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Maine Department of Transportation

Transportation Research Division

Technical Report 99-11

Innovative Solutions to Buried Portland Cement Concrete Roadways – Rt. 100 Benton – Clinton & Rt. 2 Veazie

Interim Report - Fourth Year, March 2004

Transportation Research Division

Innovative Solutions to Buried Portland Cement Concrete Roadways

Introduction

Maine has hundreds of miles of highway that were constructed of Portland Cement Concrete (PCC) roughly 5.5 to 6.0 m (18 to 20 ft) wide forty or more years ago. Since that time these same highways have been paved and widened to 6.7 or 7.3 m (22 or 24 ft) with hot bituminous pavements to accommodate increased traffic volumes and enhance roadway safety. Bituminous materials were used in place of concrete due to the ease of placement and price of material.

PCC is a rigid pavement capable of supporting weight with little deflection. In contrast, hot bituminous pavement is flexible and will flex 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 m (1 to 3 ft) 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.

It is the intent of this experimental project to explore various shoulder treatments to increase support of the extended roadway and hopefully decrease or eliminate deterioration of the shoulder pavement.

Background

Project No. STP-8651(00)X on Route 100 between the towns of Benton and Pittsfield is 26.9 km (16.7 mi) long and scheduled for an overlay of maintenance mix. This is a 7.3 m (24 ft) wide bituminous roadway over 6.2 m (20 ft) of PCC. The 0.6 m (2 ft) 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 km (2.8 mi) north of the junction of Route 100A in Benton and extending north 2.5 km (1.6 mi) to the town of Clinton was selected to construct four experimental shoulder rehabilitation sections. This project was activated in

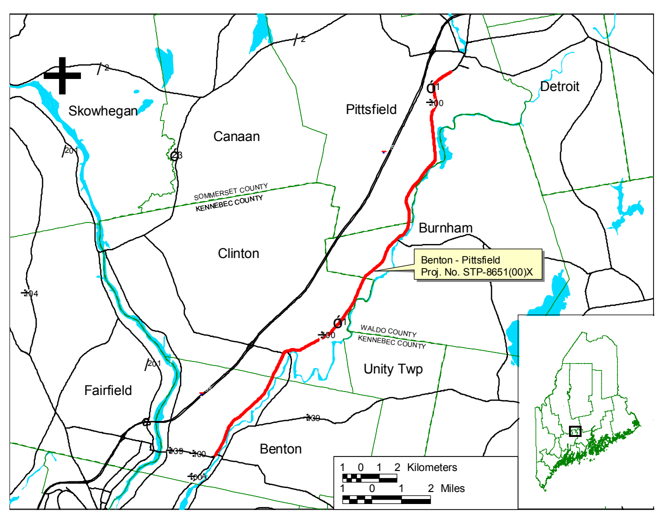

Fig. 1 Location map

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, and Geotechnical Divisions plus the Bureau of Maintenance and Operations, used this information as well as ideas of their own to design four experimental sections, each 500 m (1640 ft) in length plus a control section 500 m (1640 ft) 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 m (22 ft) bituminous highway over 5.2 m (18 ft) of PCC. This project also had poor drainage and a deteriorated pavement edge causing traffic hazards and maintenance headaches. The experimental section begins 100 m (328 ft) north of Chase Road in Veazie and extends north 190 m (623 ft).

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.

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

Control Section, Maintenance Mix

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 20 mm (0.75 in) of 9.5 mm (0.374 in) maintenance mix.

