

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION


PHYSICAL RESEARCH PROGRAM
1977 THRU 1980

Prepared By
Materials & Research Division
December 1980

Reviewed By: R. F. Nicholson
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Materials & Research Engineer

Date: Dec. 22/80

TO: R. E. W. Crisman, Secretary of Transportation

FROM: S. J. Gage, Director of Engineering & Construction 

DATE: December 22, 1980

SUBJECT: Transportation Research

In response to your questions concerning the research program of the Transportation Agency, enclosed please find an executive summary as follows:

- History of Physical Research Staffing and Action Policy
- Present Research Capability and Limitations
- Research Studies Completed During the Period 1977-1980
- Research Investigations and Product Evaluations 1977-1980
- Research Studies Currently Underway
- Research Studies Proposed
- Research Services by Outside Organizations
- Materials & Research Laboratory Testing Summary
- Annex A - Planning Research Activities
- Annex B - Structures Research Activities
- Annex C - Design Research Activities

If you desire additional information on the subject areas covered or on other activities, please let me know.

SJG/RFN/mlm

cc: Dir. of Eng. & Const. Gage
Materials & Research Eng. Nicholson
Research Specialist Frascoia
Central Files

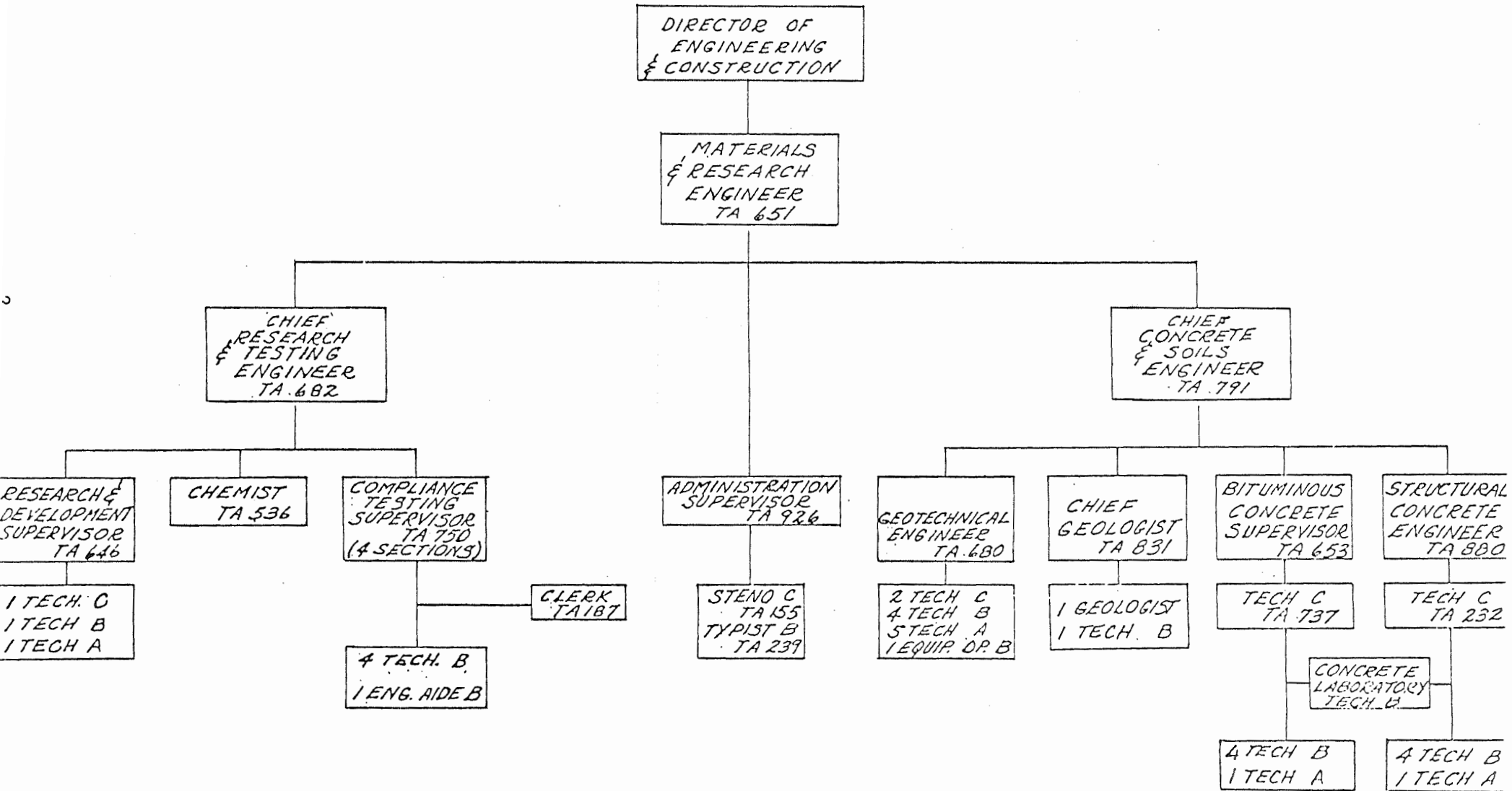
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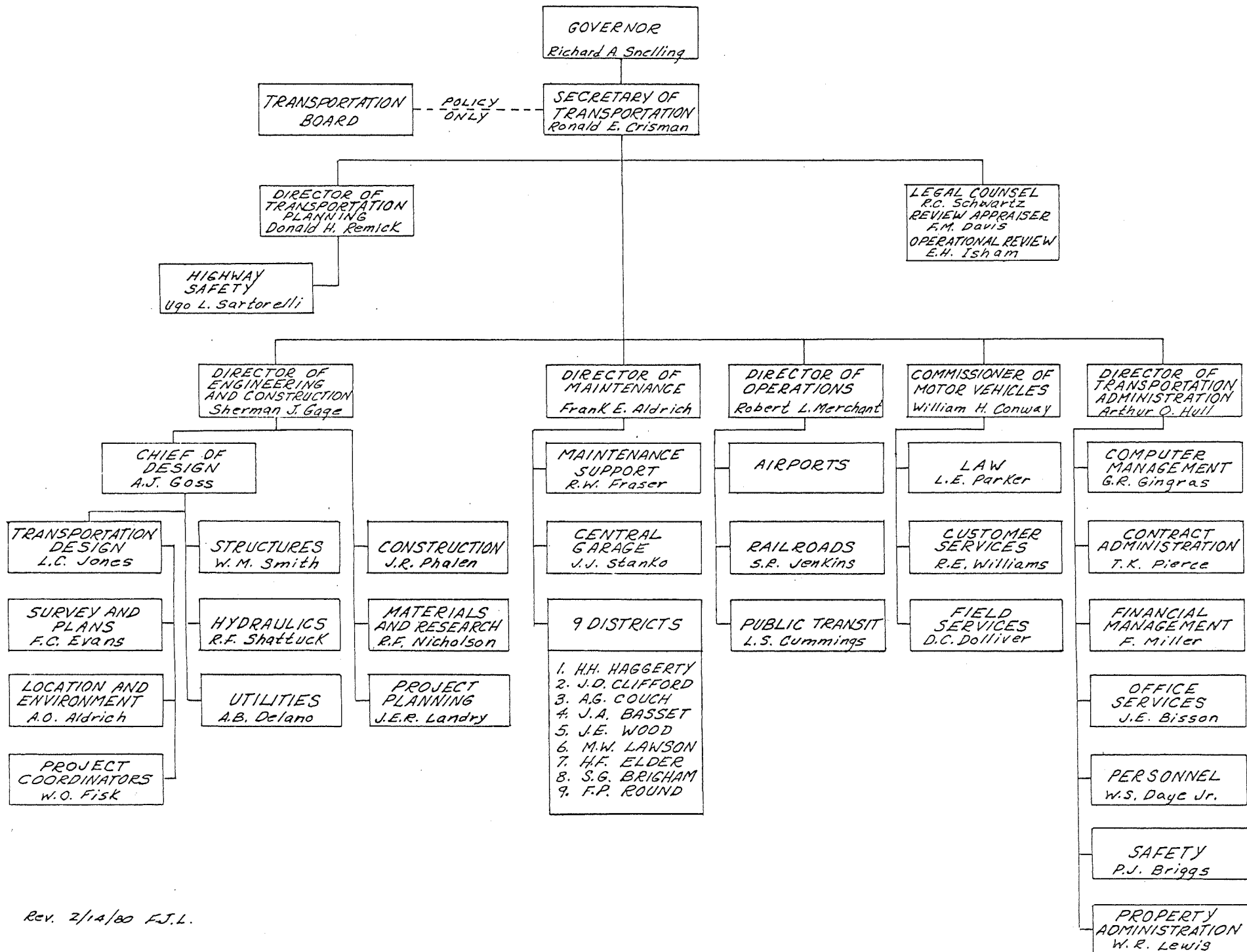
HISTORY OF PHYSICAL RESEARCH STAFFING AND ACTION POLICY

- Dec., 1970 A physical research section was established in the Transportation Agency as a subdivision in the Materials Division. The staff consisted of one position which reported to the Assistant Materials Engineer. Assistance was provided through loans of personnel from other subdivisions. All requests for research investigations were channeled through the Chief Engineer who approved/disapproved action.
- Aug., 1976 Research & Development staff increased by one position with added responsibility of developing and maintaining a pavement friction testing program as required under Federal mandate. All research projects were submitted to the Materials Engineer for approval prior to initiating action.
- May, 1978 Research & Development staff increased by two positions thereby reducing the need for borrowing personnel from other subdivisions.
- Aug., 1978 Materials Division retitled Materials and Research Division with a new position titled Chief Research and Testing Engineer made responsible for Research and Development, Compliance Testing and Chemistry Sections.
- Oct., 1979 Engineer A position in Research & Development moved to Soils subdivision and a Technician A position added to Research & Development staff.
- Oct., 1978 Secretary Crisman notified Division Heads and District Transportation Administrators that a Research and Review Committee was being established to provide the Agency with a sounding board and evaluation mechanism for prospective research projects to be undertaken by the Agency. Comments or suggestions on areas requiring improvements or research were requested.
- April, 1979 Secretary Crisman transmitted the approved guidelines for the operation of the Research and Review committee plus a suggested format for submittal of proposed research projects to Division Heads and District Transportation Administrators. All research requests or proposals are forwarded to the committee for consideration with the final recommendation on action coming from the Secretary's office.

