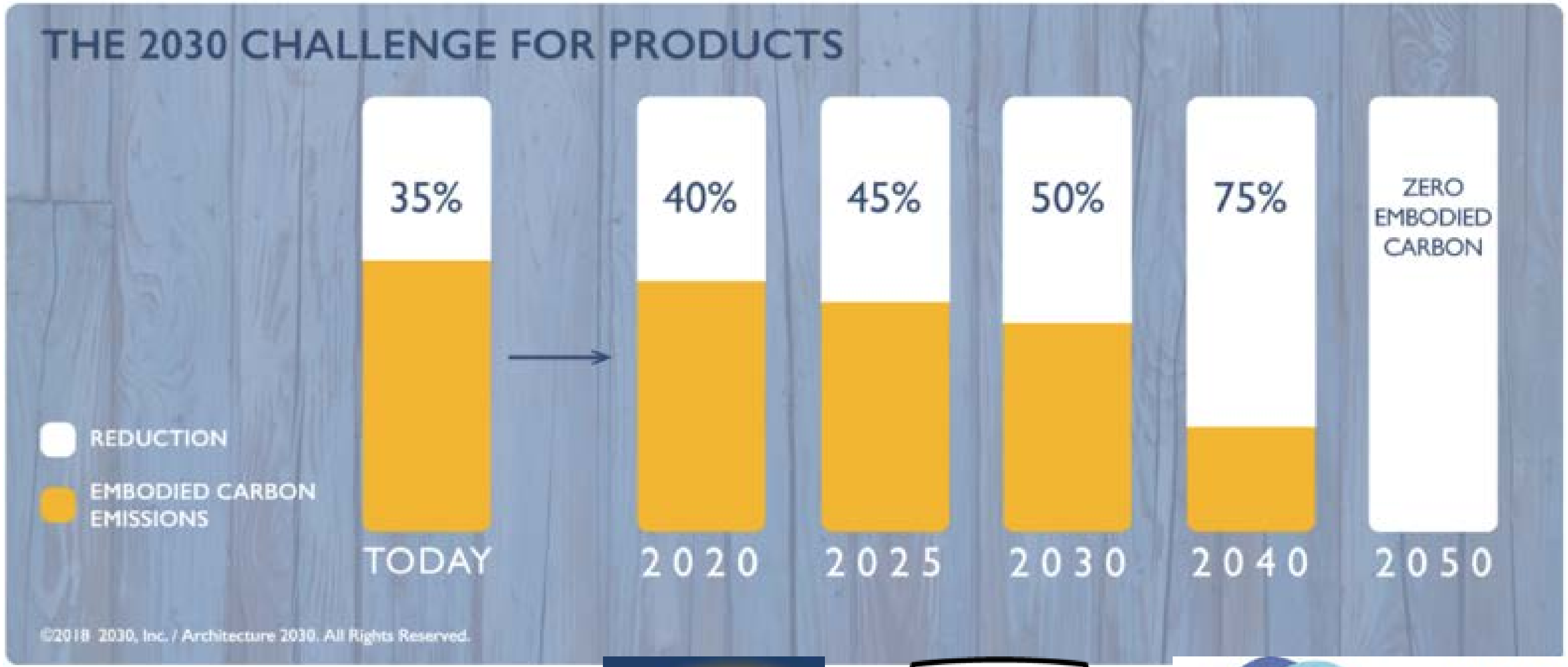
Introduction (Part II):
What's the building industry doing about embodied carbon?



The Broad Museum, Los Angeles, California. Architect: Diller Scofidio + Renfro

The Global 2050 Challenge

A multi-disciplinary challenge to achieve **zero embodied carbon by 2050**.



Mission alignment with:

