COLD RECYCLED BITUMINOUS PAVEMENT
TROY-NEWPORT VT105

INITIAL REPORT 94-3
JULY 1994

REPORTING ON WORK PLAN 92-R-8

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS AND RESEARCH DIVISION

PATRICK J. GARAHAN, SECRETARY OF TRANSPORTATION
ROBERT L. MERCHANT, DIRECTOR OF CONSTRUCTION AND MAINTENANCE
ROBERT F. CAULEY, MATERIALS AND RESEARCH ENGINEER
RONALD I. FRASCOIA, RESEARCH AND DEVELOPMENT SUPERVISOR

Prepared By:

Robert E. Brunelle, Technician IV
Research and Development Subdivision

Reviewed By:

Robert F. Cauley

R.F.Cauley,
Materials and Research Engineer

Date: 11 Aug 94

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
94-3		

4. Title and Subtitle	5. Report Date / 6. Performing Organization Code
Cold Recycled Bituminous Pavement Troy-Newport, VT 105	5. Report Date: June 1994 6. Performing Organization Code:
7. Author(s) Robert E. Brunelle	8. Performing Organization Report No. 94-3
9. Performing Organization Name and Address Vermont Agency of Transportation	10. Work Unit No. 11. Contract or Grant No. HPR
12. Sponsoring Agency Name and Address Federal Highway Administration Division Office Federal Building Montpelier, VT 05602	13. Type of Report and Period Covered Initial Report 14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes the cold recycle process for Bituminous Concrete Pavement which was utilized on VT 105 for the Troy-Newport project F034-2 (10).

This report includes initial data for a performance evaluation of Rutting, International Roughness Index (IRI) and Falling Weight Deflectometer (FWD) Values.

17. Key Words	18. Distribution Statement
Pavement Asphalt Recycling Cold	No Restrictions

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	9	

Form DOT F 1700.7 (8-69)

COLD RECYCLED BITUMINOUS PAVEMENT
TROY-NEWPORT VT 105

INTRODUCTION:

Vermont is interested in developing a broad range of pavement rehabilitation techniques which are appropriate for the entire scope of pavement reconditioning problems which the state is encountering.

Cold recycling of bituminous pavement appears to be a cost effective approach for extending the life of pavements. Consequently, this project, and other similar projects utilizing the various approaches to cold recycling have been included in a long term pavement study designed to determine service life and annualized cost of various treatments. The long term performance of each of these projects is of vital interest to the Agency, and the projects should be evaluated and compared.

Conventional wisdom relative to cold recycled bituminous pavement (CRBP) techniques suggests three common concerns. It is hoped that as a result of this evaluation new insights will be gained into the following issues:

a) If the recycled depth does not extend to subbase, is the chance of reflective cracking increased?

b) Will the degree of compaction of the recycled mix be sufficient to prevent further consolidation under traffic?

c) Will the placement of the recycled material between two more rigid and dense layers be conducive to flexural stress failures? One indicator of this would be excessive longitudinal cracking in the wheel paths.

PROJECT LOCATION AND ROADWAY DESCRIPTION:

The Troy-Newport project F 034-2(10) began at a point on VT Route 105 in the town of Troy at kmm 9.222 (MM 5.730) and extended easterly for 5.274 km (3.277 mi) to kmm 4.316 (MM 2.682) in Newport Center in the town of Newport.

From the beginning of the Troy-Newport project at kmm 9.222 (MM 5.730) through to kmm 9.534 (MM 5.924), VT Route 105 had remained unimproved since it was surfaced in 1931 with bituminous mix. This section of VT 105 has 6.7 m (22 ft) of traveled way with 0.6 m (2 ft) shoulders. There is no information available relative to original pavement and subbase depths. The remainder of Vt 105 within the limits of project F 034-2(10) was reconstructed in 1961 under project number F 034-2(2), and has 6.7 m (22 ft) roadway width and 1.8 m (6 ft) shoulders. The 1961 reconstruction included a 76.2 mm (3 in) macadam pavement and a 457.2 mm (18 in) subbase of gravel. Seven cores were taken through the length of F 034-2(10) prior to the recycling project. The cores indicated existing pavement depths which varied from 152.4 mm (6 in) to 279.4 mm (11 in), with an average depth of 196.85 mm (7.75 in). The base pavement core was macadam base course (as indicated in the route log pavement history) consisting of crushed stone or crushed gravel with a filler, shot with a tack coat. Average daily traffic (ADT) varies from 1580 to 2390 vehicles through the project length.

Pre-construction IRI values, (taken on 06/29/92) averaged 3598 mm/km (228 in/mi) through the project prior to the construction. The Troy control section had an IRI value of 3488 mm/km (221 in./mi.) and the Newport control section had a 3125 mm/km (198 in./mi.) roughness index at that time.

