REHABILITATION OF U.S. ROUTE 2 IN CONCORD, VT.
INITIAL REPORT 93-4
SEPTEMBER 1993

REPORTING ON WORK PLANS 84-R-5, 84-R-6, 84-R-7

STATE OF VERMONT

AGENCY OF TRANSPORTATION

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16. Abstract

In an attempt to address a variety of problems on a segment of US Route 2 in Concord Vermont, the VAOT initiated a rehabilitation project during late autumn of 1983. The project included the "Bell & Flynn Method", a relatively new approach to base reclamation, and only the first 1.55 mile was completed during the 1983 construction season, with activity being suspended during late October or early November of that year.

By the spring of the following year, the new construction had already shown serious problems and the original design was re-evaluated, resulting in the elimination of the "Bell & Flynn Method", and introduction of a 6" gravel interlayer between the existing and new pavements.

One other relatively new design feature was introduced, i.e. the use of geotextile membrane as a moisture barrier between the existing and new pavements. This design feature was introduced for evaluation via test sections for three distinct products: Mirafi MCF 500, Trevira S1115 and Petromat.

This report includes an account of the project's development, the problems encountered and the performance of the various design features introduced.

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INTRODUCTION

This report includes an analysis of the problems encountered when a section of US route 2 was rehabilitated in Concord Vermont, it also includes an assessment of the effectiveness of several designs which were employed to solve the problems:

1. The Bell and Flynn cold recycling process.
2. The use of granular materials as an interlayer between existing and new pavements.
3. The use of geotextile membranes to alleviate the deleterious effects of surface moisture intrusion into the subbase.

HISTORY

The rehabilitation project began at a point on existing US Route 2 in Concord, at approximate MM 4.092 and continued easterly for approximately 4.292 miles to mm 8.384.

This section of US Route 2 was reconstructed in 1961 with an 8-12-12-8 typical section which included a variable depth crushed gravel subbase (20" in cuts and 16" in fills), 3" penetration macadam base course and a wearing course of 3" Bituminous Concrete Pavement. US 2 is an east-west route with heavy trucking usage and traffic on this section is in the 4000 ADT range. By early 1983 significant deterioration of the ride quality and the manifestation of several other forms of pavement distress precipitated research investigation R-83-2. Findings of that report suggested that the primary cause of the pavement failure was a high percentage of fines in the subbase material. Test pit samples had revealed that the sand portion of the gravel subbase contained an average of 36% material passing the #200 screen, significantly in excess of the 12% maximum cited by the specification applicable at that time. Other contributing factors were suggested, such as surface and capillary moisture, high water tables, frost action and the development of ice lens. There were some dissenting opinions as to the cause(s) for the deteriorating condition of this section of US route 2. The most defensible of the alternative opinions suggested that the existing penetration macadam base course and its poor structural strength was the real problem.

Funding limitations precluded a total reconstruction project in that area at that time. The solution finally selected included measures to address all concerns. The proposal called for hammermilling (Bell and Flynn method, see appendix) of the existing pavement to a depth of 8", application of a 1-3/4", Type II binder course and a 1-1/2" Type III wearing course. Edge drains were also designed to alleviate the identified problems with surface and capillary water intrusion into the subbase and the resulting migration of fines into the subgrade.

Because project construction was not begun until late autumn of 1983, only the first 1.55 mile was completed at that time, and application of the designed 1-1/2" wearing course was postponed until the following construction season.

NEW PROBLEMS AND THE PROFFERED FINAL SOLUTION

By April of 1984 problems with the new construction were already apparent. Average to severe rutting, as well as load stress related cracking patterns had appeared on all of the portion of the reconstructed section to the east of the moose river, and even worse, the pavement had completely lost its structural integrity in some areas.

Because of the problems with the initial 1.55 miles of the project, the decision was made to reconstruct most of it. The design was revised for all but the first 0.3 mile and the "Bell and Flynn" process was abandoned:

Since the distresses mentioned above were not prevalent within the first 0.3 mi. of the newly rehabilitated section, the construction of the previous year was deemed adequate for that portion of the project, and the only work done there was the addition of the 1-1/2" bituminous concrete pavement wearing course originally designed but omitted during the earlier construction.

For the remaining 1.25 miles of the already rehabilitated portion of the project, a new design was used. From MM 4.395 to MM 5.645, the end of the original construction, a 6 " interlayer of gravel subbase was placed over the rehabilitated pavement and then this material was overlain with 3" of plant mix base course and 1-1/2" of Bituminous concrete pavement, type III.

From MM 5.645 to the end of the project at MM 8.384 (2.74 miles.) the same construction methods were used as in the previous section, except the gravel layer was placed over the original (1961) pavement.