Section 1, Cold Recycled Pavement

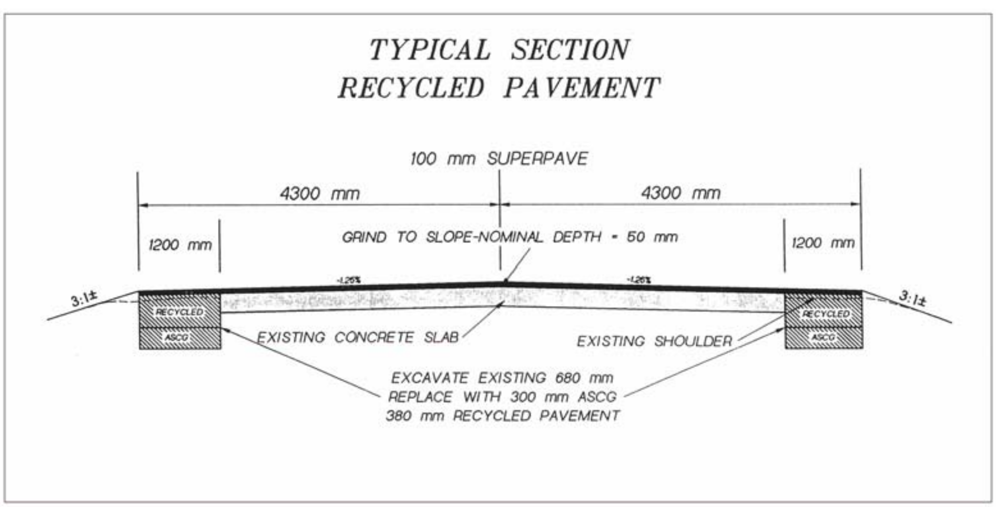

Fig. 2 Section 1

This section is located between station 1+000 and 1+500. Figure 2 contains a typical cross section of the section. The existing pavement was ground to slope to a nominal depth of 50 mm (2 in). The shoulders were excavated adjacent to the existing PCC slab edge to a depth of 680 mm (27 in) and width of 1200 mm (47 in). This boxed shoulder was then filled with 300 mm (12 in) of

Type D Aggregate Subbase Coarse Gravel (ASCG) MDOT Standard Specifications Item Number 703.06 and 380 mm (15 in) of Cold Recycled Pavement.

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

Section 2, Flowable Fill

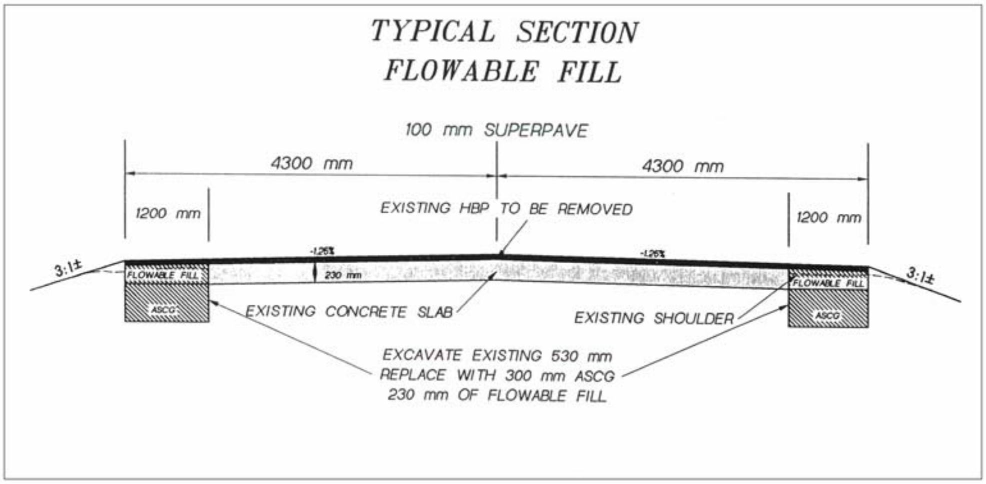

Fig. 3 Section 2A

Flowable Concrete Fill is a concrete mixture that includes 245-105 kg cement/M³ with a water-cement ratio low enough to prevent segregation of the mix and a target Air Content of 5-15 percent. A modified slump test spread of 225 - 350 mm (8.9 - 13.8 in) is considered flowable. The slump spread is obtained by setting a 75 mm x 150 mm (3 in x 6 in) 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 mm (0.6 in).

All existing pavement was removed to the PCC surface and the shoulders were excavated adjacent to the PCC slab to a depth of 530 mm (21 in) and width of 1200 mm (47 in). The exposed PCC slab could not hold up to traffic and had to be shimmed with 9.5 mm (0.374 in) bituminous mix.

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 mm (12 in) of ASCG and 230 mm (9 in) of Flowable Fill. Figure 3 contains a cross section of Section 2A.

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

Surface treatment for Section 2 consists of 60 mm (2.4 in) of 19 mm (0.75 in) Superpave Binder and 40 mm (1.6 in) of 12.5 mm (0.5 in) 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 mm (21 in) and width of 1200 mm (47 in). As with Section 2, the exposed PCC slab could not hold up to traffic and had to be shimmed with 9.5 mm (0.374 in) bituminous mix. A typical cross section of Section 3 is displayed in figure 4.

