2023

SYMPOSIUM SUBSTITUTE REPORT

RESEARCH

Vermont Agency
of Transportation

VERMONT
AGENCY OF TRANSPORTATION

2023 Symposium Lite Research and Innovation Projects

AOT Research funded projects have a project number that indicates the Federal Fiscal Year the project was selected.

Vermont Research Overview and Symposium Substitute Report Introduction

The Research Section of the Vermont Agency of Transportation conducts research to inform planning, operations, and other agency functions. A key feature of the program has been an annual, in-person symposium for vibrant discussion and detailed dissemination of internal and external research and innovations. In 2023, due to the high priority of flood recovery, the symposium did not occur. As an alternative, we have provided this Symposium Substitute Report to highlight several research and innovation projects.

The Research program is largely funded with Federal Highway Administration (FHWA) dedicated research funding that must be spent on State DOT research and development activities. Figure 1 presents how much money was expended in Federal Fiscal Year 2023 on Vermont AOT Research activities. This includes the funding spent on external research projects, Vermont's contribution to the National Cooperative Highway Research Program (NCHRP), the American Association of State Highway and Transportation Officials (AASHTO) Technical Service Programs, Federal Highway Administration (FHWA) Transportation Pooled Funds, and core support for the Transportation Research Board.

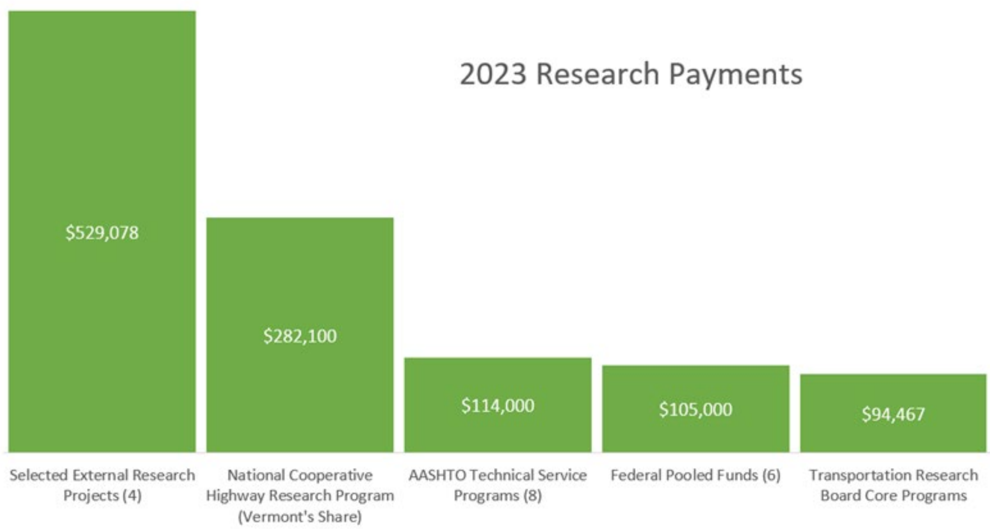

Figure 1: 2023 AOT Research Activities & Funding

Specific projects featured in this report are listed in the Table of Contents. Projects funded with Vermont AOT Research funds are labeled with the year that the project was funded (for example, 23-1). The AASHTO Technical Service Programs that VT AOT participates in, and the Research program funds, are listed in Table 1 in the Appendix. Our active FHWA Transportation Pooled Funds are listed in Table 2 in the Appendix.

Figure 2 provides a visualization of our external research process and the numbers associated with the selection of the four projects chosen in April 2023. Fact Sheets for these four projects are found on the following pages. Figure 2 starts with the submission of research ideas. Ideas can be submitted by anyone and ideas for the FFY24 external research cycle are due December 15, 2023 using this link. Research ideas must be matched by enthusiastic AOT Technical Champions to go forward in our process. Champions develop Research Problem Statements which are distributed to the 12 organizations

Figure 2: External Research Program Cycle (FFY23)

(universities and consultants) that are on our Qualified Researcher List (QRL). We will solicit a new QRL in Fall 2024. In early 2023 we received 18 Letters of Interest from 8 different QRL organizations in response to the distributed Research Problem Statements. Champions selected one team based on the Letters of Interest and that team was asked to prepare a proposal for an external research project that could be completed in 6-24 months with a maximum budget of $150,000. Nine projects were presented by the Champions to our Agency Decisionmakers and four projects were selected with this year's available funding.

This Symposium Substitute Report provides information about 16 Research and Innovation projects. More information about these projects and past Symposium projects are found in the Symposium Web Pages. Half of these projects are external research projects funded by the Vermont Agency of Transportation Research program.

The Research program focuses on sharing information about these projects for several reasons:

- The more potential users know about our projects, the greater the chance that the results may be used, or the innovations adapted elsewhere
- The projects are chosen to address Agency needs
- All research and innovations should be implemented, and an essential step towards implementation is to share information about specific projects
- All our stakeholders: within the Agency of Transportation, within the State of Vermont, at Regional Planning Commissions, in other states, etc. may benefit from aspects of these projects.

These projects range from a bridge metalizing project that was awarded FHWA Innovation funds to a toolbox of traffic safety countermeasures for addressing speeds to a round robin study of asphalt laboratory testing to internal AOT efforts to process emergency requests.

This Symposium Substitute Report includes Fact Sheets from 16 Research and Innovation projects. Projects receiving AOT Research funds are prefaced with their project number that includes the federal fiscal year that the project was selected. You are invited to review these projects, which have been organized into four categories: Materials and Pavements; Structures and Stormwater Design; Asset Management; Planning, Public Transportation, and Safety. Each Fact Sheet includes links to the 2023 Symposium Lite page that we have generated for each project and any available project reports or other related project materials. More about each of the projects is found on the 2023 Symposium Lite web pages linked here. An Appendix follows the project Fact Sheets.

Section A: Materials and Pavements

23-3 Recycled Asphalt Shingles as a Full Depth Reclamation Mechanical Stabilizer

22-2 Balanced Mix Design Round Robin

21-3 Rapid Setting Concrete for Bridge Joints

23-2 Pavement Deterioration Models

FACT SHEET

23-3 RAS as an FDR Mechanical Stabilizer

PROJECT TITLE

Recycled Asphalt Shingles as an Full Depth Reclamation Mechanical Stabilizer

STUDY TIMELINE

October 2023 – September 2025

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KEYWORDS

Recycled asphalt shingles, pavement rehabilitation, full-depth reclamation, by-product, sustainability, reuse.

FUNDING

VTRC023-603

$135,898

VTRANS PROJECT PAGE

[23-3 RAS as an FDR Mechanical Stabilizer | Agency of Transportation (vermont.gov)]

Introduction or Problem Statement

The use of recycled asphalt shingles (RAS) in transportation infrastructure has been extensively studied throughout the United States and elsewhere. An impediment in the use wide-spread use of RAS in asphalt concrete has been the increased premature cracking potential of such mixtures due to the aged and brittle nature of asphalt binder in RAS. This has resulted in restrictions on RAS usage in hot- and warm-mixed asphalts by many agencies. The Vermont state law (10 V.S.A. § 6605m) requires that asphalt shingles, predominantly generated as "Architectural Waste", be recycled. Due to concerns associated with their usage in asphalt concrete layers of pavement structures, their use within lower pavement layers needs to be explored.

The use of full-depth reclamation (FDR) for the rehabilitation of flexible pavements is preferred by many transportation agencies, including VTrans, due to cost and environmental benefits. Both are usually realized due to the "in-place" nature of the FDR process that does not require large quantities of materials to be transported off-site which in turn lowers costs and fuel usage as well as associated emissions. Often Portland and other hydraulic cements, emulsified asphalt, foamed asphalt and combinations of these materials are used as stabilizing agents in FDR to improve its structural contribution to the pavement and improve longevity of roadways using it. Most of the stabilizing agents used in FDR have high costs and carbon footprints. Due to the presence of asphalt binder, fibers and aggregate, RAS has potential to provide a degree of mechanical stabilization to the FDR layers. If RAS can be used to achieve similar stabilizing effects as non-recycled products, the lower costs and high environmental benefits of FDR can be further improved and simultaneously use of RAS in pavement infrastructure can be realized without performance concerns. To realize this goal of using RAS in FDR, two critical questions will be addressed in this research: (1) Can RAS be utilized in "as-is" condition from when it is generated as architectural waste or is there need for processing it to resize it? (2) Does RAS provide mechanical stabilization effects to FDR?

