# MATERIALS & RESEARCH DIVISION

REVIEWED

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**RESEARCH UPDATE** 

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U 96-3

# PERFORMANCE OF COLD RECYCLED BITUMINOUS PAVEMENT

#### **REFERENCES:**

Report 94-3, Report 94-6, Update U94-9, Update U94-14

#### INTRODUCTION:

The evaluation of the cold recycled bituminous pavement (CRBP) process as a rehabilitation technique is of interest to the Vermont Agency of Transportation. The primary reason for this evaluation is to determine cost effectiveness of this rehabilitation technique, while a secondary goal is the assessment of this technology as a means to recycle non-renewable resources.

#### PURPOSE:

The Agency is currently evaluating four cold recycled bituminous pavement (CRBP) projects which were constructed within the 1988-1993 time frame. The evaluations are being conducted from the standpoint of life cycle cost effectiveness. In order to facilitate the evaluation, this report will provide a consolidated set of performance data which will be updated biennially. A summary of data collected from each of four project sites is presented. A description of each of the projects follows.

## PROJECT DESCRIPTION, IRASBURG, VT ROUTE 14:

This project was completed in 1988. Irasburg project HMA 2843 began at VT Route 14 MM 0.000 in Irasburg and extended north to MM 2.325. The project included variations in the depth of CRBP and rate of application of emulsified asphalt, as well as a thin overlay of 19 mm (0.75 in) of bituminous concrete pavement.

#### PROJECT DESCRIPTION, GROTON - PEACHAM, VT ROUTE 232:

Groton - Peacham project PMA 9224 was completed during the summer of 1991. The project began at MM 0.000 (intersection of VT Route 232 with US Route 2 in Groton) and proceeded northerly on VT Route 232 for approximately 14.21 km (8.828 mi), terminating at MM 1.646 in Peacham.

# PROJECT DESCRIPTION, TROY - NEWPORT, VT ROUTE 105:

Troy-Newport project F 034-2(10) was constructed during the summer of 1992. The project began in the town of Troy on VT Route 105 at MM 5.370 and extended easterly for 5.274 km (3.277 mi) to MM 2.682 in Newport.

### PROJECT DESCRIPTION, DERBY - CHARLESTON, VT ROUTE 105:

Derby-Charleston project STP 9248(1) was completed in 1993. The treatment began at MM 0.800 of VT Route 105 in Derby and extended easterly for 7.828 km (4.864 mi) to MM 0.800 in Charleston.

#### DISCUSSION:

The Irasburg experiment was set up to evaluate different asphalt emulsion addition rates and CRBP depths and did not include a control (standard overlay) section. The distinct evaluation criteria, as well as the fact that the overlay was only 19 mm (0.75 in), preclude it from direct comparison with the other three CRBP projects. However, when evaluated in isolation as a CRBP project, it must be said that the experiment was a disappointment.

(a) The pavement began cracking after three years, with 40 m/100 m (40 ft/100 ft) measured during a 1991 survey, but the rate of crack development accelerated so that by the summer of 1994 there were 538 m/100 m (538 ft/100 ft) of cracks within the test sections.

(b) The roughness varied from 2415 mm/km (153 in/mi) to 3109 mm/km (197 in/mi), and an additional resurfacing of the project was deemed necessary, following 6 years of service.

(c) Based on an average cost of \$5.68/m<sup>2</sup> (\$4.75/SY), the treatment was 33% more expensive than a standard leveling course with a 38 mm (1.5 in) overlay, and the service life was 4 years less than the 10 years life expectancy of a standard overlay. A more comprehensive description of this project and the problems encountered with it are available in Research Update U94-14.

Of the three remaining projects, two have also demonstrated early warning of developing problems. The Pavement Life Survey of 1995 gives only vague hints of the seriousness of the developing deterioration of Vt. Route 232. The survey results suggest that the Route 232 project experimental test sections compare well with (but not significantly better than) the control sections regarding cracking, but the ride quality is rapidly deteriorating within both the control and experimental sections. Rutting within the test sections was the same for both the control and experimental sections. In short, based on the 1995 pavement survey results, no clear advantage was evident between the CRBP treatment and the standard overlay. At that point it would have been very difficult to justify the cost difference of up to 107% between the experimental and control treatments. Subsequent developments have rendered this justification impossible (see the FOLLOW-UP section, below).

