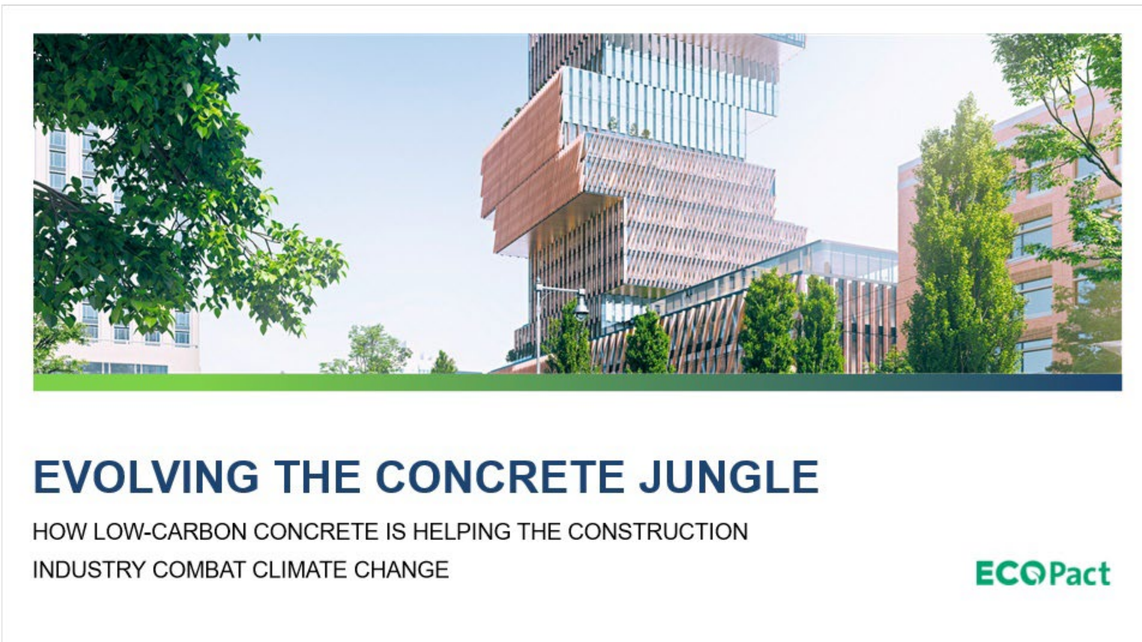
Evolving the Concrete Jungle

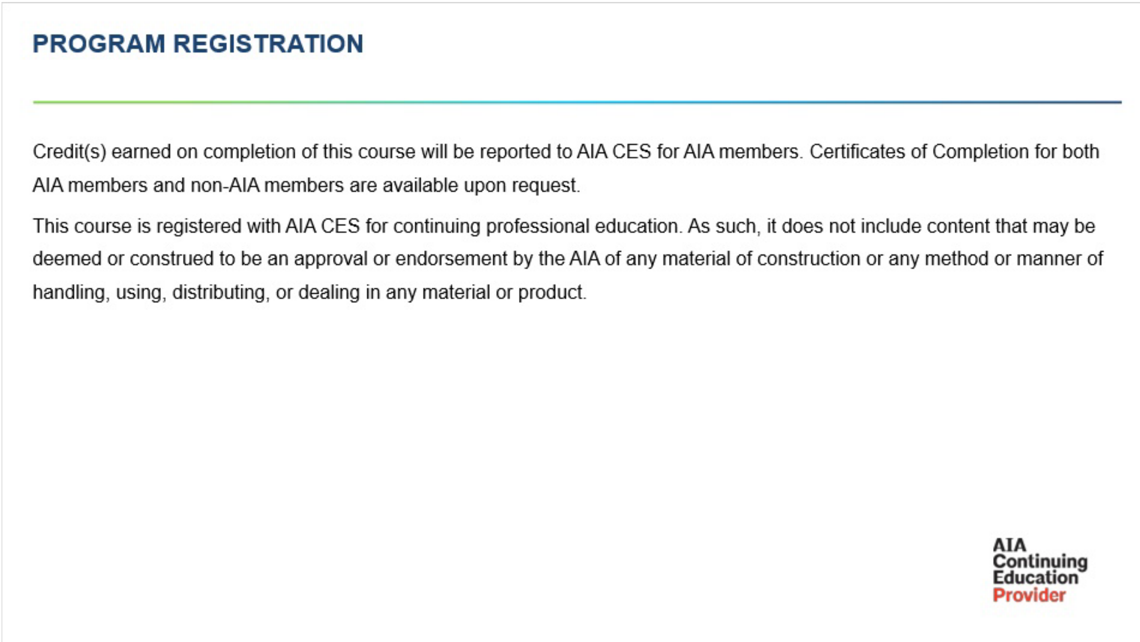
1.1 Evolving the Concrete Jungle



Notes:

Evolving the Concrete Jungle

1.2 Program Registration



Notes:

Credit(s) earned on completion of this course will be reported to AIA CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

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1.3 Copyright Materials

COPYRIGHT MATERIALS

Notes:

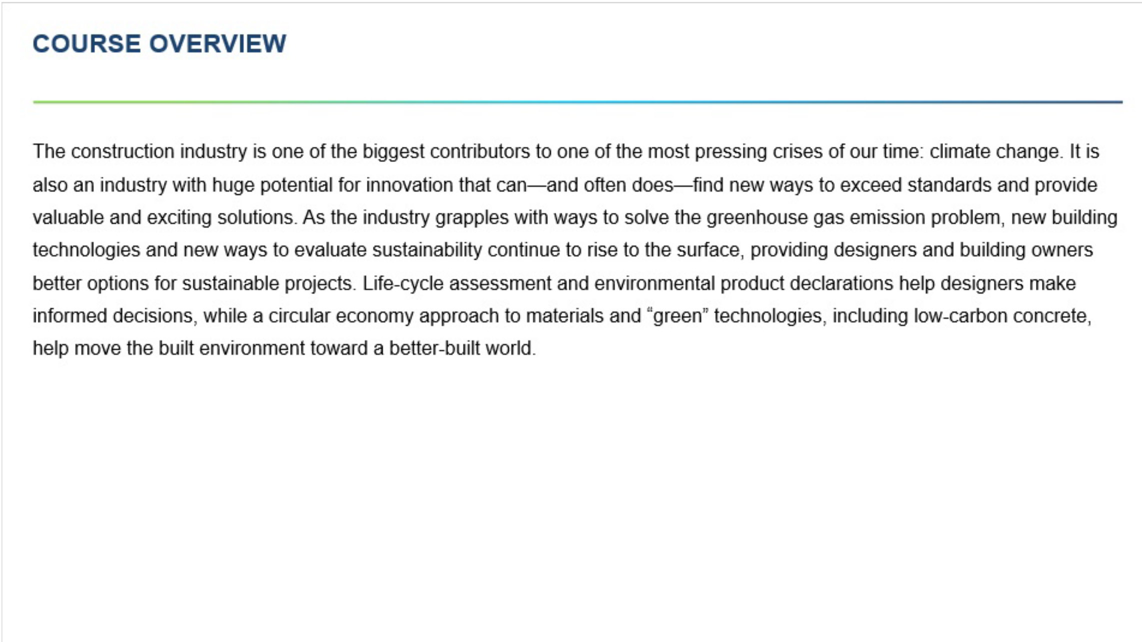
1.4 Learning Objectives

Notes:

At the end of this presentation, attendees will be able to:

- List ways in which the construction industry has an impact on global greenhouse gas emissions and global warming.
- Explain how life-cycle assessment (LCA) and environmental product declaration (EPD) help designers compare options and make informed decisions.
- Discuss how a circular economy approach to construction can benefit businesses, people, and the environment.
- Describe how low-carbon concrete is a proven alternative for the design of lower embodied carbon buildings and infrastructure.

