STATE EXPERIMENTAL CONSTRUCTION

99-11

INNOVATIVE SOLUTIONS to BURIED

PORTLAND CONCRETE CEMENT ROADWAYS

CONSTRUCTION REPORT

INTRODUCTION

Maine has hundreds of miles of highway that were constructed of Portland Concrete Cement (PCC) roughly 6 to 6.1 meters (18 to 20 feet) wide forty or more years ago. Since that time these same highways have been paved and widened to 6.7 or 7 meters (22 or 24 feet) with hot bituminous pavements to accommodate increased traffic volumes. Bituminous materials were used instead of concrete due to the ease of placement and price of material.

Concrete is a rigid pavement capable of supporting weight with little deflection. Bituminous is a flexible pavement that will bend to distribute weight across the roadway. When the highway is expanded beyond the concrete slab there is a sharp decrease of support for this bituminous pavement resulting in settlement over prolonged use. This settlement may also be compounded by poor drainage capabilities of the underlying soils causing the unsupported pavement to drop lower than the existing height of the concrete supported pavement. This creates a longitudinal crack aligning with the concrete slab edge about 0.3 to 1 meter (1 to 3 feet) from the right edge of pavement. Pavement to the right of this crack deteriorates to the point where maintenance crews attempt to smooth it out with cold patch year after year. Paving over the entire roadway is an option but, due to reflective cracking, the edge of pavement begins to deteriorate within 2 or 3 years.

BACKGROUND

Project No. STP-8651(00)X on Route 100 between the towns of Benton and Palmyra is 30.6 kilometers (19 miles) long and scheduled for an overlay of maintenance mix. This is a 7.3 meter (24 foot) bituminous roadway over 6.2 meters (20 feet) of PCC. The 0.6 meter (2 foot) edge of pavement on both sides has deteriorated, creating a traffic hazard and maintenance problem for years. Condition of the drainage ditch is poor along the entire project and there is very little underdrain. A section of this project beginning 4.5 kilometers (2.8 miles) north of the junction of Route 100A in Benton and extending north 2.5 kilometers (1.6 miles) to the town of Clinton was selected to construct four experimental shoulder rehabilitation sections. This project was activated in August with a deadline of October 30, 1998, so time and available money to develop experimental sections was limited. An E-mail request, phone interviews, and literature search of AASHTO members were conducted to gather information on techniques used to correct composite roadway shoulder problems. A panel with personal from Highway Design, Construction, Geotechnical and the Bureau of Maintenance and Operations used this information

as well as ideas of their own to design four experimental sections each 500 meters (1640 feet) in length plus a control section 500 meters (1640 feet) in length.

Another shoulder rehabilitation experiment that is not part of the Benton - Clinton project but will be included in this report was constructed in 1997-98 on Route 2 in Veazie. This is a 6.6 meter (22 foot) bituminous highway over 5.2 meters (18 feet) of PCC. This project also had poor drainage and a deteriorated pavement edge causing traffic hazards and maintenance headaches. The experimental section begins 100 meters (328 feet) north of Chase Street in Veazie and extends north 190 meters (623 feet).

CONSTRUCTION

Benton - Clinton Project No. STP-8651(00)X:

Construction of each shoulder treatment went smoothly. Most of the material excavated from the shoulders consisted of granular soil not clay as expected and the depth of each trench did not penetrate the clay subgrade.

The exposed PCC slab on Sections 2 and 3 could not hold up to traffic and had to be shimmed with 9.5 millimeter (0.374 inch) bituminous mix.

Figures 1 - 4 contain cross sections for each experimental treatment. Limits and a brief description for each section is as follows:

Section 0 Maintenance Mix (control)

This section is located between station 0+500 and 1+000. There is no shoulder rehabilitation and the roadway is treated with an estimated average thickness of 2 centimeters (0.75 inches) of 9.5 millimeter (0.374 inch) maintenance mix.

