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Page 1 of 4

RESEARCH UPDATE

U94-9

COLD RECYCLED BITUMINOUS PAVEMENT ON VT. ROUTE 232 IN GROTON

INTRODUCTION:

Vermont's principal mainstay in the maintenance/rehabilitation field is the use of a thin leveling or shim course and overlaying with a 25.4 mm (1 in) to 38.1 mm (1.5 in) wearing course of new bituminous concrete pavement. Experience has shown that the cost effectiveness of this approach remains to be proven, however, in that extension of service life may not be commensurate with cost. Additionally, experience has shown that the performance of thin overlays is limited, due in large part to the occurrence of reflective cracking. Recently the state of Vermont has investigated the use of alternates to the standard overlay. The alternates have included reclaimed base stabilization and cold recycled bituminous pavement (CRBP). This report describes the construction procedure and planned performance evaluation for the Groton-Peacham project, PMA 9224, which was completed during the summer of 1992, using CRBP.

PROJECT DESCRIPTION AND EXISTING ROADWAY CONDITION:

The proposed project began at km 0.00 (MM 0.00) of VT route 232, which is at the intersection of VT route 232 and US route 302. From this point, the project proceeded northerly on existing Vt route 232 for approximately 14.2 km (8.828 mi), terminating at km 2.649 (MM 1.646) in the town of Peacham. Project work included cold recycled bituminous pavement to a depth of 101.6 mm (4 in). The project also included resurfacing in two courses with 50.8 mm (2 in) of Type III bituminous concrete, from km 0.00 (MM 0.00) to km 2.013 (MM 1.251) in Groton and from km 2.805 (mm 1.743) in Groton to km 2.649 (MM 1.646) in Peacham. The treatment of the segment of Vt Route 232 between these two lengths did not include the CBRP but was merely paved with a 282 tn/km (500 t/mi) shim course of bituminous concrete pavement Type IV and a 19 mm (0.75 in) wearing course of bituminous concrete, Type IV.

VT Route 232 was originally constructed in segments between the years 1948 and 1971. It was first classified as a State Aid Highway, but was taken into the state system and given its Vt 232 designation in 1957. It is a north-south oriented route, beginning in Groton at its intersection with US Route 302 and proceeding northerly, it passes through the towns of Peacham and Cabot and ends in Marshfield at its intersection with US Route 2. It is primarily known as a recreational route, providing access to Groton Pond, Peacham Pond and the Groton State Forest. Average daily traffic on Vt. Route 232 varies from 390 vehicles per day at the intersection of Vt Route 232 with US Route 302 to 570 vehicles per day at the northerly terminus of the highway at km 2.649 (MM 1.646) in Marshfield.

Prior to construction the pavement structure within the project area generally consisted of the original surface treated gravel which had been retreated at varying times. Three exceptions to this were the areas (all in Groton) between km 2.115 (MM 1.251) and km 2.947 (MM 1.744), between km 4.902 and 4.936 (MM 3.046-3.067) and between km

5.785-5.906 (MM 3.595-3.670). The first of the three segments mentioned above was reconstructed with a 0.9-3.4-3.4-0.9 m (3-11-11-3 ft) typical section in 1977, while the second and third are two very short segments which were reconstructed in 1964 with a 1.2-3.4-3.4-1.2 m (4-11-11-4 ft) typical. Exclusive of the reconstructed segments, existing VT 232 roadbed widths vary from 5.5 m (18 ft) to 9.1 m (30 ft) through the project and pavement widths vary from 4.9 m (16 ft) to 6.7 m (22 ft).

Prior to construction, the project area was the subject of an intensive roadway investigation by the Research and Development section of the Materials and Research Division. The purpose for the analysis was to gain some insight into the nature of the existing pavement structure and how it varied project wide. Twelve test pits were excavated to ascertain the following facts:

a) The pavement consisted of an average six courses, with total thickness varying from 89 mm (3.5 in) to 216 mm (8.5 in).

b) Subbase thickness varied from 95 mm (3.75 in) to 267 mm (10.5 in). Minus #200 material in the subbase varied from 3.4% to 13.5%, with an average of 7.6% based upon the total sample.

c) Depth to subgrade ranged from 191 mm (7.5 in) to 406 mm (16 in). Subgrade material ranged from organic to cobbles to good gravel with a range of 4.9% to 31.6% minus #200 material.

d) Moisture content was low in both subbase and subgrade samples at the time of sampling 5/9/91 and 5/14/91.

The wide range of material quality and quantity within the project area lead to s(reservations relative to the appropriateness of the designed treatment, but finally the project proceeded according to original plan.

The contract for the PMA 9224 project was won by Pike Industries who subcontracted the in-place recycling work to Gorman Brothers, Inc. of Albany, New York. Gorman Brothers utilizes the "In Place Recycle Train" for CRBP. The apparatus employed is a 49 m +/- (135 +/- ft) long in-line configuration lead by a milling machine which tows the train as well as grinding and picking up 76 mm (3 in) to 102 mm (4 in) of asphalt pavement for one lane width. Following the milling machine is a screening/crushing unit which reduces the size of the milled material to <31.75 mm (1.25 in). The third section is a pugmill which regulates the flow of emulsified asphalt to be added to the size graded, reclaimed pavement. After the emulsified asphalt is added and mixed, the blend is laid down as a windrow and then picked up by a paver, the final section of the train, and spread as a new mat. Finally, a 31.8 t (35 tn) rubber-tired roller and a dual drum vibratory roller provide the compaction necessary to complete the process.

