Research Digest

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Southwest Region University Transportation Center (SWUTC)

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Research Digest

Item 1

Balanced RAP/RAS Mix Design and Performance Evaluation System for Project-Specific Service Conditions

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

TTI SWUTC/13/0-6092-3 • 2013

The use of reclaimed asphalt pavement (RAP) and recycled asphalt shingles (RAS) can significantly reduce the increasing cost of hot-mix asphalt paving, conserve energy, and protect the environment. However, the premature cracking problem has been a serious concern. This report presents the latest work on RAP/RAS mix design and performance analysis including field performance of a variety of RAP/RAS test sections around Texas, and the proposed RAP/RAS mix design and performance evaluation system for project-specific service conditions. RAP/RAS mixes can have better or similar performance than virgin mixes if they are well designed with balancing both rutting/moisture damage and cracking requirements. Cracking performance of RAP/RAS mixes is influenced by many factors, such as traffic, climate, existing pavement conditions for asphalt overlays, and pavement structure and layer thickness. It is obvious that a single cracking requirement does not apply to all asphalt overlay applications. Instead, a project-specific service conditions based mix design system should be developed. Based on the relationship between Overlay Test (OT) cycles and fracture properties (A and n) established under this study, a balanced RAP/RAS mix design and performance evaluation system for project-specific service conditions is proposed, and it includes a balanced mix design procedure and a performance evaluation system in which the Hamburg wheel tracking test and associated criteria are used to control rutting/moisture damage and the OT, and the required OT cycles determined from S-TxACOL cracking prediction with consideration of climate, traffic, pavement structure and existing pavement conditions. Additionally, the impacts of soft binder on engineering properties of RAP/RAS mixes in terms of dynamic modulus, HWTT rut depth, and OT cycles are investigated. The test results clearly indicated that the use of soft and modified asphalt binder (i.e., PG xx-28, PG xx-34) can effectively improve cracking resistance of RAP/RAS mixes without sacrificing much rutting/moisture damage resistance. Dynamic modulus is not a good indicator as cracking resistance of RAP/RAS mixes. Researchers highly recommend that the proposed RAP/RAS mix design and performance evaluation system for project-specific service conditions be implemented statewide.

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- Chapter 2. Field Performance of RAP/RAS Test Sections
- Chapter 3. Balanced RAP/RAS Mix Design and Performance Evaluation System for Project-Specific Service Conditions
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- Chapter 5. Summary and Conclusions
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- Appendix A. Rap Quality, Processing, and Construction Draft Specification
- Appendix B. Balanced Mix Design Procedure for HMA Mixes Using High Rap
- Appendix C. Pavement Type Selection Guidelines for the Use of High RAP Mixes
- Appendix D. Guidelines for the Use of High RAP in HMA Mixes

This report is available for free download (3.3 MB):
http://swutc.tamu.edu/publications/technicalreports/0-6092-3.pdf

Research Digest

Item 2

Compendium of Student Papers: 2012 Undergraduate Transportation Scholars Program
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/13/600451-00003-1 • 2013

This report is a compilation of research papers written by students participating in the 2012 Undergraduate Transportation Scholars Program. The 10-week summer program, now in its 22nd year, provides undergraduate students in Civil Engineering the opportunity to learn about transportation engineering through participating in sponsored transportation research projects. The program design allows students to interact directly with a Texas A&M University faculty member or Texas A&M Transportation Institute researcher in developing a research proposal, conducting valid research, and documenting the research results through oral presentations and research papers. The papers in this compendium report on the following topics: 1) Analysis of Factors Influencing Run-off Road Crashes on Horizontal Curves; and 2) Impact of Nighttime Work Zone Lighting on Motorists' Detection of Objects.

