A paper prepared for presentation for :
ASPHALT EMULSIONS: UPDATES AND NEW TECHNOLOGIES

A Seminar Sponsored By The Asphalt Emulsion Manufacturers Association
The Adam's Mark Hotel St. Louis, Missouri November 8 - 9, 1988

# "The effects of various polymers on quick-set quick-traffic emulsified asphalt micro-surfacing mixes"

David R. Jones, IV and Antonio C. Ng , ScanRoad Inc., Waco, Texas

## Objective

The aim of this work is to evaluate the effects of substituting various polymers in a quick-set, quick-traffic emulsified asphalt micro-surfacing mix.

## Introduction

Since its introduction into the United States market approximately eight years ago, polymer modified micro-surf acing has expanded the areas of application for emulsified asphalt - aggregate mixtures. Products such as Slurry Seal and emulsified Cold Mixes have traditionally been used in low traffic applications such as residential streets and rural roads.

The addition of polymers, historically Natural or SBR latexes, to these emulsified systems has expanded the use of these products into high traffic, high load applications such as rut~filling or. friction courses on interstate highways. Because the micro-surfacing emulsion is chemically broken instead of using the traditional evaporation process, micro-surfacing mixes build cohesive strength rapidly, and this allows the roadway to be opened to traffic much more quickly than with slurry seal or emulsified cold-mix technology. The rapid cure times of micro-surfacing mixes generally allows the roadway to be opened to rolling traffic in one hour or less. The development of specialized application equipment such as rut-filling laydown boxes ("rut~boxes") has also added to the versatility of this technology. As more and more regulatory agencies explore the application of these materials, there is increased interest in the evolution of this technology. This paper seeks to examine some of the variables effecting the properties of these mixes.

**Acknowledgments**

The authors are indebted to C. Robert Benedict for his help and guidance in this work.

## Objective

The aim of this work was to continue the original work on polymers in micro-surfacing mixes presented at the Asphalt Emulsion Manufacturers Association (AEMA) Seminar in November, 1988 in St. Louis, Missouri.[1] The conclusion of the above paper was that the test methods used to evaluate the various polymers did not show significant differences between polymer modified and unmodified mixes. Therefore different test methods were explored in this work to try to demonstrate and differentiate the benefits of polymer addition to micro-surfacing mixes.

## Introduction

A copy of the original work is attached to this paper. reader is urged to refer to that paper for background information.

## Experimental Design

All conditions for preparation of the test samples were the same as in the original work. The one exception is the addition of a traditional quaternary CSS-emulsifier for one set of mixes. It was substituted for Catimuls 404 in one set of mixes without polymer to provide a data point on "conventional" slurry.

The polymers used in this study were the ones which showed greatest promise in the original work. They are shown in Table I.

**Table I : Polymers used in the Test work**

| Type | Manufacturer | Brand Name |
|---|---|---|
| SBR | BASF Chattanooga, TN | 298 |
| Natural Latex. | Guthrie, Inc Baltimore, MD | Centrifuged Latex |
| Neoprene | Dupont, Inc. Wilmington, DE | 671A |
| SBS | Fina Deer Park, TX | 416 |
| EVA | Dupont Wilmington, DE | 150W |

The test methods used for evaluation in this work were:

a) Marshall Stability (140$^0$F) (ASTM D-l559)
b) Marshall Stability (180$^0$F)
c) Loaded Wheel Test (ISSA TB-109)
d) Schulze-Breuer-Ruck Test (Proposed ISSA TB-144)

## Results of the study

As a consequence of the earlier work, the polymers in Table I were selected for further evaluation. It had been suggested to the authors during presentation of the original paper that evaluating Marshall Stability at elevated temperatures might well indicate the increased performance of the polymer modified mixes. In fact, the opposite was true, and all Marshall values run at 1800F were lower than those run at 140$^0$F. This effort was therefore abandoned.

The next approach was to evaluate the various mixes using the Loaded Wheel Test (LWT) (ISSA TB-109). The vertical displacement of the samples was compared to their Wet Track Abrasion Test (WTAT) values (ASTM D-3910) from the original paper. This data is shown in Table II.

**Table II :Loaded Wheel Test Results. (ISSA TB-109)**
(1,000 cycles @ 125 lbs. load @ 77$^0$F)

| Polymer | % Vertical Displacement* | WTAT 6day g/sq ft |
|---|---|---|
| SBR | 1.3 | 15 |
| Natural Latex | 7.8 | 41 |
| SBS (Fina 416) | 8.6 | 28 |
| EVA (150W) | 11.2 | 56 |
| Neoprene 671A | 11.4 | 40 |
| None-Catimuls 404 | 14.7 | 44 |
| None-Quaternary Emulsifier | 21.1 | 247 |

*Thickness after compaction - original thickness x 100 / original thickness

The polymers have been ranked in Table II according to their vertical displacement in the LWT. There is a poor correlation between the vertical displacement and WTAT values for the various polymers, but the traditional CSS-1 emulsion made from a quaternary ammonium emulsifier clearly shows both poor LWT and WTAT. In just considering the vertical displacement data the results generally follow what the authors would expect, and one can see a clear delineation between the modified and unmodified mixes.

