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Asphalt Mix for Cold Weather Condition

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ABSTRACT

Increased environmental awareness and stricter emissions regulations have led to a development of warm mix asphalt (WMA) to reduce the high mixing temperatures of regular hot mix asphalt (HMA). Its benefits are reduction in energy consumption during production and reduced emissions during production. All methods Reduce the viscosity of the binder at a sure temperature range, allowing the aggregate to be fully coated at lower temperatures than in HMA production. Previous research has not focused much on how WMA functions in cold weather paving. This paper investigate WMA's possible in cold weather condition and expressly how Iceland, with such condition, can benefit from it. Reduced emissions are especially beneficial in densely populated areas and in non-open air paving. The decreased viscosity allows effective compaction at lower temperatures where cool down rates are slower. WMA's disadvantages are mainly related to rutting and moisture susceptibility issues. Using WMA processes at HMA production temperatures:
1) Increases the temperature gap among production and cessation, allowing e.g. increased haul distances
2) Facilitates compaction, which is beneficial for; stiff mixes and RAP, paving during extreme weather conditions and reduction in compaction effort.
Keywords: Warm mix asphalt (WMA), Hot mix asphalt (HMA), Bitumen, Coarse aggregate and Fine aggregate

I. INTRODUCTION

Environmental awareness have been increasing rapidly over the past year. Extensive measure like air pollution reduction targets set by the European Union with the Kyoto protocol has encouraged efforts to reduce pollutions.

Warm Mix Asphalt (WMA), a new paving skill that originate in Europe, is one of those efforts. It allows a reduction in the temperature at which asphalt mixes are produced and placed. It benefit are reduction in energy consumption and reduced emission from burning fuel, fume and odors generated at the production plant and the paving site. This paper investigate the potential use of warm mix asphalt in cold weather condition and specifically how countries like Iceland, with such conditions, can benefit from this technology. Early study has mainly focused on the environmental benefit and the reduced energy consumption of the technology and not as much on how its functions in cold weather paving.

The primary objective of this research is to find out whether warm mix asphalt is a viable option for the paving industry in Iceland. In the process of answering that question, warm mix asphalt's merit and demerit compared to traditional hot mix asphalt (HMA) are explored and the question of whether warm mix asphalt is a viable paving option for cold weather conditions in general is also answered. The conclusion of this paper are primarily drawn from a literature review that was conducted on warm mix asphalt to evaluate what is known about its performance and a survey that be conducted in Iceland by giving out a feedback form to professionals in the industry.

Condition and paving practice in Iceland are also explored to give an understanding of common paving issues in Iceland. Hopefully this paper can assist potential warm mix asphalt users in cold weather regions to understand the basic differences in the available methods and how they are differently suitable for the different situation that can come up in cold weather paving.

Overview of Papers

Many Warm Mix Asphalt studies has been devoted in recent days in many countries and regions. some of them are as follows in below chapter.

In 1956, Iowa State University Professor **Ladis Csanyi** used foamed bitumen as a soil binder. This process consisted of injecting steam into hot bitumen to reduce the mixing temperature within, Mobil Oil Australia worn cold water instead of steam to foam hot bitumen. This increased the practicality of the foaming process.

In 1970s, **Chevron** develop new method to prepare paving mixture stabilized by emulsify asphalt. In 1977, Chevron published their “Bitumuls Mix Manual”.

In 1994, Maccarone et al. (1994) calculated cold-mixed asphalt-based foamed bitumen and very high binder content emulsion and concluded that the use of cold mix for use on roads was gaining acceptance universal due to energy efficiency and lower emissions. In fact, they stated that, “Cold technologies represent the future in road surfacing.”

In 1994, Maccarone evaluate the performances of cold mix asphalt by using two different material, based foamed bitumen and very high binder content emulsion. The results showed a reduction in energy consumption and lower gaseous emission.

In 1995 Harrison and Christodulaki, Shell Bitumen filed a patent to cover a warm-mix asphalt technique that used a two-component technique. Koenders et al. (2000), of Shell Global Solutions, describe an inventive WMA process that was tested in the laboratory and evaluated in large-scale field trials (in Norway, the United Kingdom, and the Netherlands) with particular position to the productions and placement of dense-graded wearing courses. Shell’s work resulted in the development of WAM-Foam®.

