

Sustainable Asphalt Performance that Lowers Environmental Impact

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Environmental Life Cycle Assessment of Asphalt Emulsion Treatments

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Presentation overview

- Setting the stage
 - Importance of the environmental pillar
 - Motivation for this presentation
- Asphalt emulsion environmental considerations
 - Life Cycle Assessment (LCA)
 - Product Category Rule (PCR)
 - Environmental Product Declaration (EPD)
- Intersection of environmental considerations and treatments
 - Fog seal
 - Micro surfacing
 - Cold In-place Recycling



(roadresource.org)



Importance of environmental pillar

- Three pillars of sustainability
 - Economic, Environmental, Social
- Economic pillar most established
 - Life Cycle Cost Analysis (LCCA)
 - Many agencies comfortable with LCCAs
- Social pillar highly underdeveloped
 - Americans with Disabilities Act
 - Equitable access to transportations
 - Disadvantaged and underrepresented groups
- Environmental pillar
 - Relatively easy to quantify emissions and waste
 - Sustainability, resiliency, climate change...



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**Agencies shifting
focus to EPDs**



Motivation

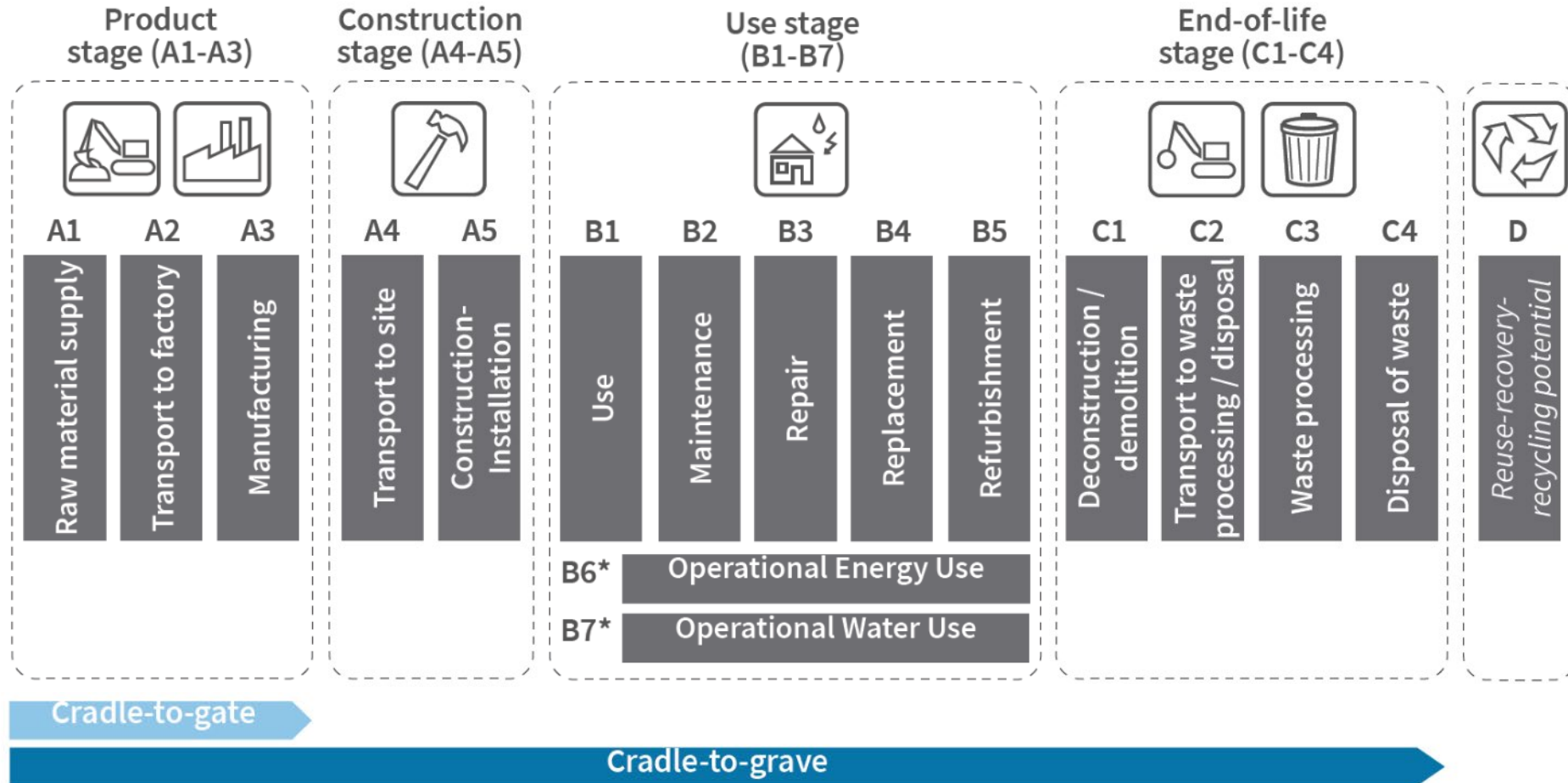
- Multiple agencies moving toward incorporating/requiring EPDs
- Lead by California → Buy Clean California Act
 - Jan 1, 2022: maximum acceptable GWP for eligible materials
 - Jul 1, 2022: GWP compliance measured through EPDs
 - Asphalt and aggregate a part of six pilot projects
- Other agencies/sources with existing/proposed legislation
 - 2019: City of Portland, MN; 2020: NY
 - 2021: CO, OR, NJ, WA, US House of Representatives
- EPDs are the end product of a sequence
 - Life Cycle Assessment (LCA)
 - Product Category Rule (PCR)
 - Environmental Product Declaration (EPD)



