Hot-Mix Asphalt vs. Warm-Mix Asphalt

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Benjamin Jennings

Ryne Wirtjes

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Southern Illinois University Edwardsville

35 Circle Drive

Edwardsville, Illinois 62025

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History of Asphalts

HMA

Today, hot-mix asphalt is the most common pavement on the market, but variations of hot-mix asphalt as we know it were first developed in mid-1800s France. It wasn’t until 1870 that the first HMA road was constructed in the United States. Once HMA proved to be a durable and cost-efficient way of paving roads, the market exploded in popularity, competition, and efficiency.

A batch of HMA consists of aggregate and a viscous binding agent, and is produced at a temperature range of about 300-350°F. There are three subcategories of HMA: Dense-graded mixes, stone matrix asphalt, and open-grade mixes. Dense-graded mixes are often used for high traffic roadways due to its durability. Stone matrix asphalt was originally produced to improve tire grip and prevent rutting on roads. This mix contains more asphalt cement, while also adding binders and fibers to the mix. While this is a quality mix, it is more expensive than other types of asphalt and is usually only used on large asphalt projects.

WMA

Warm Mix Asphalt is a relatively new technology that originated in Europe, but the technique was first created by a Professor Csanyi at Iowa State University in 1956. In 1968 Mobile Oil Australia patented the invention, and the United States began to use it after it was licensed to Conoco Inc. WMA was introduced at the 2003 National Asphalt Pavement Association Convention. In 2004 the first field trials began on U.S. soil in Florida and North Carolina. However, it wasn’t until 2007 that AASHTO began research projects on the new asphalt technology.

A batch of WMA is produced at a temperature range of 50-100°F less than a batch of HMA. There are multiple WMA technologies used in the United States, which include foaming effect, organic additive, and chemical package. The foaming effect used is used to increase workability. Water is added to lower the temperature and causes the volume of the asphalt binder to expand, which results in the foam. The organic additive improves the flow by reducing the asphalt viscosity and is used to avoid permanent deformation. The chemical package acts as a compaction aid and was developed to improve the asphalt’s workability, emulsification, and adhesion.

Figure #1 www.asphaltpavingmt.com

<u>Benefits and Uses</u>

HMA

HMA has been such a reliable pavement for so long due to its durability, strength, and low cost. The installation is a simple process and only takes a short period of time until it can be used. HMA is a suitable pavement for a variety of projects ranging from pedestrian sidewalks to multilane highways to railways beds. It generates far less traffic noise than other pavements and is rough enough to prevent skidding in wet conditions. HMA is also completely recyclable which limits natural resources used in engineering projects, promoting sustainability in the field.

WMA

The goal of using WMA is to produce quality dense asphalt mixtures at lower temperatures. The purpose of producing asphalt at lower temperatures is to cut down on emissions and boost energy savings. WMA have reached energy savings of 30% compared to HMA. The emission reduction accounts for numerous environmental and benefits. WMA is also more "worker friendly". Paving crews have been reported insisting working with WMA because of the lower temperatures and "less irritating fumes". Engineering benefits include better compaction of pavements, a longer fatigue life, and the possibility to use more recycled material. There are also numerous construction benefits to using WMA. Construction crews can pave at lower temperatures, which allows the construction zone to be opened to traffic sooner and reduces traffic congestion. The paving window is extended, which allows for a longer paving season in colder regions and the potential for longer hauling distances. The extended window also enables more paving hours in nonattainment areas.

Comparisons

HMA vs. WMA

HMA is produced and transported at a higher cost than WMA due to the higher temperatures required to avoid solidifying. The foaming technique of WMA is commonly used in the United States because of its low cost. HMA also limits the paving season since it must be poured in temperatures around 50°F and rising. This greatly affects the time that pavement can be installed in colder climates, potentially shortening the paving season by weeks and even months. HMA also causes more fumes due to the higher temperature's affect on the asphalt binder.

Polycyclic Aromatic Hydrocarbons (PAHs) emissions are present during the cooling stage after asphalt is paved. The WMA's cooling process is shorter as a result of the lower temperature, so the PAH emissions would be reduced. Fewer of these harmful fumes greatly benefit the paving crews. The emissions from WMA are significantly less than those of HMA. The PAH reduction when using WMA compared to HMA has been tested to be up to 50%, and the overall emission reduction for WMA compared to HMA is nearly 30%.