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Left: As produced architectural waste shingles; Right: resized processed waste shingles [image sources: Wisconsin Dept of Natural Resources and North Carolina Department of Environment Quality]

Methodology or Action Taken

This research study will undertake a laboratory experimental campaign and corresponding analysis to determine whether RAS can be utilized in "as-is" or resized condition to serve as stabilizing agent within FDR. This question is critical to answer since additional processing steps would have cost and logistics implications with respect to usage of RAS. A hypothesis is that the FDR process can provide some crushing effort towards breakdown of waste shingle sheets. To evaluate this hypothesis and to determine feasibility of using RAS in FDR an assessment is necessary to determine constructability of FDR stabilized using RAS, specifically in terms of compactability. This study will develop recommendations for determining suitable dosage of RAS that can be accommodated within FDR to realize appreciable mechanical stabilization effects. Further, it will also explore the use of recycling agents to provide additional stabilizing effect of RAS. Lastly, to quantify the stabilizing effects of RAS, the outcomes of laboratory characterization will be used in a pavement design and analysis system to determine life cycle cost benefits.

The laboratory experimentation effort will conduct mechanical characterization of RAS-stabilized FDR along with unstabilized control materials through measurement of resilient modulus and shear strength measurements. RAS will be evaluated for environmental contaminants, specifically, for PCB, PFAS, and PAH, including the use of Synthetic Precipitate Leaching testing (SPLP).

Conclusions or Next Steps

This project is at its initiation stage, the very immediate next step will be to conduct a comprehensive review of literature, develop experimental designs and sample materials from VTrans FDR projects for use in laboratory characterization.

Potential Impacts and VTrans Benefits

Results of this study will be in the form of recommendations for VTrans to revise FDR construction and material specifications to include RAS. The research results will also provide VTrans with quantitative measures associated with mechanical stabilization potential of RAS in FDR. Further, as a first step to implementation of using RAS in FDR, VTrans will have informaiton on optimal dosages as well as lab procedures that should be used to validate the dosage amounts. As an added outcome, this project will provide recommendations on

	suitable roadway rehabilitation candidate projects where RAS stabilized FDR would provide positive life cycle cost and pavement performance benefits. Ultimately, the results of this project will enhance the understanding of the risks or benefits associated with utilizing recycled products in FDR layers and their potential to impact pavement performance. This will ensure VTrans has the information needed to make prudent decisions regarding their asphalt pavements, as they strive to develop treatments that require less frequent maintenance and/or rehabilitation while lowering life cycle costs. The research project will conduct preliminary life cycle cost analyses comparing pavements rehabilitated using unstabilized FDR with those using RAS stabilized FDR. This research will also provide VTrans with a better tool to evaluate new materials and additives (e.g. recycling agents) resulting in improved materials. Use of RAS in FDR will allow VTrans to support Vermont's initiatives towards recycling additional construction waste materials and open up a new market for RAS in areas where inclusion in HMA is limited.

VERMONT AGENCY OF TRANSPORTATION

FACT SHEET

22-2 Inter-Laboratory Study (ILS) of Bituminous Concrete Balanced Mix Design (BMD) Tests for Use on VTrans Projects

PROJECT TITLE

Inter-Laboratory Study (ILS) of Bituminous Concrete Balanced Mix Design (BMD) Tests for Use on VTrans Projects

STUDY TIMELINE

July, 2022 – December, 2023

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KEYWORDS

Bituminous Concrete, Balanced Mix Design, Materials Testing

FUNDING

VTRC022-02
$49,880

VTRANS PROJECT PAGE

22-2 BMD Round Robin | Agency of Transportation (vermont.gov)

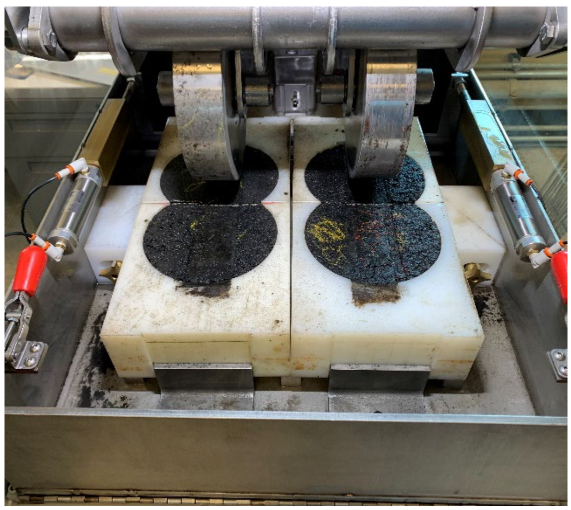
UCONN SCHOOL OF ENGINEERING

CONNECTICUT ADVANCED PAVEMENT LABORATORY

More information about the VTrans Research Program, including additional Fact Sheets, can be found at:

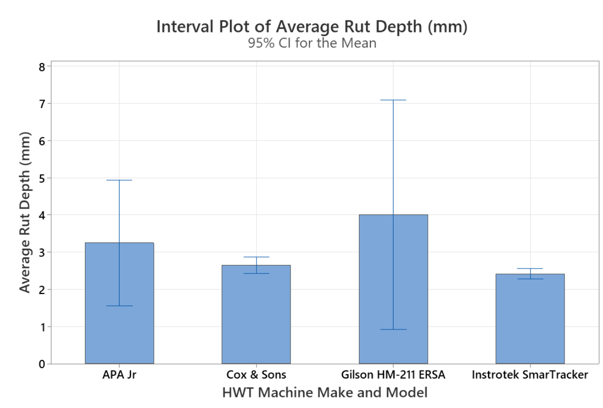
Problem Statement

This study seeks to identify the variability of Balanced Mix Design Tests (Hamburg Wheel, Flexibility Index, and Indirect Cracking Test) between machine operators and devices only by isolating the specimen fabrication to a single lab from a single plant-produced source of material.

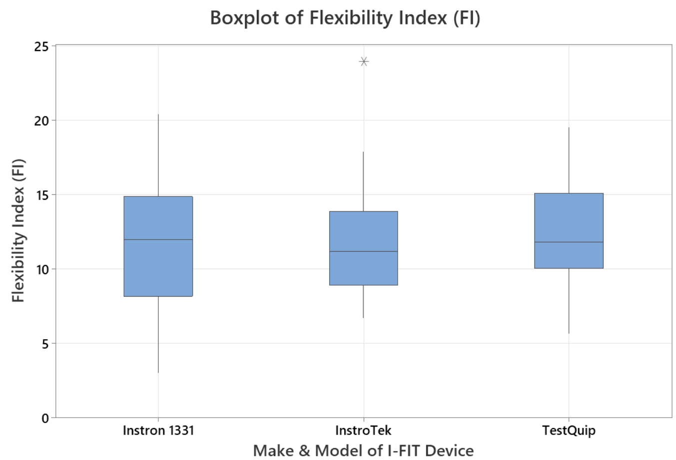


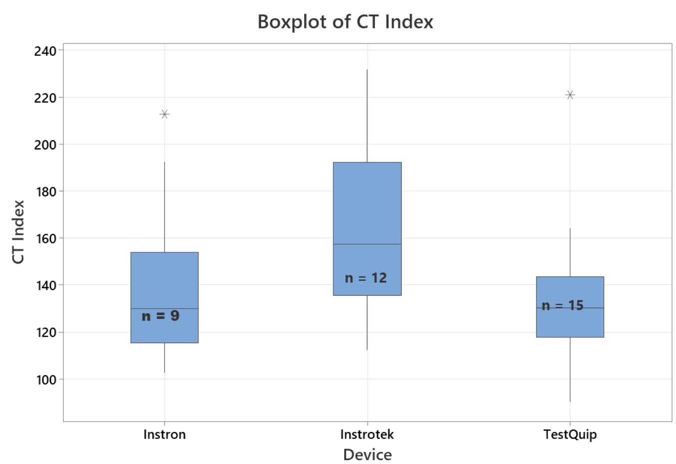
Methodology

Nearly 2,000 lbs of material was sampled from a bituminous concrete producer in VT. This material was brought back to the lab and then tested for uniformity and compacted into 500 samples to be tested across the 10 participating labs throughout the northeast. The tests performed included AASHTO T324, AASHTO T393, and ASTM 8225. Results were shared back to the CAP Lab for interpretation.



http://vtrans.vermont.gov/planning/research





Conclusions

By isolating the fabrication of the samples, overall variability of the tests results was reduced to a percent coefficient of variation below that of other studies[1]. The Hamburg Wheel Test (AASHTO T324) proved to be the most repeatable whereas the IDEAL-CT (ASTM 8225) had the greatest variability in results.

Potential Impacts and VTrans Benefits

As states (including Vermont) implement these and other Bituminous Concrete performance tests, it is critical to know what the baseline variability is when contract penalties, bonuses, and even stop-work orders are on the line during construction. Data from this research will inform future specifications and Mix Design Submittal policy for VTrans engineers.

FACT SHEET

21-3 Development of Cost-Effective Rapid-Setting Concrete for Improved Bridge Joint Performance

PROJECT TITLE

Development of Cost-Effective Rapid-Setting Concrete for Improved Bridge Joint Performance

STUDY TIMELINE

July 2021 – December 2023

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KEYWORDS

Accelerated Bridge Construction, Rapid Setting Concrete, Laboratory Testing, Durability.