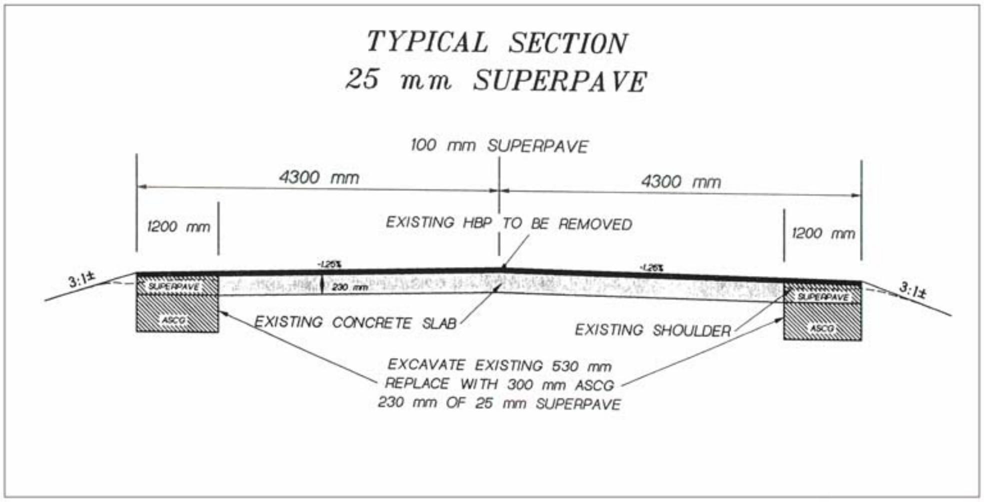

Fig. 4 Section 3

MDOT specifies that traveled way surface mix can be placed between the dates of April 15th and the Saturday following October 15th. The surface deadline was nearing before Section 3 shoulder construction was completed. To avoid the deadline, the roadway was paved with 60 mm (2.4 in) of 19 mm (0.75 in) Superpave Binder and 40 mm (1.6 in) of 12.5 mm (0.5 in) Superpave wearing coarse to an offset of 3 m (10 ft) left and right of centerline. Reconstruction of the shoulder continued after the roadway was paved. The shoulder treatment consists of 300 mm (12 in) of ASCG and 230 mm (9 in) of 25 mm (1 in) Superpave Binder. Binder and surface mix was placed on the shoulders after shoulder reconstruction was complete. This left a longitudinal joint 3 m (10 ft) left and right of centerline.

Section 4, Heavy Overlay

Section 4 is located between station 2+500 and 3+000. The existing shoulders were graded and compacted. All unsuitable material was removed and areas that were below grade were filled with ASCG and compacted to required grade. The roadway was then shimmed with a minimum of 13 mm (0.5 in) of 9.5 mm (0.374 in) bituminous mix. Then the roadway and shoulders were paved with 40 mm (1.6 in) of 12.5 mm (0.5 in) Superpave wearing coarse. A typical cross section of this treatment is displayed in figure 5.

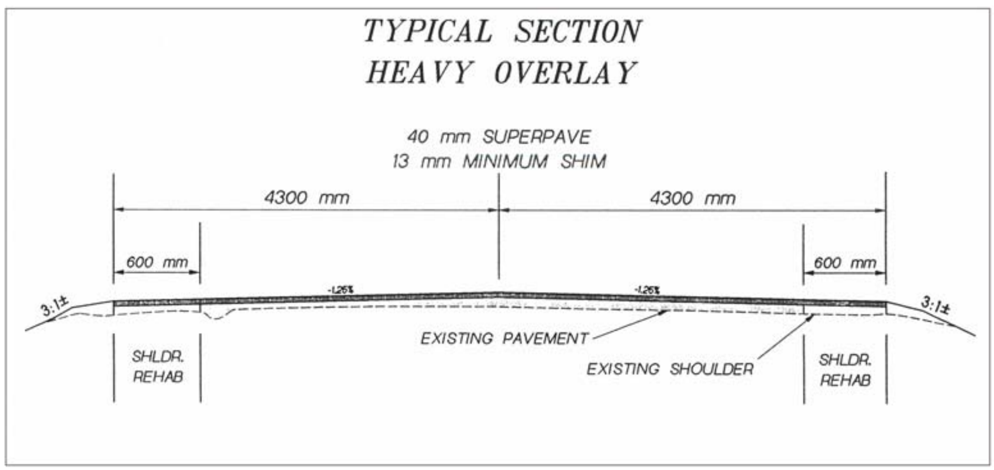

Fig. 5 Section 4

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.

A description and location for each section is as follows:

