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SEMINARIO DE LA BECA

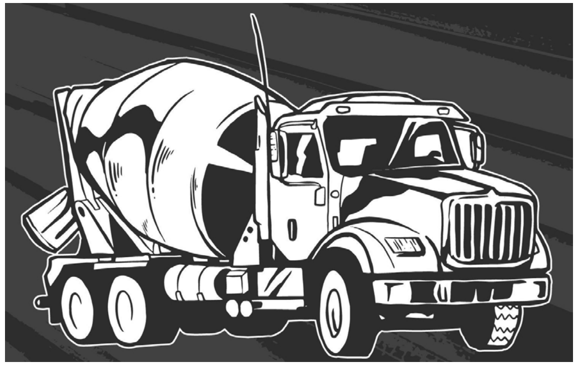
DR. RAMON CARRASQUILLO

“Transformación hacia Pavimentos Sostenibles”

30 August 2024

What is, Why, and How to Promote Pavement Sustainability

- New ways of see and measure which is the best design.
- Extensive use new materials (Concrete, Cement, Cementitious Materials) that reduce the net embodied carbon of construction.
- Efficiency in curing process
- Unleashing full potential by promoting hydration.
- Long term durability / life cycle assessments



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What is Sustainability?

- **“Meeting the needs of the present without compromising the ability of future generations to meet their own needs.”**
  - As defined by the United Nations Brundtland Commission.

Sustainable Pavements

- Achieves its specific engineering goals, while,
  - Meets basic human needs
  - Uses resources effectively
  - Preserves/restores surrounding ecosystems

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Why?..

"As greenhouse gas emissions blanket the Earth, they trap the sun's heat. This leads to global warming and climate change. The world is now warming faster than at any point in recorded history. Warmer temperatures over time are changing weather patterns and disrupting the usual balance of nature. This poses many risks to human beings and all other forms of life on Earth."

– United Nations Climate Action

https://www.un.org/en/climatechange/science/causes-effects-climate-change#:~:text=As%20greenhouse%20gas%20emissions%20blanket,the%20usual%20balance%20of%20nature.