CLF Carbon Leadership Forum

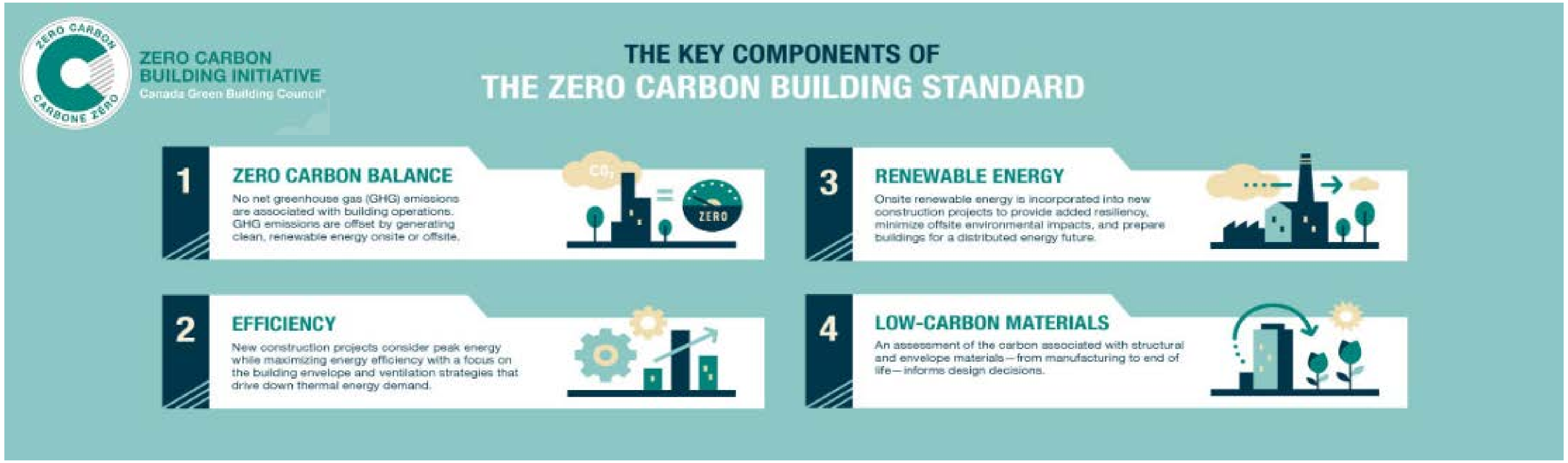
architecture 2030

SEI ASCE

WORLD GREEN BUILDING COUNCIL

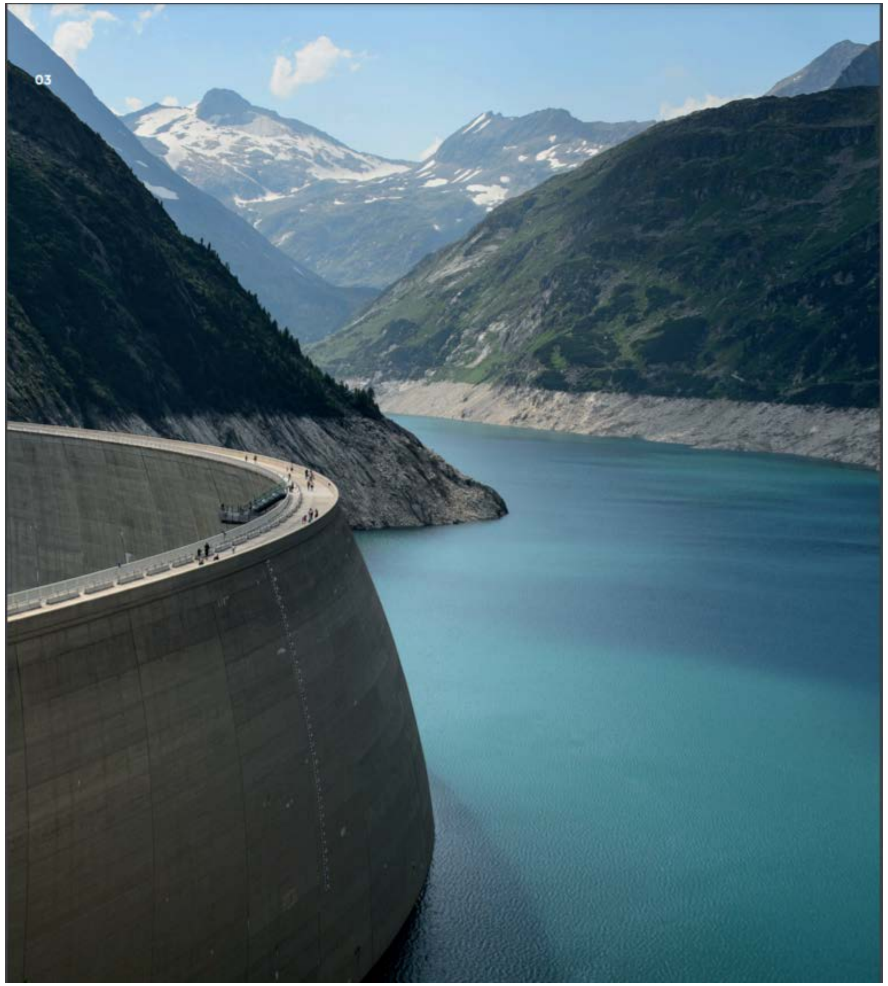
CaGBC Zero Carbon Building Initiative
A comprehensive approach to zero carbon buildings

Source: Skansa



GCCA Climate Ambition – Carbon Neutral by 2050

- Eliminating our direct energy-related emissions and maximising the co-processing of waste from other industries, which substitutes the use of fossil fuels involved in cement manufacture
- Reducing the content of both clinker in cement and cement in concrete, as well as more efficient use of concrete in buildings and infrastructure
- Reducing and eliminating indirect energy emissions through renewable electricity sources where available
- Reprocessing concrete from construction and demolition waste to produce recycled aggregates to be used in concrete manufacturing
- Reducing process emissions through new technologies and deployment of carbon capture at scale
- Quantifying and enhancing the level of CO_2 uptake of concrete through recarbonation and enhanced recarbonation in acircular economy, whole life context



Introduction (Part III):
Cement, Concrete and GHGs

Bosco Verticale, Milan, Italy. Architect: boeri studio

Concrete is the world's most important building material …

- Virtually all construction – above and below ground – requires concrete
- Twice as much concrete is used than all other construction materials combined
  - 4 billion tonnes of cement and over **20 billion tonnes of concrete** are produced globally each year* (**0.05%**)
  - Second most consumed commodity in the world, **second only to water**
- Cement is a global commodity, but concrete is inherently local

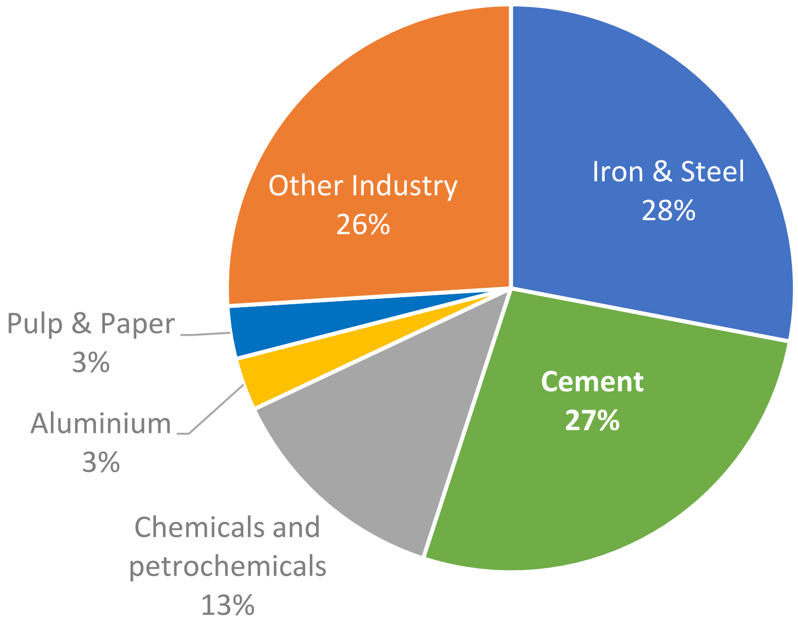
** https://www.statista.com/statistics/219343/cement-production-worldwide/*

Jasper Place Library, Edmonton

Confederation Bridge, New Brunswick / PEI

… and a significant source of GHGs

Global direct industrial CO_2 emissions (2014)