Self-Adhesive Mesh Section

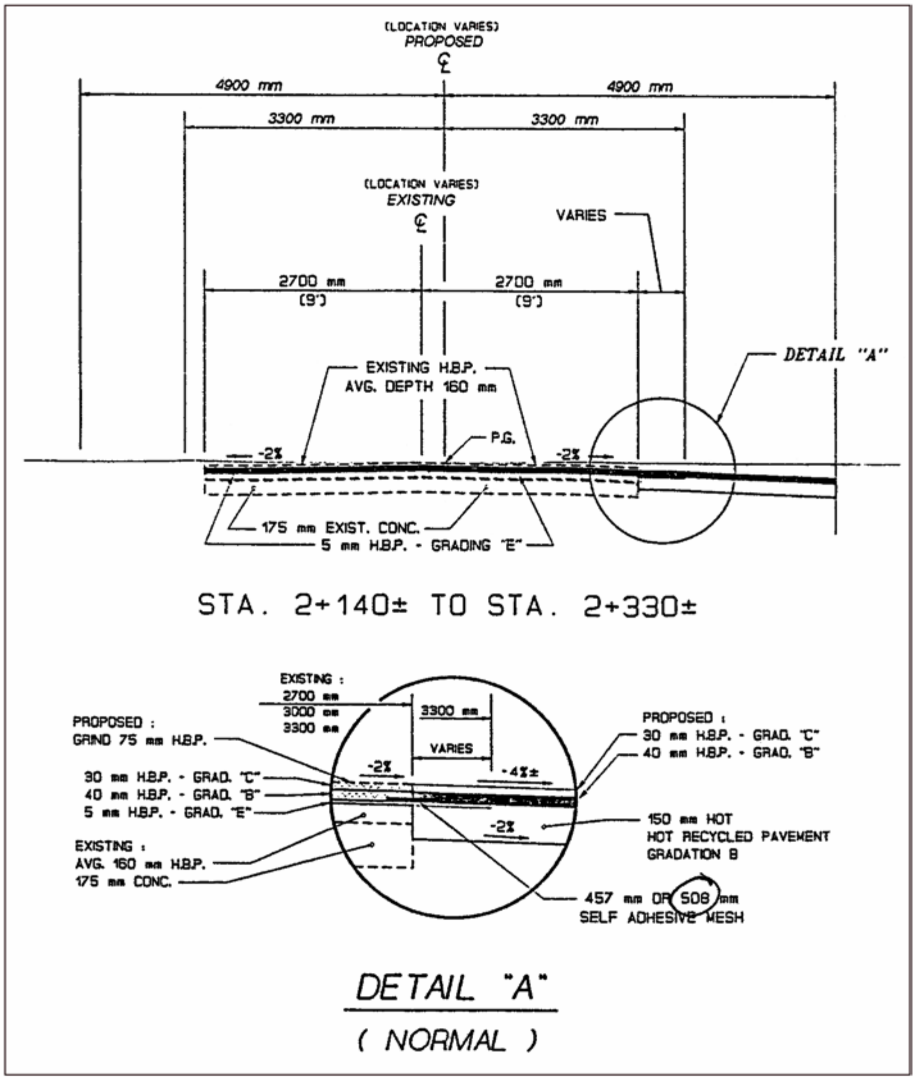

Fig. 6 Self-adhesive mesh

Figure 6 contains a cross section of the Self-Adhesive mesh section. This experimental area begins at station 2+140 and ends at 2+330. The project entails grinding 75 mm (3.0 in) of existing pavement then shimming with 5 mm (0.2 in) of 4.75 mm (0.187 in) bituminous mix.

The shoulders were trenched to a depth of 150 mm (6 in) below height of the milled and shimmed pavement and to a variable width of 0.6 to 2.5 m (2 to 8 ft). This trench is then filled with 150 mm (6 in) 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, manufactured by Contech Construction Products Incorporated, 508 millimeters (20 inches) wide was placed to bridge the transition between concrete supported pavement and Hot Recycled shoulder.

The roadway and shoulders were then paved with 40 mm (1.5 in) of 19 mm (0.75 in) binder and 30 mm (1.2 in) of 12.5 mm (0.5 in) 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 mm (3.0 in) then shimmed with 5 mm (0.2 in) of 4.75 mm (0.187 in) bituminous mix.

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

The highway and shoulders were then surfaced with 40 mm (1.5 in) of 19 mm (0.75 in) binder and 30 mm (1.2 in) of 12.5 mm (0.5 in) wearing coarse.

Cost Analysis

A cost summary of each shoulder treatment for the Benton - Pittsfield project is listed in Table 1. The Cost column represents the cost per centerline meter from shoulder to shoulder. Please note that the Control Section and Section 4 shoulder treatment costs represent a 0.6 m (2 ft) wide shoulder whereas Section 1, 2A, 2B, and 3 costs are for a 1.2 m (4 ft) shoulder.

TABLE 1. ROUTE 100, BENTON - PITTSFIELD COST SUMMARY

Section	Treatment	Station	Cost
Control	Maintenance Mix Overlay	0+500 - 1+000	$12.59
1	Cold Recycled Pavement	1+000 - 1+500	$156.60
2A	230 mm Flowable Fill	1+500 - 2+000 Left 1+500 - 1+970 Right	$174.44
2B	530 mm Flowable Fill	1+970 - 2+000 Right	$199.98
3	230 mm 25 mm Superpave	2+000 - 2+500	$223.70
4	Heavy Overlay	2+500 - 3+000	$58.87

A review of the data reveals that Section 3 with Superpave had the highest cost followed by Section 2B with Full Depth Flowable Fill, Section 2A with 230 mm (9 in) Flowable Fill, Section 1 with Cold Recycled Pavement, Section 4 with Heavy Overlay and finally Control Section Maintenance Mix.