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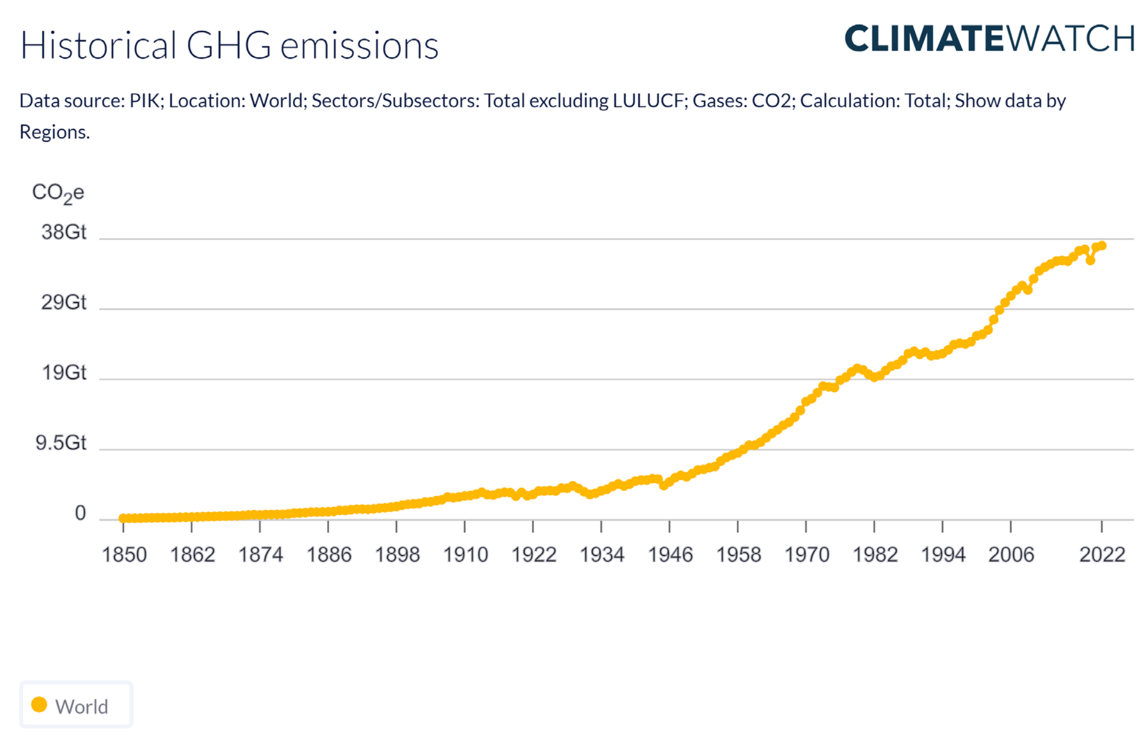
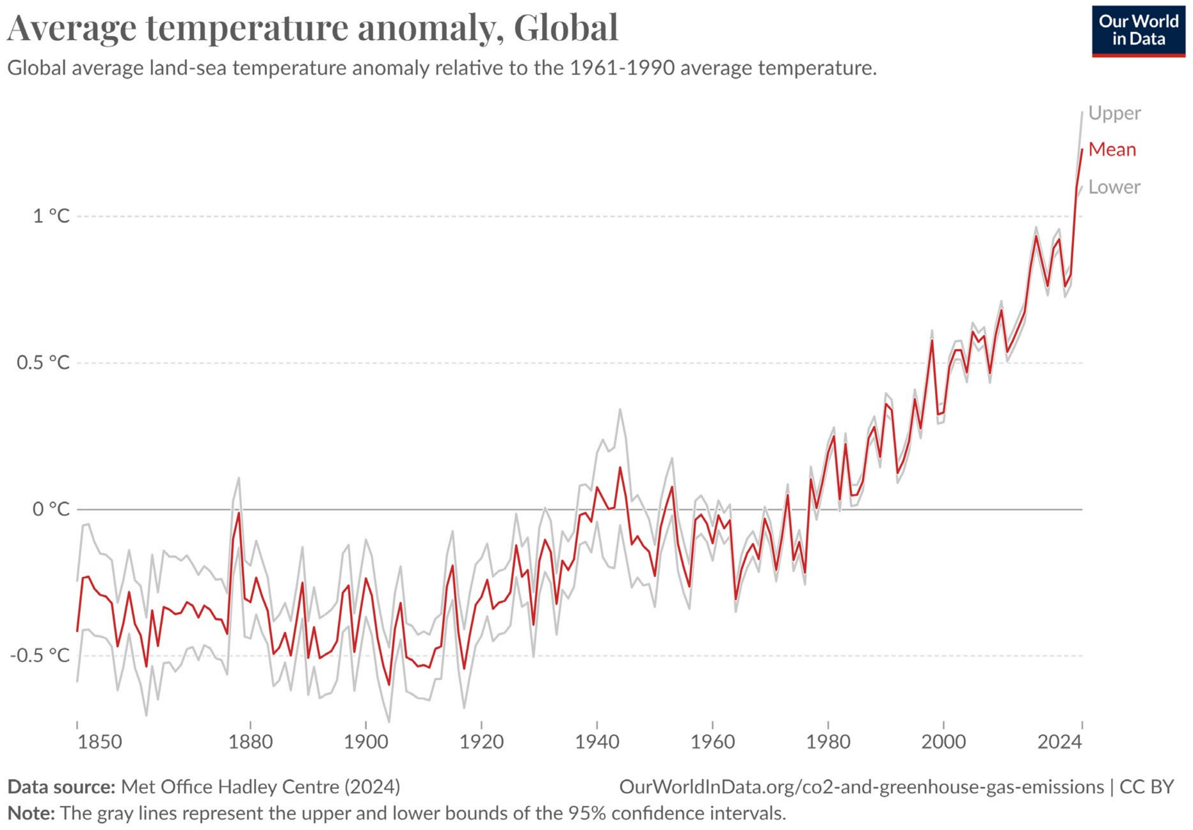
...Why?