CONTROL AND TEST SECTIONS:

Eight 0.169 km (0.1 mi) test sections were established at key points within the project. Four of the test sections are control sections which have been resurfaced with 51 mm (2 in) bituminous concrete pavement, Type III, while the remaining four test sections include the 102 mm (4 in) recycle treatment, as well as the 51 mm (2 in) overlay.

GROTON:

T.S. (MM) 1.048 102 mm (4 in) Recycle + (2 in) Bituminous Concrete
T.S. (MM) 1.148 51 mm (2 in) Bituminous Concrete (Control)
T.S. (MM) 3.225 102 mm (4 in) Recycle + 51 mm (2 in) Bituminous Concrete
T.S. (MM) 3.325 51 mm (2 in) Bituminous Concrete (Control)
T.S. (MM) 4.472 102 mm (4 in) Recycle + 51 mm (2 in) Bituminous Concrete
T.S. (MM) 4.572 51 mm (2 in) Bituminous Concrete (Control)

PEACHAM:

T.S. (MM) 1.426 102 mm (4 in) Recycle + 51 mm (2 in) Bituminous Concrete
T.S. (MM) 1.526 51 mm 51 mm (2 in) Bituminous Concrete (Control Section)

PRECONSTRUCTION CRACKING, RUTTING AND ROUGHNESS:

TEST SECTION (MM)	1.048	1.148	3.225	3.325	4.472	4.572	1.426	1.526
CRACKS (m/100 m)	165	165	10	10	205	205	80	80
(Ft/100ft	165	165	10	10	205	205	80	80
RUTTING (mm)	5	5	3	3	5	5	3	2
(1/16 in)	3	3	2	2	3	3	2	2
ROUGHNESS(mm/km)	4167	4151	3756	3741	4325	3930	1894	2083
(in/mi)	264	263	238	237	274	249	120	132

POST-CONSTRUCTION CRACKING, RUTTING AND ROUGHNESS:

TEST SECTION - 1993	1.048 GROT CRBP	1.148 GROT CONT	3.225 GROT CRBP	3.325 GROT CONT	4.472 GROT CRBP	4.572 GROT CONT	1.426 PCHM CRBP	1.526 PCHM CONT
CRACKS(m/100m)	62	42	9	6	0	59	0	16
(ft/100ft)	62	42	9	6	0	59	0	16
RUTS (WHEELPATH)								
(1/16 in)	1	1	2	0	0	0	2	1
(mm)	2	2	3	0	0	0	3	2
1994								
CRACKS(ft/100ft)	150	86	41	6	0	112	33	33
(m/100 m)	150	86	41	6	0	112	33	33
RUTS (WHEELPATH)								
(1/16 in)	2	1	1	2	***	2	2	1
(mm)	3	2	2	3	***	3	3	2

Although the most recent performance survey of the monitored control sections looked very promising, there is one area of the project where the appearance of the pavement is very inconsistent with the qualities of the remainder of the project. The previously described area between km 2.013-2.805 (MM 1.251-1.743) with the 19 mm (.75 in.) overlay shows a greater degree of cracking, based on a windshield survey. Combined longitudinal and transverse cracking there is in the range of 650m/100m (650 ft/100 ft). Since the treatment here included only a minimal 19mm (0.75in) overlay it is probably reasonable to assume that much of the cracking is reflective.

International Roughness Index (IRI) values averaged 1326 mm/km (84 in/mi) through the project length when measured subsequent to the completion of construction on 03/05/92. The most recent measurements, taken on 08/24/93 indicate an average IRI value of 1515 mm/km (96 in/mi).

PROCESS DATA:

The 101.6 mm (4 in) CRBP was tested for unit weights and air voids at two different cure times. The first tests were performed on 12 cores after 10 curing days. Average unit weight for these cores was 2184 kg/m^3 (136.7 lb/cf) and average air voids were 10%. The second test group was based on 8 cores which had cured for 20 days. Average unit weight for these samples was 2178 kg/m^3 (135.7 lb/cf) and average air voids were 10.4%.

Total recycled pavement area for the Groton-Peacham project, PMA9224 was 80,832 m^2 (96,678 SY) and the average emulsified asphalt application rate was 3.73 l/ m^2 (1.15 gal/SY) or 2.34 % by weight. The application rate varied from a minimum of 2.99 l/m^2 (0.66 gal/SY) to a maximum of 6.20 l/m^2 (1.37 gal/SY) or from 1.25% to 2.60% by weight.

COSTS:

The cost for the recycling, including a \$2.27/m^2 (\$1.90/SY) cost for CRBP and a \$2.12/m2 (\$1.77/SY) cost for emulsified asphalt was \$4.39/m^2 (\$3.67/SY). The resurfacing with 51 mm (2 in) of bituminous concrete pavement required an additional \$4.11/m^2 (\$3.44/SY) cost for a grand total of \$8.50/m^2 (\$7.11/SY).

SUMMARY AND CONCLUSIONS:

In spite of some serious reservations regarding the rehabilitation approach for the Groton-Peacham project prior to construction, the pavement seems to be holding up very well after three hard winters. The excellent pavement performance to date may very well be at least partially related to the low traffic demand on the facility, but it also suggests that the durability characteristics of the rehabilitated pavement are very good as well.

FOLLOW UP:

Observation will continue for as long as necessary to support valid conclusions as to the performance of the CRBP and the overall project.