COLD RECYCLED BITUMINOUS CONCRETE PAVEMENT ON VT ROUTE 11

INITIAL REPORT 94-1
DECEMBER 1993

REPORTING ON WORK PLAN 92-R-7

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Date: JAN 2 0 1994

TECHNICAL REPORT STANDARD TITLE PAGE

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

4. Title and Subtitle	5. Report Date
COLD RECYCLED BITUMINOUS PAVEMENT	January 1994
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Robert E. Brunelle	94-1

9. Performing Organization Name and Address	10. Work Unit No.
Vermont Agency of Transportation Materials & Research Division 133 State Street Montpelier, VT 05633	11. Contract or Grant No. HPR
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address Federal Highway Administration Division Office Federal Building Montpelier, VT 05602	Initial
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

This report describes the cold recycle process for bituminous concrete pavement utilized by Whitcomb Construction company of Walpole, NH. The process was used on 5 contiguous projects on VT Route 11 in the towns of Springfield and Chester during the period beginning in early June and ending in late August of 1993.

The construction process employed by Whitcomb Co. is distinguishable in that it includes an off-project pug mill operation. The relatively trouble free construction period, as well as the initially acceptable properties of the recycled asphalt suggest that the project was a success, but the apparent unbalanced bid would undermine the credibility of any effort to derive a reliable cost/benefit relationship for it.

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)

INTRODUCTION:

There are three major companies doing business in Vermont whose main area of expertise is pavement resurfacing and/or rehabilitation. Two of these companies, Frank W. Whitcomb Construction Company of Walpole, New Hampshire and Gorman Brothers Inc. of Albany, New York have somewhat dissimilar methodologies relative to the cold recycled bituminous pavement process, and competition has developed between the two companies. Although the third company, Pike Inc. of Tilton, New Hampshire is also active in the reclamation field, their efforts have been concentrated in full depth base stabilization.

This research project evaluates the cold recycling process used by Whitcomb, which requires off-project processing of the recycled material, and compares it with Gorman's method, which includes an in-place recycle train. This evaluation will be useful for comparisons with other resurfacing and rehabilitation techniques as well.

It is also hoped some insight regarding three issues may be gained as a result of this evaluation:

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?

PROJECT LOCATION AND DESCRIPTION:

The areas to be investigated are located along a 6.657 mile stretch of VT Route 11 in the towns of Chester and Springfield (See Appendix B), and are contained within five projects recently completed on that highway which are located along a continuous line. The most westerly of the 5 projects begins at MM 5.116 (intersection with Vt. 103) in Chester, and the most easterly project ends at MM 3.528, the westerly Federal Aid Urban (F.A.U.) limit of Springfield. Work on each of the 5 projects includes 3-1/2" cold planing, cold recycling, bituminous concrete resurfacing, signs, guardrail, drainage, pavement markings, safety upgrading and other related items.

EXISTING VT ROUTE 11

No record of original construction of the 6.657 mile section mentioned above is shown on the route log for its most westerly portion (MM 5.116-MM 5.865) in Chester, but the remainder was reconstructed at two different times under two project numbers between 1961 and 1965. Project S 0134(3) (an original 1965 project number covering construction from Chester MM 5.865 to Springfield MM 1.049), was constructed with an 8-12-12-8 typical section, a 24" gravel subbase, a 3" penetration macadam base course and a 2-1/2" surface of bituminous concrete.

The second project was constructed under the original 1961 project number

S 0134(1) and began at MM 1.049 in Springfield continuing for 2.479 miles to MM 3.528. It was constructed with a variable 40' to 43' roadbed width, a 20" gravel subbase, a 4" macadam base course and a 3" surface of bituminous concrete pavement.

Average daily traffic varies from 4000 +/- at the westerly end of the current recycle activity to 9000 +/- at the easterly end, which is within the Springfield Urban Compact.

EVALUATION PARAMETERS:

Two control sections were established for comparison with the project treatment:

a) From MM 5.865 to MM 6.065 (within the new 1992 project, Chester STP RS 0134(8)) the control section was cold planed to a 3-1/2" depth. The milled material was replaced with a 2" binder course of Type III bituminous concrete and a surface course of
1-1/2" of Type III bituminous concrete.

b) The second control section was immediately adjacent to the easterly terminus of the first, and still within the 1992 project Chester, STP RS 0134(8). Beginning at MM 6.065 in Chester, it extended easterly for 0.2 mile to MM 6.265. This segment was treated with a leveling course and a 1-1/2" wearing course of Type III bituminous concrete.

The control sections described above will be used as bases for comparison with the designed treatment. Eight test sections have been established for this evaluation. Four of these test sections lie within the control sections described above, and the other four are located at strategic points throughout the length of the project(s). Each of the test sections is 100' long . A more complete description of the test sections is included in the appendices of this document.

