COMPETITIVE ADVANTAGE: HOT MIX ASPHALT ON DEMAND

WHITEPAPER

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PelletPATCH Distributors, LLC
62 Washington Ave.
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Industry practice historically has resulted in construction of the majority of roadways being built using traditional asphalt or concrete.

Independent Engineering studies by Departments of Transportation and Academic Research Institutes (see Appendix A) over the last 20 years have concluded that:

- **Rubberized pavement prevents formation of potholes, provides quieter roadways and is more durable than straight asphalt paving**
  - **Traditional asphalt paving provides a non-elastic driving surface that has a shorter useful life and requires full or partial repaving resulting in operational maintenance costs resulting from the volume of truck & car traffic carried on those stretches of roadway**

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PelletPATCH Distributors, LLC offers a new metric to approaching the resulting degradation of pavement resulting in the creation of potholes by leveraging current labor best practices with advanced technology to provide a measurable Return on Investment and associated cost savings by adopting this methodology.

- **Patented Technology that repurposes waste tires**
  - **There are over 300 Million waste tires produced in the US each year**
- **All products and the Asphalt Patch Master are *Made in the USA***
- **Scientific evaluation & lab testing of the proper pellet/aggregate mix to use in diverse temperature climate zones**
- **Environmentally friendly**
- **Utilization of 100%Recycled Asphalt Pavement (RAP) materials**

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- **PPD materials create a Hot Mix Asphalt On Demand rubberized patch that expands/contracts under changing weather conditions**
- **Creates a permanent, durable repair that elongates the life cycle of the road**
- **Pellets are evenly heated to between 350° and 375° directly at the repair site**
    - **Minimize wasted labor time by not commuting to or waiting on-line at an asphalt plant**
    - **Material life in a hot box is typically just 3-4 hours**
    - **Material is not consistent as it cools down in transport**
- **Minimal training time for the crew to achieve certification on equipment and pellet material usage coupled with current installation practices for pothole preparation and fill.**

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- **No wasted material – heat sufficient amount of pellets to properly fill the volume of the hole and finish the repair using a vibrating compactor or roller to permanently prevent water or ice buildup in the hole**
    - **Bulk Materials placed into a hotbox do not match actual usage required at the repair site therefore providing a hidden incremental cost that increases the investment cost per ton**
- **One time investment in materials and labor by using industry proven best practices for permanent pothole repairs**
    - **No callbacks to repeatedly fill the same hole**
    - **Throw and go is not effective and produces debris that is dangerous to drivers and pedestrians**
- **Reduced calls to 311 results in enhanced constituent services for municipalities**
- **Mitigation of exposure to liability and insurance claims resulting in payout of taxpayer dollars for injury due to driving over potholes that have been repaired with temporary patch materials**
- **Could be placed at cold temperature**

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APPENDIX A

Industry Research re Crumb Rubber for Paving

(PDF copies are available upon request)

CRMB pellets for sustainable road infrastructure

Professor Serji Amirkhanian, Director of Research and Development, Phoenix Industries, Las Vegas, Nevada and Adjunct Faculty, IIT Madras

INTRODUCTION: The United States is home to nearly 3.7 million kilometers of paved roads, and 94% of these roads are surfaced with asphalt materials. It is estimated that approximately 4,000 asphalt contractors are producing approximately 500 million tons of hot mix asphalt (HMA) valued at nearly 20 billion dollars each year. The demand on highways has increased many times. For instance, since 1970, the population of the United States has increased 34%, but licensed drivers by 68%, registered vehicles by 94%, and vehicle miles traveled by 143%. However, the highway departments, due to many factors (e.g., lack of funding, etc.), around the country have added only 6% of roads for these increases. In addition, each year approximately $13 billion is spent on highway construction and repairs. Moreover, the Federal Highway Administration (FHWA) estimates that the cost to bring our nation's roads up to minimum engineering standards over the next 20 years will be over $550 billion.