VERMONT AGENCY OF TRANSPORTATION MATERIALS & RESEARCH DIVISION



VERMONT AGENCY OF TRANSPORTATION



Rev. 2/14/80 F.J.L.

AGENCY OF TRANSPORTATION

OFFICE MEMORANDUM

TO: Division Heads and District Transportation Administrators

FROM: Secretary Crisman *R. Crisman*

DATE: October 23, 1978

SUBJECT: PLEASE POST



We are establishing a Research and Review Committee to provide the Agency with a sounding board and evaluating mechanism for prospective research projects to be undertaken by the Agency. I therefore would like to appoint the following committee to act as that group and provide leadership in the identification, development and evaluation of needed research work:

W. Tripp, Chairman
E. H. Isham
J. E. R. Landry
D. Brown
J. Hoag
D. Dolliver

It will be the task of this committee to develop their own internal operating objectives and methods as well as general guidelines for the review of suggested research projects. Their purpose will be to provide support and recommendations to the Agency management for scheduling and selection of research projects.

Almost everybody in the Agency to some degree is responsible for improving the way we do things. In some cases improvement and/or experimenting requires the efforts of many people across division lines of authority. One of the tasks of the committee will be to assist in structuring the team task forces as necessary to accomplish research goals.

I would appreciate any comments or suggestions from members of the Agency on needed areas of improvements or research.

TO: Division Heads and District Transportation Administrators

FROM: Acting Secretary Merchant *M*

DATE: April 23, 1979

SUBJECT: Research and Review Committee

The subject Committee has developed approved guidelines for operation, and a copy is attached for your information. The primary purpose of this Committee, as noted in the guidelines, is to serve as a clearinghouse and review agency. The Committee will make recommendations and coordinate data, but will not, itself, be actively involved in research. All suggestions received by the Committee will be considered for further action, and if action is considered desirable by the Committee, a recommendation will be sent to this office. Directives concerning implementation of research projects will come from this office.

A suggested format for submittal of proposed projects is attached to the guidelines. Please use this for submittal of any projects you would like reviewed. This is an ongoing committee, so submittals may be made at any time by sending them to Warren Tripp, Chairman, C/o Structures Division.

Attachment



RESEARCH CAPABILITY & LIMITATIONS

The present 4 man staff in the Research & Development Subdivision divides its efforts between major research projects, typically of an experimental construction nature and the less complex research investigation or product evaluation studies.

Our present capabilities are restricted to a greater extent by limited funding for experimental projects and research studies rather than inadequate staff. There have been and still are many materials, processes and procedures which could be investigated and tried here in Vermont in anticipation of improved performance, lower initial cost or reduced maintenance requirements. Several examples include hot recycling of bituminous pavements, the design and use of sulphur extended asphalt, and new technology involving methods of protecting Portland Cement Concrete bridge decks from the damaging effects of roadway deicing chemicals. However, the use of experimental materials or methods often results in higher unit costs on the first few projects due to size of projects and lack of experience on the part of the contractor or because of additional equipment needs. This reason combined with limited funds often results in a lack of support for experimental research projects. An example of this occurred on the I-91 Springfield-Weathersfield project in 1979 when we found it necessary to eliminate the experimental hot recycling method due to high bid costs. Other potential research studies have not been supported due to the increased risk of failure present when experimental materials or procedures are tried.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

SUMMARY OF RESEARCH
STUDIES 1977-1980

TITLE	ITEM No.	REPORT No.
REDUCING REFLECTION CRACKING IN BITUMINOUS OVERLAYS UTILIZING A STRAIN RELIEVING INTERLAYER OF RUBBERIZED SLURRY	1	77-1
EVALUATION OF BRIDGE DECK MEMBRANE SYSTEMS AND MEMBRANE EVALUATION PROCEDURES.	2	77-2
EVALUATION OF SWISS HAMMER READING MODEL NA-5, SPECIAL NUMBER 1758	3	77-3
ALTERNATIVE REFLECTION CRACK TREATMENTS PULVERIZATION AND RUBBERIZED SLURRY SRI	4	77-4
CLASS B CONCRETE USING GUILDHALL AGGREGATES GUILDHALL, VERMONT	5	77-5
CLASS B CONCRETE USING CALEDONIA INC. AGGREGATES WATERFORD, VERMONT	6	77-6
DEICING-CHEMICAL RATES ON OPEN-GRADED PAVEMENTS	7	FHWA-TS-77-216
BRATTLEBORO SAND & GRAVEL BRATTLEBORO, VERMONT TRIAL MIXES FOR CLASS A & CLASS B CONCRETE	8	78-1
A.G. ANDERSON BERLIN, VERMONT TRIAL MIXES FOR CLASS A & CLASS B CONCRETE	9	78-2
INVESTIGATION OF SAND MORTAR CUBE STRENGTHS UTILIZING SANDS WITH DIFFERENT FINENESS MODULI FROM WATERFORD AND GUILDHALL	10	78-3
RESULTS OF TRIAL MIXES FOR CLASS A,B,C AND D CONCRETE USING FRANK W. WHITCOMB CONSTRUCTION CORPORATION's PROPOSED CRUSHED STONE COARSE AGGREGATE	11	78-4

Vermont Agency of Transportation
Summary of Research Studies

<u>TITLE</u>	Item No.	Report No.
EXPERIMENTAL BRIDGE DECK MEMBRANE APPLICATIONS IN VERMONT....WORK PLANS #46 - #48	12	78-5
LAWRENCE SANGRAVCO INC. ST. JOHNSBURY, VERMONT TRIAL MIXES FOR CLASS A CONCRETE	13	78-6
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STRENGTH OF CONCRETE CLASS AA MODIFIED (4½" to 5" SLUMP).	17	79-2
CONCRETE CURING MATERIALS & ADMIXTURES SECTION 725 TESTING PROGRAM 1970-1978 SUMMARY OF RESULTS	18	79-3
INVESTIGATION OF CONCRETE CURING MATERIALS TESTING EQUIPMENT AND PROCEDURES	19	79-4
EXPERIMENTAL USE OF AN ASPHALT RUBBER STRESS ABSORBING MEMBRANE INTERLAYER	20	79-5
LAB COMPARISON OF VARIOUS CONCRETE MIXES.	21	80-1
PHYSIO - CHEMICAL STUDIES OF CONCRETE CHIMNEY BLOCKS . .	22	80-2
EVAZOTE - 50 EXPANSION/CONTRACTION JOINT SYSTEM	23	80-3
PAVEMENT LIFE RESEARCH PROJECT	24	80-5

RESEARCH STUDIES COMPLETED
(1977 through Present)

Reducing Reflection Cracking
in Bituminous Overlays Utilizing a Strain Relieving
Interlayer of Rubberized Slurry

Final Report 77-1

A final report covering the use of rubberized slurry as a strain relieving interlayer to reduce reflective cracking of bituminous overlays. The research involved an experimental construction method on Interstate 91 in Putney, VT.

Evaluation of Bridge Deck Membrane Systems
and Membrane Evaluation Procedures

Report 77-2

An investigation undertaken to evaluate the field performance of 24 membrane systems and to identify the limitations of the nondestructive tests being used evaluate membrane waterproofing systems. The special study was funded by the Federal Highway Administration in conjunction with the National Experimental and Evaluation Program No.12 Bridge Deck Protective Systems.

Evaluation of Swiss Hammer
Reading Model NA-5, Serial Number 1758

Report 77-3

The purpose of this study is to correlate Swiss Hammer rebound value with compressive strength for a variety of samples and to describe the use of the resulting data base for predicting compressive strengths from Swiss Hammer Readings.

Alternative Reflection Crack
Treatments Pulverization and
Rubberized Slurry SRI

Report 77-4

A final report covering two experimental construction methods (pulverization and rubberized slurry) tried to reduce reflective cracking on five miles of Interstate 91 in Northern Vermont.

Class B Concrete Using Guildhall Aggregates
Guildhall, Vermont

Report 77-5

An investigation designed to obtain a Class B structural concrete mix design that will achieve a compressive strength of 3500 psi under field conditions and during temperatures experienced with summer placement.

Class B Concrete Using Caledonia Inc. Aggregates
Waterford, Vermont

Report 77-6

An investigation designed to obtain a Class B structural concrete mix design that will achieve a compressive strength of 3500 psi under field conditions and during temperatures experienced during summer placement.

Deicing-Chemical Rates
On Open-Graded Pavements

Report FHWA-TS-77-216

A study funded by the Federal Highway Administration and conducted by Vermont and three other states to determine if more sodium chloride (road salt) is needed to clear open-graded asphalt friction courses during winter storms than is needed to clear conventional asphalt pavements.

Brattleboro Sand & Gravel
Brattleboro, Vermont
Trial Mixes for Class A & Class B Concrete

Report 78-1

An investigation to evaluate mix designs for Class A & Class B concretes to determine if concrete of the desired quality can be produced.