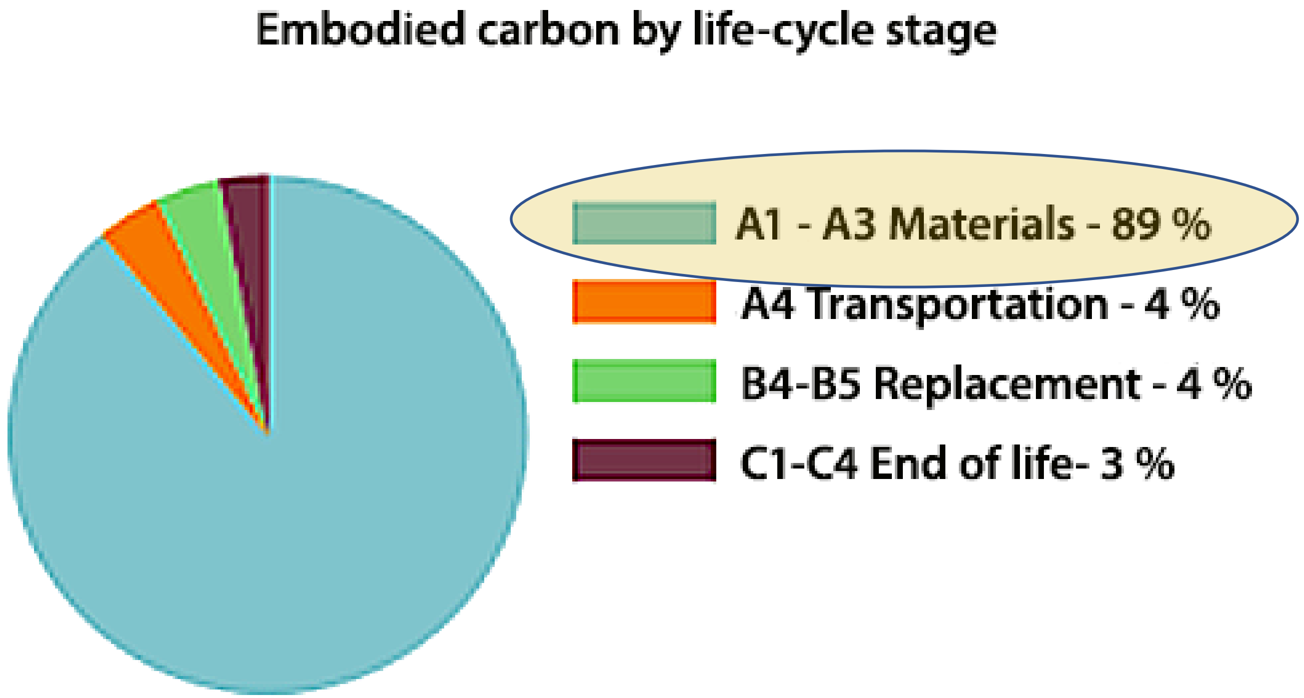


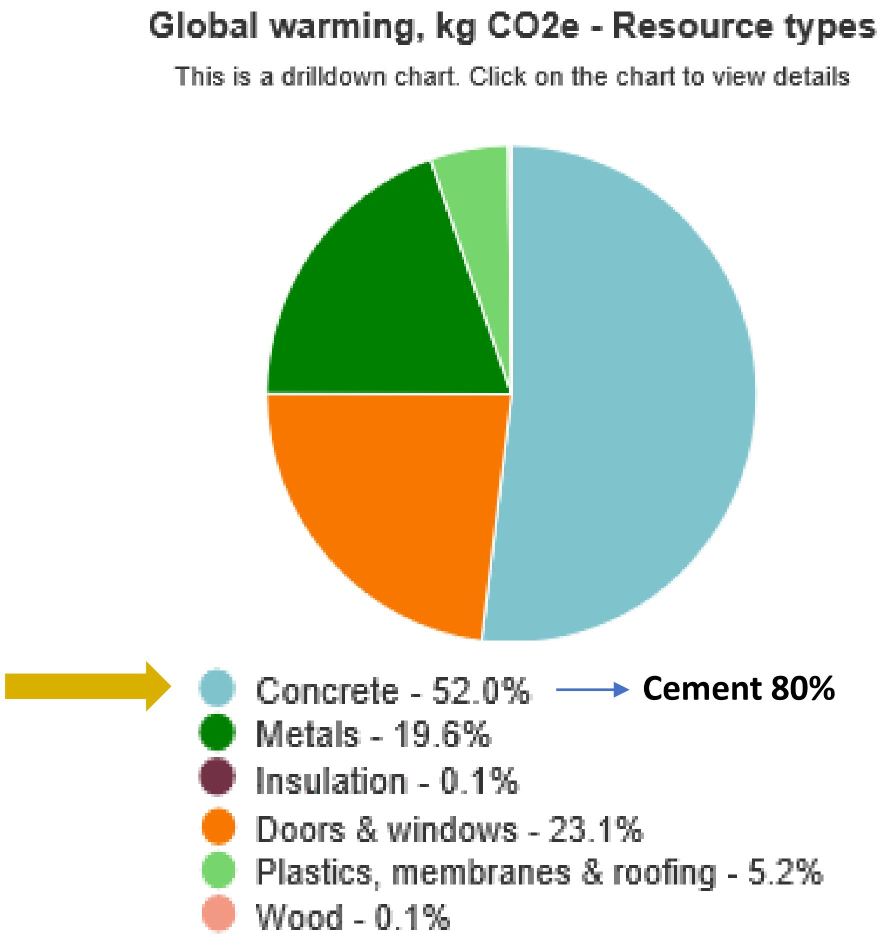
Information on this slide is sourced from International Energy Agency, Energy Technology Perspectives 2017

- Up to **8% of global emissions** come from the cement produced to make concrete*
- **1.5%** (10.8MT) of Canada's GHG emissions in 2017**
- Deep cement and concrete decarbonization technologies and strategies are essential to decarbonizing the built environment.

