International Journal of Civil and Structural Engineering– IJCSE
Volume 1 : Issue 3 [ISSN 2372 – 3971]
Publication Date : 30 September, 2014

Effect of water and emulsion contents for Microsurfacing Mix Properties

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Abstract — The purpose of this study is the evaluation of effect of water and emulsion contents in microsurfacing mixture design. Micorsurfacing method which is one of pavement preservation technologies is currently used in Korea. Hot-mix asphalt(HMA) overlay is generally used for pavement preservation treatment in Korea. Microsurfacing treatment was commonly used for pavement preservation and maintenance in the world. Microsurfacing consists of a mixture of polymer-modified asphalt emulsion, aggregate, mineral filler, water and other additive. As changed contents of water and emulsion, the performance of microsurfacing would be changed. Excessive water and emulsion content may cause the mix to segregate and leave a flushed or excessively smooth surface texture or less adhesion.

To determinate a wearing qualities of microsurfacing system under wet abrasion conditions, wet track abrasion test was adopted in this study. Also, Cohesion test was conducted to determine the cohesion build-up in a microsurfacing mixture.

As changed the amount of water and emulsion contensts, the abrasion rate and adhesion test results were clearly changed. It indicates that water and emulsion contents definitely affect the performance of microsurfacing's mixture characteristics. Thus, Optimum volume of emulsion and water is so important to extend the microsurfacing service life.

Keywords*—component, formatting, style, styling, insert *(key words)

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I. Introduction

Microsurfacing is a commonly used method for both pavement preservation and preventative maintenance in the world. It is generally considered to be a highly specialized process, and public highway agencies often depend on the experience of the microsurfacing contractor and its emulsion supplier for both design and construction.[1] Figure 1 shows the difference between microsurfacing and the two slurry seals and Table 1 consolidates the ISSA definitions and other technical definitions found in the literature. Microsurfacing appears to have three features that differentiate it from slurry seals:

Microsurfacing is an effective tool for pavement preservation and maintenance programs in North America. It is not used in large amounts nor is it a technology that is kept in-house by public highway agencies.[1] Overall, the survey respondents were satisfied with their microsurfacing contractors performance and depend on the technology to extend pavement service life. Microsurfacing is suited to address rutting, raveling, oxidation, bleeding, and loss of surface friction. Microsurfacing does not perform well if it is applied to structurally deficient pavements. This makes project selection the most important step in the microsurfacing design process with regard to impact on the final performance of the microsurfacing itself.[1]

The majority of the survey respondents assign the contractor the responsibility for developing the job mix formula (i.e., the mix design). [1]

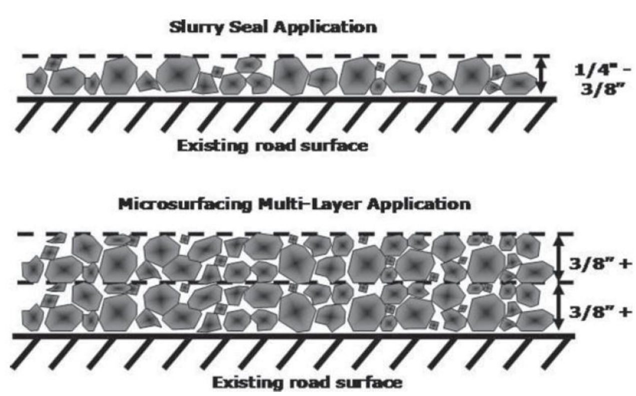

Figure 1 Difference between slurry seals and microsurfacing (adapted from Bickford 2008).

The purpose of this study is the effect of various both water and emulsion contents for microsurfacing mix properties in mix design. In this paper, three different laboratory experiments were conducted to estimate various performances such as abrasion resistance, stability and resistance to compression. To estimate the performance of microsurfacing, the two test methods were adopted as microsurfacing test performance guidelines of International slurry surfacing the Association (ISSA), it is performed for cohesion test (ASTM D 3910), and the wet track abrasion test, (ASTM D 3910). As changed the amount of water and emulsion, the abrasion rate and adhesion were clearly effected.