A.G. Anderson
Berlin, Vermont
Trial Mixes for Class A & Class B Concrete

Report 78-2

An investigation to evaluate mix designs for Class A & Class B concretes to determine if concrete of the desired quality can be produced.

Investigation of Sand Mortar Cube Strengths
Utilizing Sands with Different Fineness Moduli
from Waterford and Guildhall

Report 78-3

An investigation of three factors believed to influence the compressive strength of the mortar portion of concrete mixes. These factors are the variance of the fineness modulus of the sand, the percent of material passing the 200 mesh sieve and the amount of water required to create a constant flow.

Results of Trial Mixes for Class A, B, C and D Concrete
using Frank W. Whitcomb Construction Corporation's
Proposed Crushed Stone Coarse Aggregate

Report 78-4

An investigation to evaluate mix designs for Class A, B, C and D concretes when used with a new aggregate source to determine if concrete of the desired quality can be produced.

Experimental Bridge Deck Membrane Applications
in Vermont....Work Plans #46 - #48

Report 78-5

A report covering the application and initial evaluation of four **experimental** bridge deck systems on eight interstate bridges in the Newbury-Barnet area.

Lawrence Sangravco Inc.
St. Johnsbury, Vermont
Trial Mixes for Class A Concrete

Report 78-6

An investigation to evaluate Vermont Agency of Transportation mix designs for Class A concrete when used with various water reducing and retarding admixtures to determine if concrete of the desired quality can be produced.

Lower Bituminous Mixing Temperatures

Report 78-7

This report investigates the effects of lowering the mixing temperature of bituminous concrete on the physical properties of the mix, during and after lay down.

J. P. Carrara & Sons
North Clarendon, Vermont
Trial Mixes for Class A & Class B Concrete

Report 78-8

An investigation to evaluate mix designs for Class A & Class B concretes to determine if concrete of the desired quality can be produced.

Investigation of Structural Lightweight
Aggregate Concrete
Containing "Solite" 3/4" Coarse Aggregate

Report 78-9

An investigation undertaken to determine the physical properties of "Solite" 3/4" structural lightweight aggregate and its effect on concrete mixtures when used in combination with normal weight fine aggregate. The results obtained in the testing program have resulted in the use of lightweight concrete on several recent construction projects.

Strength of Concrete
Class AA Modified (4½" to 5" Slump)

Report 79-2

A report which investigates the use of Concrete Class AA Modified with a 4½" to 5" slump for use in filling steel grid flooring. Three trial mixes were used to determine the cement content required to yield a compressive strength of 3750 psi in seven days using a Type II Portland Cement.

Concrete Curing Materials & Admixtures
Section 725 Testing Program 1970-1978
Summary of Results

Report 79-3

A report which summarizes the results of several testing programs and recommends products covered under Section 725, Concrete Curing Materials and Admixtures, for inclusion on the List of Approved Materials.

Investigation of Concrete Curing Materials
Testing Equipment and Procedures

Report 79-4

A report which investigates the performance of polyethylene film, waterproof paper and curing compound when tested in accordance with AASHTO, T155 "Water Retention Efficiency of Liquid Membrane - Forming Compounds and Impermeable Sheet Materials for Curing Concrete." This report also determines if the equipment capability exists in the Materials and Research Division to perform the desired tests as specified.

Experimental Use of an Asphalt Rubber Stress
Absorbing Membrane Interlayer

Report 79-5

A report which covers the construction phase of a field trial utilizing an asphalt rubber stress absorbing membrane interlayer. Application procedures, product composition, cost, and performance are examined.

Lab Comparison of Various Concrete Mixes

Report 80-1

A report which investigates the use of a low water-cement ratio or dense concrete, and polymer modified concrete overlays.

Physio - Chemical Studies of Concrete Chimney Blocks

Report 80-2

A report which investigates possible causes of concrete chimney block failure.

EVAZOTE - 50 Expansion/Contraction
Joint System

Report 80-3

A report detailing the placement and evaluation of an experimental joint system on an interstate bridge in Montpelier.

Pavement Life Research Project

Report 80-5

The indepth study covering the deterioration of the 1975 Bolton-Colchester Interstate overlay project with recommendations for corrective action.

RESEARCH INVESTIGATIONS AND PRODUCT EVALUATIONS

CATEGORICAL TABLE OF CONTENTS (1977 THROUGH PRESENT)

ADHESIVES

P78-6	Top-Bond #40 ... Epoxy Bonding Compound	Feb 1978
P78-7	Epi-Seal (C-1) ... Epoxy Bonding Compound	Feb. 1978
P78-11	Epi-Seal Con-Hesive #524 ... Epoxy Bonding Compound	Mar 1978
P78-12	Epi-Seal #39L350, 396010 ... Epoxy Bonding Compound	Mar 1978

DEICING CHEMICALS

P77-6	Keene Ice Melter "M"	Apr 1977
P77-30	Minimum Salt Requirements For Winter Sand Stockpiles	Oct 1977

JOINT SEALERS - FILLERS

P78-17	Sonolastic ... Single Component Urethane Sealant	Apr 1978
P78-18	Sikaflex - 1a ... Fast Cure Single Component Urethane Sealant	Apr 1978
P78-19	FX 66 ... Two Component Urethane Sealant	Apr 1978
P78-20	Sonolastic NP II ... Two Component Polyurethane Sealant	Apr 1978
P78-31	Dualthane ... Joint Sealant	Sep 1978
P78-32	Pourthane ... Joint Sealant	Sep 1978

MULCH & EROSION CONTROL

P77-10	Hold Gro ... Erosion Control Matting (Final Eval.)	Jul 1977
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PATCHING MATERIALS

P77-1	Sylvax U.P.M. ... Bituminous Patch	Jan 1977
P77-13	Sonopatch ... Quick Set Patching Material	Oct 1977
P77-15	Exide Maricrete ... Quick Set Patching Material	Oct 1977
P77-16	Five Star Instant Grout ... Quick Set Patching Material	Oct 1977
P77-17	Set 45 ... Quick Set Patching Material	Oct 1977
P77-18	Rock Mount Highway Patch ... Quick Set Patching Material	Nov 1977
P77-19	Roadpatch ... Quick Set Patching Material	Nov 1977
P77-20	Set Instant ... Quick Set Patching Material	Dec 1977

PATCHING MATERIALS (con't.)

P78-1	Fast Set Pre-Krete ... Quick Set Patching Material	Jan	1978
P78-2	Octocrete ... Quick Set Patching Material	Jan	1978
P78-34	Duracel Cement - Quick Set Patching Material	Dec	1978
P79-2	Set 45 (RETEST) - Quick Set Patching Material	Jan	1979

PORTLAND CEMENT CONCRETE ADMIXTURES

P77-4	Pozzolith 122 N ... Water Reducing Admixture	May	1977
P77-7	Fox FX-32 RA ... Catalytic Agent for Concrete	Jun	1977
P77-8	Fox FX-32 ... Catalytic Agent for Concrete	Jun	1977
P77-11	DOW Chemical Modifier A ... Latex Concrete	Jul	1977
P77-21	WRDA ... Water Reducing Admixture	Dec	1977
P77-22	WRDA with Hycol ... Water Reducing Admixture	Dec	1977
P77-23	Mighty 150 ... Water Reducing Admixture	Dec	1977
P77-24	Pozzolith 200 N ... Water Reducing Admixture	Dec	1977
P77-25	Sikament ... Water Reducing Admixture	Dec	1977
P77-26	FX 32 D ... Water Reducing Admixture	Dec	1977
P77-27	FX 32 (Normal) ... Water Reducing Admixture	Dec	1977
P77-29	Tigercrete ... Quick Set Patching Material	Dec	1977
P78-5	Iowa Mix (Low Slump) Concrete	Feb	1978
P78-9	Sikament ... Super Water Reducer	Mar	1978
P78-10	Mighty 150 ... Super Water Reducer	Mar	1978
P78-15	FX-32 "D" ... Catalytic Agent	Mar	1978
P78-16	FX-32 ... Catalytic Agent	Apr	1978

PORTLAND CEMENT CONCRETE FINISHING PRODUCTS

P77-12	Super Tuf-Cote ... Concrete Surface Retarder	Jul	1977
P78-27	TCA Bridge Cote ... Textured Coating For Concrete	Aug	1978
P78-28	XL-70 ... Textured Coating For Concrete	Aug	1978

REFLECTIVE CRACK CONTROLS

P77-14	Typar ... Road Support Fabric	Aug	1977
P78-3	Arm-R-Shield ... Rubberized Asphalt	Feb	1978
P78-4	Rubberized Asphalts ... Blended AC 5 & 10 Asphalts	Feb	1978
P78-25	Investigation Of The Possibility Of Recycling Soil Cement Base and Bituminous Concrete Surface On Route 66 in Randolph, Vermont	Jun	1978
P78-26	Investigation Of The Feasibility Of Cold Recycling Bituminous Concrete On Route 4 In Sherburne and 302 In Wells River, Vermont	Jun	1978

RUST PASSIVATORS

P78-23	Rust-Go ... Rust Remover	May	1978
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STRUCTURAL MATERIALS & COMPONENTS

P78-35	Epoxy Coated Reinforcing Steel - Barre Decks	Dec 1978
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STRUCTURAL PAINTS

P79-4	Viscoat Vinyl Coating	Mar 1979
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TRAFFIC MARKING MATERIALS

P77-3	LDP-8 Plastic Post ... Delineator Post	Feb 1977
P77-28	Flexopost ... Flexible Delineator Post	Dec 1977
P78-22	LDP-6 Snap Back Delineator Post	May 1978
P78-24	Adcolite ... Reflective Sheeting	May 1978
P78-29	Carsonite Delineation Guide Marker Post	Aug 1978
P78-30	Stamark Brand Pavement Marking Film	Aug 1978
P79-1	Scotch-Lane - Pavement Striping Tape	Mar 1979