Table 2 contains a summary of costs per meter for the Veazie - Orono project. The cost column 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 is based on a 0.6 m (2 ft) shoulder.

TABLE 2. ROUTE 2, VEAZIE - ORONO COST SUMMARY

Section	Treatment	Station	Cost
SAM	Self Adhesive Mesh	2+140 - 2+330	$78.85
Control	150 mm Hot Recycled Pavement	3+230 - 3+540	$60.85

Falling Weight Deflectometer Test Results

Photo 1. Falling Weight Deflectometer

Falling Weight Deflectometer (FWD) readings were collected for the Benton - Clinton project on July 19, 2002. Deflections were recorded on the experimental shoulders and on the PCC supported roadway adjacent to each shoulder test. Table 3 illustrates average FWD deflections recorded from sensor # 1 as well as the difference between roadway and shoulder deflections and the average five-year variance. Raw deflections were used due to software limitations when processing data collected on composite roads containing PCC. FWD deflections could not be collected on the Veazie – Orono project because of the limited space between the PCC edge and sidewalk curb.

Average roadway deflections are very consistent throughout the project.

Shoulder deflections on the other hand are consistent for 1998, 2000, 2001, and 2002 but low for all Sections in 1999 with the exception of Section 3. FWD tests in 1999 may have been collected on or very close to the PCC edge resulting in low deflection readings. For this reason we will be evaluating 1998, 2000, 2001, and 2002 data only. Section 3 shoulder tests for all five years are typical readings possibly due to the constructed longitudinal pavement joint (see Photo 2) paralleling the PCC edge directing the FWD operator more toward the shoulder. In the future, FWD tests will be monitored to assure accurate data collection.

Photo 2. Section 3

All sections with shoulder treatments have lower deflections (greater strength) than Section 4 and the Control Section.

Section 4, Heavy Overlay, and the Control Section with Maintenance Mix, continue to have the highest shoulder deflections (less stability) at 29.16 and 33.19 mils respectively. Data reveals that shoulder deflections have increased from last years deflections in these two sections whereas shoulder deflections have somewhat stabilized in Sections 1, 2A, 2B, and 3.

Section 2B with 530 mm of Flowable Fill continues to have the lowest average shoulder deflection at 6.83 mils and the least amount of PCC related edge cracking (summarized later). The average shoulder deflection is lower or more stable than the average roadway deflection.

Section 3 with Superpave continues to be very stable with an average shoulder deflection of 10.58 mils. This section also has a low amount of PCC related edge cracking.

TABLE 3. FALLING WEIGHT DEFLECTOMETER SUMMARY

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

Section	Treatment Type	Average Shoulder Deflection (mils)					Average Roadway Deflection (mils)					Shoulder vs Roadway Comparison Variance (mils)					
		1998	1999	2000	2001	2002	1998	1999	2000	2001	2002	1998	1999	2000	2001	2002	Average
Control	Maintenance Mix	30.26	20.37	34.73	25.93	33.19	10.85	11.44	11.88	9.79	9.58	19.41	8.93	22.85	16.14	23.61	20.50
1	Recycled Pavement	15.46	13.46	14.73	15.82	14.67	9.44	8.96	9.76	8.12	9.10	6.02	4.50	4.97	7.70	5.57	6.07
2A	230 mm Flowable Fill	17.87	13.60	17.30	16.57	17.68	9.29	8.07	10.31	8.78	9.36	8.58	5.53	6.99	7.79	8.32	7.92
2B	530 mm Flowable Fill	N/A	4.73	9.44	6.73	6.83	N/A	6.12	8.24	5.82	7.10	N/A	-1.39	1.20	0.91	-0.27	0.61
3	Superpave	8.44	9.32	9.05	10.58	9.65	7.49	6.63	7.45	6.36	6.56	0.95	2.69	1.60	4.22	3.09	2.46
4	Heavy Overlay	29.66	24.11	30.65	26.23	29.16	7.39	7.14	8.35	7.13	7.76	22.27	16.97	22.30	19.10	21.40	21.27

Lower deflection (mils) denotes greater stability
Highlighted data excluded from evaluation.

Section 1, Recycled Pavement, and Section 2A, 230 mm Flowable fill, continue to have the highest shoulder deflections of the four treated shoulders with an average of 14.67 and 17.68 mils respectively. These sections also have the greatest amount of PCC related edge cracking of the four treated shoulders.

Visual Evaluation

A visual evaluation was conducted on November 14, 2002. Table 4 contains a pavement condition summary for the Benton - Clinton and Veazie - Orono projects.

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

Control Section, Maintenance Mix

Photo 3. Control Section

Rut depths have increased in severity throughout this section. Three percent of the section had rut depths less than 6 mm (0.25 in), forty two percent were in the range of 6 to 13 mm (0.25 to 0.5 in), and fifty five percent are greater than 13 mm in depth, this is an increase of forty five percent in one year.

