The Road Forward **Climate-Conscious** Pavement Design

CLIMATE ADAPTABLE MATERIALS FOR RESILIENT INFRASTRUCTURE

Jo E. Sias, PhD, PE, FASCE, *Director, University of New Hampshire Center for Infrastructure Resilience to Climate*

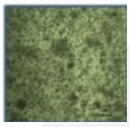
Climate change is increasingly becoming a primary concern in the design, construction, operation, and maintenance of transportation infrastructure. New approaches, techniques, and tools are needed to address the challenges posed by climate change to increase the resilience of our infrastructure to both gradual changes and extreme events. One aspect of resilience is the ability to adapt to or withstand changing environmental conditions[1] and one tool to do this in transportation infrastructure is the use of climate adaptable materials.

WHAT ARE THEY?

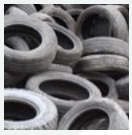
Climate adaptable materials are specialized construction materials designed to withstand the impacts of climate change, such as extreme temperatures, increased precipitation, and flooding. For asphalt pavements, selecting climate adaptable materials is an inherent advantage, as the pavement structure can be designed and built to perform effectively in the local environment, considering both current and future climatic conditions.

EXAMPLES OF CLIMATE ADAPTABLE MATERIALS AND TECHNOLOGIES FOR ASPHALT PAVEMENTS:

Performance Graded Asphalt Binders: The selection of asphalt binder is based on the temperatures at which the pavement must perform. As climates change, binder grades can be adjusted to account for higher temperatures during heat related events or lower temperatures during cold related events. This ensures the pavement remains functional over a broad range of temperatures.



Polymer-Modified Binders (PMB): These binders are enhanced with polymers to increase high-temperature strength and low-temperature elasticity, which helps resist rutting and cracking under variable climate-induced stresses.

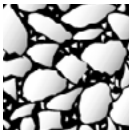


Recycled Tire Rubber (RTR): Incorporating recycled tire rubber into asphalt mixtures can enhance resistance to rutting and cracking. This recycling process contributes to sustainability by repurposing waste streams to eliminate the need for virgin materials.

[1]Statutory Definition of "Resilience" at 23 U.S.C. § 101(a)(24). Section 11103 of the Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act, Pub. L. 117-58 (Nov. 15, 2021)

Warm-Mix Asphalt (WMA) Technologies: WMA technologies allow for the production and placement of asphalt mixtures at lower temperatures compared to traditional hot-mix asphalt. This allows for emergency repairs to be conducted in sub-optimal conditions (e.g., colder temperatures) and for longer haul distances if local plants are compromised during an event. Lower production temperatures also reduce energy consumption and greenhouse gas emissions, contributing to sustainability.

Porous Asphalt Pavements: These pavements are designed to manage stormwater and can mitigate flooding by allowing water to permeate through the pavement surface, directly into an underlying stone recharge bed where the stormwater is naturally treated before it is discharged to groundwater or nearby water bodies. This reduces runoff and improves groundwater recharge, effectively managing the water flow and enhancing the pavement's environmental benefits.



Stone Matrix Asphalt (SMA): This is a type of asphalt mixture that provides a stone-on-stone contact structure, resulting in high rut resistance under heavy traffic and high temperatures. SMAs can also improve thermal cracking resistance through the relatively thick binder film and use of PMB. This makes SMAs suitable for roads that experience a wide range of service temperatures and heavy traffic loads.

Anti-Strip Agents: These are added to asphalt mixtures to improve the binding between aggregates and asphalt binder, which enhances resistance to moisture damage — a problem with some aggregates sources that is exacerbated by climate change-related precipitation increases.

THE TAKEAWAY

Incorporating climate adaptable materials into asphalt pavement designs can help ensure long-term performance and durability in the face of changing climate conditions. These materials can also contribute to the overall resilience of transportation infrastructure, aiding in the adaptation to climate change while improving the sustainability of transportation infrastructure.

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