WATERPROOFING MEMBRANES & MATERIALS

P77-2	Nylene ... Silicone/Urethane Coating	Jan 1977
P79-5	Duralokote 304 LV	May 1979
P79-6	Mobilplast A	May 1979

MISCELLANEOUS

P77-5	Forney's Plastic Concrete Cylinder Molds	May 1977
P77-9	Dayton Float Drum ... Floation Device	Jul 1977
P77-31	Spartan's All Purpose Cleaner & SD-20	Mar 1977
P78-8	Liqui-Slip ... Asphalt Release Agent	Feb 1978
P78-21	Salt/Guard Spreader Lining System	Apr 1978
P78-33	Rouses Point Bridge	Oct 1978
P79-3	Microphor - Low Flush Toilet	Mar 1979

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

SUMMARY OF ONGOING RESEARCH STUDIES

BITUMINOUS CONCRETE

Loss of Fines Study

Effects of Baghouse Fines on Bituminous Concrete

Effect of Water on Cohesion of Compacted Bituminous Mixtures

SOILS

Constant Dry Weight Method of Field Compaction

PAVEMENT TREATMENTS

Asphalt Emulsion for Surface Treatment

Asphalt Rubber Surface Treatment

Cold Recycling Asphalt Pavement

BRIDGE DECK PROTECTION

Effect of Holidays on Epoxy Coated Reinforcing Steel

Performance of Galvanized Coating for Rebars

Bridge Deck Membrane Performance Study

Evaluation of Darex Corrosion Inhibitor

MAINTENANCE

Pavement Reinforcing Fabrics to Reduce Reflective Cracking

Study of Salt Usage and Salt Effects as Associated with Normal Salting Operations in Vermont

Study of the Effects of Road Salt on Soil & Water

SPECIAL PROJECTS

Pavement Friction Testing Program

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Loss of Fines Study

RESEARCH PROBLEM STATEMENT:

During the extraction process of a bituminous sample, fine particles of aggregate pass through the filter paper and are lost. This occurs in varying degrees depending on particle size. When this occurs, the asphalt content is affected as the loss of fines appears as asphalt, giving an incorrect asphalt content.

OBJECTIVE:

Determine a reliable method to obtain the correct asphalt content of a bituminous concrete mix.

URGENCY:

This problem has been a concern for several years and should be settled as soon as possible.

DATE STARTED: December, 1979

ESTIMATED COMPLETION DATE: May, 1981

PRINCIPLE INVESTIGATOR: Earle Chaffee, Jr., William Royce, and David Day

PAST RELATED ACTIVITIES:

Work has been done developing fines factors for mixes, but is unreliable.

COST:

Study Cost charged to Administration.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Effects of Baghouse Fines on Bituminous Concrete

RESEARCH PROBLEM STATEMENT:

Since the implementation of baghouse systems to control air pollution of bituminous concrete batch plants, there is great concern as to the effects that the fines have on mix quality. Prior to the advent of these systems, dust emissions were controlled by wet scrubbing systems. These systems washed the fine dust particles from the plants into settling ponds, where they were wasted. With very strict environmental laws, the baghouse systems have become very popular. These systems satisfactorily meet all of the environmental laws concerning pollution.

The baghouse systems are much like a huge vacuum cleaner. They pull nearly all of the dust particles from the aggregate during the drying process. These fine particles are then deposited into bins and/or large bags much the same as vacuum cleaner bags. These fines are then reintroduced into the aggregate.

This introduction of fines creates a situation where material that was previously washed away and wasted, is now a part of the bituminous concrete.

It is believed by many that these fines are detrimental to the mix. They may adversely effect all of the mix properties.

OBJECTIVE:

1. To determine what effects varying amounts of baghouse fines have on the properties of bituminous concrete.
2. To determine what method of introduction of fines to the mix is most advantageous.

URGENCY:

This project is being initiated throughout the industry and should be completed as soon as possible.

DATE STARTED: December, 1979

ESTIMATED COMPLETION DATE: May, 1981

PRINCIPLE INVESTIGATOR: Earle Chaffee, Jr., William Royce, and David Day.

PAST RELATED ACTIVITIES:

Many research projects have been and are being conducted throughout the industry. The results are inconclusive at this point since many of the projects have not been completed or circulated.

COST:

Study Cost charged to Administration.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Effect of Water on Cohesion of Compacted Bituminous Mixtures

RESEARCH PROBLEM STATEMENT:

During recent years the problem of asphalt stripping has become a major concern of the Bituminous Concrete industry. Numerous methods have been used to evaluate this problem. Some of these methods were felt to be too strict, others too lenient.

Methods used to control stripping problems vary from Agency to Agency.

OBJECTIVE:

The general objective of this study is to provide data to be used in developing specifications and procedures to be used when the quality of an aggregate indicates a loss of retained strength.

URGENCY:

Present conditions indicate only a small problem relative to stripping. With new sources of aggregates being proposed and a changing market relative to asphalt cements, quality control methods such as the one proposed will prove very beneficial.

DATE STARTED:

December 1980

ESTIMATED COMPLETION DATE:

May 1981 (Initial Report)

PRINCIPLE INVESTIGATOR:

David Day and William Royce

PAST ACTIVITIES:

A review of the available information indicates little has been published that produced definite results on this subject.

PROGRESS DURING 1980:

Project was started in December 1980. Collection of test data should be completed by March of 1981.

COST:

Study Cost charged to Administration. Future cost estimated at \$6000.00.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Constant Dry Weight Method of Field Compaction

RESEARCH PROBLEM STATEMENT:

Due to manpower shortages and the large number of construction sites required to be checked for in situ soils density tests, an expedient and reliable method of testing in situ density is needed.

OBJECTIVE:

To compare the reliability of the CDW Method of testing in situ density of soils with that of the Standard Proctor Test. The use of the CDW test to supplement nuclear probe testing in the determination of percent compaction will also be evaluated.

URGENCY:

Due to anticipated cost and labor savings, the project should be completed as soon as possible.

DATE STARTED: December, 1977

ESTIMATED COMPLETION DATE: April, 1981

PRINCIPLE INVESTIGATOR: C. H. Cookson

PAST ACTIVITIES:

Data from borrow pit areas and construction sites were tabulated in pairs. (One pair consisting of a CDW test and a Proctor test from the same location).

PROGRESS DURING 1980:

A statistical analysis of past data, correlating the two different compaction methods, is currently underway.

COST:

Study cost charged to Administration. Future costs estimated at \$1800.00.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Asphalt Emulsion for Surface Treatment

RESEARCH PROBLEM STATEMENT:

Increasing concern about energy and our environment requires investigation into use of different construction methods and materials. Vermont used an emulsion for a surface treatment in lieu of cut back asphalt. Construction cost and energy use evaluations, along with long term field evaluations are required to determine effectiveness.

OBJECTIVE:

The objective, by use of data collected before, during and after application of the emulsion surface treatment, is to determine the energy saved, cost effectiveness, and quality of surface obtained. Such an evaluation could be used as a tool for justifying further use of emulsions.

DATE STARTED:

July, 1980

ESTIMATED COMPLETION DATE:

December, 1986

PRINCIPLE INVESTIGATOR:

P. E. Corti

PAST ACTIVITIES:

Certain Agency Districts have been using emulsions for surface treatments extensively, while others use none. Records and reports of the performance or even types of emulsions used are limited or not available.

COST:

The category III experimental project is being funded with Region 15, Demonstration Project No. 55 funds as follows:

Construction = \$15,000
Evaluation = \$10,000

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Asphalt Rubber Surface Treatment

RESEARCH PROBLEM STATEMENT:

The recent leveling off of gas tax revenues available to State governments to finance highway construction and maintenance combined with a rapid escalation in the cost of bituminous materials makes it necessary to seek alternate methods or materials for the rehabilitation of distress bituminous pavements.

OBJECTIVE:

Specify and apply an asphalt rubber surface treatment for the purpose of ~~comparing~~ its performance and cost with that of the standard pavement maintenance rehabilitation procedure.

DATE STARTED: July, 1979

ESTIMATED COMPLETION DATE: December, 1982

PRINCIPLE INVESTIGATOR: R.I. Frascoia

PAST ACTIVITIES: An ~~intial~~ report (79-6) covering the construction phase and 4 month evaluation of a 145,292 square yard application of asphalt rubber made on I91 in Springfield and a 13,376 sy application made on I89 in Richmond, VT. was completed in December, 1979.

PROGRESS DURING 1980:

Field evaluations have been conducted as required and a one year followup report is being prepared.

COST:

The category III experimental project is being funded with Region 15 Demonstration Project No.37 funds as follows:

Construction	=	\$35,000
Evaluation	=	10,000

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Cold Recycling Asphalt Pavement

RESEARCH PROBLEM STATEMENT:

Vermont's standard pavement maintenance-rehabilitation procedure consists of routing and filling cracks in the existing pavement, placing a $\frac{1}{2}$ inch leveling course and overlaying with 1-2 inches of new bituminous concrete pavement. Experience has shown that this procedure does not prevent cracks in the old pavement from reflecting up through the new overlay, often during the first winter of exposure.

OBJECTIVE:

Specify and utilize cold recycling as a means of eliminating the cracks in an existing pavement, thereby preventing reflection cracking. Determine if the cold recycling process will provide secondary benefits by reducing energy requirements, conserving aggregates and asphalt and reducing future maintenance costs.