FUNDING

VTRC021-003
$142,999

VTRANS PROJECT PAGE

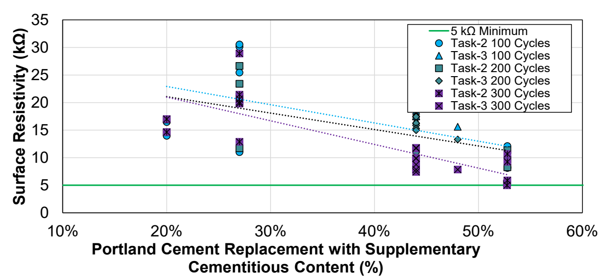
21-3 Development of Cost-Effective Rapid-Setting Concrete for Improved Bridge Joint Performance | Agency of Transportation (vermont.gov)

Introduction or Problem Statement

Vermont Agency of Transportation (VTrans) was an early adopter of the accelerated bridge construction (ABC) approach and has led the nation in using ABC to successfully deliver bridge construction and reconstruction projects. While ABC projects enjoy high material quality due to a large fraction of precast and prefabricated elements, connections between these elements must be placed in-situ, these are often treated as a “weak-link” due to potential risk for inferior performance. VTrans has adopted the use of rapid-setting concrete (RSC) for construction of connections between precast elements in ABC (see figure below showing an example of connection on a VTrans ABC project), which follows the current state of practice. Current VTrans practice dictates use of a membrane and overlay on ABC projects due to concerns of poor durability of RSC in ABC connections. Durability concerns that have prevented use of bare decks have not been studied or evaluated. This study comprehensively assessed durability of RSC used by VTrans for ABC connections and proposed proportion based standardized mix designs to lower costs.

Left: VTrans ABC Connections (in red boxes) ready for RSC placement

Right: RSC Mix design being tested for its compressive strength



Effects of Portland cement replacement with supplementary cementitious content on the chloride ingress potential of rapid setting concretes at different levels of freeze-thaw cycling.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Methodology or Action Taken

This research study is focusing on an extensive laboratory evaluation of currently used RSC by VTrans to assess durability of these materials as well as to assess their structural performance. Testing scope includes strength (compressive and flexural), elastic modulus, chloride permeability, and bond capacity measurements for several RSC materials that have been used on VTrans ABC projects. Lab tests were conducted on control specimens as well as those with laboratory-imposed freeze-thaw cycling. Further, several variations on RSC mix designs used in past were evaluated through two-phased experiments (phase-I (task-2) used partial factorial experimental design and phase-II (task-3) design only varied a single variable at a time). Twenty RSC materials were comprehensively evaluated.

Conclusions and Next Steps

Comprehensive literature review found that that limited work has been conducted to comprehensively assess durability of RSC with respect to use in ABC connections, however a significant amount of literature is based on developing RSC as a rapid setting patching and repair material. Laboratory evaluation conclusively demonstrated that there is not a concern for loss of durability in RSC materials due to freeze-thaw cycling, specimens with up to 300 freeze-thaw cycles maintained mechanical performance, bond strength and lower permittivity to chloride ions. Through statistical analyses of laboratory experimentation data, the research team has proposed material compositional limits for RSC materials that would reduce performance testing requirements for RSC used on individual projects. The target for total cementitious content of 850 lbs./yd^3 with 44% supplementary cementitious content is recommended. The final report is currently being reviewed by the project TAC.

Potential Impacts and VTrans Benefits

This research provides several potential benefits to VTrans that will improve the performance of bridges in the state as well as decreasing both initial and life cycle costs. The initial costs of ABC projects will be reduced via use of proportion-based RSC mix design(s) that are less prone to variability in properties; therefore, requiring less quality control tests. The life cycle costs of ABC projects will be reduced due to demonstrated durability of RSC materials which results in changes to agency practice that will eliminate the need for membrane and bituminous overlay treatments on ABC projects. Also, the improved and more cost-effective RSC material specifications will allow for an increased number of ABC projects as the structural performance will not be compromised; this has the potential to limit traffic disruption and overall construction time. The project outcomes have the significant potential to reduce the initial project costs and maintenance costs and provide VTrans with the means to repair or replace more structurally deficient bridges with a limited budget. The benefits of the project can be quantified from multiple perspectives:

- Initial project cost savings can be directly calculated using information on the cost of testing requirements within current quality assurance process.
- Potential initial project cost savings can be directly calculated by eliminating the need for membrane and pavement on ABC projects.
- Life cycle cost savings can be determined based on the expected improvements in performance and durability using the improved RSC designs, no future maintenance of membrane and pavements which have a lower design life and are prone to maintenance issues, and an increased resiliency in ABC projects.
- The decrease in traffic disruption for projects using ABC and RSC materials as compared to traditional construction can be determined; and,
- Contributions to sustainability aspects can be quantified, including reduction in carbon footprint.

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PROJECT TITLE
Pavement Deterioration Models for Pavement Management

STUDY TIMELINE
April 2023 – April 2024

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KEYWORDS
Pavement, pavement management, asset management, performance modeling

FUNDING
$118,193

VTRANS PROJECT PAGE
[23-2 Pavement Deterioration Models | Agency of Transportation (vermont.gov)]

applied pavement TECHNOLOGY

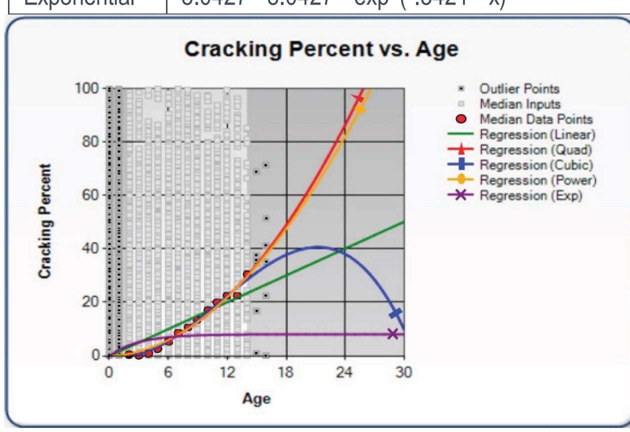
FACT SHEET

23-2 Pavement Deterioration Models for Pavement Management

Introduction

The Vermont Agency of Transportation (VTrans) owns and maintains 3,100 centerline miles of paved public roads. VTrans annually collects pavement condition data on this network such as smoothness, rutting, and cracking. These data are stored in a pavement management system (PMS) database that uses pavement deterioration models to predict future pavement conditions. These predictions support Transportation Asset Management Plan (TAMP) related activities including reporting performance, setting condition targets, life-cycle planning, and financial planning. During this research effort, the pavement performance models in the Deighton Total Infrastructure Management System (dTIMS) will be updated using historical pavement performance data. This process will determine whether revisions to existing models are needed to better reflect deterioration trends. Additionally, new pavement deterioration models for bonded wearing course pavements and National Performance Measures
(NPM) will be developed.

Model Form	Equation	R^2
Linear	-1.904504E-009 + 1.6740 * x	0.8362
Quadratic	-1.882023E-010 + .07461 * x + .14711 * x^2	0.9791
Cubic	3.449848E-012 - .7959 * x + .3465 * x^2 - .010303 * x^3	0.9862
Power	-2.826787E-010 + .19828 * x^(1.8965)	0.9801
Exponential	8.0427 - 8.0427 * exp^(-.3421 * x)	-0.0836



More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Methodology

More than 20 years of Vermont historical pavement condition data will be analyzed to identify pavement performance trends and establish updated prediction models. Models will be based on existing VTrans model formats and family groupings such as asphalt over concrete, thin pavement on strong bases, or thin pavement on weak bases. For each model to be delivered, the research team will review historical performance, identify outliers, and identify statistical indicators which are expected to provide the best approach for performance prediction. Values such as mean, median, and percentile will be observed to support identifying model coefficients which most reasonably predict future performance.

Next Steps

Proposed revisions to existing pavement performance models and proposed new models for bonded wearing course pavements and NPMs will be presented to relevant VTrans personnel during a virtual agency review meeting. During that time, the research team will review each proposed model revision using a live review of data plots that show existing and proposed models against historical data in the APTech pavement performance modeling (PPM) tool. The team will discuss fitness statistics such as coefficient of determination values, for existing and proposed models to determine the final set of coefficients. Based on VTrans feedback provided during agency review, the research team will compile all findings and documentation into a final report and provide a summary table with the final model coefficients. VTrans staff will be responsible for entering new and revised model coefficients into the PMS.

Potential Impacts and VTrans Benefits

This review of pavement deterioration models will ensure that the VTrans' PMS analysis provides reliable forecasts that increase confidence in future funding needs analyses. Results from these improved analyses will be used to ensure pavement resurfacing and maintenance programs will use available funds productively to achieve long-term performance targets. Having accurate life-cycle planning tools will minimize waste within the pavement resurfacing and maintenance program by achieving long-term performance targets at the lowest practicable cost, which makes funding available for other programs such as bridges, capacity, or safety. The project results are expected to improve pavement construction and maintenance program activities that will lead to increased reliability in planning future investment programs.