1.5 Course Overview



Notes:

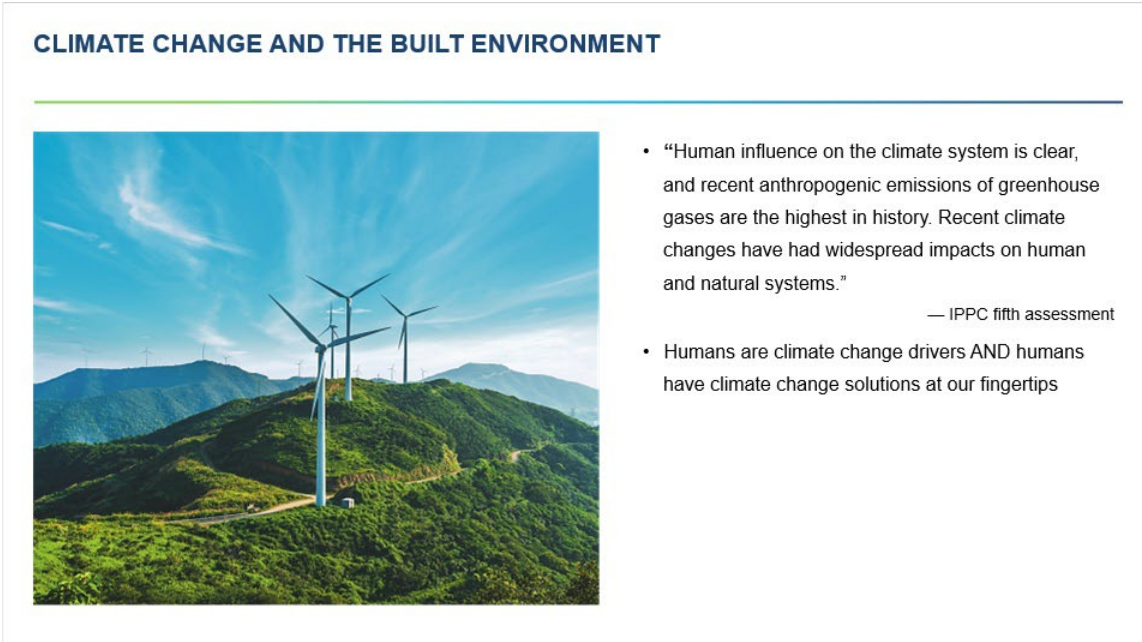
The construction industry is one of the biggest contributors to one of the most pressing crises of our time: climate change. It is also an industry with huge potential for innovation that can—and often does—find new ways to exceed standards and provide valuable and exciting solutions. As the industry grapples with ways to solve the greenhouse gas emission problem, new building technologies and new ways to evaluate sustainability continue to rise to the surface, providing designers and building owners better options for sustainable projects. Life-cycle assessment and environmental product declarations help designers make informed decisions, while a circular economy approach to materials and “green” technologies, including low-carbon concrete, help move the built environment toward a better-built world.

1.6 Section 1

Notes:

In this section we will provide a broad overview of climate change and explore the problem of greenhouse gas emissions (GHGs). We will discuss how the construction industry impacts climate change and how—even given this daunting problem—the construction industry can choose materials and approaches that limit emissions and help shift our course away from disaster.

1.7 Climate Change and the Built Environment

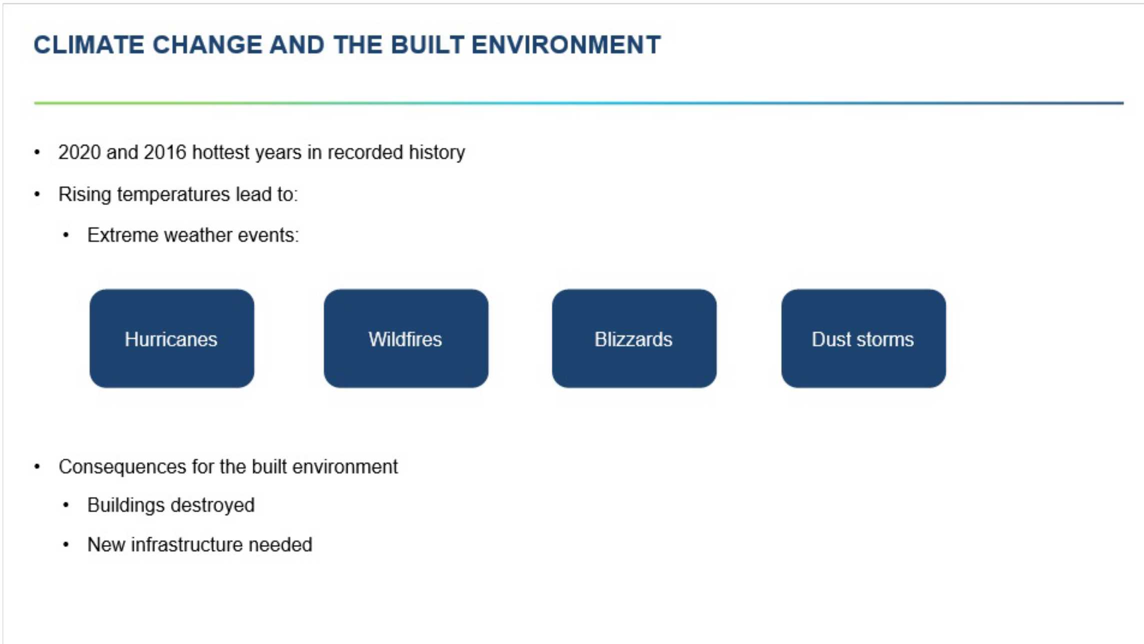


Notes:

There is a consensus among the international scientific community that human activity is a driver of global climate change. According to the Intergovernmental Panel on Climate Change (IPCC) in its fifth assessment report, "human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems."

But if it is human activity that is driving climate change, that means it is in human hands and at our fingertips to find solutions—and those solutions are out there.

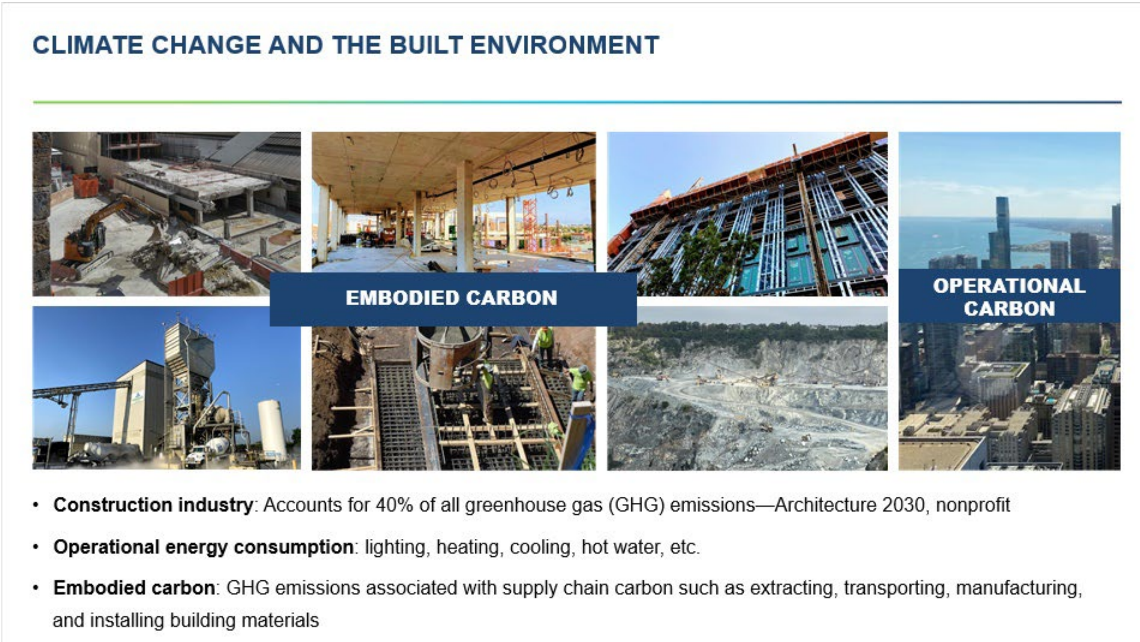
1.8 Climate Change and the Built Environment



Notes:

According to NASA and the National Oceanic and Atmospheric Administration, 2020 tied with 2016 as the hottest year since the late 19th century when modern recording of temperatures first started. Over time, these rising temperatures worsen extreme weather events such as hurricanes, wildfires, blizzards, and dust storms. They lead to consequences for the built environment, such as the destruction of buildings and the need for new, more durable infrastructure that can withstand extreme events. Each rise in degree is worse for the planet than the last—which all sounds so bleak. But the truth is, it is not too late to mitigate disaster.

1.9 Climate Change and the Built Environment



Notes:

One area where climate change solutions can materialize is within the construction industry. In fact, it is imperative that the construction industry be a lead innovator when it comes to the health of the planet, because the construction industry is a major contributor to climate change. According to Architecture 2030, a nonprofit seeking to "rapidly transform the built environment" toward climate change solutions, buildings account for nearly 40 percent of all greenhouse gas (GHGs) emissions. And that number gets bigger when you consider infrastructure and activities associated with buildings. Greenhouse gas emissions are associated with operational energy consumption in buildings, such as lighting, heating and cooling. But the other area associated with emissions is embodied carbon—the sum of carbon emitted for construction materials over the product's life cycle through extraction, transportation, manufacturing, installation of building materials and, eventually, demolition and recycling.