CONTENTS
  • Analysis of Factors Influencing Run-off Road Crashes on Horizontal Curves / Amelia Celoza
  • Impact of Nighttime Work Zone Lighting on Motorists' Detection of Objects / Kayla Weimert

This report is available for free download (2.1 MB):
http://swutc.tamu.edu/publications/technicalreports/compendiums/600451-00003-1.pdf

Item 3

Comprehensive Characterization of Asphalt Mixtures in Compression
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/13/600451-00006-1 • 2013

Permanent deformation (i.e., rutting) is one of the major distresses in asphalt pavements, and it consists of irrecoverable deformation due to viscoplastic flow and viscofracture fatigue damage. The mechanisms of rutting have not been well addressed due to the complexities of asphalt mixture including (a) distinctions between compression, extension, and tension; (b) rate and temperature dependence; (c) dilative volumetric change; (d) frictional material with cohesion; (e) inherent anisotropy due to preferential aggregates' orientation; (f) crack-induced anisotropy due to crack growth; (g) strain hardening during viscoplastic accumulation; and (h) strain softening during viscofracture evolution. In this project, all of the aforementioned fundamentals of asphalt mixtures were simultaneously characterized by a comprehensive viscoplastic-fracture mechanistic model, which was incorporated with (a) a modified effective stress to consider the inherent anisotropy and the crack-induced anisotropy due to viscofracture cracking in compression; (b) a smooth and convex Generalized Drucker-Prager (GD-P) yield surface; (c) a non-associated viscoplastic flow rule; (d) a rate- and temperature-dependent strain hardening rule; and (e) a viscofracture evolution that was modeled by an anisotropic damage density-based pseudo J-integral Paris' law. The model parameters were related to fundamental material properties that were measurable and understandable for civil engineers. A systemic testing protocol including five individual test methods were proposed to determine the model parameters and material properties. The test protocol was demonstrated to be efficient, as one asphalt mixture could be completely characterized within 1 day. The GD-P yield surface model was validated by octahedral shear strength tests at different normal and confining stresses. The GD-P model was able to characterize the full range of the internal friction angles from 0 to 90 degrees. In contrast, the widely used Extended Drucker-Prager (ED-P) model can only be used for a material that has an internal friction angle less than 22 degrees due to the convexity criterion of the yield surface.

This report is available for free download (2.9 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00006-1.pdf

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Item 4

Cycling in the African American Community: Safety Training Guidelines and Findings

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/13/600451-00070-1 • 2013

This report is a program user's manual for the Cycling in the African American Community (CAAC) safety training intervention. The CAAC safety training intervention was designed to "nudge" more African Americans, who are often beginning cyclists or non-cyclists, to participate in a physical activity that promotes health and builds community. One of the most cited reasons for not riding is that cycling is perceived as being unsafe. The CAAC intervention attempts to address this issue through a carefully designed safety intervention that encompasses a pre and post survey, used in conjunction with an on-road cycling curriculum. The report includes best practices for staging the intervention and analyzing outcomes. Preliminary findings show that the safety training is significantly improving perceptions of cycling.

CONTENTS
  • Introduction
  • Step 1. Recruiting Participants
  • Step 2. Staging the Intervention
  • Step 3. Analyzing the Data
  • Step 4. Follow-Up

This report is available for free download (1.7 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00070-1.pdf

Item 5

Development of an Interactive GIS Based Work Zone Traffic Control Tool

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/13/600451-00069-1 • 2013

The purpose of this study was to include consideration for intersections into the previously created GIS traffic control planning tool. Available data for making intersection control calculations were collected and integrated into the design of the tool. The limitations created by required assumptions were addressed, as well as more advanced techniques for overcoming these problems. The tool can be used to estimate capacity calculations at any signalized intersection within the NCTCOG modeling region. These calculations can be used to inform users about the effects of a construction plan. Inputs for using dynamic traffic assignment to further understand these effects is then addressed, focusing on the development of a subnetwork to reduce computation time for multiple temporary traffic control plans.

