TEXAS TRANSPORTATION INSTITUTE
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Project Summary Report 0-4756-S
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Project 0-4756: Identify Pavement Related Issues for High Speed Corridors

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PROJECT SUMMARY REPORT

Synthesis of Pavement Issues Related to High-Speed Corridors: Summary Report

The Trans Texas Corridor (TTC) (Figure 1) will be a multi-modal transportation system that includes separate lanes for passenger vehicles and trucks, high-speed passenger rail, commuter and freight rail, and a dedicated utility zone for water, petroleum pipelines, electricity, and data. The futuristic concept of the TTC is to intra-connect Texas by a 4200-mile network of corridors up to 1200 feet wide with separate lanes for passenger vehicles (three in each direction) and trucks (two in each direction) (Figure 2).

The corridor will include six rail lines (three in each direction): one for high-speed passenger rail between cities, one for high-speed freight, and one for conventional commuter and freight. The third component of the corridor will be a 200-foot wide dedicated utility zone. The estimated total cost for the TTC ranges from $145 billion to $184 billion. The TTC is the largest engineering project ever proposed for Texas. It is a world-class concept.

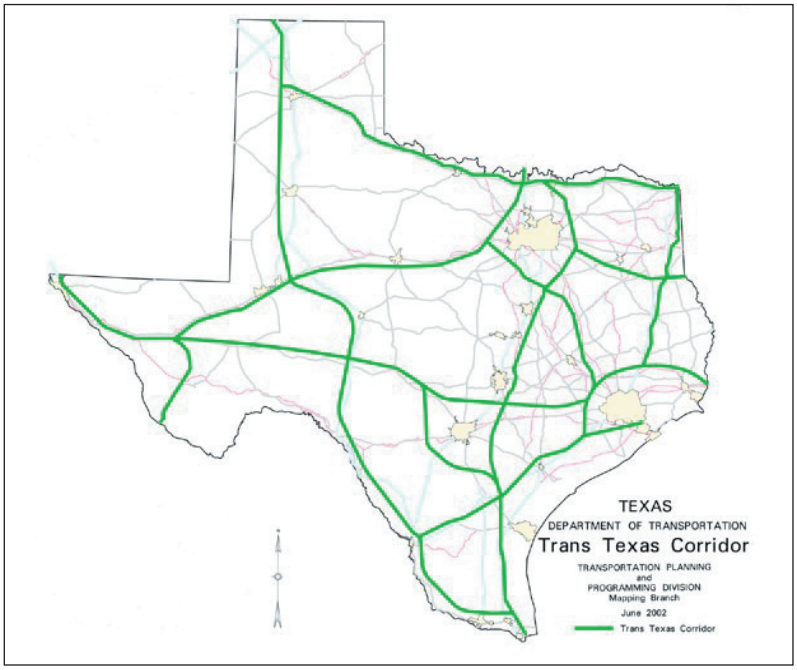

Figure 1. Planned Locations for Trans Texas Corridor (After TxDOT, "Crossroads of the Americas: Trans Texas Corridor Plan—Report Summary," Austin, Texas, June 2002) (http://www.dot.state.tx.us/ttc/ttc_report_summary.pdf).

What We Did...

The objective of this research project was to prepare a synthesis of available worldwide information to support specific areas related to pavements for the safe, economical development of the TTC. The complete synthesis is divided into nine sections:

- pavement design for heavy vehicles,
- pavement design for light vehicles,
- skid resistance issues on high-speed corridors,
- issues related to traffic characterization,
- smart pavements for high-speed corridors,
- pavement material response to dynamic loads and performance prediction,
- safety issues related to splash and spray,
- ride quality for high-speed corridors, and
- miscellaneous pavement-related issues.

The synthesis recommends state-of-the-art technology to the Texas Department of Transportation (TxDOT) for use during development of the TTC

Figure 2. Conceptual Image of the Trans Texas Corridor (After TxDOT, "Crossroads of the Americas: Trans Texas Corridor Plan—Report Summary," Austin, Texas, June 2002) (http://www.dot.state.tx.us/ttc/ttc_report_summary.pdf).

and recommends research to support elements of the TTC.

What We Found…

In general, TxDOT, through its robust research programs, stays reasonably current with national research findings. The researchers identified some potential solutions to address issues related to the TTC and described them near the end of each section in the synthesis (Report 0-4756-1). Since the synthesis is quite lengthy and covers several different subjects, only a few selected solutions are highlighted here.

TxDOT should examine the findings of the recently completed European studies COST 333 and its continuation project called AMADEUS. Findings from these studies may offer valuable information related to design methods for truck-only pavements for the TTC. In addition, TxDOT should examine design procedures used for runways and aprons that carry heavy aircraft and those used for design of industrial pavements at intermodal container terminals, as these may have application for design of truck-only pavements in the TTC.

The Federal Highway Administration (FHWA) sponsored development of a software analysis tool that can evaluate the relative performance benefits and costs associated with adding different design features to a Portland cement concrete (PCC) pavement design. Various design features (e.g., dowel bars, tied shoulders, and drainable bases) may be added to a PCC pavement design to improve its overall performance by maintaining a higher level of serviceability or by extending its service life. The effects of adding more design features to a PCC pavement design may produce smaller performance gains while significantly increasing the overall costs of the structure. Current design practices do not always consider this trade-off when design features are added to a PCC pavement design.

