Research Digest

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Southwest Region University Transportation Center (SWUTC)

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Research Digest

Item 1

Accessing the Mega-Region: Evaluating the Role of Livable Community Patterns in Gulf Coast Mega-Region Planning

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

U-NOLA SWUTC/15/600451-00109-1 • 2015

This research analyzes both the need and mechanisms for integrating livability components such as transit and active transportation into a broader mega-regions transportation framework. The research builds a conceptual framework for understanding how transportation livability concepts fit within the larger mega-regions literature. This framework based around the study of regional green infrastructure greenbelt systems is then used to analyze key strategies that could be integrated into the larger Gulf Coast/Texas mega-region transportation planning framework through analysis of three case studies in greater Houston, Austin/San Antonio, and New Orleans/Baton Rouge regions. Major existing and emerging opportunities to tie infrastructure into a mega-region transportation system are identified in these three case studies.

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http://swutc.tamu.edu/publications/technicalreports/600451-00109-1.pdf

Item 2

Controlling Conductivity of Concrete with Graphite

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TTI SWUTC/14/600451-00025-1 • 2014

Electrically conductive asphalt concrete has a huge potential for various multifunctional applications such as self healing, self-sensing, and deicing. In order to utilize the full spectrum of applications of electrically conductive asphalt composites, precise control of the asphalt mixture resistivity is needed. Most of the previous research using conductive fibers as the primary conductive additives observed a sudden transition from the insulated to conductive phase, commonly known as the percolation threshold, which obstructs more precise conductivity control. Aiming to control the electrical conductivity of asphalt concrete with a smooth transition from the insulated to conductive phase, the researchers have selected graphite powders as an alternative conductive additive in this study. Nine types of graphite having different particle shape, size, and origin were mixed with asphalt binders, and their effects on imparting conductivity were investigated. Based on the results, the research team selected two types of graphite and evaluated the effects on the electrical conductivity of asphalt concrete. The team also examined the effects of aggregate gradation, binder content, and binder type... The electrical and mechanical data obtained from this study provide essential information on the selection of graphite type and asphalt mixture design to achieve the proper electrical conductivity required for the probable multifunctional applications of asphalt concrete, which will lead to technical innovations for sustainable pavements.

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Item 3

The Effect of the City of Houston Transit Corridor Ordinance on Development along METRO's Light Rail Corridors

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TSU SWUTC/14/600451-00047-1 • 2014

Many cities are moving toward more compact, transit friendly development. Specifically when the focus of the development is the transit, the concept is considered transit friendly and termed transit supportive or transit oriented development. Typically rail stations or transit centers spawn medium to high density mixed-use developments, designed to promote walking, transit and bicycling in those areas.. It is common for cities to revise codes and guidelines to encourage transit friendly development. The City of Houston's development, public infrastructure and built environment are guided by the Chapter 42 Subdivision, Developments, and Platting Ordinance. In 2009 the City of Houston added a Transit Corridor Ordinance, a code in Chapter 42 to encourage an urban environment that improves pedestrian mobility, supports METRO's light rail investment, and helps accommodate the City's anticipated growth. This research examines developer response to the Transit Corridor Ordinance and determines which parcels owners have chosen to undertake design of elements within this code. Other agency TOD efforts, various developer rail station projects and best practices of public and private joint developments are also explored.

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Item 4

Examining the Market Potential for Natural-Gas-Powered Trucks: Barriers and Opportunities for Promoting Environmental Sustainability and Economic Prosperity

