IMPLEMENTATION PLAN
FIELD AND LABORATORY EVALUATION OF WARM MIX ASPHALT– PHASE 1

Implementation Report: NM13MSC-04

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August 30, 2014

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1.0 Introduction

The purpose of this implementation plan is to provide detailed guidelines and instructions to the project’s technical panel regarding implementation of the research results of the project as described in the final report. The document can thus serve as a simple, concise and straightforward guidebook for the Panel in bringing forth recommendations to senior NMDOT management relating to the selection of the most appropriate procedures, policies and technologies toward the use of Warm Mix Asphalt (WMA) pavements in New Mexico. The plan provides a description of the current need for WMA mix design and testing methods.

2.0 Target Audience

The implementation plan audience includes the following:

- Asphalt mix plant engineers, pavement construction contractors and laboratory personnel who are responsible for gradation and basic testing of asphalt and soils within construction specification
- State Pavement Material Engineers who are responsible for designing and testing asphalt mixes, soils, and aggregates in New Mexico
- State Pavement Design Engineers who are responsible for pavement design in New Mexico
- Federal agencies, including the Federal Highway Administration (FHWA), who are using state collected material data to study pavement performance with local materials
- Individual citizens and citizen groups with an interest in accessing WMA mix design and testing for New Mexico.

3.0 Implementation Impacts

The Implementation Plan suggested in this document will impact the WMA pavement design and materials as well as asphalt mix performance evaluation in the following manner:

- Implementation of proposed WMA mix design and testing methods will provide better laboratory WMA mix design estimation.
Implementation of the WMA mix design and testing methods will assure the WMA mixture quality and reduce the unexpected damage of New Mexico’s WMA pavements. This will ultimately reduce the cost of maintenance.

Laboratory and field evaluations of WMA mixtures will help to better understand the effects of different WMA technologies on the performance characteristics of mixtures and pavements.

4.0 Current Status of WMA mix design and WMA testing implemented in New Mexico

4.1 WMA Mix Design

Currently, NMDOT’s WMA mix design is similar to hot mix asphalt (HMA) design except mixing temperature. In the recent past, WMA mixing temperature, specially foaming WMA, could go above 280 °F (138 °C). The NMDOT specifications now requires that the temperature of the WMA discharged from the mixer into the transport vehicle should not be greater than 275 °F (135 °C) and less than 215 °F (102 °C) unless written recommendations by the asphalt cement supplier, the warm mix additive supplier and/or the mix design laboratory are approved by the NMDOT Project Manager.

4.2 WMA Performance

Like HMA, only one mix performance index, called tensile strength ration (TSR) of wet to dry conditioned specimens, is used to ensure moisture susceptibility. A TSR value of 0.85 is required for WMA.

5.0 Products of the Current Research

5.1 Product One: WMA in USA

A comprehensive literature review documents current state of WMA in USA. A number of WMA technologies (as many as 35) are available under three categories of WMA: foaming, organic additive, and chemical additive. Overall, WMA technology is new in USA, which covers around 35% market share of HMA. Generally, WMA performs as well as HMA. However, being a new technology, WMA lacks information of long-term field performances. In addition, long-term laboratory performances are complicated by individual state specific materials, WMA technology, and test methods, which are used to find WMA laboratory and field performances.

5.2 Product Two: WMA in NM
Questionnaire and field survey were conducted to find the current state of WMA in NM. From questionnaire survey, no clear answers about the serviceability and durability of WMA vs. HMA revealed due to reasons: WMA are relatively new and did not show any major failure yet. Both questionnaire and field survey revealed that only two technologies are used in NM from 2011: evotherm and foaming. Field survey of six WMA projects, three evotherm and three foaming, concluded that overall WMA pavements perform well. Evotherm uses mixing temperature much lower than foaming (above 280 °F). Pavement distress data show that HMA performed slightly better than foamed WMA, which performed slightly better than evotherm WMA. However, this result should be used cautiously because most of the WMA were covered by OGFC layer, which made field inspection difficult to evaluate WMA layer. A true evaluation should include some field and laboratory testing of WMA layer.

5.3 Product Three: Review of WMA Performances

- A list of laboratory test methods, devices and procedures used for performance and mix design evaluations are documented. The common issues related to laboratory testing for WMA researches have been reviewed including volumetric properties, rutting, modulus, fatigue cracking, low temperature cracking, and moisture susceptibility, and workability and compactability. Other particular concerns associated with WMA have also been reviewed including, RAP incorporation, oxidative aging of WMA, and performance of WMA OGFC.

- In general, air voids, rutting resistance, dynamic modulus of WMA mixture are slight lower than control HMA.