(escalontimes.com)

**What are the
"stages" of interest?**

Stages of interest



(CLF, 2021)

How do we apply LCA → PCR → EPD?

The flow of terms



Let's go over each of these terms



- 1)
- 2) Construction ^{ls}
- 3) Use
- 4) End of life

Life Cycle Assessment (LCA)

- Compile and quantify inputs/outputs of four stages
 - Product/materials, construction, use, end of life
 - Called “environmental flows”
- Inputs to LCA
 - Extraction, transportation, manufacturing, maintenance, etc.
- Outputs to LCA
 - Fuel/electricity use, waste (solid, liquid, hazardous), emissions, etc.
- Translate environmental flows to environment/human impacts
 - Impacts: depletion of resources, human health, ecosystem
 - Categories: energy use, resource use, emissions, toxicity, fresh water use, hazardous waste

Example: asphalt emulsion



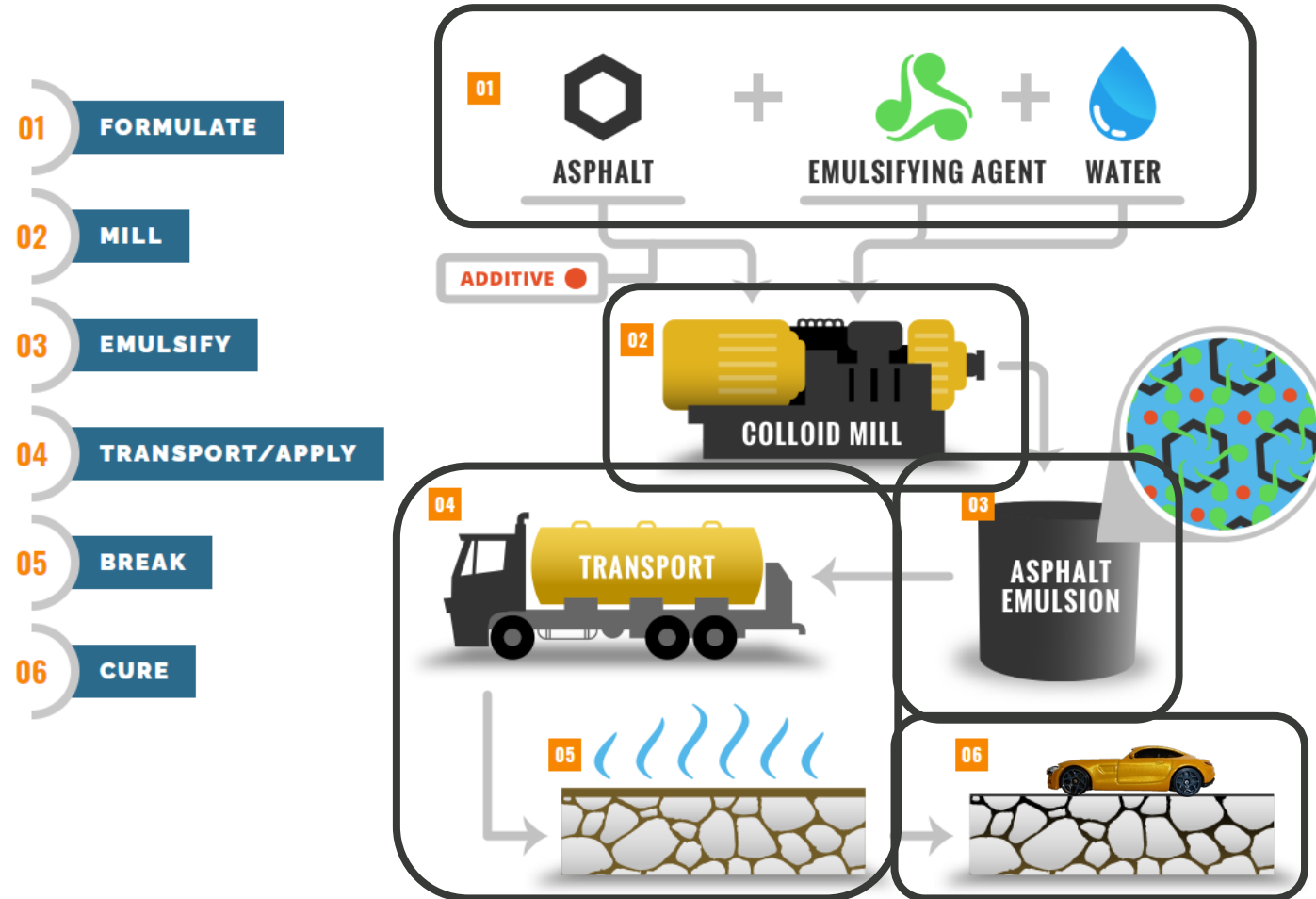
Asphalt emulsion life cycle: from RoadResource.org