Section 1 Cold Recycled Pavement

This section is located between station 1+000 and 1+500. The existing pavement was ground to slope to a nominal depth of 50 millimeters (2 inches). The shoulders were excavated adjacent to the existing PCC slab edge to a depth of 680 millimeters (27 inches) and width of 1200 millimeters (47 inches). This boxed shoulder was then filled with 300 millimeters (12 inches) of Type D Aggregate Subbase Coarse Gravel (ASCG) MDOT Standard Specifications Item Number 703.06 and 380 millimeters (15 inches) of Cold Recycled Pavement.

The roadway and shoulders were then paved with a 60 millimeter (2.4 inch) layer of 19 millimeter (0.75 inch) Superpave Binder and topped with a 40 millimeter (1.6 inch) layer of 12.5 millimeter (0.5 inch) Superpave wearing coarse.

Section 2 Flowable Fill

Flowable Concrete Fill is a concrete mixture that includes 245-105 kg cement/M^3 with a water-cement ratio not high enough to cause segregation of the mix and a target Air Content of 5-15 percent. A modified slump test spread of 225 - 350 millimeters is considered flowable. The slump spread is obtained by setting a 75 millimeter x 150 millimeter cylinder mold, open on both ends, on a flat surface, then filling the cylinder and striking off the top. During a count of three seconds, lift the cylinder straight up allowing the sample to spread on the flat surface. The spread diameter is measured to the nearest 15 millimeters (0.6 inches).

All existing pavement was removed to the PCC surface and the shoulders were excavated adjacent to the PCC slab to a depth of 530 millimeters (21 inches) and width of 1200 millimeters (47 inches).

There are two separate shoulder treatments within this section. Section 2A located between station 1+500 to 1+970 right and 1+500 to 2+000 left. This section has 300 millimeters (12 inches) of ASCG and 230 millimeters (9 inches) of Flowable Fill.

Section 2B is located between station 1+970 and 2+000 right. This section has no ASCG and 530 millimeters (21 inches) of Flowable Fill.

Surface treatment for Section 2 consists of 60 millimeters (2.4 inches) of 19 millimeter (0.75 inch) Superpave Binder and 40 millimeters (1.6 inches) of 12.5 millimeter (0.5 inch) Superpave wearing coarse.

Section 3 Superpave

This section is located between station 2+000 and 2+500. The existing pavement was removed and shoulders were excavated beside the PCC slab to a depth of 530 millimeters (21 inches) and width of 1200 millimeters (47 inches).

The shoulder treatment consists of 300 millimeters (12 inches) of ASCG and 230 millimeters (9 inches) of 25 millimeter (1 inch) Superpave Binder.

Again, the roadway and shoulders were paved with 60 millimeters (2.4 inches) of 19 millimeter (0.75 inch) Superpave Binder and 40 millimeters (1.6 inches) of 12.5 millimeter (0.5 inch) Superpave wearing coarse.

Section 4 Heavy Overlay

Section 4 is located between station 2+500 and 3+000. The existing shoulders were graded to slope and the roadway was shimmed with a minimum of 13 millimeters (0.5 inches) of 9.5 millimeter (0.374 inch) bituminous mix. Then the roadway and shoulders were paved with 40 millimeters (1.6 inches) of 12.5 millimeter (0.5 inch) Superpave wearing coarse.

Veazie - Orono Project No. STP-6683(00)X:

Construction of this shoulder treatment and application of the self adhesive mesh went smoothly with no setbacks. Figure 5 contains a typical section for the self adhesive section.

A description and location for each section is as follows:

Self Adhesive Mesh Section

This experimental area begins at station 2+140 and ends at 2+330. The project entails grinding 75 millimeters (3.0 inches) of existing pavement then shimming with 5 millimeters (0.2 inches) of 4.75 millimeter (0.187 inch) bituminous mix.