1.10 Climate Change and the Built Environment

CLIMATE CHANGE AND THE BUILT ENVIRONMENT

Construction industry aspirations to combat climate change:

- Consider your partners and stakeholders. Every design professional can have an influence on the environmental impacts of a construction project.
- Pay attention to energy, water, waste, chemicals, pollution and biodiversity issues

Notes:

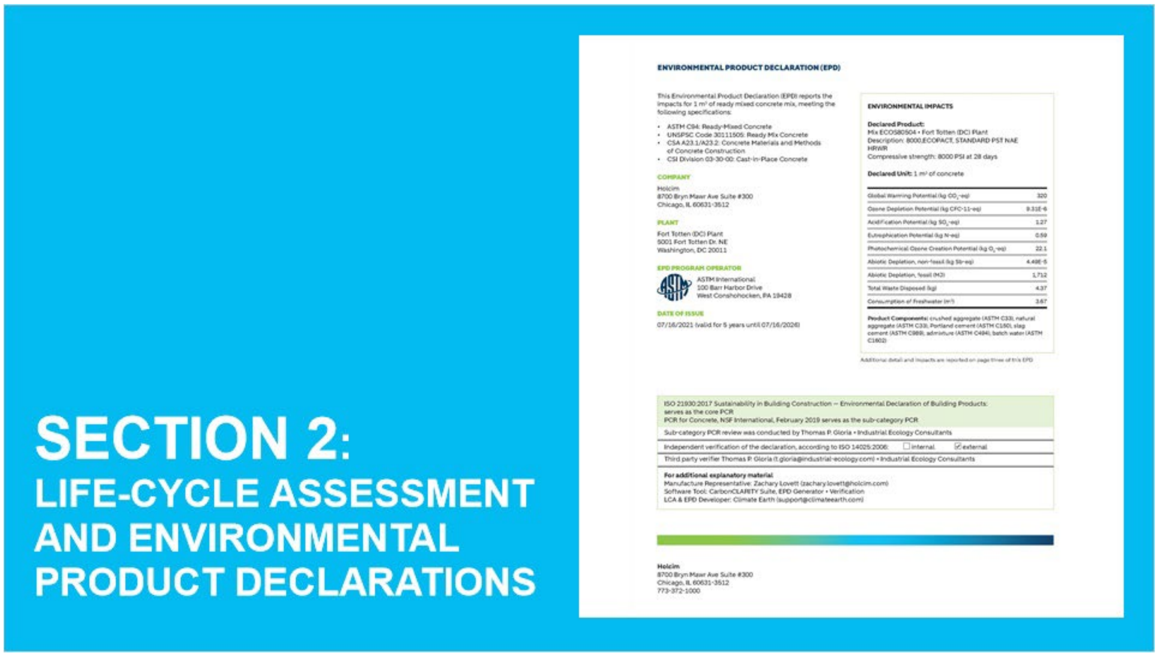
Goals:

- The lowering carbon intensity of building materials in the upstream production process of materials
- The implementation of climate-smart, low, and clean energy consumption in the use phase of real estate and infrastructure
- The design of more recyclable materials and closed material flows in the refurbishment and demolition phases (circularity of building materials)

For that reason, the goal of the construction industry should be to reduce the impact of climate change across the life cycle. That means considering manufacturers that work with suppliers in the shared goal of sustainability and working to mitigate issues regarding energy, water, waste, chemicals, pollution and biodiversity.

Goals for climate change action in the construction industry should include decarbonization along the entire value chain to influence lowering carbon intensity of building materials in the upstream production process of materials; the implementation of climate-smart, low, and clean energy consumption in the use phase of real estate and infrastructure; and the design of more recyclable materials and closed material flows in the refurbishment and demolition phases.

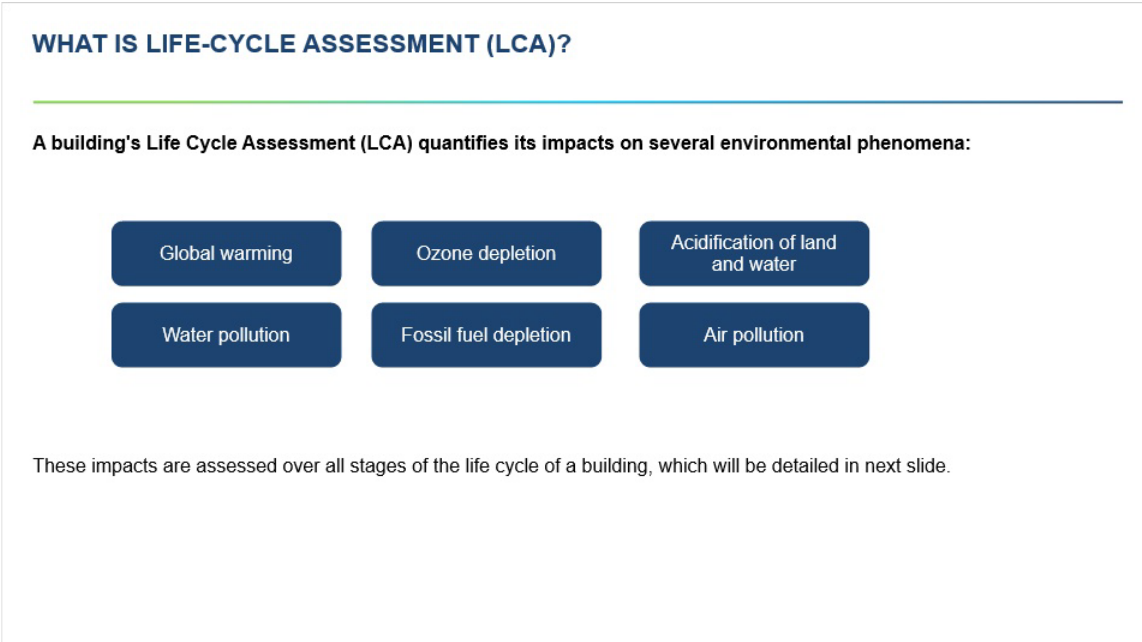
1.11 Section 2



Notes:

In the face of climate change, how can designers choose the best products and approaches for constructing buildings? This section will discuss how life-cycle assessment (LCA) works and what environmental product declarations (EPD) can tell you about a product's impact on the environment.

1.12 What is Life-Cycle Assessment (LCA)?



Notes:

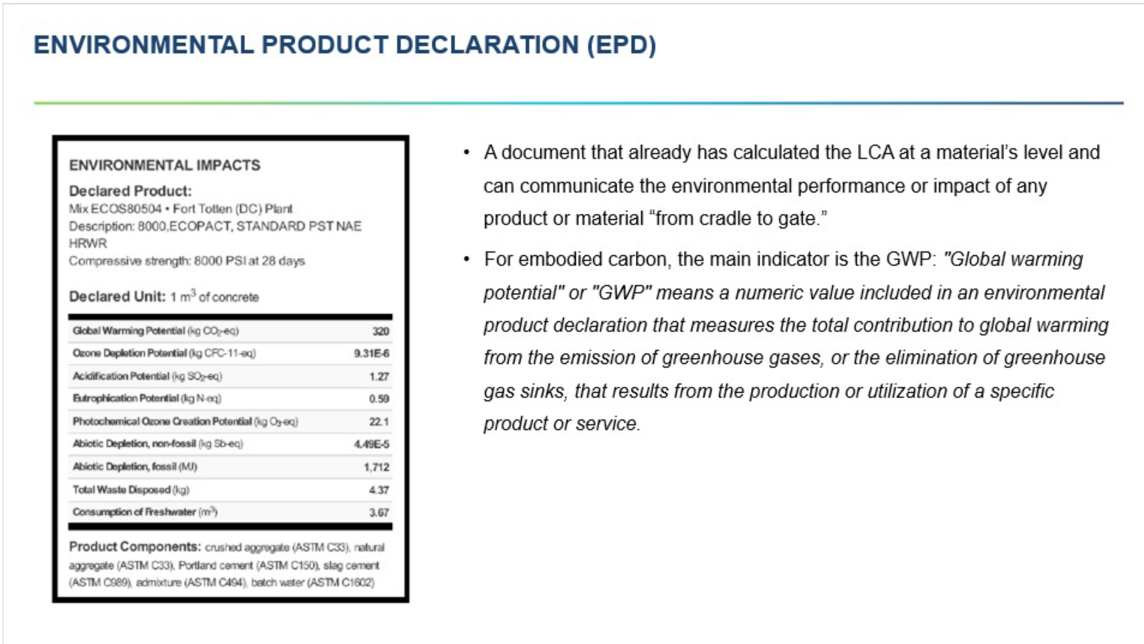
A life-cycle assessment (LCA) is a standardized methodology that quantifies a building's environmental impact. It is not just the footprint of a building, but a more holistic calculation and assessment of several criteria. Those criteria include global warming, ozone depletion, acidification of land and water, water pollution, fossil fuel depletion, air pollution.