The centerline joint has no ravel and joint separation has increased from 51.4 to 65.2 percent.

The number of transverse cracks between the wheel path has decreased from last year. Many of these cracks have developed into full or half roadway transverse cracks resulting in an increase of half and full roadway transverse cracks.

Ninety nine percent of PCC edge related cracking has reflected thru the pavement (see Photo 3) and the shoulder elevation has dropped 4 to 12 mm (0.2 to 0.5 in) below roadway elevation.

Section 1, Cold Recycled Pavement

Eighty eight percent of this section has rut depths in the < 6 mm (< 0.25 in) range and 12 percent in the 6 – 13 mm (0.25 to 0.5 in) range, a slight increase from the 2001 evaluation.

The amount of centerline joint ravel has increased from 3 to 4.8 percent and joint separation has increased slightly from 95.1 to 95.2 percent.

The number of transverse cracks between the wheel path and across one lane has decreased from 40 to 13 and 10 to 6 respectively. A number of these cracks have extended across the roadway and are now full width transverse cracks. The number of full width transverse cracks has increased from 1 to 16.

Photo 4. Section 1

PCC related longitudinal cracking has increased dramatically from 28.5 to 71.2 percent (see Photo 4). This is the greatest amount of this type of cracking among the experimental sections.

Section 2A, 230 mm Flowable Fill

Photo 5. Severe Rutting in Section 2A

The severity of rutting has increased in Section 2A. Rut depths < 6 mm (0.25 in) in depth has decreased from 83.4 to 80 percent of the total section and rutting between 6 and 13 mm (0.25 and 0.5 in) in depth has also decreased from 10.8 to 5 percent while rutting greater than 13 mm (0.5 in) in depth has nearly tripled from 5.8 to 15 percent. There are a few areas in the South bound lane that have ruts at the PCC edge crack that are greater than 38 mm (1.5 in) in depth (see Photo 5).

Centerline joint condition has not changed much from the last evaluation. Joint seperation remained the same at 98.5 percent of the section and the amount of ravel increased from 0 to 1.5 percent.

The amount of transverse cracks has increased. Full width increased from 12 to 18, half width increased from 10 to 19, and cracks between wheel paths increased from 10 to 14.

PCC related edge cracking has increased nearly a third from 49.2 to 71.1 percent with no shoulder elevation change (see Photo 6). This is the second highest amount of PCC related edge cracking among the experimental sections.

Photo 6. Section 2A

Section 2B, 530 mm Flowable Fill

Although Section 2B is short, it continues to outperforming all other experimental sections.

Rut depths have remained the same at < 6 mm (< 0.25 in).

Centerline joint separation increased from 73 to 85.3 percent.

The number of full and half roadway transverse cracks has remained the same at 1 and 0 respectively. One transverse crack has developed between the wheel paths.

There has been a slight increase in PCC related edge cracking from 8.3 to 9.3 percent. This experimental treatment has reduced the amount of PCC related edge cracking better than all other sections. In the lower left hand corner of Photo 7, you can see where PCC edge cracking in Section 2A has stopped at the beginning of Section 2B.

Photo 7. Section 2B

Section 3, 230 mm of 25 mm Superpave

The longitudinal shoulder construction joint, 3 m (10 ft) left and right of centerline, has separated from the roadway throughout 99.7% of this section. The joint is greater than 24 mm (1 in) in width in some areas (see Photo 8).

Rut depths continue to increase in depth. Sixty percent of this section has ruts < 6 mm (<0.25 in) in depth and 25 percent is between 6 and 13 mm (0.25 and 0.5 in) in depth. Rut depths greater than 13 mm (0.5 in) in depth have increased from 5 percent to 15 percent.

Photo 8. Section 3 Construction Joint

This section has the lowest amount of centerline joint separation at 17.4 percent with no raveling.

The number of transverse cracks has increased. Full width increased from 1 to 11, half width increased from 4 to 9, and between wheel path increased from 5 to 13. Although the number has gone up, this section has the second lowest number of transverse cracks.

The amount of PCC related edge cracking has increased from 22.7 to 26.1 percent.

There is a 20 m (66 ft) long area in the North bound lane where the shoulder elevation is higher than the roadway. Shoulder height has increased from 25 to 30 mm (1 to 1.25 in)over the past year. Photo 9 displays the elevation change. This is the only section where the shoulder elevation is higher than the roadway elevation. Water may be saturating the shoulder subbase by entering thru the bituminous construction joint and PCC edge crack. If the excess water does not have enough time to properly drain from the subbase aggregate before the roadway freezes, frost action in the spring may be raising the shoulder elevation above the roadway.