Section B: Structures and Stormwater Design

FACT SHEET

22-3 Advancing the use of DWTRs in stormwater treatment features to enhance phosphorus removal for transportation projects

PROJECT TITLE

Advancing the use of DWTRs in stormwater treatment features to enhance phosphorus removal for transportation projects

STUDY TIMELINE

September 2022 – August 2024

INVESTIGATORS

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KEYWORDS

stormwater infrastructure; urban stormwater treatment; drinking water treatment residuals; phosphorus; phosphorus removal, sand filter

FUNDING

VTRC022-003

$150,000 / 24 mo

VTRANS PROJECT PAGE

22-3 Phosphorus Reduction | Agency of Transportation (vermont.gov)

Introduction or Problem Statement

Previous laboratory and field research at University of Vermont suggests that drinking water treatment residuals (DWTRs) have high phosphorus (P) sorption capacity and can aid in the removal of dissolved P in stormwater treatment systems such as roadside bioretention.[1,2] Additional field verification of effective P removal from stormwater in full-scale treatment practices is needed to inform use of DWTRs in transportation projects. Two stormwater treatment sand filters were recently constructed with a uniformly mixed filter media consisting of ≥95% sand and ≤5% DWTRs in Chittenden County, VT. One filter receives runoff from a small catchment (< 2 acres) and the other from a larger catchment (> 2 acres) (Fig. 1) The DWTRs used are alum-based and were obtained from a local drinking water treatment facility. The UVM research team is studying P inputs to and outputs from these DWTR-amended sand filters during rain events.

Figure 1. Photos of the small catchment and large catchment sand filter systems and associated sampling.

Methodology or Action Taken

Storms are monitored by taking uniform time-based sub-samples of stormwater inflow to, and outflow from, the sand filters using auto-sampler equipment. Sub-samples are composited for each storm event and analyzed for concentrations of total phosphorus (TP), total dissolved phosphorus (TDP), particulate phosphorus (PP), soluble reactive phosphorus (SRP), dissolved organic phosphorus (DOP), and chloride (Cl^-). Concentration data, paired with flow data recorded from a combination of pressure transducers and volumetric weirs, are

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

used to estimate influent and effluent P loads for each event. A total of 45 storms between the smaller and larger sites will be monitored as part of this project.

Conclusions or Next Steps

The study's preliminary results from the small catchment sand filter indicate that the DWTR-amended sand is performing well in terms of dissolved P removal (~70% reduction in SRP concentration on average). Reductions have been observed even when influent SRP concentrations are <0.1 mg/L. Event mean SRP concentrations of treated effluent have been approximately 0.025 to 0.050 mg/L regardless of influent concentration, except in cases where filter bypass is observed (e.g., overflow). The large catchment sand filter has not yet been monitored due to construction delays. This second site will also be studied to evaluate P removal efficacy. Including DWTRs at a proportion of 3-5% of sand filter media is not anticipated to impact system performance negatively and is expected to substantially increase the longevity of P treatment by the filter media.

Potential Impacts and VTrans Benefits

Mixing DWTRs into sand media-based stormwater infrastructure can enhance P removal before stormwater from transportation projects reaches downstream lakes. A conventional sand filter primarily removes P through filtering of *particulate P*. However, DWTRs chemically sorb *dissolved P*, which is often not removed or may even be exported in conventional stormwater treatment systems.[3] As the first field study of sand filters enhanced with DWTRs in VT, this study will clarify anticipated P load reductions for DWTR-amended sand filters and provide guidance for future stormwater treatment practices used in transportation projects. Anticipated benefits of this practice include: 1) no substantial additional cost, 2) reuse of local residual material that would otherwise be discarded/landfilled, and 3) substantial increase in the longevity of P removal in sand-based treatment practices, targeting dissolved P that often passes through or is exported from stormwater treatment practices.

References

[1] Ament, M. R., Hurley, S. E., Voorhees, M., Perkins, E., Yuan, Y., Faulkner, J. W., & Roy, E. D. (2021). Balancing hydraulic control and phosphorus removal in bioretention media amended with drinking water treatment residuals. ACS ES&T Water, 1(3), 688-697.

[2] Ament, M. R., Roy, E. D., Yuan, Y., & Hurley, S. E. (2022). Phosphorus removal, metals dynamics, and hydraulics in stormwater bioretention systems amended with drinking water treatment residuals. Journal of Sustainable Water in the Built Environment, 8(3), 04022003.

[3] The Water Research Foundation. International Stormwater BMP Database: 2020 Summary Statistics.

Acknowledgements

Field and lab work for this study is being performed by UVM M.S. student Micayla Schambura in the Department of Civil & Environmental Engineering. Assistance has been provided by UVM undergraduate students Oscar Ewald and Alyssa Barroso.

VERMONT AGENCY OF TRANSPORTATION

FACT SHEET

The Impact of the Use of Geofoam Adjacent to the Back Walls on the Design of Foundation Piles in Integral Abutment Bridges (IABs)

PROJECT TITLE

The impact of the abutment walls heights, bridge span range, and the roadway profile grade on the forces/moments and lateral displacement profile of W or HP piles caused by thermal expansion in integral abutment bridges (IABs)

STUDY TIMELINE

June 2018 – June 2023

INVESTIGATORS

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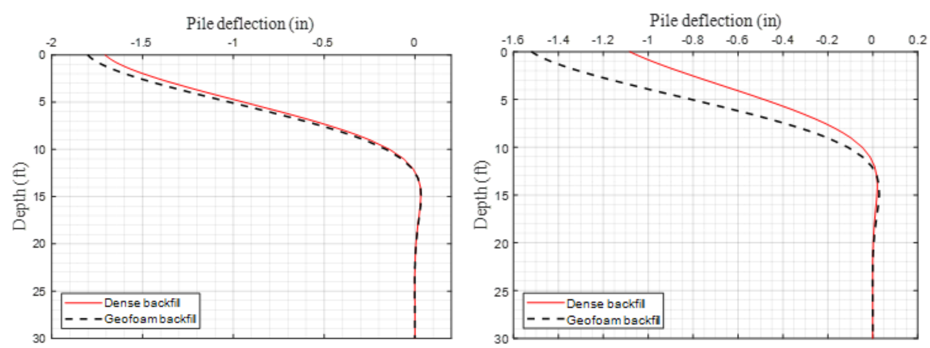
KEYWORDS

Integral abutment bridges (IABs)
Design optimization
Soil profile
Indeterminate framed structures.
Thermal expansion
HP or W shape piles
Fixity point
Abutment wall height
Variation of Soil property

Introduction

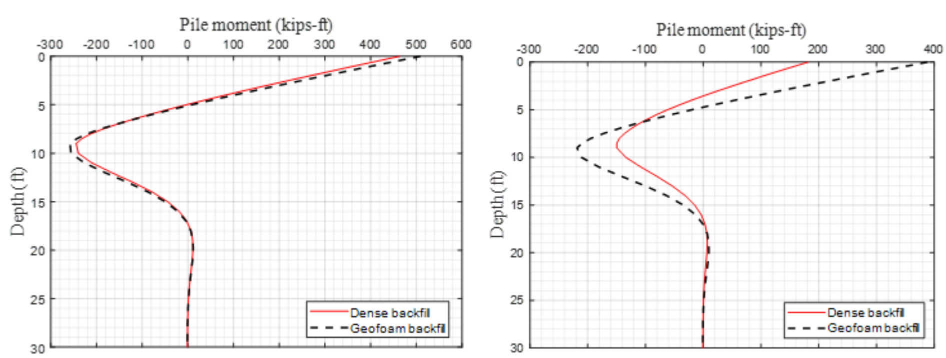
Integral abutment bridges (IABs) are indeterminate framed structures interacting with the soil behind the back walls and the soil surrounding the piles. The thermal loading is a major contributor to the stress in the superstructure and substructure of IABs. The biggest uncertainty in the analysis and design of IABs is the reaction of soil behind the abutment walls and next to the foundation piles.

In many long span IABs the soil adjacent to the back wall is replaced by Geofoam to allow the back wall to move more freely to reduce stresses in the girders and the back wall. This, however, adversely affects the foundation piles. There has not been any significant study on the impact of Geofoam on foundation piles and there is a need for such studies.



(a) H=8 ft (b) H=12 ft

Fig.1 Displacement Profiles of Abutment Pile. L=550 ft, $\Delta T = 100^{0F}$



(a) H=8 ft (b) H=12 ft

Fig.2 Moment Profiles of Abutment Pile. L=550 ft, $\Delta T = 100^{0F}$

FUNDING

Acknowledgements: This project was financially sponsored by the University of Transportation Center (UTC) led by University of Maine and collaborated with Vermont Agency of Transportation (VTrans).