CO2 Emissions



Temperature Anomaly



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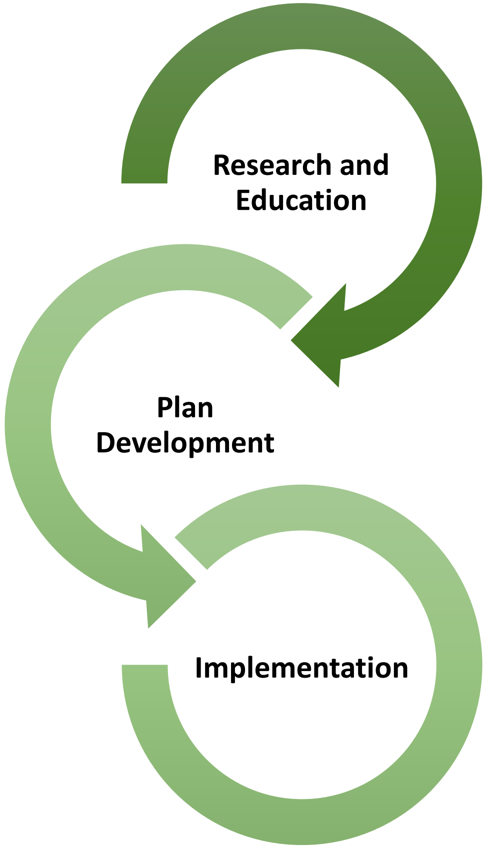
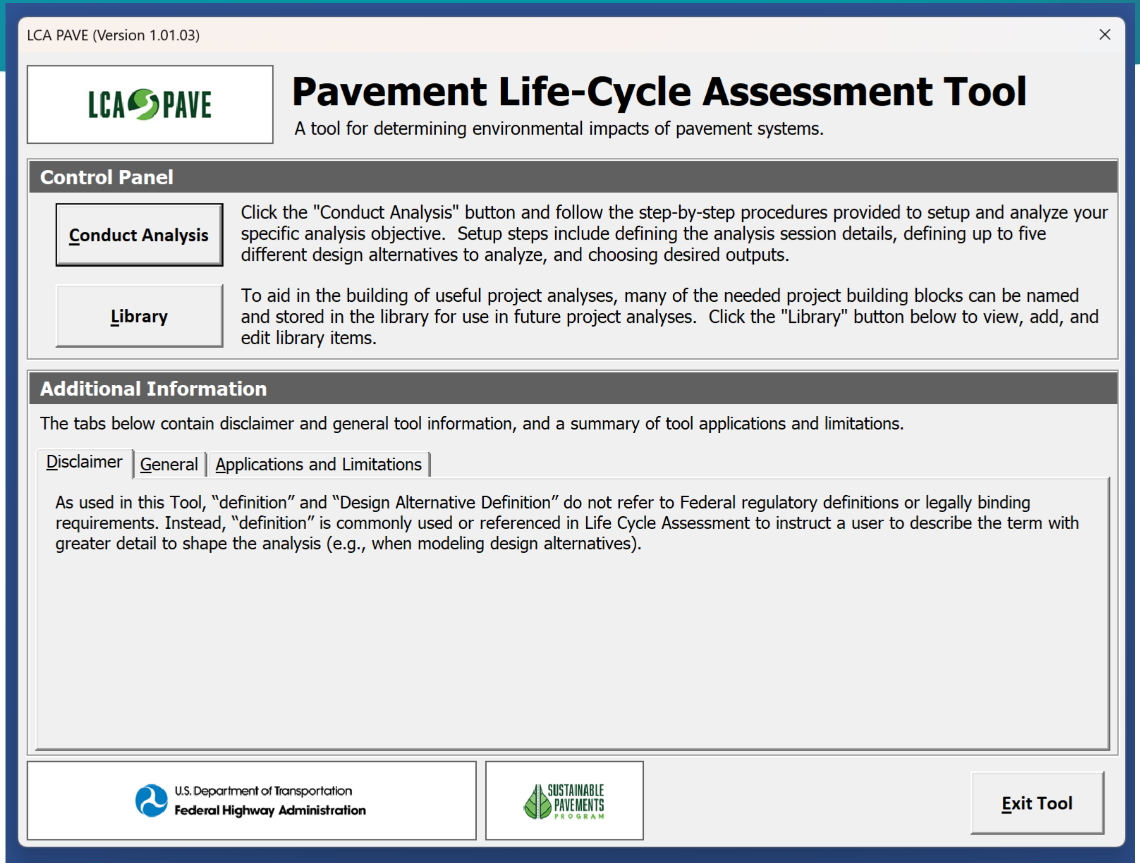
How?

