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TECHNICAL QUARTERLY

AN EXCHANGE OF IDEAS
Editor:
Kathleen M. Jones

TXMLS — IT'S YOUR MACHINE

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BACKGROUND

Remember the last major overlay or rehabilitation project you designed? Do you ever ponder if the final design was better than the other alternatives evaluated? Do you doubt the rehabilitated project will last as long as predicted? Do you wonder if the rehabilitation design methods you used were compatible or related to your project? If you have these concerns, you are not alone.

As engineers and technicians, we do our best measurements and calculations and follow the currently accepted design methodologies available. We investigate the history of the project site. We sample and test the existing site and the proposed new materials. We measure current traffic and predict future traffic. Often, we consider the effects of environment. Finally, we produce rehabilitation strategies, and from them, we choose the "better" one. Despite our greatest efforts, we still are limited by the tools and technology of our time.

Well, soon you will be able to sleep better at night knowing the design option you chose is the best of those investigated. You will also know that it will survive a certain number of predicted traffic loadings. You will know this with great confidence. Your confidence will not be in the use of some recommended method and strategy based on an outdated road test performed far from your site having entirely different soil and environmental conditions and extrapolated to apply to your project. Your confidence will be founded on

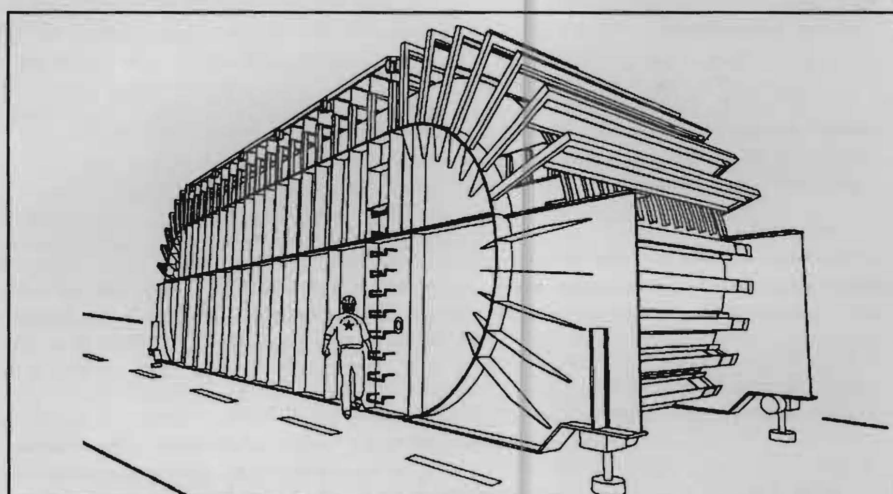

FIGURE 1: Texas Mobile Load Simulator (TxMLS) preliminary structural system.

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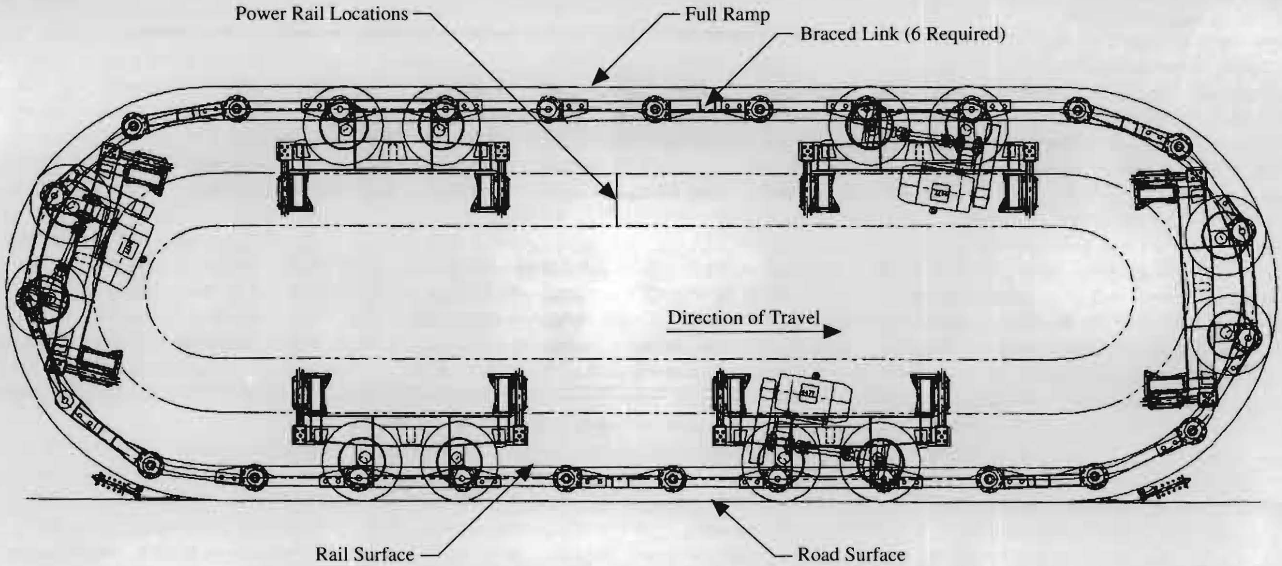

FIGURE 2: TxMLS bogie and chain arrangement.

cold, hard facts that you can see for yourself. This will all be made possible by a new testing machine (Fig. 1) called the *Texas Mobile Load Simulator* (TxMLS).

