Asphalt Recycling

Justin A. Casey

Southern Illinois University Carbondale

Illinois Asphalt Pavement Association

1/25/23

Asphalt is one of the world's most widely used materials found today. Whether it be roads, commercial parking lots, residential driveways, walking paths, and even as shingles for roofs, asphalt can be found virtually everywhere you look. The main use of asphalt throughout the world would most certainly be for making roads. In the United States, asphalt is used on nearly 94% of all paved roads (1). Asphalt is used substantially more than concrete and other materials for roads because of many beneficial reasons. Compared to concrete, asphalt is cheaper to install and maintain, provides a safer driving surface, and it is 100% recyclable (2). This means that when a road starts to deteriorate and needs to be repaved, all asphalt used to make the new road can be completely recycled. Not only is asphalt 100% recyclable, but it is also the United States most recycled material, and is even more recycled than any paper products, plastic products, or metal products used today (8). Being able to recycle asphalt has many environmental benefits, economic benefits, and even has benefits to the new asphalt itself that is being laid down.

Before it can be discussed how asphalt is recycled, it is important to know the materials used to make asphalt, the different kinds of asphalt mixes used for different applications, and how asphalt is made. Asphalt is made of a combination of an aggregate and a binder. The aggregate is simply a combination of crushed stones, gravel, and sand, while the binder is a sticky black byproduct of petroleum known as bitumen (3). The amount of material used in each batch of asphalt differs from batch to batch depending on what specific properties the asphalt is supposed to have. The three main kinds of asphalt are known as Hot-mix asphalt (HMA), Warm-mix asphalt (WMA), and Cold-mix asphalt (3). Depending on the project and what kind of performance is needed determines what kind of asphalt will be used. Hot-mix asphalt is the most common asphalt used in the US on roads and highways (4). How-mix asphalt is made by heating the materials and binder between 280°F to 325°F and the asphalt must be laid while the material

is still very hot. Since cold weather can cause the base of the asphalt to cool to rapidly, the asphalt cannot be laid in temperatures that are lower than 40°F (4). Warm-mix asphalt is a newer form of asphalt that is seen as a "medium ground" between Hot-mix asphalt and Cold-mix asphalt (3). Warm-mix asphalt is made by mixing the binder and materials and heating them to a temperature between 200°F and 250°F (3). Some of the benefits of Warm-mix asphalt over Hot-mix asphalt is that it pours easier, can be spread at lower temperatures, can be transported longer distances, and is safer to work with than Hot-mix asphalt (3). Cold-mix asphalt is unlike either Hot-mix asphalt and Warm-mix asphalt and does not need to be heated at all (3). Instead, it uses a different mixture of oils and other additives that make it possible for the mixture to be stored before it is laid down. The major downfall of Cold-mix asphalt is that it is not nearly as strong as Hot-mix asphalt (3). It is, however, more affordable, and much more convenient to use in small quantities, which makes it an excellent option when working on temporary patches such as cracks and potholes (3).

As it has already been mentioned, the main use of asphalt is for roads and nearly 94% of all roads in the United States are made of asphalt (1). To put this information into more precise numbers there are over 2.3 million miles of asphalt roads in the United States which is equivalent to 18 billion tons of asphalt, and this is not even including the fact that 9 out of 10 parking lots are also made with asphalt (5). Another practical and common use for asphalt is for roofing shingles. Even though shingles does not supply as much recycled asphalt as pavement does, it still provides a substantial amount of recycled asphalt, and it should be noted within this report because of the normality of roofing shingles found within residential homes and used for some kinds of commercial buildings. The two main kinds of recycled asphalt are known as RAP (recycled asphalt pavement) and RAS (recycled asphalt shingles). Every year in the United State

there are about 76.2 million tons of RAP and 1 million tons of RAS recycled in the United States (9).