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/14/600451-00078-1 • 2014

Over the past decade, public concerns have grown over America's energy use and production. Pushes towards more environmentally friendly and sustainable sources of energy have moved out of fringe politics and into mainstream political discourse. Advances in drilling technology and increased exploration of shale gas plays have made natural gas more available and accessible. The abundance of natural gas has led to its growing role in the U.S. electric production and has provided the United States with an opportunity to become a net exporter of energy in the near future. The availability of natural gas, coupled with uncertainty in the liquid petroleum market, has prompted stakeholders to search out additional uses for this low-cost energy source. The result has been a large-scale effort to encourage the use of natural gas-based fuel within the trucking industry. Commercial long-haul trucks and truck fleets are a prime target of these efforts. The number of natural gas fueling stations around the country is increasing, and there are growing investments in new technologies and government incentives to retrofit and upgrade the nation's trucking fleet, making the logistics of a large-scale switch from a liquid petroleum-based fuel to natural gas much less complicated. Through a detailed analysis of natural gas trucks, fueling infrastructure, and case studies, this report seeks to reach conclusions over the role natural gas vehicles (NGVs) should play in the future U.S. transportation system.

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Item 5

Fatigue and Fracture Properties of Aged Binders in the Context of Reclaimed Asphalt Mixes

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/14/600451-00076-1 • 2014

Evidence in the literature indicates that the stiffness of the asphalt binder increases and ductility of the binder decreases with oxidative aging. Typically for unmodified asphalt binders, increase in stiffness or decrease in ductility is regarded as detrimental to the fatigue cracking or fracture resistance of the asphalt binder. However, fundamentally the stiffness of the binder and its strength are two different attributes that may not necessarily be related to each other. There is very little information in the literature that relates the fatigue cracking resistance or strength of the asphalt binder to the extent of oxidative aging. This information is not only important to assess the durability and cracking life of asphalt pavements but is also very important in the context of reclaimed asphalt pavements (RAP). The use of RAP not only educes the waste produced from milling and removing the asphalt pavement layers at the end of their service life, but also reduces the amount of asphalt required for the construction of new roadways. In an effort to improve sustainable practices associated with pavement constructions, state DOTs have been gradually increasing the allowable percentage of RAP in new asphalt mixtures over the last two decades. However, the asphalt binder in RAP is highly oxidized and is deemed to be susceptible to load related fatigue cracking. The focus of this study was to investigate the effect of asphalt binder oxidation on its fracture properties and fatigue cracking performance. To this end, fatigue cracking resistance of an asphalt binder was measured at different levels of aging using a standardized glass bead composite. The glass bead composite simulates the stress state that asphalt binders experience in the field, while it excludes aggregate-asphalt binder interactions. Furthermore, this research also investigated the effect of aging on fracture properties of an asphalt binder by conducting monotonic fracture tests using a poker chip test geometry. The findings from this study provide a better understanding of the effect of aging on the fracture and fatigue properties of asphaltic materials.

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Item 6

Next generation safety performance monitoring at signalized intersections using connected vehicle technology

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TTI SWUTC/14/161303-1 • 2014

Crash-based safety evaluation is often hampered by randomness, lack of timeliness, and rarity of crash occurrences. This is particularly the case for technology-driven safety improvement projects that are frequently updated or replaced by newer ones before it is possible to gather adequate crash data for a reliable and defensible before-after evaluation. Surrogate safety data are commonly used as an alternative to crash data; however, its current practice is still resource intensive and subject to human errors. The advent of connected vehicle technology allows vehicles to communicate with each other and infrastructure wirelessly. This platform also offers the opportunity for automated and continuous tracking of vehicle trajectories and signal status at the facilities in real time. These types of data can potentially be extracted and used to detect the deficiencies in the safety performance of the facility operation.

This project examines the viability of long-term monitoring of connected vehicle data for safety performance evaluation. As limited saturation of onboard equipment (OBE) is expected in the near-term evolution, the study focuses on a connected vehicle application that can process data elements from OBEs via vehicle-to-infrastructure communications using standard message sets. To accomplish the objective, a signalized intersection test bed was created in VISSIM while the wireless communications capability and the application were implemented using Car-to-Everything Application Programming Interface. The evaluation results indicated that the application can effectively detect changes in safety performance at full market penetration. Sensitivity analysis showed that at least 40 percent penetration rate is desirable for reliable safety deficiency detection under light to moderate traffic volume conditions. The observation period can be extended to compensate for low sample size under low OBE market penetrations. The required observation periods vary with the types of safety indicators being collected and the levels of OBE saturation.

