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FLORIDA SUPERPAVE EXPERIENCE

I. INTRODUCTION

Traffic loads and traffic volume on our highway system have increased dramatically and at an astonishing rate. According to the FHWA, traffic volumes have increased nearly 100 % and traffic loads more than 250 % over the past 10 years. Both factors, increasing loads and increasing volumes, means that asphalt highways have to be tougher and more durable.

Over the past 10-15 years, some asphalt pavements on Interstate projects in north Florida have experienced premature failures, primarily due to rutting. As a result of these failures, it was believed by many that the fine-graded, 50-blow Marshall mix designs used in Florida were inadequate to withstand current loading conditions. The development of the Superpave System under the Strategic Highway Research Program (SHRP), with its superior mix design method and improved binder specifications, represented an opportunity to address a number of Florida's asphalt pavement problems.

Consequently, the Florida Department of Transportation (FDOT) made a concerted effort to implement the new Superpave technology in north Florida in 1996. This effort resulted in the placement of approximately 345,000 tons of Superpave mix on ten (10) projects that year. As with any new technology, Superpave represented a significant departure from the more traditional methods of designing, producing, placing and compacting asphalt concrete mixtures. While this new technology offers the potential for improved pavement performance, there has been a very limited experience nationally with its field application. As such, Florida has had the opportunity to learn many things in terms of design and construction of Superpave pavements. This presentation will share some of Florida's experiences with the implementation of Superpave.

II. POST-CONSTRUCTION PROBLEMS

In order to accelerate the use of Superpave in 1996, FDOT decided to add the Superpave specifications to on-going projects through the use of Supplemental Agreements. This implementation gave the asphalt contracting industry in Florida the opportunity to gain experience with Superpave and avoid "blindly" bidding on the future Superpave projects. This shared the risks associated with accelerated implementation between FDOT and the industry.

On these 10 early projects, the mixes were designed by the contractors using the Superpave technology. The existing construction specifications were then used to build them. The construction typically involved milling the existing roadway to a depth of from 3.5 to 5 inches, followed by the placement of an Asphalt Rubber Membrane Interlayer (ARMI), then two layers of a coarse-graded Superpave mix (19.0 mm & 12.5 mm). The ARMI layer acts as a moisture barrier and crack relief layer. The mixes were designed using the standard Superpave mix design method, with the exception that the binder used was an AC-30, which satisfies the requirements of a PG 67-22. The Contractor designed the mix using granite from Georgia, limestone screenings from Florida, and Reclaimed Asphalt Pavement (RAP) milled from the projects. During production, the Contractor tested the volumetric properties, gradation, and binder content of the mix twice per day. Acceptance of the mix by FDOT was based on gradation, binder content and density. Production and placement of the mix went quite smoothly. The only problems encountered were related to compaction. Eventually, the Contractor was able to obtain passing densities, using FDOT's standard density specifications. These use a Nuclear Density Gauge in the back-scatter mode. Acceptance is based on average lot density as a percentage of nuclear control strip density, with each lot having to meet a minimum of 98 percent of nuclear control strip density for full pay. (About 90 % of Gmm)

Shortly after completion, a number of the projects started to show signs of water migration in and out of the pavement surface. Since water trapped inside an asphalt pavement can cause the pavement to deteriorate by stripping the asphalt coating off of the aggregate, this unexpected permeability problem had to be resolved.

In late 1996, answers to several fundamental questions were needed. How to measure the permeability problem? How to prevent future problems? How to prevent existing permeable Superpave pavements from deteriorating prematurely? What is the most desirable density for the Superpave mix and how to compact the pavement to achieve that density at the job site?

III. SOLUTIONS AND RECOMMENDATIONS

At first, FDOT developed a device and a test procedure to measure permeability. Roadway cores were then cut from the Superpave projects and tested for density and permeability. From the test information, a relationship between the two properties was established. An acceptable level of permeability and required density were determined to prevent any future problems. At the job site, contractors experimented with various types of rollers, rolling patterns, lift thicknesses and temperature ranges in order to optimize their compaction operations.

Based on the lab investigation and field construction experience, FDOT reached the following conclusions:

- Compaction of coarse-graded Superpave mixes is (as expected) significantly more difficult than the compaction of fine-graded Marshall mixes. Therefore, heavier rollers with more compactive effort is needed.

(2) The nuclear density gauge in the back-scatter mode as used by FDOT is not as accurate in establishing the relative density of coarse-graded Superpave mixes as compared with its previous use with fine-graded Marshall mixes, particularly with higher in-place air void contents.

(3) There appears to be a distinct relationship between lift thickness and compactability of coarse-graded Superpave mixes.

(4) Coarse-graded Superpave mixes require a higher level of density to reduce the water permeability to a level that is comparable with existing fine-grade Marshall mixes.