Like all things, these roads and roofing shingles will deteriorate over time and need to be replaced. With the best conditions possible and with low traffic, a well-built road can be expected to last around 25 years before needing to be replaced and roofing shingles are expected to have the same life expectancy (6). Several factors can speed up the process of how quickly a road and shingles deteriorate as well. Some of these factors include freezing, poor drainage of water, traffic fatigue, and improper maintenance of potholes and cracks (7). With as many roads as a DOT must monitor and maintain, it is safe to assume that a lot of roads see these factors that make a road deteriorate faster than normal and that most roads do not make it the full 25 years of their expected life expectancy. The same can be said regarding a roof as it is impossible to keep extreme elements from having wear and tear. If roads were made with completely new materials every time that road was to be replaced this would cause for extremely high costs to taxpayers and be considered a waste of materials if the asphalt used for the previous road was not reused in some shape or manner. Even though economic value is the first thing that comes to mind as to why recycling asphalt is important it is not the only benefit from the process of recycling asphalt. In the coming paragraphs we will discuss the economic benefits, environmental benefits, and benefits created to the asphalt through asphalt recycling but first, we will break down the process of recycling asphalt pavement and asphalt shingles to give us a better understanding of the created benefits.

The first process we will discuss is the process of collecting recycled asphalt pavement. To begin collecting and recycling asphalt pavement, the asphalt needing to be replaced must be removed. This is done in one of two ways, by milling or by full depth removal (11). Milling is the process of stripping the top layer of asphalt without disturbing the sub-base of the road or

parking area (8). This process can strip up to 50 mm at a time of the asphalt surface (11). Below is a picture of a roadway that is under the milling process.

Figure 1) Roadway under milling process (8)

Unlike milling, in full depth removal, the subbase of the asphalt is also removed (11). A “rhino horn” or a bulldozer are used to break up the pavement (11). After either milling or full depth removal is completed, the materials are then hauled back to the asphalt plant where the recycled asphalt pavement is produced using processes like crushing, screening, conveying, and stacking (11). Since other materials such as dirt and other debris can be introduced into the soil during this procedure of milling and full depth removal the recycled asphalt pavement will need to be checked to make sure that the quality will meet the standards needed (12). Even though milling and full depth removal are the main forms of collecting asphalt, they are not the only way to create recycled asphalt pavement. Pulverization is a process that grinds up the old materials at the job site and recycles them without the need of taking the old materials back to the asphalt plant. This process involves the removal of the old surface, mixing in new materials such as virgin aggregate, binder, and or softening or rejuvenating agents, and then placing and

compacting the finished asphalt in one mix (11). When compared to milling and full depth removal, pulverization has many benefits. The main benefit from pulverization would come down to the time and money that is saved (8). Old base layers are mixed in during the process of pulverization, this saves on time and money that would have had to been used to excavate the old layers of the asphalt and it also cuts back on the amount of transportation needed to send the old materials back to an asphalt plant, and the transportation needed to send the new materials back to the construction site (13). In more recent years, the amount of recycled asphalt pavement used has gone upwards in a positive trend.

Other than recycled asphalt pavement, recycled asphalt shingles makes up a large quantity of the amount of asphalt that is recycled every year. Every year in the United States, there are nearly 11 million tons of recycled shingles but in more recent years in Illinois there has been a large decrease in the amount of shingles recycled (14). According to the IDOT recycling report, in 2019, about 49,860 tons of recycled shingles were used while in 2020, only 37,655 tons were used (10). This large decrease could be from a number of different factors such as not as many roofs needing new shingles due to a lack of severe storms. Obviously to start the recycling process, old, worn-out shingles are taken off roofs and then taken to a place where shingles can be recycled. Once at the recycling plant, the shingles must first be cleaned of debris, such as nails, wood, and other debris that could still be attached to the shingles from removing the shingles from the roof (15). After this the shingles then need to be grinded down to state or local agency regulations (14). This process of grinding down the shingles is more favorable to do in colder weather since the shingles are more brittle (15). If grinding is done on warmer days, the shingles may get hot and begin to stick together and need to be sprayed with water or need sand or gravel added into the grinder to prevent the shingles from sticking together so badly. Pictured

below is a machine that is used to grind down shingles and pile the crushed shingles into a stockpile

 .

