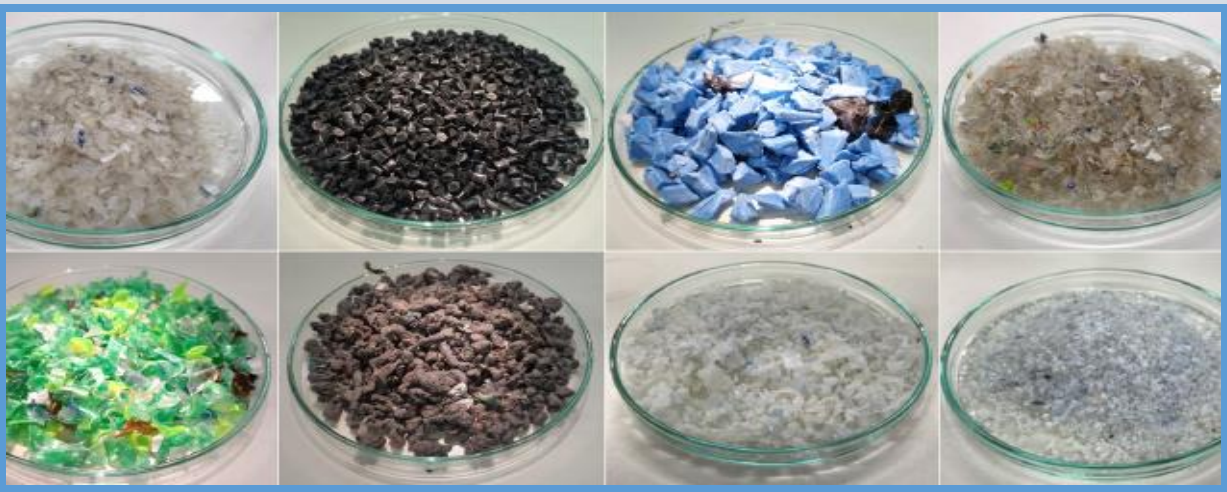


THE USE OF RECYCLED PLASTICS IN ASPHALT PAVEMENTS

January, 2023

Photo: Austroads

Background

In 2018, China banned the import of waste plastic from other countries. Prior to that time, China took in approximately 45% of all of the world's waste plastic, amounting to some 106 million metric tons annually. The action created serious management concerns over increasing amounts of waste plastic in the US and other countries[1]. This plastic makes up approximately 13.2% of total waste generation in the US; less than 9% of waste plastic ends up being recycled, with the rest being landfilled or burned. Plastic makes up just over 19% of total waste in landfills[2]. Statistics such as these are encouraging many to look for new and innovative ways to recycle plastics.

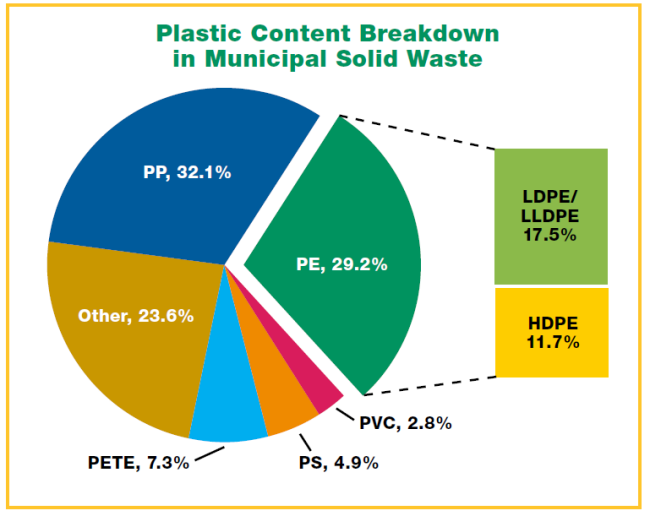
What is Asphalt?

Asphalt is a combination of aggregate and bitumen, a by-product of crude oil refining. The service life of asphalt is affected by increases in heavy traffic, as well as fluctuations in temperature. Modifying asphalt mixtures using the addition of polymers and fibers has been shown to prolong service life and reduce maintenance, as well as provide improved bonding to aggregate particles

As early as the 1990s, low-density polyethylene plastic was used in asphalt mixtures, with varying degrees of success. More recently, social media and traditional media outlets began touting the use of recycled plastics in asphalt production. Companies that developed proprietary recycled plastic materials for use in asphalt production aggressively marketed their products, and calls for legislative action were made[4]. However, many of the claims regarding the effectiveness of using waste plastic for this purpose lacked the technical data to allow a thorough evaluation.

Not all plastic is the same

Most recycled plastic being considered for use with asphalt mixtures comes from post-consumer resin streams. Forms of polyethylene (PE), which make up just under 30% of municipal solid waste, are commonly considered the best choice for this process, and most research has focused on this type of plastic[3].



