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In this Issue:

TxDOT Research Reports (Feb.-Apr. 2015)

Table of Contents

Item 1

Traffic Control Device Evaluation Program: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 1001-14-1 • 2015

This project provides the Texas Department of Transportation with a mechanism to quickly and effectively conduct high-priority, limited scope evaluations of traffic control devices. Work during the 2013-2014 fiscal year included three main tasks: updating the Texas Curve Advisory Speed (TCAS) program, testing alternatives to the existing exit gore sign requirements, and evaluating pilot vehicles and portable traffic control signals with and without a flagger. The TCAS program was developed to assist practitioners in the implementation of the guidelines for setting curve advisory speeds and choosing curve traffic control devices. Researchers updated the calculations contained within the TCAS program to reflect the guidelines in the Texas Manual on Traffic Control Devices (TMUTCD). Researchers also added a new set of calculations so that users have the choice of applying either the TMUTCD or the Procedures for Establishing Speed Zones. Exit gore signs are often hit and require constant maintenance, which puts maintenance crews at risk. The study's objective was to develop potential alternative(s) to provide the road user the same level of information but reduce or eliminate the risk during maintenance. Researchers selected alternative exit gore treatments to test in TTI's driving simulator. The vertical chevron paired with chevron pavement markings performed consistently well, but none of the alternative treatments performed notably poorly. Typically, flaggers direct traffic when a lane on a two-lane, two-way road is closed for construction or maintenance, but Texas also uses portable traffic control signals and pilot vehicles to control operating speeds within the lane closure. Researchers conducted field studies to test driver compliance, and overall, only 3 percent of drivers did not comply with the portable traffic control signals and pilot vehicle for both conditions studied (with and without a flagger). Researchers also developed a tool to help pilot vehicle drivers estimate the minimum green time needed to clear the vehicle queue at the portable traffic signal. The report also discusses two ongoing tasks: coordinating state asset data collection efforts and evaluating rumble devices.
(x, 109 pages)

CONTENTS

This report is available for free download (8.7 MB):
http://tti.tamu.edu/documents/9-1001-14-1.pdf

Item 2

Performance of Lap Splices in Large-Scale Column Specimens Affected by ASR and/or DEF. Extension Phase

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 5722-2 • 2015

A large experimental program, consisting of the design, construction, curing, exposure, and structural load testing of 16 large-scale column specimens with a critical lap splice region that were influenced by varying stages of alkali-silica reaction (ASR) and at least early-stage delayed ettringite formation (DEF), was conducted. This report details the developing expansion from late-stage ASR and at least early-stage DEF in the remaining eight specimens since September 2011 and the structural testing of two of these specimens during the three-year project extension phase. In comparison with the response of the control specimens, specimens exhibiting primarily ASR (and at least early-stage DEF) had similar initial stiffness and behavior up to first cracking, had about a 25 to 35 percent increase in post-cracking stiffness up to yielding, had about a 5 to 15 percent increase in yield strength, and showed no overall detrimental effects on the structural response. The increase in stiffness and strength can be explained by the resulting volumetric expansion of the concrete due to the ASR that engaged the transverse reinforcement for better confinement of the core concrete, and engaged the supplemental post-tensioning reinforcement and the column longitudinal reinforcement to generate additional axial compression load. Although the structural performance of column splice regions with varying levels of ASR and up to some DEF showed no detrimental effects, the vulnerability of the column splices with increased levels of DEF and other developing deterioration mechanisms, such as corrosion, could not be evaluated to date.

(x, 95 pages)

CONTENTS

This report is available for free download (16.9 MB):
http://tti.tamu.edu/documents/0-5722-2.pdf

Item 3

Structural Assessment of "D" Regions Affected by Premature Concrete Deterioration: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 5997-2 • 2015