1.13 Life Cycle of Buildings and Materials

Notes:

Materials are an important part of a building’s impact, because they already contain embodied carbon when they are purchased. Their production—from extraction to manufacturing and transportation in between—has all caused GHGs to be released into the atmosphere.

1.14 Environmental Product Declaration (EPD)



ENVIRONMENTAL PRODUCT DECLARATION (EPD)

ENVIRONMENTAL IMPACTS

Declared Product:
Mix ECOS80504 • Fort Totten (DC) Plant
Description: 8000,ECOPACT, STANDARD PST NAE HRWR
Compressive strength: 8000 PSI at 28 days

Declared Unit: 1 m^3 of concrete

Global Warming Potential (kg CO_2-eq)	320
Ozone Depletion Potential (kg CFC-11-eq)	9.31E-6
Acidification Potential (kg SO_2-eq)	1.27
Eutrophication Potential (kg N-eq)	0.59
Photochemical Ozone Creation Potential (kg O_3-eq)	22.1
Abiotic Depletion, non-fossil (kg Sb-eq)	4.49E-5
Abiotic Depletion, fossil (MJ)	1,712
Total Waste Disposed (kg)	4.37
Consumption of Freshwater (m^3)	3.67

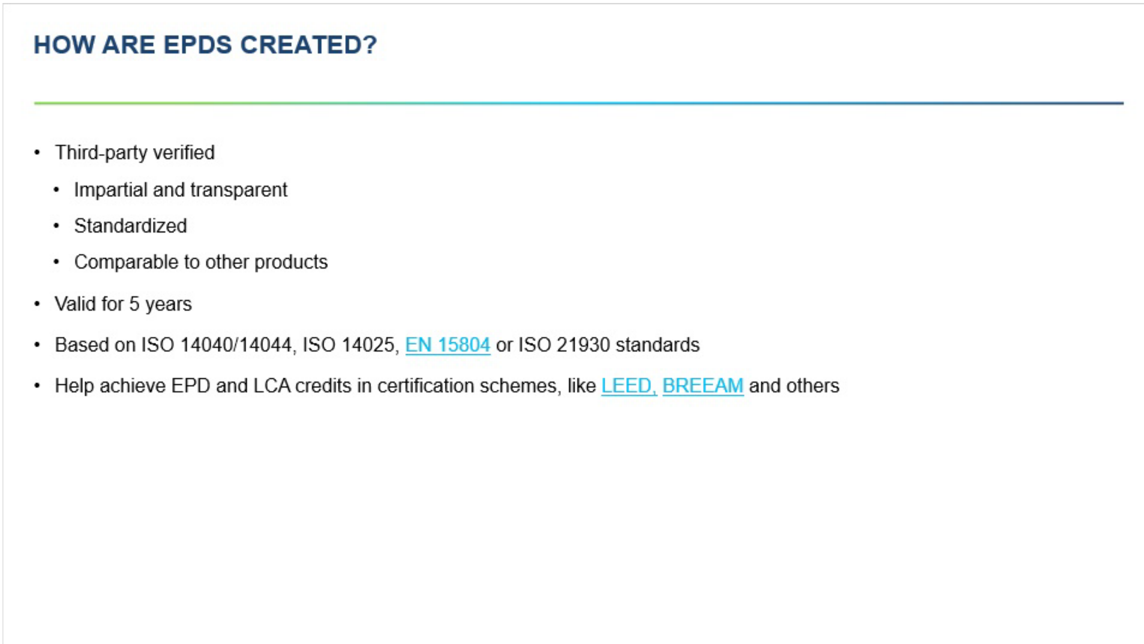
Product Components: crushed aggregate (ASTM C33), natural aggregate (ASTM C33), Portland cement (ASTM C150), slag cement (ASTM C989), admixture (ASTM C494), batch water (ASTM C1602)

- A document that already has calculated the LCA at a material's level and can communicate the environmental performance or impact of any product or material "from cradle to gate."
- For embodied carbon, the main indicator is the GWP: *"Global warming potential" or "GWP" means a numeric value included in an environmental product declaration that measures the total contribution to global warming from the emission of greenhouse gases, or the elimination of greenhouse gas sinks, that results from the production or utilization of a specific product or service.*

Notes:

One way to understand a material's LCA is through an Environmental Product Declaration (EPD), a document that communicates the environmental performance or impact of any product or material "from cradle to gate." It offers information already calculated for a product's LCA, at least from extraction to manufacturing. Use, replacement, repair, disposal and recycling can also be included into the EPD results. Many countries are pushing for EPD databases that have already done the LCA calculations of materials produced by manufacturers.

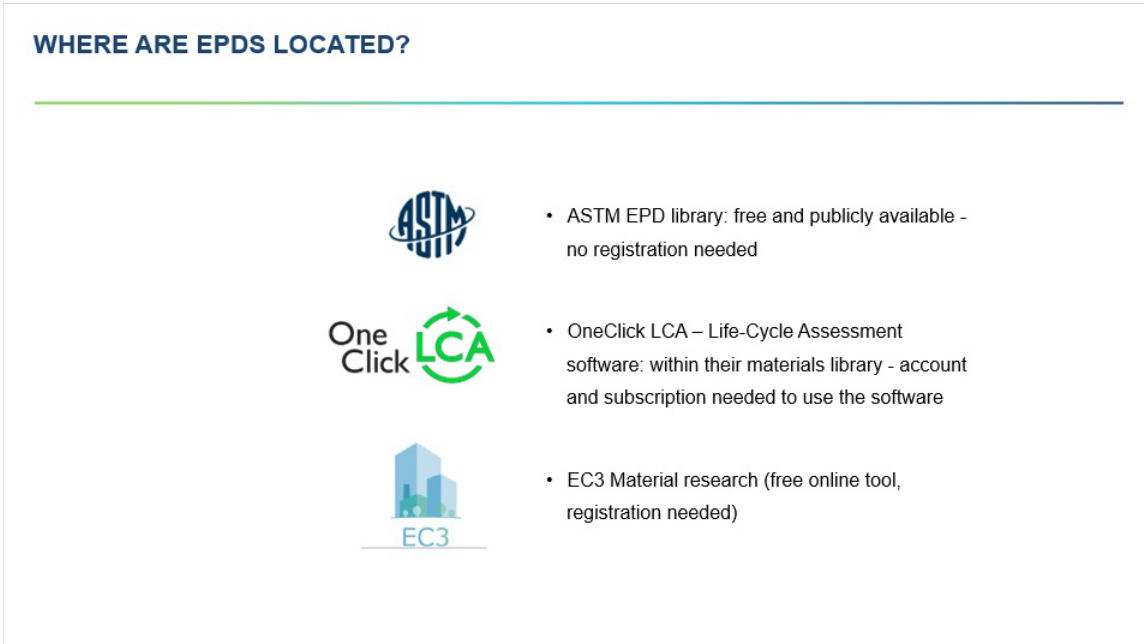
1.15 How are EPDs created?



Notes:

An EPD is third-party verified, which gives them value as impartial, transparent, standardized, comparable information. They are usually valid for five years and are based on the ISO 14040/14044, ISO 14025, EN 15804 or ISO 21930 standards. EPDs help to achieve EPD and LCA credits in certification schemes, like LEED, BREEAM and others.

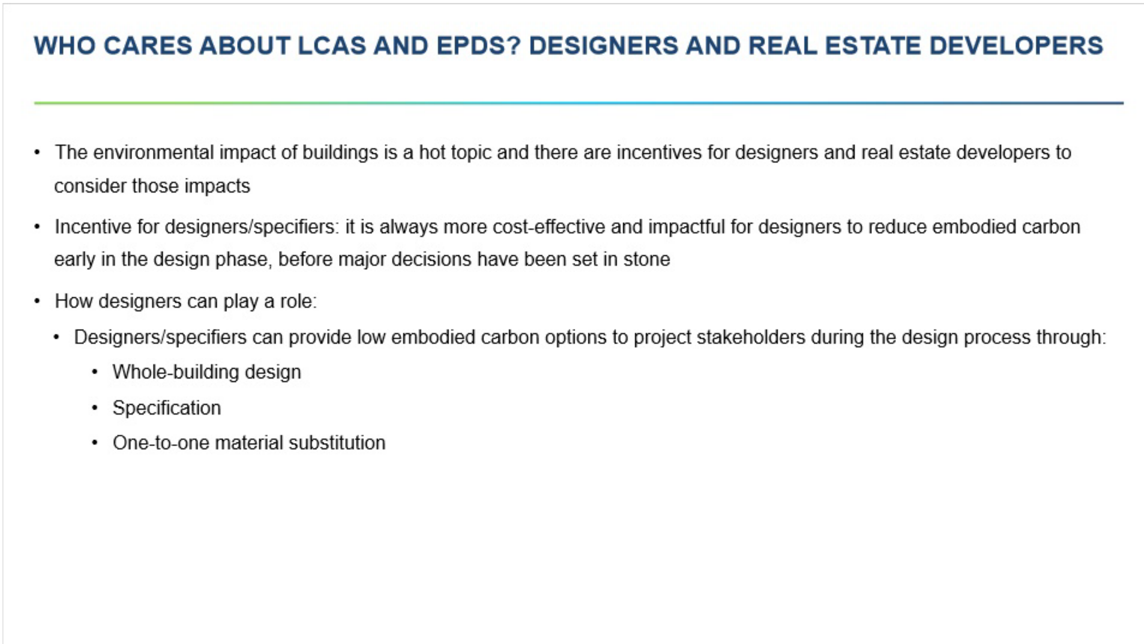
1.16 Where are EPDs located?