Life Cycle Stages

- 1)
- 2) Construction
- 3) Use
- 4) End of life

How is an Emulsion Made?

Designed for Precision & Performance



**An LCA for
asphalt
emulsion is in
progress**

Life Cycle Stages

- 1)
- 2) ~~Construction~~ Is
- 3) ~~Use~~
- 4) ~~End of life~~

Anticipated LCA content for asphalt emulsion

- Raw materials acquisition
 - Asphalt binder: extracted crude oil, transport, refine
 - Water: treatment
 - Emulsifier: plant/animal raising, transport, refine
 - Additives: polymer, acids, bases, recycling agents, etc.
- Transport – raw materials to plant
- Asphalt emulsion production
 - Electricity, natural gas, heating oil, propane, diesel, etc.
 - Storing, pumping, milling, loading



Product Category Rule (PCR)

- Set of rules, requirements, guidelines for developing EPDs
- Main components
 - Definition and description
 - Goal and scope, stages
 - Environmental flows
 - Environment/human impacts
 - Materials and substances to be declared
 - Instructions for producing data, content, and format
 - Period of validity (five years)
- Third part review panel is required

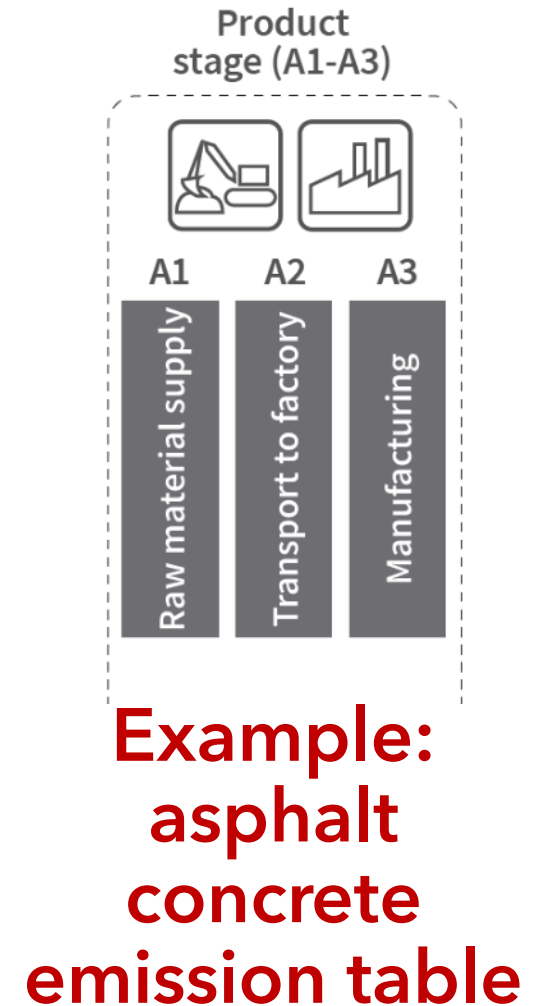


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Environmental Product Declaration (EPD)

