



GSA Public Buildings Service

GSA Industry Webinar on New Concrete and Asphalt Standards

May 5, 2022

Agenda

- **Opening Remarks**
 - Chuck Hardy, GSA Acting Chief Architect
 - Sonal Larsen, GSA Senior Advisor on Climate
 - Andrew Mayock, Council on Environmental Quality (CEQ) Federal Chief Sustainability Officer
- **Summary of GSA's New Standards**
 - Walter Tersch, GSA
- **Environmental Product Declarations**
 - Danny Macri, EPA
 - Stacy Smedley, Building Transparency
- **Asphalt Industry**
 - Joseph Shacat, National Asphalt Paving Association (NAPA)
 - Ben Bowers, Auburn University's National Center for Asphalt Technology (NCAT)
- **Concrete Industry**
 - Michelle Wilson, Portland Cement Association (PCA)
 - Tien Peng, National Ready Mixed Concrete Association (NRMCA)
- **Conclusion and Q&A**

Overview of U.S. General Services Administration

- Portfolio of over 8,800 assets
 - 1,600+ owned assets (186+ million square feet)
 - 7,100+ leased assets (184+ million square feet)
- 480+ historic buildings
- House 1.1 million federal employees
- Landlord for over 400 different federal agencies, bureaus and commissions



Morse U.S. Courthouse
Eugene, OR



NPS
Omaha, NE



U.S. Census Bureau
Suitland, MD



U.S. Courthouse
Bakersfield, CA



Garcia U.S. Courthouse
San Antonio, TX

Administration and Executive Order Priorities

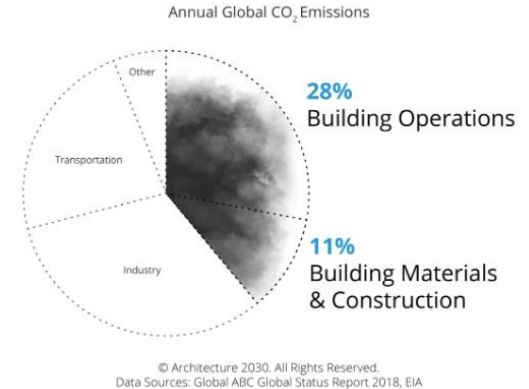
- ❑ Net zero energy owned building portfolio by 2045
- ❑ Reduce building energy use, water use, and waste
- ❑ 100% carbon pollution-free electricity (CFE) by 2030, including 50% 24/7 CFE; 100% 24/7 CFE by 2035
- ❑ Zero-emission fleet (electric vehicles and charging stations)
- ❑ **Sustainable procurement (products), supply chain, and vendors (disclosure)**
- ❑ Climate adaptation, climate risk management, and resilience

Market Research on Concrete and Asphalt

In February 2022, GSA released two requests for information (RFIs) to gather current marketplace insights from industry on the national availability of concrete and asphalt materials with lighter environmental footprints.

Of the 130+ respondents, 34% of concrete manufacturers, were small businesses, and 61% of asphalt manufacturers

- Concrete
 - 80% already produce low embodied carbon concrete, and 60% have developed a product-specific environmental product declaration (EPD)
 - Most say low-embodied-carbon concrete costs about the same, and have used carbon-reducing supplementary cementitious materials
- Asphalt
 - 90% use reclaimed asphalt pavement, and over 70% use warm mix technology to reduce environmental impact
 - Over 65% say environmentally preferable asphalt costs the same -- or less -- than conventional equivalents



“Buildings generate nearly 40% of annual global CO₂ emissions.

*Of that total, building **operations** are **responsible for 28%** annually, while building materials and construction (typically referred to as **embodied carbon**) are responsible for an **additional 11%** annually.”*

-AIA Architecture 2030

Material Standards for All GSA Projects

GSA.gov/p100 has the new concrete and asphalt standards issued in March. They are being included in solicitations for all GSA building or paving projects that use at least 10 cubic yards of material. In summary:

- Require environmental product declarations (**EPDs**) and **lower-carbon concrete (20% lower global warming potential, vs. limits in proposed code language)**
- **Asphalt** mixes shall provide an EPD, and **use two or more of the following:**
 - Reclaimed asphalt pavement (RAP) content (over 20%)
 - Warm mix technology
 - Non-paving recycled content
 - Bio-based or alternative binders
 - Improved plant/ equipment efficiency OR
 - Other environmentally preferable features or techniques

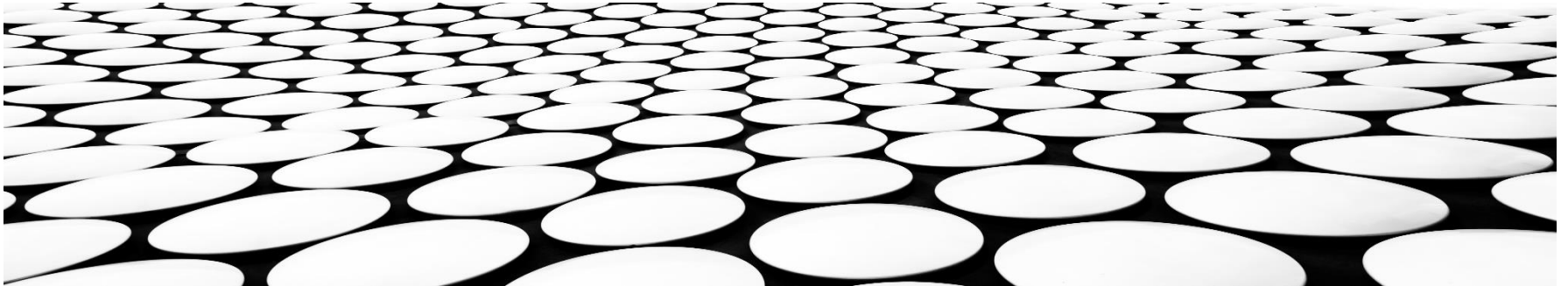
A P100 waiver process is available where compliance is infeasible. Collecting this data enables GSA to build its own global warming potential baseline. These material standards complements a whole-building carbon reduction policy.



OVERVIEW OF ENVIRONMENTAL PRODUCT DECLARATIONS

MAY 5, 2022

Danny Macri
U.S. EPA



THE NEED FOR EPDS

Need for:

- Internationally recognized, comprehensive disclosure of a product's environmental impact.
- Data on impact, not just assurances a product meets minimum criteria

EPDs are disclosure mechanisms for state and federal low-embodied carbon procurement programs and criterion for several ecolabels and standards.



WHAT IS AN EPD

Discloses the “lifecycle” environmental impacts of a product similar to a nutrition label

ENVIRONMENTAL IMPACTS	
Declared Product:	
Plant name	
Compressive strength: 3000 PSI at 28 days	
Declared Unit: 1 m ³ of concrete	
Global Warming Potential (kg CO ₂ -eq)	281
Ozone Depletion Potential (kg CFC-11-eq)	7.8E-6
Acidification Potential (kg SO ₂ -eq)	0.84
Eutrophication Potential (kg N-eq)	0.37
Photochemical Smog Creation Potential (kg O ₃ -eq)	16.9

In other words, 281 kg of CO₂e were emitted when producing 1 cubic meter of this concrete.

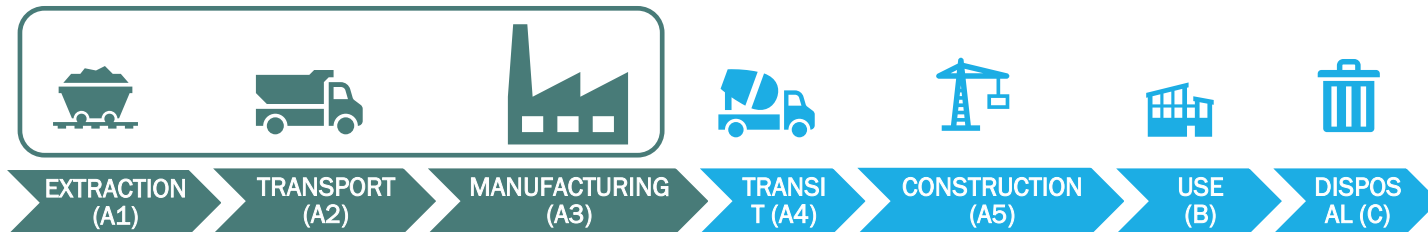
....but without the “recommended values”

Up to “buyer” to specify thresholds

Nutrition Facts	
Serving Size 2/3 cup (55g)	
Servings Per Container 8	
Amount Per Serving	
Calories 230	Calories from Fat 70
% Daily Value*	
Total Fat 8g	12%
Saturated Fat 1g	5%
Trans Fat 0g	
Cholesterol 0mg	
Sodium 160mg	7%
Total Carbohydrate 37g	12%
Dietary Fiber 4g	16%
Sugar 12g	

EPDs are just the data

- Don't require minimum criteria to be met (like Ecolabels)
- Ensure standardization *within product category*



EPDs for construction materials usually only report “Cradle-to-Gate” emissions.

WHAT IS AN EPD

Types of EPDs

Facility-Specific EPD

Represents the impacts of a specific product from a single facility

Ex: [Company B's] Fabricated Hot-Rolled

GWP [kg CO ₂ eq.]		TOTAL
Steel plant A	, AR	1.83E+03
Steel plant B	, SC	9.96E+02

Product (Company-Specific) EPD

Represents the impacts of a specific product for a single manufacturer across multiple facilities

Ex: [Company A's] Merchant Bar and Light Structural Shapes

Table 1: Impact assessment results for 1 metric ton of merchant bar

Indicator	Unit	Total (A1-A3)
GWP 100	kg CO ₂ eq	748

Industry EPD

Represents the average environmental impacts of a product across multiple manufacturing plants and manufacturers in an industry.

Supply Chain EPD

A product EPD that uses actual (instead of generic or average) data from the most impactful area of a product's lifecycle

From carbon standpoint the most precise EPDs are those that rely on actual data from facilities upstream in the supply chain, rather than an industry average.