Long term performance of the project will be evaluated using three criteria which will be periodically checked within each of the test sections: crack counts, rutting measurements, and structural strength (Falling Weight Deflectometer readings). One other index (Mays Meter roughness) will be checked every 0.2 mile along the entirety of each of the five project lengths, at the same time as measurement of the other criteria.

THE WHITCOMB CONSTRUCTION PROCESS:

The recycle effort began on June 8, 1993 and the 79,360 SY of VAOT Construction Specification Section 415 work was completed on June 22, 1993. The final pavement (wearing) course was applied during the period 8/20/93-8/30/93.

The Whitcomb process is not an in-place method, as outlined in the original Section 415 specification, but was modified as follows:

The milled material was hauled by truck to a pug mill operation. The location of this activity was at a site just off VT 11 at approx. MM 1.50+/- in Springfield. The pug mill phase included crushing and screening to pass the maximum 3/4" size and addition of emulsified asphalt to the mix. This was a one-pass operation and oversized material was separated and used elsewhere, off

project. The emulsified asphalt was added to the milled material at the base rate of 1.69% by weight. Adjustments were made to this rate on a daily basis, contingent upon the daily status of the gradation and moisture content of the milled material.

Daily records were kept of the application rates of the emulsified asphalt, and the mileages to which they were applied. A summary of these records is appended to this report. It should be noted here, however, that the proper interpretation of this data will be very challenging, at best, without the concurrent values of the two variables mentioned above, and Whitcomb considers that information to be a "trade secret".

Subsequent to the replacement of the milled material in the roadway, it was compacted as follows:

1 (one two way pass) with the vibratory roller
4 or 5 (two way) passes with rubber tire rollers
2 (two way) passes with the finish roller

COMPLIANCE TESTING:

Some 19 tests were performed to evaluate compaction during the construction period (6/8 thru 6/22). The compaction varied from 94% to 104% with an overall average of 98.2%. Percent compaction was based on an optimum density which averaged 130lb/ft3. These tests were performed by the contractor.

The 3-1/2" milling depth was systematically monitored through all five of the projects and any deviations from the specified dimension were noted and/or corrected.

It was apparent from the outset that independent assurance of quality by the state would be problematic for the Chester - Springfield project.
The principal causes of the difficulty were limited experience in the reclamation field and a lack of precise definition in the new Section 415 specification.

The only other quality control performed by state forces was the periodic checks by the Regional Testing Technician for gradation and moisture content.

PROBLEMS ENCOUNTERED - PROGNOSIS FOR SUCCESS:

Subsequent to the cessation of project activity the Resident Engineer was interviewed and his opinion as to the success of the project was solicited. His perception was that the project was completed with very few complications and that all indications are that the long term results will be satisfactory. He did cite some minor problems encountered:

RAVELING:

As previously mentioned, in the Whitcomb process, the rate of addition of emulsified asphalt is contingent upon current status of two conditions relative to the milled material, moisture content and gradation. Early on during the recycle process, it became apparent that the relationship was not absolutely predictable based on previous experience. On 6/10/93 the high moisture content of the milled material indicated an emulsified asphalt addition rate

of 1.51%. This was done, but later on in the day, some raveling in the newly placed recycled mix was apparent. The problem was identified as an insufficient application rate of emulsified asphalt and correction was made for the following day. For the remainder of the construction period the AE addition rate ranged from 1.64% to 1.91% and no further problems with raveling were encountered.

"FAT" SPOTS

It appears that the Whitcomb milling process is imperfect in its current state of development and at times develops an excessive percentage of fines in the milled material. A high percentage of fines results in a commensurately higher surface area exposed for coating by the emulsified asphalt additive. Since there is very little blending of the milled material there is no opportunity for an even dispersion of these concentrations of asphalt rich material. This has resulted in an unacceptable concentration of asphalt emulsion in localized areas. These "Fat Spots" were identified and corrected by removal and replacement with Bituminous Concrete Pavement, Type II.

COST COMPARISON - COST EFFECTIVENESS:

Award of Derby - Charleston, STP 9248(1), a 5.68 mile pavement recycling project was won by Gorman Brothers and was constructed during the same time frame as the Chester Springfield contract. Regardless of the circumstances that resulted in the construction of two projects of similar scope during the same time frame by the two rival companies Gorman Brothers and Whitcomb, it creates an advantageous situation for evaluating and comparing the recycling methods of the two companies. Aside from the fact that benefits cannot be realistically analyzed for either project without the necessary time lapse to evaluate performance, other factors preclude a realistic comparison of cost data. It is a generally held perception that one of the most significant pay items within the Chester-Springfield contract was grossly underbid and that this was done as a competitive maneuver. Although this was advantageous to the state from an economic standpoint, it would tend to discredit any attempt to analyze the cost/benefit relationship.