- Current efforts are performed as part of federal programs.
- Initial goal is to promote the use of pavements developed with materials, products, and processes that have lower levels of embodied greenhouse gas emissions, mostly focused on carbon, while maintaining desired performance.
  - Emissions will be evaluated through Life Cycle Assessments (LCA) and Environmental Product Declarations (EPD).
- We will start with research and education, then producing a plan, and then proceed with implementation.



LCA

- Method for evaluating the total environmental burden of a product by examining all the inputs and outputs over the life cycle,
- For pavements, this cycle includes the material production, design, construction, use, maintenance and rehabilitation, and end-of-life stages.



From https://www.fhwa.dot.gov/pavement/lcatool

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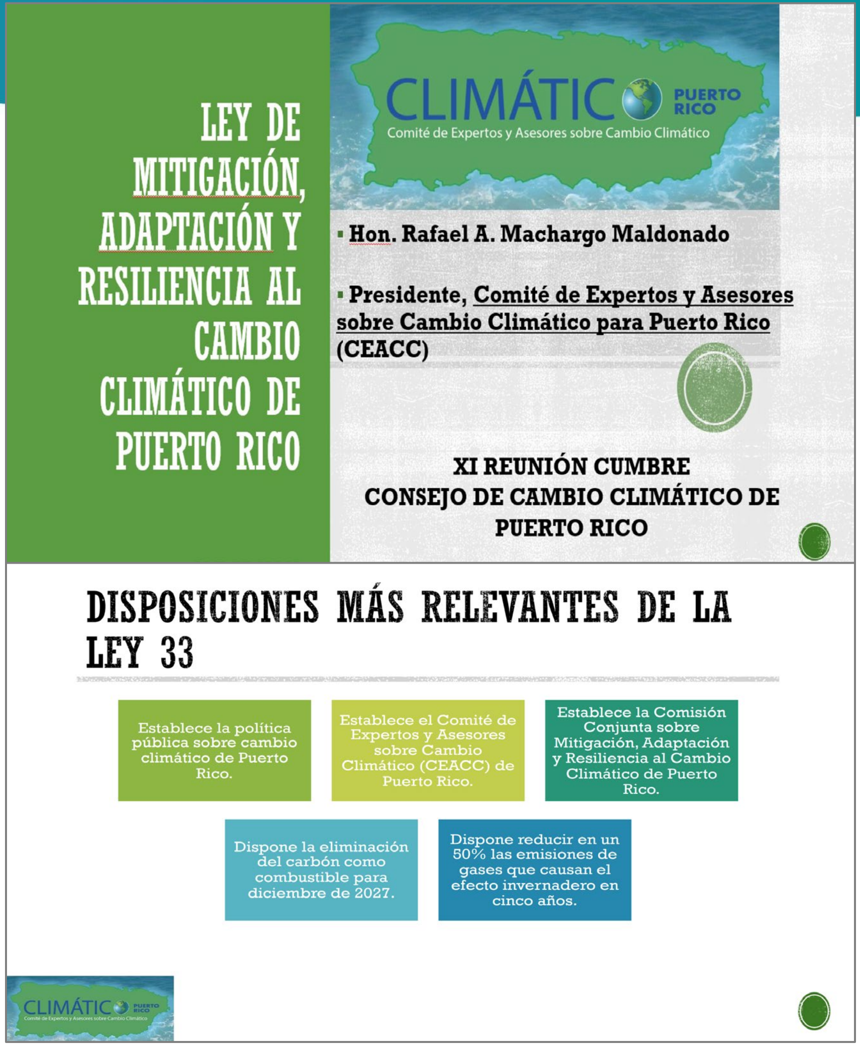
Puerto Rico Regulation Initiative