The current study is a continuation of the earlier study that investigated the effects of Alkali Silica Reaction (ASR) and Delayed Ettringite Formation (DEF) induced deterioration on the D-Regions of structures. Of the four near full-scale C-Beam specimens that were constructed, and conditioned over time as part of the earlier study, the last specimen (Specimen 3), which was field conditioned through the Texas heat along with supplemental water for a period of five years, is the main focus of this study... A minimalist semi-empirical analysis technique is developed to model the expansion strains caused by ASR/DEF expansion in reinforced concrete. The proposed model takes into account the effects of compressive and tensile prestrains on the expansion strains caused by ASR/DEF, in addition to the daily variations in temperature and humidity. This enables the model to capture the expansion strains in reinforced concrete structures that are exposed to environmental conditions. The model is validated and applied to simulate the expansion strains observed for the C-Beam specimens. Considering the complex nature of the ASR/DEF phenomena, the nature of the structure considered, and the variability in the field recorded data, the model simulates the expansion strains quite well. The Compatibility Strut-and-Tie Modeling (C-STM) technique, which was developed and verified in Phase I of this report, is used to model the force-deformation behavior of C-Beam Specimen 3. The expansion strains that are obtained from the ASR/DEF model is used to compute the prestress loads to be applied in the C-STM technique to account for the effects of ASR/DEF expansion in the model. The C-STM simulates the overall force-deformation and the internal behavior of the structure quite well.

(xv, 194 pages)

CONTENTS

This report is available for free download (20.7 MB):
http://tti.tamu.edu/documents/0-5997-2.pdf

Item 4

Developing a Mixture-Based Specification for Flexible Base

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6621 PSR • 2015

The Texas Department of Transportation (TxDOT) currently utilizes Item 247, "Flexible Base," to specify a foundation course of flexible base utilized in a pavement. Base materials are not allowed to be used by the contractors until the materials have been approved in the stockpile, typically at the point of production or at or near the construction site. This project evaluated the current method of base material acceptance, as required in Item 247, and investigated methods to replace material approval based on stockpile sampling and testing with a mixture design methodology and quality control procedure.
(2 pages)

This report is available for free download (256 KB):
http://tti.tamu.edu/documents/0-6621-S.pdf

Item 5

0-6635, Water Quality Performance of Permeable Friction Course on Curbed Sections

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

CTR 6635 PSR • 2015

"The Texas Department of Transportation (TxDOT) has funded a number of studies to investigate the pollutant removal associated with use of the permeable friction course (PFC) on highways... By removing water from the road surface, PFC improves safety by reducing splashing and improving visibility. In addition to safety benefits, the previous research by TxDOT demonstrated that PFC reduces concentrations of pollutants commonly observed in highway runoff... Based on the previous work, the Texas Commission on Environmental Quality (TCEQ) recognized PFC as an approved practice for complying with the water quality requirements; however, the approval was limited to the highway configurations previously tested, which included a maximum of two lanes of traffic and a rural cross section (no curb and gutter). The primary objective of this work was to determine whether the same water quality benefits would be realized on wider highways that included a curb and gutter drainage system."
(2 pages)

This report is available for free download (338 KB):
http://library.ctr.utexas.edu/ctr-publications/psr/0-6635-s.pdf

Item 6

Behavior of the Splice Regions of Spliced I-Girder Bridges

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)
CTR 6652-2 • 2015

Spliced girder bridge technology continues to attract attention due to its versatility over traditional prestressed concrete highway bridge construction. Relatively limited data is available in the literature, however, for large-scale tests of spliced girders, and few studies have examined the behavior of the cast-in-place (CIP) splice regions of spliced girder bridges. In addition to limited knowledge on CIP splice region behavior, a wide variety of splice region details (e.g., mild reinforcement details, shear interface details, overall geometry, etc.) continue to be used in the field. In response to these issues, the research program described in this report was developed to (i) study the strength and serviceability behavior of the CIP splice regions of spliced I-girders, (ii) identify design and detailing practices that have been successfully implemented in CIP splice regions, and (iii) develop design recommendations based on the structural performance of spliced I-girder test specimens. To accomplish these tasks, an industry survey was first conducted to identify the best practices that have been implemented within the splice regions of existing bridges. Splice region details were then selected to be included within large-scale post-tensioned spliced I-girder test specimens. Two tests were conducted to study splice region behavior and evaluate the performance of the chosen details. Consistent with their design, the failure mechanisms of both test girders were characterized by a shear-compression failure of the web concrete with primary crushing occurring in the vicinity of the top post-tensioning duct. Most significantly, the girders acted essentially as monolithic members in shear at failure. The web crushing extended across much of the test span and was not localized within the splice regions. Based on the results of the tests, design recommendations were developed, including recommended CIP splice region details.
(xvi, 249 pages)