DATE STARTED: October, 1978

ESTIMATED COMPLETION DATE: December, 1983

PRINCIPLE INVESTIGATOR: R.I. Frascoia

PAST ACTIVITIES: An initial report (79-1) covering the construction phase of a 1.5 mile cold recycle project on US Rte 4 in Sherburne Vt. was completed in January, 1979.

PROGRESS DURING 1980:

Field evaluations have been conducted as required and a one year follow-up report was completed in June, 1980.

COST:

The category III experimental project is being funded with Region 15 Demonstration Project No.39 funds as follows:

Construction = \$30,000
Evaluation = 7,500

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Effect of Holidays on Epoxy Coated Reinforcing Steel

RESEARCH PROBLEM STATEMENT:

The premature deterioration of reinforced concrete bridge decks has resulted in a concentrated effort to identify protective systems which will increase the life of such structures. Accomplishments resulting from the research include the identification of a number of epoxy resins that are suitable protective coatings for reinforcing steel. Further research is required to determine if holidays, cuts or breaks in the coating have a serious effect on long term performance.

OBJECTIVE:

Determine what effect holidays or breaks in the coating have on the performance of epoxy coated reinforcing steel placed in structural concrete subjected to deicing chemicals (sodium chloride).

DATE STARTED: February 15, 1979

ESTIMATED COMPLETION DATE: December, 1989

PRINCIPLE INVESTIGATOR: R.I. Frascoia

PROGRESS DURING 1980:

Reinforced concrete specimens have been constructed and treated with daily applications of 3% sodium chloride solution. Periodic testing has been carried out as required.

COST:

Study cost charged to Administration.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Performance of Galvanized Coating for Rebars

RESEARCH PROBLEM STATEMENT:

The use of zinc coating (hot dip galvanized) has been specified as a means of increasing the maintenance-free life of reinforcing steel placed in bridge decks which will be subjected to deicing chemical applications. Although a number of bridges utilizing galvanized rebars have been in service for up to five years, field evaluations have not clearly defined the value of the zinc coating. In addition, laboratory evaluations of galvanized reinforcing steel have produced varying results with at least one case reporting a higher percent of concrete failures with treated bars than with regular steel.

OBJECTIVE:

The objective of this research is to evaluate the value of a hot dip galvanized coating on reinforcing steel.

Specific objectives include the following:

- A. Determine the average age when electrical potential levels reach the corrosion threshold on galvanized reinforced concrete cylinders.
- B. Determine what potential level is indicative of corrosion on galvanized reinforcing steel.
- C. Determine the average age when electrical potential levels reach the corrosion threshold (0.35 volts) on reinforced concrete cylinders.
- D. Determine the average age when corrosion on both galvanized and untreated reinforced concrete cylinders is sufficient to cause visual cracking.
- E. Determine the average time span between initial corrosion and visual cracking.
- F. Determine the average age when corrosion is sufficient to cause concrete delamination.
- G. Compare the performance of the galvanized specimens with that of the unprotected reinforced concrete cylinders.

DATE STARTED: January, 1977

ESTIMATED COMPLETION DATE: December, 1987

PRINCIPLE INVESTIGATOR: R.I. Frascoia

PROGRESS DURING 1980: Conducted periodic monitoring of laboratory constructed samples.

COST: Study cost charged to Administration.

VERMONT AGENCY OF TRANSPORTATION

MATERIALS & RESEARCH DIVISION

Research Project

RESEARCH PROJECT TITLE:

BRIDGE DECK MEMBRANE PERFORMANCE STUDY

RESEARCH PROBLEM STATEMENT:

The intrusion of chloride and moisture into reinforced concrete bridge decks results in premature deterioration of such structures. Vermont has applied a number of different membrane systems in an attempt to determine which product or general class of material is capable of providing the maximum level of protection. Long term field evaluations are required to determine the effectiveness of the various systems used.

OBJECTIVE:

The objective of this research project is to conduct a field evaluation program which insures continuous updating of membrane performance information. Such information will insure that the Agency is able to constantly update and modify the waterproofing specifications to include the membrane system(s) which provides the greatest level of protection.

URGENCY:

The establishment of this program will provide valuable information to our Agency and others who are urgently in need of a solution to the problem of premature bridge deck deterioration. The program offers the secondary benefit of providing information on the condition of all bridge decks included in the field evaluation program.

DATE STARTED: August, 1971

ESTIMATED COMPLETION DATE: December 31, 1987

PRINCIPLE INVESTIGATOR: R. I. Frascoia

PAST ACTIVITIES:

During the period 1971 - 1978, thirty three different membrane systems were experimentally placed on 69 bridge decks under the National Experimental & Evaluation Program #12, Bridge Deck Protective Systems and under NCHRP Project 12-11. Investigations have resulted in the completion of 11 reports and 4 papers on the subject. Most of the information has been distributed nationwide.

COST:

The project is being funded with HPR Part II funds as follows:

Fiscal 1981 = \$7,458.00
Fiscal 1983 = \$8,366.00

Fiscal 1985 = \$9,378.00
Fiscal 1987 = \$10,511.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Evaluation of Darex Corrosion Inhibitor

RESEARCH PROBLEM STATEMENT:

Chemical deicers used during winter months causes premature corrosion of reinforcing steel in concrete bridge decks. One proposed means of preventing chloride-induced corrosion is with the use of corrosion inhibiting concrete admixtures such as Darex Corrosion Inhibitor. These materials retard corrosion by preventing the normal corrosion reactions at the anode (anodic inhibitors), the cathode (cathodic inhibitors), or both (mixed inhibitors).

OBJECTIVES:

Evaluate the long term performance of Darex Corrosion Inhibitor for its ability to prevent corrosion of reinforcing steel in concrete. Determine also, if the admixture has an effect on the compressive or flexural strength, durability, and resistance to chloride penetration.

DATE STARTED: August, 1978

ESTIMATED COMPLETION DATE: April, 1985

PRINCIPLE INVESTIGATOR: R. I. Frascoia

PROGRESS DURING 1980:

Conducted periodic testing on concrete samples constructed in the laboratory containing Darex Corrosion Inhibitor.

COST:

Study cost charged to Administration.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Pavement Reinforcing Fabrics to Reduce Reflective Cracking

RESEARCH PROBLEM STATEMENT:

A high percentage of cracks in old pavements will reflect up through new bituminous overlays, often during the first winter. Various processes have been designed to reduce ~~or eliminate~~ reflective cracking, one such system is the use of synthetic fiber fabric as an interlayer between old and new pavement.

OBJECTIVE:

Evaluate, by field application, four different brands of reinforcing fabrics to determine their effectiveness in reducing reflective cracking in a new bituminous overlay.

DATE STARTED: June, 1978

ESTIMATED COMPLETION DATE: December, 1981

PRINCIPLE INVESTIGATOR: R.I. Frascoia

PROGRESS DURING 1980:

Conducted field evaluation of the experimental application of fabrics in Colchester. Report on construction phase and results of field survey completed in July.

COST:

The construction phase of the category II experimental project was funded with construction project funds. There are no funds for the followup evaluation.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION
RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Study of Salt Usage and Salt Effects as Associated with Normal Salting Operations in Vermont.

RESEARCH PROBLEM STATEMENT:

Increased concern about our environment requires that we investigate and determine what effect road salting operations have on adjacent soils, surface water, and ground water supplies.

OBJECTIVE:

Isolate and study the mechanics and transport of highway deicing salts in specific areas of Vermont where particular geologic, hydrologic, and highway maintenance conditions exist. The overall goal is to establish:

- A. The sodium and chloride levels in soils and groundwaters in both salted and non-salted areas before, during and after salting operations.
- B. Sodium and chloride levels in surface water adjacent to salted and non-salted areas before, during and after salting operations.
- C. The rate of contamination of soil and groundwater and duration thereof by salt applications.
- D. What type of soil and terrain characteristics produce the highest potential contamination problem.

URGENCY:

It is imperative that we enhance our knowledge of salt contamination and infiltration rates on surface water, groundwater and soils adjacent to our transportation network.

DATE STARTED: July, 1978

ESTIMATED COMPLETION DATE: August 30, 1981

PRINCIPLE INVESTIGATOR: Spectrum Research, Inc.

PAST ACTIVITIES:

Five reports covering the 1978-1979 salting season were received in 1979.

PROGRESS DURING 1980:

A final report covering salting years 1978-1980 was received in

October, 1980.

COST:

The two year study cost \$71,635. A projected cost of \$25,348 has been estimated for continuation of the study through September 30, 1981.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Study of the Effects of Road Salt on Soil & Water.

RESEARCH PROBLEM STATEMENT:

A section of I-91 near the northern boundry of St. Johnsbury passed thru the water-shed of E.H.V. Weidmann Industries, Inc. This water shed supplies water used in the manufacture of electrical insulation board. Excessive amounts of chloride in the water will affect the insulation value of the product and therefore cannot be tolerated. The Agency has agreed to monitor the sodium & chloride ions in the water sources and soil in this area of I-91. A reduced deicing salt application rate has been strictly enforced in the test area.

OBJECTIVE:

To monitor the migration of sodium and chloride ions from the application point of the road salt into the adjacent soil & water. Using this information, project future increases in the level of such ions.

URGENCY:

If such monitoring shows that the chloride ion level is above that which can be tolerated by E.H.V. Weidmann Industries, Inc., steps may have to be taken to limit the run-off from I-91 or install de-ionization equipment at the plant.