Comparison of experimental and control sections for the Troy-Newport project discloses crack averages of 233 m/100m (233 ft/100 ft) and 65 m/100 m (65 ft/100 ft), respectively. The cracking data for the Troy-Newport project should be evaluated in the light of another consideration, however.

(a) 1993 field investigation of the Troy-Newport project revealed significant lengths of potential and actual longitudinal cracking located approximately 2.3 m (7.5 ft)left and right of centerline. A probable cause of much of this longitudinal cracking, aside from any weakness of the rehabilitation method, may be related to equipment. The paver utilized on the Troy-Newport project was equipped with a power extendible "OMNISCREED". This equipment has been recognized as the cause of premature cracking when the necessary adjustments are not maintained.

(b) The problems with the equipment may have been exacerbated by the use of a "stiffer" bituminous mix, using a 75 blow Marshall design. The modified mix design was intended to promote mix stability and increase rut resistance, but may have contributed to crack development at the weaker, transitional points in the pavement mat.

(c) If the cause of the longitudinal cracking is assumed to be independent of the rehabilitation treatment, a favorable judgement regarding the experimental treatment is possible. There is no significant difference between the experimental and control sections in either ride or rutting values for the Troy-Newport project.

The recycle treatment is performing well on the Derby-Charleston project through two years of service and the experimental and control sections compare about equally in all of the performance factors.

In general, the performance of the projects under evaluation suggests that in two of the three cases (with the Groton-Peacham project an exception), a reasonable service life may be obtained. However, since the cost of the recycle process was from 31% to 107% greater than the standard overlay, the cost effectiveness of the CRBP treatment will remain in question until the end of the service life is reached.

#### SUMMARY OF PERFORMANCE:

The table shown on the following page summarizes the current status (as of summer 1995) of the three CRBP projects which were compared against the standard overlay control sections. The performance data shown represent averages for all the test sections within each project.

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CURRENT			PERFORMANCE STATUS			
DATA ELEMENT	GROTPEACH. EXP.	GROT PEACH. STD.	TROY-NEWP. EXP.	TROY-NEWP. STD.	DRBYCHRLST. EXP.	DRBY CHRLST STD.
PROJ.LIMITS	0.00-1.65		5.73-2.68		0,80-0.80	
PROJ.LNGTH KM (mi)	14.21 (8.82)		5.27 (3.28)		7.83 (4.86)	
ADT	560		2520		2927	
YRS . SERV .	4	÷	3		2	
DPTH CRBP mm (in)	102 (4)		102 (4)		102 (4)	
OVL DPTH mm (in)	51 (2)	51 (2)	76 (3)	76 (3)	83 (3.25)	83 (3.25)
CRACKS m/100 m (ft/100 ft)	28 (28)	68 (68)	73 (73)	164 (164)	42 (42)	144 (144)
RUTS mm (1/16 in)	5 (3)	5 (3)	2 (1)	2 (1)	0	0
MAYS mm/km (in/mi)	2841 (180)	2683 (170)	1389 (88)	1278 (81)	1057 (67)	1152 (73)
CRBP Cost/m <sup>2</sup> (Cost/SY)	\$4.39 (\$3.67)		\$3.67 (\$3.07)		\$2.54 (\$2.12)	
CRBP+OVLY Cost m <sup>2</sup> (Cost/SY)	\$8.50 (7.11)		\$10.20 (\$8.53)		\$9.54 (\$7.67)	
STD.OVLY Cost/SY		\$4.11 (\$3.44)		\$6.53 (\$5.46)		\$7.00 (\$5.85)

#### FOLLOW UP:

Following a report from the District 7 D.T.A., a field inspection of the Groton-Peacham project was conducted by Research Section personnel on 18 Mar 96. It was found that the condition of the pavement had deteriorated significantly through the winter, especially at the eastern (Groton) end of the project. Cracking and pavement deformations had significantly increased, but most notably, center line joint cracks were prevalent and had opened up as much as 64 mm (2.5 in). A more complete update report describing these developing conditions will be offered subsequent to completion of the annual pavement life survey of the Groton-Peacham project which will be conducted this summer.

Performance monitoring will continue on all of the projects described above until firm conclusions can be drawn as to their cost effectiveness.