- Objectives of an EPD
 - Encourage improvement of environmental performance
 - Provide information for assessing environmental impacts of products over life cycle
 - Assist purchasers, users → make informed comparisons between products
- Asphalt emulsion EPD preliminary steps
 - Eight EPDs: neat binder, polymer modified binder, rejuvenator, fuel oil
 - First wave of LCA data collection complete, second starting shortly
 - Cradle to gate (A1-A3)
 - Anticipated that companies will be able to generate their own, site specific EPDs



One example from National Asphalt Pavement Association

PARAMETER	UNIT	A1	A2	A3
Global Warming Air, incl. Biogenic Carbon	[kg CO2-Equiv.]	22.9	2.34	2.86
Ozone Depletion Air	[kg CFC 11-Equiv.]	4.84e-09	9.89e-11	2.1e-11
Acidification	[kg SO2-Equiv.]	0.133	0.0114	0.00693
Eutrophication	[kg N-Equiv.]	0.00794	0.000737	0.000433
Smog Air	[kg O3-Equiv.]	2.36	0.358	0.275
Abiotic Depletion for Fossil Resources	[MJ surplus energy]	MND*	MND*	MND*

A1: materials A2: transport A3: production

1 short ton asphalt mixture (dense graded, 3/4" NMAS, 0% RAP, hot mix)



Pivoting to three treatments

1. Fog seal
 - Maintenance treatment
 - Spray asphalt emulsion only
2. Micro surfacing
 - Maintenance treatment
 - Asphalt emulsion mixed stockpiled aggregate
3. Cold In-place Recycling (CIR)
 - Rehabilitation treatment
 - Asphalt emulsion mixed in-placed aggregate



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Three general scenarios of asphalt emulsion treatments



1) Fog seal: background

- Spray, maintenance activity
 - Diluted asphalt emulsion (dilute at plant)
 - For light cracking (1/16" wide), raveling, oxidation
 - May contain rejuvenating agent (1/8" wide cracks)
- Material
 - Anionic or cationic
 - Low viscosity (-1), slow/medium/rapid set
- Construction
 - 1:1 dilution, 0.06-0.22 gal/yd²
 - Clean surface, fill cracks >1/8", "triple overlap"



(roadresource.org)

What are potential LCA considerations?



1) Fog seal - LCA content

- Material extraction and production
 - Asphalt binder
 - Emulsifier
 - Additives (i.e. rejuvenator)
 - Blotter material (i.e. aggregate)
- Transportation of material
 - Asphalt binder, emulsifier, additives to emulsion plant
- Manufacturing of asphalt emulsion
 - Heating, pumping, mixing, etc.
 - Soap production and emulsion production



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Remember - this is just the production stage



2) Micro surfacing - overview (ISSA A143)

- Mix, maintenance activity
 - Seal pavement surface, small top-down cracks, restore skid resistance, rut fill
- Material
 - High quality, crushed fine aggregate
 - Quick setting (chemical break), polymer modified emulsion, Portland cement
 - 7 required tests (ISSA technical bulletins): mix time, cohesion stripping, abrasion, etc.
- Construction: > 50°F and rising, no rain
 - Clean surface, fill cracks >1/4", tack coat
 - Mix water, aggregate, emulsion, cement
 - 8-30 lb/yd² (higher rate with higher traffic)



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What are potential LCA considerations?



2) Micro surfacing - LCA content

- Material extraction and production
 - Asphalt binder
 - Emulsifier
 - Polymer and other additives
 - Aggregate
 - Mineral filler (i.e. cement)
- Transportation of material
 - Asphalt binder, emulsifier, polymer, additives to emulsion plant
 - Aggregate, mineral filler to “gate”
- Manufacturing of asphalt emulsion



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Assuming “cradle to gate”



3) Cold In-place Recycling (CIR): overview

- Mix, rehabilitation activity
 - Only bound material mixed (3-5" depth)
 - Severe cracking, potholes, rutting/shoving
- Material
 - Medium/slow set emulsion
 - Cement, lime, water, add stone
 - Optimal emulsion/water content
- Construction: > 50°F and rising, no rain
 - Place dry additives
 - Mill in-place road with water and emulsion
 - May have screens/crushers/pugmill
 - Pick-up and paving machine, compact
 - Place surface layer (2-14 after CIR)



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What are potential LCA considerations?



