ISSUE
2
MAY
2025

Road Map to Sustainable Pavements

AMAP ADVISORY COMMITTEE QUARTERLY TECH BRIEF

Contributions: National Asphalt Pavement Association, Asphalt Institute, National Center for Asphalt Technologies, and Pavement Preservation & Recycling Alliance

AMAP
Association of Modified Asphalt Producers

AMAP Advisory Committee

AMAP has an Advisory Committee comprised of members from several aspects of the industry. The Committee consists of a Roofing, Paving, Agency Subcommittees (SC). The Committee's primary goal is to maintain open communication between AMAP and the rest of the industry, offering education and insights on modified asphalt, from its definition to its usage and performance.

PAVING & AGENCY SC

The Paving SC consists of representatives from AI, NAPA, PPRA, & NCAT. The Agency SC consists of representatives from DOTs in each region, the Asphalt Pavement Alliance (APA), and the American Public Works Association (APWA).

GET INVOLVED

Find out how to get involved! Contact us at info@modifiedasphalt.org.

this issue

We begin the journey of describing each of the Phases in the Pavement Life Cycle. Further we will start to tie the important balance of Sustainability, Performance, and Economics.

Phases in the Asphalt Pavement Life Cycle and Sustainability

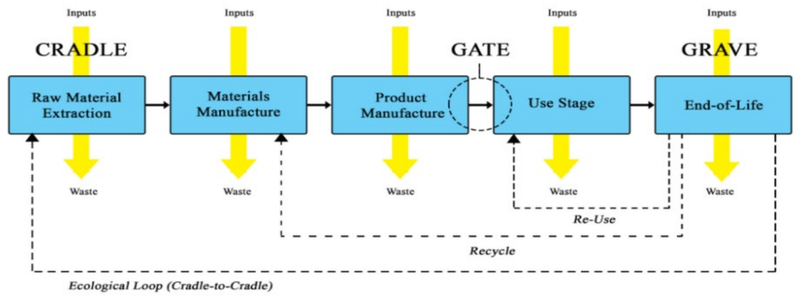
The asphalt pavement life cycle consists of several key phases: material extraction and production, construction, use, maintenance, and end-of-life. Each phase has sustainability implications and requires a balance among sustainability, performance, and economics to ensure long-term viability.

1. **Material Extraction and Production**
   The sustainability of asphalt pavement begins with the extraction and processing of raw materials, including aggregates and asphalt binders. The production of these materials can be energy-intensive and generate emissions. However, incorporating reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), warm mix asphalt (WMA), sustainable materials, and locally available binders can reduce environmental impact.
2. **Construction**
   During construction, fuel consumption, emissions, operational efficiencies, and material waste are key sustainability concerns. Sustainable practices such as optimizing material transport, using recycled or reclaimed materials, reducing construction time, minimizing equipment downtime, and using energy-efficient equipment can minimize embodied carbon. Proper construction techniques also ensure long-lasting pavements, reducing future resource demands.
3. **Use Phase**
   The longest phase in the life cycle, the use phase, involves pavement performance under traffic and environmental conditions. Well-designed and constructed asphalt pavements with smooth surfaces reduce vehicle fuel consumption, lowering vehicle
4. emissions; these emissions are the largest source by far of greenhouse gases in the pavement life cycle. Sustainable road design also improves safety and reduces maintenance needs, offering life-cycle cost savings.
5. **Maintenance and Rehabilitation**
   Appropriate, routine preservation, maintenance and timely rehabilitation techniques extend pavement life and reduce the need for complete reconstruction. Sustainable approaches, such as pavement preservation techniques, in-place recycling, and the use of durable materials, improve longevity while minimizing material use and energy consumption.
6. **End-of-Life and Recycling**
   At the end of its service life, more than 93% of asphalt pavements are recycled and incorporated into new pavement layers, significantly reducing waste and demand for virgin materials. RAP and reclaimed aggregates lower production costs, save natural resources, while maintaining performance standards.

Don't Miss Our Next Issue

In this issue will highlight a recent white paper prepared for DelDOT leadership on the Low Carbon Transportation Materials (LCTM) grant and its potential to advance low-carbon strategies in transportation. We also explore how states are integrating EPDs, low-carbon materials, and sustainability into their transportation programs—demonstrating how policy and practice are aligning to reduce pavement-related emissions.

Graphic credit: NAPANOW featured Story, "FHWA announces low-carbon transportation materials program details," March 12, 2024.



Graphic Credit: Wikipedia graphic on *Life-Cycle Assessment.* https://en.wikipedia.org/wiki/Life-cycle_assessment#. May 2025

Sustainability Concepts in Asphalt Pavement Life Cycle

Different sustainability assessment frameworks apply to asphalt pavement, each considering varying system boundaries and impacts. These include **Cradle-to-Gate, Cradle-to-Site, Cradle-to-Grave,** and **Cradle-to-Cradle**. While each approach provides insight into environmental impacts, they also present unique challenges

1. **Cradle-to-Gate (A1-A3)**
   This assessment considers the environmental impact from raw material extraction to the point where the asphalt mix leaves the production facility. A major advantage is that it allows manufacturers to quantify emissions and energy use, driving improvements in production efficiency and material choices. However, it does not account for transportation, installation, or long-term pavement performance, limiting its usefulness for full life-cycle sustainability assessments.
2. **Cradle-to-Site (A1-A5)**
   Extending beyond production, this concept includes transportation to the construction site and construction activities. It provides a more complete picture of the early-stage environmental impact, helping optimize material sourcing and logistics. However, it still omits operational performance, preservation, maintenance, and end-of-life considerations, making it an incomplete measure of overall sustainability.
3. **Cradle-to-Grave (A1-C4)**
   This approach evaluates environmental impact throughout the entire pavement life cycle—from raw material extraction to production, construction, vehicles operations, maintenance, and eventual disposal. It provides a comprehensive sustainability assessment, ensuring that long-term impacts are addressed. The challenge, however, lies in accurately predicting factors like maintenance cycles, traffic loads, and deterioration rates, which affect emissions and resource consumption over time.

4.Cradle-to-Cradle (A1-D)
The most sustainable framework, Cradle-to-Cradle, focuses on a circular economy by ensuring that materials are continuously repurposed or recycled. In asphalt pavement, this means maximizing reclaimed asphalt pavement (RAP), using renewable binders, additives, and designing pavements with recyclability in mind. While this model reduces waste and reliance on virgin materials, challenges include maintaining performance standards, ensuring cost feasibility, and overcoming technical limitations in recycling processes.

Balancing Sustainability and Practicality
Each of these approaches plays a role in advancing asphalt pavement sustainability. While **Cradle-to-Gate** and **Cradle-to-Site** help improve early-stage efficiencies, **Cradle-to-Grave** and **Cradle-to-Cradle** offer a broader perspective on long-term impacts. However, the challenge remains in balancing sustainability goals with economic and performance considerations, ensuring practical and cost-effective solutions that support infrastructure longevity and environmental responsibility. innovative materials to minimize both life cycle cost and environmental impact, while at the same time increasing preservation options. Expanding beyond Cradle-to-Gate is a time consuming, data intensive, and complex process, but capturing the advantages of asphalt pavement over the entire life cycle is well worth the effort.