Recycled Asphalt Shingles

Executive Summary

Asphalt shingles are the most prevalent roofing material in the United States. After their lifespan of 10–30 years, asphalt shingles require replacement, and the old material becomes waste that is either diverted to landfills or recycled into post-consumer products used in the building industry. Asphalt shingles can be ground into granular particles for utilization as base layers or additives for roadway pavements. The incorporation of recycled asphalt shingles (RAS) into pavement can decrease the cost of roadway construction, but only a fraction of total asphalt shingle waste is recycled. The processing, storage, and implementation of recycled asphalt shingles have raised concerns of emissions of dangerous airborne particles and leaching of chemicals into soil and water. Several states, including Missouri, utilize pavements that incorporate recycled asphalt shingles. Proposed during the 2022 Missouri legislative session, HB 2447, HB 2485, and SB 984 seek to allow processed recycled asphalt shingles to be used for structural fills, reclamation, or other beneficial purposes. Processed recycled asphalt shingles would also be considered as clean fill.

Highlights

- In the United States, approximately 13 million tons of asphalt shingle waste is sent to landfills annually.
    - In Missouri, roughly 146,500 tons of asphalt shingles are discarded annually.
- Recycling asphalt shingles reduces the need to extract raw natural resources (e.g., petroleum) and minimizes the amount of waste sent to landfills.
- The incorporation of RAS can increase pavement durability and reduce cracking and ruts, but research assessing performance is variable and inconsistent.
- Health concerns cited from recycling asphalt shingles include possible exposure to asbestos, secondary organic aerosols, and petroleum-based chemicals called polycyclic aromatic hydrocarbons (PAHs).
    - Research suggests that PAHs do not readily leach from asphalt products.

Limitations

- Investigations of the site-specific environmental and health impacts of recycled asphalt processing are limited.
- There is a lack of research regarding both the performance and market demand of recycled asphalt shingles for structural fill.

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Research Background

Asphalt Shingles Life Cycle

In the United States, approximately 80% of all households use asphalt shingles as a roofing material.[1] Asphalt shingles are composed of a felt paper coated with hot asphalt and covered with ceramic-coated mineral granules. The composition is 1–25% base material (i.e., felt, or other paper base), 20–40% asphalt, and 40–70% granular particles.[2] Asphalt shingles have a typical lifespan of 10–30 years before requiring replacement.

Approximately 13.2 million tons of asphalt shingles are sent to landfills each year in the U.S. and 146,500 tons are discarded annually in Missouri.[3,4] Overall, 10–20% of the total asphalt shingle waste is recycled, and the rest goes to landfills.[5]

Asphalt Shingle Recycling

Since asphalt shingles are similar in composition to asphalt used for pavement, they can be substituted for some of the material input.[6] However, to be used as a raw material, asphalt shingles must first be processed.[1] Shingles from post-consumer tear-offs (i.e., roof replacements) have nails, tarpaper, sheet metal, and other materials in them that are removed with blowers and magnets. The asphalt shingles are then reduced in size by grinding and screening.[1] The final size of the recycled asphalt shingle (RAS) depends on the application: coarser mixtures are used for structural fills and finer mixtures are used in hot mix asphalt for roadways.[1]

Like asphalt for pavement, RAS are petroleum-based, they are not considered suitable for clean fills. Clean fill materials in Missouri are approved by the Department of Natural Resources for fill, reclamation, or other beneficial uses.[3]

Applications of Recycled Asphalt Shingles

Recycled asphalt shingles can be used as an additive for pavement mixtures or as structural fill (e.g., base layers for pavement).[7] The addition of RAS to asphalt pavement can improve performance, but results vary depending on the percentage of RAS, the binder used, traffic density, and environmental conditions.[8] In one test, both summertime rutting and wintertime cracking were reduced in pavements with RAS, whereas another study found that pavements with RAS were brittle and highly cracked.[9,10] Optimizing and balancing pavement composition with RAS and other recycled materials remains a challenge, and is a current research priority in the field.[8,11]

There is limited research on RAS as a structural fill. In one of the only studies explicitly studying the matter, it was found that RAS were viable as structural fills, but that they needed to be mixed with other materials to become solid enough to be used as base layers for roadways.[5]

Health Concerns

One of the major impediments to wide scale use of RAS is the concern of negative impacts on human health and the local environment. Potential areas of concern include the presence of asbestos, polycyclic aromatic hydrocarbons (PAH), and the production of secondary organic aerosols (SOA).

Asbestos

Asbestos is a natural fibrous mineral that has been banned as a building material since the early 1980s, but it was historically used in shingle manufacturing.[1] Although shingles are typically replaced every 30 years, in some cases shingles are installed on top of old shingles, meaning that asbestos is still present in the built environment. However, asbestos is rarely found in asphalt shingles waste. Out of 27,000 samples taken across several states, 1.5% contained detectable levels of asbestos, the majority of which were contained in other roofing materials such as mastic, and not in the shingles themselves.[1] The presence of asbestos will likely continue to decrease over time as older roofs are replaced.[1]

Asbestos is known to cause cancer, asbestosis, and mesothelioma.[1] Studies of workers suggest that the principal route of exposure to asbestos is through inhalation of asbestos fiber-containing dust and the most likely route of asbestos exposure during asphalt shingle recycling. This makes the grinding process of asphalt recycling potentially dangerous. Asbestos-related diseases may take years to develop after exposure with symptoms appearing 10–40 years later.[1]

Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons are a family of over 100 compounds that are naturally found in petroleum-based products including shingles.[12] Several of these compounds pose severe health risks for humans, and have been associated with conditions such as cancers, kidney problems, cataracts, and jaundice.[12] A review of several laboratory studies indicated that PAH do not readily leach from asphalt products and that runoff from asphalt pavement in a stream resulted in PAH below the detectable limit.[1] PAH compounds can be emitted when asphalt mixtures are heated, such as during the production of hot mix asphalt. Further, PAH emissions can be mitigated by up to 90% with the addition of PAH filters at processing facilities.[1] The impact of recycled asphalt shingles on these emissions are not well understood.