II. Literature Review

One of the early studies done on microsurfacing in the United States foreshadowed the favorable conclusions of further research by recommending that microsurfacing be approved for routine use in restoring flexible pavements to fill surface ruts and cracks, seal the surface and restore skid resistance [3]. The Georgia DOT had great success with microsurfacing in correcting smoothness and friction deficiencies, and stopping raveling and load cracking without an increase in pavement noise levels. A good aesthetic value was also achieved with these applications. [4] Critical components to ensure the success of a microsurfacing project include a comprehensive mix design process, quality materials, and the use of a knowledgeable and experienced contractor [5]. Olsen also reported that workmanship is a key factor in the effectiveness of microsurfacing treatments.[6] Other studies have shown microsurfacing performance is strongly affected by workmanship and the condition of the pavement at the time of application is the most important factor contributing to success [2, 6]. Pederson et al. [3] categorically stated that the quality of a finished microsurfacing project depends greatly on the skill of the operator and crew.

III. Materials and Mix Design

Microsurfacing mix type III was selected to use for two case studies in metropolitan area. This mix was designed by the A143 recommended performance guideline for microsurfacing which was adapted from the International Slurry Surfacing Association (ISSA. 2009).

Table 2 Design gradation of microsurfacing

	Sieve Size				
	3/8”	#4	#8	#50	#200
Passing percentage	100	80	60	28	10

10-mm screenings, latex and polymer-modified emulsion, and Type I Portland cement were selected to produce microsurfacing mix type III. The microsurfacing emulsion was modified with 3% of natural latex solids. The microsurfacing emulsion has about 66.8% of residual asphalt content. A specific gravity of microsurfacing emulsion was measured as 1.016 at 25°C [8].

Table 2 summarizes the design gradation of 1st and 2nd microsurfacing for this study. Based on the results of this design, a satisfactory mix for the first project was obtained with 12 percent emulsion, 1.0 percent mineral filler, and 10.0 percent water. Also, a satisfactory mix for the second project was obtained with 11.5 percent emulsion, 1.0 percent mineral filler, and 11.0 percent water. The different weather conditions of each project affected on each satisfactory mixture.

IV. Experimental Set up

To this study, two different test methods which were the typical test requirements for microsurfacing mix designs based on the International Slurry Surfacing Association’s (ISSA) formal designs were adopted; cohesion test (ASTM D 3910), the wet track abrasion test, (ASTM D 3910). Figure 2 and Figure 3 show used equipment for each test.

The Wet track abrasion test(WTAT) method measures the wearing qualities of microsurfacing under wet abrasion conditions. The test specimens are disk-shaped, 6 mm thick, and 279 mm in diameter. After initial set of the mix, the specimen is dried to constant weight in an oven for 24 hours at 60°C. The cured microsurfacing specimen was placed in a water bath for one hour and then mechanically abraded under water with a rubber hose for five minutes. The abraded specimen is washed free of debris, dried in the oven, weighed and calculated wear loss. [7]

Figure 2 Wet track abrasion

Figure 3 Cohesion test

A cohesion-testing device as seen in Figure 3 is generally used to measure cohesion at the interface between a rotating neoprene cylinder and the slurry seal test specimen, at different times after mixing and setting of slurry seal test specimens. The test specimen was disk shaped with dimension of 6mm thickness and 60mm diameter. A pressure of 200 kPa is applied through the neoprene foot while the cylinder is rotated 90 to 120 degrees. The torque needed to rotate the cylinder in contact with the specimen was measured with a torque wrench at 30-minute intervals. [7]

V. Test Results

A. *Wet track abrasion*

This method is used to measure the lower limit of bitumen content and abrasion resistance in slurries and microsurfacings. This is critical in mix design and is a part of the standard specification of most authorities including the International Slurry Surfacing Association.(ISSA) It is essential for ASTM D-3910 ISSA TB 100. The maximum loss is 0.06 g/cm^2 in criteria of ISSA. Figure 4 shows the test results as function of changed both water and emulsion content after one hour sock. [9] As seen in Figure 4, All results were satisfied the ISSA criteria. There was significantly changed abrasion rate in case of 11.5% emulsion content. It indicates that low emulsion rate is so sensitive with abrasion rate. Also, generally, the abrasion rates were decreased as increased water contents regardless different emulsion contents.