STEPS TO CREATE AN EPD

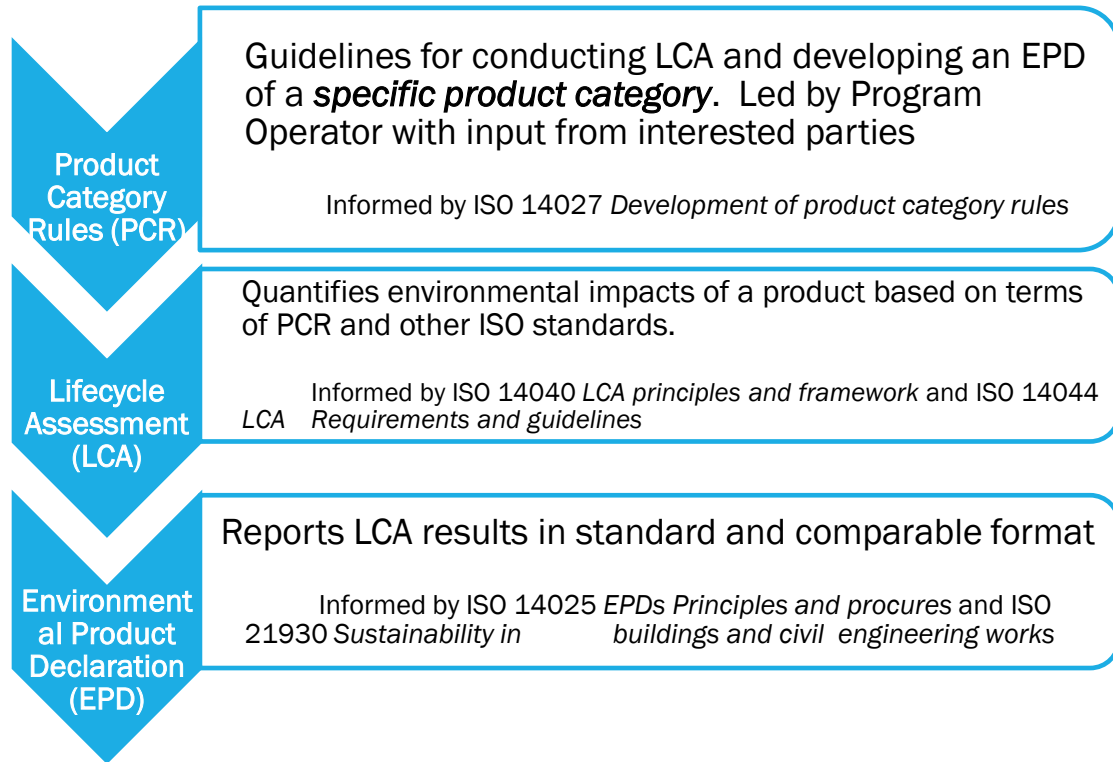
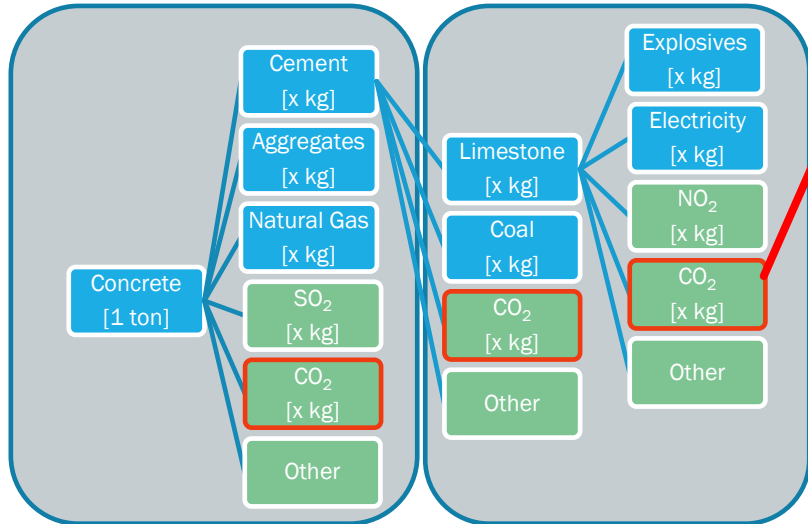


Table 1: Impact assessment results for 1 metric ton of merchant bar

Indicator	Unit	Total (A1-A3)
GWP 100	kg CO ₂ eq	748

LCA OVERVIEW

1) Life Cycle Inventory (Cradle-to-Gate)

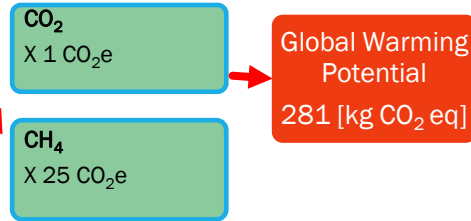


Foreground Data
(Usually A3)

Background Data
(Usually A1-A2)

Displays illustrative, not comprehensive, inputs and outputs for concrete manufacturing. Each substance can have over a dozen inputs and types of emissions.

2) Life Cycle Impact Assessment (Classification & Characterization)



3) Environmental Product Declaration

ENVIRONMENTAL IMPACTS	
Declared Product:	
Plant name	
Compressive strength: 3000 PSI at 28 days	
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Global Warming Potential (kg CO ₂ -eq)	281
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Photochemical Smog Creation Potential (kg O ₃ -eq)	16.9

Industry-specific tools exist to simplify and streamline the process for creating LCAs and EPDs!

SUMMARY: WHAT EPDS DO AND DON'T DO

Do	Do not
Quantify impact in terms of environmental performance	Explain how the impact was made (management, technology, electricity grid)
Typically, use actual data from last leg of chain	Use actual data from entire supply chain
Rely on established standards for PCR, LCA and EPD generation	Address all questions stakeholders may want considered for procurement

Embodied Carbon in Construction Calculator (EC3) demo

Stacy Smedley, [Building Transparency](#)

- **How do I add an EPD?**

- You can
- (a) email the PDF to **epd-uploads@buildingtransparency.org**, or
- (b) upload it directly to <https://cqd.app.box.com/folder/49153084885> (if you have access), or
- (c) Enter the values via the web interface at <https://buildingtransparency.org/dashboard/epds>

Asphalt Industry Overview

Low Carbon and Sustainable Asphalt Pavements

May 5, 2022



Joseph Shacat

Director of Sustainable Pavements

jshacat@asphaltpavement.org

- Trade Association representing asphalt industry
- NAPA's Mission
 - Support
 - Advocate
 - Advance

**What Is
NAPA?**



The Road Forward

A Vision for Net Zero Carbon Emissions
for the Asphalt Pavement Industry

Learn more at
asphaltpavement.org/climate



Vision: Sustainable communities and commerce, connected by net zero carbon emission asphalt pavements

Mission: Engage, educate, and empower the U.S. asphalt community to produce and construct net zero carbon emission asphalt pavements

What is Asphalt Pavement

75% virgin aggregates



5% asphalt binder



20% reclaimed asphalt pavement (RAP)



And paved at elevated temperature



Asphalt mix is produced at an asphalt plant



Asphalt by the Numbers

- Approximately 3,600 asphalt plants in the U.S.¹
- 94% of U.S roads are surfaced with asphalt²
- 408 million tons of asphalt mixture produced in 2020³
 - Average reclaimed asphalt pavement (RAP) content 21.3% = 87 million tons
 - Use of RAP in 2020 reduced upstream GHG emissions by **2.3 MMT CO₂e** while saving \$3 billion
 - Equivalent to emissions from 510,000 passenger vehicles

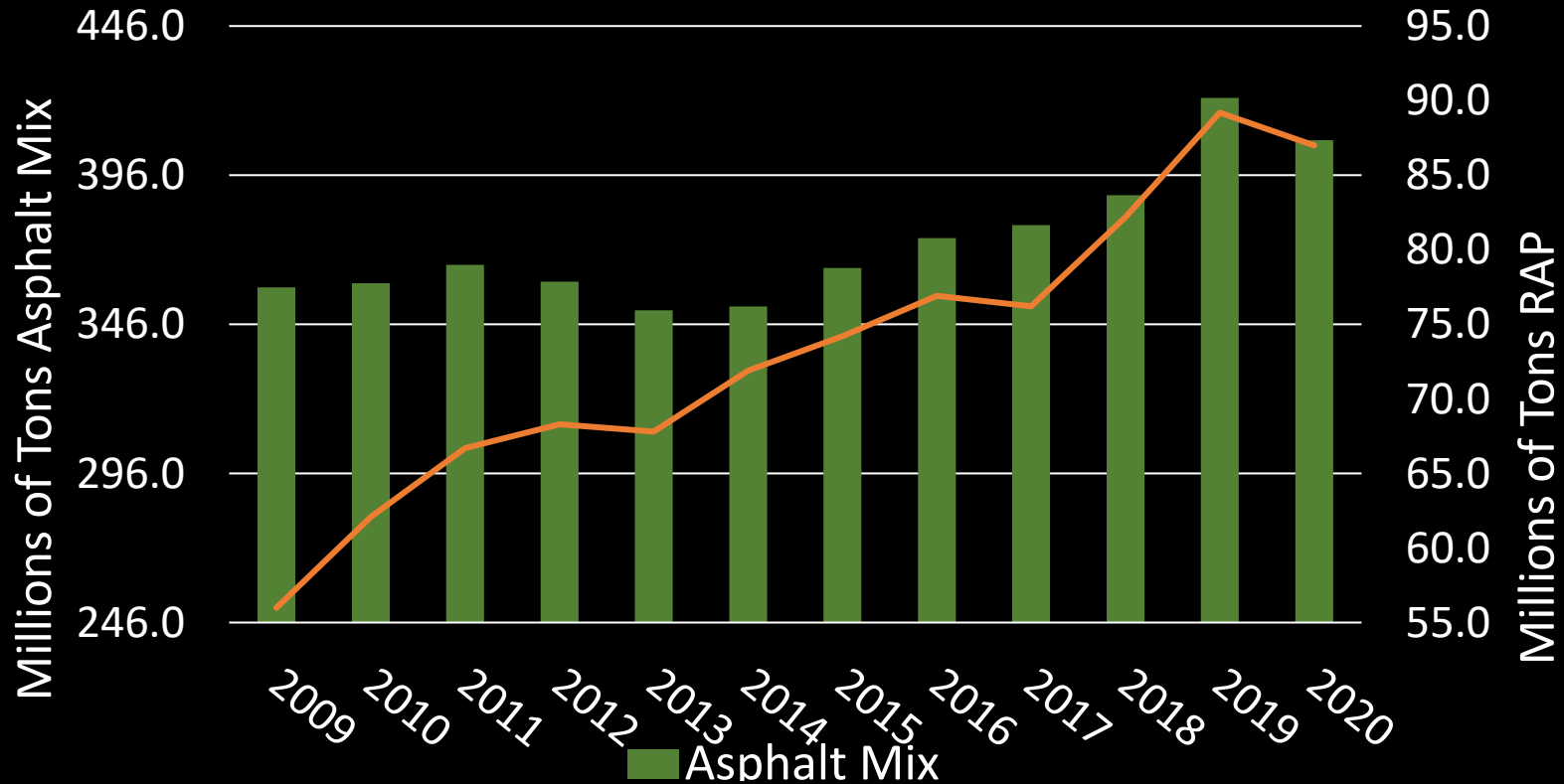
1 <https://www3.epa.gov/ttn/chief/ap42/ch11/related/ea-report.pdf>

3. <https://www.asphaltpavement.org/expertise/sustainability/sustainability-resources/recycling>