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Item 7

Nondestructive Test Methods for Rapid Assessment of Flexible Base Performance in Transportation Infrastructures: A Dissertation

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TTI SWUTC/14/600451-00035-1 • 2014

Well-built roads with longer service life and lesser life cycle cost are the key to meet the desired target of satisfying the public without compromising the quality of roads. Roads that are constructed and built with poor quality materials and inadequate design considerations frequently require costly maintenance and rehabilitation often resulting in detours and lane closures, which not just reduce the comfort of the public but also interrupt the efficient flow of transporting goods, and hence the associated businesses. Therefore, it is imperative that alternative quality control and quality assurance methods along with effective test methods and smart transportation planning must be considered and implemented to help communities increase the economic prosperity while retaining and ensuring a high quality of life to the people. The appropriate application of reliability to pavement design is essential to achieve the main objectives of designing quality pavements to serve the traveling public with comfort and safety while being durable in service at a minimum life cycle cost. The quality of the base layer of the pavement, which is located directly beneath the surface, is one of the most critical components in designing a pavement with increased service life and durability. The base layer is primarily composed of aggregates and contributes to the structural stability of the pavement system by providing load transfer and support. A base course with adequate thickness and built with high quality aggregates is essential to meet the necessary performance criteria and in doing so will cut down on reconstruction cycles and cost of maintenance. This research attempts to contribute in this regard by evaluating the significance of using the fundamental material properties to develop models which characterize the base layer in a pavement system. These new models will have significant contributions to soil mechanics and highway design procedures. This research and the developed models depend upon fundamental soil properties. This work capitalizes upon the fundamental properties to make extensive use of these models for quality control (QC) and quality assurance (QA), in the pre-design procedure and construction phase. The most significant impact of the work is to replace and improve current methods, increase work efficiency, minimize time spent in the laboratory, find more convenient relationships, reduce costs, and improve sustainability. In addition, the quickly and accurately measured aggregate characteristics of base courses will be used to determine the in-place and as-compacted design properties for QC and QA.

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Item 8

A Novel Approach to Modeling and Predicting Crash Frequency at Rural Intersections by Crash Type and Injury Severity Level

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/15/600451-00077-1 • 2015

Safety at intersections is of significant interest to transportation professionals due to the large number of possible conflicts that occur at those locations. In particular, rural intersections have been recognized as one of the most hazardous locations on roads. However, most models of crash frequency at rural intersections, and road segments in general, do not differentiate between crash type (such as angle, rear-end or sideswipe) and injury severity (such as fatal injury, non-fatal injury, possible injury or property damage only). Thus, there is a need to be able to identify the differential impacts of intersection-specific and other variables on crash types and severity levels. This report builds upon the work of Bhat et al. (2014) to formulate and apply a novel approach for the joint modeling of crash frequency and combinations of crash type and injury severity. The proposed framework explicitly links a count data model (to model crash frequency) with a discrete choice model (to model combinations of crash type and injury severity), and uses a multinomial probit kernel for the discrete choice model and introduces unobserved heterogeneity in both the crash frequency model and the discrete choice model. The results show that the type of traffic control and the number of entering roads are the most important determinants of crash counts and crash type/injury severity, and the results from our analysis underscore the value of our proposed model for data fit purposes as well as to accurately estimate variable effects.