- Law 33 of May 22, 2019 **Mitigation, Adaptation, and Resiliency to Climate Change in Puerto Rico**
  - **Establishes policy** related to climate change and mitigation, adaptation, and resiliency processes by sectors.
  - **Establishes** and perform **inventory** of greenhouse gasses emissions.



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Puerto Rico Pavement Sustainability Efforts as part of Federal Initiatives

CLIMATE CHALLENGE

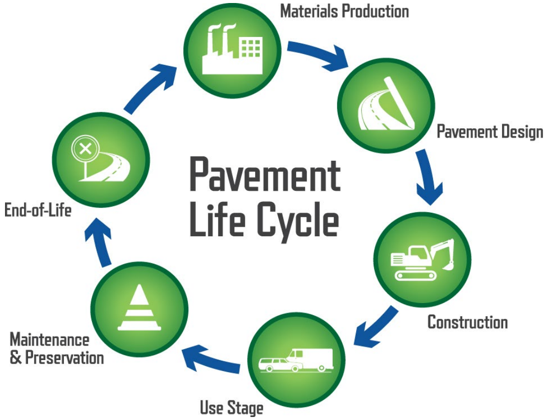
EDC Round 7

FHWA Climate Challenge

Quantifying Emissions of Sustainable Pavements

FHWA CLIMATE CHALLENGE

- Supports Executive Order 14057 of December 8, 2021 goals
  - Achieve a carbon pollution-free electricity sector by 2035
  - Achieve net-zero emissions economy-wide by no later than 2050
- Provides resources to promote the use of LCAs and EPDs as a standard practice to
  - Enhance sustainable pavement practices
  - Quantify emissions
  - Facilitate informed decisions on pavement material and design selection



From

- https://www.fedcenter.gov/programs/eo14057
- https://www.fhwa.dot.gov/infrastructure/climatechallenge/

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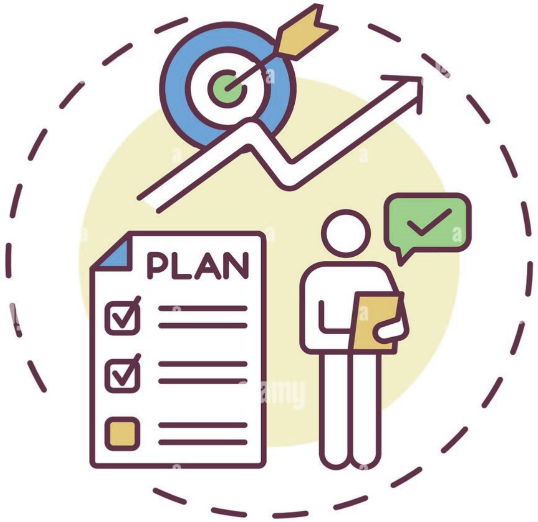
Every Day Counts Round 7 (2023-2024)

- State-based model that identifies and rapidly deploys proven, yet underutilized innovations that make our transportation system adaptable, sustainable, equitable and safer for all.
- Innovation: EPDs for Sustainable Project Delivery
    - Support procurement decisions and quantify embodied carbon reductions using life cycle assessments for sustainable pavements.