DATE STARTED: September, 1976

ESTIMATED COMPLETION DATE: September, 1981

PRINCIPAL INVESTIGATOR: D.C. Brown

PAST ACTIVITIES:

A similiar study was started and has been continuing on Vt. Route 108 in Stowe

PROGRESS:

The main part of the study was terminated by mutual consent after 3 years. The preparation of a final report is required.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Pavement Friction Testing Program

RESEARCH PROBLEM STATEMENT:

There is a need for the reduction of wet weather accidents. Vermont's Friction Testing Program provides an inventory of pavement friction values to insure suitable friction properties for the needs of traffic. Identifying hazardous locations or highways of suspect skid nature is this programs responsibility.

OBJECTIVE:

Wet weather accidents can be reduced through utilization of test data collected by the Friction Testing Program.

Computer Program (H 611) was developed to store friction values, project and other related data as part of the records.

Program (H 612) uses information from (H 611) and from the "Accident" program to collate friction values to accidents.

This data helps to determine proper pavement designs, best construction practices, acceptable construction materials and effective maintenance practices with safety in mind for the traveling public.

DATE STARTED:

August 1976

ESTIMATED COMPLETION DATE:

Ongoing

PRINCIPLE INVESTIGATOR:

J. L. Bullard

PAST ACTIVITIES:

In June 1976 a "Memorandum of Agreement" was established with F.H.W.A., Region 15, Demonstrations Branch to perform friction tests. At present time all public paved highways with a posted speed of 40 mph or greater have been tested.

Present work is in the area of developing our computer programs so that our objectives and goals will be established.

PROGRESS DURING 1980:

Field work has been completed with progress now being made on fuller development of the computer programs.

COST:

Federal Funds allocated for fiscal 1980 = \$24,673.56.

Funds Expended:

F.H.W.A. Region 15 Field Testing	\$11,483.50
Computer Expenses and Salaries	<u>\$13,082.99</u>
Total Expenditure	\$24,566.49

The Pavement Friction Testing Program is funded with Federal Highway Safety Grants.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

SUMMARY OF PROPOSED RESEARCH STUDIES

BITUMINOUS CONCRETE

Use of Antistripping Additives in Bituminous Concrete Mixtures

STRUCTURAL CONCRETE

Evaluation of a Pozzolanic Material, Fly Ash, As a Partial Replacement for Portland Cement

Improved Concrete for Bridge Decks

Development of a Field Method to Evaluate the Efficiency of Membrane Curing Compounds

SOILS & BASE COURSES

An Evaluation of Airport Base Course Density Test Requirements

Allowable Level of Fines in Base & Sub-base Materials

MAINTENANCE

Durability of Metal Culverts

Evaluation of Permanent Pavement Marking Materials

SPECIAL PROJECTS

The Determination of Energy Consumption Data For Use in an Economic Comparison of Flexible and Rigid Pavement Systems

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Use of Antistripping Additives in Bituminous Concrete Mixes.

RESEARCH PROBLEM STATEMENT:

There is an increasing awareness of bituminous concrete pavement failures caused by stripping of asphalt cements from the aggregates. Consequently we are specifying the use of antistripping additives more frequently. If an additive is used when it is not needed, the added cost is an economic waste. If an additive is used ineffectively, the pavement may require early and costly maintenance and/or rehabilitation. The Agency needs information on the selection, effectiveness, and use of antistripping additives.

OBJECTIVE:

The general objective of this research is to provide information on the selection and use of antistripping additives (materials used to improve the asphalt-aggregate adhesion in bituminous concretes). However, the immediate specific objective of this research is to develop guidelines for the incorporation of antistripping additives in bituminous concrete paving mixtures considering the influence of such factors as (1) storage and handling of the additives, (2) determination of the need for antistripping additives, (3) determination of the dosage where an additive is needed, and (4) identification of required construction control procedures for incorporation of additives into bituminous concrete mixtures.

URGENCY:

Although the problem of stripping appears to be minor in this state at the present time it does not preclude the fact that the future could bring on an increasing number of problems with stripping.

Development of tests, specification and procedure for handling anti-stripping additives should be investigated before the problem occurs.

Literature review indicates many states now are faced with problems of stripping. They were not prepared for problem so have had to fight the problem while it is occurring.

Failure on our part to investigate prevention measure at this time could prove extremely costly at a later date.

PAST RELATED ACTIVITIES:

Individual projects have been implemented by many states but were applied to that states problem only.

COST:

Estimated cost of this study is \$6,000.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Evaluation of a pozzolanic material, Fly Ash, as a partial replacement for Portland Cement.

RESEARCH PROBLEM STATEMENT:

The cement manufacturing industry is highly energy intensive. Rapid increases in the cost of energy are reflected in the cost of cement and products which use cement. Use of pozzolanic materials, in combination with lime, has been recognized since early Roman Days for its cementitious properties. Fly Ash, a by-product of coal burning industries, has been used in concrete for many years as a replacement for part of the cement. The Federal government is now encouraging the increased use of Fly Ash as an energy conservation measure.

OBJECTIVE:

The objective of this research proposal is to determine the feasibility of using Fly Ash concrete on Vermont Agency of Transportation construction projects. If the use of Fly Ash is proven feasible, a moderating effect on the rising cost of concrete construction could be possible.

RESEARCH PROPOSED:

The research would be divided into four major areas:

1. Literature Search-A search of available literature will be conducted to determine current state-of the-art techniques involved in the use of Fly Ash.
2. Availability and Cost Study-One of the most important aspects in determining feasibility of using Fly Ash will be present and future availability and cost. Some of the questions to be addressed include:
 - a. Should the Fly Ash be interground with the Portland Cement or be used as an admixture?
 - b. How far do acceptable materials have to be transported?
 - c. Will concrete suppliers be willing to provide equipment for transporting, storing and batching of Fly Ash?
 - d. What are the prospects for future availability of Fly Ash in this area of the country?
3. Laboratory studies-An indepth laboratory investigation will be conducted to examine the effects of Fly Ash on the properties of plastic and hardened concrete. Some of the properties to be studied include:

- a. Water/cement ratio.
 - b. Strength development - early and longrange strength gains.
 - c. Freeze-thaw durability.
 - d. Chloride intrusion.
4. Field Evaluations - Establish projects in areas of the state where equipment currently exists for handling and batching Fly Ash. Carefully monitor and record all phases of construction using the Fly Ash.

URGENCY:

The cost of structural concrete for Vermont Agency of Transportation construction projects will escalate in the future with the cost of energy. Efforts to reduce costs while maintaining quality should be encouraged. Fly Ash offers an example of one way to achieve this goal.

RECOMMENDED FUNDING:

Fiscal Year	1982	=	\$14,000.00
"	"	1983	= 14,000.00
"	"	1984	= 21,000.00
"	"	1985	= 20,000.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Improved Concrete for Bridge Decks

RESEARCH PROBLEM STATEMENT:

Bridge decks in Vermont are being constructed with concrete mixtures which seem to bleed excessively. The bleeding of any concrete produces a weak and less durable layer, (and in some cases causes cracking), at the horizontal surface where the bleed-water accumulates. Bleeding also produces vertical channels in the interior of the concrete through which deicer chemicals could gain easy access to the reinforcement. These destructive effects hasten the corrosion of the reinforcement that causes premature deterioration of the concrete, and shortens the life of the deck.

Current solutions nationwide to the problem of reinforcement corrosion are to:

- 1) create a protective shield around the reinforcement; either at the reinforcing steel surface (by coating the rebar with an epoxy compound) or at the concrete surface (by the use of an impermeable membrane) or
- 2) retard the corrosion reaction chemically (by introducing a chemical corrosion inhibitor with the normal mix ingredients) or
- 3) render the concrete impermeable (by sealing it internally with wax). The first solution has been tried in Vermont with uncertain success. Besides being costly, this solution will have ignored the no-cost benefits inherent in the concrete itself, if it is possible to inhibit the ingress of corrosion-causing salts by eliminating the destructive effects of bleeding.

OBJECTIVE:

The objectives of the research would be:

- 1) Conduct a literature search to determine whether existing research addresses this problem.
- 2) If not; can bleeding be reduced by minimizing void content?
- 3) If so, is there a significant a) increase in freeze-thaw durability, and b) decrease in chloride permeability; enough to warrant continued study?
- 4) If significant, evaluate conditions unaccounted for in the laboratory study from a field trial.

TASK 1

Circulate questionnaire to other Agencies to determine whether bleeding is a problem and if so has it been corrected? And, How?
Also search the technical journals to determine whether existing research addresses this problem. If no significant data proceed to Task 2.

TASK 2

Establish a laboratory program to measure, with the use of a Jencons Voidmeter, the Void Content of Standard Agency of Transportation concrete mixtures.

TASK 3

Attempt to modify the mixtures to affect minimum void content while maintaining workability. Evaluate the effect on bleed rate.

TASK 4

Determine freeze-thaw durability and chloride permeability of the standard and modified mixtures.

TASK 5

Evaluate the data and determine significance of the laboratory program. If promising; proceed to Task 6.

TASK 6

Establish a field trial of the modified mixture and determine whether the laboratory results can be duplicated in the field.

RECOMMEND FUNDING

Fiscal	1982	=	\$ 7,600.00
Fiscal	1983	=	\$15,000.00
Fiscal	1984	=	\$23,000.00
Fiscal	1985	=	\$ 3,500.00
Fiscal	1986	=	\$ 2,500.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Development of a field method to evaluate the efficiency of membrane curing compounds.

RESEARCH PROBLEM STATEMENT:

"The object of curing is to keep concrete saturated, or as nearly saturated as possible, until the original water-filled space in the fresh cement paste has been filled to the desired extent by the products of hydration of cement." Of the six curing methods allowed in the Vermont Standard Specifications for Highway and Bridge Construction, curing by means of an impermeable membrane forming compound is the one which offers the greatest flexibility in terms of the variety of surfaces to which it can be applied. There is however, currently no method by which the curing compounds on the market in Vermont can be evaluated for water retention performance. Such a non-destructive test should be developed to screen and approve for use only the most efficient curing compounds on Agency projects.

