U.S. TIRE MANUFACTURERS ASSOCIATION

THE USTMA APPROACH TO SUSTAINABILITY:

USTMA seeks to advance a sustainable U.S. tire manufacturing industry through thought leadership, partnerships with other stakeholders and a commitment to science-based public policy advocacy.

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SUSTAINABILITY

A Path to Realizing the Sustainability Benefits of Rubber-Modified Asphalt

Tires remain one of the most recycled and reclaimed products in the United States. Since 1990 — through the combined efforts of the U.S. Tire Manufacturers Association (USTMA), state and federal regulators, recyclers and other stakeholders — 94% of the scrap tires stockpiled in the U.S. have been abated. However, recent trends show that scrap tire markets are not keeping up with growth in new tire shipments. **USTMA is working with other stakeholders on multiple fronts to encourage the growth of circular, sustainable markets for scrap tires, including the use of Ground Tire Rubber in Rubber-Modified Asphalt (RMA).**

Can RMA help eliminate scrap tire stockpiles in the U.S., boost pavement sustainability and longevity, and allow more miles of roads to be repaired?

RMA has been used in the U.S. since the 1960s — to date, 31 states are either using, testing or planning projects using RMA — but despite demonstrable performance and environmental benefits, extensive market adoption has yet to occur. To better understand the potential obstacles to wider use of RMA, USTMA collaborated with The Ray — a philanthropic organization dedicated to the discovery and implementation of sustainable transportation technologies — and researchers at the University of Missouri-Columbia to produce a **State of Knowledge report on RMA.** Published in May 2021, the report identifies knowledge gaps and offers recommendations for future research and investment based on a study of scholarly articles and reports dating back to the early 1960's and a new survey of 26 U.S. state highway agencies.

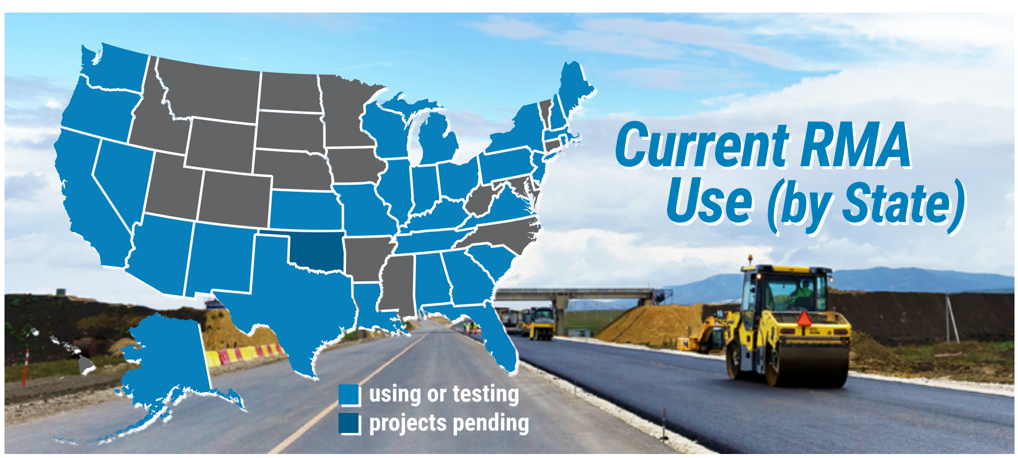
The key findings and recommendations are highlighted below. More detailed excerpts from report's executive summary appear on the reverse. USTMA is making this report available to all relevant stakeholders and stands ready to work in partnership to ensure that the full sustainability potential of RMA is realized to the benefit of all Americans.

KNOWN BENEFITS OF RMA:

- **Extended pavement life**
- **Reduced maintenance needs**
- **Reduced life-cycle costs**
- **Improved vehicle fuel economy (leading to reduced greenhouse gas emissions)**
- **Improved ride quality**
- **Improved skid resistance**
- **Reduced traffic noise**
- **Reduced tire wear**

OBSTACLES TO ADDRESS:

- **Lack of practical experience with modern RMA**
- **Updated Life Cycle Assessment methodologies needed**
- **Additional data on RMA characteristics needed to facilitate road design**
- **RMA-specific testing standards needed**
- **Sometimes higher initial (versus life-cycle) cost**



EXCERPTS FROM THE EXECUTIVE SUMMARY:

State of Knowledge Report on Rubber Modified Asphalt

PERFORMANCE BENEFITS: The overarching research shows that rubber modified asphalt extends pavement life, resisting early pavement failures modes such as rutting and cracking. Additionally, RMA was also found to significantly mitigate noise from traffic and enhance ride quality and safety.

Longevity - The past two decades of research indicate that all three primary RMA approaches, i.e., traditional wet process, terminal-blend wet process, and the modern dry process (engineered crumb rubber) lead to extended pavement life as compared to pavements made with unmodified binders. Moreover, RMA can provide similar performance as pavements constructed with costly polymer-modified binders.

Pavement noise reduction - or more precisely, the mitigation of road noise emanating from vehicles, has been quantified in several studies in recent years. Noise reduction arising from RMA use has been measured to range from 1-10 decibels, depending on a mix type, traffic level, vehicle speeds, and other environmental variables.