CONTENTS

This report is available for free download (17.9 MB):
http://library.ctr.utexas.edu/ctr-publications/0-6652-2.pdf

Item 7

Rapid Field Detection of Moisture Content for Base and Subgrade: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6676-2 • 2015

Mixing and compacting soil and flexible base pavement materials at the proper moisture content is critical for obtaining adequate compaction and meeting construction specification requirements. This project sought to evaluate rapid non-nuclear techniques for measuring the moisture content on roadway base and subgrade materials.This report presents results from the final stages of testing in this project, which included 3 non-nuclear approaches, the nuclear gauge for comparison, and the over dry gravimetric moisture as the reference value. Researchers evaluated each test for bias, precision, and sensitivity, and then scored the devices according to bias, precision, sensitivity, cost, turnaround time, suitability for uncompacted materials, and suitability for compacted materials. With these scoring parameters, the data showed the moisture analyzer most suitable for implementation. The report presents a draft test method for measuring moisture content with the moisture analyzer. The test turnaround time is typically between 15 and 30 minutes.
(x, 39 pages)

CONTENTS

This report is available for free download (2.4 MB):
http://tti.tamu.edu/documents/0-6676-2.pdf

Item 8

Improving DMS 9210 Requirements for Limestone Rock Asphalt

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6686-2 • 2015

Limestone Rock Asphalt (LRA) mixtures have been produced and placed for several decades using specification requirements currently listed under DMS 9210. Several districts have had placement issues and premature failures at the beginning of 2010. These issues and failures have been attributed to material properties. Requirements for DMS 9210 have not changed for several years and need to be evaluated to possibly produce a higher quality material to reduce the occurrence of premature failures and to minimize placement issues. The objectives of the study are to (1) evaluate specification requirements of Item 330 and DMS 9210, (2) conduct field evaluations and lab testing to determine workability and acceptability as stockpile material for use as needed in pavement maintenance, and (3) consider improvements to the specification requirements to ensure an acceptable and workable stockpile material for up to 6 months. (viii, 26 pages)

CONTENTS

This report is available for free download (997 KB):
http://tti.tamu.edu/documents/0-6686-2.pdf

Item 9

Managing the TDM Process: Developing MPO Institutional Capacity. Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6691-1 • 2015

Within Texas, the development of urban travel demand models (TDMs) is a cooperative process between the Texas Department of Transportation and Metropolitan Planning Organizations (MPOs). Though TxDOT - Transportation Planning and Programming Division is responsible for developing and validating TDMs for many of the Texas MPOs, the MPOs play an important role in model development by providing the demographic data and regional roadway information required for model development and forecast applications. Like other MPOs nationwide, Texas MPOs struggle with the difficulties of limited resources, time, and staff for the development of accurate and reliable TDMs. Owing to the cooperative process between TxDOT and Texas MPOs, and the different sizes and staff resources among Texas MPOs dedicated to model development, the MPOs in Texas have different needs and challenges in this regard. This project researches current practices, trends, and innovations by MPOs in Texas and nationwide for managing this process. The goal is to assist MPOs in developing institutional capacity to undertake travel-related technical analyses in a complete and timely manner. While the results from the study will include tiered recommendations appropriate for MPOs of all sizes, the focus will be on small and medium-size MPOs with limited staff and data resources for providing information for developing models. In addition to this report, a product of this research includes a training course targeting MPO directors or those leading TDM tasks for an MPO.
(xiii, 172 pages)

CONTENTS

This report is available for free download:
http://tti.tamu.edu/documents/0-6691-1.pdf