Figure 2) Shingles being grinded down (16)

Once the shingles are grinded down to the specifications needed, they are ready to be reused for an asphalt product such as hot mix asphalt used for making roads (15).

Now that the process as to how recycled asphalt pavement and recycled asphalt shingles are made has been discussed we can now discuss the benefits of using both recycled asphalt pavement and recycled asphalt shingles. The first of the three main benefits from using recycled asphalt pavement and recycled asphalt shingles would be the environmental benefits. By using recycled asphalt, the amount of virgin materials needed to make new asphalt is cut significantly. This helps to cut back on the aggregate needed to make new asphalt and helps to reduce the amount of oil needed to make new asphalt which could in turn reduce the demand of total oil needed by the country (8). Since there are not as many materials being wasted, recycling asphalt also saves on the amount of materials that are sent to landfills (8). This helps to save space in our

landfills and helps to maintain more of the natural land areas that natural wildlife seeks. The following table shows the amount of resources saved from recycling 1,800 tons of asphalt.

Table 1) Materials saved from recycling 1,800 tons of asphalt (12)

The savings of **1800 tons** of **recycled asphalt** are illustrated below:

Asphalt saved from landfills	**1,820 tons**
Rock that did not need to be mined/quarried	**1700 tons**
Oil that did not need to be refined or delivered	**29,120 gallons**
Greenhouse gas emissions that were not put into the atmosphere	**70 tons**

**Numbers based on 1800 tons of asphalt recycled by M. Leeder Construction during an operating time period.*

The main thing that jumps out from this table is the amount of oil that is saved. Earlier in this report, it was mentioned that 76.2 million tons of RAP, and 1 million tons of RAS were used each year in the United States. That would mean that every year in the United States well over 1.2 billion gallons of oil are saved from using recycled asphalt. Another key item listed on the table that is conserved using recycled asphalt would be the greenhouse gas emissions that were not put into the atmosphere. By using recycled asphalt, the wellbeing and structure of our natural environment is being helped to stay intact.

Another way that using recycled asphalt pavement is beneficial is by the economic benefits that it produces. The materials saved earlier not only are beneficial for the environment but are also beneficial economically. For example, if an old asphalt road did not need to be taken to a landfill, then the cost of transporting the material is nonexistent and if a large amount of oil is being saved from the asphalt making process, then it limits the amount of oil that must be bought. The two main materials saved in recycling asphalt would be the aggregate and the binder. It would make sense that the binder used to make new asphalt would cost more than the aggregates that go into the process. A study done by Purdue University stated that between 2007

and 2008 the cost of making binder rose approximately 300% and today the binder makes up 70% of the price of asphalt (17). By using recycled asphalt, the amount of binder needed to make new asphalt can be reduced as a result of the binder that is already found in the recycled asphalt. In the recycled asphalt report by IDOT it was said that in the year 2020 that the cost of all recycled asphalt was $65,356,915. These cost savings not only benefit the contractor and agency putting in a new road, but they also benefit the consumers and the people who drive on the road. The money used to make a new road or make improvements to an already existing road cannot just come out of thin air. General taxes and gas taxes paid by consumers cover much of the expenses used to build and maintain roads (18). It would make sense that as recycled asphalt is used and the cost of replacing or repairing a new road decrease, that the taxes placed on the consumers to pay for the construction and materials of these new roads would also decrease. The consumer is not the only one who enjoys economic benefits from using recycled asphalt. Contractors working to replace or improve roads can also see economic benefits from using recycled asphalt. By using recycled asphalt, a contractor can expect to save on transportation costs and materials needed to complete a job (8). The last economic benefit to recycled asphalt has to do with the fact that asphalt is 100% recyclable (2). Since asphalt is 100% recyclable and it can be recycled many times, it ensures the value of asphalt (8). This makes it only make sense to use asphalt in more places over other materials such as concrete. These economic benefits should make recycled asphalt appealing to use for all agencies, contractors, and consumers who spend tax dollars to pay for roads.