Crumb Rubber Modification of Binders: Interaction and Particle Effects

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ABSTRACT: Crumb rubber has been used to enhance the performance of hot mix asphalt pavements since the 1960s by improving the rheological properties of the crumb rubber modified (CRM) binders. Several researchers have identified the CRM-binder interaction as diffusion of the lighter binder fractions into the CRM particles. This physical interaction is two-fold: (1) the rubber particles swell and (2) the viscosity of the binder matrix increases due to removal of a portion of the oily fraction. While this interaction has been the major consideration with CRM binders, the effect of the CRM particles acting as fillers has not received much attention. This investigation resulted in a method to quantify both the interaction effect (IE) and particle effect (PE) of CRM, which contribute to the increased rheological properties of CRM binders. These effects were determined using a rotational viscometer and a dynamic shear rheometer (DSR) to measure the rheological properties of CRM binders produced with three sizes

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of CRM, two crumb rubber processing methods (ambient and cryogenic grinding), two CRM contents, and three binder sources. It was concluded that binder source had a significant effect on the IE, followed by CRM content. The PE was most significantly affected by the CRM content, followed by the CRM particle size.

Effects of Compaction Temperature on Volumetric Properties of Rubberized Mixes Containing Warm-Mix Additives

Chandra K. Akisetty[1]; Soon-Jae Lee[2]; and Serji N. Amirkhanian[3]

Abstract: The warm-mix asphalt _WMA_ refers to technologies that allow a significant reduction of mixing and compaction temperatures of asphalt mixes through lowering the viscosity of asphalt binders. Several studies have been carried out evaluating the properties of WMA, and it is found that warm mix additives work in different ways either in reducing the viscosity of the binder or allowing better workability of the mix at lower temperatures. In terms of rubberized asphalt mixtures, they are generally produced and compacted at higher temperatures than conventional mixtures, based on the field experience. If the technologies of warm-mix asphalt are incorporated, it is expected to reduce the mixing and compaction temperatures of rubberized asphalt mixtures to those of conventional mixtures. This study was initiated to investigate the effects of compaction temperature on rubberized mixes containing the warm mix additives. For this, four Superpave mix designs for two asphalt binders and two aggregate sources were conducted to determine optimum asphalt contents. Warm rubberized mixes were produced using two of the available processes. A total of 192 specimen's _4 mix types: control mix, rubberized mix, warm rubberized mix 1, and warm rubberized mix 2_2 aggregate sources _4 compaction temperatures: 97, 116, 135, and 154°C_6 repetitions_ were fabricated using Superpave gyratory compactor. Volumetric properties of the specimens were evaluated. The results showed that the warm mix processes were effective to improve the volumetric properties of rubberized mixes at a certain range of compaction temperatures.

Estimating correlations between rheological and engineering properties of rubberized asphalt concrete mixtures containing warm mix asphalt additive

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A b s t r a c t
In recent years, warm mix asphalt (WMA) is widely used for reducing energy requirements and emissions in hot mix asphalt (HMA) industry. In addition, the use of rubberized asphalt in the past has proven to be economical, environmentally sound and effective in improving the performance of pavements across the US and the world. The objective of this research was to investigate the mixture

performance characteristics of rubberized warm asphalt mixtures, and their correlation with binder properties, through a series of laboratory tests (e.g., viscosity, dynamic shear rheometer (DSR), and bending beam rheometer (BBR)) conducted on the binders, and obtaining the indirect tensile strength, rutting resistance, and resilient modulus of various mixtures. The results of the experiments indicated that the use of crumb rubber and WMA additive in HMA can effectively improve the engineering properties of these mixes at lower mixing and compacting temperatures and some statistical correlations between rheological and/or engineering properties were developed successfully.