The shoulders were trenched to a depth of 150 millimeters (6 inches) below height of the milled and shimmed pavement and to a variable width of 0.6 to 2.5 meters (2 to 8 feet). This trench is then filled with 150 millimeters (6 inches) of Hot Recycled Pavement made up of a blend of 60 percent virgin aggregate and 40 percent recycled pavement with an asphalt content of 2.5 to 4.5 percent using AC-20 grade asphalt cement. A layer of PavePrep SA7 self adhesive mesh 508 millimeters (20 inches) wide manufactured by Contech Construction Products Incorporated was placed to bridge the transition between concrete supported pavement and Hot Recycled shoulder.

The roadway and shoulders were then paved with 40 millimeters (1.5 inches) of 19 millimeter (0.75 inch) binder and 30 millimeters (1.2 inches) of 12.5 millimeter (0.5 inch) wearing coarse.

Control Section

This section is located between station 3+230 and 3+420. The existing pavement was milled to a depth of 75 millimeters (3.0 inches) then shimmed with 5 millimeters (0.2 inches) of 4.75 millimeter (0.187 inch) bituminous mix.

Shoulders were excavated to a width of 600 millimeters (22 inches) beyond the PCC edge and depth of 150 millimeters (6 inches) below the milled pavement surface. This boxed shoulder area was filled with 150 millimeters (6 inches) of Hot Recycled Pavement.

The highway and shoulders were then surfaced with 40 millimeters (1.5 inches) of 19 millimeter (0.75 inch) binder and 30 millimeters (1.2 inches) of 12.5 millimeter (0.5 inch) wearing coarse.

TEST RESULTS

Falling Weight Deflectometer (FWD) tests were recorded on the Benton - Clinton project. Tests were collected on the experimental shoulders and on the PCC supported surface adjacent to each shoulder test. Unfortunately, there were no tests recorded on Section 2B Full Depth Flowable Fill. Table I contains raw FWD deflections in mils recorded from sensor # 1. Raw deflections were used because of software limitations when processing data collected on composite roads containing PCC.

The shoulder FWD tests on Section 3 Superpave produced the lowest deflections (lower deflections denote stronger highways) followed by Section 1 Cold Recycled Pavement, Section 2A 230 mm Flowable Fill, Section 4 Heavy Overlay and finally Section 0 Maintenance Mix.

As mentioned earlier, there were no tests recorded on Section 2B Full Depth Flowable Fill and also on the Veazie - Orono project. Deflections will be collected on these areas for the first interim report.

COST ANALYSIS

A cost per Section summary for the Benton - Clinton project is listed in Table II. The Section/Meter totals for each treatment represents the cost per centerline meter from shoulder to shoulder. Please note that Section 4 shoulder treatment costs represent a 0.6 meter (2 foot) wide shoulder whereas Section 1, 2 and 3 costs are for a 1.2 meter (4 foot) shoulder.

A review of the data reveals that Section 3 Superpave had the highest cost followed by Section 2B Full Depth Flowable Fill, Section 2A 230 mm Flowable Fill, Section 1 Cold Recycled Pavement, Section 4 Heavy Overlay and finally Section 0 Maintenance Mix.

Table III contains a summary of costs per meter for the Veazie - Orono project. The column labeled Section/Meter represents the cost per centerline meter from shoulder to shoulder. Since the Experimental Section has a wider shoulder treatment than the Control Section, the cost analysis for this section will be based on a 0.6 meter (2 foot) shoulder.

SUMMARY

According to the FWD numbers Section 3 Superpave is supporting the pavement almost as well as the PCC roadway, but at a greater cost compared to other treatments. The contractor bid a price of $65.00/Mg for 25 millimeter (1 inch) Superpave Binder used on Section 3 assuming a lot of hand work had to be used to compact the mix. When constructing this section a small roller was used instead of hand labor, this would significantly reduce the cost of applying this treatment in future applications. Section 1 Cold Recycled Pavement also looks very promising with the second lowest deflections and lowest cost per shoulder treatment.

In October of 1998 a visual inspection of the Veazie - Orono project was conducted and revealed no pavement distress.

FWD tests, visual evaluations, roughness and rut depths will be collected on both projects and reported annually for a period of five years.

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