TxMLS DESIGN

The TxMLS will allow us to simulate 10 to 20 years of traffic and environment in a few weeks (on a farm-to-market road) to only a few months (on a major highway). The TxMLS will far exceed any existing accelerated testing facility, not only in speed of application of simulated traffic, but also in the tremendous array of variables and problems we can test for and evaluate due to the unique and advanced design of the TxMLS. The TxMLS will be used for both rigid and flexible pavements as well as short span bridge deck structures. In addition, the TxMLS will provide immediate relative evaluations of specially constructed test sections and new pavement materials and should prove to be a quantum leap in pavement engineering knowledge.

TxMLS Compared to Other Load Simulators

The TxMLS will be far advanced relative to any existing device of its kind (i.e., the HVS of South Africa and the ALF of Australia used by FHWA in the U.S.A.) in rate of traffic simulation as well as use of off-the-shelf truck components. The South African HVS applies 1,200 coverages per hour by traveling in both directions at a wheel speed of 8 mph. The Australian ALF applies 380 coverages per hour by traveling in one direction at a wheel speed of 12 mph. The TxMLS will apply approximately 10,500 coverages per hour by traveling in one direction at an approximate wheel speed of 20 mph. The HVS and ALF use only the off-the-shelf wheels and tires while all other components are custom fabricated. The TxMLS will use off-the-shelf wheels, tires, axles, axle drive train, suspension systems, and chassis rails as well as an off-the-shelf electric 200 Hp electric motor to power the axles (Fig. 2).

The TxMLS in Action

The TxMLS will be a transportable testing facility which applies full-scale, legal axle loads (or can apply up to 26 percent overload) with environmental interaction to a section of real pavement. The legal load will be applied by actual truck single, tandem, or tridem axle units. The weight will be applied to the axles from a load beam built into the structure of the TxMLS and will make use of the weight of the TxMLS structure to apply the load through the load beam. During the application of the simulated traffic, the pavement will be monitored and records of the pavement response to the traffic loads will be analyzed.

TxMLS Development

The TxMLS is currently being developed by the Center for Transportation Research (CTR) of The University of Texas at Austin in conjunction with the Pavement Management Section of the Division of Maintenance and Operations of the Texas Department of Transportation (D-18PM of TxDOT).

Dr. Fred Hugo, P.E., and Dr. B. Frank McCullough, P.E., are the CTR principal investigators on the project. Mike McNerney, a research engineer and Ph.D. student at CTR, was brought on board the project this October to assist Dr. Hugo. Mike Murphy and Jeff Jackson are the D-18PM representatives on the project. Design is expected to be completed by early spring 1992 and construction by mid to late fall 1992.

TxMLS LONG-RANGE TEST PLAN

Dr. McCullough and Dr. Hugo are currently directing Jeff Jackson and Mike Murphy in the development of a long-range plan for the implementation and use of the TxMLS.

The long-range test plan maximizes the usefulness of knowledge gained from each test by developing a matrix composed of test types representing the most critical areas of need for pavement design and rehabilitation information for the state. Key considerations for identifying test types will include (1) district needs, (2) coordination with on-going and completed pavement research projects, and (3) information required for use in the states' network and project level pavement management systems.

DISTRICT USE OF TxMLS

The ultimate goal of the TxMLS project is to build a machine which can provide fast answers to district pavement performance questions. In line with this goal, it is extremely important that each district work interactively with D-18 PM to identify specific pavement problem areas which could become candidate tests for the long-range test matrix. Jeff and Mike invite the districts to contact them personally to ask questions, give comments and discuss specific pavement problems which could be addressed by the TxMLS.

Some examples of the types of problems which could be addressed by the TxMLS include determination of the life expectancy (axle loads to failure) of new paving materials, pavement designs or construction techniques. These tests could be performed on specially constructed or in-service test sites in a district prior to a major rehabilitation project. Another possible use of the TxMLS is evaluating the remaining life of an existing pavement to aid in determining the most economical rehabilitation strategy.

A few examples of other types of tests which could be performed are (1) determination of the increase in rate of damage to different types of pavements due to overloaded trucks, (2) the effects of new axle configurations or tire designs on pavement performance (for example the impact of super-single (wide base) tires), and (3) calibration of existing pavement design models.