**Andrew, R.M., Global CO_2 emissions from cement production, Earth System Science Data, 2017*
***Environment and Climate Change Canada*

Example: Office Building

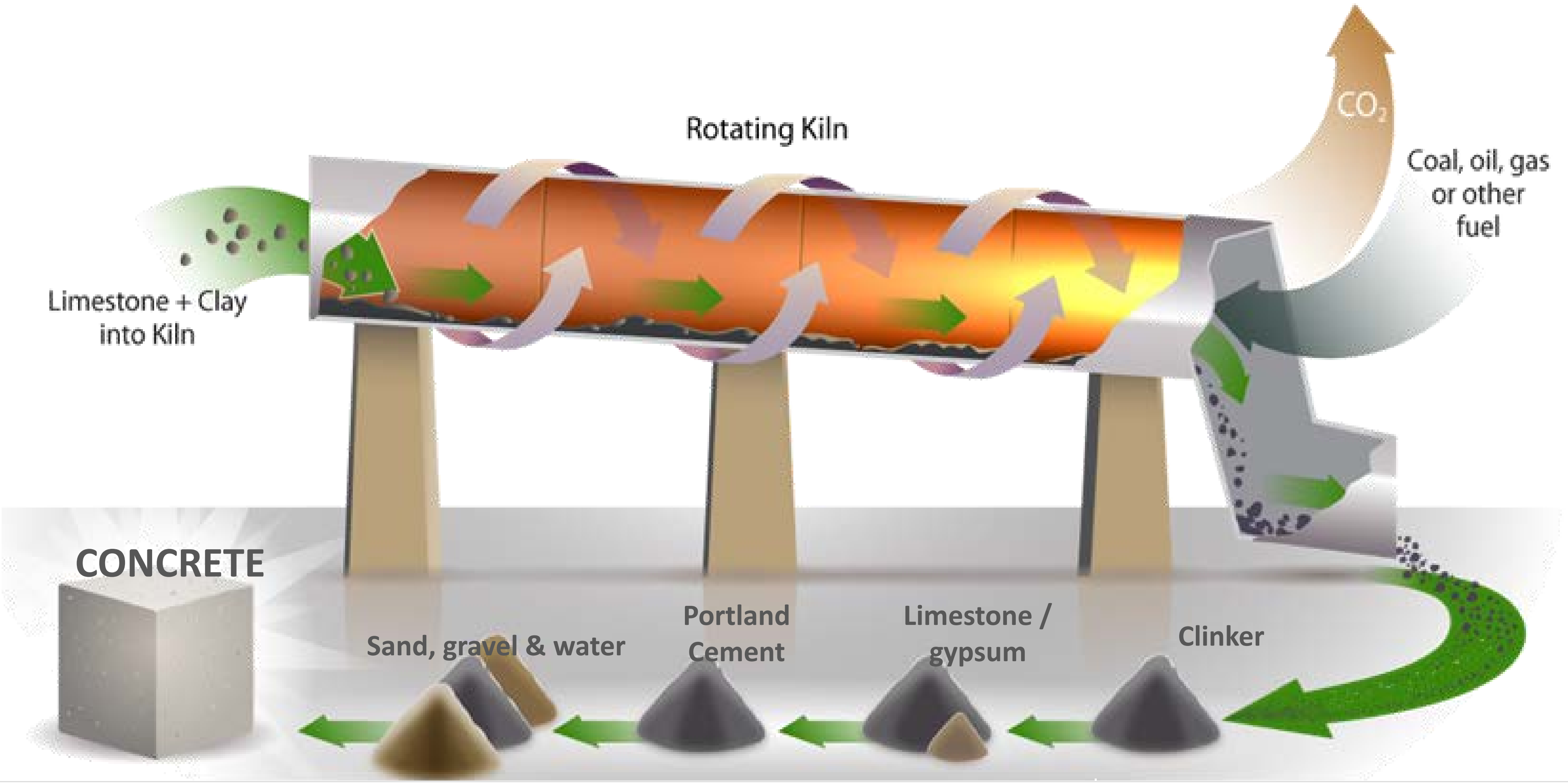




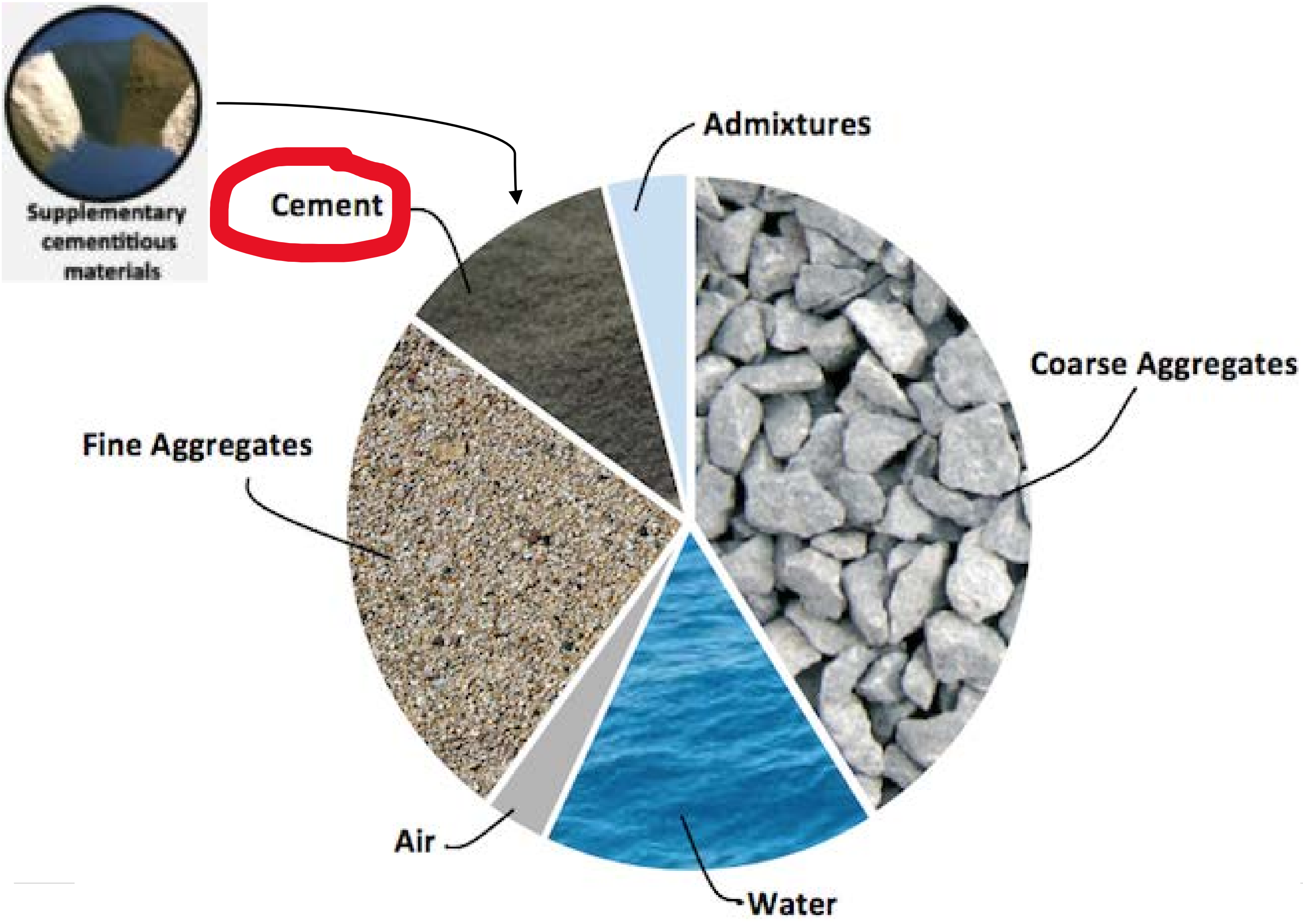
Decarbonizing Concrete (Part I):
How cement & concrete are made

Rogers Place, Edmonton, AB. Architect: HOK.