Item 10

Crash Test and MASH TL-3 Evaluation of the TxDOT Short Radius Guardrail

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6711-1 • 2015

When a roadway intersects a highway with restrictive features such as a bridge rail and canal, it becomes difficult to fit a guardrail with the proper length, transitions, and end treatment along the highway. Possible solutions include relocating the constraint blocking the placement of the guardrail, shortening the designed guardrail length, or designing a curved guardrail. Curved, or short radius, guardrails typically present the most viable solution for these areas. However, no previously designed short radius guardrails meet national Cooperative Highway Research Program (NCHRP) Report 350 Test Level 3 (TL-3) guidelines. Now, the American Association of State Highway and Transportation Officials (AASHTO) Manual for Assessing Safety Hardware (MASH) has updated crash testing criteria. The new guidelines supersede NCHRP Report 350 and increased the size of test vehicles and changed the test matrices to include more impact conditions. Therefore, meeting new impact standards for short radius guardrails has become more challenging. TTI researchers investigated, modeled, and simulated an optimized short radius design under this project. Subsequently, TTI researchers crash tested this system successfully to MASH 3-33, 3-32, 3-31, and 3-35 test conditions. This innovative design utilizes an energy dissipation component plus a cable anchor that provides tension capacity to the rail section on the primary roadway, though an anchor BCT post on the secondary road portion of the system. These new innovative design details made the system very effective in capturing the vehicles in short distances while using readily available components.
(xviii, 395 pages)

CONTENTS

This report is available for free download (38.3 MB):
http://tti.tamu.edu/documents/0-6711-1.pdf

Item 11

Evaluating the Performance of Alternative Supplementary Cementing Material in Concrete

UNIVERSITY OF TEXAS AT AUSTIN. CENTER FOR TRANSPORTATION RESEARCH (CTR)

CTR 6717-1 • 2015

"Uncertainty in the supply of Class F fly ash due to impending environmental restrictions has made it imperative to find and test alternate sources of supplementary cementitious materials (SCMs) that can provide similar strength and durability benefits to concrete as Class F fly ash. This project summarizes the key findings of research that was conducted to characterize and evaluate the performance of eight natural pozzolans, commercially available in Texas, to assess their potential as Class F fly ash replacements in concrete. Of the eight pozzolans tested, six were found to be viable alternatives for Class F fly ash. Methods to further enhance the performance of these SCMs were explored and guidelines are provided on the optimum SCM replacement levels for different applications. Finally, recommendations are presented on how to improve current testing practices for SCMs."
(xiv, 129 pages)

CONTENTS

This report is available for free download (5.2 MB):
http://library.ctr.utexas.edu/ctr-publications/0-6717-1.pdf

Item 12

0-6722, Spread Prestressed Concrete Slab Beam Bridges

TEXAS DEPARTMENT OF TRANSPORTATION (TXDOT). RESEARCH AND TECHNOLOGY IMPLEMENTATION OFFICE (RTI)

TTI 6722 PSR • 2015

"The Texas Department of Transportation uses precast prestressed concrete slab beam bridges for shorter-span bridges of approximately 30–50 ft in length. Conventional slab beam bridges have slab beams placed immediately adjacent to one another with a cast-in-place (CIP) topping slab. While these bridges are used extensively, they are more expensive than traditional prestressed I-beam structures on a per-square-foot basis. This project investigated the use of slab beams that are spread apart with precast concrete panel (PCP) stay-in-place forms between beams and a CIP concrete deck. Design guidelines have been developed for this alternate spread slab beam bridge system."
(2 pages)

This report is available for free download (494 KB):
http://tti.tamu.edu/documents/0-6722-S.pdf

Item 13

Evaluation of Generic and Branded Herbicides: Technical Report

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6733-1 • 2015

As with other generic brand products in the marketplace, generic herbicides often have a lower initial product cost than their brand-name counterparts. While the purchase price of herbicides is important to TxDOT, it is essential to look at more than just initial costs to determine whether generic or branded products is the best practice. One should consider safety, effectiveness, and application rates/procedures as well as product availability and equipment requirements. This project focused on three herbicides (Roundup PROMAX®, Escort® XP, and Transline®) that TxDOT currently uses. The multi-disciplinary research team conducted a literature review, survey of practice, and cost/benefit analysis to determine whether generic herbicides meet equivalent performance, toxicology, environmental impact, and safety requirements as branded herbicides with significant cost-savings. This study found that generic products with the same or similar formulation often proved equivalent to branded products in human/wildlife effects, performance, and equipment requirements. However, the potential lack of quality control was identified as a concern because many of the generic herbicides were produced overseas. The uncertainties of inert ingredients also made assessments of risks and performance unclear. Meanwhile, the cost-saving benefit by using generic products was not proven, particularly for projects requiring a large amount of herbicide. The generic product may have a cheaper price but may not include the same amount and quality of active ingredient as the brand-name product. Therefore, to achieve an equivalent rate of active ingredient, more of the generic material may need to be used, thereby potentially eliminating whatever cost savings was realized at the initial purchase of the generic product. Other concerns identified with generic herbicides include the lack of availability, and lack of diverse discounts offered by branded herbicide manufacturers.
(ix, 53 pages)