This report is available for free download (4.3 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00069-1.pdf

Item 6

Electric Vehicles and Public Charging Infrastructure: Impediments and Opportunities for Success in the United States

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/13/600451-00064-1 • 2013

This report seeks to reach conclusions over the role that electric vehicles (EVs) and public charging infrastructure should play in the future U.S. transportation system As demonstrated in this report, electric vehicles are neither new nor technologically infeasible. Current circumstances have initiated what appears to be a revival of the EV – these circumstances include high oil prices, geopolitical instability, and growing awareness of environmental concerns resulting from conventional vehicles (CV) usage. Nevertheless, impediments remain. One of the most important is the prospect of building public charging infrastructure to allow drivers to use an EV like their conventional vehicle, for both long and short distances. Public charging infrastructure, however, cannot be built without some critical mass of EVs on the road to use them – otherwise they are not economically feasible. This report analyzes various facets of both EVs and public charging infrastructure to give the reader a clear understanding of the complex criteria that must be understood to assess EVs in the United States. Texas is given special consideration as a case study in this report, particularly the Austin area where public charging infrastructure for EVs is currently being implemented.

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- Chapter 1. Introduction
- Chapter 2. United States Transportation Sector
- Chapter 3. Electric Vehicles
- Chapter 4. Overview of Electric Vehicle Charging Stations
- Chapter 5. Public Policy Environment--Electric Vehicles and Charging Infrastructure
- Chapter 6. Case Study: Austin Energy
- Chapter 7. Conclusions
- References

This report is available for free download (1.8 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00064-1.pdf

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Item 7

Equity Evaluation of Sustainable Mileage Based User Fee Scenarios

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/14/600451-00007-1 • 2013

The Texas state gas tax has been 20 cents per gallon since 1991, and the federal gas tax has been 18.4 cents per gallon since 1993. The gas tax is not only stagnant, but depreciating in value due to inflation. This is forcing some transportation providers to increase their focus on spending for a more sustainable transportation system, thus shifting how tax revenues are spent. One proposed alternative to the gas tax is the creation of a mileage-based user fee (MBUF), which would then shift how revenues are collected. This research examined potential equity impacts of these shifts in the collection and disbursement of transportation funds. This research used 2009 National Household Travel Survey (NHTS) Texas data along with detailed spending estimates from the Texas Department of Transportation to consider the equity impacts surrounding three MBUF and spending scenarios. NHTS data were weighted to reflect results representative of Texas vehicle-owning households. Each scenario was run both statically and dynamically under the assumption that the MBUF would replace the state gas tax. Results indicate that the impact of the MBUF on geographic equity can be different depending on allocation of transportation funding. However, the MBUF was essentially as equally vertically equitable as the current state gas tax.

This report is available for free download (1.8 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00007-1.pdf

Item 8

An Evaluation of the Effectiveness of Voice-to-Text Programs at Reducing Incidences of Distracted Driving
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/13/600451-00011-1 • 2013

Text messaging is no longer limited to manual-entry. There are several mobile applications that aim to assist the driver in sending and receiving text messages by incorporating a voice-to-text component. To date, there has been no published research that evaluates the impact of voice-to-text mobile applications on driver behavior and safety. To address this issue, 43 participants drove an instrumented vehicle on a closed course for a baseline as well as three texting conditions: manual-entry, using Siri, and using Vlingo. Results indicate that driver reaction times were nearly two times slower than the baseline condition, no matter which texting method was used. Eye gazes to the forward roadway also significantly decreased compared to baseline, no matter which texting method was used. Additionally, it took drivers longer to complete the same texting task using the voice-to-text applications than it did when texting manually, though Siri produced the fewest errors. Self-assessment feedback revealed that participants felt less safe using any of the three texting methods compared to the baseline, but felt safer using either voice-to-text application than when manually texting. These results have immediate implications for improving our understanding of the dangers of texting while driving and the potential safety improvements of using voice-to-text options.