Photo 9. Section 3 Elevation Change

Section 4 Heavy Overlay

Rut depths have increased dramatically from the last evaluation. While the amount of rutting < 6mm

(< 0.25 in) and 6 – 13 mm (0.25 – 0.5 in) in depth has decreased from 88.9 to 50 percent and 11.1 to 8 percent respectively, the amount of rutting greater than 13 mm in depth has increased from 0 to 42 percent.

Centerline joint cracking has increased from 85.1% to 97.1%.

The number of transverse cracks has increased slightly with full width cracks up from 21 to 28, half width from 12 to 17 and between wheel path cracks from 20 to 21.

PCC related edge cracking has increased from 40.3 to 68.6% (Photo 10). This is significantly less than the Control Section and slightly less than experimental Sections 1 and 2A. Experimental Sections 2B and 3 continue to have less PCC edge cracking.

Shoulder elevation remains even with the roadway.

Photo 10. Section 4

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

A natural gas pipeline was installed at an offset of between 4 and 5 m (13 and 16 ft) right of centerline on the entire project.

Self Adhesive Mesh Section

Photo 11. Self Adhesive Mesh

The Self Adhesive Mesh experimental section continues to perform very well.

Rutting remained the same at 6 to 13 mm (0.25 to 0.5 in) in depth.

Most of the centerline joint is intact with only 5.8 percent beginning to separate.

The number of full and half roadway transverse cracks has remained the same. Transverse cracking between wheel paths have increased from 2 to 4.

PCC edge related cracking has increased from 5.9 to 16.8 percent (Photo 11). Although this is nearly three times higher than the last evaluation, it is still well below the amount of cracking in the Control Section.

Shoulder elevation is still even with the roadway.

Table 4. Pavement Condition Summary

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

	Rutting (%)												Centerline joint condition								Number of transverse cracks												PCC related longitudinal cracking (%)				Shoulder elevation change (mm)			
	< 6 mm				6 - 13 mm				> 13 mm				Ravel (%)				Separation (%)				Full width (across two lanes)				Half width (across one lane)				Between Wheelpath											
Section	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'
Control	65	32	25	3	0.8	64	65	42	4	4	10	55	0	0	2.4	0	0	6.1	51.4	65.2	25	47	47	64	12	20	36	81	102	321	348	277	49.5	85.7	92.7	99	0	0	-4	-12
1	100	100	100	88	0	0	0	12	0	0	0	0	90	90	3	4.8	0	0	95.1	95.2	0	0	1	16	1	2	10	6	0	2	40	13	0.6	7.7	28.5	71.2	0	0	0	0
2A	100	96.7	83.4	80	0	3.3	10.8	5	0	0	5.8	15	83	83	0	1.5	0	0.2	98.5	98.5	1	3	12	18	0	5	10	19	0	4	10	14	0	25.3	49.2	71.1	0	0	0	0
2B	100	100	100	100	0	0	0	0	0	0	0	0	0	0	0	0	0	3	73	85.3	0	1	1	1	0	0	0	0	0	0	0	1	0	3.3	8.3	9.3	0	0	0	0
3	100	91.7	77	60	0	6.4	18	25	0	1.9	5	15	30	30	24	0	0	0	8.1	17.4	0	0	1	11	0	0	4	9	0	0	5	13	10.7	14.5	22.7	26.1	6	13	25	30
4	100	100	88.9	50	0	0	11.1	8	0	0	0	42	85	85	7.2	0	0	0.3	85.1	97.1	8	9	21	28	11	12	12	17	13	16	20	21	0.4	14.6	40.3	68.6	0	0	0	0

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

	Rutting (%)												Centerline joint condition								Number of transverse cracks												PCC related longitudinal cracking (%)				Shoulder elevation change (mm)			
	< 6 mm				6 - 13 mm				> 13 mm				Ravel (%)				Separation (%)				Full width (across two lanes)				Half width (across one lane)				Between Wheelpaths											
Section	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'	'99'	'00'	'01'	'02'
SAM	100	100	0	0	0	0	100	100	0	0	0	0	0	0	0	0	0	0	0	5.8	2	2	2	2	2	2	2	2	2	2	2	4	2	2	5.9	16.8	0	0	0	0
Control	100	100	0	0	0	0	68.4	65	0	0	31.6	35	0	0	0	0	0	0	0	1.8	2	2	2	3	0	0	1	2	1	1	3	4	28	30.6	33.3	36.8	0	10	6	6

Control Section


Photo 12. Control Section

Rut depth severity has increased somewhat. Rutting in the 6 to 13 mm (0.25 to 0.5 in) range decreased from 68.5 to 65 percent and ruts greater than 13 mm (0.5 in) in depth increased from 31.6 to 35 percent.
Centerline joint separation increased from 0 percent to 1.8 percent.