2. <https://www.fhwa.dot.gov/policyinformation/statistics/2020/hm12.cfm>

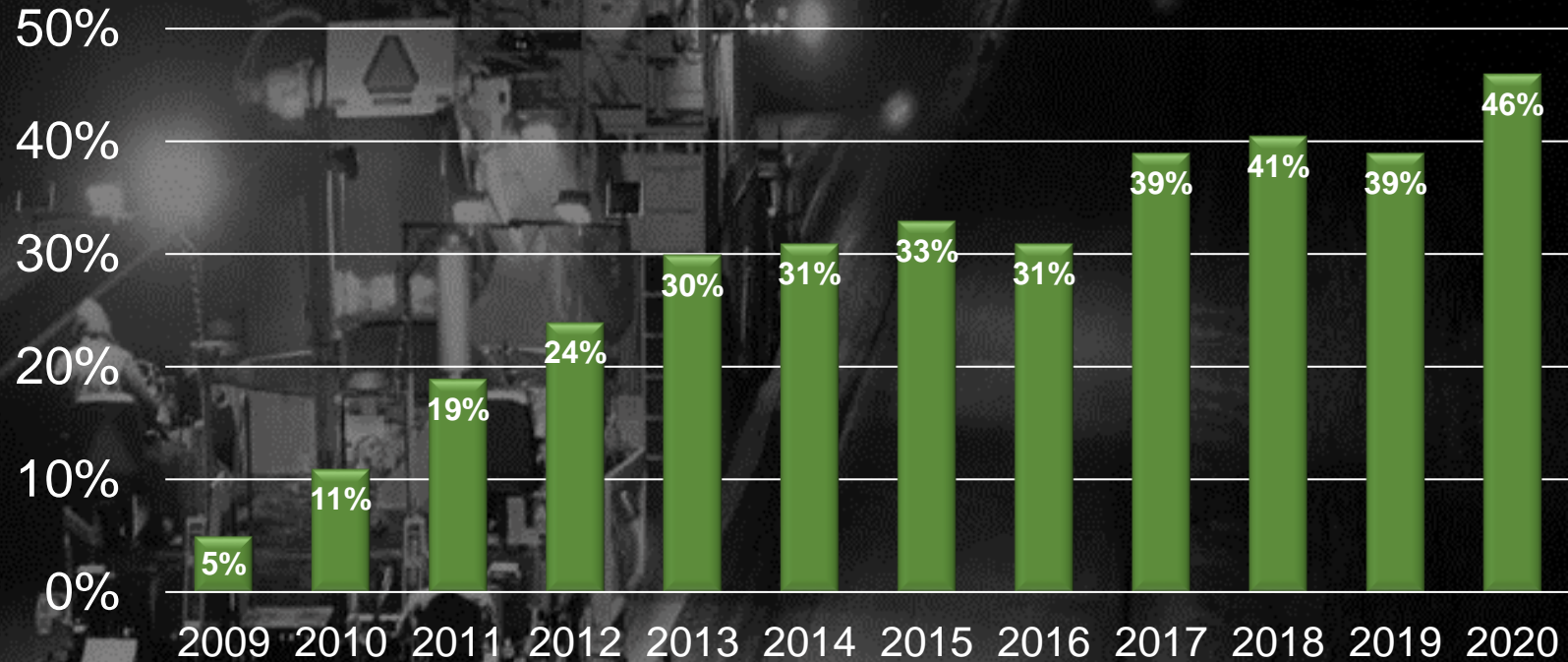
Asphalt Mix and RAP Tonnage

Total Production and Use in the U.S.



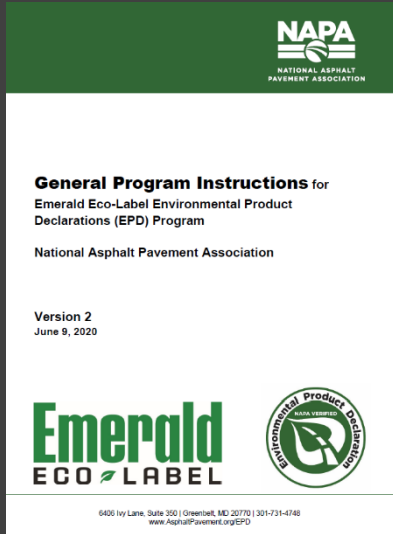
Warm Mix Asphalt (WMA) Technologies

Percentage of Total Asphalt Production in the U.S.



Key Components of NAPA's EPD Program

General Program Instructions




NAPA
NATIONAL ASPHALT
PAVEMENT ASSOCIATION

**General Program Instructions for
Emerald Eco-Label Environmental Product
Declarations (EPD) Program**

National Asphalt Pavement Association


Version 2
June 9, 2020

**Emerald
ECO LABEL**




6406 Ivy Lane, Suite 350 | Greenbelt, MD 20770 | 301-731-4748
www.AsphaltPavement.org/EPD

Underlying Life Cycle Assessment



Update to the Life Cycle Assessment for Asphalt Mixtures in Support of the Emerald Eco Label Environmental Product Declaration Program

April 2022



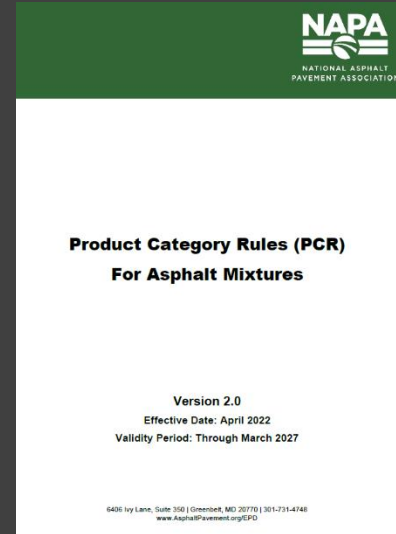
Amitan Mukherjee, Ph.D., PE
Professor
Department of Civil, Environmental & Geospatial
Engineering
Michigan Technological University
Houghton, MI 49931



Michigan Tech

For:
National Asphalt Pavement Association
6406 Ivy Lane, Suite 350
Greenbelt, MD 20770-1441

Product Category Rules (PCR)



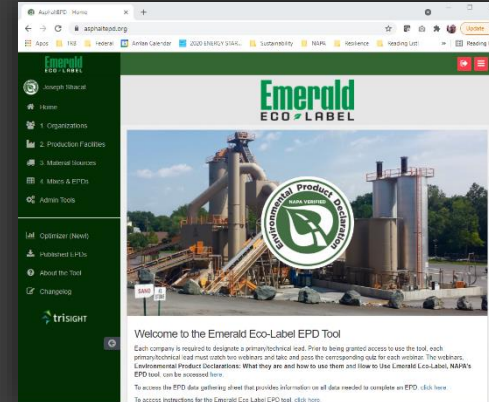
NAPA
NATIONAL ASPHALT
PAVEMENT ASSOCIATION

**Product Category Rules (PCR)
For Asphalt Mixtures**

Version 2.0
Effective Date: April 2022
Validity Period: Through March 2027

6406 Ivy Lane, Suite 350 | Greenbelt, MD 20770 | 301-731-4748
www.AsphaltPavement.org/EPD

EPD Software



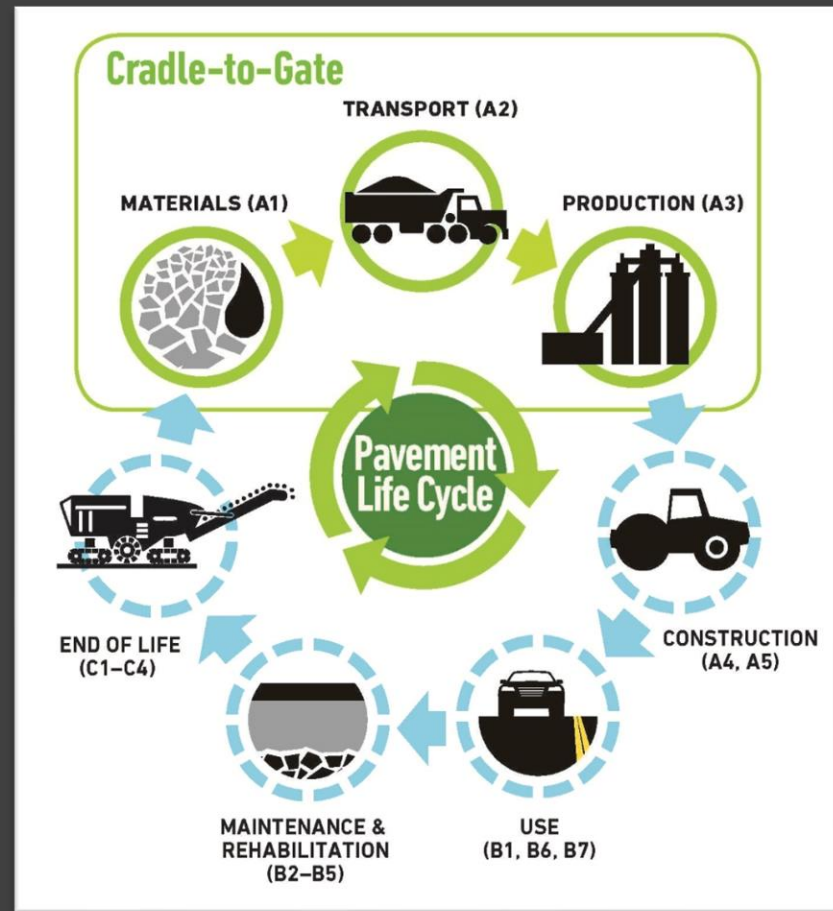
Screenshot of the Emerald Eco-Label EPD Tool software interface. The interface shows a sidebar with navigation options: Home, Organizations, Production Facilities, Material Mixtures, Sites & PFTs, Admin Tools, Optimizer (New!), Historical EPDs, About the Tool, and Changelog. The main content area displays the Emerald Eco-Label logo and a welcome message: "Welcome to the Emerald Eco-Label EPD Tool. Each company is required to designate a primary technical lead. Prior to being granted access to use the tool, each primary technical lead must complete his or her training and take and pass the corresponding quiz for each section. The required Environmental Product Declarations: What they are and how to use them and how to take Emerald Eco-Label, NAPA's EPD tool can be accessed here." Below the message, there is a link to "Access the EPD data gateway sheet that provides information on all data needed to complete an EPD." and a link to "click here to access instructions for the Emerald Eco-Label EPD tool."

Learn more at www.asphalt pavement.org/epd

Key Aspects of Emerald Eco-Label Software

- Digital platform
- Independently verified
- All EPDs expire with the PCR
- Designed for asphalt mix producers
 - Low cost and easy to use

Published EPDs available at
<https://asphaltep.org/published/>



Thank You!

Joseph Shacat

jshacat@asphaltpavement.org

Environmentally Preferable Asphalt

examples and opportunities

Benjamin F. Bowers, PhD, PE
Assistant Professor
Auburn University



THIS IS ENGINEERING.

WHAT WILL WE DISCUSS?