This report is available for free download (3.4 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00011-1.pdf

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Item 9

Future Mobility Demand in Megaregions: A National Study with a Focus on the Gulf Coast
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
CTR SWUTC /13/ 600451-00074 -1 • 2013

About three fourth of national population and wealth are concentered in the 11 megaregional areas that occupy one fourth of the land areas in the US. NHTS reveal that megaregions also concentrate current and future mobility demand. This report presents an approach that utilizes aggregate data for mobility study (for both passenger and freight) in a megaregional scale through a case study of the Gulf Coast megaregion (GCM). GCM exhibits unique travel characteristics relative to the national trend. A preliminary analysis on freight flow was also conducted for the GCM areas utilizing the 2002 and 2007 Commodity Flow Survey (CFS) data. The study shows that the GCM area would experience an enormous amount of mobility growth by year 2050. The per capita traffic volume generated by each traveler in 2050 would double the 2010 level. The total traffic volume in 2050 would grow much faster, four times higher than in 2010. Freight demand in the GCM area is also fast growing. The projected trends of future travel demand indicate a growing pressure on the transportation infrastructure in GCM. It is unlikely that the demand for high-speed travel can all be met by air travel. Accordingly, planning for megaregional transportation should seriously consider high-speed travel in the form of High Speed Rail (HSR) to accommodate the future travel demand in the GCM area.

This report is available for free download (1.6 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00074-1.pdf

Research Digest

Item 10

Investigation of Improvements to Truck Volume Assignments and Public Transportation Benefits Methodologies in TTI's Urban Mobility Report

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TTI SWUTC/13/600451-00013-1 • 2013

The Texas A&M Transportation Institute's (TTI's) often-cited Urban Mobility Report (UMR) provides transportation decision-makers with urban-area congestion statistics and trends. Data and their availability have continued to evolve rapidly over the years that this report has been produced, and TTI researchers have updated the UMR methodology as new data sources and information become available.

The objectives of this project were to (a) investigate the UMR methodology assumptions related to the daily volume distributions for trucks and possible methodology improvements, and (b) investigate the UMR methodology related to the benefits of transit ridership and transit delay reduction calculations and possible methodology improvements.

To satisfy the first objective, TTI researchers collected vehicle classification data from Georgia, Texas, Washington, and Colorado. While there were only 36 sites used to investigate potentially new truck distribution graphs, the results indicate that trucks have a different time-of-day distribution than a distribution created from all vehicles together. Because the sample size of these findings is relatively low, researchers hope to investigate these findings on larger samples prior to making methodological changes in the UMR. To satisfy the second objective, TTI researchers collaborated with public transit experts at the University of South Florida, Center for Urban Transportation Research. Chapter 4 provides several proposed methodological improvements to the transit benefits methodology for the 2013 UMR, including (a) explicitly accounting for the miles traveled by roadway-based transit vehicles operating in mixed traffic conditions, and (b) more accurately accounting for the potential shift to private passenger vehicles in a post-transit environment by transit riders for the passenger miles they have actually traveled by transit. Researchers plan to incorporate these proposed changes into the 2013 UMR. Chapter 4 also documents future improvement opportunities for the short term and long term.

This report is available for free download (2.7 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00013-1.pdf

Item 11

Life-cycle Energy Implications of Different Residential Settings: Recognizing Buildings, Travel, and Public Infrastructure
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
CTR SWUTC/13/600451-00067-1 • 2013

The built environment can be used to influence travel demand, but very few studies consider the relative energy savings of such policies in context of a complex urban system. This analysis quantifies the day-to-day and embodied energy consumption of four different neighborhoods in Austin, Texas, to examine how built environment variations influence various sources of urban energy consumption. A microsimulation combines models for petroleum use (from driving) and residential and commercial power and natural gas use with rigorously measured building stock and infrastructure materials quantities (to arrive at embodied energy). Results indicate that the more suburban neighborhoods, with mostly detached single-family homes, consume up to 320% more embodied energy, 150% more operational energy, and about 160% more total life-cycle energy (per capita) than a densely developed neighborhood with mostly low-rise-apartments and duplexes. Across all neighborhoods, operational energy use comprised 83 to 92% of total energy use, and transportation sources (including personal vehicles and transit, plus street, parking structure, and sidewalk infrastructure) made up 44 to 47% of the life-cycle energy demands tallied. Energy elasticity calculations across the neighborhoods suggest that increased population density and reduced residential unit size offer greatest life-cycle energy savings per capita, by reducing both operational demands from driving and home energy use, and from less embodied energy from construction. The results support the notion that transportation and the built environment are strongly linked, and improving urban energy efficiency must come from policies and designs targeting embodied sources, not just a household's travel and daily energy consumption.