Since all pavements are designed to carry the heavy loads and the passenger car/light trucks are considered inconsequential, design of pavements for light vehicles may offer the most innovation. Engineers should develop an atypical philosophy for designing and building highway pavements for light vehicles. Mixture design should be integrated with pavement design. That is, because of the relatively light loads, hot-mix asphalt could be designed with higher asphalt contents and possibly lower grades of asphalt and still resist rutting and, further, be more resistant to moisture damage, cracking (fatigue and thermal), and oxidative aging. Expensive modified binders are not likely to be needed. With no trucks, one may expect less densification of the mat following construction; therefore, one should require higher densities at construction for these types of pavements.

Pavement for light vehicles is the logical place to use lower-quality local construction materials, recycled materials, and industrial byproducts and save the higher-quality and more expensive materials for the truck-only lanes. Sand asphalt can provide a highly workable mixture and a smooth, quiet pavement surface with low permeability. Its disadvantage might be wet weather skid resistance on a high-speed corridor; however, well-designed sand-asphalt mixtures might provide adequate service in certain dry climates of western Texas.

For high-traffic corridors, engineers often avoid seal coats for pavement preservation and skid resistance restoration due to the potential for flushing during hot weather. For light-traffic pavements, seal coats may serve quite well.

Highway signs to indicate reduced speed limits when roads are wet can reduce the liability of the state for wet weather accidents on state-maintained highways. Fixed warning signs for temporary hazards have demonstrated poor effectiveness; slight improvement may be obtained by posting an advisory speed. Variable signs controlled by automatic sensors that display a warning and/or speed restriction only when the pavement is wet should be better.

Exposed-aggregate concrete is providing very good skid resistance with significant noise reductions on European motorways.

The Researchers Recommend…

Research needs related to the TTC are merely highlighted here. Significantly more recommendations

and details for the specific areas are provided in the synthesis (Report 0-4756-1).

Truck-Only Pavements

Specific research areas should include:

- quality control and assurance to include state-of-the-art nondestructive testing;
- laboratory and nondestructive field test procedures to predict performance;
- continued research on new materials specifications;
- new construction methods; and
- accelerated pavement testing to evaluate performance when utilizing new specifications, verify pavement designs, and verify and calibrate models.

Light-Vehicle Pavements

Develop a completely new design strategy for light-vehicle pavements. Adopt a new philosophy for development of structural design procedures, mixture design procedures, materials selection guidelines, materials test methods and criteria, and construction specifications to optimize performance and cost-effectiveness.

Skid Resistance

Laser-based systems offer significant promise for estimating skid resistance at atypical high speeds. To apply TxDOT's current laser-based system to high-speed corridors, additional research will be required. Research should examine the suitability of some of the new pavement surfaces, adequacy of current test methods for measuring skid resistance, physical properties of coarse aggregates, and related aggregate specifications.

Traffic Characterization

Research is needed to determine the effects of heavy, high-speed trucks on state-of-the-art traffic characterization devices to be used on the TTC. It should focus on same-vehicle repeatability, vehicle calibration, and axle response/stability.

Smart Pavements

Research is needed to conduct field evaluations of the most promising "smart" materials, devices, and systems with particular emphasis on unique elements of the TTC. Smart systems will have particular value in remote areas where urgent conditions can be rapidly detected and transmitted to a central control group. Technology is available to automatically detect overloaded trucks, trigger mechanisms to capture their license plate numbers, and transmit the data to enforcement officials; however, operational capabilities and legal issues need to be studied.

Response to Loads and Performance Prediction

A major coordinated national research effort is assembling and developing extensive information related to pavement responses to loads and environmental conditioning and prediction of pavement performance. These studies include the following NCHRP projects: 1-37A(01), 1-39, 1-40, 1-40A, 1-40B, 1-41, 9-19, 9-22, 9-23, 9-29, and 9-30.

Future TTC research should examine the concept of post-tensioned continuously reinforced concrete pavement design. This process could provide practical construction of thinner concrete pavement with no concern about longitudinal joint separation and minimal concern about load transfer at the transverse cracks.

Splash and Spray

Justification for installing permeable friction course (PFC) pavements needs to be investigated. If noise is not an issue, the additional cost of installing and maintaining PFC in areas with low annual rainfall rates may not be justified merely to address splash and spray and wet friction. In remote western Texas where the population and annual rainfall rates are low, high texture may be the most logical solution to address the issues related to wet pavements.

The Texas Transportation Code states: "A vehicle shall display each required lighted lamp and illuminating device on the vehicle: (1) at nighttime; and (2) when light is insufficient or atmospheric conditions are unfavorable so that a person or vehicle on the highway is not clearly discernible at a distance of 1000 feet ahead." Neither drivers nor police officers can accurately determine a distance of 1000 feet with the unaided eye. Therefore, the law can be neither heeded nor enforced. To increase safety during rainfall and provide an understandable and enforceable statute, the Texas State Legislature should revise the code to state: "…a vehicle shall display lighted headlamps whenever the windshield wipers are in use due to rainfall." Incorporation of this wording into the code would not increase sight distance when driving through splash and spray, but it would improve conspicuousness of vehicles driving in splash and spray, particularly during daylight hours.

Ride Quality

TxDOT is leading the state of the art in specifying and measuring pavement smoothness and has an ongoing research program. Nevertheless, a national group has recommended additional research on improved materials and techniques to assist transportation agencies in providing the public with smoother roads and highways. Additional studies of pavement smoothness appear particularly appropriate for the TTC, which may permit speeds unprecedented in the United States.

Web-Based Training

Many distance-learning courses are available on the World Wide Web. These can be located by using key words with web browsers. Some are free, but most of the substantive courses are accessible only for a fee. A research agency could maintain a catalog of current information on available courses and their costs for TxDOT. These could be used to efficiently train individuals at their home stations.

For More Details...

The research is documented in Report 0-4756-1, *Synthesis of Pavement Issues Related to High-Speed Corridors*.

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