DuBois, 2017

Two Methods to Incorporate Plastics

1. *Wet Process: Plastic is added to and incorporated into the asphalt binder*
2. *Dry Process: Plastic is added directly into the mixture as an aggregate replacement*

There are seven types of plastics identified by resin codes – the numbers stamped on the consumer items. The physical properties vary widely, and this variability makes it difficult to know the exact properties of any post-consumer waste stream. Packaging is often a multi-layered system that can use several different types of plastics. Added to this is the fact that most post-consumer plastic is part of co-mingled recyclables, making contamination from other materials likely[2].

The percentage of plastics that can be added to mixtures is fairly small. For wet process mixtures, rates of 2-8% by weight of binder have been considered, equating to 2-8 pounds of recycled plastic per ton of asphalt mix. Dosage rates for the dry process range between 0.2-1% by weight of aggregate, or roughly 4-19 pounds of recycled plastic per ton of asphalt mix[2].

What does the future look like?

Determining the viability of incorporating postconsumer recycled plastics into asphalt mixtures is a fairly new field of research. In a review of over 110 English-language papers dealing with the topic, over 70% were produced within the last decade, the vast majority of which involved research done in the laboratory[2]. Knowledge gaps are being identified, and work is being done to address these gaps. Some of the concerns being discussed include:

- Research on the sourcing and processing of waste plastic to provide consistency in the production of road-grade material. This will involve creating standardized guidelines and terminology accepted throughout the industry.
- Managing risks of environmental and human health impacts during both construction and operation.
- Ensuring that the use of recycled plastics produces performance and durability at least equal to, if not better than, equivalent conventional material.
- Ensuring storage stability and handling.
- Ensuring that the materials can be recycled at the end of life without excessive additional requirements. In 2019, 89.2 million tons of recycled asphalt pavement (RAP) was incorporated into new pavement, making it one of the most recyclable materials in the US[7]. If the addition of plastics is found to compromise the ability to reuse the asphalt, the benefits would be greatly reduced.

What is being done today?

While many of the early studies on plastics in asphalt were conducted internationally – which may or may not translate well to domestic usage – current research is taking place in the US on both state and federal levels. The National Cooperative Highway Research Program (NCHRP), administered through the Transportation Research Board (TRB), is in phase 2 of the ongoing project*, Performance Properties of Laboratory Produced Recycled Plastic Modified (RPM) Asphalt Binders and Mixtures*. Other studies are being done through the Center for Integrated Asset Management for Multimodal Transportation Infrastructure Systems (CIAMTIS) at Pennsylvania State University and the National Center for Transportation Infrastructure Durability & Life-Extension (TriDurLe) at Washington State University. Transportation research is coordinated between the states and federal agencies to ensure that the benefits of this work are available to all states and to avoid redundant efforts.

Asphalt pavement industry technologists express "cautious optimism" when asked about using plastics in asphalt

Field studies are being performed by several states and universities, including a 2020 one-mile paving project by the California Department of Transportation (Caltrans) using a mixture of recycled asphalt pavement (RAP) combined with waste from single-use plastic bottles. This stretch of roadway, pictured below, will be monitored in the years to come to assess the product's durability and functionality.

These are the first steps of a long research process. Since most of these projects are only a few years old, the long-term resilience of the field tests will take years to determine. As a point of comparison, establishment of the current US national average of 21% RAP in asphalt mixtures took 40 years and millions of research dollars to put into practice[2].

As the scientific research data is established, communication between the asphalt industry, the plastic industry, academia and governmental and private road owners needs to take place to find ways to move forward responsibly and establish the necessary criteria for future activity. It is clear that there will be no "magic bullet" in dealing with the management of waste plastics, but with thoughtful and focused research, it seems hopeful that the asphalt industry may one day be able to contribute to the effort.

Photo: Caltran

1.Bennert, T., Haas, E., Ericson, C., Wass, E., Tulanowski, D., Cytowicz, N., . . . Federal Highway, A. (2022). *Impact of Recycled Plastic on Asphalt Binder and Mixture Performance*. Retrieved from https://cait.rutgers.edu/wp-content/uploads/2020/08/cait-utc-reg-37-final.pdf

2. Willis, R., Yin, F., Moraes, R., National Asphalt Pavement, A., & Asphalt, I. (2020). *Recycled Plastics in Asphalt Part A: State of the Knowledge*. Retrieved from https://member.asphaltpavement.org/Shop/Product-Catalog/Product-Details?productid={314FA049-911F-EB11-A813-000D3A4DF1CD}

3 Rangelov, M., Dylla, H., & Sivaneswaran, N. (2021). Life-Cycle Assessment of Asphalt Pavements with Recycled Post-Consumer Polyethylene. *Transportation Research Record: Journal of the Transportation Research Board, 2675*(12), pp 1393-1407. doi:https://doi.org/10.1177/03611981211033862

4 Willis, J. R., & Howard, I. L. (2020). Asphalt Recycling: History of Recycled Materials and Lessons Learned About Recycling Plastic. *TR News*(330), pp 21-27.

Prepared by the ODOT Research Unit/ODOT Library.