CONTENTS

This report is available for free download (1.8 MB):
http://tti.tamu.edu/documents/0-6733-1.pdf

Item 14

Evaluation of Design and Construction Issues of Thin HMA Overlays

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6742-1 • 2015

While the overall implementation of thin HMA overlays in Texas has been successful, some issues need to be addressed: appropriate blending of SAC A and SAC B aggregate to ensure adequate skid resistance; best practices to achieve adequate bonding (surface prep and tack coats); and correct quality assurance test methods to achieve adequate compaction. The purpose of this research, therefore, was to address these concerns through laboratory and field testing. In addition, preliminary work to refine a crack propagation model for thin overlays was performed.
(218 pages)

CONTENTS

This report is available for free download (8.7 MB):
http://tti.tamu.edu/documents/0-6742-1.pdf

Item 15

Project Consistency with Transportation Plans and Air Quality Conformity Workshops: Materials

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6758-01-P5 • 2015

Streamlined project delivery is a federally mandated goal that the Texas Department of Transportation (TxDOT) leadership supports. Federal and state transportation planning statutory and regulatory laws require transportation projects to be consistent with transportation plans and improvement programs before the Federal Highway Administration (FHWA) or the Federal Transit Authority (FTA) can take federal action on a project requiring one. Consequently, significant delays in project delivery can potentially occur, as the federal funding will be withheld for such projects and FHWA/FTA will not authorize their construction until the inconsistencies are fully addressed. Project consistency is required based on federal code 23 CFR 450 and Texas code 43 TAC 16. This issue is especially critical for projects in nonattainment (NA) and maintenance areas because an individual project's project-level conformity is directly linked to the consistency of the project with appropriate transportation plans and improvement programs, and a nonconforming project might trigger a conformity failure or delayed determination for the entire plan and/or program and required by conformity regulation 40 CFR 93, subchapter A. [The guidebook] was developed for transportation professionals responsible for project development." --Part A.

"This Supplementary Information Document (SID) was developed for transportation professionals responsible for project development and has a basic goal of providing an overview of the subjects that are deemed necessary for maintaining project consistency. It provides an overview of the transportation planning process, air quality conformity process, and environmental process under the National Environmental Policy Act (NEPA)—processes that either include or impact steps in the project development process—and identifies the entities responsible for advancing projects through the various steps in each process." --Part B.

CONTENTS

- Project Consistency Guidance. Part A, Project Consistency Guidebook: Maintaining Project Consistency throughout the Project Development Process [November 2014]
- Project Consistency Guidance. Part B, Supplementary Information Document: Maintaining Project Consistency throughout the Project Development Process
- Project Consistency Workshop. Session 1: Supplementary Background Information [.pptx with instructor notes]
- Project Consistency Workshop. Session 2: Maintaining Project Consistency [.pptx with instructor notes]

This report is available for free download (6.3 MB ZIP file):
http://tti.tamu.edu/documents/5-6758-01-P5.zip

Item 16

Development of Delineator Testing Standard

TEXAS A&M UNIVERSITY. TEXAS TRANSPORTATION INSTITUTE (TTI)

TTI 6772-1 • 2015

"The objective of this project was to develop a new test method for evaluating the impact performance of delineators for given applications. The researchers focused on developing a test method that was reproducible and attempted to reproduce failure modes witnessed through field observations. The researchers also attempted to optimize the testing standard to minimize the cost and effort to evaluate the products. The researchers feel that the process was successful, and a balanced testing standard meeting all requirements has been developed."
(xii, 96 pages)

CONTENTS

This report is available for free download:
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