1

Solutions for *today*

2

Solutions for *tomorrow*

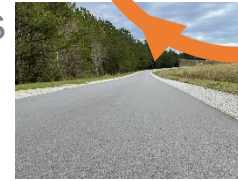
3

Combined solutions

Solutions for [today]

High Reclaimed Asphalt Pavement (RAP) content

- Defined as >20% RAP
 - Some states routinely use 30%+ in their mix designs
 - Research ongoing into 40 and 50%+ mixes
- Replacement for both binder and aggregate
- How do we do this?
 - Balanced Mix Design - Balancing cracking potential with rutting potential)
 - Rejuvenating agents – Return the binder to an earlier, or like-earlier form
 - *Virginia DOT and others are placing pilot projects with approach this now!*



Solutions for [today]

Warm Mix Asphalt

- Lowers asphalt temperatures by 25F to 90F
 - Resulting in less energy for production
 - Less emissions from plant
 - Increased density (long term performance)
- Has been used successfully since the early 2000's
- Numerous studies show success:
 - NCHRP Report 691
 - NCHRP Report 779



HMA (above) and WMA (below)
at the asphalt plant.



Images courtesy of FHWA

Solutions for [today]

Cold Recycling Techniques

- A set of cost-effective and environmentally sensitive techniques for pavement rehab
 - Cold In-place Recycling
 - Cold Central Plant Recycling
- Advantages
 - 30 to 50 percent cost savings
 - 50 percent less greenhouse gases emitted
 - Fix deterioration causes rather than symptoms
- Used since the 1970s. Significant recent research at NCAT, Virginia, Minnesota, California, Nevada, and elsewhere.



Solutions for [today]

Recycled Tire Rubber

- Dry blend
 - Ground tire rubber added to the aggregate mixture during production at the asphalt plant
 - Aggregate replacement (1-3%)
- Wet blend
 - Ground tire rubber blended with the asphalt binder
 - Increased elasticity of the asphalt binder
 - Replacement for polymer modifiers



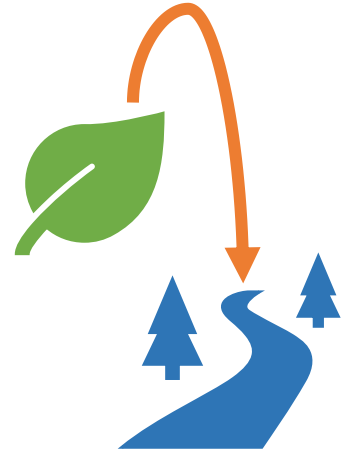
Some solutions for the [future]

Bio-binders

- Can we replace the asphalt binder with a bio-based binder?
- Full replacement or partial replacement
- Research ongoing in this area

Recycled plastics

- May be added in “wet” form to binder or “dry” form to mix
- Work is ongoing in this area, so the jury is still out on long-term performance



[Combined] solutions

- Full depth reclamation

- Fixes deep deterioration (bound and unbound layers)
- Uses foamed asphalt, asphalt emulsion, or cement
- Can be used with cold central plant recycled mix or other environmentally preferable asphalt mixture



Thank you!
Questions?

Benjamin F. Bowers, PhD, PE

Assistant Professor | Auburn University

✉ bfbowers@auburn.edu |  aub.ie/bfbowers



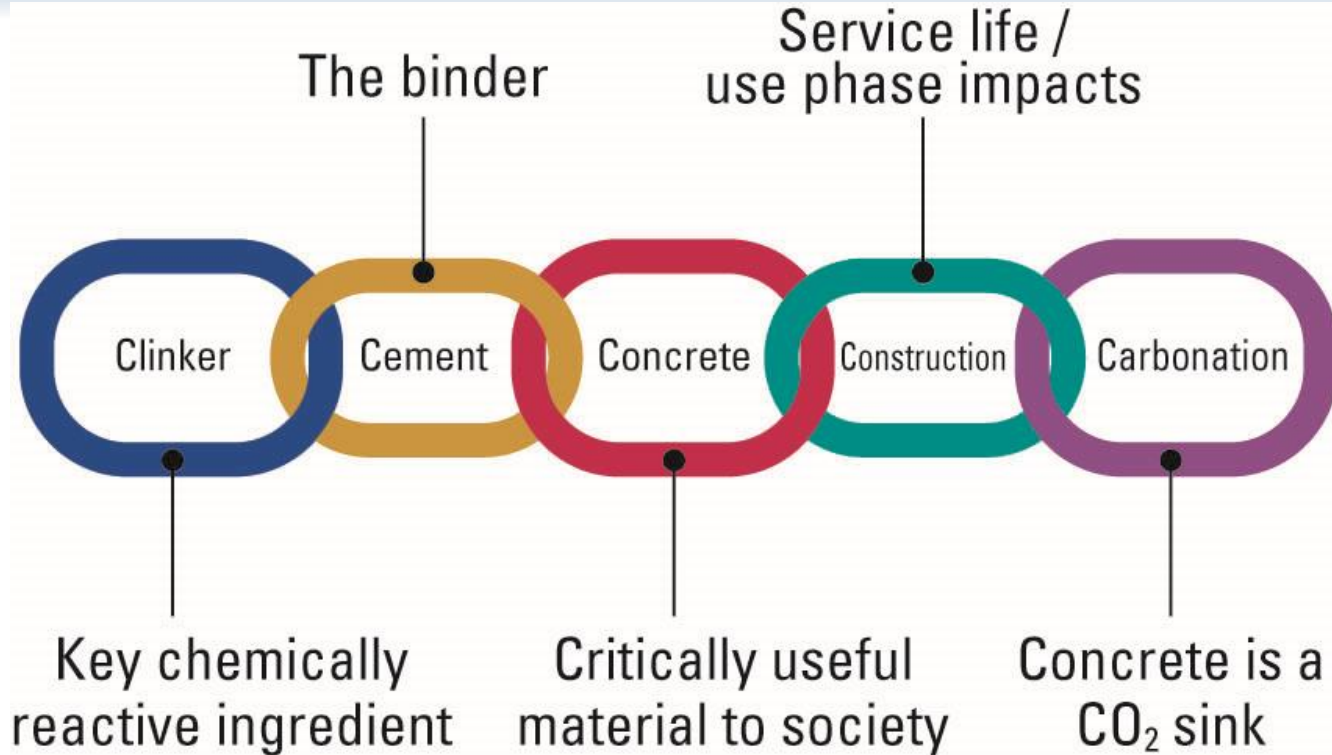


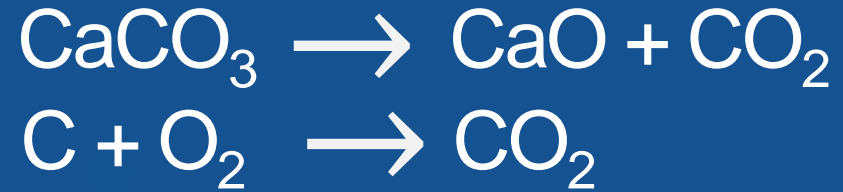
ROADMAP TO CARBON NEUTRALITY

Michelle L. Wilson

Senior Director, Concrete Industry Outreach and Support
Portland Cement Association

THE VALUE CHAIN





U.S. Cement Industry contribution:

- Global GHG = 0.17% CO_{2eq}
- U.S. GHG = 1.25% CO_{2eq}

OPTIMIZING CLINKER

AT THE CEMENT PLANT



Increase the use of decarbonated raw materials



Decrease the use of traditional fossil fuels by 5X



Increase the use of alternative fuels



Push efficiency and decrease energy intensity for one metric ton of clinker



Utilize carbon capture to avoid the release of CO₂ emissions



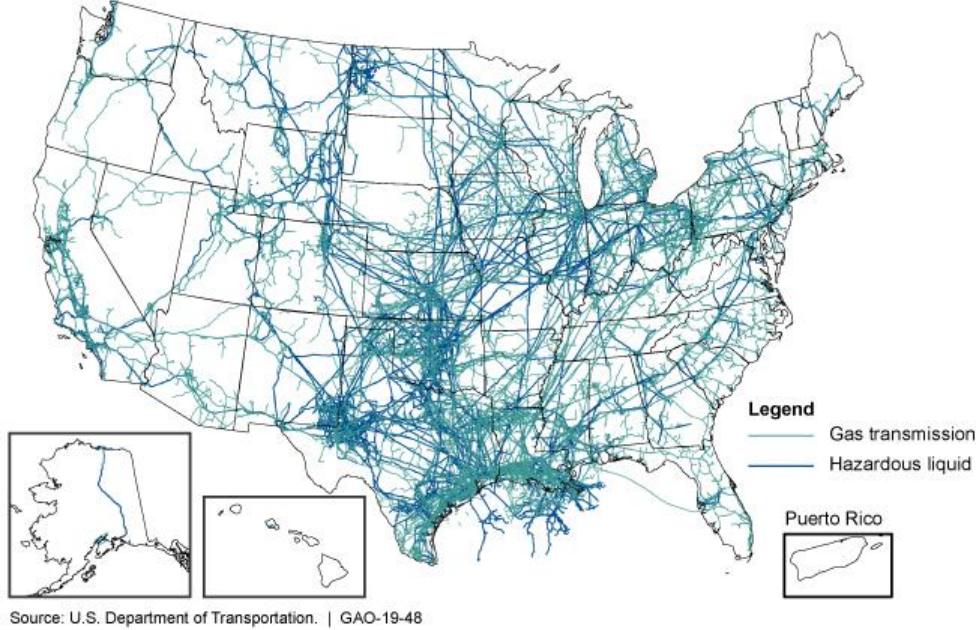
Reduce clinker production emissions



AT THE PLANT: CARBON CAPTURE



INFRASTRUCTURE NEEDS- Pipeline Capacity



INFRASTRUCTURE NEEDS- ENERGY

- Energy consumed by CCUS
- Energy delivered by On-site Power Generation
- Energy from Renewable Sources



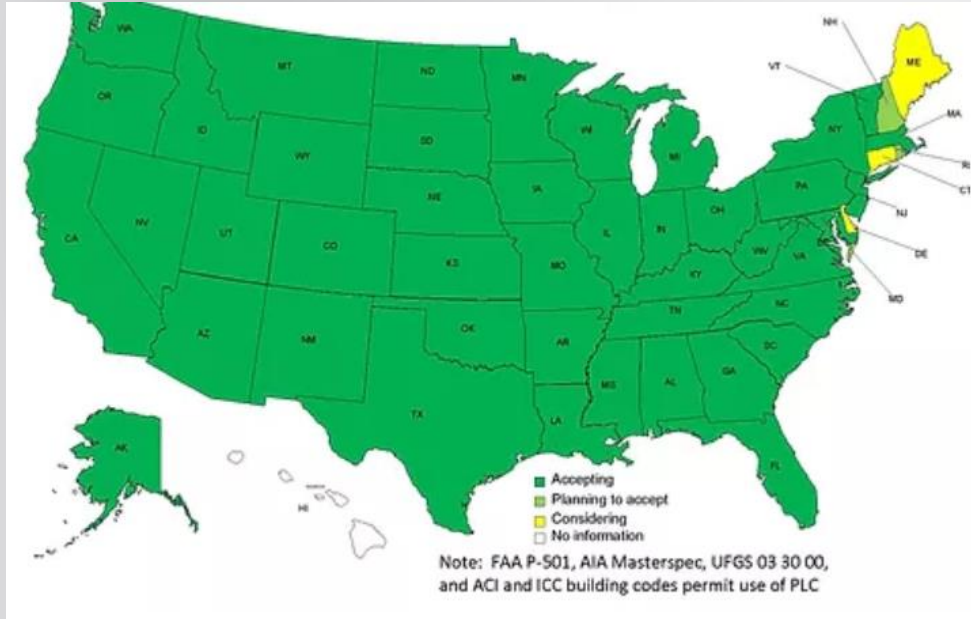
OPTIMIZING CEMENT



- Right sizing the amount of clinker in cement
- Using more non-gypsum additions
- Choosing the right cement specification for specific application
- Zero emissions bulk transportation (rail/truck)