How cement and concrete are made



Cement is a small part of the concrete recipe, but responsible for most of concrete’s embodied carbon

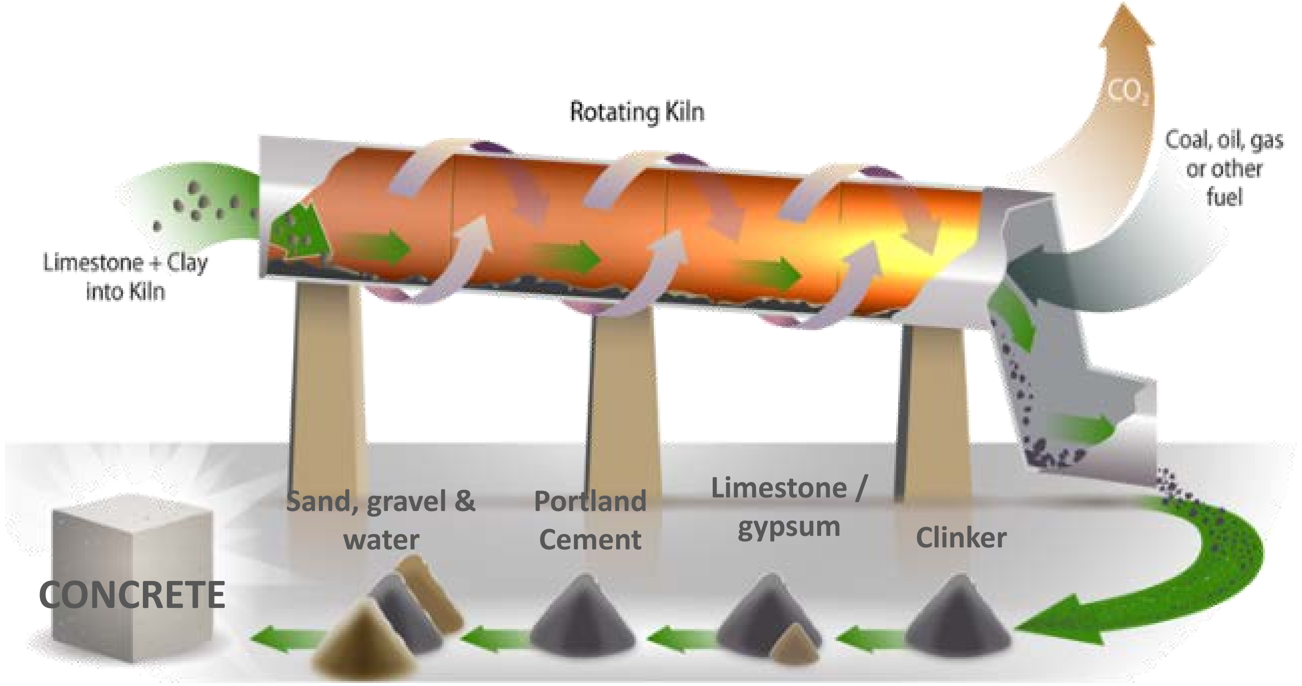


Concrete

- Typically 7-15% cement added to water, sand and gravel
- Cement comprises up to 85% of concrete’s carbon footprint

