MaineDOT

Spring 2011 Transportation Research Summary

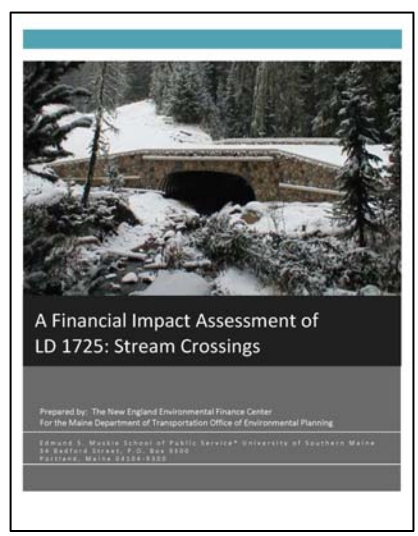
Advanced Bridge Safety Initiative: Program Impacts on Bridge Safety and the Maine Economy

MaineDOT is responsible for 2,723 bridges and minor spans, of which 271 are in poor condition and 226 are structurally deficient. Nine percent of Maine's bridges are over 81 years old and 37% are over 61 years old. MaineDOT estimates that 288 bridges are at risk of closure or weight restrictions in the next decade. Closing or restricting a bridge places additional hardships on Maine people and Maine companies. MaineDOT struggles to balance public safety and socioeconomic concerns when faced with bridge closure and load restriction decisions. On the other hand, the cost of replacement or rehabilitation needed to keep such a bridge open to all traffic is extraordinary.

This study investigates the use of finite element (FE) analysis to determine the load carrying capacities of existing concrete slab bridges as compared to more conservative methods. In addition to commercial FE programs, this project will develop FE software designed specifically for rating flat slab bridges. Methods of FRP flexural reinforcement of flat slab bridges will also be experimentally investigated for strength and durability.

Preliminary results from analysis of the initial ten bridges are very promising. The finite element analysis (SlabRate) shows that six bridges do not require truck weight restriction posting that normally would using the conventional analysis method. The cost avoidance is very significant since there's no adverse impact to the trucking industry and there's no need to repair or replace these structures in the immediate future. Estimates show an average savings of $1.25M on a single bridge when replacement is avoided. **More on next page.**

A Financial Impact Assessment of LD 1725: Stream Crossings



The purpose of this study was to document and to present a financial impact analysis of LD 1725, a legislative resolve, which would result in expanding the physical size requirements needed for stream crossing construction in the State of Maine. The study was conducted by the New England Environmental Finance Center (EFC), in coordination with the Maine Department of Transportation (MaineDOT), Maine Department of Environmental Protection (DEP), and state, nongovernmental, and local stakeholders. LD 1725 proposed modifying certain provisions of the Maine DEP rules. **More on next page.**

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Advanced Bridge Safety Initiative (continued)

A second set of 10 slab bridges were load rated using both the conventional method and the SlabRate finite-element analysis program. Seven of these bridges which had a rating factor below one based on the conventional AASHTO method had a rating factor greater than one based on finite-element analysis. Basically, seven bridges do not require load posting, avoiding impacts to truckers and costly bridge repair or replacement.

A Financial Impact Assessment of LD 1725: Stream Crossings (continued)

The modification would define the "natural stream flow" provisions to be met under Natural Resources Protection Act (NRPA) exemptions, when constructing stream crossings, such as highway culverts. The study presented information to the DEP rulemaking stakeholder workshops.

The rule under consideration would require that "natural stream flow" be met when constructing stream crossings and that crossing structures must be at least 1.2 times the natural bankfull width of the stream. A natural stream bed, either an embedded or "bottomless" structure would also be required. If an existing crossing could not meet the 1.2 bankfull sizing through maintenance, rehabilitation, or replacement, then a full permit process would be required, leading to increased project costs and also delay. As drafted, the 1.2 bankfull requirements in LD 1725 would cause structure widths to increase from 175% to 325% for stream crossing projects, thereby resulting in cost increases.

A statewide cost estimate of $230 - $474 million was projected for only the additional pipe material costs incurred due to culvert upsizing. The total overall statewide cost impact of LD1725 would ultimately include construction, engineering, permitting and other related costs. When combined, these costs could be more than 50% higher than material costs. Although these total overall costs would be spread out over roughly 20 years (as existing stream crossings are replaced), Maine municipalities and Maine Department of Transportation will face the substantial annual financial requirements of the proposed rule without any additional source of funding.

Historical Changes in Annual Peak Flows in Maine and Implications for Flood-Frequency Analyses

Annual peak flows have increased at most rivers in Maine during the last century. What effect does this have on computed peak flows, such as the 100-year flows, that are used for designing bridges and other structures?

In this USGS—MaineDOT cooperative study it is found that the increases in 5-year peak flows based on data from recent decades are consistent with the observed increasing annual peak flows in Maine. The increases in 100-year peak flows based on data from recent decades are generally consistent with observed increasing annual peak flows. In limited cases, 100-year peak flows, based on data from recent decades, are relatively low. Many of these stations had a very high peak flow early in their record, which affected the magnitude of the 100-year peak flows more than it affected the magnitude of long-term changes in annual peak flows. What's it all mean? One suggested approach is to conduct analysis based on the more recent data and based on the traditional long term data. The more conservative values could be used for determining bridge opening size.

Bridge Testing and Diagnostics for Enhanced Load Rating

Accurate bridge load rating is essential for identifying problem structures and keeping our bridges safe and in service. Measuring actual bridge response (strains and displacements) under truck loading coupled with subsequent advanced structural analysis is perhaps the most reliable way to assess bridge capacity. Coupled field load testing and analysis has been shown to lead to significantly higher load ratings than those predicted with standard AASHTO methods, and has the potential to save the MaineDOT and the State significant funds through more efficient use of our existing bridge inventory.