This report is available for free download (816 KB):
http://swutc.tamu.edu/publications/technicalreports/600451-00067-1.pdf

Item 12

Methodology for Developing Performance-related Specifications for Pavement Preservation Treatments: A Dissertation
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/13/600451-00022-1 • 2013

Current materials and construction specifications for pavement preservation treatments are predominantly prescriptive and they have little or no methodical linkage between initial treatment quality and future performance. There is an imperative need for performance-related specifications (PRS) that link the initial quality of pavement preservation treatments to their long-term performance and life-cycle costs so that rational pay adjustment and acceptance decisions can be made. However, the current literature lacks a methodology for developing PRS for pavement preservation treatments. The aim of this research is to fill this gap in the literature, with focus on thin HMA overlays. In this dissertation, a novel approach was devised for developing performance prediction models for pavements that received preservation treatments. In this approach, the model consists of two tightly-coupled components: the first component is responsible for predicting the performance (e.g., IRI) of the existing pavement if no treatment was applied. The second component is responsible for predicting the reduction in pavement deterioration due to the application of the treatment. Inputs to the first component include material and construction properties of the existing pavement layers, climatic conditions, and traffic factors. Inputs to the second component include the treatment's acceptance quality characteristics (AQCs), climatic conditions, and traffic factors. The artificial neural networks (ANNs) and the Bayesian regression methods were used for developing the two model components. Using this approach, a model was developed for predicting the International Roughness Index (IRI) of flexible pavement treated with thin HMA overlay. The data used for developing and testing this model was obtained from the Long-Term Pavement Performance (LTPP) database. Artificial neural networks (ANNs) and Bayesian regression techniques were employed for developing the first and second components of this model, respectively. A PRS methodology was developed for quantifying the difference between the initial quality levels of as-constructed and as-designed treatments. This methodology consists of a novel approach for determining the probability distributions of service life and present-worth value (PWV). This approach allows for transforming the probabilistic distribution of future IRI (predicted by the Bayesian model) into probability distributions for service life and PWV. Pay factors are then estimated based on the difference between the as-constructed and target PWVs. Finally, this dissertation provides insights into the relationships between initial quality (measured in terms of both mean and standard deviation of key acceptance quality characteristics) and expected pay factors through analysis of real world case studies of asphalt pavements treated with thin HMA overlays.

This report is available for free download (4.7 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00022-1.pdf

Item 13

New Spatial Multiple Discrete-Continuous Modeling Approach to Land Use Change Analysis

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
CTR SWUTC/13/600451-00063-1 • 2013

This report formulates a multiple discrete-continuous probit (MDCP) land-use model within a spatially explicit economic structural framework for land-use change decisions. The spatial MDCP model is capable of predicting both the type and intensity of urban development patterns over large geographic areas, while also explicitly acknowledging geographic proximity-based spatial dependencies in these patterns. At a methodological level, the report focuses on specifying and estimating a spatial MDCP model that allows the dependent variable to exist in multiple discrete states with an intensity associated with each discrete state. The formulation also accommodates spatial dependencies, as well as spatial heterogeneity and heteroscedasticity, in the dependent variable, and should be applicable in a wide variety of fields where social and spatial dependencies between decision agents (or observation units) lead to spillover effects in multiple discrete-continuous choices (or states). A simulation exercise is undertaken to evaluate the ability of the proposed maximum approximate composite marginal likelihood (MACML) approach to recover parameters from a cross-sectional spatial MDCP model. The results show that the MACML approach does well in recovering parameters. An empirical demonstration of the approach is undertaken using the city of Austin parcel level land use data.