Multiple pathways needed to reduce emissions

Sources of GHGs in cement production



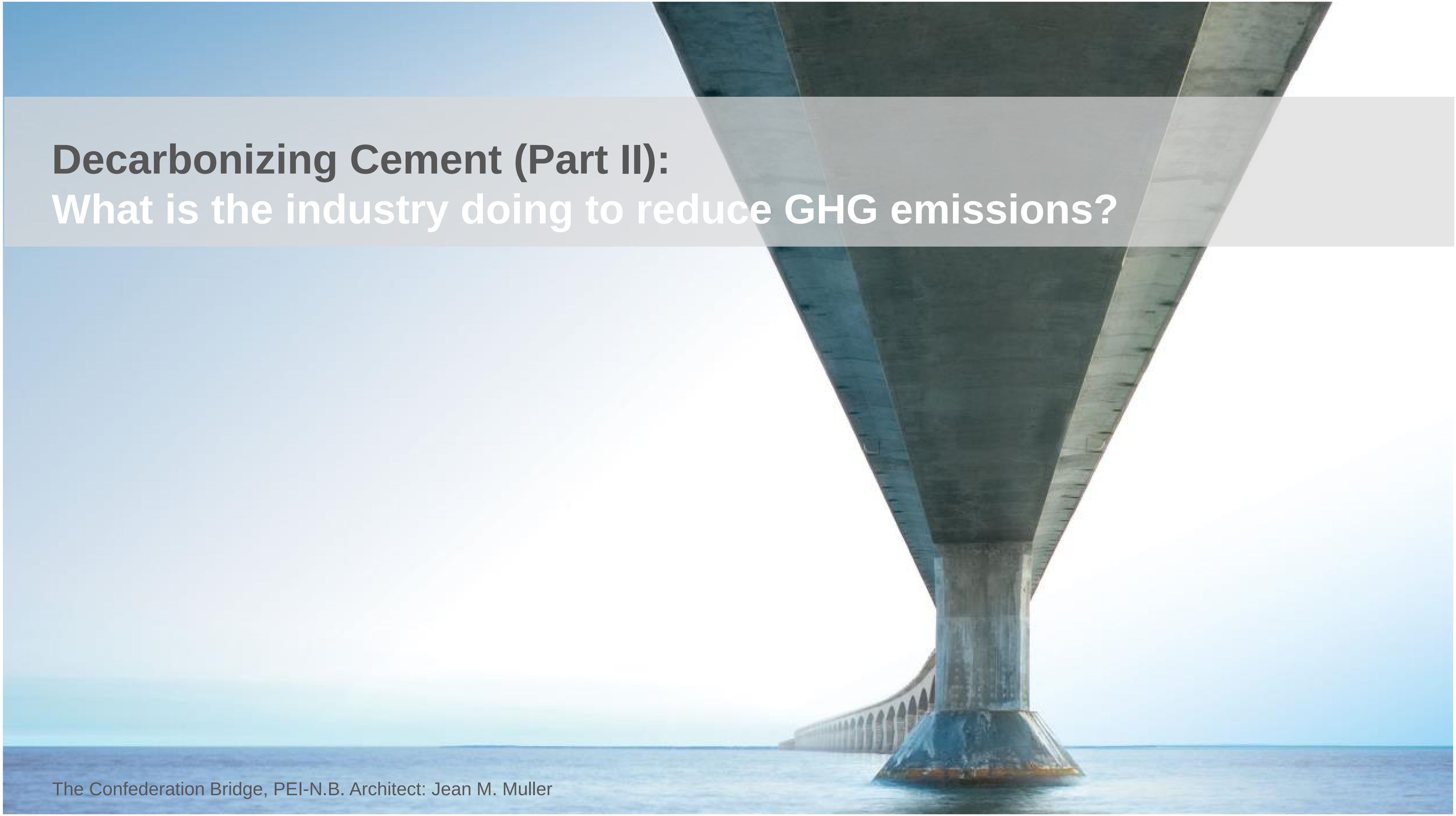
1/3rd combustion emissions

- *Can be addressed using lower carbon fuels*

2/3rd industrial process emissions

- ***Can only be addressed with:***
  - Clinker substitution (blended cements)
  - Cement substitution (SCMs)
  - Material efficiency (optimized design)
  - Carbon capture technologies (which can target the combustion emissions as well)

Decarbonizing Cement (Part II):
What is the industry doing to reduce GHG emissions?



The Confederation Bridge, PEI-N.B. Architect: Jean M. Muller

1. Cement Reductions – Low carbon fuels

- **Typical substitutes**
  - C & D waste (i.e. wood, shingles, etc.)
  - Non-recyclable plastics
  - Non-recyclable tires
- **Future**:
  - Biosolids?
  - Renewable natural gas?
  - Hydrogen?

✓ **Reduction Potential: ~ 33%**

2. Cement Reductions – Portland-limestone cement (PLC)

- Produces concrete with the same durability and performance
- Code-approved, available across the country
  - **OPSS.MUNI 1350 (Nov. ‘19) for Municipalities (1350.05.01.01 Cementing Materials)**
- Could reduce Canada’s GHGs by about 1,000,000 tonnes per year
- Higher limestone content (even lower GHGs) is possible and in use elsewhere in the world once PLC is more broadly accepted
- Benefits additive to carbon reductions from using SCMs, like slag and flyash

✓ **Reduction Potential: 5 - 10%**

Place Victoria, Gatineau, built using Portland-limestone cement

3. Cement Reductions – Carbon capture & utilization

Carbon capture at the cement plant

- Two full scale pilots under development in Western Canada

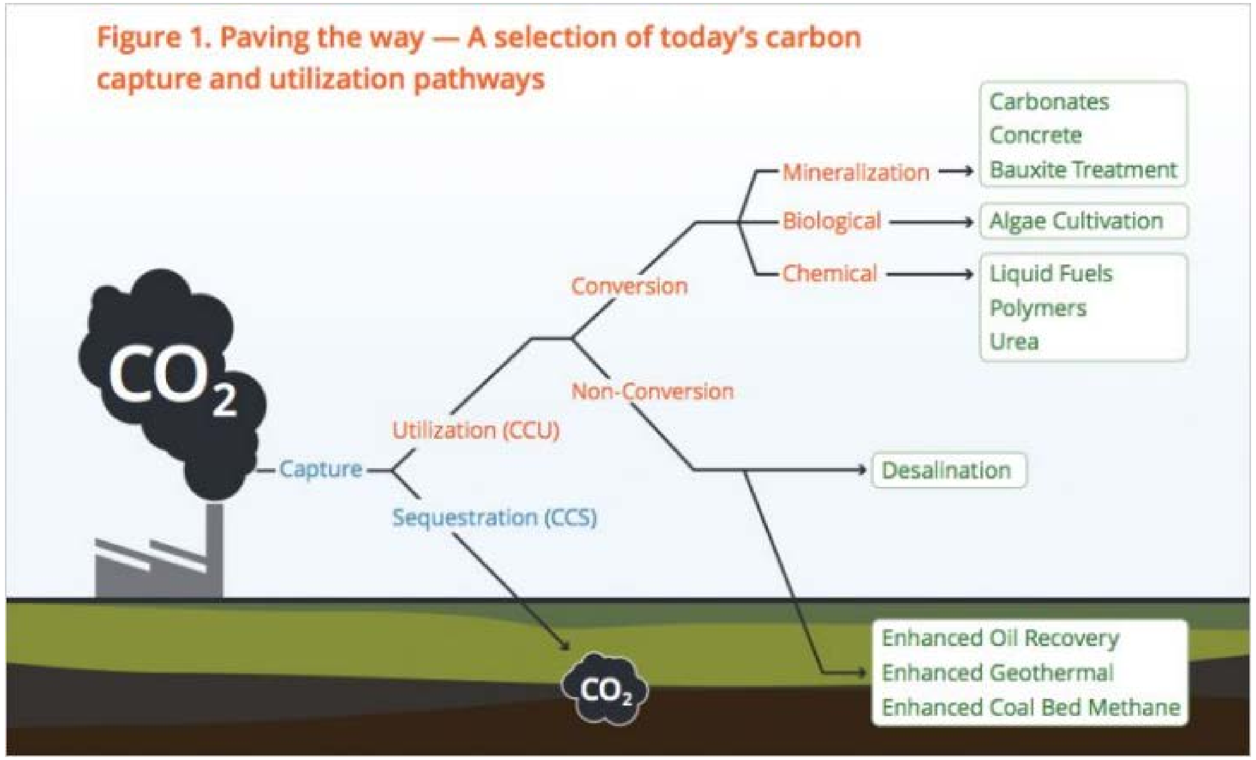
✓ **Reduction Potential: 90 – 95%**

Carbon utilization in concrete

- Multiple pathways

✓ **Reduction potential: 1 – 70%**

- Future: > 100% ??