VTRANS SYMPOSIUM PAGE

[The Impact of the Use of Geofoam Adjacent to the Back Walls on the Design of Foundation Piles in Integral Abutment Bridges (IABs) | Agency of Transportation (vermont.gov)]

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Methodology

The objective of this work has been to compare the effect of the use of Geofoam adjacent to the backwall, instead of dense soil, on the thermally induced displacements, forces, and moments in steel piles in IABs. To accomplish this objective, a parametric study was conducted using a commercially available finite element software to create a full three-dimensional finite element model of a three-span IAB with a total span length of 550 ft, a width of 54 ft., and with seven rows of plate girders and seven rows of W piles supporting each back wall and then comparing the displacements and moment profiles of the piles in the case of dense soil with that of Geofoam.

Conclusions

This study shows that, under thermal expansion, increasing the abutment wall height will decrease the piles maximum displacement and maximum moment.

Using Geofoam to replace the dense soil adjacent to the abutment wall will have adverse effects. It will increase the pile's maximum displacement and maximum moment. The increase is less critical for shorter back walls, but it is critical for longer walls.

Potential Impacts

The knowledge gained will help bridge engineers to design the foundation piles of IABs more accurately, leading to a reduction in construction cost and an increase in their safety.

FACT SHEET

Hartford Bridge 7 Integral Abutment Monitoring for Complex Structures

PROJECT TITLE
Hartford Bridge 7
Integral Abutment Monitoring for Complex Structures

STUDY TIMELINE
5 years (minimum) after 2024 construction start

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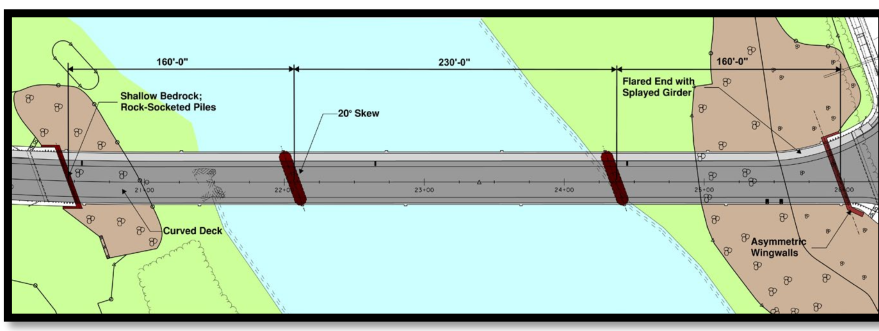
KEYWORDS
Integral Abutment
Bridges
Field Testing

FUNDING
$452,360*
*This was the construction bid for the acquisition and installation of the sensors and data acquisition system. This cost does not include project team costs by VTrans, HNTB, and UMass for review, oversight, data collection, etc.

Introduction or Problem Statement

Construction for the replacement of Hartford Bridge 7 is currently underway. The new structure will be a three span, 550-ft integral abutment bridge with a flared and curved roadway at the bridge ends, skewed substructures, asymmetric abutments and wingwalls, a 4% profile grade, and variable subsurface conditions. This bridge length and geometry would typically prohibit the use of integral abutments due to excessive thermal movements and unbalanced pressures on the abutments and foundations.

Replacement of this bridge provided an opportunity to push the limits of integral abutment implementation. Refined analyses were used to gain a deeper understanding of the behavior of this structure, and corresponding force distribution. The bridge will be actively monitored with a comprehensive instrumentation system for five years beginning during construction. The accumulated data will be used to help verify analytical models and provide a better understanding of design parameters to be used in future structures.



Methodology or Action Taken

The proposed instrumentation system is comprised of approximately 300 sensors, including pressure cells, extensometers, tiltmeters, and strain gauges. These sensors will be used to measure critical bridge behaviors such as movements and rotations of the abutments and strain induced in the girders and piles. Ambient air temperature will be recorded so all device measurements can be viewed in the context of changing temperature. The data collection will be used to validate the original design model and support the development of design guidelines for longer, more complex integral abutment structures.

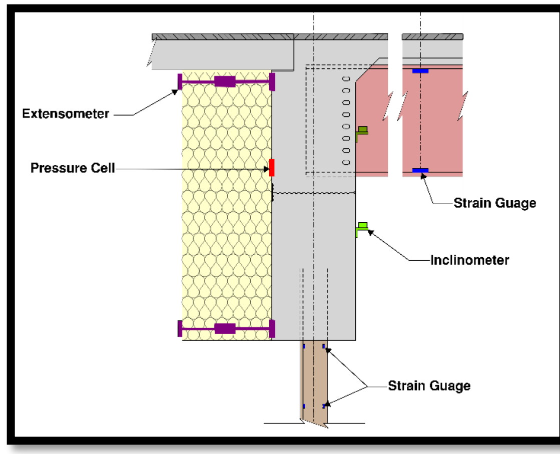
Conclusions or Next Steps

VTrans is partnering with UMass Lowell to process the data collected. Currently the plan is to monitor the bridge continuously throughout construction and for a minimum of five years after traffic is transferred to the new bridge. Collected

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

VTRANS SYMPOSIUM PAGE
Hartford Bridge Instrumentation | Agency of Transportation (vermont.gov)

data will be regularly reviewed, and results shared to understand behavioral patterns.



Potential Impacts and VTrans Benefits

Integral abutment bridges are cost effective, rapidly constructed supports with reduced long-term maintenance compared to conventional abutments. Generally, integral abutments are the preferred support type. However, usage of integral abutment bridges remains limited to shorter, simpler structures. This project will provide an extensive amount of field data on a structure that pushes the envelope of typical usage. Understanding how this structure behaves will enable VTrans to utilize integral abutments on a larger array of projects in the future.

FACT SHEET

Field Metalizing of a Steel Beam Bridge

PROJECT TITLE
Field Metalizing of a Steel Beam Bridge

STUDY TIMELINE
January 2020 – July 2023

INVESTIGATORS
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KEYWORDS
Field Metaling of structural steel

FUNDING
FHWA Accelerated Innovation Deployment Grant

VTRANS SYMPOSIUM PAGE
Field Metalizing of a Steel Beam Bridge | Agency of Transportation (vermont.gov)

More information about the VTrans Research Program, including additional Fact Sheets, can be found at:
http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

The goal of this project is to determine the current cost of field metalizing an existing steel beam bridge. Painting has been the standard method of providing a protective coating to steel bridges in Vermont. However, paint systems require re-painting every 25-30 years. Metalizing has a life span of nearly 60 years reducing the necessity of future projects and subsequent disruption to traffic. The goal of the project is to determine if the cost of field metalizing is worth the expected life span.

Application of Field Metalizing

Methodology or Action Taken

A project was completed in 2021 to field metalize 6 rolled beams comprising an 82 ft long simple span bridge on VT 16 in Hardwick VT. The cost of the field metalizing on this project came in low due to the contractor's desire to gain field metalizing experience.

Conclusions or Next Steps

The construction portion of the project went well with little to no problems occurring. The metalizing coating specification included a two-year warranty on performance. The coating was inspected in 2023 and appears to be performing as expected.

Potential Impacts and VTrans Benefits

Subsequent bidding and construction costs of future field metalizing projects will determine the cost effectiveness of this system. If acceptable, this coating will be added to the Agency's toolbox for protective coatings of steel bridges.

Section C: Asset Management

FACT SHEET

23-1 Assessing and Monitoring Performance of Small Culverts

PROJECT TITLE
Assessing and Monitoring Performance of Small Culverts

STUDY TIMELINE
October 2024 – September 2026

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KEYWORDS
Culvert, inspection, robot

FUNDING
VTRC023-601
$134,987

VTRANS PROJECT PAGE
[23-1 Small Culvert Performance | Agency of Transportation (vermont.gov)]

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Problem Statement

The Vermont Agency of Transportation (VTrans) has adopted a policy requiring all culverts to be inspected every 5 years, resulting in around 9,600 small culverts needing to be inspected annually. Many of these culverts have small diameters that preclude human inspection. Culvert failures can be expensive, such as the recent high-profile collapse under I-89S near Richmond, VT (this was a 96" culvert not a small culvert). With improved methods of monitoring and assessing the conditions of culverts, proper maintenance or replacement projects can be planned and implemented before catastrophic failure of a culvert occurs.

Fig. 1 HIVE 2 Culvert Inspector

Fig. 2 Distressed culvert

Methodology or Action Taken

This project will build on previous research by our team on improved low-cost robotic culvert inspection systems, i.e., the HIVE 2.0. The plan for the project is to work closely with the VTrans Project Champion, Michelle Redmond, and other VTrans personnel to develop performance specifications for the HIVE 2.1, followed by building and testing protypes. The research will fine tune the design for low-cost assembly and durability, then build a small fleet of tank-style robots, examine performance, add techniques for enhanced telemetry and surveillance. Additional research includes the development of low-cost flow sensors and explore the use of legged dog robots for culvert inspection. This research will span two years, with two summers being the primary time for field testing of prototypes.