CONCLUSIONS

As with every project which the department undertakes, the key factors which ensure success are team work and a willingness to share ideas, knowledge and experience at all levels within the organization. The success of the TxMLS project will depend on input from many sources. These sources include district personnel experienced in the design and construction of pavements who are willing to share their knowledge and make recommendations on how the TxMLS can best be utilized, division personnel who will operate the TxMLS and analyze the data generated during testing, and university researchers whose specialized knowledge in pavement materials, design and construction will provide valuable knowledge and guidance which will aid in implementing the knowledge gained through testing.

Again, Jeff and Mike invite the districts to contact them at Tex-An 241-3684 (Jeff) or 241-3686 (Mike) or FAX 241-3681 with ideas, comments and suggestions on how best to utilize the TxMLS. Working together, we plan to make the TxMLS accelerated testing program the best in the world and an accomplishment that Texas can be proud of.

A new video and brochure of TxMLS are available on loan through the Research Library. Contact Ms. Dana Herring at (512) 465-7644 or Tex-An 241-7644 to request a copy.

TXDOT REAPS BENEFITS OF HIGHER EDUCATION

Jeff Jackson and Mike Murphy are in the interesting position of working for the department and pursuing department-sponsored Ph.D.'s at the same time. As in the department's Master of Science in Civil Engineering Graduate Program, the benefits are threefold: the candidates receive higher education; the university gets qualified researchers who understand department, particularly district, needs; and, in this case, the department gets two highly educated engineers who have been part of the design team of a sophisticated piece of equipment and who can deliver their expertise to others in the department. Their suitability for their dual role is shown by their biographies.

Jeff completed a bachelor's and master's degree in Civil Engineering at McNeese State University in Lake Charles, Louisiana, and worked for the Louisiana DOT for four years prior to coming to work for the department in the Waco District in 1989. Jeff worked in the Marlin Residency for one year prior to transferring to Austin to work in D-18 Pavement Management (PM) and is currently pursuing a Ph.D. in Civil Engineering at the University of Texas in conjunction with his work on the TxMLS project.

Mike completed a bachelor's and master's degree in Civil Engineering at Oklahoma State University and worked for the Oklahoma DOT in the Rural Roadway Design Section for eight years. He came on board with the department in 1983 and worked six and one-half years in the Wichita Falls District Design Office prior to transferring to the D-18PM Section in 1989. Mike is also pursuing a Ph.D. in Civil Engineering, specializing in pavement design.

Both Jeff and Mike currently perform structural evaluations of load-zoned roadways and work with districts, in conjunction with D-8 Pavement Design Section, in collecting and analyzing deflection and visual distress data to determine the causes for premature deterioration of a given pavement section or rehabilitation strategy.

For more information on the department's Master of Science in Civil Engineering Graduate Program, call Deborah Morris, P. E., Division of Human Resources (D-13), (512) 483-3623 or Tex-An 885-3623. For information on the General Education Assistance Program, call Mac McAdams, D-13, (512) 483-3610 or Tex-An 885-3610.

The *TQ* Reader's Survey is for *YOU*!

SUCCESSFUL VOID DETECTION ON US 59 USING GPR

by **Tom Scullion**
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Research and Development Section
Division of Transportation Planning
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BACKGROUND

Where on the road should I spend our limited amount of rehabilitation money to get the best effect? This was Sally Wegmann, Humble Residency Design Engineer's, question when she requested assistance from the Division of Maintenance and Operations' Pavement Management Section (D-18PM) to evaluate US 59 with the **A**utomatic **R**oad **An**alyzer (ARAN) unit and the profilometer. The Houston District residency faced the well-known, unenviable problem: how to detect voids beneath the concrete slabs before any major distresses occur, and what amount of undersealing would be required. Although many pavement problems can be detected from the surface, others can not. D-18PM staff recommended that ground penetrating radar (GPR) should also be utilized, since the conditions were ideal to validate recent advances in the reliability of GPR to detect voids. The results were good and of use to the residency.

The residency had budgeted $250,000 for full-depth repairs in 1991 on US 59. The highway carries upwards of 75,000 average daily traffic (ADT), both directions, with a large percentage of heavy trucks. Several sections of the highway are in bad condition. Major problems are slabs with longitudinal cracking, faulting, and poor ride quality. The 10-inch jointed concrete pavement on a 6-inch cement-treated base is over 20 years old. The section to be rehabilitated is a four-lane divided highway 17.67 miles long.

Long-term plans call for upgrading this highway to interstate standard with complete replacement of the existing lanes. However, this work is not scheduled to start until 1996, at the earliest. The residency is gambling that an effective undersealing program using pressure grouting will slow pavement deterioration and potentially eliminate future full-depth repair work.

FIGURE 1: The GPR system.