Item	Chest - Spfld bid	Derby - Chrlstn bid	AWLB
404.65(mod)	$1.00	$9.60	$24.00
406.25	28.10	32.40	28.00
415.20	1.65	1.65	Not available

PRELIMINARY CONCLUSIONS:

1. Due to an apparent unbalanced bid price for the emulsified asphalt item, a cost/benefit comparison of the Chester - Springfield project with similar cold recycle projects would probably not be a valid exercise.

2. Although there were some minor process problems, the Chester -Springfield project seemed to have progressed quite well, and the Resident Engineers prognosis for long term success is favorable.

3. Process problems related to excessive moisture and gradation anoma-

lies seem to be minor and workable.

4. Based on the experience gleaned from this project it is apparent that resolution of the quality control problem will not be achieved easily. More precisely defined control in the specification will serve no useful end until the agency has acquired sufficient understanding of the recycle process and the interaction of its variables. A reasonable interim solution would be to pool the available knowledge of this technology, and to gradually re-write the specification as the more precise language can demonstrably improve the process.

FOLLOW UP:

Performance monitoring for the Chester - Springfield projects will continue on an annual basis, with emphasis on crack counts, rutting measurements, structural strength (FWD) testing and roughness (IRI) measurements. The evaluation will continue until the effectiveness of the Whitcomb process has been clearly and definitively established.

APPENDIX A

PRE-CONSTRUCTION PAVEMENT CONDITION DATA

Test Site	5.9	6.0	6.1	6.2	7.2	1.0	2.2	3.4
Cracking	261	497	359	445	388	425	445	407
Rutting	2.22	1.26	1.19	3.04	1.41	1.78	2.89	5.04

Cracking was measured in feet/100'
Overall Average Rutting was measured in sixteenths of an inch.

POST CONSTRUCTION IRI VALUES

Test Site	5.9	6.0	6.1	6.2	7.2	1.0	2.2	3.4
IRI(EB)	122	****	72	****	109	113	101	126
IRI(WB)	124	****	122	****	116	126	123	116
IRI(AVE)	123	****	97	****	113	120	112	121

**** - Data Not Available

FWD value of the recycled base @ test sites:

Test Site	5.9	6.0	6.1	6.2	7.2	1.0	2.2	3.4
Pre-Const.	4.03	4.20	4.18	3.75	3.85	4.15	4.10	3.55
Post CIR	3.58	3.68	N/A	N/A	3.50	3.70	3.53	****
Post Lev.	3.78	3.88	4.38	4.03	3.80	3.98	4.00	****
Final Surf.	****	****	4.95	4.35	4.43	4.50	4.45	3.98

**** -Data Not Available

APPLICATION RATES OF ASPHALT EMULSION
(% of weight of Emulsified Asphalt)

6/8/93	MM 6.720 - 7.031	1.96%	(Chester EB)
6/9/93	NO WORK		
6/10/93	MM 7.031 - 7.975	1.51%	(Chester EB)
	(Some raveling detected the next day)		
6/11/93	MM 7.975 - 8.245	1.669%	(Chester EB)
	MM 0.000 - 0.585	1.669%	(Springfield EB)
6/12/93	MM 0.585 - 1.277	1.900%	(Springfield EB)
6/14/93	MM 1.277 - 2.455	1.900%	(Springfield EB)
6/15/93	MM 2.455 - 3.450	1.640%	(Springfield EB)
6/16/93	MM 6.272 - 7.458	1.790%	(Chester WB)
6/17/93	MM 7.548 - 8.245	1.810%	(Chester WB)
"	MM 0.00 - 0.817	1.810%	(Springfield WB)
6/18/93	MM 0.817 - 2.101	1.670%	(Springfield WB)
6/19/93	MM 2.101 - 2.860	1.910%	(Springfield WB)
6/22/93	MM 2.860 - 3.528	1.880%	(Springfield WB)
"	MM 3.468 - 3.528	1.880%	(Springfield EB).1s1

DESCRIPTION OF TEST SECTIONS

Test Section 5.9 begins @ MM 5.90 (control section 1) Vt 11, Chester STP 9235(1)S

Test Section 6.0 (control Section 1) Begins @ MM 6.0 (control section 1) Chester RS 0134(8)

Test Section 6.1 (control section 2) Begins @ MM 6.1 on Vt 11 Chester RS 0134(8)

Test Section 6.2 (control section 2) Begins @ MM 6.2 on Vt.11 Chester

RS 0134(8)

Test Section 7.2 (Chester Vt. 11 project) Begins @MM 7.2 Chester RS 0134(8)

Test Section 1.0 (Springfield Vt 11 project) Begins @ MM 1.0
Springfield STP 9361(1)S

Test Section 2.2 (Springfield Vt. 11 project) Begins @ MM 2.2 Springfield
RS-0134(7)

Test Section 3.4 (Springfield Vt.11 project) Begins @ MM 3.4, Springfield
M2500(9)S