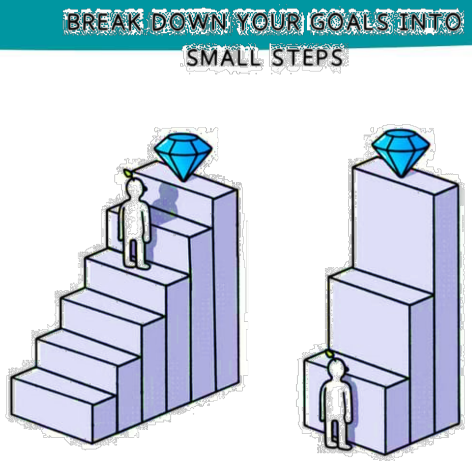
From:

- *https://www.fhwa.dot.gov/innovation/everydaycounts/about-edc.cfm*
- *https://www.fhwa.dot.gov/innovation/everydaycounts/edc_7*

Puerto Rico Sustainable Pavement Initiative Development Plan



Plan Development General Strategies



- Consider strategies that have been successful in other places.
- Consider industry recommendations.
- Consider the gap between current procurement processes vs the target process.
- Identify funding sources.
- Establish realistic performance measures and targets.
- Establish simple processes.
    - Monitoring performance measures and targets
    - Establish feedback and update process
- Establish training program.
- Establish transition plan and schedule.

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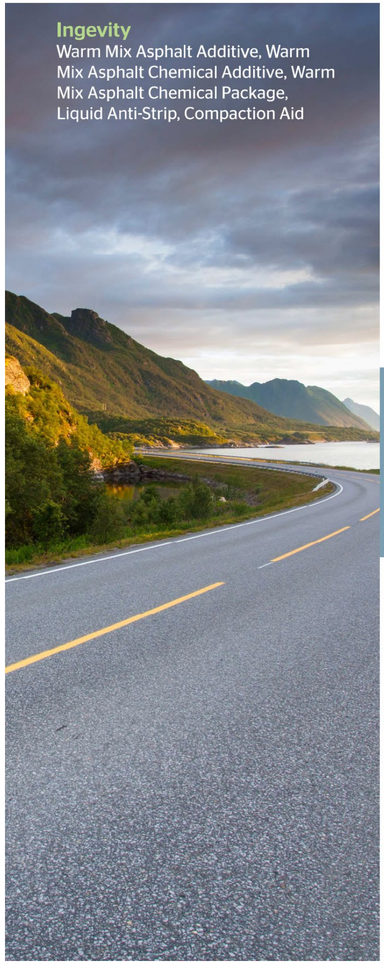
EPD From Supplier

Environmental Product **Declaration**



Product
Evotherm M1

Third party reviewed core EPD based on the EN15804:2012 + A2

Issue Date	12/26/2022
Valid until	12/25/2027
Collection period	2020
Version	1.10

Company
Ingevity Corporation
5255 Virginia Avenue
North Charleston, SC 29406 U.S.A.
www.ingevity.com
+1 800-458-4034

DEMONSTRATION OF VERIFICATION

EN15804:2012+A2 serves as core PCR
Third party verification of the declaration, according to ISO 14025

❒ Internal Third party verifier
☑ External Amlan Mukherjee, PhD, PE. Michigan Technological University

Data on this certificate have been generated by The Right Environment, Ltd. using SimaPro. Primary data has been collected for the processes controlled by Ingevity for the year 2020. Background data for energy, electricity and transportation are based on the NAPA PCR v2.