Next Steps

Design, Build and Test HIVE 2.1 – This is to build a new and improved Hydraulic Inspection Vehicle Explorer based on the Sherman tank platform of the HIVE 2.0. These improvements include ease of manufacture, assembly and maintenance. Additional research will examine the development of low-cost wireless flow sensors and the use of a 4-leg dog robot to examine the inside of small culverts.

Evaluate Performance of HIVE 2.1 in Culvert Tests – These tests will be conducted in collaboration with VTrans Project Champion, with the bulk of the activity in the summer seasons.
Deliver HIVE 2.1 Robots – These robots will be delivered for use in inspection of small culverts by VTrans maintenance personnel.
Technology Transfer and Guidelines for Implementation including information on the design, fabrication, and use of HIVE 2.1

Potential Impacts and VTrans Benefits

Culverts are an important aspect of transportation infrastructure. They manage and channel stormwater flow under roadways and other structures. Unexpected culvert failures can lead to cascading damage and expensive repairs. Small culverts are impossible to inspect with humans. The new and improved HIVE 2.1 robot will enable efficient and cost-effective inspections of small culverts and provide information for timely maintenance and repair.

VERMONT AGENCY OF TRANSPORTATION

FACT SHEET

21-2 RFID and Wireless IoT Technologies for Transportation Maintenance Operations and Asset Management

PROJECT TITLE
RFID and Wireless IoT Technologies for Transportation Maintenance Operations and Asset Management

STUDY TIMELINE
10/2021 – 09/2023

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KEYWORDS
Asset management
Maintenance operations
RFID
IOT

FUNDING
VTRC021-2
$74,623

VTRANS PROJECT PAGE
21-2 Radio Frequency Identification (RFID) and Similar Technologies for Transportation Asset Management | Agency of Transportation (vermont.gov)

Introduction

For Asset Management, an important aspect is keeping track of each asset item and recording its attributes, which requires each asset to be quickly and accurately identified. RFID is a wireless tracking technology that enables a reader to activate, read, and/or write data remotely between a transponder and a radio frequency tag attached to or embedded in an object. The advantages of RFID technology make it a key enabler to develop an automated transportation asset management system.

RFID Tags on other asset items

Asset in garage

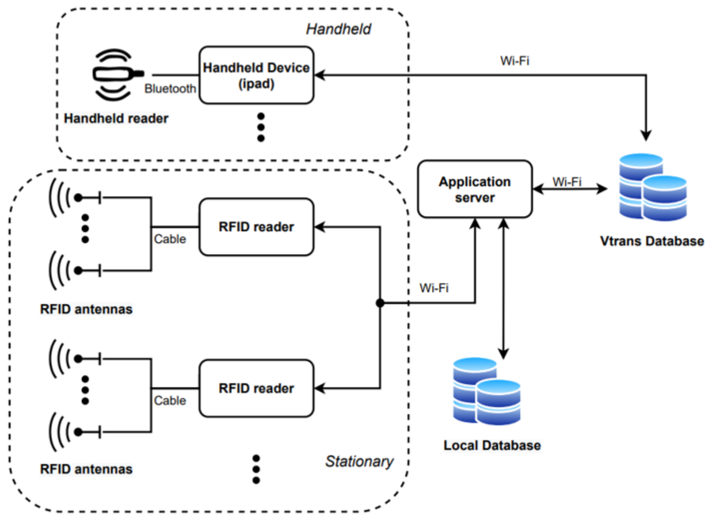

Figure: RFID transportation asset management system diagram

Methodology

We explore radio frequency identification (RFID) and other wireless Internet of Things (IoT) technologies to develop a solution to automate efficient transportation maintenance operations and asset management. We will fulfill the following objectives:

- To study the specific features and needs of transportation maintenance operations and asset management.
- To investigate how RFID and IoT can be used for transportation maintenance operations and asset management and what the technical challenges for actual deployment and the corresponding solutions are.
- Develop an integrated system and create a test site for technology demonstration and benchmark.

Conclusions

Our system offers integrated, comprehensive, and efficient solutions to practical problems arising in various environmental and operational conditions. Extensive laboratory and field tests validate the system performance and functionality.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research.

Potential Impacts and VTrans Benefits

- Automating maintenance operations and asset management workflows and processes.
- Integrating with other data platforms and various accounting systems to provide accurate and real-time data to optimize resource allocation and facilitate decision making.
- Improving supply chain visibility to allow better tracking original suppliers and manufacturers of various assets.

FACT SHEET

Object Tracking and Geo-Localization from Street Images

PROJECT TITLE
Object Tracking and Geo-Localization from Street Images

STUDY TIMELINE
March 2018– Jul 2023

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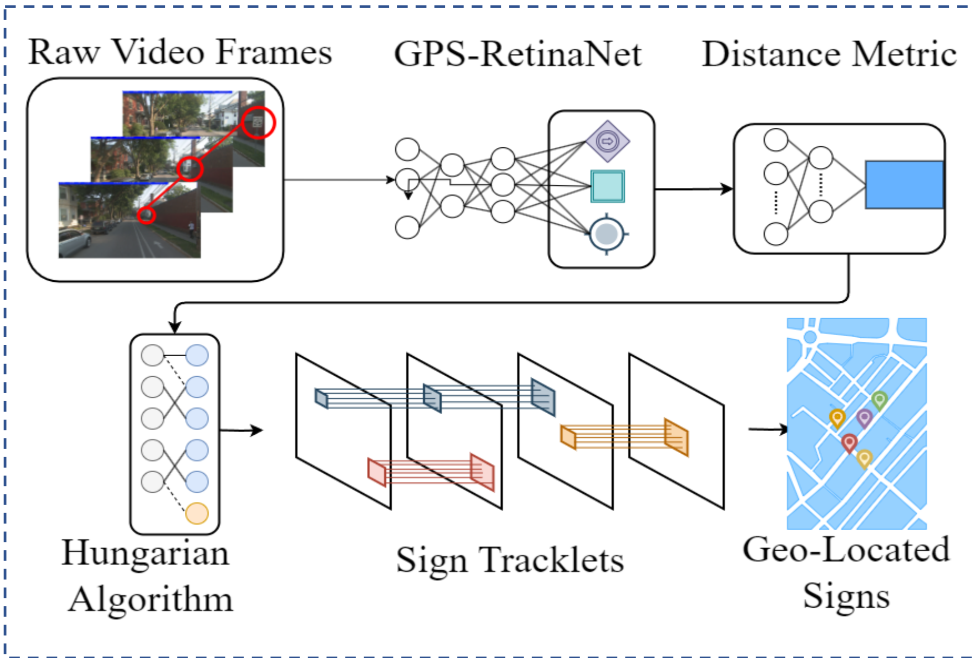
KEYWORDS
Traffic Signs, Object Geo-Localization, Deep Learning, Computer Vision

VTRANS SYMPOSIUM PAGE
Object Tracking and Geo-Localization from Street Images | Agency of Transportation (vermont.gov)

The University of Vermont

Introduction or Problem Statement

Our project applied novel artificial intelligence algorithms to construct an automated system which detects, classifies, and geo-localizes traffic signs using roadside images as input. We have also constructed a viewer widget which enables users to view signs, their class types, and locations on a GIS map.



Methodology or Action Taken

We have constructed a deep learning-based object detector which uses a cascade of convolutional networks to predict sign classes and coordinates. We have built a new semi-supervised dataset containing over 100,000 images. To merge repeated occurrences of the same sign from separate images, we have constructed a "tracker" which consists of a neural network to compute a similarity score between detections, and match repeated signs using the Hungarian Algorithm. Finally, we have built a multi-year tracker which detects repeated occurrences of the same sign across different years.

Conclusions or Next Steps

We have completed our fully functioning AI pipeline, and have applied it to process over 5 terabytes of Vermont street imagery from 2018-2022. The resulting images and AI predictions can be viewed using the developed web viewer widget.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Potential Impacts and VTrans Benefits

Our research provides an automated system to construct a GIS map of signs from street-side images, and a widget which visualizes the output signs and allows the user to interact with them. These tools enable more efficient inventory assessments and maintenance plans. Additionally, the large dataset we have constructed will support future research VTrans may wish to perform in this field.