Because the consensus was that the original pavement distress was to a large extent moisture related and was prevalent in fill, as well as cut sections, the preponderance of opinion supported the contention that surface moisture penetration rather than ground water was the chief cause of the poor ride. Underdrain was designed for the particularly wet cut areas, and three test strips were designated for the placement of experimental geotextile fabric. The selected fabrics were of a design that was appropriate to promote lateral surface moisture drainage away from the pavement, while retaining the fines.

The use of these fabrics was an experiment, and from it, the Agency hopes to determine the effectiveness of three types of geotextile membranes in applications of this type.

DESCRIPTION OF THE TEST SECTIONS

Because of the unique design and development of this project, several of its elements are of interest to the Agency. Test sections have been set up and are being observed to monitor their performance as follows:

TEST SECTION 1A - The 0.3 mile of the "Bell and Flynn" cold recycling process will be monitored on test section 1A. The test section begins 150 feet south of the southerly end of BR#117 (over the Moose river) This test section is in the area where the original design was employed and left undisturbed. The typical section here includes these features:

8" reclaimed base (Bituminous Base Stabilization-Bell and Flynn method)
1-3/4" Bituminous Conc. Pav't Type II Binder Course
1-1/2" Bituminous Conc. Pav't Type III Wearing Course

TEST SECTION #1 (MM 6.912, 200' westerly of test section 2. Test section 2 was originally designated as section 4A (Mirafi test site). This test section lies within the segment of the project constructed in 1984, and includes all of the revised design, with the one exception that it doesn't include any of the experimental membrane fabrics:

6" subbase of crushed gravel on existing pavement.
3" Plant Mix Base Course
1-1/2" Bituminous concrete Pavement, Type III

TEST SECTION #2 - Begins at approximate MM 6.968. This is the MIRAFI MCF 500 test site. This product was laid loose on the existing pavement surface. The fabric has an impermeable polypropylene film on its top surface, providing both an isolation barrier between the original pavement and the gravel interlayer above, as well as a lateral drainage plane between them. Construction here included:

MIRAFI MCF 500 Fabric
6" Subbase of crushed gravel
3" Plant Mix base Course
1-1/2" Bituminous Concrete pavement, Type III

TEST SECTION #3 (Begins 100 feet east of MM 7.026) This is the TREVIRA S1115 test site. - The 4.5 ounce, non-woven fabric was placed on existing pavement using an asphalt tack coat. The tack coat serves the same function as the polypropylene film with the MIRAFI Product.

TREVIRA S1115 Fabric
6" Subbase of crushed gravel
3" Plant Mix Base Course
1-1/2" Bituminous Concrete Pavement, Type III

TEST SECTION #4- Begins 100 feet easterly of MM 7.100, the test section is a 150' long. This is the PETROMAT test section. Petromat is a 4 oz non- woven product. It was applied in the same manner as Trevira S1115.

PETROMAT FABRIC
6" Subbase of Crushed Gravel
3" Plant Mix Base Course
1-1/2" Bituminous Concrete Pavement, Type III

TEST SECTION #5 (MM 7.166-150' EAST) Same construction features as test section #1.

PERFORMANCE MONITORING

As explained above, test sections have been established at selected sites to enable monitoring of each of the distinctive design features which have been incorporated into this project. Long term performance has and will continue to be measured within each of the test sections for cracking, rutting, Mays Meter (ride) and falling weight deflectometer (structure no.) values.

The data tabulated below indicates the performance within each of the test sections after a time interval of approximately nine years.

1993 PAVEMENT CONDITION DATA

	TEST SECTION					
	#1A B&F	#1 Control	#2 Mirafi	#3 Trevira	#4 Petromat	#5 Control
Crking-ft/100'	367	511	1531	549	587	945
Rut 1/16"	0.8	1.3	1.4	1.4	1.2	1.7
IRI(AVE.)"/mi.	130	120	114	117	135	135
Struct.No.	3.9	3.5	3.7	3.8	4.0	4.1

RECAPITULATION

Even as the original analysis of the problems that caused the severe deterioration of US route 2 in Concord might very well have been correct, it is just as reasonable to assume that the original treatment was appropriate also. The cause for the rapid and severe deterioration of the rehabilitated section of US 2 during the winter and spring of 1984 was never clearly identified, but an apparent "knee jerk" reaction seems to have been the motivation of the Agency to withdraw its support for the design which included the relatively new and untested "Bell and Flynn"

process. The evidence in support of, or adverse to the reclaimed base design is incomplete and the passage of time has rendered the detailed scrutiny of the application of the process impossible. But the meager evidence at hand suggests that the "Bell and Flynn" process might very well have taken a 'bum rap. Two facts suggest this. First, the time frame of the original construction, i.e. late autumn, might very well have severely and negatively affected the process, which properly applied could quite possibly have been successful. Secondly, the 1-1/2" wearing course designed to add structural support for traffic loading during the critical spring period was never applied. Finally, recently taken crack counts and rut readings suggest that the 0.3 mile of the project where the original design was left intact with the addition of a 1-1/2" overlay is significantly out-performing the rest of the project.