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Item 9

Productivity-based Approach to Valuation of Transportation Infrastructure

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/14/600451-00089-1 • 2014

Transportation infrastructure, a vital component to sustain economic prosperity, represents the largest public-owned infrastructure asset in the U.S. With over a trillion invested dollars invested into long-lived physical assets such as roads and bridges, transportation agencies are tasked with maintenance and rehabilitation efforts to ensure that the access to transportation facilities is readily available and that the infrastructure is properly preserved. The management of these assets and the determination of their value, however, have been at the forefront of discussions in many state agencies and local governments. As a consequence, asset valuation has become a key component in asset management because it links the performance of infrastructure and deterioration process with the value of the infrastructure and its depreciation, providing critical information for decision makers at various levels to make more informed decisions. A utility-based methodological framework for the valuation of transportation infrastructure is presented along with a case study to demonstrate its applicability. A general framework is presented with emphasis on the valuation of pavement infrastructure. The results from the framework is then compared to existing valuation methods in addition to a series of sensitivity analysis on the variation of performance measures and their effect on the value of an asset. The development of this valuation approach serves as a starting point for assessing, in addition to the physical condition of an asset, the operational measures that can often make an asset less useful to its customers and managing agency. Utility theory can be utilized to combine the effect of performance indicators of varying measures and scales on the value of an asset. The proposed framework can assist state and local transportation agencies in the optimization of resource allocation procedures for better coordination of asset investments, facilitating benefit-cost analyses to quantify the impact of infrastructure investments. This tool allows agencies to detect deficiencies if any, in the management of its assets, providing a feedback mechanism that can foster an introspective review of its current management practices that may need further refinement or possibly elimination.

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Item 10

Regional decision-making and competitive funding: metropolitan planning organizations and the Transportation Investments Generating Economic Recovery program

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

U-NOLA SWUTC/14/600451-00106-1 • 2014

Transportation benefits and economic stimulus were behind the creation of the Transportation Investment Generating Economic Recovery (TIGER) program in 2009. New transportation funding programs exist in a landscape of other programs, and in addition extensive federal rules require that state-designated metropolitan planning organizations (MPOs) lead regional transportation planning and produce near and long-range plans. This report examines the potential for the TIGER program to conflict with these mandated planning processes. To learn about the connection between MPOs, their planning documents, and TIGER applications, the primary dataset for analysis was a survey of metropolitan planning organizations. The roles that MPOs and their planning documents played in TIGER application processes were highly varied. While some MPOs were local project sponsors and others advised or provided data, a sizable share of MPOs reported no role in the regional process to select projects for TIGER applications, despite federally mandated regional coordination and planning. MPO capacity appears to differ significantly and to affect the roles that MPOs play in regional processes. While there are already additional planning requirements for larger urbanized areas, further differentiation of roles and expectations for MPOs may be appropriate. New programs, especially those with short time lines, may obscure the process for joint decision making and complicate adherence to regional planning mandates. Results on MPO roles and the relationship between plans and candidate projects suggest that MPOs are not always the decision site as language in plans would suggest, but they can be an important site for convening stakeholders.

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Item 11

Use of Infrared Thermography to Detect Thermal Segregation in Asphalt Overlay and Reflective Cracking Potential

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

SWUTC/15/600451-00111-1 • 2015

The objectives of this study were to assess whether temperature differentials measured using Infrared Thermography (IRT) occur in an overlay built on top of discontinuities such as joints and cracks and to study the horizontal and vertical thermal profiles in the asphalt overlay using a validated Finite Element (FE) modeling approach. To achieve this objective, an infrared camera was used to monitor the temperature profiles in the asphalt mat in a number of field projects from the time it was placed to after completion of the compaction process. The temperature profiles were monitored on top and away of severe discontinuities and joints in the existing pavement. Results showed that thermal measurements on top of the joints were consistently lower than away from it, which may indicate that temperature loss may occur at the joints. Further, a validated FE model predicted a slightly higher rate of thermal loss at the bottom of the overlay above the joint than away from it due to convection losses at the joint. While this difference may not be large enough to be identified as thermal segregation, it can influence the bulk properties of the overlay at the joints and promote early cracking. Thermal differences were also observed in the vertical direction as lower temperatures were predicted at the top and the bottom of the overlay during construction due to convection losses with the ambient atmosphere and conduction between the hot overlay and the existing pavement.

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