US 59 had been mudjacked around 1981, and voids had developed around the cement used. When Ms. Wegmann began searching for rehabilitation methods, the answer kept coming up, "pressure grouting." Even though no one seemed to like the technique much, no one offered any plausible alternatives. Ms. Wegmann needed to estimate the volume of the voids in order to calculate reasonably the amount of grout needed, as well as the other rehabilitation costs including slab replacements, grinding, and joint sealing. Lacking X-ray vision to show her where and how big the voids were, she turned to a high-tech solution offered by research.

The Texas Department of Transportation (TxDOT), through cooperative research projects with the Texas Transportation Institute (TTI), has been experimenting for a number of years with ground penetrating radar to locate voids under portland cement concrete pavements. A major advantage to using GPR, rather than the falling weight deflectometer (FWD), in a lengthy, high-traffic section is that GPR is a rapid rolling operation. It would have taken approximately 3 months to do a void survey of 17 miles of four-lane roadway with the FWD, which would have caused major traffic control problems. Recent advancements have increased the reliability of GPR results when used in this capacity.

TTI currently has a state-funded research project (Research Study 1923), "Continued Development of the Texas Ground Penetrating Radar System," which is aimed at determining when and where GPR technology can be used by TxDOT. On the advice of Bob Briggs from D-18PM, Wegmann contacted Tom Scullion of TTI to see if GPR could be used to detect these voids. Mr. Scullion thought that the project on US 59 certainly fit Study 1923's needs.

To evaluate GPR's ability to detect voids, the district staff selected two test areas (based on other surveys performed by the ARAN and the Profilometer), one northbound, the other southbound. Both areas contained 24 test slabs. The district staff thought that voids were present in both test areas. In one location, the asphalt shoulder had separated the width of a fist from the portland concrete pavement. This location exhibited longitudinal cracking, base pumping, and failures. Moisture was definitely sitting at the slab/cement-treated base interface.

The researchers used the GPR for void location detection. They also collected FWD data on each joint in the test area for correlation purposes. The ARAN and Profilometer runs were made to assist Ms. Wegmann in planning slab replacement, grinding,

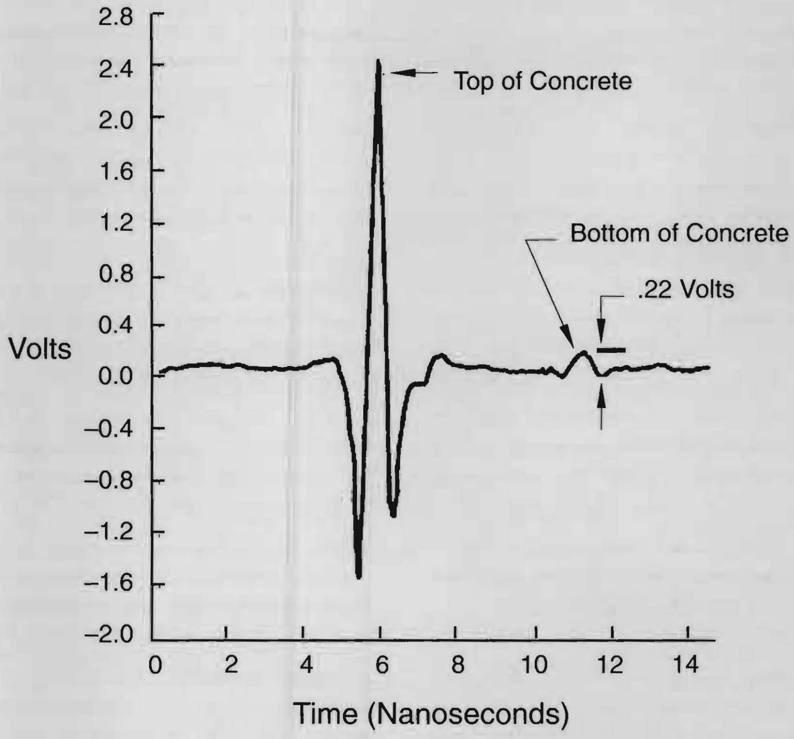

FIGURE 2: Typical radar trace for US 59.

and shoulder sealing requirements. Work got underway in September of 1991.

PRINCIPLES OF GPR

The TTI GPR system is shown in Figure 1. The antenna is boom mounted at the front of the vehicle and sends an electromagnetic wave into the pavement layers. A portion of the wave energy is reflected at each pavement layer interface. These reflected waves are captured by a TTI-developed data acquisition system inside the test vehicle.

The amount of energy which is reflected from each layer interface is a function of the dielectric (nonconductive of direct electrical current) properties of the lower layer. The factor that most influences these properties is the moisture content of the layer. As the moisture content of the layer increases, more energy will be reflected. This energy will be observed as higher peak voltages in the radar trace.