PROJECT DESIGN AND CONTROL SECTIONS:

Project work included 102 mm (4 in) of cold recycled bituminous pavement, a 44.45 mm (1.75 in) binder course of Type II bituminous concrete pavement and a 31.75 mm (1.25 in) surface course of Type III bituminous concrete pavement. Project work also included replacement of non-standard guard rail and upgrading of existing signs and sign supports.

Based on projected pavement loading of 368 equivalent single axle loadings (ESALs) per day for the ten year design period, the Agency's Pavement Management Section recommended a structural number (SN) of 4.20. Five falling weight deflectometer (FWD) tests taken on the existing pavement had revealed an average SN of 4.28. It can be assumed that the CRBP process results in a structural strength loss of the recycled pavement at an estimated rate of 0.15 of the SN per inch. The corrected SN after cold recycling was estimated at 3.68, and on that basis the Pavement Management Section recommended leveling plus a 38 mm (1.5 in) overlay. That application would have approximated the required SN. However, the final design overlay of 76.2 mm (3 in) represents a significant overdesign and should serve well for the 10 year design period.

EXPERIMENTAL CONTROL AND TEST SITES:

A 0.32 km (0.2 m) control section was constructed between kmm 10.154 (MM 6.31) in Troy and kmm 0.034 (MM .0189) in Newport. The control section consisted of a standard overlay in two courses, a 44.45 mm (1.75 in) layer of Type II bituminous concrete pavement, followed by a 31.75 mm (1.25 in) layer of Type III bituminous concrete pavement.

Performance is being evaluated through comparison of seven test sites which are located at various points within the rehabilitated areas of the project, with two test sites within the control section described above. The test sites (TS) are all 30.48 m (100 ft) long and are located as follows:

TS 6.0 kmm 9.656 (MM 6.00) Troy 102 mm (4 in) recycle
+ 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 6.34 kmm 10.203 (MM 6.34) Troy (Control) level
+ 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 0.01 kmm 0.016 (MM 0.01) Newport (Control) level
+ 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 0.15 kmm 0.241 (MM 0.15) Newport 102 mm (4 in) recycle
+ 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 0.40 kmm 0.644 (MM 0.40) Newport 102 mm (4 in) recycle + 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 0.98 kmm 1.577 (MM 0.98) Newport 102 mm (4 in) recycle + 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

TS 1.80 kmm 2.897 (MM 1.8) Newport 102 mm (4 in) recycle + 45 mm (1.75 in) binder + 32 mm (1.25 in) surface

CONSTRUCTION PROCESS:

The "in place recycle train" is the method used by Gorman Brothers Inc. of Albany, New York for cold recycling of bituminous concrete. The 49 m +/- (135 ft +/-) long in-line configuration is lead by a milling machine which tows the entire train as well as grinding and picking up 76 mm (3 in) to 102 mm (4 in) of asphalt pavement for a 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 precise amount of emulsified asphalt to be added to the size graded, reclaimed asphalt pavement. After the emulsified asphalt is added and blended, the mixture 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 necessary compaction to complete the recycling process.

The process described above was employed by Pike Industries, Inc. of Tilton NH in a subcontract agreement with Gorman Brothers when they executed the contract for the Troy-Newport project F 034-2(10), during the summer of 1992.

The recycle portion of the Troy-Newport project F 034-2(10) began on July 6, 1992 and was completed on July 17, 1992. When the recycled asphalt pavement was resurfaced with a 44.45 mm (1.75 in) Type II binder course, acceptable compaction values were unattainable. While the minimum acceptable range for compaction is 92% to 96% only 88% to 92% was achieved on the Troy - Newport project. The contractor attributed the shortfall to the soft surface of the reclaimed material; however, it should be noted that compaction values were also a problem on the old pavement overlay sections.

Cores were taken in the 102 mm (4 in) recycled course. Recovery depths of that material ranged from 22.2 mm (0.875 in) to 57.2 mm (2.25 in). These same cores yielded an average 8.8% air voids and an average density of 2221 kg/m^3 (138.3 lb/cf).

Subsequently, the Construction Division took six more cores on the project during January of 1993. The cores taken after approximately six months cure time and traffic loading indicated an average recovery thickness of 92.08 mm (3.625 in), unit weight of 2214 kg/m^3 (137.9 lb./cf) and 8.4% air voids.

FWD readings were taken within several of the test sections, both before and after the recycle activity and before resurfacing. As expected these readings demonstrate a loss of structural strength of the roadbed, and more specifically, a loss of strength in the layer of reconstituted material subsequent to the recycle activity. In the case of the Troy- Newport project, the average loss of structural value per inch of recycled material was -0.08.