As a general rule, a comparison or evaluation of EPD data is only possible when all of the data records to be compared have been drawn up in accordance with EN 15804 and the building context and/or product-specific performance features are taken into consideration. EPDs of construction products may not be comparable if the requirements in EN 15804 section 5.3 are not met, the EPDs are not seen in a building context, and other requirements (e.g. background LCI data, assumptions around onsite emission measurements, type of EPD, reference service life, boundary conditions and functionality) are not equivalent.

ingevity

Environmental profile (TRACI 2.1)

		Product stage	Delivery	Installation	Use and maintenance	End-of-life				Moldule D
Parameter	Unit	A1, A2, A3	A4	A5	B1 - B7	C1	C2	C3	C4	D
Global Warming	kg CO2	3.90E + 03	MND	MND	MND	MND	MND	MND	MND	MND
Ozone Depletion	kg CFK-11	1.40E - 03	MND	MND	MND	MND	MND	MND	MND	MND
Eutrophication	kg N eq	8.88E + 00	MND	MND	MND	MND	MND	MND	MND	MND
Acidification	kg SO2	1.83E + 01	MND	MND	MND	MND	MND	MND	MND	MND
Smog	kg O3	2.26E + 02	MND	MND	MND	MND	MND	MND	MND	MND
Carcinogenics	CTUh	2.74E - 05	MND	MND	MND	MND	MND	MND	MND	MND
Non-carcinogenics	CTUh	9.40E - 04	MND	MND	MND	MND	MND	MND	MND	MND
Respiratory effects	kg PM2.5 eq	1.38E + 00	MND	MND	MND	MND	MND	MND	MND	MND
Ecotoxicity	CTUh	2.68E + 03	MND	MND	MND	MND	MND	MND	MND	MND
Fossil fuel depletion	MJ surplus	8.58E + 03	MND	MND	MND	MND	MND	MND	MND	MND

Biogenic carbon (in product) (included in EN15804 results, not included in the TRACI results)

Biogenic carbon 0.323 ton/ton

Other information

Emissions
There are no indoor air health quality related concerns for the use of the products declared as the application is outdoors. There are no emissions to soil and water during the use stage.

Normative references
- ASTM D803-15 (2020) Standard Test Methods for Testing Tall Oil
- ASTM D6816-11 (2016) Standard Practice for Determining Low-Temperature Performance Grade (PG) of Asphalt Binders (equivalent to AASHTO R49)
- ASTM D7643-16 Standard Practice for Determining the Continuous Grading Temperatures and Continuous Grades for PG Graded Asphalt Binders (equivalent to AASHTO M320)
- ASTM D6373-21 Standard Specification for Performance-Graded Asphalt Binder (equivalent to AASHTO M332)
- ASTM D2726/D2726M-19 Standard Test Method for Bulk Specific Gravity and Density of Non-Absorptive Compacted Asphalt Mixtures (equivalent to AASHTO T166)

Standards that apply to methodology and rules for this EPD:
- ISO 14040:2006: Environmental Management-Life Cycle Assessment-Principles and framework
- ISO 14044:2006: Environmental Management-Life Cycle Assessment-Requirements and guidelines
- ISO 14025:2006: Environmental labels and Declarations-Type III Environmental Declarations-Principles and procedures
- EN 15804+A2:2019

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Low Carbon Transportation Materials Grant