GPR TESTING ON US 59

Radar data was collected at 15 mph to get a radar trace for every foot of each test section. A typical radar trace for this highway is shown in Figure 2. The large peak is from the surface echo. A smaller peak is observed at 11 nanoseconds; this peak is from the concrete slab/cement-treated base interface. This trace was taken in a slab area where a moisture-filled void was known to exist beneath the slab. The dielectric properties of the concrete and cement-treated base are very similar. If good contact is present, no peaks should be detected at this interface. The researchers hypothesized that the 0.22 volt peak is caused by the presence of moisture beneath the slab.

Using the 0.22 volts as a criterion, the TTI researchers were able to process rapidly all of the 500 radar traces collected in this test section. Software written by TTI allows the user to window into a portion of the GPR trace and measure the amplitude of the peaks in that window. The results of this analysis (Fig. 3), show the amplitude of the reflected wave from the slab/cement-treated base interface for all 24 slabs in the northbound direction. The first 11 joints in this section have a low amplitude, indicating good condition. Major reflections are present for joints 12 through 18. The worst section is around joint 12 where an approximately 11 foot long void is present.

VALIDATION

Five locations were selected for additional testing to verify the accuracy of the GPR predictions. Three were predicted to have voids, and two were predicted to have no voids. Joint 6 was selected from the data shown in Figure 3 as a no void location and

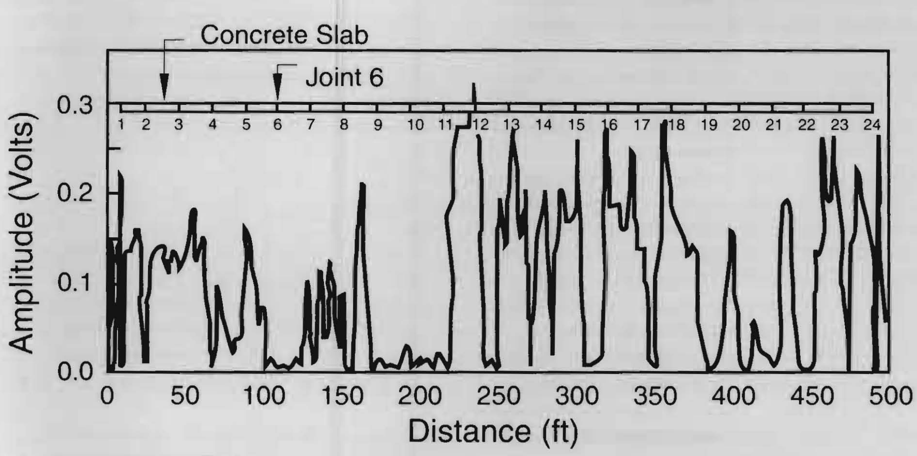

FIGURE 3: Amplitude analysis of GPR trace.

FIGURE 4: Filling dry-drilled hole with red epoxy.

joint 12 as the void location. To validate the void predictions, the research team made an epoxy core test at each of the five locations. An epoxy core test consists of dry drilling a one-inch diameter hole through both the PCC and the cement-treated base, then filling the hole with a fluid epoxy glue (Fig. 4). Red food coloring was mixed with the epoxy to highlight the void location. The epoxy is left for two days to cure fully, and then a standard 4-inch diameter core is taken with the edge of the core being over the hole containing the epoxy. Extracted cores from two locations are shown in Figure 5. The core from slab 6 shows a good contact between PCC and cement-treated base. However, the core from slab 0 (southbound direction) clearly shows the presence of a void at the interface. For this core, void thicknesses ranged from 1/8 inch to 1/4 inch although in some places stone-to-stone contact still existed. Larger voids were found as predicted in the other locations. The voids appear to have been formed by the erosion of the top of the cement-treated base. In the field, these voids were all found to be moisture filled. The validation tests proved to be successful: voids were found in all three void locations, and no voids were found, as predicted, in the other two.

Having successfully completed the pilot test, TTI performed a GPR survey of the worst stretches of this highway in both northbound and southbound directions (approximately 6 miles each way) in February. Analysis of this second survey was completed, and void locations were identified and forwarded to the Humble Residency. A video tape of the section which includes DMI information was also sent to assist the residency staff in accurately locating problem areas.