OBJECTIVE:

The objective of this research would be to:

- 1) Determine whether a procedure for evaluating the moisture content of fresh in-situ concrete can be developed, if so;
- 2) Determine whether a non-destructive procedure for evaluating the moisture content of hardened in-situ concrete can be developed; if so;
- 3) Evaluate the moisture retention properties of several proprietary curing compounds under field conditions using the methods developed and select the best to be approved for use on Agency projects.

Task 1

Conduct a literature search to determine whether existing research addresses this problem.

Task 2

Develop a method using a microwave oven to determine the moisture content of fresh concrete.

Task 3

Develop a method using a nuclear moisture/density gauge to determine the moisture content of hardened concrete.

Task 4

Evaluate all curing compounds marketed in Vermont for moisture retention performance.

PAST RELATED ACTIVITIES:

A limited study was completed in 1972 by the Materials and Research Division on several curing compounds using data from Schmidt Hammer tests and drilled cores. In 1979, a Materials and Research Division study confirmed this Divisions ability to carry out the AASHTO T-155 laboratory evaluation of the "water retention efficiency of liquid membrane forming compounds and impermeable sheet materials for curing concrete."

RECOMMENDED FUNDING:

Fiscal 1982 = \$2500.00

Fiscal 1983 = \$2500.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

An Evaluation of Airport Base Course Density Test Requirements

RESEARCH PROBLEM STATEMENT:

During recent airport construction projects, the Soils Subdivision has performed density testing on crushed aggregate base courses. The reliability and practicality of this requirement and method of testing is in question. The preliminary laboratory work alters the material to a state that it does not resemble the true nature of the material in place.

OBJECTIVE:

To modify this method of test requirement and develop a way which would truly reflect the stability and firmness of the base course.

URGENCY:

A study should be done in order to present a case before the Specifications Committee before any anticipated airport work is begun.

COST:

The cost of the study is estimated at \$1000.00.

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Allowable Level of Fines in Base & Sub-base Materials.

RESEARCH PROBLEM STATEMENT:

Specification Base & Sub-base Materials are fast being depleted in certain areas of Vermont. Consequently the specifications are continually being modified to make use of locally available Materials. Some means must be established to determine the frost susceptibility of these materials as related to particle size distribution. This will allow the modification of the specifications to use such local materials while assuring that we are not building in the problem of frost susceptibility.

OBJECTIVE:

The objective of this proposed research project is to establish criteria and test methods to be used in measuring the frost susceptibility of a material based on some means of grain size analysis. This will include a search of available reports & publications which address the problem.

The information gained by this research will enable Agency Personnel to upgrade the specifications to allow the use of available materials without building in problems causing the expenditure of additional funds for corrective maintenance.

URGENCY:

This project will allow us to modify our specification requirements to take advantage of locally available materials with the knowledge that we are not compromising the structural integrity of our facilities.

PAST ACTIVITY:

Many studies have been done on this type of problem, however we need to relate this information to Vermonts particular soils and aggregates.

ESTIMATED COST:

\$5,000.00 to do the initial records search and determine what criteria we will use as a basis to test materials.

\$5,000.00 to run preliminary tests on representative samples of Vermonts sands & gravels

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Durability of Metal Culverts.

RESEARCH PROBLEM STATEMENT:

A number of steel culverts within the state are showing signs of extensive corrosion, causing growing concern that the protective coatings on the steel culverts are failing to provide the expected design life. The prospect of premature deterioration of steel culverts threatens to create an expensive maintenance problem.

OBJECTIVE:

The objective of the project would be to determine the following:

- 1). At what rate or extent is the deterioration occurring?
- 2). Type of deterioration and cause of it.
- 3). Possible corrective measures for deteriorating culverts.
- 4). How wide spread is the problem within the state?
- 5). Types of protective coatings that give maximum protection.

URGENCY:

Left unattended the problem could develop to a stage where numerous and costly replacements are needed. Addressing the problem within the near future would increase the chance of developing a solution and also prevent the problem from occurring on new projects.

PAST RELATED ACTIVITIES:

On site inspections have been made at three locations on the Interstate System where culverts are exhibiting extensive corrosion. Water and soil samples have been obtained for testing.

COST:

The cost of the study is estimated at \$5,000.00

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

Evaluation of Permanent Pavement Marking Materials

RESEARCH PROBLEM STATEMENT:

Lack of adequate lane guidance can be a critical highway safety problem which is magnified when traveling at night or during adverse weather conditions. The present paint system in use has poor durability and requires frequent repainting. Consequently, in areas of heavy traffic, there are numerous times when lane marking is inadequate or even non-existent during the winter months when repainting is not possible.

OBJECTIVE:

The objective of this research proposal is to establish a field evaluation program which will compare the performance of a variety of new permanent marking materials with the Agency's standard paint for pavement centerlining and marking. The evaluation should include the following areas:

- 1.) Intensity and effectiveness of delineation produced.
- 2.) Durability to withstand heavy traffic and snowplowing.
- 3.) Cost effectiveness.
- 4.) Quality of performance on open-graded asphalt friction course.
- 5.) Ease of application.

URGENCY:

Increased traffic flow in urban areas and use of open-graded friction course has augmented the need for a more durable pavement marking system.

PAST ACTIVITIES:

Pavement marking tape has been applied in limited amounts at four different locations within the state. Product evaluations have been written documenting the applications and initial performance.

RECOMMENDED FUNDING:

Estimated cost of this study is \$10,000 (material cost not included).

STATE OF VERMONT
AGENCY OF TRANSPORTATION
MATERIALS & RESEARCH DIVISION

PROPOSED RESEARCH PROJECT

RESEARCH PROJECT TITLE:

The determination of energy consumption data for use in an economic comparison of flexible and rigid pavement systems.

RESEARCH PROBLEM STATEMENT:

Escalating costs make it imperative that the best value be obtained from construction and maintenance dollars. The cost of energy today seems to be a major cause of these escalating costs; they should be identified and reduced wherever possible. It is becoming increasingly evident that decisions made years ago on the choice between flexible and rigid pavements may no longer be valid. A method should be developed to provide designers faced with this choice, with the appropriate information on energy consumption.

OBJECTIVE:

The objective of this research would be:

- 1) Conduct a literature search to determine whether existing research addresses this problem.
- 2) If not, identify all energy-consuming elements in both flexible and rigid pavement systems.
- 3) Determine whether energy use data on manufacturing, construction, and maintenance activities is available; if so
- 4) Determine total energy consumption for each system using the following design alternatives:
 1. Soil stabilization by:
 - a) Fly Ash
 - b) Lime
 - c) Soil cement
 - d) Asphalt emulsion
 2. Partial replacement of Asphalt cement and Portland Cement by:
 - a) Sulphur
 - b) Fly Ash
 3. Recycling.

RECOMMENDED FUNDING:

Fiscal year 1982 = \$13,856.00
Fiscal year 1983 = \$13,856.00

RESEARCH SERVICES BY OUTSIDE ORGANIZATIONS

The Vermont Agency of Transportation supports research by outside organizations through a contract with the National Academy of Sciences and our subscription to the Transportation Research Board.

The contract with the National Academy of Sciences supports the National Cooperative Highway Research Program (NCHRP) with the commitment of 4 1/2 percent of our 1 1/2 percent Federal aid planning and research (HPR) funds. This amounts to \$22,767 for the period October 1, 1980 - September 30, 1981.

The subscription to the Transportation Research Board (TRB), currently set at \$19,700, provides the Agency with a "Research Correlation Service", and gives our representative the right to submit research proposals to the TRB and vote on the selection of NCHRP research projects. The activities supported by the Research Correlation Service Subscription include the collection of available information concerning past, current, and proposed research related to transportation from all sources including governmental agencies, colleges and universities, research and planning organizations, as well as the TRB Annual Meeting and conference programs; the study and correlation of this information and dissemination of the useful findings of research and other information by all feasible means including the several TRB publication series, the output of the Transportation Information Services, and through personal contacts by the TRB professional staff.

State of Vermont
Agency of Transportation
Materials & Research Division

Report on Laboratory Testing Production

	<u>7/1/76</u> <u>6/30/77</u>	<u>7/1/77</u> <u>6/30/78</u>	<u>7/1/78</u> <u>6/30/79</u>	<u>7/1/79</u> <u>6/30/80</u>
Aggregate Laboratory	2139	1996	2155	2219
Bituminous Laboratory	1183	1027	1246	1543
Cement Laboratory	1940	1223	932	1011
Soils Laboratory	1331	1147	1775	3459
Compliance Testing Certifications	488	655	688	810
Bituminous Concrete and Field	6553	7018	5955	6686
Structural Concrete and Field	3115	4461	2257	2626
Field Compaction Reports	<u>2802</u>	<u>2552</u>	<u>1115</u>	<u>1081</u>
*Total	19551	20079	16123	19435

Total for Fiscal years 1977, 1978, 1979 and 1980 = 75188

*Each numbered sample may have several laboratory tests performed in order to check for specification compliance. The number and complexity of tests will vary with the type of sample.

TRANSPORTATION RESEARCH

ANNEX A

PLANNING ACTIVITIES

SUMMARY OF THE ONGOING RESEARCH
ACTIVITIES OF THE PROJECT PLANNING DIVISION

The Project Planning Division's principal task is to assemble facts as to the use and condition of the State's Highway and Airport Systems. Following the assembly of data, conditions of the transportation facilities are rated and ranked as to need of improvements. Projects are planned and developed with local and regional officials on a conceptual basis and matched to funding opportunities. Much of the Division's work program is, therefore, related to the investigation of specific problems and the development of solutions. However, the Division also maintains a program of research to monitor the condition and use of Vermont's transportation system as a whole and to further the science of transportation planning in the State. To this end, and in recognition of the changes in driving habits, increasing transportation costs and questionable motor fuel availability, the following general research activities are in progress in the Project Planning Division.