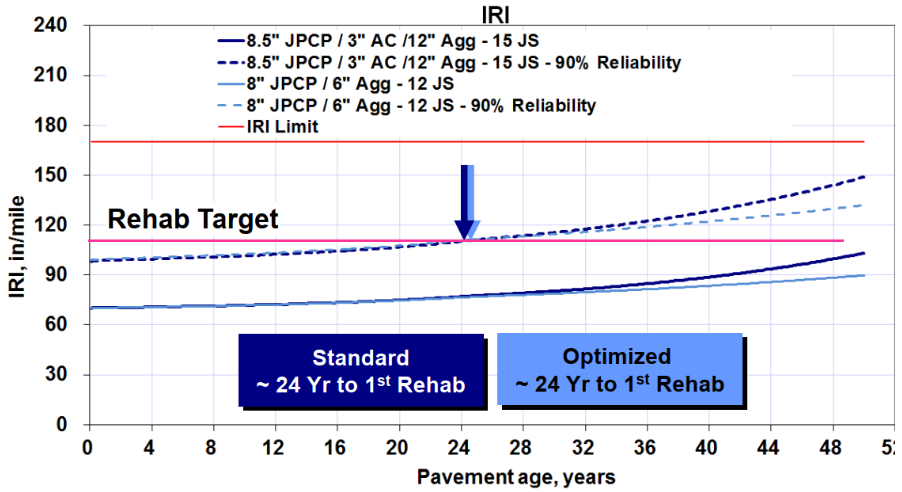
- The PRHTA submitted an application for the LCTM grant.
- If awarded, funds will be used to aid on the future implementation of the Sustainable Pavement Initiative Development Plan .

Potential Challenges

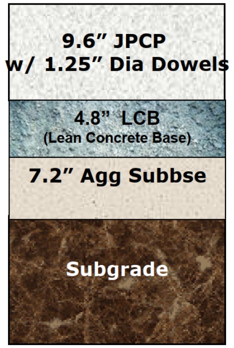
- Availability to the industry of the information necessary to develop the LCAs and EPDs.
- Potential additional costs to the industry related to the development of the LCAs and EPDs, and its repercussion on the cost of their products.
- Availability of adequate resources to develop LCAs and EPDs.
- Need for training to the industry on the development of LCAs and EPDs.
- Need for training to the PRHTA on the practical interpretation of EPDs for project prioritization and selection.
- Need for PRHTA design, bid, and construction processes modification to include the consideration of EPDs.

Performance Challenge

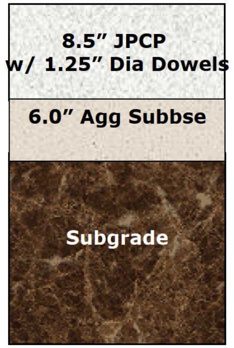
- Finding the balance between embedded carbon, engineering performance, and cost.



CALTRANS Concrete Design



Optimized Concrete Design



	Original CALTRANS Schedule		Optimized Pavement-ME Design	
	LCA (tons CO2e)	LCCA (NPV $)	LCA (tons CO2e)	LCCA (NPV $)
Initial Const.	**3,954**	**$3,147,585**	**3,063**	**$2,256,638**
Pavement	*2,860*	*$2,229,803*	*2,803*	*$2,021,307*
LCB	*781*	*$644,902*	*--*	*--*
Agg Subbase	*313*	*$272,880*	*260*	*$235,331*
Rehabilitation	**479**	**$911,663**	**54**	**$315,798**
Carbonation	**(123)**		**(87)**	
PVI-Deflection	**604**		**704**	
PVI-Roughness	**1,912**		**2,110**	
Total	**6,826**	**$4,059,248**	**5,844**	**$2,572,437**

Optimization reduced the initial construction GWP by 890 tons (22.5%) and the life cycle GWP by 980 tons (14.3%)

Optimization reduced the initial construction costs by $890k (28.3%) and the life cycle cost $1.48M (36.6%)

Caltrans Concrete Design: From Table 623.1E (South Coast/Central Coast, Type II SG
Initial AADTT = 1,357 / day, 4% Compound Growth (Initial ESAL = 335,000 / yr)
20 Yr ESALs = 10,650,000; 50 Yr ESALS = 51,151,000

Tyler Speakmon, Cemex

https://acpa-se.org/images/downloads/2023_Conference_Materials/ferrebee_designing_more_sustainable_pavements_nc_conf.pdf.

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News in concrete…….!

Concrete pavements Specs that are in the process of revision:

- Concrete pavement smoothness (Spec 510)
- Unbonded Concrete Overlay (new Spec)
- Bonded Concrete Overlay (new Spec)

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Questions?