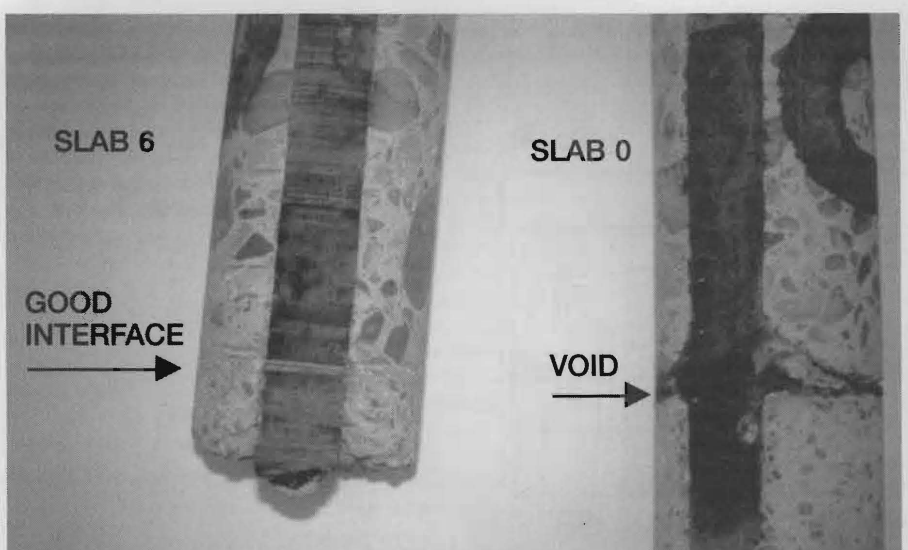

FIG. 5: Extracted cores: void indicated by dark (red) horizontal layer of epoxy.

CONCLUSIONS

Ms. Wegmann thinks that GPR can be helpful in Humble Residency's pavement investigations. Not only does GPR give her a scientifically supportable way to estimate her materials needs for pressure grouting, it also is a method of nondestructive testing that does not require stopping or lane closure. The radar testing is performed at speeds of 15 to 20 mph. Furthermore, GPR could be used postconstruction to evaluate the success of the undersealing.

The aim of the current TTI research studies on ground penetrating radar is to determine under what circumstances this technology can be used by TxDOT. On US 59, with moisture-filled voids between a portland concrete slab and cement-treated base, the GPR predictions were very successful. However, GPR may not work for every set of pavement conditions. The TTI researchers are currently performing a series of laboratory and theoretical modeling studies which will give a better understanding of when and how to use GPR.

For more uses of the GPR, see page 12.

The mentioning of brand names is strictly for informational purposes and does not imply endorsement or advertisement of a particular product by the Texas Department of Transportation.

DID YOU KNOW...

The U.S. Army Corps of Engineers, Washington, D. C., and several industry partners are launching a three-year project to develop automated thermal-spay technology for "rehabilitation and maintenance of civil works infrastructure." Another joint project in the Corps' Construction Productivity Advancement Research (CPAR) Program is focusing on developing construction materials from commingled waste plastics.

"Technical Bulletins," ***Advanced Materials & Processes*** *140 (Nov. 1991):14.*

EPOXY-COATED REINFORCING STEEL

by **Robert L. Sarcinella**
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Texas Department of Transportation

The quantity of epoxy-coated reinforcing steel used by the Texas Department of Transportation (TxDOT) increases yearly. Epoxy coating of reinforcing steel has long been touted as a deterrent to the corrosive actions of chlorides. However, the available information concerning the effectiveness and long-term durability of the epoxy coating is incomplete.

TxDOT, in cooperation with the Federal Highway Administration (FHWA), is currently funding a research project to determine some of this "missing" information. Entitled the *Structural Integrity of Epoxy-Coated Bars* (CTR 1265), this project is being conducted by the Center for Transportation Research (CTR) of the University of Texas at Austin. Lloyd Wolf, P.E., Division of Bridges and Structures, is the project's Technical Panel Chairman (TC).

The most common use in the state of Texas of this "coated" steel is in the top mat reinforcement for bridge decks. This part of the structure is one of the most vulnerable areas to attack from chloride corrosion (Fig. 1). The most common source of this chloride is salt. Whether in the form of *road salt* or in coastal areas as *sea salt*, the chloride can penetrate the concrete and attack the reinforcing steel. The resulting corrosion causes the reinforcing steel to expand, forcing the surrounding concrete to spall. To date, no reliable determination of the long-term durability or cost effectiveness of epoxy-coated reinforcing steel has ever been completed.

Some of the aspects of epoxy reinforcing steel that are currently being analyzed by CTR are:

1. The identification of durability problems;
2. Types of damage found during fabrication, handling, and placement of the steel;
3. Experimental study of "as received" and "induced" damage under various conditions.

The department has already benefited from information obtained from the accelerated corrosion testing performed by the researchers. This test consisted of subjecting samples of epoxy-coated reinforcing steel to wet and dry cycling in a saltwater solution. The tested samples were prepared with varying amounts of damage, with and without repair (patching). At the end of numerous cycles, the samples were evaluated for the extent of the corrosion.

Preliminary results showed that some of the minor damaged areas, whether patched or unpatched, corroded at a faster rate than the larger damaged areas. In some cases, the patch material appeared to offer little or no protection (Fig. 2). However, these are *preliminary* results and should be viewed as such.