Besides having economic and environmental benefits, using recycled asphalt can also provide benefits to the new asphalt that is being made. By using recycled asphalt in new pavements for roads, the new asphalt can have qualities that can make the road last longer than virgin asphalt (8). Since there are still mineral filterers and other organic materials found in the

recycled asphalt, the new asphalt made may be stronger and more resistant to cracking (8). This added strength to the asphalt also gives the asphalt other benefits such as a prevention of rutting in roads (8). As it was mentioned earlier, potholes, cracks, ruts and other structural damage to roads can speed up the deterioration process of a road. If new roads are built with recycled asphalt, then their added strength can help eliminate these structural problems from occurring and in turn help to improve the life span of a given road.

It may seem that using recycled asphalt has no flaws but that is not the case. There are also some disadvantages that could possibly arise from using recycled asphalt. In the last paragraph it was mentioned how added recycled asphalt within a new mixture of asphalt can add more strength and stiffness to an asphalt mixture. This extra strength and stiffness is not always a good thing though. If too much recycled asphalt is used, then it can create problems. Too much recycled asphalt may cause a new batch of asphalt to be stiff and can cause fatigue cracking, reflection cracking, low temperature cracking and an accelerated aging process (9). To help account for this over stiffness in the asphalt, often the virgin binder that is mixed with the recycled asphalt is a softer blend of asphalt or softening agents are added to the mix (19). There are issues within the recycled asphalt shingles process as well. Tear-off shingles are not normally clean from debris such as wood, plastic, and nails and the cleaning process of these shingles can be tedious and time consuming (9). Another disadvantage of recycled asphalt shingles is the possibility of asbestos within the recycled shingles (9). Even though these disadvantages can make the mixing process of getting a good blend of new asphalt difficult, they do not outweigh the benefits of using recycled asphalt.

In summary the asphalt recycling process is one of the most important recycling processes in not only the United States, but across the world. Its ability to be 100% recycled makes it a smarter choice to use in areas where other materials like concrete could possibly be

used such as roads, parking lots, and walking paths. The many different environmental, economic, and benefits to new asphalt itself makes recycled asphalt a very appealing choice to use for any agency or contractor replacing a road, any consumer who must pay taxes on a new road being put in, and any environmentalist who cares about the natural resources used to make virgin asphalt. Even with some of the disadvantages and challenges that using recycled asphalt can introduce, it doesn't seem like the use of recycled asphalt is slowing down any time soon, and in more recent years, the use of recycled asphalt has seen a positive trend in the upward direction. In the IDOT recycling report it was reported that the use of asphalt increased from a use of 1,226,574 tons of recycled asphalt in 2019, and 1,439,041 tons of recycled asphalt were used in 2020 (10). This is a significant increase of about 17% use of recycled asphalt and shows just how much the Illinois Department of Transportation sees the many benefits that using recycled asphalt can have.

References

(1) UNIQUE paving Materials . (2022, April 11). *What are the uses of Asphalt?* UNIQUE Paving Materials. Retrieved January 12, 2023, from https://www.uniquepavingmaterials.com/what-are-the-uses-of-asphalt/

(2) BuilderSpace. (2021, September 21). *Why are roads made of asphalt and not concrete?* BuilderSpace. Retrieved January 12, 2023, from https://www.builderspace.com/why-are-roads-made-of-asphalt-and-not-concrete

(3) UNIQUE Paving Materials. (2023, January 6). *What is asphalt and how is it made?* UNIQUE Paving Materials. Retrieved January 12, 2023, from https://www.uniquepavingmaterials.com/what-is-asphalt-and-how-is-it-made/

(4) Premium Asphalt. (2022, March 21). *What type of asphalt mix is right for your next paving project?* Premium Asphalt Paving & Sealcoating - Asphalt Paving & Sealcoating in Bryan/College Station. Retrieved January 12, 2023, from https://www.premiumasphaltpaving.com/what-type-of-asphalt-mix-is-right-for-your-next-paving-project/

