Illinois Asphalt Pavement Association (IAPA)
Scholarship Research Report

ASPHALT CONCRETE PAVEMENT MILLING

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Introduction

Asphalt milling is the process of removing old asphalt pavement on the road. To remove the asphalt safely from the road, engineers and construction managers use a machine called the asphalt milling machine, and it removes the bituminous material from the road and will leave the road in a rough but drivable condition. The first milling machines were made in the 1970s in Ohio, and they were called Galion, later to be just called a milling machine; a typical milling machine is shown in figure 1.

Figure 1: Milling Machine [1]

The main reason that asphalt milling began was that the old asphalt pavements continued to be layered with more asphalt concrete and this method of road paving brings many problems to the rainwater drainage because the road is being lifted without any updates on it. As well as have to raise the curb with every layer of asphalt concrete placed on the road and it costs a lot of extra time and money as the curb would need to be destroyed and redone, leading to more wasted material that is non-renewable. When asphalt milling began, there was the hope of reusing the material that was being taken out of the existing roads, and it would be used as recycled material known as Reclaimed Asphalt Pavements (RAP) [1]. Also, milling helps remove damaged and distressed asphalt concrete and provides a better and distress-free surface for new asphalt

overlays. If paving is done on the old and distressed asphalt layer, the cracks continue to grow through the new asphalt layer, and the process is called reflective cracking. For this reason, milling should be done before doing asphalt resurfacing or overlays.

Asphalt Milling

Asphalt milling has many names, but all the techniques share a similar process that involves the removal of the surface layer of asphalt, followed by the resurfacing of the road. A resurfacing job may be the best option for a road that has been damaged over time. Resurfacing a road can be done faster, leading to fewer traffic disruptions. The removed surface layer is used again as a new aggregate for a different road to have a sustainable structure. Milling can also improve the friction on a surface in the road to provide more grip to a car's tires. This affects the road materials and the materials used for cars, such as the tires. The more the car has a grip, the less the tire gets worn out and needs to be replaced and thrown in a landfill. Improving one aspect can create a chain reaction leading to better use of other materials [6].

When a damaged asphalt road is planned on being fixed, it brings many benefits, such as using old asphalt to create a new and more robust asphalt that otherwise would have ended up in a landfill. The recycled asphalt is taken to a facility mixed with other materials such as sand, stone, gravel, and binding agents to create that stronger paving material. Also, the price for the older asphalt is cheaper and will help the businesses that need to construct a new asphalt parking lot. Asphalt is used on roads and in roofing, shingles, cable coatings, and waterproofing materials. Engineers have found that the old asphalt concrete works with those structures [6].

Asphalt is a very dependable source when used in construction. An asphalt parking lot can last up to 20 to 30 years if correctly placed and maintained. Even with all the traffic that uses the asphalt roads and parking lots, it is still far more affordable than a Portland cement

concrete (PCC) road. If an asphalt road can last for that long, reusing that same material will lead to 40 to 60 years of continued use. As humans, we like to use many materials until they cannot be used, so why cannot we invest in the materials involved in the road development process [6].

Milling Machines

The asphalt milling machine has a mandrel, also called a head, that rotates on the surface at the exact depth that the milling needs to be done once determined by the engineer. The head has hundreds of teeth that cut the bituminous material into a small granular shape. The teeth are made from metal as that material is very durable at breaking other resources. As engineers, we need to remember that metal is a non-renewable material, so keeping the equipment in the best shape is vital. The material that is being milled is then placed in a dump truck to be taken offsite to be recycled [6].

Milling Depth

One thing that needs to be identified before starting the milling process is figuring out the milling depth. The milling depth should come from the core testing of the road. It is essential to base the depth from these cores to help attain an excellent road performance in the long run. These cores should be taken on each lane for every mile. As shown in figure 2, the depth of the cracks in the asphalt helps engineers determine the milling depth to get the best results on the road and not go too deep or too shallow when grinding. It can also tell the engineer how good the asphalt holds the cracks and material and compactness. If the asphalt concrete still appears to be in good condition, it will save money and materials that would have been used if the engineer decided to completely renew the street and take all the asphalt off [5].

Figure 2: Asphalt Cores [5]

Milling Steps

Before beginning the milling procedure, one must inspect the machine and ensure it is working and up to date with all its maintenance needs. The construction workers must have the tools on hand that is usually needed to fix the milling machine if anything happens or cool it down when it gets too hot as it grins up the asphalt layer. Finally, having a crew that understands the milling machine, the typical road design, and its layers is essential to completing and saving money/materials [1].

All machines take time to warm up to be used efficiently. When starting the job, the speed of the milling machine can help the quantity and quality of the asphalt that is going to be reused. The milling machine needs to start slow, then speed up, and when turning it off, it needs to be slowed down. The more the machine slows down, the better the milling quality will be, and the teeth on the machine will not wear out as fast [1]. If the machine goes at high speeds, it risks damaging it and its teeth. Also, it will leave the RAP at a larger coarse material that producers will need to run through a crusher to refine into smaller pieces, which will waste more money and time than running the milling machine slower and having finely ground coarse aggregate.

Engineers use fossil fuels to power the machines used to grind the material even finer if not appropriately milled, leading to a waste of non-renewable material.