Secondary Organic Aerosols (SOA)

Asphalt in general releases SOAs, especially when exposed to heat and solar radiation. Asphalt from roads, roofing, and other sources produce more SOAs pollution than cars, especially on hot, sunny days.[13] Secondary organic aerosols have been shown to be associated with county-level cardiorespiratory death rates in the U.S., particularly in southeastern states.[14]

Environmental Impact

Recycling asphalt shingles reduces the amount of waste that is diverted to landfills and decreases the need for extracting and processing raw materials.[15] Nationally, construction and demolition wastes account for nearly twice as much as municipal solid wastes, and nearly 10% of that is made up of asphalt shingle waste.[15]

Further, in a 2015 study, it was found that energy usage, global warming potential, and building costs went down with increasing amounts of recycled materials in pavement.[8] One study found that the use of RAS in pavement could amount to a 16% decrease in greenhouse gas emissions in roadway construction projects.[16] Shingle recycling may also reduce the emission of potentially hazardous components associated with the mining, production, and transport of raw materials used in the manufacture of binder and aggregates.[16]

A few studies have investigated the impacts of RAS processing and storage on soil and water contamination. Polycyclic aromatic hydrocarbons are not water soluble, but they can be readily absorbed into plants and animals, and persist in the environment.[12,17] Furthermore, PAHs bind strongly to clayey soils and can be difficult to remove once they have entered the environment.[12] Data relating to water contamination from asphalt shingles are limited, but the available research suggests that PAH leaching from RAS is generally negligible and below the allowable limit for waterways.[1]

Economic Benefits

The use of RAS in pavement mixtures can reduce construction costs. The Missouri Department of Transportation (MODOT) estimated that the use of RAS saves $3-$5 per ton of asphalt.[18] Given that a typical asphalt resurfacing project requires 30,000 tons of asphalt, utilizing RAS confers potential economic savings of $90,000–$150,000 per project.[18] From 2011–2015, MODOT saved $43.5 million by using RAS in pavement.[18]

Recycled Asphalt Shingles by State

As of 2016, 31 states permitted RAS to be used in pavement for roadway construction.[4] The Missouri Department of Transportation was one of the first state agencies to allow RAS, and now they are used widely throughout the Midwestern U.S. (**Figure 1**). Missouri allows up to 7% of pavement mixtures to be composed of RAS whereas most other states (e.g., Georgia, Maryland, Minnesota, Ohio) allow a maximum of 5%. Some states have provided discounted disposal fees at recycling centers or other incentives for recycling post-consumer asphalt shingles.[4,19] Proposed in the 2022 Missouri legislative session, HB 2447, HB 2485, and SB 984 seek to allow processed RAS to be used for structural fills, reclamation, or other beneficial purposes, and also to designate it as clean fill. There is documentation of using RAS for structural fill in Wisconsin.[5] Otherwise, there is a lack of information regarding the use of RAS for structural fills in other states.

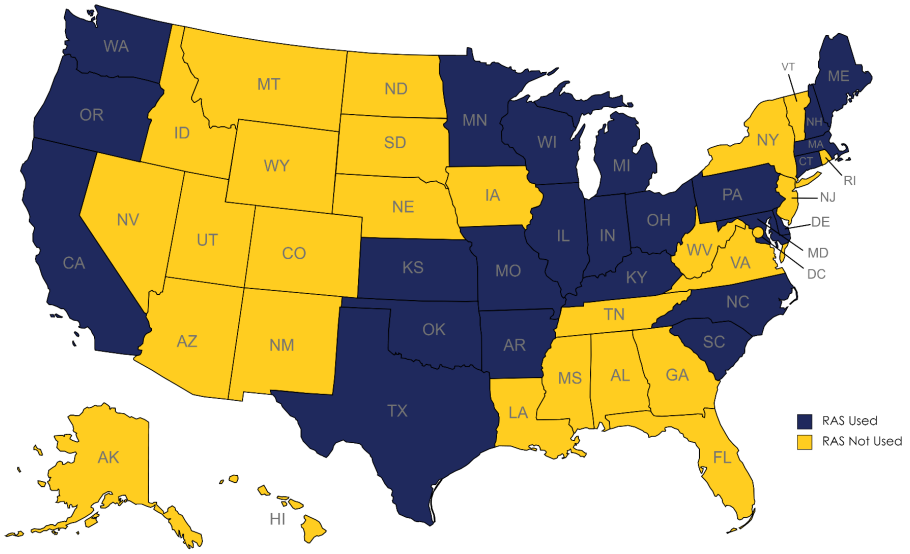

Figure 1. Map of the U.S. showing states reporting RAS usage in 2020. Created using data from 2020 National Asphalt Pavement Association Report.[20]

Shingle storage and processing facility siting can result in significant pushback from the local community. In Floral Farms, Texas, an illegally sited shingle storage facility ("Shingle Mountain") became the focal point of national conversations related to environmental racism and racial zoning, ultimately resulting in lawsuits against the city and the owners of the facility.[21,22,23] Therefore, taking proper consideration of potential economic and environmental benefits of RAS with local community concerns related to health, society, and environment, may help to avoid certain problems related shingle storage and processing facility siting.

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