This report is available for free download (1.9 MB):
http://swutc.tamu.edu/publications/technicalreports/600451-00063-1.pdf

Item 14

Performance Analysis Of Isolated Intersection Traffic Signals: A Dissertation
SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)
TTI SWUTC/13/600451-00021-1 • 2013

This dissertation analyzes two unsolved problems to fulfill the gap in the literature: (1). What is the vehicle delay and intersection capacity considering left-turn traffic at a pre-timed signal? (2). What are the mean and variance of delay to vehicles at a vehicle-actuated signal? The first part of this research evaluates the intersection performance in terms of capacity and delay at an isolated pre-timed signal intersection. Despite of a large body of literature on pre-timed signals, few studies have examined the interactions between left-turn and through vehicles. In order to examine this missing part of study on the signalized intersection, two probabilistic models are proposed to deal with the left-turn bay blockage and queue spillback in a heuristic manner. The second part of this research studies an isolated intersection with vehicle-actuated signal. The actuated system dynamically allocates the green time among multiple approaches according to vehicle arrivals. We develop a model to study the vehicle delay under a general arrival distribution with a given unit extension. The model allows optimizing the signal performance over the unit extension. The third part of this research applies graphical methods and diffusion approximations to the traffic signal problems. We reinterpret a graphical method originally proposed by Newell in order to directly measure the variance of the time for the queue clearance at a signalized intersection. Furthermore, we investigate the problems of disruptions occurred during a pretimed traffic signal cycle. By diffusion approximation, we provide the quantitative estimation of the duration that the effects of disruptions dissipate.

This report is available for free download (Webpage with link to PDF):
http://swutc.tamu.edu/2013/10/21/600451-00021-1/

Item 15

Simulation of Investment Returns of Toll Projects

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

CTR SWUTC/13/600451-00075-1 • 2013

This research develops a methodological framework to illustrate key stages in applying the simulation of investment returns of toll projects, acting as an example process of helping agencies conduct numerical risk analysis by taking certain uncertainties associated with toll projects into consideration. The numerical financial model provides a deterministic financial evaluation for the project. Next, there are four risk sources identified in this research, including project-based risks, cost-based risks, toll-based risks and finance-based risks. For each risk source, critical variables are recognized and probability distributions are suggested. The deterministic financial evaluation result is obtained through the projected single-value estimates of these variables. By considering the variability associated with the components of a project, the Monte Carlo simulation technique is used to estimate the overall project risks. Risk simulation results are interpreted through various numerical measures of project's risks, which further provide agencies with quantitative information to set investment decision criteria. For risk optimization, exploration of optimal value-combination of variables and utilization of single-variable control method are discussed, which could assist agencies in setting threshold toll prices in order to achieve the goal revenue and maximize potential returns on the investment. The risk analysis, consisting of risk simulation and risk optimization, can give the statistical distribution of investment returns for a project under analysis, providing decision makers with a direct approach to the evaluation of the projects' financial risks and the development of recommendations for risk control measures.

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Item 16

Transportation Security Institute: Recruiting Next Generation Professionals

SOUTHWEST REGION UNIVERSITY TRANSPORTATION CENTER (SWUTC)

TSU SWUTC/13/161340-1 • 2013

The Center for Transportation Training and Research (CTTR), as part of Texas Southern University (TSU), served as host for the 2013 Transportation Security Institute (TSI) in Houston and surrounding area. The 2013 Houston TSI focuses on the mission and objectives of transportation security professionals and introduces a pre-selected group of high school students to the various career opportunities within the profession. TSI provides a curriculum framework that exposes high school students to the transportation security industry via hands-on technical activities, field trips to transportation facilities, lectures by transportation professionals, and on-site seminars. Furthermore, the primary goal of TSI is to introduce exemplary secondary school students to various career opportunities in transportation security. Secondly, industry professionals will reinforce the importance of mathematics, science, and technology skills in the twenty-first century. Lastly, students will observe how public/private partnerships work to strengthen the link between today's students and future transportation security professionals.

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http://swutc.tamu.edu/publications/technicalreports/161340-1.pdf