In 1999, Jenkins came up with new techniques that involve a half-warm foamed bitumen treatment. Jenkins investigate the concept and profit of preheating aggregate to temperature above ambient level and below 212°F (100°C) before adding foamed bitumen. The results showed a good particle coating, mix cohesion, tensile strength, and compaction.

In 2000, Harrison and Christodulaki by adding Aspha-min to the mix at the same time as the binder, a very fine water vapor is created. This release of water creates a volume expansion of the binder that outcome in the formation of asphalt foam, allowing increased workability and aggregate coating at lower temperatures. Eurovia recommends adding Aspha-min at the rate of 0.3% of the mass of the total mix, which can result in a potential 54°F (30°C) reduction in typical HMA production temperatures. This reduction in temperature was reported to lead to a 30% reduction in fuel energy consumption. Eurovia stated that all commonly known asphalt and polymer-modified binders can be used with Aspha-min. Also, the addition of recycled asphalt is compatible with Aspha-min.

In 2000 Harrison and Christodulaki Warm mix asphalt (WMA) in its present form was first developed in Europe. WMA was report on by Harrison and Christodulaki at the First International Conference of Asphalt Pavement (FICAP) in Sydney, Australia in 2000.

In 2000 Koenders the same year a paper was prepared by Koenders and his team, who evaluated the performance of WMA by testing a mix in the laboratory and at field locations in Norway, the UK, and the Netherlands. Koenders et al emphasized the production and application of dense graded wearing courses.

In 2006 Kristjansdottir Aspha-min is a product of Eurovia Services GmBH Bottrop, Germany (Von Devivere et al. 2003), often referred to as Eurovia. It is available as a very fine white powder in 25 or 50 kgs bags or in bulk for storage in silos. It is a manufactured synthetic zeolite (Sodium Aluminum Silicate), which has been hydro thermally crystallized. Water is held internally by the Aspha-min at 21 percent by mass and is release in the temperature range of 185°F to 360°F (85°C to 182°C). The framework silicates (zeolites) in Aspha-min have large vacant spaces in their structure that allow space for large cations such as sodium, potassium, barium and calcium, and even relatively large molecules and cation groups such as water. In their most of use form, the space are interconnected and form several long, wide channels of varying sizes depending on the mineral. These channels allow the easy movement of the resident ions and molecules into and out of the zeolite structure. The most well-known use for zeolite is in water softeners. Zeolite is characterized by its ability to lose and absorb water without damage to its crystal structures. It can have the water in their structures driven out by heat and other solutions pushed through the structure. It can then act as delivery system for the new fluid.

II. OBJECTIVES OF THE STUDY

- To conduct a detailed laboratory study that evaluates the engineering properties of conventional HMA mixtures compared to WMA mixtures.
- To examine the influence of WMA pavement thickness on the tensile strain developed at the bottom of the perpetual pavement layer.
- To monitor and test pavement sections paved using WMA techniques and the conventional HMA at the site.
- To compare the performance of WMA mixtures and pavements with that of conventional HMA in the controlled setting in the field section.

III. EXPECTED OUTCOMES

Warm mix asphalt is a undertake approach to production and placement of paving material. Research work worldwide is evidently demonstrating that WMA systems are providing significant benefits with regards to the environment, in facilitating paving practices and, with regards to field performance. The response from the paving industry is unprecedented universal. In actual fact, it is believed that the development of WMA is impacting and will continue to have an influence on the paving industry in as similar manner as the development of the binder “Performance Grading” and “Superpave”.

These are mentioned below.

- The possibility of placement at a lower temperature. Important when there are long haul Distances.
- Reduction in energy consumption and lower emissions.
- Reduction in energy consumption and environmental factors.
- Reduction in heat i.e. energy consumption during production and placement and the possibility of longer haul distances.
- Reduction in energy consumption during production is a factor that will be use to evaluate the advantage of WMA if it will lower the overall cost of a project.
- Reduction in energy consumption because of lower temperatures, longer paving season and lower environmental impact of production and placement in urban areas.

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