Decarbonizing Concrete (Part III):
What you can do

The Mayfair Recreation Center, Winnipeg, MB. Architect: Bridgman Collaborative Architecture

Design and specification GHG touchpoints

- **Concrete's role in infrastructure**
  - Strength
  - Durability
  - Resilience

- **Low carbon concrete strategies**
  - Portland-limestone cement
  - Mix optimization
  - Material efficiency
  - Design for carbonation
  - Recyclability

What is missing in this picture?????

Carbon ROI: Resilience, Durability and Longevity

- **Durability and longevity** are an overlooked carbon reduction strategy
- Repurpose existing structures
- Build structures to a much higher standard of durability and resilience

Europe Hotel, Vancouver. Parr and Fee Architects

- 6-storey reinforced concrete heritage building
- Built in 1908-09
- Restored and converted to affordable housing in 1983

- CN Tower -
- Built in 1975 -
- Life expectancy over **300 years**

Know your concrete

- Standard mix designs save embodied carbon (**by over 30%**)
  - **Portland-limestone cement**
  - **Supplementary cementitious materials (SCMs)**
    - **Slag**
    - **Flyash**
  - **Admixtures**
- New tools emerging to help with project specific mix optimization decisions (e.g. on-demand mix-specific Environmental Product Declarations (EPDs))

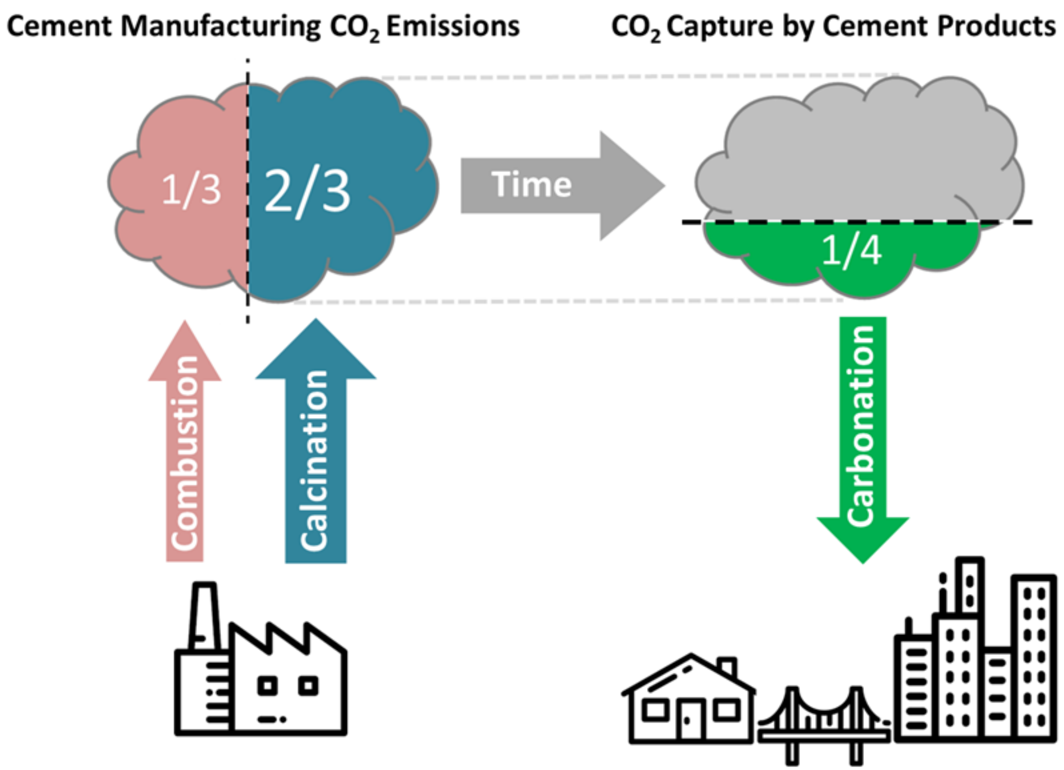
Source: CMRCA Member Industry-Wide EPD for Canadian Ready Mixed Concrete

Table 8. Summary Results (A1-A3): 31-35 MPa re

Indicator/LCI Metric	GWP	ODP
Unit (equivalent)	kg CO2	kg CFC-11
Minimum	260.49	3.69E-06
Maximum	449.79	6.40E-06
#39-35 GU with air 0-14% FA/SC	449.79	5.37E-06
#40-35 GU without air 0-14% FA/SC	386.61	4.76E-06
#41-35 Industry Average Benchmark	417.05	5.42E-06
#42-35 GU with air 15-29% FA	403.68	4.88E-06
#43-35 GUL with air 15-29% FA	362.81	4.59E-06
#44-35 GU without air 15-29% FA	347.87	4.35E-06
#45-35 GUL without air 15-29% FA	313.52	4.10E-06
#46-35 GU with air 30-40% FA	353.84	4.36E-06
#47-35 GUL with air 30-40% FA	318.82	4.10E-06
#48-35 GU without air 30-40% FA	305.99	3.90E-06
#49-35 GUL without air 30-40% FA	276.55	3.69E-06
#50-35 GU with air 25-34% SC	364.06	6.11E-06
#51-35 GUL with air 25-34% SC	329.36	5.86E-06
#52-35 GU without air 25-34% SC	314.59	5.38E-06
#53-35 GUL without air 25-34% SC	285.41	5.16E-06
#54-35 GU with air 35-50% SC	329.77	6.40E-06
#55-35 GUL with air 35-50% SC	299.71	6.18E-06
#56-35 GU without air 35-50% SC	285.78	5.62E-06
#57-35 GUL without air 35-50% SC	260.49	5.44E-06

Design for (re)carbonation (emerging science)

- Concrete naturally absorbs carbon over its life
- Rate of carbon uptake depends on exposure to air, atmospheric conditions, concrete composition etc.
- Could represent **>20% of the industrial process emissions** associated with cement content
- Exposed concrete maximizes the effect
- End of life strategies to optimize (re)carbonation are also being explored



Putting low carbon concrete strategies into practice

Canada Line Rapid Transit, Greater Vancouver Area, BC

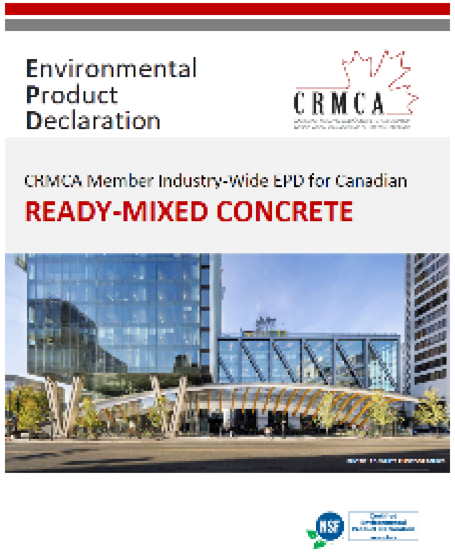
Communicate carbon reduction goals

Factors affecting CO_2

- Design
- Construction method
- Construction schedule
- Jobsite and seasonal conditions

Industry benchmarks:

- CRMCA industry average EPD for ready mixed concrete



Where Does the CO_2 Come From?