Section D: Planning, Public Transportation, and Safety

VERMONT AGENCY OF TRANSPORTATION

FACT SHEET

23-4 Validating Collection Methods for and Quantification of Travel Time Delay Through Work Zones Across Vermont

PROJECT TITLE

Validating Collection Methods for and Quantification of Travel Time Delay Through Work Zones Across Vermont

STUDY TIMELINE

June 2023 – June 2024

INVESTIGATORS

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KEYWORDS

Work zone capacity, work zone speed impacts, work zone delay, travel time delay, value of travel time, travel time reliability

FUNDING

VTRC023-604
$140,000

VTRANS PROJECT PAGE

23-4 Travel Time Delay Through Workzones | Agency of Transportation (vermont.gov)

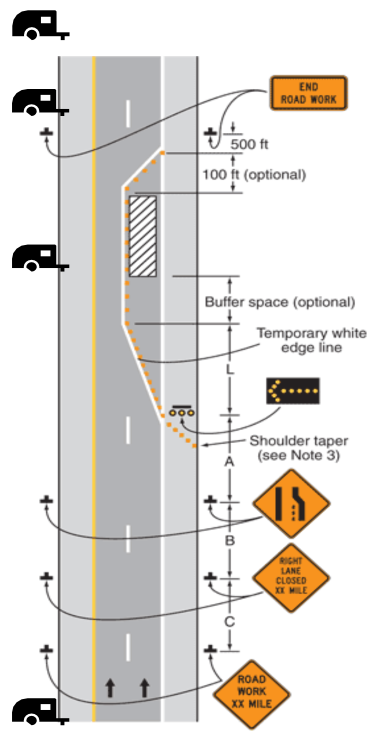
vhb

THE UNIVERSITY OF VERMONT TRANSPORTATION RESEARCH CENTER

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

Although the Vermont Standard Specifications for Construction identify an acceptable delay in work zones of less than 10 minutes per operation and less than 15 minutes cumulatively for a project maintaining one-way traffic, it is recognized that these thresholds have been set without consideration for context, procedures for measuring delay, or methods for mitigating delay. The objectives of this project are to validate the effectiveness of various types of travel-time delay measurement methods and quantify the delays incurred across a variety of work zones in Vermont. These objectives aim to recommend changes to the current and future VTrans construction specifications and updates to the VTrans Work Zone Safety and Mobility Guidance regarding a standard operating procedure for collection of data and measurement of delay to ensure compliance with the specification.



A - LONG-TERM AND INTERMEDIATE

Methodology or Action Taken

The initial phase of the project reviewed the work zone safety and mobility practices in Vermont and researched best practices from other state DOTs for both standards of allowable travel time delay and methods for quantifying delay in work zones. This information was used to help identify delay measurement methods to test via mobile traffic monitoring platforms (MTMPs).

Assembly of the MTMPs was initiated while the team gathered information on potential candidate projects for measuring travel time delay in the field based on project significance levels, project timelines, and feasibility of sites for the MTMP deployments.

The team anticipates deployment of the MTMPs in candidate work zones through the Fall 2023 and into Spring construction season in 2024. Data gathered will be post-processed to establish a travel-time delay calculation procedure. Methods of data collection and delay measures will be evaluated based on measures of effectiveness (MOEs) identified in the literature review.

Conclusions or Next Steps

The project team is working on final assembly and testing of the MTMPs for deployment at candidate test sites. This data collection phase is expected to span the Fall construction season and resume in the Spring of 2024.

Potential Impacts and VTrans Benefits

This research will serve to directly inform the criteria for context-sensitive, maximum-acceptable travel time delays through work zones in Vermont and identify viable methods and procedures for quantifying delay through work zones in support of the established Work Zone Safety and Mobility Policy goals. The findings of this project will be used by the VTrans WZTC to make recommendations for changes to the current and future VTrans construction specifications and to make future updates to the VTrans Work Zone Safety and Mobility Guidance document. Ultimately, the anticipated benefits of this research will be a practical implementation of the travel-time delay standards for work zones in Vermont, which will serve to increase mobility and improve VTrans' level of service to the travelling public.

FACT SHEET

22-4 Vermont Smart Growth, VMT and GHG Research

PROJECT TITLE
Vermont Smart Growth, VMT and GHG Research

STUDY TIMELINE
July 2022 – October 2023

INVESTIGATORS
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KEYWORDS
Smart Growth
Vehicle Miles Traveled
Land Use Planning
Greenhouse Gas Emissions

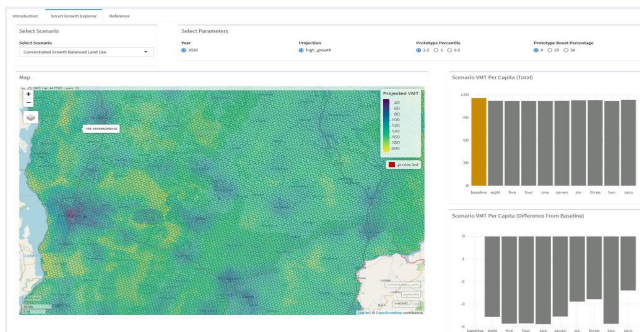
FUNDING
RDWP022-701
$140,000

VTRANS PROJECT PAGE
[22-4 SmartGrowth, VMT and GHG | Agency of Transportation (vermont.gov)]

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

This project has leveraged big data to understand how compact, mixed-use development in Vermont affects vehicle miles travelled (VMT), mode share, greenhouse gas (GHG) emissions, and other VMT reduction co-benefits (i.e. health, safety, and reduced maintenance costs) compared to more dispersed development patterns.



Methodology or Action Taken

The research team has developed a model estimating VMT based on passively collected location-based data and built environment factors across Vermont. The model is linked to downstream estimates of changes in GHG emissions, health impacts, and other co-benefits associated with VMT reductions. The project team, in coordination with stakeholders, has developed several future growth scenarios, modeling the implications of land use policies and influential built environment parameters. The various future scenarios and adjustable parameters are embedded in an interactive dashboard tool that will be shared with decision makers and the public.

Conclusions or Next Steps

The team is finalizing a dashboard tool that will allow policy makers to evaluate a host of different growth scenarios. Users will be able to adjust model parameters to better understand the implications of land use policies on vehicle miles traveled and the co-benefits of reduced VMT out into the future.

Potential Impacts and VTrans Benefits

The project helps VTrans and other stakeholders understand how land use policy and future development patterns may help meet GHG emission reductions targets as promulgated in the Vermont Pathways Analysis Report. Further, this project seeks to understand how smart growth development patterns may reduce infrastructure maintenance costs, provide health benefits, and spur economic development opportunities in Vermont communities.

VERMONT
AGENCY OF TRANSPORTATION

FACT SHEET

21-1 Traffic Safety Toolbox—Addressing Speeds

PROJECT TITLE
Traffic Safety Toolbox—Addressing Speeds

STUDY TIMELINE
April 2022 – March 2023

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VTRANS CONTACTS
Josh Taylor, Traffic Engineer

KEYWORDS
Speeding, countermeasures, toolbox, safety, rural transition zones

FUNDING
RDWP022-928
$85,000

VTRANS PROJECT PAGE
21-1 Traffic Safety Toolbox - Addressing Speeds | Agency of Transportation (vermont.gov)

FINAL REPORT
20230606 Speeding Countermeasures for Vermont Final Report.pdf

TOOLBOX
20230606 Toolbox.pdf (vermont.gov)

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

Speeding on lower speed and local roadways is a major contributor to speeding-related fatalities in Vermont. In 2018, over half of all fatal crashes occurring on local and collector roadways were classified as speeding-related. Vermont does not currently have a "toolbox" for engineers and local officials to help determine the most effective speeding countermeasures to improve safety on roads. While our engineers have experience using various tactics to improve road safety and reduce speeds, compiling all our resources into a single location will help identify the correct measures to take and how to implement them. This project will help the Districts and Towns where the responsibility of addressing speeds and improving safety often falls to local engineers or DPW superintendents, many of whom have limited experience in transportation safety.

Methodology or Action Taken


PROFILES OF SPEEDING COUNTER-MEASURES
HORIZONTAL DEFLECTIONS
NEIGHBORHOOD TRAFFIC CIRCLE
Effective speed reduction within a village or town center
FACTS AT A GLANCE
PROS
CONS
USE IN VERMONT
Neighborhood traffic circles, or intersection islands, are round islands that reduce speeds as vehicles are routed around the island rather than straight through the intersection. The presence of the center island has been shown to reduce vehicle speeds and minimize points of conflict.
CONTEXT
DESIGN CONSIDERATIONS

This project identified a collection of 15 countermeasures that can be implemented by towns in Vermont to lower roadway speeds. Their application in the Vermont context was supported by 4 speeding field tests and 4 interview-based case studies. For each countermeasure, the research team created a profile sheet that includes illustrations, description, context discussion, design considerations, implementation pros & cons, and links to local case studies, field tests, and sources of further information. These profile sheets were compiled into a dynamic pdf document for use by towns in identifying countermeasures suited to their specific context.

Potential Impacts and VTrans Benefits

This resource will improve VTrans' workflow, providing access to a much-needed resource for our districts and towns to identify the most effective ways to reduce speeding and prevent future speeding-related fatalities on our roadways.