The next set of experiments involved the Schulze-Breuer-Ruck abrasion test (proposed ISSA TB-144). Wherein a sample of the cured material is pressed into a "pill", which is then soaked in water (Absorption) tumbled in a Rotary device (Loss), boiled in water (Adhesion) and the remaining largest fragment weighed (Integrity). These values are then graded on a point scale, and an overall rating assigned. These data are presented in Table III.

**Table III: Results of Schulze-Brueur-Ruck Testing** (Proposed ISSA TB 144)

| Polymer | Absorption (g) | Loss(g) | Adhesion(g) | Integrity (%) | Rating |
|---|---|---|---|---|---|
| SBR | 1.25 | 0.96 | 99 | 98 | 11 |
| Natural | 2.30 | 1.49 | 99 | 95 | 9 |
| SBS (Fina 416) | 2.18 | 0.82 | 99 | 40 | 8 |
| EVA (150W) | 1.64 | 1.13 | 99 | 67 | 8 |
| Neoprene (671A) | 2.06 | 1.51 | 99 | 96 | 9 |
| None Catimuls 404 | 1.35 | 1.97 | 99 | 62 | 7 |
| None EM26 | 1.59 | 2.01 | 99 | 33 | 5 |

"European Standards require less than one gram abrasion loss. It is suggested 11 points be established as a minimum rating . " (Proposed ISSA TB 144)

The absorption data (column 1) show no correlation with polymer content, both unmodified mixes being lower in absorption than all the polymers save one. The loss after tumbling (column 2) shows the polymers to better advantage. Adhesion (column 3) gives no differentiation, and the integrity (column 4) has mixed results. The SBS sample had the lowest loss after tumbling$_1$ but also the next to poorest integrity. The overall point ratings did a better job in separating out the polymer modified materials, with the SBR modified mix clearly standing out from the other polymer modified mixes.

## CONCLUSIONS

The very nature of this set of experiments certainly limits the conclusions that can be drawn from this work. By not "fine-tuning" any of the mixes to the particular polymer-emulsifier-aggregate-ashpalt interactions the "best" test results were not obtained. However the original concept of this work was to hold constant as many variables in the mix design as possible, to allow examination of the polymer's role in the micro-surfacing system.

The authors feel that both the Loaded Wheel and the SchuizeBreuer-Ruck Tests show promise in demonstrating the role of polymers in micro-surfacing mixes. The ISSA should adopt the proposed TB-144, and make the Schulze-Breuer-Ruck Test (S-B-R) part of its methods. The adoption by the user agencies of the LWT and the S-B-R methods into their specifications will help assure a quality product is produced. The Marshall test, whether at standard temperature ($140^0$F) or at elevated temperature ($180^0$F) seems to be a function only of aggregate gradation and the "tightness" of the mix. Its value is in assuring good aggregate gradation, and should be used solely for that purpose.

Several of the polymers show excellent promise for use in micro-surfacing mixes. The SBR latex continues to perform well in virtually all the laboratory tests to which it has been subjected. Limited field data supports this.

Natural rubber latex$_1$ while not performing as well in laboratory testing, shows good long term performance in many years of field use.

The Neoprene used in this part of the study showed considerably better laboratory results than the earlier work. The authors are not aware of any field placement of this material in micro-surfacing mixes.

The materials which were received as latexes tended on average to outperform the solid polymers. The ease with which these latexes are dispersed into the asphalt may well contribute significantly to their excellent performance in laboratory and field testing.

The SBS polymers behave well in the laboratory tests. The difficulty i~ consistently dispersing a solid polymer in the asphalt must be Overcome for them to be a reliable performer.

The EVA polymers seem to lack something in performance both in the original work and in this testing. This may be a function of their lack of resiliency, and consequent inability to hold the aggregate together under abrasive stress.

Results for specific polymers will depend on the polymer~asphalt-aggregate-emulsifer interactions, and the complexity of these chemical systems argues very strongly for the need of a laboratory mix design and thorough investigation prior to field work.

**References**
1)Jones, David R. IV, Ng, Antonio C. "The effects of various polymers on quick-set/quick-traffic emulsified asphalt micro-surfacing mixes," AEMA - Asphalt Emulsion Seminar, St. Louis, MO, 11/9/88.