The Division of Materials and Tests (D-9) has taken a closer look into the way that inspections are presently performed at epoxy application plants. Due to the early findings of the research, more attention is being given by D-9 to the cleaning and repair operations performed by the applicator. In addition, a prequalification procedure has been developed and is currently being performed at all epoxy applicators' plants that furnish material for TxDOT use. This procedure has produced a list of "Approved Epoxy Applicators" that meet all of the requirements of the current TxDOT specifications.

FIG. 2: Corrosion under patching.

The new specification for the epoxy coating of reinforcing steel (included in Item 440 of the proposed 1992 Specification Book) has also

FIG. 1: Eastern Texas deck replacement due to severe corrosion of uncoated rebar. Epoxy-coated steel, at a slightly higher initial cost, might have added 20 years of useful life.

been modified. TxDOT is currently using a "hybrid" version of the AASHTO and ASTM specifications, since they do not adequately address all phases of the coating operation. A tighter range for acceptable coating thickness and steps for improved repair procedures are among the changes being offered to the TxDOT Specification Committee.

The research study has recently started the second year of its three year contract. Additional information as to the handling, repair, and placement of epoxy-coated reinforcing steel is planned for the future. The final result will be to gain a better understanding of the strengths and weaknesses of epoxy coating for reinforcing steel.

Your questions and comments on this matter would be greatly appreciated. Please contact Robert L. Sarcinella (D-9) at (512) 465-7302 (Tex-An 241-7302) or Lloyd Wolf (D-5) at (512) 416-2279 (Tex-An 249-

TxDOT INCIDENT MANAGEMENT EFFORTS IN FORT WORTH

by **Wallace E. Ewell, P.E.**
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Fort Worth District
Texas Department of Transportation

THE PROBLEM

Traffic jams are a waste of time! They are hard on our nerves, squander costly fuel, poison the air we breathe, and cost our nation billions of dollars a year in lost productivity and increased commercial transportation costs. This problem is not just confined to the big cities; it has been estimated that a high percentage of our nation's rural interstate highways are also congested during rush hours [Ref. 1].

A disabled vehicle on the shoulder of a freeway may result in only minor traffic slowdowns during off-peak hours, but the same occurrence during rush hour, when the freeway is approaching capacity, may result in lengthy backups. Research has shown that an incident that results in closing just one lane in one direction of a three-lane freeway can reduce the capacity of the entire freeway section by 50 percent [Ref. 2].

We expect to find the roads crowded during the times when everyone wants to use them at the same time, such as traveling to and from work or outside a ball park on game day. If we know that a traffic problem may exist, we can start our trip earlier or try to avoid going through those areas. However, we are not able to foresee that a car will break a timing chain in the middle of a busy intersection or that a loaded eighteen-wheeler will turn over and block three lanes of a four-lane highway for seven hours. The only way for officials charged with keeping the roads clear to deal with this type of congestion is to find problems as soon as possible and to send someone out there to untangle the vehicles and get traffic moving again.

The job of handling traffic problems has traditionally fallen to local law enforcement agencies. However, rush hour is also a busy time for overworked, understaffed police departments. Many transportation agencies have found that traffic delays can be reduced significantly by supplementing the police with motorist assistance patrols and major incident management teams. Good examples of these programs are in the cities of Los Angeles and Chicago. These cities have had large, well-staffed motorist assistance patrols and incident management teams for years. These services are expensive to operate and maintain, but the efforts are definitely worthwhile. In Los Angeles, early detection and rapid removal of unusual incidents reduced nonrecurring congestion by 65 percent [Ref. 2].

THE DISTRICT 2 COURTESY PATROL

District 2 of the Texas Department of Transportation is headquartered in Fort Worth and is responsible for department activities in nine north central Texas counties. In 1991, the population of this area was estimated to be 1,426,016. Tarrant County is the largest county in the district, and the two largest cities are Fort Worth and Arlington [Ref. 4].

The district's motorist assistance patrol, or Courtesy Patrol as it is called in Texas, began operations in 1973. The original purpose of the Patrol was to keep the freeways clear and running smoothly. It was charged with monitoring collision damage to state property and with providing a quick response to occurrences, such as objects in the roadway, that could pose an immediate danger to the traveling public. This program minimized the need to call out district maintenance forces to handle minor problems. Helping stranded motorists was not the primary focus of the Patrol when it was started, but it seems to be now. The district's senior Safety Officer and supervisor of the Courtesy Patrol, Mr. Howard Hill, estimates that the Patrol assists approximately 3,650 disabled vehicles per year. They also help the local police direct traffic at about 730 accidents a year. The Patrol logged 336,000 miles on their trucks in 1991.

The Courtesy Patrol trucks operate twenty-four hours a day, seven days a week. They patrol IH 820 (the loop) around Fort Worth and all the state-maintained freeways within the loop. Their usual schedule is as follows:

Monday through Friday —
2 trucks from midnight to 8:00 A.M.
1 truck from 8:00 A.M. to 3:30 P.M.
2 trucks from 4:00 P.M. to midnight.