- Fatigue life and low temperature cracking resistance of WMA are better or comparable to HMA.

- WMA pavements are more likely to be susceptible to moisture-related damages during their early life as compared to HMA pavements. However, the difference between HMA and WMA moisture damages is less after WMA mixtures have experienced aging.

- From the literature review, it is evident that WMA performances are affected by factors like those are HMA factors such as: binder grade, aggregate source, gradations, additive rates, mixing and compaction temperatures. WMA performances are also affected by WMA technology used (e.g. half-life, expansion rate, dosages, coating, compactibility). Therefore, WMA evaluations should be conducted individually for different projects.
6. Tasks to Complete Implementation

This is a phase I of the study. Definitely phase II is need for full implementation.

6.1 Mix Design Testing

Several reports (NCHRP 9-43, 9-47A) address differences between designing WMA and HMA. These reports also recommend addition mix design tests such as coating, compactability, moisture susceptibility, and rutting resistance. NMDOT should perform and evaluate performances of WMA mixes used in NM.

6.2 WMA Technology Specific Testing

WMA technology specific test data are not known for technologies used in NM. For each foaming process, water injection rate (expansion ratio, half-life) should be evaluated as they affect long-term performances. For each evotherm, how the dosage rate affect temperature and WMA mix property is very important.

6.2.1 Binder Testing

WMA binders should be tested for their aging and temperature behaviors, specifically with different water injection rate and/or dosages.

6.2.2 WMA Mixture Testing

6.2.2.1 Laboratory Testing

Laboratory-mixed laboratory-compacted (LMLC) WMA specimens should be used for mix design testing to evaluate the effects of temperature, water injection rate or dosage rate on the WMA performances. Testing objectives should include coating, compactability, volumetric properties, dynamic modulus, rutting resistance, moisture susceptibility, fatigue cracking, low temperature cracking, and so on.

Plant-mixed laboratory-compacted (PMLC), and plant-mixed field-compacted (PMFC) WMA specimens should be used for quality assurance (QA) and long-term performance. Testing objectives should include dynamic modulus, rutting resistance, moisture susceptibility, fatigue cracking low temperature cracking, and so on.

HMA control specimens should be used for all the WMA testing to evaluate the differences between WMA and HMA.
6.2.2.2 Field Testing

Field testing should be conducted to evaluate the performance of WMA pavements. Testing should include visual distress survey, rut depth profile, in-place thickness and density, smoothness (IRI), FWD, permeability, and so on. HMA control pavements should be used for comparisons.

6.2.3 Address Other Issues

- Most of the foaming technology WMA projects included in this study used temperature higher than traditional definition of 275 °F. High mixing temperature make the mix more aged, stiffer, and increased TSR value to pass. Field performances of these projects should be studied through field core testing in the laboratory as well as non-destructive testing of field pavements.

- A comprehensive study is needed to differentiate the stripping and oxidative performances between evotherm and foaming WMA technologies in New Mexico. Often, the evotherm suppliers claim that evotherm help reduce stripping because it encapsulates the lighter component of the asphalt binder and thereby help reduce oxidation and better coating and works as an anti-stripping agent.

- It was evident from the field visuals inspections in this study, reflective cracking are severe on the shoulder and edge of the pavements. Because shoulders oxidized more than lane because of UV radiation, heat, and no kneading action by traffic. In the past, shoulders would have contained 0.5% more binder than the paving lane to have high film thickness. In this regard future research can determine the film thickness of evotherm and foaming technology by taking cores from six projects surveyed.

- As RAP is used in WMA and OGFC can be made out of WMA, some laboratory testing such as dynamic modulus, creep, drain-down tests can be performed to separate benefits of using evotherm from foaming technology. Of course, field FWD and GPR testing are always encouraged.

6.3 Training and Technology Transfer

Materials engineer, Laboratory technicians, district laboratory managers, asphalt mix plant QC/QA personnel, pavement design engineers and other relevant
members of the pavement materials community should read this report, attend project presentations, and keep pace with WMA technologies. The Department should:

- Ensure that selected department staff is able to attend regional and national conferences devoted to WMA material.

- Enroll staff in appropriate short courses or webinars devoted to WMA mix design and WMA testing.

- Provide annual in-house training to district pavement laboratory supervisors and staff to discuss problems and evaluate WMA mix design, test methods, and field performances.

- Organize events that involve vendors who can demonstrate current WMA testing, and also promote innovative stakeholders in solving current WMA variables and issues.

- NMDOT needs to invest in personnel and resources to deal with WMA performance and design parameters.