Influences of crumb rubber size and type on reclaimed asphalt pavement (RAP) mixtures

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Abstract
Over the years, recycling has become one of the most attractive pavement rehabilitation alternatives, and different recycling methods are now available to address specific pavement distresses and structural needs. The objective of this study was to investigate and evaluate the engineering properties of crumb rubber size and type influences on reclaimed asphalt pavement (RAP) mixtures. The experimental design for this study included the use of three rubber sizes and two rubber types (ambient or cryogenic) in the mixture containing 25% RAP mixtures. In this study, the results of the experiments indicated that the addition of crumb rubber was helpful in increasing the voids in mineral aggregate (VMA) in Superpave mix design and improving rutting resistance of mixture regardless of rubber size and type. On the other hand, indirect tensile strength (ITS) values show no significant difference for mixtures made with three type rubber sizes. However, the increase of rubber size, regardless of rubber type, reduced the resilient modulus values but extended the fatigue life of the modified mixtures.

Rutting Resistance of Rubberized Asphalt Concrete Pavements Containing Reclaimed Asphalt Pavement Mixtures

ASCE Journal of Materials in Civil Engineering
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Abstract: Improved understanding of rutting resistance of a rubberized asphalt concrete (RAC) pavement that contains reclaimed asphalt pavement (RAP) is important to stimulating the use of rubberized asphalt mixtures. Use of RAP in the past has proved to be economical, environmentally sound and effective in increasing the rutting resistance of asphalt mixtures. Rubberized asphalt has been used successfully in improving the mechanical characteristics, such as rutting resistance, of typical hot mix asphalt (HMA) mixture around the country and the world. The objective of this research was to investigate the rutting resistance characteristics of the rubberized asphalt mixtures through a laboratory testing program. The experimental design included use of two rubber types (ambient and cryogenically produced), four rubber contents, and three crumb rubber sizes. The results of the experiments indicated that the use of RAP and crumb rubber in the HMA can improve effectively the rut resistance of these mixes.

HIGH TEMPERATURE PROPERTIES OF CRUMB RUBBER MODIFIED BINDERS

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ABSTRACT: Each year, in the U.S. approximately 290,000,000 scrap tires are generated. There are many issues associated with the disposal of these tires, so there have been efforts to use these tires in civil engineering applications such as crumb rubber modified (CRM) asphalt. This study evaluated the high temperature properties of CRM asphalt binders made with varying sizes, types, and percentages of crumb rubber. In addition, two binder grades from two different crude sources were also included. A total of 108 CRM binders were tested in their original and rolling thin-film oven aged conditions using a rotational viscometer and dynamic shear rheometer. Results of this study indicated that the crumb rubber content had the largest effect on the high temperature properties. The size and type of crumb rubber also had significant effects on the CRM binder properties. Finally, the crude source was found to have a significant effect on the performance of the CRM binders.

The influence of crumb rubber modifier (CRM) microstructures on the high temperature properties of CRM binders

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Many physical and chemical factors affect the rheological properties of crumb rubber modifier (CRM) binders. This study is aimed at understanding the influence of CRM microstructure on one of the rheological properties, the high temperature properties of the CRM binders. To this end, the high temperature properties of the binders that were modified by two types of CRM with different microstructures, three different sizes, two percentages as well as three different mixing times, were evaluated by dynamic shear rheometer (DSR) test on samples before and after RTFO aging. A series of scanning electron microscope (SEM) were taken on the two types of CRM of three different mesh sizes. Results from this study showed that: (1) ambient CRM has porous surfaces and cryogenic CRM has angular with smooth cracked surfaces; (2) an addition of 10–15% of CRM in the binder can increase one and two PG grades at high temperature for either ambient or cryogenic CRM regardless of the microstructure of CRM; (3) when a high percentage and coarser CRM is mixed, the microstructures of CRM have significant influence on the high failure temperature and (4) change in mixing time from 15 to 45 min did not alter much in the failure temperature, suggesting that a mixing time of 15 min interact completely for 15% CRM with the binder.