The number of transverse cracks has increased. Full width increased from 2 to 3, half width increased from 1 to 2, and between wheel path cracks increased from 3 to 4.

PCC edge related cracking has increased somewhat from 33.3 to 36.8% (Photo 12) and shoulder elevation has remained the same at 6 mm (0.25 in) below the roadway.

Summary

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

Experimental Section 2B with 530 mm of Flowable Fill continues to outperform all other sections. This shoulder treatment is very stable with FWD deflection readings nearly equal to or lower than the adjacent composite roadway. Only 9.3 percent of the 30 m (100 ft) section is showing PCC edge cracking, an increase of only 1 percent. Photo 7 displays the effectiveness of 530 mm (21 in) of Flowable Fill by blocking the migration of PCC edge cracking from Section 2A with 230 mm (9 in) of Flowable Fill. Rutting has remained the same at a depth of under 6mm (0.25 in) while the remaining sections have experienced greater rutting. Centerline joint separation and transverse cracking is about the same as other sections when you take into account the short length of this section. Stable shoulder deflections combined with little rutting and movement at the transition area between the PCC supported roadway and the expanded roadway makes this treatment a viable solution for extending the width of composite highways.

Section 3 with 230 mm (9 in) of 25 mm (1 in) Superpave is also proving to be a stable shoulder treatment. Shoulder deflections are only 47.1 percent higher than roadway deflections and PCC edge cracking was evident in only 26.1 percent of the section, an increase of 3.4 percent from year 2001 evaluation. The increased shoulder elevation is isolated to a 20 meter area in the North bound lane and the remaining shoulder elevation is even with the roadway. Rut depths in this section appear to be caused by shoulder construction procedures rather than a failure of the shoulder treatment. Severe rutting is due to the shoulder elevation change in the North bound lane and a majority of the remaining ruts are caused by the longitudinal construction joint and transition between roadway and shoulder bituminous pavement. This section has the smallest amount of centerline separation and second least number of transverse cracks. With proper construction procedures, this application could be used to extend lane width of a composite road.

Experimental Section 1 utilizing Cold Recycled Asphalt Pavement has a large amount of centerline joint separation and transverse cracking. PCC edge cracking is evident on 71.2 percent of the section while the shoulder elevation remains even with the roadway. Even with the significant amount of PCC edge cracking, the severity of rutting has been moderate at 88 percent < 6 mm (< 0.25 in) in depth and 12 percent in the 6 to 13 mm (0.25 to 0.5 in) range. Average shoulder deflections are 61 percent higher than average roadway deflections. Because Section 1 has the lowest cost of the experimental treatments and has reduced the amount of rutting it could be considered as a cost effective construction treatment to extend the width of composite roadways.

Section 2A utilizing 230 mm (9 in) of Flowable Fill has the highest average shoulder deflections than all the experimental sections but lower than Section 4 and the Control Section. Although this treatment has a high amount of centerline joint separation, transverse cracking and PCC edge cracking it is reducing the development of severe rutting in the right wheel path and the shoulder elevation continues to be even with the roadway. Due to the modest construction costs and performance to date, this treatment could be used to extend composite roadway widths.

Section 4 with Heavy Overlay has very high average shoulder deflections as compared to Section 1, 2A, 2B, and 3. The shoulder elevation is even with the roadway but rutting continues to increase in depth. When comparing this section to the Control section the only noticeable improvement is fewer transverse cracks. High shoulder deflections is an indicator of shoulder deterioration in the future and because of this and the severity of rutting this treatment should not be considered to increase the width of composite roadways.

The Control Section has failed in all categories and should not be used to support shoulder extensions on composite roadways.

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

The Self Adhesive Mesh combined with recycled pavement continues to reduce the amount of PCC related edge cracking and rutting. Shoulder elevation is even with the roadway and the number of transverse cracks is similar to the Control Section. PCC edge cracking has increased from 5.9 to 16.8 percent but this is half of the amount noticed in the Control Section. Self Adhesive Mesh combined with recycled pavement and relatively low cost is a reliable treatment to bridge the transition between PCC and shoulder.

The Control Section experienced a 3.5 percent increase in PCC related edge cracking from 33.3 to 36.8 percent and the shoulder elevation change continues to be at 6 mm (0.25 in) below the roadway. As mentioned in the Third Interim Report, most of the PCC related cracking is adjacent to the gas pipeline construction. It's possible that construction of the pipeline could have caused the shoulder to shear aiding in the development of PCC edge cracking. The opposite lane has very little PCC edge cracking. Although there is a slight increase in edge cracking and rutting, the section appears to be performing well.

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Additional Documentation:

TR 99-11 Construction Report, January 1999
TR 99-11 First Interim, May 2000
TR 99-11 Second Interim, April 2001
TR 99-11 Third Interim, May 2003