PRELIMINARY CONCLUSIONS

1. Properly applied, the "Bell and Flynn" process would have probably performed satisfactorily. The reason for the failure was ostensibly its application very late in the construction season and an inadequate allowance for cure time.

2. The evidence is still inconclusive regarding the effectiveness of two of the geotextile membrane installations. Present trends suggest that Petromat and Trevira S115 are not performing as well as sections with no geotextile. It should be noted here, however, that the design of these fabrics is such that they would not be expected to show improved performance until cracking is more severe and significant moisture ingress has resulted.

3. The third product, Mirafi MCF 500, is clearly inappropriate for this application since the treated area is currently showing a high level of rutting, and an unquestionably greater and unacceptable degree of cracking.

4. Preliminary data suggests that the gravel interlayer design is performing satisfactorily without the geotextile membrane application.

Follow Up

The performance monitoring will continue on an annual basis, with emphasis on roughness, crack development, rutting and structural strength.

APPENDIX

THE "BELL AND FLYNN" METHOD

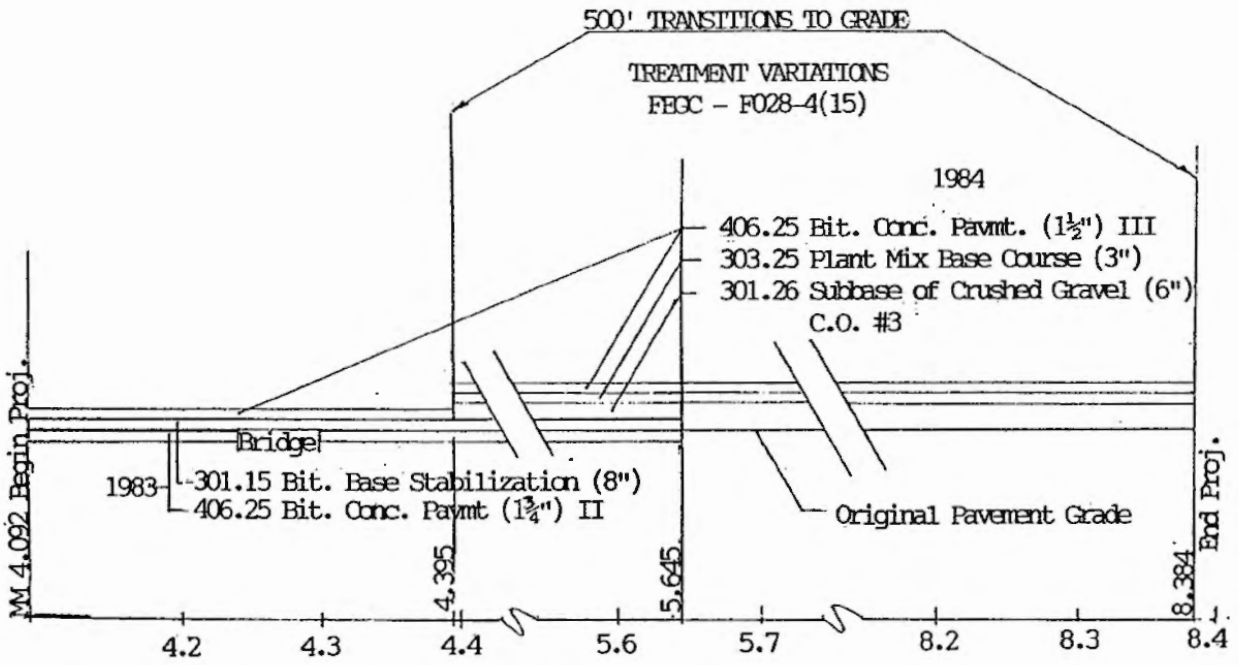
Bell and Flynn Inc. was founded in 1955 by two civil engineers, John A. Bell and John W. Flynn. The Bell and Flynn firm was the self proclaimed pioneer in research and design of pavement reclamation methods in the northeast. The "Bell and Flynn" process which was originally proposed for the entire Concord, US Route 2 rehabilitation project in 1983 was a base stabilization/reclamation method which had been successfully tested at four sites previously, i.e. three airport runway projects in Massachusetts, and rehabilitation of an urban street in Ulster, New York. One statement made in the contractors proposal stands out as quite significant and a presage of the impending project failure. We quote it here. "Our experience on the Martha's Vineyard Testing Program indicates that there is a curing period for the pavement structure. Consequently we will allow the pavement to cure as long as possible prior to the onset of cold weather, and then conduct the dynamic test program (most likely in October 1983)".