Accurately load testing multiple in-service bridges can be accomplished only with specialized sensing, monitoring, and data-acquisition equipment that can be installed and used with minimal effort. The scope of work will identify critical bridges, perform diagnostic live load testing with the BDI bridge diagnostic equipment, and the analyze the load-tested bridges to develop refined rating factors.

Premature Pavement Distresses in Region 5

Over the past few years hot mix asphalt pavements are showing early distresses of rutting and raveling. It is theorized that the more recent (past five years) HMA mixes have become more susceptible to moisture causing early raveling and rutting. In fact, in 2010 two projects in Region 5 were paved using anti-strip additives. On both projects control sections were constructed as well to provide a comparison of pavement performance over time.

The research will include two major tasks. The first is to conduct a thorough investigation into the paving projects in Region 5. This will involve analysis of project pavement designs, materials used, paving practice/methods, paving reports, quality acceptance tests to try to determine why the HMA pavements are showing early signs of distress. The second task will involve sampling pavement material from 2011 projects and conducting pavement performance tests in the laboratory on moisture conditioned and unconditioned samples. The results will show if moisture susceptibility is the culprit and if the anti-strip additive is going to resolve the issue. Data from the 2010 experimental construction projects will be analyzed as well. The final deliverable will be a thorough review, testing and analysis leading to a better performing HMA pavement.

Analysis of Projected Replacement and Costs for Potential Aquatic Barriers maintained by MaineDOT

Recent discussions around State and federal stream crossing regulations have focused on resolving existing barriers to fish movement created by culverts and struts associated with transportation infrastructure. Approximately 30% of Maine has been surveyed for stream barriers through the joint efforts of state and federal fisheries agencies and non-government organizations, which have mapped this data via GIS. These same entities are currently working toward prioritizing identified barriers according to potential habitat value and species status. The resulting database contains location information, but does not differentiate crossings for which the state is responsible from those under local or private responsibility. This lack of distinction makes it near to impossible to quantify specific future costs to MaineDOT other than on a crossing by crossing basis. Because the database does not account for the age of individual structures, it is not possible to determine if barriers have been exacerbated by recent replacements and rehabilitations or if the barriers to fish movement are historic and therefore likely to be remedied in the relatively near future through standard MaineDOT maintenance protocols. Study tasks include:

Stream barrier, resource priority and MaineDOT road layers are overlaid to determine scope of MaineDOT responsibility;

Condition, age, and event history of each MaineDOT stream barrier verified using MATS database and regional office input;

Using condition date, project timeline for replacement/rehabilitation according to future work plan scheduling;

Estimate project-specific costs based on site conditions using cost modeling developed by the New England Environmental Finance Center in 2010;

Identify MaineDOT barriers of high resource priority as candidates for potential funding partnerships.

Cone Penetration Test Correlations for Presumpscot Clays

The Presumpscot clay is a soft, low plasticity, sensitive silty clay deposit that covers significant portions of southern and coastal and lowland Maine. The deposits low strength, sensitivity, and presence of heterogeneity (e.g., silt and sand seams) presents challenges to site characterization, engineering design, construction, and long-term stability. Currently site investigation practice is limited by cost and engineering parameters are often obtained from discrete soil property measurements. These include highly variable profiles of in situ vane shear strength, correlations based on soil composition, and on limited data from laboratory testing of undisturbed tube samples. A new method for more rapid and comprehensive subsurface profiling to obtain a wider range of engineering parameters is needed for more reliable and efficient design.

Cone penetration testing with pore water pressure measurement (CPTU) provides near continuous profiles of subsurface resistance (tip and sleeve) and penetration-induced pore pressure that are used to indicate layering, lateral and depth heterogeneity, and relative soil composition (e.g., "soft" clays, "stiff" sands). Seismic testing can be incorporated (i.e., SCPTU) to measure shear wave velocity for earthquake design. Notably, the CPTU/SCPTU can be used to determine soil engineering parameters across a site, however these profiles must first be calibrated to engineering properties determined from laboratory testing on undisturbed tube samples.

This proposed research initiative is aimed at developing a framework for using SCPTU profiling in Presumpscot clay through the correlating with profile data with in situ vane shear strength, and soil properties commonly used design measured in the laboratory on undisturbed samples. This work is currently underway for a single site in Falmouth, Maine, however, this work must be expanded to at least four other sites regionally to create more robust and site transferable correlations for the Presumpscot clay. A secondary aim is to provide a summary of engineering design frameworks that utilize CPTU/SCPTU data that will bring relevance to these methods in the Presumpscot clay.

Development and Evaluation of Pile Load Test Database

The recommended (since 1986) FHWA method for static pile capacity estimates is the Nordlund method developed from 25 ft long friction piles in sands. Most piles in Maine are longer than 25 ft, and many are end bearing in till and rock. The Nordlund method often gives unreliable estimates of pile capacity for piles in Maine as compared to load tests. The Canadian Foundation Engineering Manual method gives a wide range of estimates for pile capacities bearing on bedrock in Maine.

Since 1990, MaineDOT has conducted dynamic pile load tests on most projects. These numerous load tests can verify which currently used static pile capacity methods offer the best estimates of pile capacity in Maine soil and bedrock conditions. The load tests give values for side shear and for end bearing. Thus estimating methods for side shear in granular and clay as well as for end bearing in tills and on bedrock can be made reliable.