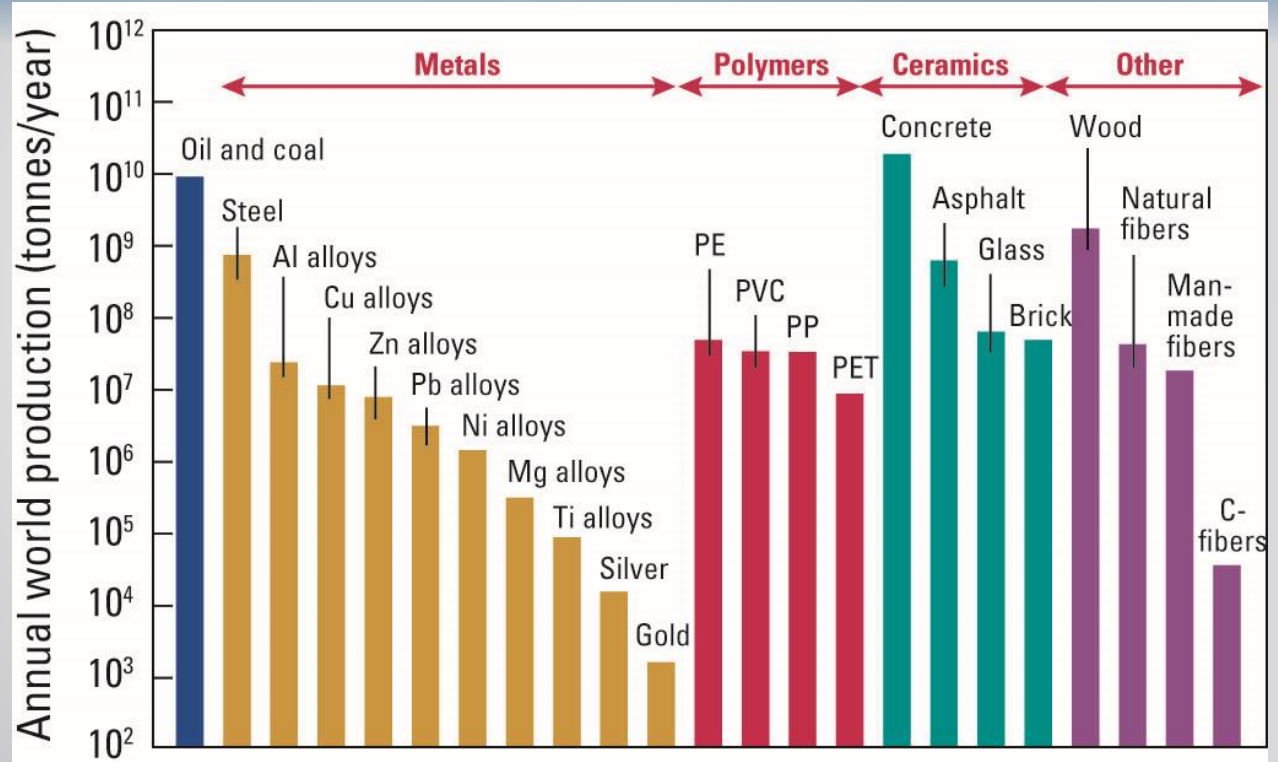
PORTLAND-LIMESTONE CEMENT

- 4 Million Metric Tons of PLC used in US from 2012-2018 = 325,600 MMT CO₂ Savings.



greencement.org

CONCRETE AND CO₂



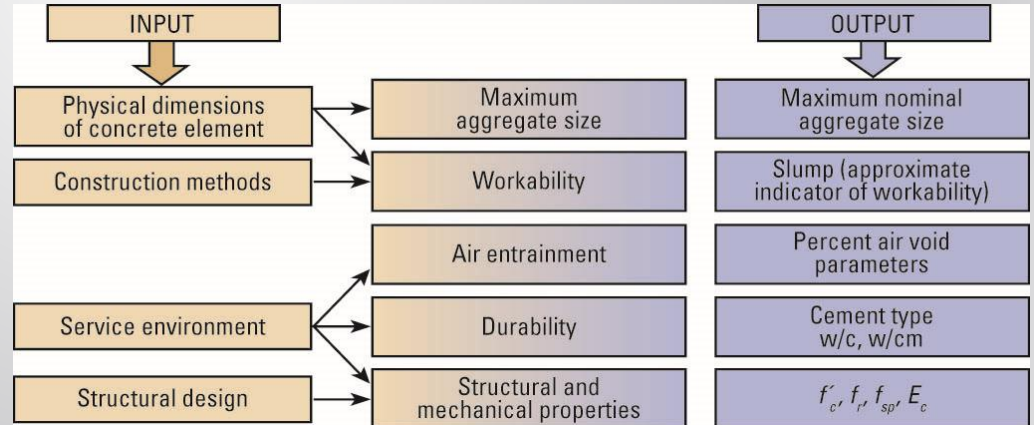
(after Ashby 2009)

OPTIMIZING CONCRETE MIXTURES

- Shift from Prescriptive to Performance
- Incentivize Innovation
- Design Concrete Mixtures Intentionally for Each Application to Achieve Performance



Including Sustainability in Design Input

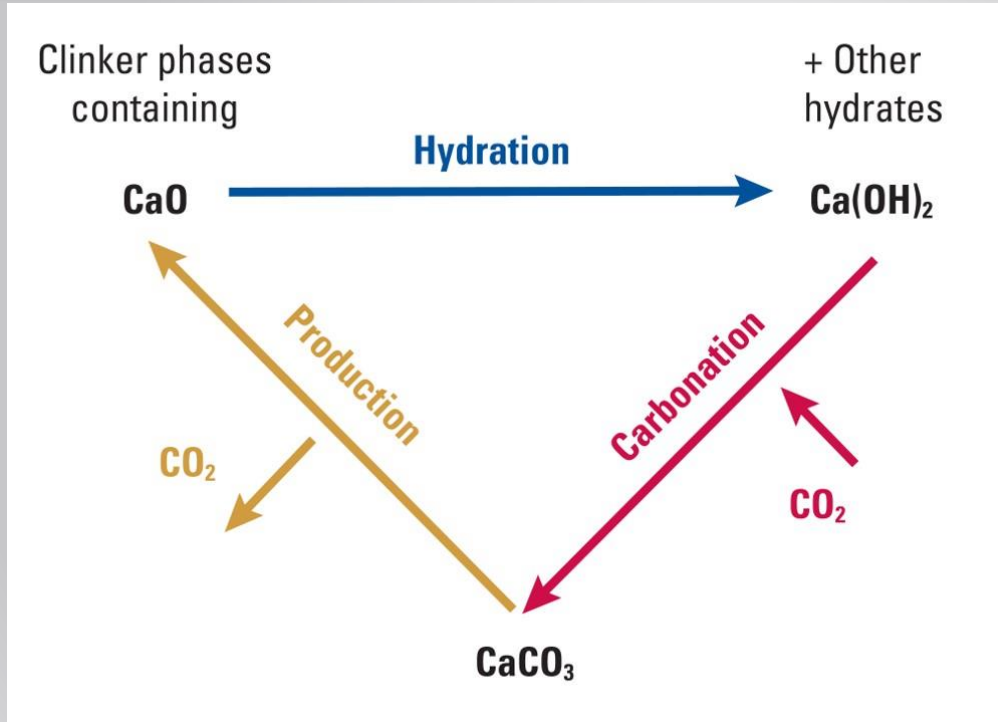


OPTIMIZING CONSTRUCTION

- Optimize and Avoid Over-design
- Leverage Construction Technologies
- Incentivize energy efficient buildings
- Increase Recycled Materials
- Decrease Maintenance
- Use Renewable Fuels



CONCRETE AS A CARBON SINK



THE IMPORTANCE OF LIFE CYCLE

- Completed January 1943
- 435,000 cubic yards of concrete
- 43,000 tons of steel
- 680,000 tons of sand and gravel
- Still absorbing CO₂ after nearly 80 years



SOCIETY NEEDS CONCRETE... AND CONCRETE NEEDS SOCIETY



THE BIG TEN- IMPLEMENTATION



Research, Development & Innovation



Regulations, Permitting & Guidance



Financial Incentives & Support



Performance-Based Material Standards



Market-Based Carbon Pricing



Market Acceptance



Community Acceptance



Cradle to Cradle Life Cycle-Based Procurement



Low-Carbon Infrastructure



Level Playing Field

PCA
Since 1916
America's Cement Manufacturers™

shaped
BY CONCRETE



ROADMAP TO CARBON NEUTRALITY

A more sustainable world is
Shaped by Concrete

Available At:

cement.org/sustainability/roadmap-to-carbon-neutrality

ABOUT THE PORTLAND CEMENT ASSOCIATION

PCA, founded in 1916, is the premier policy, research, education, and market intelligence organization serving America's cement manufacturers. PCA member companies represent the majority of U.S. cement production capacity, having facilities across the country. PCA promotes safety, sustainability, and innovation in all aspects of construction; fosters continuous improvement in cement manufacturing and distribution; and promotes economic growth and sound infrastructure investment.

For more information, visit www.cement.org and shapedbyconcrete.com.