Ride quality and safety - RMA has been shown to create smoother pavements and therefore better ride quality for motorists. In addition, the use of RMA provides better pavement skid resistance, which can reduce traffic accidents during wet weather .

ECONOMIC BENEFITS: RMA has been shown to be a cost-effective option as it increases the service life of a pavement and reduces and/or delays the occurrence of maintenance activities. This leads to significant cost savings when evaluated using life cycle cost analysis techniques.

Initial costs – Based on initial, per-ton costs only, RMA is generally more expensive than unmodified asphalt, but less expensive than polymer modified asphalt. However, in the case of asphalt overlay rehabilitation projects on a cost-per-square-yard basis, it has been shown that thin RMA overlays can be built at a lower cost as compared to unmodified asphalt overlays.

Life cycle cost savings – Life cycle cost analysis (LCCA) studies have reported life cycle cost savings for RMA spanning widely, from a range of 4% to 40% savings in a study compiled for Caltrans to more than 400% savings when basing the results on laboratory-based fatigue performance. More work is needed to develop a more comprehensive national database of pavement costs, including both initial costs and subsequent maintenance costs, and pavement service life, which can be used to more accurately assess the life cycle cost benefits of RMA.

Implications – By using RMA to upgrade significantly more miles of pavement each year for each dollar spent, cities and states can begin to address the current backlog of deferred pavement maintenance that exists in their network.

ENVIRONMENTAL BENEFITS: The use of RMA results in the reduction of CO_2 emissions and lower energy consumption over the lifetime of a pavement. Additionally, since RMA pavements are stiffer and smoother, they reduce the generation of tire wear particles and improve water quality in roadway runoff.

Reduction in tire wear - Generation of micro-particles from on-road vehicle traffic has generated significant research interest in recent times. Studies have shown that the use of RMA pavement surfaces can significantly reduce tire wear as compared to concrete pavements.

Reduction in rolling resistance and fuel consumption – Compared to standard asphalt pavements, RMA surfaces are usually stiffer and smoother, and should therefore lead to lower rolling resistance. The existing literature on the impact of rubber modification on fuel consumption is sparse, but the limited studies available indicate a minor-yet-positive effect in RMA surfaced pavements as compared to polymer modified in terms of vehicle fuel consumption.

Environmental impact of RMA as estimated through LCA – Life cycle assessment/analysis (LCA) studies that have focused exclusively on the production process of RMA, without focusing on the whole life cycle and wider boundary conditions, unsurprisingly reported negative impacts of RMA. This is mostly due to higher production temperatures and the energy-intensive process needed to produce high-quality crumb rubber from scrap tires. On the other hand, studies that considered the whole life cycle of RMA pavements in comparison to conventional or traditional polymer-modified pavements, with proper assumptions of service life and lift thicknesses, have shown RMA pavements to have a net positive environmental impact. Also, the majority of LCA studies in the literature are attributional, meaning that these studies present a comparison between two or more products of the same kind. However, given the need to leverage the growing circular economy paradigm shift, there is a need to develop up-to-date, *consequential* LCA studies to drive policy-based decisions that optimize the utilization of ground tire rubber (GTR) in engineering applications.

KNOWLEDGE GAPS: Based upon the comprehensive State-of-Knowledge (SOK) assessment of RMA carried out in this study, the following general knowledge gaps were identified:

Experience - Most state highway agencies and asphalt contractors have limited-to-no experience with modern RMA products, and limited knowledge of the new performance trends, economics, and sustainability of RMA. Rather than the current piece-meal approach, comprehensive, national efforts to provide highway agencies and contractors with up-to-date technical data, best practice summaries and sample specifications are critically needed.

Testing and standards – Almost none of the modern, advanced asphalt binder and mixture performance tests and associated specifications were developed with RMA in mind. This must be addressed in new, purpose-built specifications for modern RMA materials and construction methods.

Design – The ability to accurately design pavement layer types and thickness with RMA is currently difficult at best. Additional research is needed to better reflect RMA properties and characteristics as inputs in modern pavement design software programs for new pavements and rehabilitation activities, such as resurfacing with asphalt overlays.

Assessment – Life expectancy assumptions for rubberized pavements during the use phase in LCA studies are currently based on outdated studies, particularly in the case of dry process RMA and impact categories for LCA studies involving RMA need to be expanded. A comprehensive study is needed to facilitate more accurate consequential LCA calculations to be made for RMA materials.

Questions around microparticles – LCA models for impact categories related to quantifying eco-toxicity are, at the current time, underdeveloped. With the recent increase in attention to the question of generation of microparticles by RMA and its effects on aquatic life, it is a good time for the industry to come forward and establish an Environmental Product Declaration (EPD) for using rubber modification in asphalt mixtures.

Quantification of functional benefits – A more rigorous quantification of improvement in functional characteristics (noise reduction, skid resistance) of pavements resulting from the use of RMA is needed. National-level collaborations to quantify and standardize these social elements of LCA, categorized as functional performance of pavements, is important.

RECOMMENDATIONS: In addition to the identified research gaps, a comprehensive set of recommendations for future research and strategic investments to enable the expanded use of sustainable, durable, and economical RMA pavements in the US are provided at the end of the SOK report. To download a copy of the full report (including citations) please click here.