(5) The maximum acceptable coefficient of permeability, based upon permeability levels of fine-graded Marshall mixes, is 125×10^{-5} cm/s when measured with the Karol-Warner Permeability apparatus.

(6) Laboratory testing indicates that fine-graded Superpave mixes appear to have the same

permeability characteristics as fine-graded Marshall mixes.

(7) To reduce the likelihood of problems due to moisture damage on some of the completed projects, drainage seams were cut transversely across the paved shoulder from the edge of the roadway. This innovative engineering technique allowed water trapped inside the pavement to be released.

In order to address the permeability and density testing problems encountered in our Superpave implementation, FDOT has made the following changes to its existing Superpave specifications:

(1) The density requirement for coarse-graded Superpave mixes has been increased to minimum of 93.5 % of G_{mm} as determined from cores taken from the pavement. The target G_{mm} value is based on the daily average of the Contractor's maximum specific gravity tests (AASHTO T-209). Should the density drop below 93.0 % of G_{mm}, FDOT will evaluate the pavement's permeability, and if it is found to be excessive (greater than 125×10^{-5} cm/s), removal and replacement will be required.

(2) Grant the Contractors a 105 % pay incentive for density equal to or higher than 94.5 % of G_{mm} (for coarse-graded mixes only).

(3) The Contractor shall control air voids (V_A) during production (for coarse-graded mixes only) in the range of from 2.5 to 5.0 %. Plant operations shall be stopped if a single test is below 2.0 or above 5.5 % or when two consecutive tests are below 2.5 %.

(4) The allowable structural layer thicknesses for coarse-graded Superpave mixes have been increased as follows:

SP- 9.5mm 40mm - 50mm

SP-12.5mm 50mm - 80mm

SP-19.0mm 80mm - 90mm

Basically, the minimum lift thickness is four times the nominal maximum aggregate size for coarse mixes. For fine-graded Superpave mixes, the lift thickness criteria is the same as the fine-graded

Marshall mixes.

(5) For initial use of a Superpave mix design, full-scale production and placement of the mix is limited to a test strip of 900 metric tons (for each mix) to demonstrate the capability of producing, placing and compacting the mix as designed. This includes acceptable volumetric properties, acceptable gradation and asphalt content, acceptable density values, and acceptable in-place permeability values.

From the field work perspective, the experience with Superpave construction in Florida can be summarized as follows:

- It is essential to utilize the test strip to develop a compaction process and rolling pattern so that the VPM (vibrations per minute) , amplitude, number~~s~~ of coverages, travel speed and temperature range for different rollers can be determined before the start of full-scale production.

- No two Superpave projects are alike and the construction crew needs to be on top of the compaction process at all times. Not only from project- to- project but also from day-to-day operations on a single project. FDOT recommends that the contractor periodically measure~~s~~ the pavement surface temperature along with the nuclear density during the rolling operation and to verify the effectiveness of compaction efforts. Each roller operator needs to understand what roadway surface temperature ranges he/she should be rolling in.

- Coarse-graded Superpave mixes often tend to cool quickly, and the most efficient way to get the mix compacted is to keep the breakdown roller right behind the paver. In Florida, vibratory rollers are typically selected as the breakdown roller and this initial compaction is conducted at the temperature zone between 285 degrees to 300 degrees F. Vibratory rollers that have been used most successfully typically weigh over 12 tons, and are 84 inches wide.

- In the temperature zone approximately from 200 degrees to 260 degrees F, many of the mixes (particularly coarse-graded mixes) become tender and unstable. Compaction should be avoided (or else use a pneumatic-tire roller if possible) while the pavement cools through this "Tender Zone".

(5) The risk of over compaction must always be considered at the job site to avoid pavement cracking and aggregate crushing.

(6) For finish rolling, a heavy static tandem roller or a vibratory roller operating in static mode can be used roughly in the temperature range from 140 degrees to 160 degrees F. This last process will roll

out marks and irregularities while obtaining the final density. Florida has been surprised by how much additional density the back roller picks up.

(7) The selection of high quality and consistent aggregates for the Superpave mix will positively benefit the Superpave construction. Aggregates with high absorption, prone to degradation and contamination will make it tough to construct a good Superpave pavement structure.

IV. CONCLUSION

Since 1996, FDOT has completed over 95 Superpave projects including the placement of over 3,756,000 tons of Superpave mix. In spite of some initial problems implementing Superpave in Florida, FDOT held onto its belief that this technology would result in higher quality asphalt pavement. As of January 1998, all FDOT highway projects have been designed using the Superpave system. Until now, the FDOT has been monitoring the 95 previously completed projects very closely. The performance on these 95 projects has been outstanding.

Superpave mixes have offered some challenges, and FDOT and the Asphalt Industry continue to learn and modify the mix designs, construction operations and specifications. FDOT is convinced that Superpave has the potential to provide dramatically improved pavement performance at a reasonable cost in Florida.