Notes:

You can find EPDs in a few different ways. One way is to check the ASTM EPD library, which is free and publicly available and does not require registration. Another route is to use OneClick LCA software, which does require an account and subscription. And finally, the EC3 Material tool is an online tool that requires registration but is free.

1.17 Who cares about LCAs and EPDs? Designers and Real Estate Developers



Notes:

Who cares about EPDs and LCAs? Designers and real estate developers do. The environmental impact of buildings is a hot topic and there are incentives for designers and real estate developers to consider those impacts.

The incentive for designers is simple: it is always more cost-effective and impactful for designers to reduce embodied carbon early in the design phase, before major decisions have been set in stone.

What role can they play? Designers can reduce the embodied carbon of a building by influencing the design goals and providing low embodied carbon options to project stakeholders during the design process. They can achieve reductions through a few different strategies including whole-building design, specification and in terms of one-for-one material substitution.

1.18 Who cares about LCAs and EPDs? Designers and Real Estate Developers (cont.)

WHO CARES ABOUT LCAS AND EPDS? DESIGNERS AND REAL ESTATE DEVELOPERS (CONT.)

Incentives for developers:

- Reduced embodied carbon = reduced project costs and maximized financial returns
- Developers want to satisfy leading-edge environmental certification programs, many of which focus on low-embodied carbon

How real estate developers can play a role:

- Set the tone by establishing clear environmental goals
- Encourage project team designers to find more opportunities to reduce embodied carbon
- Set cost thresholds
- Reuse existing building materials

Notes:

Developers are directly incentivized to reduce embodied carbon because doing so will reduce project costs and maximize financial returns. Second, developers aim to satisfy leading-edge environmental certification programs, which increasingly focus on low-embodied carbon design. Finding low- or no-cost approaches to reducing embodied carbon allows them to pursue both goals.

How can real estate developers play a role in reducing embodied carbon? There are several strategies, but a few of them include setting the tone from the beginning by establishing clear environmental goals for the project. Encouraging project team designers to find more opportunities to reduce embodied carbon. Developers can also set cost thresholds. And, they can choose to reuse existing building materials at the site whenever possible, rather than building new, which can result in significant embodied carbon savings.

1.19 Section 3

Notes:

What is the circular economy and why does it matter? The circular economy starts by avoiding waste. This section discusses the goal of decoupling business growth from the consumption of the world's finite resources. It explores how the construction industry can take measures toward this goal in a way that benefits everyone: business, people and the environment. It touches on the three principles of the circular economy: reduce, reuse and recycle, with an emphasis on building more with less. Regarding concrete manufacturing, this approach involves recycling concrete into aggregates, recycling water, and even using crushed concrete back into cement manufacturing.

1.20 What is the Circular Economy?

WHAT IS THE CIRCULAR ECONOMY?

- An economy that uses a systems-focused approach and involves industrial processes and economic activities that are restorative or regenerative by design
- Resources maintain their highest value for as long as possible
- Aims to eliminate waste through smart design of materials, products and systems (including business models)
- Contrast to the model that mines resources, make products and throws them away
- A reduce, reuse, recycle systems approach

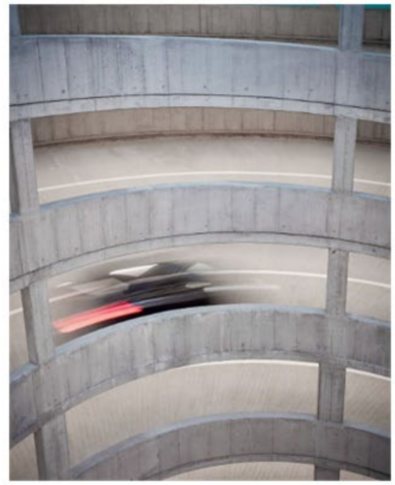
Notes:

A circular economy, as defined in the Save Our Seas 2.0 Act, refers to an economy that uses a systems-focused approach and involves industrial processes and economic activities that are restorative or regenerative by design. This economy enables resources to maintain their highest value for as long as possible. Its aim is to eliminate waste through smart design of materials, products and systems (including business models). It stands in sharp contrast to the model that mines resources, makes them into products and then throws them away. A circular economy subscribes to reduce, reuse, recycle as a systems approach.

1.21 What is the Circular Economy?

WHAT IS THE CIRCULAR ECONOMY?

- The circular economy starts by avoiding waste. It benefits business, society and the environment by eliminating waste and decoupling business growth from the consumption of the world's finite resources.



Notes:

The circular economy starts by avoiding waste. It benefits business, society and the environment by eliminating waste and decoupling business growth from the consumption of the world's finite resources.

1.22 Reduce

REDUCE

- Using only the materials that are needed and nothing more
- 3D concrete printing uses minimum materials for maximum strength to lower a building's environmental footprint by up to 60%
- **Other example**: Striatus bridge combines
  - Shape optimization (less materials)
  - Design for deconstruction and reuse (circularity)

www.holcim.com/striatus-first-3D-concrete-printed-arched-bridge

Notes:

One major component of the circular economy in construction is reducing waste by using only the materials and nothing more. In the example of concrete, 3D printing is an efficient approach that uses minimum materials for maximum strength to lower a building's footprint by up to 60 percent.

1.23 Reuse and Recycle

REUSE AND RECYCLE

- Create more value from waste by transforming it into resources for all production processes
- Providing sustainable waste treatment solutions
- Using construction and demolition waste to produce recycled aggregates—a key ingredient in concrete
    - Up to 10% recycled aggregates are allowed in US mix designs without any additional trials
    - Up to 50% of coarse aggregates can be replaced by Recycled Concrete Aggregates (RCA)
        - Need to select high quality demolition or returned concrete, without contaminants
        - Need to test the concrete mix to ensure same performance without additional cement content
    - Transportation of materials must be reduced as much as possible, in order to truly benefit from this approach without creating additional GHG emissions

Notes:

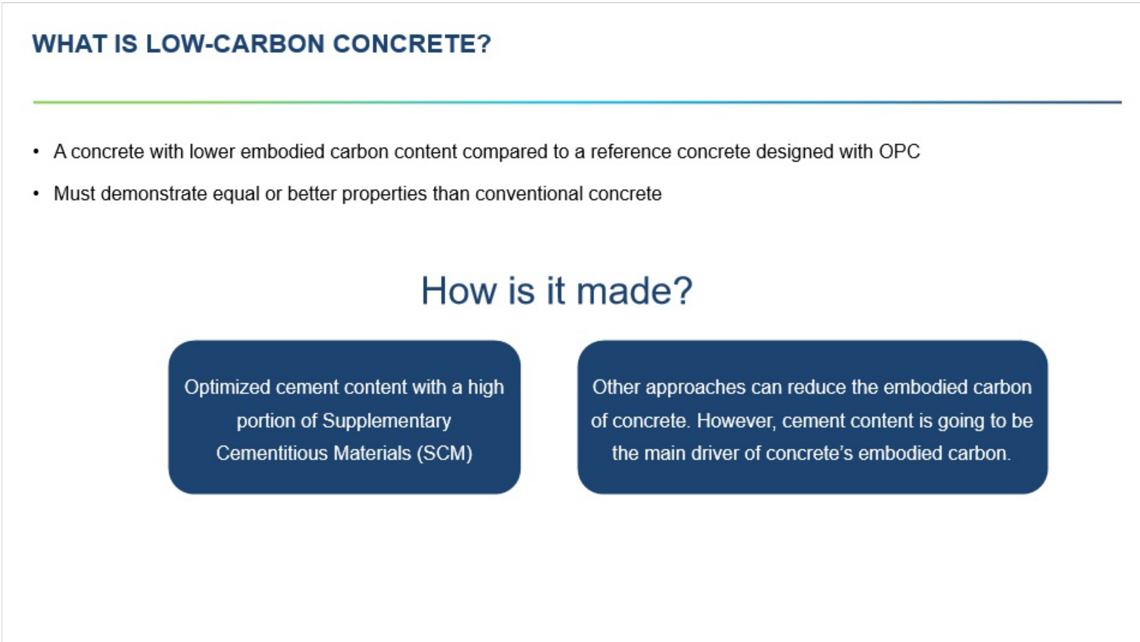
Two other components of the circular economy are reuse and recycle. You can create more value from waste by transforming it into resources for product processes. Sustainable waste treatment solutions also help with recycling. And using waste from demolished construction sites to produce recycled aggregates is one way to turn a waste product into a key ingredient for concrete, for instance.