FACT SHEET

Rapid Process Modernization During an Emergency Response

PROJECT TITLE
Rapid Process Modernization During an Emergency Response

STUDY TIMELINE
July 10 – July 30 2023

INVESTIGATORS
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KEYWORDS
Microsoft, Innovation, Process Automation

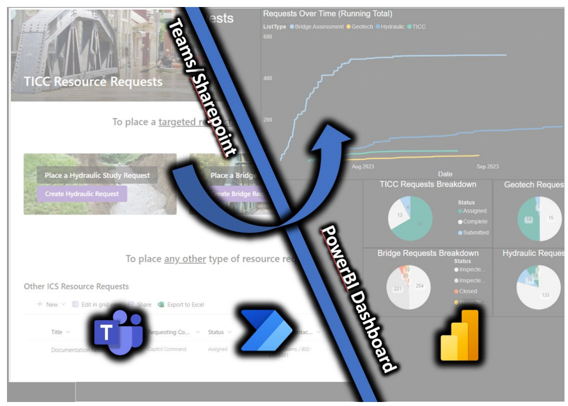
FUNDING
N/A

VTRANS SYMPOSIUM PAGE
[Rapid Process Modernization During an Emergency Response | Agency of Transportation (vermont.gov)]

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Introduction or Problem Statement

Following a 100-year flood event, how do you efficiently manage 100+ requests per day for emergency bridge inspections, geotechnical surveys, hydraulic studies, temporary bridges and more? This impromptu project set about to tackle this very problem with a "we need it done yesterday" timeline. With out of the box thinking, objective and direct decision making, and iterative adaptation from all stakeholders, all expectations were surpassed.



Methodology or Action Taken

The existing process for managing resource requests relied on a generic PDF fillable form that was to be emailed to a logistics team for fulfillment. For several reasons, this was not ideal. The two standout issues with this approach were insufficient detail on a one size fits all form, and an emailed PDF is susceptible to being lost inside of one person's Inbox amongst many others.

To address this, we rapidly created Teams/SharePoint Lists for each type of request and utilized Power Automate to automatically notify stakeholder of updates to their requests, and notify logistics of new or pending requests. Comprehensive situational awareness was then established by connecting these lists to a Power BI Dashboard.

Conclusions & Next Steps

With command structure mandating ICS staff to utilize this new solution, it was fully implemented in a matter of hours. During the After-Action Review, this solution was regarded as one of the best successes in the days following the event and managed over 700 resource requests. As of right now, there are no set plans for the future, however, there have been several requests to continue using the solution on a permanent, non-emergency basis. Going forward, it is recommended that this solution be utilized in table-top events and extended to continue to meet needs during emergencies.

Potential Impacts and VTrans Benefits

This solution was fast to implement, provided superior functionality over the traditional methods of resource requests, saved valuable staff time and, accordingly, there are likely many other business processes at VTrans that could benefit from this approach.

FACT SHEET

Vermont Statewide Microtransit Study

PROJECT TITLE

Vermont Statewide Microtransit Study

STUDY TIMELINE

Final Report: May 2023

INVESTIGATORS

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Vermont Department of Transportation (VTrans)

VTRANS CONTACTS

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KEYWORDS

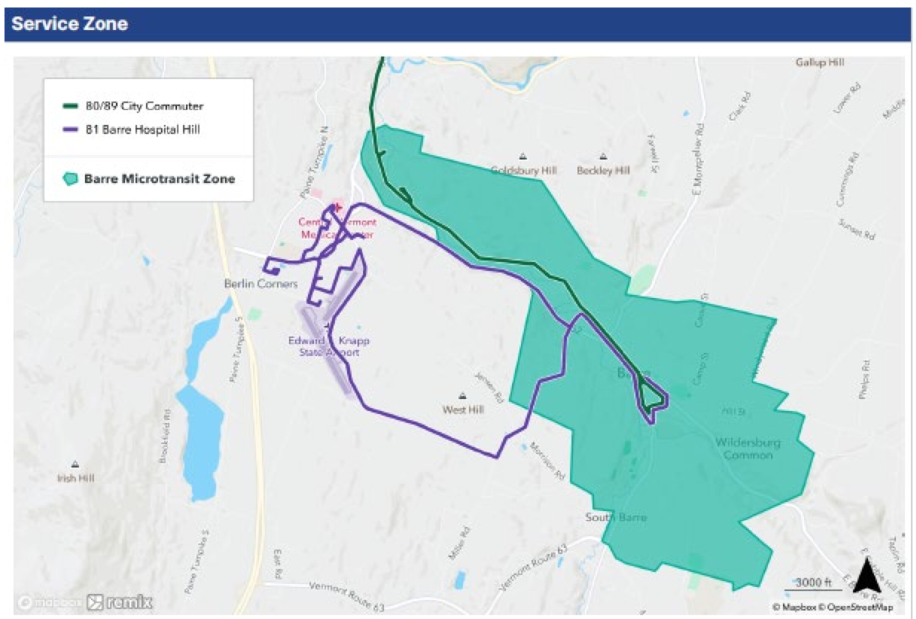
Microtransit; Rural; Small Town

VTRANS SYMPOSIUM PAGE

[Conditions Appropriate for Micro Transit in Vermont | Agency of Transportation]

Introduction or Problem Statement

Microtransit, also known as on-demand transit, is a technology-enabled transit system that dynamically routes vehicles based on real-time passenger demand. While demand-response transit has existed for decades, often in the form of Dial-a-Ride and other paratransit services, microtransit has grown in popularity just in the last few years. The key difference is that microtransit is technology driven and encourages riders to book trips through a mobile phone app, allowing on-demand booking in addition to pre-booking. For this project, a total of twelve studies were conducted across Vermont, investigating the potential for microtransit to serve diverse communities in areas covered by six different transit agencies.



Methodology or Action Taken

Each Study included an analysis of existing conditions, such as an analysis of demographics in the area and an assessment of existing transit services (if any). Alternatives were developed based on this analysis, with guidance from each agency partner along with VTrans. Microtransit alternatives were designed to improve local mobility and promote regional connectivity through transfers to other transit services where possible. Some service alternatives considered replacing, supplementing, or modifying fixed routes, while others considered introducing transit to previously unserved areas. Demand estimates were developed for each microtransit alternative based on Via's internal demand model along with the analysis of existing transit in the zone. Using the demand estimates, the performance of each microtransit service alternative was simulated with outputs like the number of vehicles required to meet expected levels of demand, projected service efficiency, and measures of customer experience.

More information about the VTrans Research Program, including additional Fact Sheets, can be found at: http://vtrans.vermont.gov/planning/research

Conclusions or Next Steps

Some communities are better suited for microtransit transit than others. It was found that service categories small town, demand response, and rural are suitable for microtransit while service categories urban and tourism are sometimes suitable. Many technology features are also recommended for microtransit services in Vermont, such as intermodal capabilities, fixed-route bus referral, and commingling. Vermont can also realize several benefits from statewide coordination of microtransit services like knowledge sharing, overhead costs, and marketing and customer awareness. The final report for this project also contains other recommendations for Vermont.

Potential Impacts and VTrans Benefits

Microtransit services are typically open to anyone to use for any trip purpose. This is unlike some paratransit or other dial-a-ride services that limit trips to seniors or people with disabilities or to medical appointments. Microtransit can be used for shopping, recreational trips, regular work commutes, medical visits, or any other trip purpose. Wheelchair-accessible vehicles ensure the microtransit service is accessible for people with disabilities. Microtransit can often complement an existing paratransit service by offering an alternative that has fewer restrictions such as advanced booking requirements, therefore reducing the demand for paratransit services. With many areas in Vermont being rural and small towns, microtransit can provide a relatively efficient form of coverage and allow smaller fleets to serve larger areas. In small towns, microtransit can connect customers with regional fixed-route services for trips between towns. The recommendations provided can help Vermont citizens to connect with one another and businesses.

Appendix

Table 1: AASHTO Technical Service Programs

AASHTO Technical Service Programs	
Technical Service Program	**Expenditure**
Product Evaluation and Audit Solutions (Formerly National Transportation Product Evaluation Program (NTPEP))	$ 25,000
Preservation Management (Formerly Transportation System Preservation Technical Services Program (TSP2))	$ 20,000
Materials Guidelines (Formerly Development and Maintenance of Materials Standards)	$ 10,000
Design Guidelines (Formerly Design Publications Maintenance)	$ 15,000
Winter Weather Management (Formerly Snow & Ice Operations (SICOP))	$ 4,000
Equipment Management (Formerly Equipment Management Technical Services Program (EMTSP))	$ 5,000
Structures Guidelines (Formerly AASHTO's LRFD Specifications Maintenance (LRFDSM))	$ 15,000
Technical Training Solutions (Formerly Transportation Curriculum Coordination Council (TC3))	$ 20,000

Table 2: FHWA Pooled Funds AOT Participated in FFY23

FHWA Pooled Funds AOT Participated in FFY23	
Pooled Fund	**Expenditure**
Traffic Safety Culture Phase II TPF-5(444)	$ 10,000
Clear Roads, Phase 3 TPF-5(479)	$ 25,000
Demo to Advance New Pavement Technologies TPF-5(478)	$ 10,000
Building Information Modeling (BIM) for Bridges and Structures TPF-5(372)	$ 25,000
Hydrologic and Hydraulic Software Enhancements TPF-5(464)	$ 5,000
Traffic Speed Deflection Devices (TSDD) TPF-5(385)	$ 30,000
New England Transportation Consortium TPF-5(222)	$ 0
Research Project Tracking System TPF-5(467)	$ 0