Strategies

to Reduce Concrete's Carbon Footprint NOW

GSA May 5, 2022

Tien Peng
SVP, Sustainability, Codes and Standards



Industry Progress Towards Carbon Neutrality

2009



2012



2014



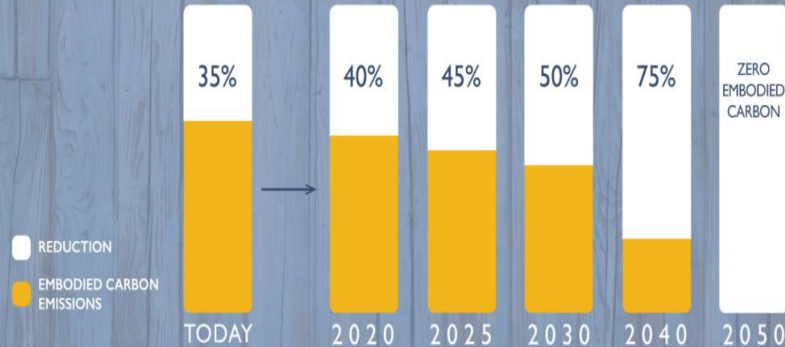
2016



2021

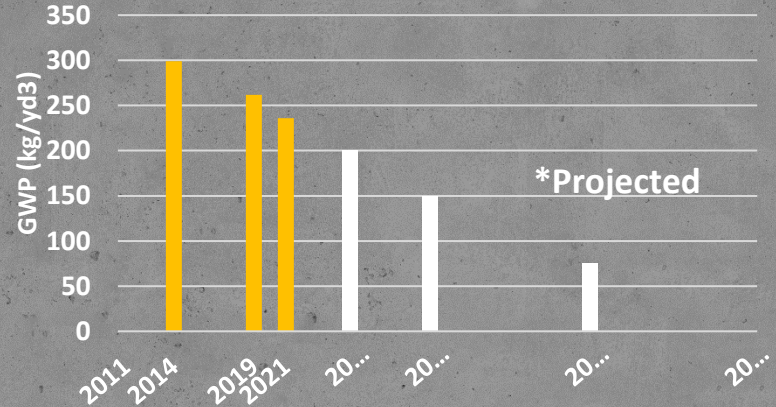


THE 2030 CHALLENGE FOR PRODUCTS



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CARBON FOOTPRINT OF CONCRETE




Industry-Wide + Product Specific EPDs

Environmental Product Declaration



NRMCA MEMBER INDUSTRY-AVERAGE EPD FOR READY MIXED CONCRETE

Athena Sustainable Materials Institute
www.athenasmi.org

Appendix D: NRMCA Member National and Regional LCA Benchmark (Industry Average) Report – V 3.0

Summary: Appendix D is intended for use by NRMCA members, who participated in the IW-EPD, that have developed product specific third-party verified LCAs and/or EPDs to compare the environmental impacts of their products with industry average impacts.



Environmental Product Declaration

This Environmental Product Declaration (EPD) covers 1,478 of 7 different service areas at 8 concrete plants owned and operated by Central Concrete in the San Francisco Bay Area.

Company
Central Concrete, a U.S. Concrete Company, has been serving the San Francisco Bay Area for over 50 years. The company works to engineer high performing concrete while Central Concrete has continued to collaborate with owners, architects and contractors to ensure project requirements and identify solutions that meet each client's unique needs.

Headquarters
Central Concrete
750 Stockton Avenue
San Jose, CA 95128
800-624-1000

Service Areas covered in this EPD

Redwood City Redwood City Plant 11711 Bonaparte Boulevard Redwood City, CA 94063	San Jose Stockton Plant 750 Stockton Avenue San Jose, CA 95128
Hayward Hayward Plant 1844 W. Wilson Avenue Hayward, CA 94545	Marina Marina Plant 1844 W. Wilson Avenue Hayward, CA 94545
Marina Marina Plant 1844 W. Wilson Avenue Hayward, CA 94545	South San Francisco South San Francisco Plant 1300 San Mateo Avenue South San Francisco, CA 94080



Environmental Product Declaration

For ekkonmax™ Cement, Concrete

This Environmental Product Declaration (EPD) covers 1 concrete mix produced at the ekkonmax™ cement plant. The additional plant is located in Huntington Beach, CA. This plant produces concrete for ready mix concrete plants throughout the U.S. to ready mix plants that produce the ekkonmax™ concrete.

Company
Ceratech USA
1001 S. Bascom Blvd.
San Jose, CA 95128
Phone: 707-944-1100
Website: ceratech.com



Environmental Product Declaration

This Environmental Product Declaration (EPD) covers twelve concrete mixes produced by CEMEX at the Pier 92 plant in San Francisco, California.

Company
CEMEX is a leading global provider of high quality products and reliable services to customers in infrastructure, commercial, industrial, energy, water, and other sectors. CEMEX is committed to sustainable development and has established strong relationships with its stakeholders.

Headquarters
CEMEX Headquarters
1000 California Street, Suite 1500
San Francisco, CA 94109
(415) 774-6200

Plant
CEMEX Plant 4433 Pier 92
800 Amador Street
San Francisco, CA 94104
(415) 964-4714




Environmental Product Declaration (EPD) for Concrete




Plants covered in this EPD

Plant	Address	City	State	Zip
Atlanta	1000 North Ave	Atlanta	GA	30309
Birmingham	1000 North Ave	Birmingham	AL	35203
Charlotte	1000 North Ave	Charlotte	NC	28203
Chicago	1000 North Ave	Chicago	IL	60606
Columbus	1000 North Ave	Columbus	GA	31906
Dallas	1000 North Ave	Dallas	TX	75201
Denver	1000 North Ave	Denver	CO	80202
Fort Worth	1000 North Ave	Fort Worth	TX	76102
Houston	1000 North Ave	Houston	TX	77002
Los Angeles	1000 North Ave	Los Angeles	CA	90001
Memphis	1000 North Ave	Memphis	TN	38103
Minneapolis	1000 North Ave	Minneapolis	MN	55401
Phoenix	1000 North Ave	Phoenix	AZ	85001
Richmond	1000 North Ave	Richmond	VA	23219
Salt Lake City	1000 North Ave	Salt Lake City	UT	84103
San Antonio	1000 North Ave	San Antonio	TX	78201
San Diego	1000 North Ave	San Diego	CA	92101
Seattle	1000 North Ave	Seattle	WA	98101
Tampa	1000 North Ave	Tampa	FL	33601
Washington DC	1000 North Ave	Washington DC	DC	20001

Granite Ready-Mix Concrete

Environmental Product Declaration (EPD) for Concrete




About Cimentos Argos Panama

Argos Panama S.A. is a manufacturer of concrete and concrete supplier that is the market leader in the country. Through its network of Argos concrete plants located in the country, its annual concrete production reaches 480,000 m³. As the market leader, Argos Panama S.A. is a member of the Argos Group, a company whose headquarters are located in Colombia. For the detailed environmental profile of Argos Panama S.A. please refer to the Argos Group Environmental Profile.

Cimentos Argos Panama
Tulla Argos, 01 Barú
Tulla Argos, 02 Barú
Tulla Argos, 03 Barú
Tulla Argos, 04 Barú
Tulla Argos, 05 Barú
Tulla Argos, 06 Barú
Tulla Argos, 07 Barú
Tulla Argos, 08 Barú
Tulla Argos, 09 Barú
Tulla Argos, 10 Barú

Planta Miraflores
Transmision, Via Simon Bolivar, Ciudad de Panama



35,000+ EPDs today

GSA Embodied Carbon Limits for Concrete

	Maximum Global Warming Potential Limits for GSA Low Embodied Carbon Concrete (kilograms of carbon dioxide equivalent per cubic meter - CO ₂ e kg/m ³)		
Specified compressive strength (f'c in PSI)	Standard Mix	High Early Strength	Lightweight
up to 2499	242	326	462
2500-3499	306	413	462
3500-4499	346	466	501
4500-5499	385	519	540
5500-6499	404	546	N/A
6500 and up	414	544	N/A

These numbers reflect a 20% reduction from GWP (CO₂e) limits in model code language: [“Lifecycle GHG Impacts in Building Codes”](#) by the New Buildings Institute, January 2022.

Comparison Risk: Application NOT Reported in EPDs

Mix Code	Plant	Perf.		Impacts						
		CS	TPE	CWB	CWW	GWP	ODP	AP	EP	POCP
	<i>minimum</i>	2,000	2.155E+03	6.871E-02	4.504E-03	2.058E+02	3.634E-06	1.513E+00	8.143E-02	2.568E+01
	<i>maximum</i>	6,000	3.629E+03	7.287E-02	4.504E-03	4.819E+02	6.637E-06	3.466E+00	1.395E-01	4.745E+01
325PC901	Brentwood	2,500	2.556E+03	6.871E-02	4.504E-03	3.058E+02	4.237E-06	2.174E+00	9.251E-02	3.072E+01
325PC902	Brentwood	2,500	2.552E+03	7.287E-02	4.504E-03	3.056E+02	4.249E-06	2.173E+00	9.197E-02	3.067E+01
325PC9D1	Brentwood	2,500	2.231E+03	6.871E-02	4.504E-03	2.529E+02	3.634E-06	1.513E+00	8.143E-02	2.572E+01
325PC9D2	Brentwood	2,500	2.225E+03	7.287E-02	4.504E-03	2.525E+02	3.638E-06	1.513E+00	8.143E-02	2.568E+01
325PC9Q1	Brentwood	2,500	2.161E+03	6.871E-02	4.504E-03	2.062E+02	4.591E-06	1.515E+00	1.004E-01	2.760E+01
325PC9Q2	Brentwood	2,500	2.155E+03	7.287E-02	4.504E-03	2.058E+02	4.571E-06	1.513E+00	9.997E-02	2.754E+01
325PG9C1	Brentwood	2,500	2.536E+03	6.871E-02	4.504E-03	3.047E+02	4.147E-06	2.170E+00	8.987E-02	3.063E+01
325PG9D1	Brentwood	2,500	2.311E+03	6.871E-02	4.504E-03	2.674E+02	3.760E-06	1.894E+00	8.401E-02	2.707E+01
325PG9Q1	Brentwood	2,500	2.344E+03	6.871E-02	4.504E-03	2.310E+02	5.036E-06	1.704E+00	1.109E-01	3.082E+01
325PG9Q2	Brentwood	2,500	2.345E+03	7.287E-02	4.504E-03	2.316E+02	5.064E-06	1.707E+00	1.106E-01	3.085E+01

Impacts vary by 1.5X

These mixes with same PSI all have different performance requirements.

Concrete Climate Solution

Aligned Purpose



- 1) Communicate Goals
- 2) Set Footprint Targets

Smart Design



- 3) Optimize Volume
- 4) Don't Limit Ingredients
- 5) Use "SCMs"
- 6) Include Alternate Cements
- 7) Use Admixtures

Partner for Success



- 8) Sequester CO2 in Concrete
- 9) Good Quality Control
- 10) Encourage Innovation

1. Clearly & Frequently Communicated Goals

#1



Concrete Specs: “This project has a goal of reducing the embodied carbon footprint over a typical project by 30%”

Design: Project collaboration

Pre-Bid Meeting: Re-state the carbon reduction goals and encourage innovation.

2. Set Carbon Footprint Targets



EPD: Use industry average Environmental Product Declarations (EPDs) to help set specific reduction target.

Specification Example: Supply concrete mixtures such that the total Global Warming Potential (GWP) of all concrete on the project is less than or equal to 4,298,000 kg of CO₂ equivalents.