One of the main problems of milling was that the teeth of the head would wear out quickly, and construction workers would need to replace the teeth more frequently. This is a problem because they are removed individually when the teeth need to be removed. The old teeth need to be pulled off from the head of the machine and are thrown out as they are not reusable. If the milling machine drives slow, then fewer teeth must be replaced. The teeth are made of metal, so welding involves replacing new teeth. The welding of new teeth individually takes up the time saved if the machine runs slower. With the invention of new tools, the teeth can be bolted onto the machine's head and placed back with pneumatic tools, increasing productivity. The cutting drum has teeth with a spacing of 5/8”, which is the standard, or 5/16”, the fine-textured teeth shown in figure 3 below. If there are more teeth, the smoother the milled surface will be. However, the teeth that measure 5/8” will only give a smooth surface if the forward speed of the milling machine is reduced.

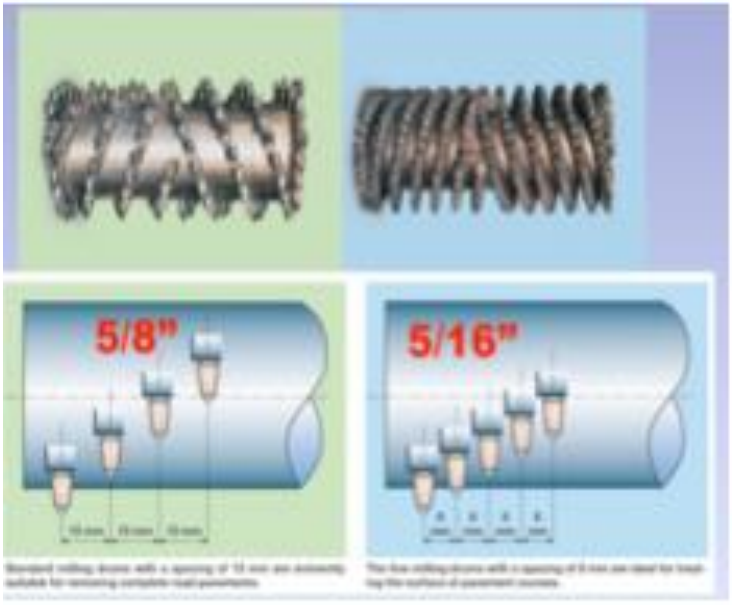

Figure 3: Teeth on Drum [7]

The workers on the job also need to inspect the teeth routinely during their use for any damage or uneven teeth. If the teeth become uneven at any point in the milling process, this creates a non-uniform milled surface. This results in waves on the road, and when the asphalt concrete is placed, it will follow the same pattern and have waves. Figure 4 below demonstrates when the teeth are uneven and the uneven road beneath the teeth [7].

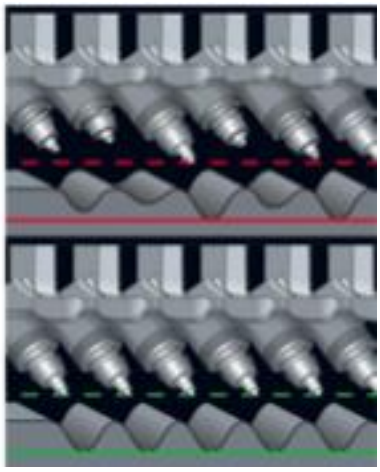

Figure 4: Even and uneven teeth [7]

More things need to be considered, such as structures in the road like manholes for utilities and sewer maintenance to storm drains that collect all the rainwater. Another thing to consider is that some driveways also are made up of asphalt concrete and need to be careful when milling. There is an edge milling process to get around those structures and driveways. Edge milling is critical to do before starting the milling of the main road, and it is the removal of asphalt in certain areas of the pavement. When edge milling is used, it eliminates the problem that may come after, such as an uneven road to the driveway of a house, which creates more materials to be used in the and the destruction of old. Also, it eliminates the manhole lids to rise over the asphalt and cause bumps on the road or even being buried beneath the new asphalt road. Edge milling also reduces the damages that a milling machine can produce on the structures. The

edge milling is done slowly around the structure and keeps damages to a minimum instead of wrecking the whole street [2].

Figure 5: Asphalt Edge Milling

Micro Milling

Micro milling is a new technique used to mill the road more efficiently, and it leaves the road smooth enough that people can drive on the road at the same speeds as if the road was brand new and repaved. The micro milling process is like that of standard milling; however, it is done at a slower pace to achieve that smoothness on the road, and there is not a lot of wear and tear on the teeth. Even though the machine is going slower, there is time saved as the machine can run at longer intervals without changing teeth or needing to cool it down. The drum has three times more teeth than the standard milling machine, and the teeth are 2/10” spaced apart [4].

Milling Costs

Milling machines cost much money to rent and to own. A milling machine can range from $200,000 to $300,000. The cost to maintain the machines can range from $15,000 to

$20,000 on a machine that has been used for a total of 14,000 to 15,000 hours a year. In the long run, renting a machine every year for the same hours will become more costly than investing in one and maintaining it. A milling machine will typically rent between $700 to $800 per hour. If renting out a machine for, let's, say 14,000 hours, expenses would go through the roof. Asphalt millings cost between $10 to $20 per ton used, which is way cheaper than new hot mix asphalt that rates from $40 to $80 per ton used [3].

Conclusion

In the end, there are many techniques that construction workers use to achieve the goal, but there is a better way to conserve materials and money. Slowing down the milling machine when grinding up the road, the material is finely ground asphalt concrete to be reused in RAP solutions. The machine itself can be preserved at a slower pace if the teeth become uneven and cool down the machine if it gets hot. Lastly, having a competent crew is essential for the operation because a crew that does not understand the road and the machine is at risk of damaging the road, the machine, and oneself, including the other workers. With time, there will be more advanced technology to mill a road and find faster and better ways to pave the road, but these steps will take an effective milling technique.

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