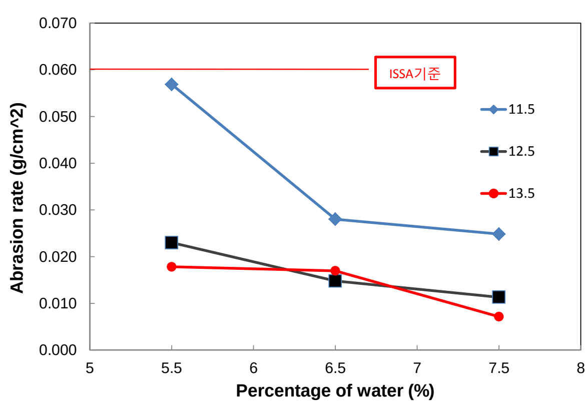

Figure 4 Wet track abrasion test result

B. *Adhesion Test*

An adhesion property is so important factor in the microsurfacing pavement to avoid unexpected failure. Thus, the microsurfacing build sufficient cohesion to resist abrasion resulting from traffic. Thus, ISSA give a number, minimum 24kg·cm Torgue, for right time for open traffic after 60 min curing time. Early stone shade is not normally a problem but in early spring or late fall when temperatures are low, shaded areas must dry without the benefit of sun or warm temperatures in microsurfcing.[7] If the microsurfacing pavement was opened to traffic too early it would ravel off quickly, particularly in high stress areas. It is important that the mixture develops adequate cohesion before it is opening traffic. Choosing the right time to open traffic is based experiences. ISSA gives a specific number to open traffic after cure well. Figure 5 and Figure 6 show the test results as changed emulsion contents with two different water contents. Based on this study, the increasing emulsion contents gives the higher toque values regardless of different water contents.

When water content was 5.5%, the curing time was need for time to open traffic. Only 13.5% of emulsion content was satisfied the criteria after 150 min curing time with 5.5% water content.

However, there was a chance to open traffic after 60 min with 6.6% water and 13.5% emulsion content. It implies that there is dramatically affect the mixture properties between emulsion and water content.

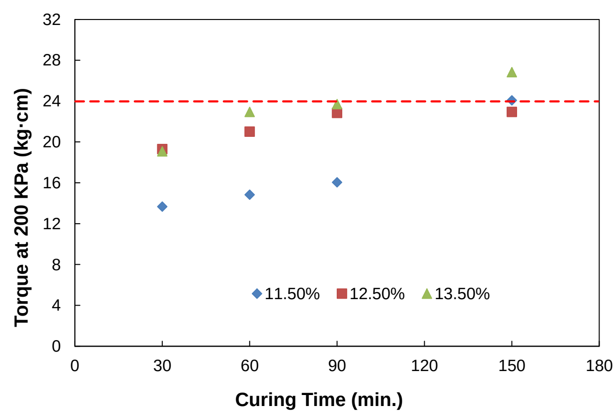

Figure 5 Adhesion result (water 5.5%)

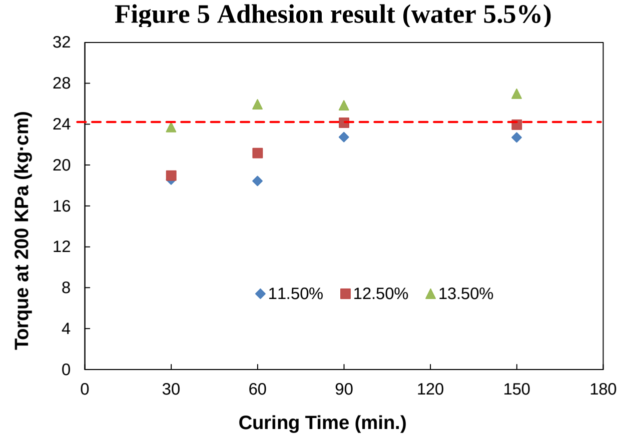

Figure 6 Adhesion result (water 6.5%)

VI. Conclusion

Based on limited study, water content and emulsion content were significantly affected the mixture properties of microsurfacing as found below.

1. Less emulsion content was sensitive with changed water content in case of wet abrasion rate.
2. Less water content need more curing time to open traffic based on adhesion test result.

Acknowledgment

This study is carried out with the great supports from Ministry of Land, Infrastructure and Transport Affairs Pavement Management System, and we really appreciate your supports.

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