Schedule, Not Technology, is the Challenge

#2

PT Decks
3 day strength
Strip forms
Less SCMs

Mat Slabs, Footings
56 or 90 day strength
control heat of hydration
More SCMs

Equation:

$$\text{SUM (GWP1)(V1) + (GWP2)(V2)...(GWPN)(Vn) \leq 0.9((GWPA1)((V1))+(GWPA2)(V2)...(GWPA n)(Vn)}$$

3. Optimize Volume

#3



Sustainable Solutions

- Less concrete ≠ weaker build
- Efficient structural systems
- High-performance concrete
- Dense rebar design
- Maximize value

4. Don't Limit Ingredients

- ~~Maximum w/cm ratio~~
- ~~Min / Max cement content~~
- ~~Min / Max slag / fly ash~~
- ~~Potable water~~
- ~~High-Air content~~
- ~~Branded admixtures~~
- ~~Strength gain times~~

Specify the required performance... 

Class	Location	Nominal Max. Aggregate Size	Exposure Class	F'c, Psi @ Age
1	Mat Foundation	3"	F0, S1, W0, C0	6,000 at 90 days
2	Basement Walls	1-1/2"	F0, S1, W0, C0	4,000 at 56 days
3	Shear Walls	3/4"	F0, S0, W0, C0	6,000 at 56 days
4	Columns Level B2-L6	3/4"	F0, S0, W0, C0	6,000 at 28 days
5	Columns Level L7-L12	3/4"	F0, S0, W0, C0	4,000 at 28 days
6	Slabs	3/4"	F0, S0, W0, C0	5,000 at 28 days
7	Exterior Pavements	3/4"	F3, S1, W0, C0	4,000 at 28 days

5. Use Supplementary Cementitious Materials

Global Warming Potential:

Cement US Standard: 922 kg CO₂eq

Slag Standard: 140 kg CO₂ eq

Fly Ash Standard: 0 kg CO₂ eq

SCM Specifications:

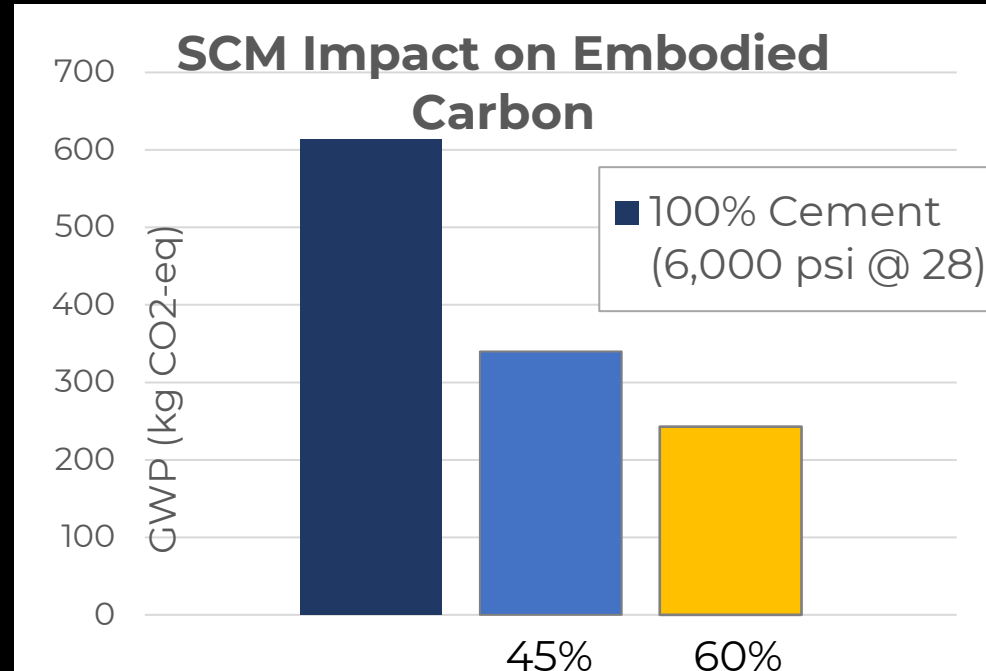
Hydraulic Cement: ASTM C150,
ASTM C595, or ASTM C1157

Fly Ash or Natural Pozzolan:
ASTM C618

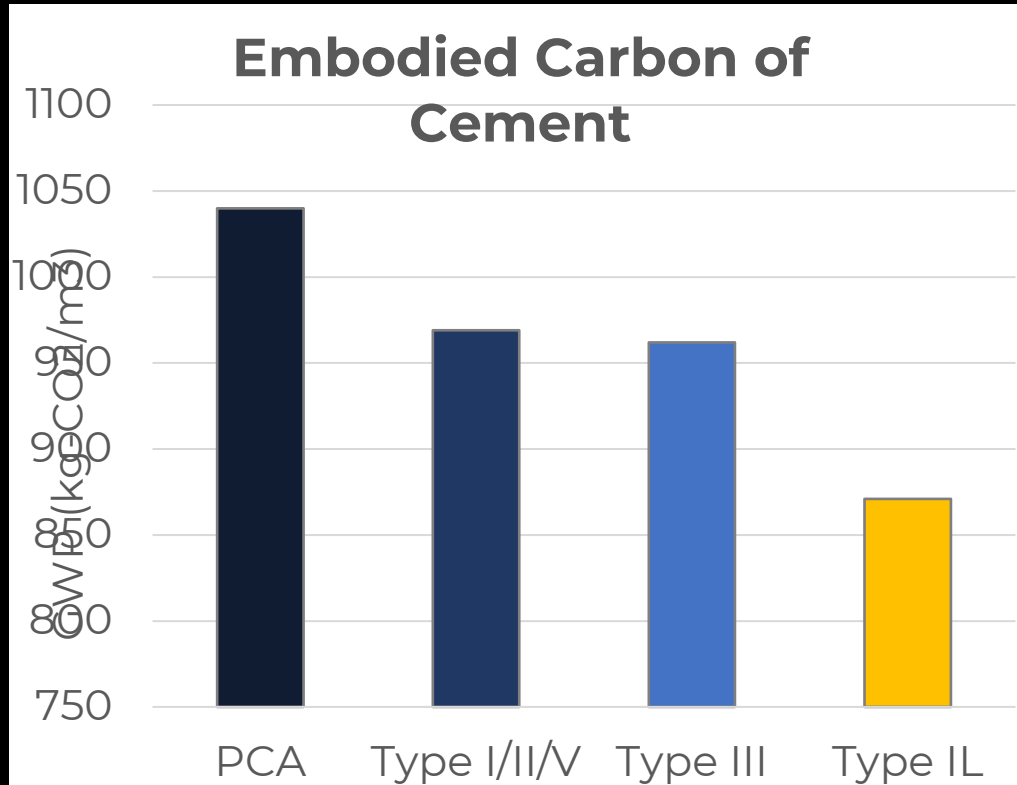
Slag Cement: ASTM C989

Silica Fume: ASTM C1240

Glass Pozzolan: ASTM C1866



6. Include Alternate Cements



**Hydraulic Cement
for Concrete**

ASTM C150

ASTM C595

ASTM C1157

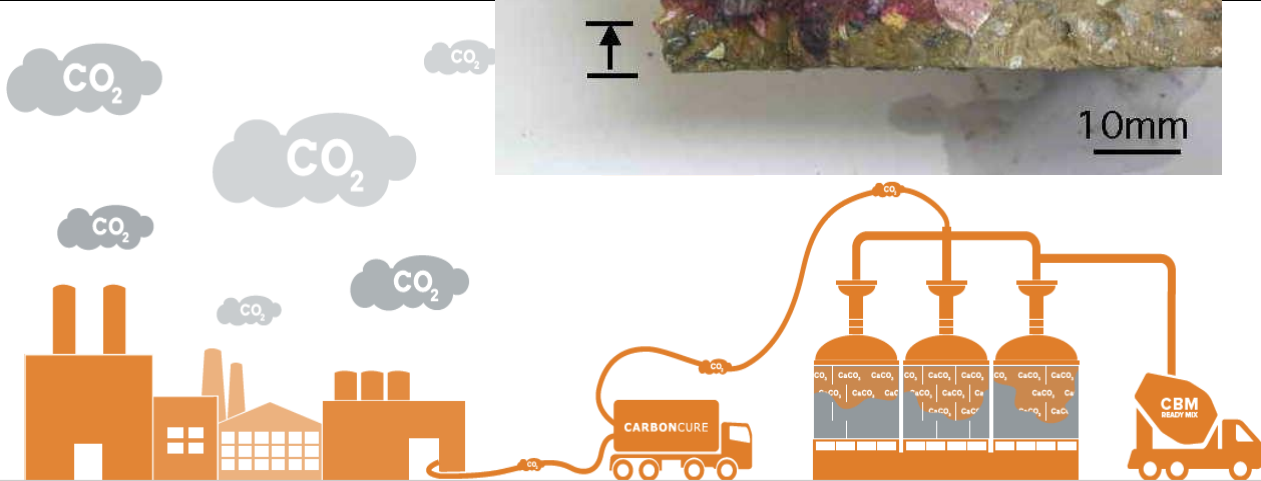
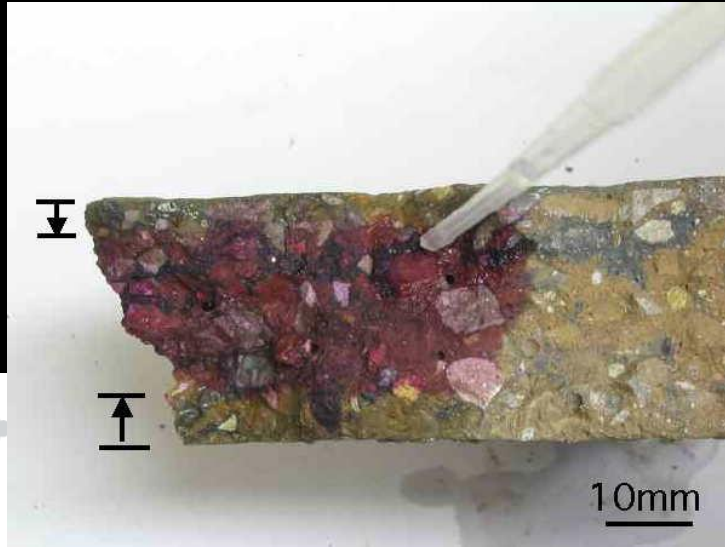
7. Use Admixtures

Chemical Admixtures

1. Air-Entraining Admixture:
ASTM C 260/C 260M
2. Water-Reducing Admixture
ASTM C 494/C 494M Type A
3. High-Range Water-Reducing
Admixture: ASTM C 494/C 494M
Type F or G
4. Accelerating Admixture:
ASTM C 494/C 494M Type C or E
5. Retarding Admixture: ASTM C 494/
C 494M Type B or D
6. Hydration Control Admixture:
ASTM C 494/C 494M Type B or D



8. Sequester CO₂ in Concrete



9. Good Quality Control

Manufacturer

- NRMCA Certified Concrete Production Facility
- NRMCA Concrete Technologist Level 2