ZGF Architects Carbon Calculator

Concrete Materials	Proportions (kg/m^3)	CO_2 (kg/m^3)	
Cement	285	296	76.9%
Slag	70	2	0.5%
Coarse Agg.	1036	27	7.0%
Fine Agg.	853	57	14.8%
Water	154	3	0.8%
		385	

Proposed Mix - Suspended Slab - 30 Mpa - Sample Mix

Application	Suspended Slab	
Mix Design #/Name	Sample Mix	
Strength (psi)	30 Mpa	
Total CM of Mix in Building	1	m3
SCM Ratio (of SCM+Cement)	19.7	%
% SCM (of Total Mix)	2.9	%
% Cement (of Total Mix)	11.9	%

	Ingredients (kg/m3)	Acidification Potential (kgSO2eq)	Eutrophication Potential (kgNeq)	Global Warming Potential (kgCO2eq)	Ozone Depletion Potential (CFC-11eq)	Smog Formation Potential (kgO3eq)	Primary Energy Demand (MJ)	Non-renewable Energy Demand (MJ)
Cement	285	0.66	0.05	295.89	0.0000	14.29	2099.33	1916.55
Fly ash	0	0.00	0.00	0.00	0.0000	0.00	0.00	0.00
Slag	70	0.01	0.00	1.92	0.0000	0.31	30.81	29.38
Coarse Aggregate	1,036	0.15	0.01	27.24	0.0000	3.52	452.68	424.59
Lightweight Aggregate	0	0.00	0.00	0.00	0.0000	0.00	0.00	0.00
Fine Aggregate (Sand)	853	0.18	0.01	57.48	0.0000	4.37	955.10	927.12
Water	154	0.02	0.00	3.25	0.0000	0.32	53.78	50.88
Steel Reinforcement	150	1.08	0.03	211.46	0.0000	12.81	2980.23	2805.75
Per 1 CM of MIX	2548	2.10	0.10	597.23	0.0000	35.63	6571.94	6154.27
Total Impact	2548	2	0	597	0.0000	36	6572	6154

Disclaimers & Credits | Instructions and Assumptions | Mix LCA - CRMCA Baseline | Mix LCA - Custom Baseline

Ensure good project QA & QC

Additional cement can no longer be the solution to poor concrete testing!

What we need is:

- CCIL-certified laboratories
- ACI- or CCIL-certified field technicians
- Immediate distributions of test reports
- Addressing jobsite cylinder storage challenges

Optimize Concrete Volume

- Consider the cost/benefits of higher performance concrete if it reduces the total volume of concrete
- Total CO_2 is the real metric to consider
- Requires input from the concrete producer

Utilise Portland-Limestone Cement (PLC) whenever possible

- **Straight 1:1 replacement for GU**
- Higher use of inter-ground limestone reduced CO_2 by approximately **10%**
- Equivalent performance
- Product is being rolled out across Canada

Encourage the use of Supplementary Cementing Materials

Why are SCMs a great idea?

- Significantly reduce the permeability of the concrete and improve critical performance properties
- As by-products from other industries that only require minimal processing, they **significantly reduce the CO_2 of the concrete**
- Replacement levels for Portland cement can be **as high as 70%**

Optimize the use of chemical admixtures

Admixture Mix Optimization:

- A primary concrete performance metric is the **Water / Cementing Materials Ratio (W/CM)**
- Admixtures that reduce the water content without increasing the plastic slump of the concrete can reduce the cement content of the mix design
- Specialty admixtures may assist in cement reduction optimization

Don’t specify materials or limit material usage

Critical Factors:

- Don’t specify **minimum cement contents**!
- Don’t specify the use of proprietary materials that the producer is not familiar with!

Look at methods that sequester carbon dioxide

How can concrete sequester CO_2:

- CarbonCure
- Blue Planet

Over time, concrete absorbs CO_2

- More than 60% of the CO_2 released by the cement originates from the calcination of limestone
- This CO_2 is slowly reabsorbed from the air during the life of the concrete

CO_2 reduction strategies | Example project

Ontario example – The CORE, Tomlinson Group, Ottawa

Ontario Concrete Award – Sustainability

- **Architect**: Christopher Simmonds Architect Inc.
- **Length of Construction** = 36 Months
- **Area of Facility** = 84,703 sq ft

Ontario example – The CORE, Tomlinson Group, Ottawa

Specialty Concrete Mix Designs:

- Total concrete usage = 7,000 m^3
- Architectural self-consolidating concrete
- High slump silica fume columns
- High SCM replacement levels
- Integrally coloured concrete
- **Smart Concrete™** – Real time strength and temperature monitoring

Ontario example – The CORE, Tomlinson Group, Ottawa

Sustainability Aspects:

- LEED Silver designation
- Exposed concrete throughout
- Targeted CO_2 reductions of 20% via use of:
  - Silica fume
  - Slag
  - Optimized Mix Designs
  - **Avoided ~563 tonnes of CO_2**
- Wireless strength sensors to allow for greater SCM usage in winter months

Ontario example – The CORE, Tomlinson Group, Ottawa

Getting to Zero | Concrete's role in decarbonizing the built environment

- Concrete is an essential construction material
- Durability and long life are synonymous with concrete
- Significant steps can be taken to reduce the CO_2 impacts of concrete if we work together
- The cement and concrete industries have a goal of being carbon neutral by 2050

Questions?

Kahoot for Amazon E-gift Cards

- Pop quiz to determine if you paid attention!
- The faster you answer, the more points you will receive

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