Disadvantages of WMA are still being found today. The long-term performance of WMA is uncertain, and the risk of water damage is greater than that of HMA. These two possibilities could result in more frequent maintenance that would put more heavy trucks and equipment on other roads potentially degrading them as well as emitting a greater number of emissions in the environment. If the chemical packaging technique is used, various additives could also have a dangerous environmental impact.

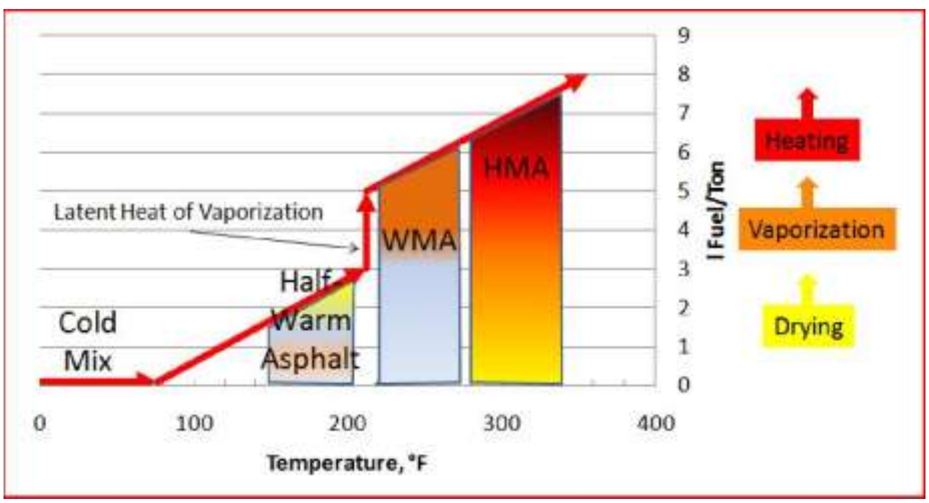

Figure #2 Temperature vs Fuel/Ton

Laboratory Procedural Differences

HMA vs. WMA

The key difference between HMA and WMA is the temperature at which the pavement is produced. HMA is typically produced between 275-350°F while WMA can be produced 100 degrees lower. This can be achieved by a "foaming" process which happens by strategically adding water which turns to steam, causing the binder to expand into foam. A series of foaming tests can be conducted to find the optimum water content, which will yield a lower temperature of the asphalt without losing its strength.

Figure #3 Wirtgen WLB 10 S Foaming Device

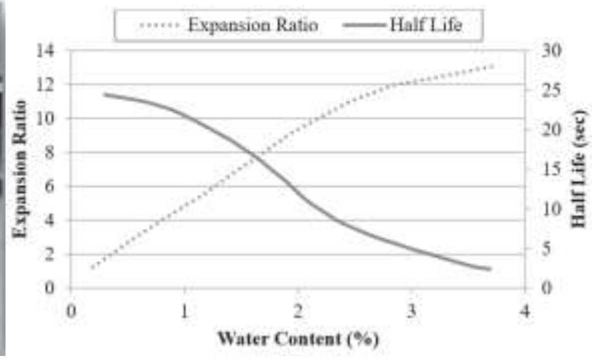

Figure #4 Foaming Properties of Asphalt Binder

Chemical additives can also be introduced to the mix to reduce the asphalt viscosity, in turn allowing the aggregate to be coated at lower temperatures. Though the HMA procedure deals with asphalt that is 100 degrees warmer, both lab procedures require safety glasses, gloves, and long pants due to the high temperatures. The chemical additives in the WMA procedure could put someone at higher risk of injury if the chemicals come into contact with skin or eyes.

Southern Illinois University Edwardsville has a civil engineering materials lab in which students design, prepare, and evaluate an HMA specimen using the Superpave (Superior Performing Asphalt Pavements) mix design method and criteria. Various types of equipment needed for this lab include: thermostatically controlled ovens, 10 qt. mechanical mixer, thermometers to measure 250-350°F, heat resistant gloves with Kevlar sleeves, and a Gyratory Compactor with computer (for compacting and recording specimen data). If the university incorporated a WMA lab with the foaming technique, then most of the same equipment could be used. The WMA lab would require a foaming device. Figure #3 shows a Wirtgen WLB 10 S Foaming Device. A used device could range from $8,000-$16,000, and a new device could cost upwards of $70,000. Universities around the country could benefit investing in a foaming device for a WMA lab. This would give both professors and students a chance to become familiar with the relatively new asphalt technology: warm-mixed asphalt.

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