Installer

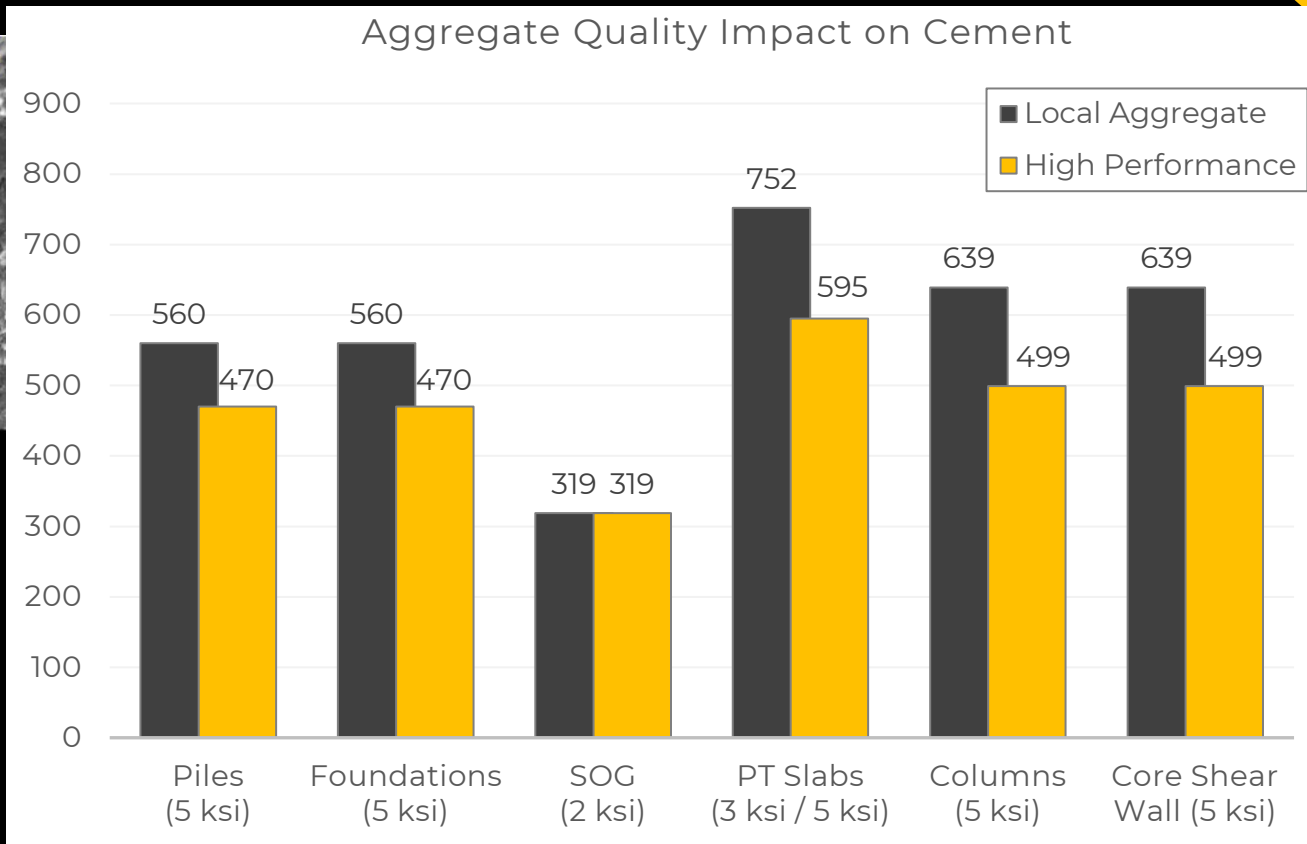
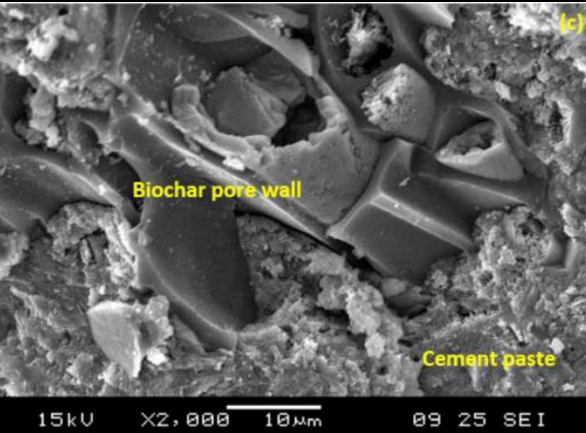
- ACI Flatwork Finisher

Testing Agency

- Meets ASTM C1077
- ACI Concrete Field Testing Technician Grade I
- ACI Concrete Laboratory Testing Technician Level I
- Results certified by a registered design professional



10. Encourage Innovation



Concrete Climate Solution

Aligned Purpose



- 1) Communicate Goals
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Partner for Success



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Questions

<https://www.nrmca.org/association-resources/sustainability/>

Prior Industry Input

Portland Cement Association, May 2021 letter to GSA:

“GSA has a unique opportunity to influence the sustainability of federal operations for decades to come, as well as those of states, localities, and the private sector. To do so, it should embrace **procurement practice grounded in whole-life cycle product performance**, robust data and methodologies, and policies that allow building materials and manufacturers to compete on a level playing field. PCA and NRMCA look forward to working with GSA and its sister agencies to achieve these shared goals.”

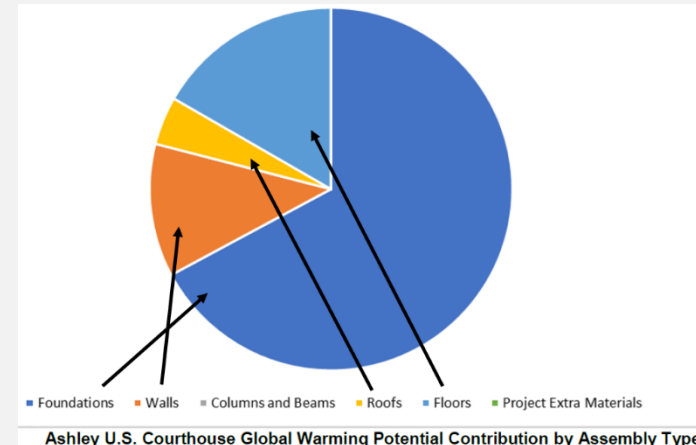
GSA uses Whole Building Life Cycle Assessment

Embodied Carbon Reduction Measure: GSA's new construction and major modernization designs must **target a 20% reduction in their buildings' embodied carbon**, compared to a project-specific standard baseline designs, as determined by the architect. Active FY22 measure.

- Compare embodied carbon footprints for at least the structure and enclosure of a comparable standard baseline design, and the proposed facility, using a GSA-approved estimation tool.
- Earn LEED's *Building Life-Cycle Impact Reduction* credit using *Whole-Building Life-Cycle Assessment* option.

Embodied carbon estimation tools include:

- (a) Tally (from Building Transparency)
- (b) EC3 (Embodied Carbon in Construction Calculator)
- (c) One Click LCA
- (d) Athena's Impact Estimator for Buildings
- (e) Autodesk's Insight 360



Applicability

- [GSA.gov/p100](https://www.gsa.gov/p100) contains GSA issuance memo and the new concrete and asphalt standards. They apply to:
 - All projects (incl. repairs) that use at least 10 cubic yards of material, including onsite mobile batch plants
 - Design and construction contract awards for all GSA projects, both capital and small, regardless of funding source: paving upgrades, modernizations, new construction, customer-funded projects through BA80 Reimbursable Work Authorizations, privately-financed projects such as Energy Savings Performance Contracts, and all Bipartisan Infrastructure Law projects
- These do NOT apply to:
 - Leased space except lease-construct
 - Precast concrete panels or bricks that were fabricated off-site

Frequently asked questions (1/2)

- Achievability?

	Reference	Maximum Global Warming Potential Limits* for GSA Low Embodied Carbon Concrete (kilograms of carbon dioxide equivalent per cubic meter - CO ₂ e kg/m ³)		
		Standard Mix	High-early Strength	Lightweight concrete
Specified compressive strength (f _c in PSI)	National Average (50th percentile per National Ready Mixed Concrete Association (NRMCA))			
f _c , psi	Maximum CO ₂ e kg/m ³ (kilograms of carbon dioxide equivalent per cubic meter)			
up to 2499	266	242	326	462
2500-3499	291	306	413	462
3500-4499	342	346	466	501
4500-5499	405	385	519	540
5500-6499	429	404	546	N/A
6500 and up	498	414	544	N/A

Compared to NRMCA national averages, GSA's Standard Mix GWP limits are:

- 9% lower
- 5% higher
- 1% higher
- 5% lower
- 6% lower
- 17% lower

- GSA's limits are 20% lower than NBI's proposed [75th percentile of GWPs] code language.
 - GSA's Standard Mix GWP limits are on average only 5% lower than industry-standard NRMCA baselines.**

- Workability?

- RFI respondents reported that potential low carbon concrete challenges -- workability, especially finishability and pumpability, slower early strength development, and availability of raw materials -- can be overcome with mixture optimization and admixtures.
- Quality, workability, or durability challenges with low embodied carbon concrete were "Not [experienced] when the mixture is properly optimized. Many times the results are equal to or better than straight cement mixtures."

Frequently asked questions (2/2)

- Isn't this a big change?
 - No. Since 2015, P100 has stated that “Concrete ready mix and site mix must have a minimum amount of fly ash equal to or greater than 15%, or ground granulated blast-furnace (GGBF) slag equal to or greater than 25%.” (§ 3.3.5 “Masonry and Concrete Materials”).
 - This carbon-lowering standard has also been in GSA’s [Key Sustainable Products](#) since 2014.
 - The fly ash requirement stems from EPA’s [Comprehensive Procurement Guidelines](#) (CPG) program, authorized by Congress under Section 6002 of the Resource Conservation and Recovery Act of 1976, as amended, (RCRA) (42 U.S. Code 6962).
 - CPG promotes the use of recovered waste materials.
 - EPA published [guidelines](#) designed to encourage the use of cement and concrete containing coal fly ash in the Federal Register in January 1983
- What if one of my mixes complies, but another doesn't?
 - Current standard requires a waiver on a per-mix basis. However, depending on what we learn as more projects apply it, GSA may evaluate a weighted average compliance approach.

Concrete Plants with EPDs, and GSA's upcoming [border station](#) and LPOE paving projects



This GSA-maintained map shows the location of concrete plants with published EPDs as of 4/18/22, from EC3.

Questions and Discussion

- GSA: Chuck Hardy, Sonal Larsen, Walter Tersch
- CEQ: Andrew Mayock
- EPA: Danny Macri
- Building Transparency: Stacy Smedley
- NAPA: Joseph Shacat
- NCAT: Benjamin Bowers
- PCA: Michelle Wilson
- NRMCA: Tien Peng