1.24 Section 4

Notes:

One material that has evolved toward sustainable practices is concrete. There are many misconceptions about the current role of concrete in construction. In recent years, the concrete suppliers have worked to change the impact of concrete on greenhouse gas emissions. This section will explore low-carbon concrete benefits and specification details.

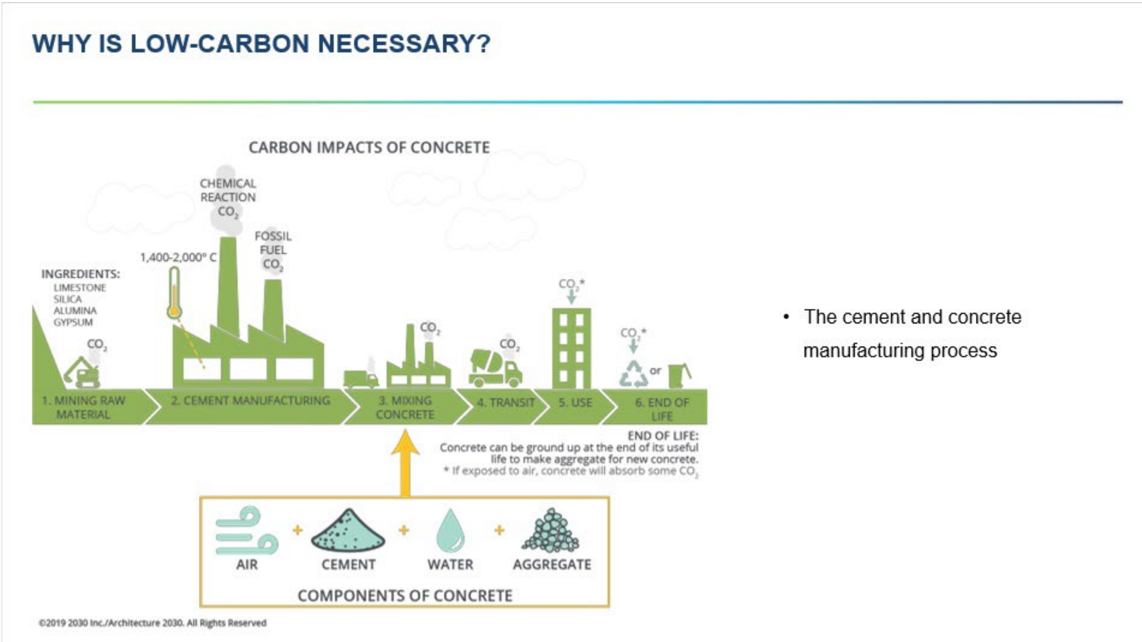
1.25 What is Low-Carbon Concrete?



Notes:

What is low-carbon concrete? It's concrete with lower embodied carbon content compared to concrete designed with ordinary Portland cement (OPC). When low-carbon concrete is made, it needs to demonstrate equal or better properties than conventional concrete and include optimized cement content with a high portion of Supplementary Cementitious Materials (SCM), which improve the overall hardened properties of concrete.

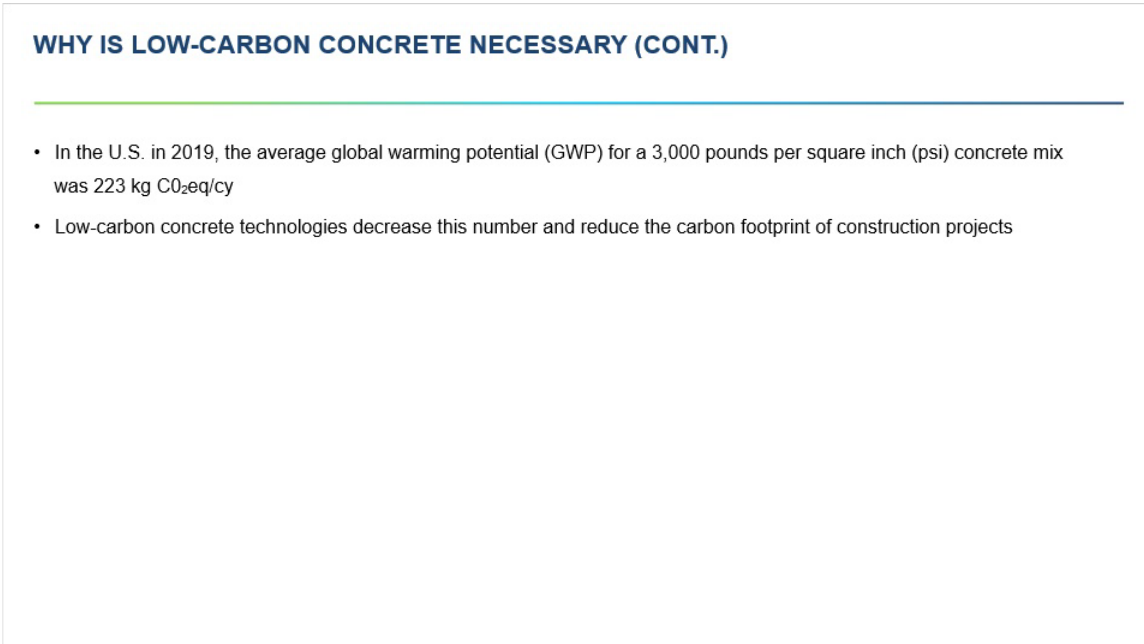
1.26 Why is Low-Carbon Necessary?



Notes:

Low-carbon concrete is highly important because each phase of concrete's life cycle involves embodied carbon—the release of carbon dioxide emissions that impact climate. The process begins with mining raw material for the concrete ingredients: limestone, silica, alumina and gypsum. During manufacturing, the ingredients are heated to between 2552°F and 3632°F, a manufacturing process that relies on chemical reactions and fossil fuels that emit $C0_2$. The cement is mixed with water, air and aggregate to make concrete, transported to the site and used in the construction process. All of these steps in the process release $C0_2$.

1.27 Why is Low-Carbon Concrete Necessary (cont.)



Notes:

In the U.S. in 2019, the average global warming potential (GWP) for a 3000 pounds per square inch (psi) concrete mix was 223 kg CO_2 eq/cy. Low-carbon concrete technologies have become more available in the U.S., which has helped to decrease this number and reduce the carbon footprint of construction projects.

1.28 How to Identify a Low-carbon Concrete Mix

HOW TO IDENTIFY A LOW-CARBON CONCRETE MIX

- How to know if concrete is low-carbon:
  - Check the global warming potential (GWP) value of the concrete Environmental Product Declaration (EPD)

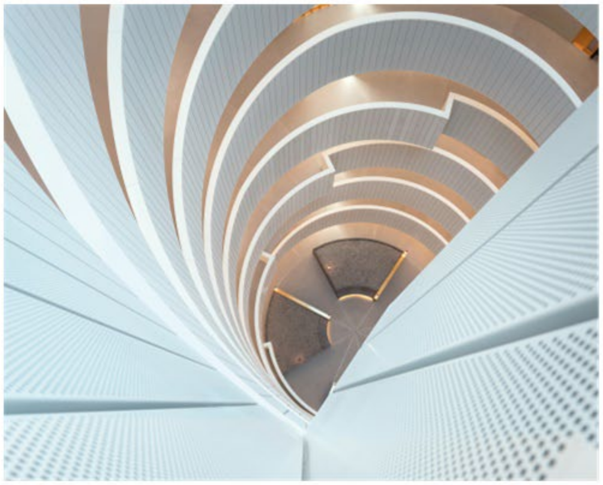
    Note: The GWP value will most likely be in kg $C0_2$eq/cubic meter and not /cubic yard.
  - Compare to a benchmark or baseline, for the same strength and performance

Notes:

As mentioned earlier in the presentation, an EPD is a declaration that discloses the cradle-to-gate environmental performance of products and services. It is not a claim of environmental superiority, but the comprehensive, third-party-reviewed process and documentation provides product-specific GWP savings for low-carbon concrete, which helps back up the claim of a minimum 30% GWP savings compared to OPC. The EPD helps avoid greenwashing concerns and inefficient recipes. The low-carbon concrete should also be compared to benchmark or baseline averages for strength and performance qualities.