STATION (MM)	RECYCLED (Y/N)	S.N. BEFORE	S.N. AFTER
6.000 EB	YES	3.93	3.65 (-0.28)
6.283 EB	YES	4.10	3.68 (-0.42)
0.018 EB	NO	3.92	4.06 (+0.14)
0.150 EB	NO	3.90	4.03 (+0.13)
0.400 EB	YES	3.65	3.46 (-0.19)
0.980 EB	YES	4.17	3.40 (-0.77)
1.800 EB	YES	3.86	3.15 (-0.71)

Based on the final quantity for Item 415.20 Cold Recycled Bituminous Pavement, 33,298 m^2 (39,825 SY), the production rate for that item averaged 2775 m^2/day (3319 SY/day). Utilizing the final quantity for item 415.20 as well as for Item 404.65 (Mod.) Emulsified Asphalt, 98.9 t (2176 CWT) and assumed values of 2220 kg/m^3 (138.3 lbs/cf) for the unit weight of the compacted recycled material and 8.41 lb./gal. as the density of the emulsified asphalt, the percent by weight of the emulsified asphalt averaged 1.31% for the entire project.

PRE-CONSTRUCTION CRACKING & RUTTING (06-04-92):

Test Section (TS)	6.0	6.34	0.01	0.15	0.40	0.98	1.80
Cracking m/100m (lf/100 ft)	468	1388	1414	661	870	806	976
Ave.Rutting mm	8	11	6	8	6	6	11
(1/16 in)	5	7	4	5	4	4	7

POST CONSTRUCTION CRACKING & RUTTING (04-21-93):

The same sections were surveyed on 10/04/92, shortly after the project was completed and no cracking or rutting was recorded; but after a year (on 04/21/93), some stress was observed:

Test Section	6.0	6.34	0.01	0.15	0.40	0.98	1.80
Cracking m/100 m	121	100	15	104	7	128	215
lf/100ft.) Same	121	100	15	104	7	128	215
Pav.Jnt. m/100	19	100	15	69	0	82	5
lf/100 ft.	19	100	15	69	0	82	5

Note the large percentage of cracking along the centerline paving joint, particularly within test sections 6.34, 0.15 and 0.98.

One other possible source of extensive future cracking has been observed on this project. A 1993 field investigation revealed significant lengths of potential and actual longitudinal cracking located approximately 2.3 m (7.5 ft) left and right of centerline at three test sections, sections 0.40, 0.98 and 1.80. These developing cracks had been noted previously, along with similar problems on the Ryegate-Newbury project F 026-1(37), earlier during the spring of 1993. The probable cause of these cracks has been identified. Different paving equipment was used on the US Route 302 and Vt 105 projects, but both were equipped with power extendible "OMNISCREEDS" between the 1991 and 1992 paving seasons. This equipment has been recognized as the cause of similar problems in the past. The screeds require continuing adjustments to insure a uniform texture across the mat and to avoid an uneven texture or tearing and/or transition lines. The evidence that the paving equipment was the cause of the problem is readily apparent. The pavement has lines of visual distortion approximately 2.3 m (7.5 ft) left and right of centerline. This problem was probably exacerbated by the use of a "stiffer" bituminous mix utilizing 75 blow Marshall design on these projects. The modifications were made to increase mix stability and rut resistance. The stiffer/coarser mix has probably contributed to crack development at the weaker transitional points on the pavement mat.

POST CONSTRUCTION IRI (INTERNATIONAL ROUGHNESS INDEX):

Measurements of IRI values taken subsequent to construction have had the following results:

10/05/92	Overall Average	Troy Control Section	Newport Control Section
mm/km	994	789	852
in./mi.	63	50	54
08/12/93			
mm/km	1152	1310	1184
in./mi.	73	83	75

The current trend indicated by the MAYS data shown above is very encouraging. If the gradual rate of increase in roughness per year is maintained it would seem reasonable to forecast a relatively trouble free and lengthy service life for this section of VT 105.

COSTS:

The costs to reclaim 4 inches of pavement on the Troy-Newport project were \$3.67/m^2 (\$3.07/SY). The total recycle cost included \$2.99/m^2 (\$2.50/SY) for item 415.20 and an average cost of \$0.68/m^2 (\$0.57/sy) for item 404.65 (mod.). The total expenditure to recondition the pavement would be \$10.20/m^2 (\$8.53/sy) if the \$6.53/m^2 (\$5.46/SY) costs for the 76.2 mm (3 in) overlay of bituminous concrete pavement were included.

PRELIMINARY CONCLUSIONS:

1. The absence of any significant problems during the construction period suggests the Troy-Newport project has a reasonably good chance for success.

2. The use of "OMNISCREED" paving equipment and a "stiffer" bituminous mix utilizing 75 blow Marshall design has resulted in significant preliminary longitudinal cracking. These factors are a potential source of even more extensive cracking over the long term.

FOLLOW UP:

Performance monitoring for the Troy-Newport project will continue on an annual basis until the effectiveness of the rehabilitation has been established.

COLD-IN-PLACE RECYCLE
TROY-NEWPORT
VT.105 ADT=1930
COMPLETED 1992