Traffic on Vermont's highways is monitored on a 24-hour basis on 45 permanent and 6 supplementary traffic recorder stations. These stations are distributed among the various highway systems so as to provide a representative sample of statewide traffic volumes and their respective fluctuations over the course of a year. The current focus on research activities is to assess the rate of change in travel patterns. This data is reviewed and cataloged and entered into a permanent record. This information is presented on monthly Automatic Traffic Recorder (ATR) Reports for general distribution. Information is combined with annual turning movement and vehicle classification studies and is used to

provide the Biennial Traffic Flow Map for State Highways, which shows what is occurring on Vermont's highways.

The Division also conducts a Biennial Truck Weight Study. Vehicle classifications and truck weights are taken at seven locations throughout the State for a 24-hour period. This information is compiled to present a picture of the potential effects of truck traffic on Vermont highways and reflects the generally increasing weights being carried by State Highways. This information is fed to the National Data Center to assess truck weight impacts and is ultimately used in highway design criteria. Useful information concerning state of registry and commodity carried is also obtained from each vehicle identified.

The Division computes sufficiency ratings (structural condition, safety, service and traffic adjustment) for all State Highways. This is completed on a 2- or 3-year update cycle and includes physical observation of each highway segment and examination of accident records and traffic studies. These ratings are used as one of the key elements in development of highway construction programs. A similar program is maintained to evaluate rail/highway crossings. All public and private rail crossings are evaluated as to sight distance, alignment and grade, warning devices, and train and highway traffic movements. The research activities lead to priorities for rail-highway safety improvements.

The Division also maintains a computerized record of all police reported accidents. All accidents are recorded on a daily basis and are evaluated as to location, cause, type, etc. This research is used for investigating high accident locations, for project priority and for updating the sufficiency ratings.

State Highways and Class 1, 2, and 3 Town Highways are required to be remeasured at least once each 10 years to meet Vermont Statutes. The Project Planning Division remeasures all highways in at least one county each year. This includes field check by measurement and location each year, all road changes due to additions, deletions or relocations. The research is used by the Vermont Legislature to evaluate the effectiveness of funding formulas for town highways and to designate scenic highway segments.

Each year the Project Planning Division conducts a computer assisted investigation of the year's construction projects to determine the average weighted low bid prices for each item in the Design Specifications Manual. This information is used throughout the Agency to project future costs for transportation systems construction projects and programs.

The Division also conducts on a continuing basis research into the effectiveness of highway signing techniques and placement from an engineering viewpoint. The results of this study are used to develop safer geometric design and sign placement policies for highways.

In addition to researching the effectiveness of highway and rail transportation systems in Vermont, the Project Planning Division has responsibility for the Vermont Airport System. Inventory and study of specific airports is augmented by periodic surveys of air travelers. This research into travelers' general socio-economic status and trip purpose have developed a data bank useful in forecasting air-travel demand and air-travel patterns in Vermont.

In the area of long-term research projects, the Division since 1970 has maintained a file of all Act 250 applications and permits in Vermont. Each

application is cataloged for retrieval and each site is located by type on overlay maps of each county. This provides a graphic presentation of the development patterns in Vermont as to type and intensity. Research in this area has proved useful in solving a variety of travel forecasting problems.

A new research activity undertaken by the Project Planning Division is the Barre-Montpelier Commuter Study initiated in October 1980. This project was developed in response to the need for information as to the impacts of the energy crisis on commuter travel. A survey is conducted each month (Wednesday nearest the 15th of the month) on US Route 302 of Montpelier-bound traffic. Each vehicle between 6:00 - 9:00 A.M. is counted and classified as to size and number of passengers. A survey of area gasoline prices is also conducted. The intent of the study is to determine how fluctuations in the price of gasoline affect the percentage of subcompact cars and passenger vans on the road, as well as the occupancy rates of all vehicles. It is hoped that the results of this study can be used to predict how changes in the energy situation will affect commuter travel patterns.

This outline summarizes the general research activities of the Project Planning Division of the Agency of Transportation. This program is carried out in conjunction with the authorized work program of the Division, to develop improvement projects for Vermont's transportation system. It is hoped that this inquiry will further the knowledge of the workings of the transportation system in Vermont specifically and will improve the art of transportation planning in general.

TRANSPORTATION RESEARCH

ANNEX B

STRUCTURES ACTIVITIES

1. Weathering ("Rusty") steel. For approximately 10 years, we have been using this product for almost all steel structures. This was done to reduce future maintenance (painting) costs while at the same time taking advantage of the higher strength provided by this steel. To date the decision appears to be a good one. Some concern has been expressed relative to excessive corrosion, and for several years New Hampshire painted this type of steel. However, they have now abandoned the paint system and are using the steel without any protective coating. We have been making special note of corrosion on our bi-annual inspections and have observed only minimal problems.
2. Lightweight Concrete. Recently we realized that in certain applications lightweight concrete would be advantageous for use on structures. Samples of lightweight aggregate were obtained, and our Materials Division conducted various laboratory tests on sample mixes. As a result of favorable lab results, we used lightweight concrete for the "Jersey" barrier on Milton - Colchester, and for the deck on Sheldon, Vt. 105, Br. 10. This was done to reduce dead load on these structures while at the same time providing us with actual field data. We have been impressed with the results reported to us thus far, and based on these results, will probably specify more lightweight concrete in the near future.
3. Bridge deck membranes. Reports and data are available from the Materials Division.
4. Elastomeric Bridge Bearing Pads. Several years ago we tried these pads on a limited basis. Results were good, whereas the "Lubrite" bearing plates which were used before that began to be a maintenance problem. Therefore, we have gone almost exclusively to the elastomeric pads.
5. Bridge Expansion Joints. During the past 10 years we have tried numerous types of expansion joints. Some were done as experimental projects, others were "unofficial" experiments. As a result of our field observations, combined with similar data from other states, we have selected the strip seals as being the most maintenance free joint. At the same time, through project testing, we have determined that in many instances we can eliminate joints completely with no apparent detrimental results.
6. Metal Curb Facing. Several years ago we tried a galvanized metal curb facing as an alternative to granite curb. The initial results were favorable, and we have since used the item on several bridges. If no problems develop we anticipate more widespread use of this material.
7. Programmable Calculator. In an attempt to reduce the use of the S.I.S. computer system for simple design problems, we are using a desk top programmable calculator. This has proven to be efficient and time saving, well worth the small initial investment required.

8. Pentel Drawing Pencils. Several years ago we tried a few Pentel mechanical pencils to determine the feasibility of using them in lieu of the conventional drafting pencils. They proved to be very successful, and we now use them almost exclusively. The end result has been a savings in cost as well as in time.

Except for bridge membranes and certain joints, the above items have not been official research projects. However, in each case their use was experimental to a degree, and results of their use were used to determine future use. This ongoing implementation of new products and ideas is an important part of our efforts to provide the public with the best product at the least cost.

TRANSPORTATION RESEARCH

ANNEX C

DESIGN ACTIVITIES

DESIGN RESEARCH ANNEX

Stream Gaging Program - the Agency through the Districts assured operational control of 21± stream gages from USGS in 1975. With the readings from these, we could develop our own hydrological predictive methods. Unfortunately, the Districts have not been too cooperative in reading these and therefore, we do not have enough information to go to the step of developing the necessary equations.

We are working with CRREL in Hanover to utilize a bridge pier where ice forces may be measured. CRREL would do the work; we would only select the site which we have not yet been able to do.

We are on both the AASHTO Task Force on Hydrology and Hydraulics and the TRB Committee on Hydrology and Hydraulics. The TRB Committee especially is very research oriented, while the AASHTO group is developing methods of solving hydraulic problems.

We are serving as a test state for a new CRREL computer program concerning flow profiles on ice-covered streams. Again, we are not proceeding too quickly with this as computer has given this program a lower priority than I would like.

We are developing our own hydraulic and hydrologic calculation programs for the TI-59 to improve on accuracy and efficiency. These could be termed computer hydraulic research.

Rexnord Corporation of Milwaukee, Wisconsin, is presently analyzing the characteristics of the Potash Brook watershed in South Burlington as a site for a FHWA Research Project "Effects of Highway Runoff on Receiving Waters". If they decide to utilize the site, Hydraulics may be involved in some of the field monitoring.

Utilities has an on-going program of installing and monitoring water meters for water supplies that appear to be affected by highway construction projects. We are equipped to monitor water lines of ½ inch thru eight (8) inches diameter. This is done in advance of projects to ascertain the flow and use and we try to have records for at least a year prior to construction in the area. Some past examples are "Gingue Springs", E. H. V. Wiedeman, & Arlington Water Company.

Based on present-day technology, most existing guardrail systems are considered substandard due to structural inadequacies and improper location. Current emphasis is to provide a guardrail system that redirects or cushions the impact of a vehicle and does not trap or pocket the vehicle, which sometimes happens with cable or beam systems using heavy posts.

The procedure of modifying substandard guardrail to meet current barrier requirements is worth consideration. This upgrading is accomplished by revising post spacing with the pulling of every other post, and by reducing the cross-sectional area at the ground line of all "heavy" wood or steel posts. This will cause the posts to react as breakaway upon impact. Repositioning three cables at the proper height and spacing with the proper anchorage, completes the upgrading.