1.29 Different SCMs and Properties

DIFFERENT SCMS AND PROPERTIES



Various Supplementary Cementitious Materials (SCMs) can be used to replace cement and reduce the GWP of concrete:

- Fly ash
- Slag cement
- Natural pozzolans
  - Expanded shales
  - Calcined clay
- Engineered products
- Harvested / processed / beneficiated ash

Notes:

Various supplementary cementitious materials, known as SCMs, can replace cement to reduce the global warming potential—or embodied carbon footprint. Examples of these materials include fly ash, slag cement, natural pozzolans such as expanded shales and calcined clay, engineered products and harvested, processed or beneficiated ash.

1.30 The Slag Example

THE SLAG EXAMPLE

- Powder from iron processing in blast furnaces
- Pre-consumer recycled product
- Must meet ASTM C989 – Grade 100, 120
- Can replace ordinary cement up to 80%
- Properties:
  - Reduced GWP
  - Alkali Silica Reaction Mitigation
  - Increased Sulfate Resistance
  - Improved Long term Strengths
  - Control heat of hydration effects in mass concrete
  - Lower short-term strength can be offset by using admixtures

Notes:

Slag cement, for example, is a powder from iron processing in blast furnaces. Because it is the resulting product of another process it is considered a pre-consumer recycled product. Slag cement must meet ASTM C989, Grade 100, 120. It can replace ordinary cement up to 80%. Its properties include reducing the global warming potential, ASR mitigation, increasing sulfate resistance, improving long term strengths, mass concrete. Its lower short-term strength can be offset by admixtures.

1.31 Quality Low-Carbon Concrete

QUALITY LOW-CARBON CONCRETE

- Quality low-carbon concrete will reach its design strength in 28 days
- It can also be designed specifically for high-early strength, if needed for the project, using admixtures
- Cement replacement rate can be further increased to further reduce the mix GWP, which could result in mixes reaching strength in 56 days instead of 28 days. Designers need to be mindful of this, and adapt their design accordingly.

Notes:

Quality low-carbon concrete will reach its design strength in 28 days. It can also be designed specifically for high-early strength, if needed for the project, using admixtures.

Whenever schedule or application allows, the cement replacement rate can be further increased to further reduce the mix GWP, which could result in mixes reaching strength in 56 days instead of 28 days.

1.32 Cast-In-Place Concrete Specification

CAST-IN-PLACE CONCRETE SPECIFICATION

Specification Guidelines

SUBMITTALS

- Request product specific, third-party verified type III Environmental Product Declarations
- Must state conformance to ISO 14025 and EN 15804 or ISO 21930, and have at least a cradle-to-gate scope

CONCRETE MATERIALS

- Allow Blended Cements and Supplementary Cementitious Materials (SCM)

CONCRETE MIXTURES

- Maximum Global Warming Potential (GWP) per class of mix or on average
- Performance based and adapted to each structural category (ie. foundations, slabs, columns)

Notes:

When specifying cast-in place concrete it is important to submit a request for product-specific, third-party verified type III EPDs. The EPD must state conformance to ISO 14025 and EN 15804 or ISO 21930, and have at least a cradle-to-gate scope.

Allow for blended cements and supplementary cementitious materials (SCM). Seek out maximum global warming potential per class of mix or on average. The mixtures should be performance based and adapted to the particular structural category they will be applied to, whether it be foundations, slabs, columns, or some other category.

1.33 Cast-In-Place Concrete Specification (cont.)

CAST-IN-PLACE CONCRETE SPECIFICATION (CONT.)

Engage the manufacturer early as possible, to confirm the following technical and commercial criteria:

- Possible mixes for the project’s specific applications
- Advice and first estimate of the GWP savings, depending on the selected mixes and volumes per class of mix
- Local partners (contractors)
- Specification guidelines and insert

Notes:

When working on a low-carbon concrete project it’s best to engage the manufacturer as early as possible to confirm technical and commercial criteria such as possible mixes for the project’s specific applications and getting advice and first estimate of the GWP savings, depending on the selected mixes and volumes per class of mix. It’s also good to get information on local partners and contractors and have, on hand, specification guidelines.

1.34 Section 5

Notes:

This section looks at a few case studies that feature low-carbon concrete.

1.35 Boston University Computing and Data Sciences Center

BOSTON UNIVERSITY COMPUTING AND DATA SCIENCES CENTER

Data Sciences Center

Type: Higher education

Surface: 345,000 square feet

Structure: 19-story steel structure with concrete foundations

Certification: seeking LEED Platinum

Year: 2020-2021

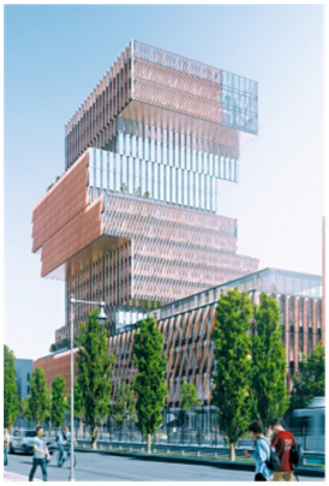
- Central to meeting the university's climate action plan of net zero emissions by 2040
- 100% fossil fuel-free and zero net-energy facility
- Rely on geothermal wells for heating and cooling, solar and wind renewable energy for electricity
- Will be the largest carbon-neutral building constructed in Boston since the city's climate action plan update in 2019
- Eco-friendly, high-performance concrete represents a significant portion of the structure to minimize the environmental footprint

Notes:

The Computing and Data Sciences Center in the heart of Boston University's central campus is a 19-story building that resembles a stack of books. Its innovative design mimics its innovative function as an interdisciplinary hub for mathematics, statistics, and computer science departments, all under one roof. Its innovative design is also central to meeting the university's climate action plan of net zero emissions by 2040. The 100 percent fossil fuel-free and zero net energy facility will rely on geothermal wells for heating and cooling, solar and wind renewable energy for electricity, and many other sustainable elements. It will be the largest carbon-neutral building constructed in Boston since the city's climate action plan update in 2019. Concrete represents a significant portion of the structure. The use of eco-friendly high-performance mixes was of paramount importance to minimize the environmental footprint.

1.36 Boston University Computing and Data Sciences Center

BOSTON UNIVERSITY COMPUTING AND DATA SCIENCES CENTER



The Challenge

- Sustainable concrete solutions for the wide range of necessary construction applications while attaining structural performance and constructability goals

The Solution

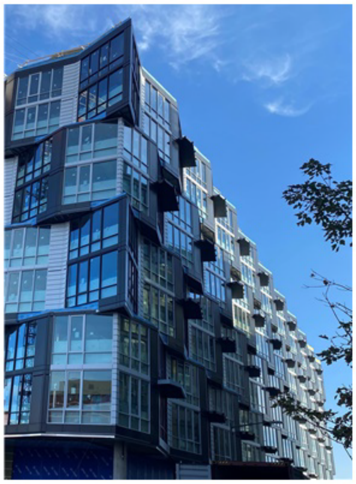
- Two proprietary green concrete products containing minimum 50 percent recycled materials
- Designed to reduce the global warming potential (GWP) by 30 to 50 percent compared to standard concrete
- Equivalent to taking 50 average passenger cars off the road for one year

Notes:

For the Computing and Data Sciences Center, the challenge was to come up with ideal sustainable concrete solutions for the necessary construction applications while attaining structural performance and constructability goals. This project offered an ideal opportunity for using green concrete. Two proprietary green concrete products containing 50 percent recycled materials were developed. These innovative mixes were designed to reduce the global warming potential (GWP) by about 30 percent compared to standard concrete. This is the equivalent to taking 50 average passenger cars off the road for one year.

1.37 An Apartment Community in Washington DC

AN APARTMENT COMMUNITY IN WASHINGTON DC



Certification: LEED Gold

Type: Residential multi-unit | Retail

Location: Washington, D.C.