3) CIR - LCA content

- Material extraction and production
 - Asphalt binder
 - Emulsifier
 - Polymer and other additives
 - Aggregate (add stone)
 - Mineral filler (i.e. cement)
- Transportation of material
 - Asphalt binder, emulsifier, polymer, additives to emulsion plant
 - Aggregate, mineral filler to “gate”
- Manufacturing of asphalt emulsion

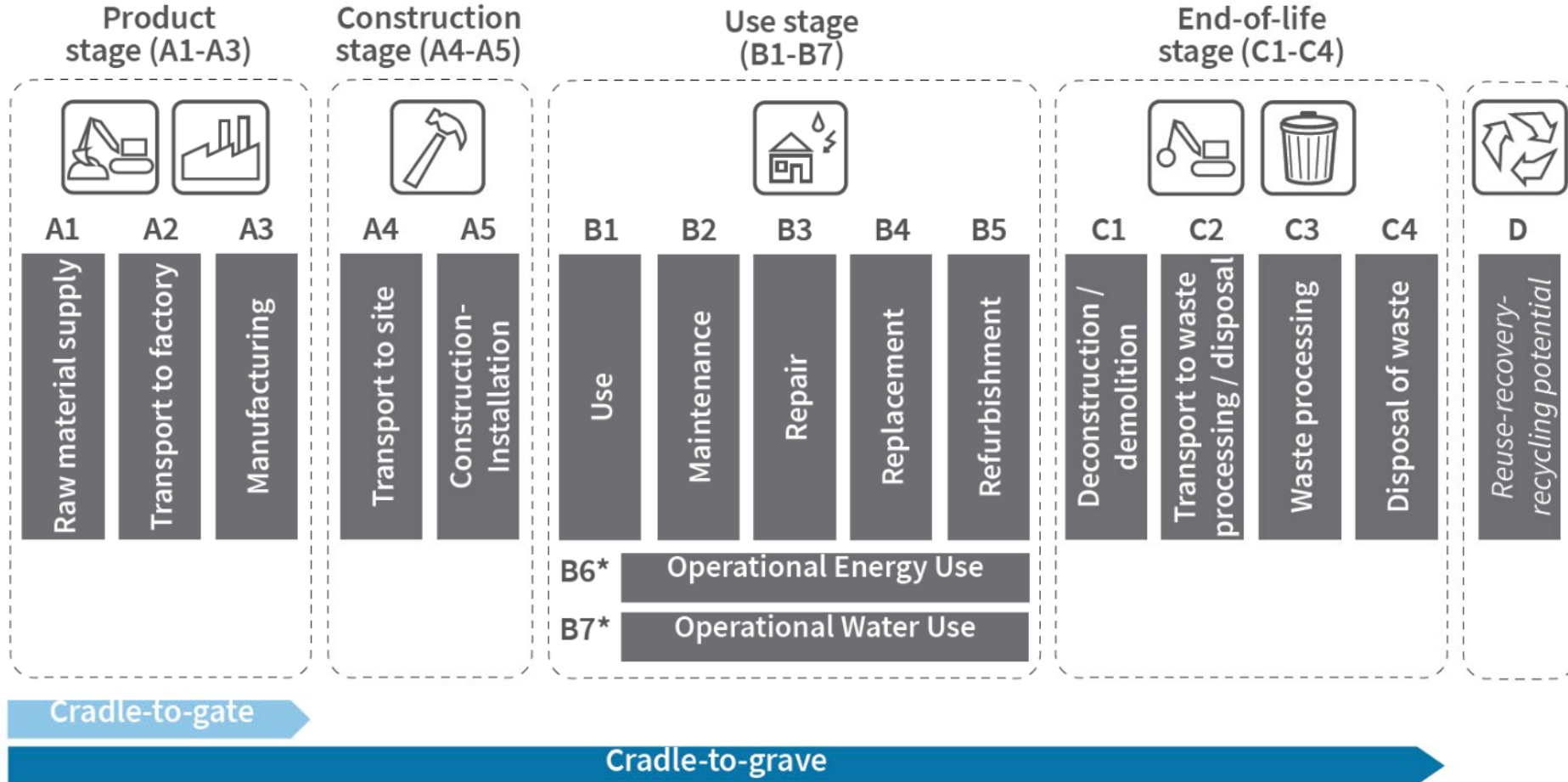


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Assuming A1-A3: what about stages A4-5, B, or C?



Asphalt emulsion treatments could shine



(CLF, 2021)

This is a very open area of knowledge

Wrap up

- Motivation → EPDs are here
- Asphalt emulsion environmental considerations
 - Life Cycle Assessment (LCA)
 - Product Category Rule (PCR)
 - Environmental Product Declaration (EPD)
- Intersection of environmental considerations and treatments
 - Fog seal, micro surfacing, CIR
- Asphalt emulsion treatments high potential upside in construction/use phases



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Thank you!
Questions?