(5) National Asphalt Pavement Association. (2014, February 11). *National Asphalt Pavement Association*. National Asphalt Pavement Association (NAPA) - National Asphalt Pavement Association. Retrieved January 12, 2023, from https://www.asphaltpavement.org/

(6) Dcparkinglot. (2021, June 17). *What is the typical life cycle of an Asphalt Road?* D & C Parking Lot Maintenance. Retrieved January 12, 2023, from https://dcplm.com/blog/what-is-the-typical-life-cycle-of-an-asphalt-road/

(7) Ayres. (2022, November 8). *The long and short of it: Lifespans of paved roadways*. Ayres. Retrieved January 12, 2023, from https://www.ayresassociates.com/the-long-and-short-of-it-lifespans-of-paved-roadways/

(8) Mrugacz, J. (2019, April 17). *Recycled asphalt: Learn the benefits and process of recycling pavement*. Wolf Paving. Retrieved January 12, 2023, from https://www.wolfpaving.com/blog/recycled-asphalt-learn-the-benefits-and-process-of-recycling-pavement

(9) Sciences, C. N. A. of. (2020, March 23). *Evaluating the effects of recycling agents on asphalt mixtures with high ras and rap binder ratios*. The National Academies Press. Retrieved January 12, 2023, from https://nap.nationalacademies.org/catalog/25749/evaluating-the-effects-of-recycling-agents-on-asphalt-mixtures-with-high-ras-and-rap-binder-ratios#:~:text=More%20than%2090%20percent%20of,recycled%20asphalt%20shingles%20(RAS)%20each

(10) Morse, K. (221AD, August 23). *Illinois Department of Transportation*. ILLINOIS HIGHWAY MATERIALS SUSTAINABILITY EFFORTS 2020. Retrieved January 12, 2023, from https://idot.illinois.gov/Assets/uploads/files/Transportation-System/Research/Physical-Research-Reports/PRR%20168.pdf

(11) US Department of Transportation Federal Highway Administration . (2016, August 3). *User guidelines for waste and byproduct materials in pavement construction*. FHWA. Retrieved January 12, 2023, from https://www.fhwa.dot.gov/publications/research/infrastructure/structures/97148/rap131.cfm#:~:text=The%20cold%20in%2Dplace%20recycling,compacted%20in%20a%20single%20pass.

(12) Joel. (2019, August 29). *What is recycled asphalt?* Pavement Recyclers. Retrieved January 12, 2023, from https://pavementrecyclers.com/what-is-recycled-asphalt/

(13) Mrugacz, J. (2013, March 26). *Asphalt pulverizing - an asphalt recycling process*. Wolf Paving. Retrieved January 12, 2023, from https://www.wolfpaving.com/blog/bid/92378/asphalt-pulverizing-an-asphalt-recycling-process

(14) Davis, J. (n.d.). *Using recycled asphalt shingles in asphalt pavements*. Asphalt magazine. Retrieved January 12, 2023, from http://asphaltmagazine.com/using-recycled-asphalt-shingles-in-asphalt-pavements/
(15) Connecticut Department of Energy & Environmental Protection. (2020, May 19). *Asphalt shingles - CT*. Asphalt Roofing Shingle Recycling. Retrieved January 12, 2023, from https://portal.ct.gov/DEEP/Reduce-Reuse-Recycle/Construction-and-Demolition/Asphalt-Shingles
(16) Broderick, C. (2021, April 29). *GAF introduces the first recycled shingles created from waste*. Residential Products Online. Retrieved January 12, 2023, from https://www.residentialproductsonline.com/gaf-introduces-first-recycled-shingles-created-waste
(17) Bonte, D., Riley, R., & McDaniel, B. (2009, November 12). North Central Superpave Center. Retrieved January 12, 2023, from https://engineering.purdue.edu/NCSC
(18) Dutzik, T. (2022, August 23). *Who pays for roads?* Frontier Group. Retrieved January 12, 2023, from https://frontiergroup.org/resources/who-pays-roads/
(19) M Rathore *et al* 2019 *IOP Conf. Ser.: Mater. Sci. Eng.* **660** 012046