Surface: 258,000 square feet

Structure: Mid-rise concrete

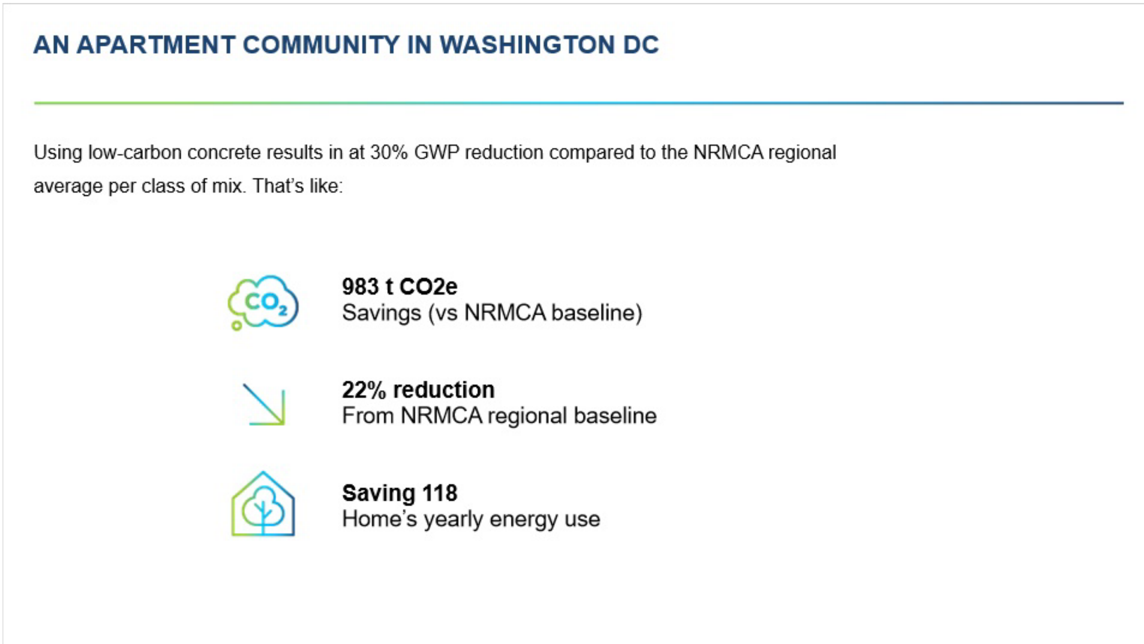
Year: 2021

- Used 13,000 cubic yards of low-carbon concrete = 95% of the project
- High-early strength concrete gained strength in the first 24 hours after site pouring, saving time and costs. Low-carbon lightweight concrete was also used on the project. Important because lightweight concrete has a higher GWP on average than traditional concrete. Therefore, low-carbon lightweight really makes a difference.

Notes:

Another example of a low-carbon concrete project is this private real estate company that obtained LEED Gold for its residential multi-unit building with bottom-floor retail. The mid-rise structure used 13,000 cubic yards of concrete, making the material about 95% of the project. The high-early strength concrete was able to achieve its structural quality in the first 24 hours after site pouring, saving time and costs. Low-carbon lightweight concrete was also used on the project. Important because lightweight concrete has a higher GWP on average than traditional concrete. Therefore low-carbon lightweight really makes a difference.

1.38 An Apartment Community in Washington DC



Notes:

Using the low-carbon concrete resulted in a 22% GWP reduction compared to the NRMCA (National Ready Mix Concrete Association) regional average per class of mix. 983 metric tons of CO_2 equivalent were saved, which is comparable to the energy used by 118 homes in one year.

1.39 Georgetown University Residence Hall on H Street

GEORGETOWN UNIVERSITY RESIDENCE HALL ON H STREET

Type: Student housing | Higher-ed | Retail

Surface: 33,000 square feet

Structure: Post-tensioned concrete floor decks

Certification: LEED Platinum

Year: 2021

- 12-story building for 476 students and an innovative design
- Designed to exceed LEED Platinum status
- Include energy-use monitoring system, extensive solar panels, exterior sun shading, rainwater collection, and many other environmentally conscious features
- High-performance, low-carbon concrete for timeliness, durability and sustainability

Notes:

Georgetown University, which is the anchor of the Washington D.C., neighborhood of the same name, expanded into the city with a new residence hall. This project features a 12-story building for 476 students and an innovative design that supports the university's commitment to both sustainability and creating a vibrant campus experience. Designed to exceed LEED Platinum status, the structure includes an energy-use monitoring system, extensive solar panels, exterior sun shading, rainwater collection, and many other environmentally conscious features, including low-carbon concrete. As with so many projects the high-performance concrete needed to come up to strength in a timely fashion for the project to stay on the timeline—which it did, because of its high-early strength qualities.

1.40 Georgetown University Residence Hall on H Street

GEORGETOWN UNIVERSITY RESIDENCE HALL ON H STREET

- Low-carbon concrete required strength, durability and speediness, but it also needed to fit the carbon emission reduction goals for the building
- LEED design aspects focused on long-term reductions while the concrete reduced the embodied carbon in the up-front construction part of the process
- The 8,300 cubic yards of concrete was able to reduce GWP by at least 50% compared to standard concrete mixes
- Equivalent to taking a passenger car that drives more than one million miles off the road

Notes:

The low-carbon concrete required strength, durability and speediness, but it also needed to fit the carbon emission reduction goals for the building. LEED design aspects focused on long-term reductions while the concrete reduced the embodied carbon in the up-front construction part of the process. The 8,300 cubic yards of concrete was able to reduce GWP by at least 50% when compared to standard concrete mixes. This is the equivalent to taking a passenger car that drives more than one million miles off the road. The concrete company worked closely with structural engineer and contractors in developing the concrete for specified strengths.

1.41 Living Tomorrow Innovation Campus, Brussels

LIVING TOMORROW INNOVATION CAMPUS, BRUSSELS

Year: 2022

Opportunity:

- Massive 50-meter tower housing a hotel, gourmet restaurant, experimental innovation center and landing place for taxi drones
- For architects and design offices to work on sustainability solutions
- Open to public for the purpose of education and promotion of green concrete
- Serving as a laboratory for new ways of living, lodging and working
- Low-carbon concrete projected to provide a reduction of 69% in $C0_2$

Notes:

A new project in Brussels called the Living Tomorrow Innovation Campus seeks to demonstrate the benefits of low-carbon concrete and work toward innovations. Slated to open in 2022, the massive 50-meter tower housing a hotel, gourmet restaurant, experimental innovation center and landing place for taxi drones will be used by architects and design offices to work on sustainability solutions in service to GHG reduction goals for climate change. The tower will be open to public for the purpose of education and promotion of green concrete and serving as a laboratory for new ways of living, lodging and working. Its use of low-carbon concrete is projected to provide a reduction of 69% in $C0_2$ compared to traditional concrete.

1.42 Section 6

Notes:

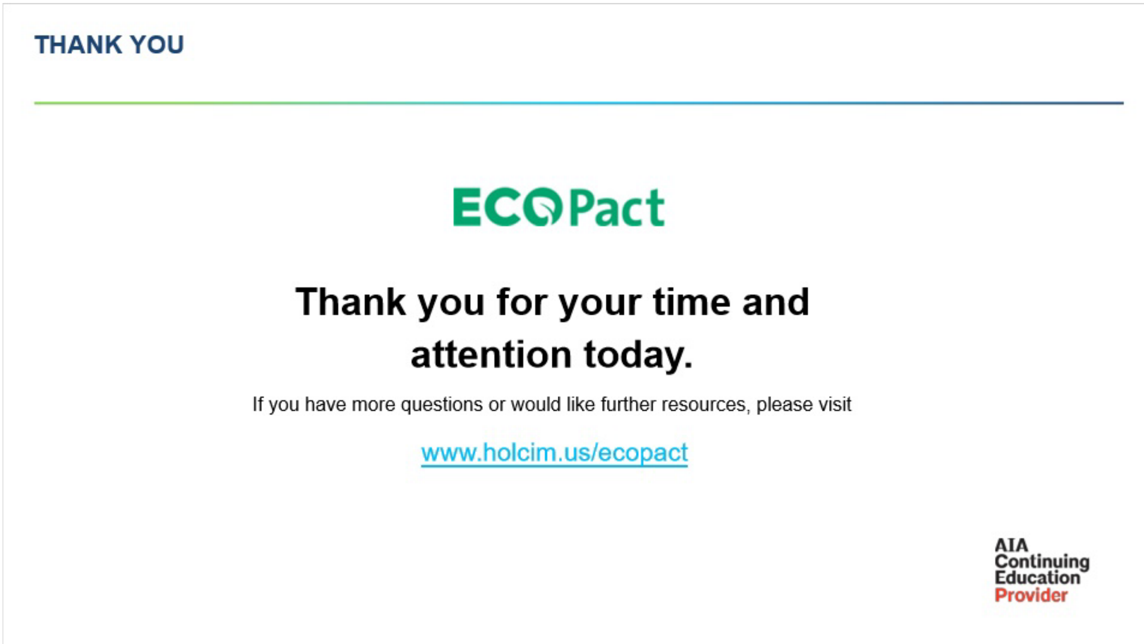
This section will be a brief review of course material and provide resources for attendees seeking more information.

1.43 Review

Notes:

Over the course of this presentation, you have learned how the construction industry impacts global gas emission and global warming in a substantial way. You should now be able to explain how life-cycle assessment (LCA) and environmental product declarations (EPDs) help designers and developers compare options and make informed decisions. You should be able to discuss how a circular economy approach to construction can benefit business, people and the environment. And finally, you should be able to describe how low-carbon concrete is a proven alternative for design when it comes to lower embodied carbon buildings and infrastructure.

1.44 Thank You



Notes:

Thank you for your time and attention today. If you have more questions or would like further resources, please visit www.holcim.us/ecopact.