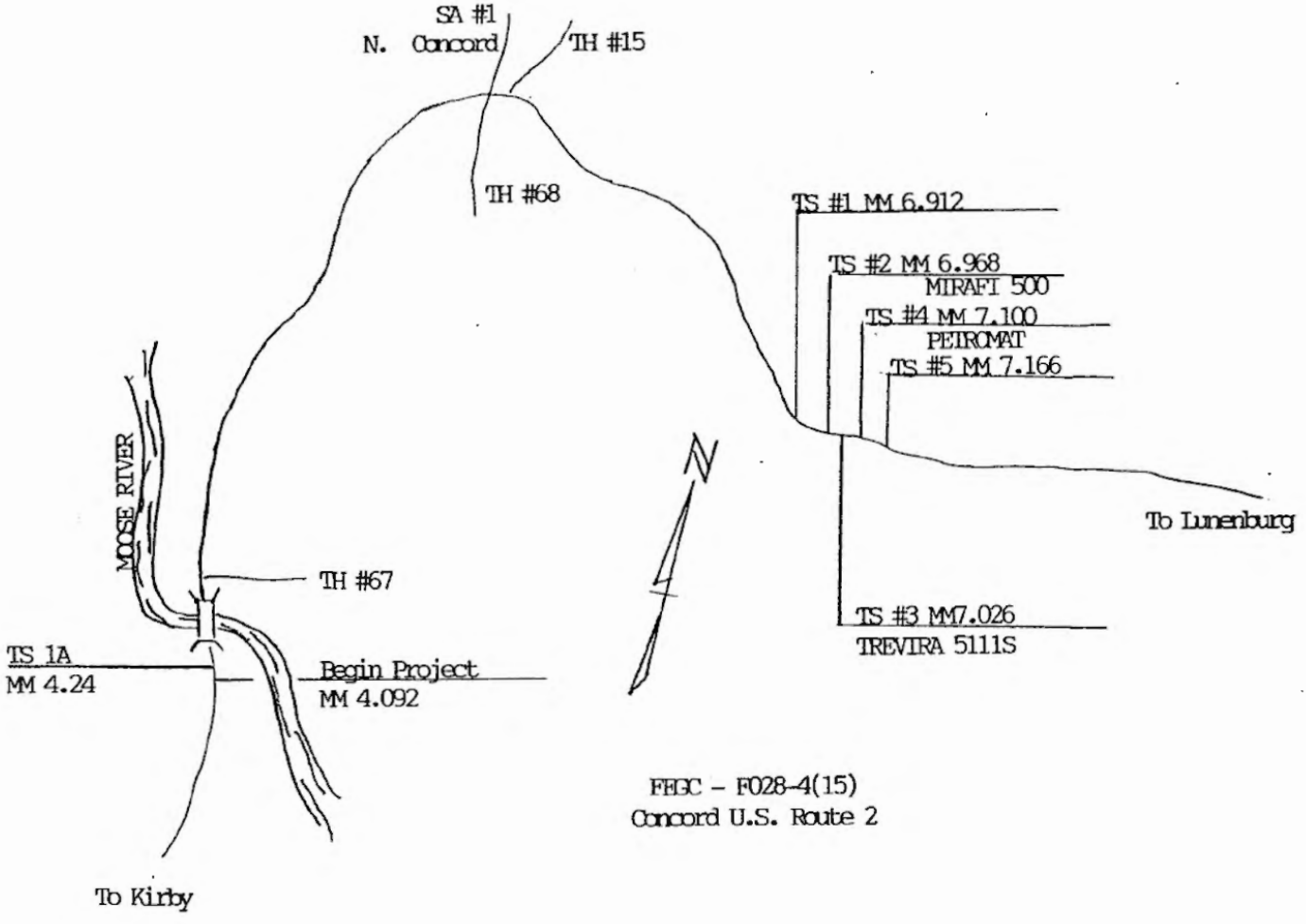
The foregoing statement clearly suggests that proper implementation of the Bell and Flynn process required a project completion date well in advance of the onset of cold weather, while it is clear that the first Concord project construction was not concluded until late October or early November of 1983.

REFERENCE Research Investigation R83-2 Interim Report
Work Plans 84-R-5, 84-R-6, 84-R-7

COST DATA

Mirafi MCF 500 -$2.50/SY
Petromat - $3.00/SY
Trevira - $3.00/SY





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