Saturday, Sunday & holidays —
2 trucks on 12 hour shifts.

The Patrol consists of 16 personnel, including 3 radio dispatchers. Two people are assigned to each truck because it has been determined that many incidents require at least two people to handle them safely and properly. For example, one person may be setting out flares while the other turns on the truck's electronic arrow board and starts to help a stalled motorist or helps provide traffic control at an accident scene. Training for new personnel is conducted on the job. The usual practice is to assign novices to work with an experienced operator.

It costs approximately $100,000 to purchase, equip, operate, and maintain one Patrol pickup truck for a year. The trucks have a two-way radio to communicate with their dispatcher and a citizen's band radio to talk to motorists and commercial truckers with similar equipment. Some drivers have purchased their own portable cellular telephones and carry them on patrol. The trucks have push-bumpers and carry jumper cables, air tanks, water cans, gasoline, tools, traffic cones, and flares. The operators will push a stalled vehicle to safety, give motorists a gallon of gasoline, or try to help them repair their vehicle. They can use their two-way radio to call for a wrecker of the motorist's choice or to call someone to come get them.

Motorists are not charged for these services and the operators will not accept tips or donations. After helping a stalled motorist, the Courtesy Patrol operators will hand them a comment card and invite them to fill it out and mail it back to the district headquarters. Approximately 75 percent of these cards are returned and the response is usually favorable.

HANDLING MAJOR INCIDENTS

The Courtesy Patrol is able to handle most minor incidents, but specialized equipment and expertise are needed to deal with more serious problems. The district's two Safety Officers, Howard Hill and Jerry Woolridge, work with the police to clear major incidents, such as overturned trucks, spilled cargo, and hazardous materials.

Mr. Hill was hired in 1971 and started working major incidents in 1972. Mr. Woolridge joined him in 1982. Mr. J. R. Stone, the District Engineer, had become concerned about the time that it took to remove major incidents from the roadway and clean up the mess. In the past, a roadway may have been blocked for hours, even days, while trucking companies hand-picked spilled cargo. State law seemed to imply that the department had the authority to keep the roadways clear and to assist with the removal of spilled cargo. Unfortunately, some people in the department and many local officials were so concerned about the possible liability of pushing valuable equipment and cargo off the road with a front-end loader that they were reluctant to get involved. Mr. Stone felt that the authority was clear enough and that it was time to do something about the problem. He charged Mr. Hill with establishing a working relationship with the local police and approved the use of state forces to expedite the removal of traffic obstructions.

The district, using the existing legal authority interpretation, remained actively involved in the removal of wrecks and spilled cargo for almost 20 years. During that period, liability for damages was never found to be a problem. In 1991, the State Legislature clarified their intent in this matter by passing specific supporting legislation. State Senate Bill 312 was signed by Governor Ann Richards on May 22, 1991. This bill authorized the Texas Department of Transportation to remove spilled cargo and personal property from the roadway or right-of-way when the department determines that the spillage is blocking the roadway or endangering the public safety. It specifies that department employees will not be held liable for any damages or claims of damage to removed cargo or personal property unless the removal or disposal was carried out recklessly or in a grossly negligent manner.

The Safety Officers are on 24-hour call. Mr. Hill has a white Dodge sedan and Mr. Woolridge has a large yellow Suburban. These vehicles bristle with antennas and emergency lights. They are crammed with radio equipment and cellular phones, linking them to the Courtesy Patrol, the district dispatcher, and various other emergency agencies. The Safety Officers work directly with the local police and fire department personnel at the scene of an accident. If required, they will call in state personnel and heavy equipment to push the wrecked vehicles and spilled cargo off the road.

Through the years, the district's Safety Officers have dealt with many types of spilled cargo. Among these have been hundreds of gallons of sticky molasses, produce of all kinds, terrified cattle, computers, soft drinks, beer, and even a truckload of Bailey's Irish Cream. If hazardous materials, such as gasoline or caustic chemicals, are involved, they will call in local experts and specialized equipment to handle the cleanup. They also have the option to call in heavy-duty wreckers and airbag specialists to upright and haul away overturned trucks. An accident on IH 20 a few years ago resulted in their enlisting the equipment of a nearby roadway contractor to remove a bridge that had been knocked down by an errant water wagon. The department bills the trucking companies for the cost of removal and cleanup of major incidents, and Fort Worth District has an 80 percent recovery rate [Ref. 3].

It costs the district approximately $35,000 a year to support that portion of the Safety Officers' time and vehicles used for incident management. When they aren't working wrecks, the Safety Officers teach driver's training classes, monitor employee driving behavior, recommend remedial action for poor driving performance, and patrol the district's highways looking for unsafe conditions.

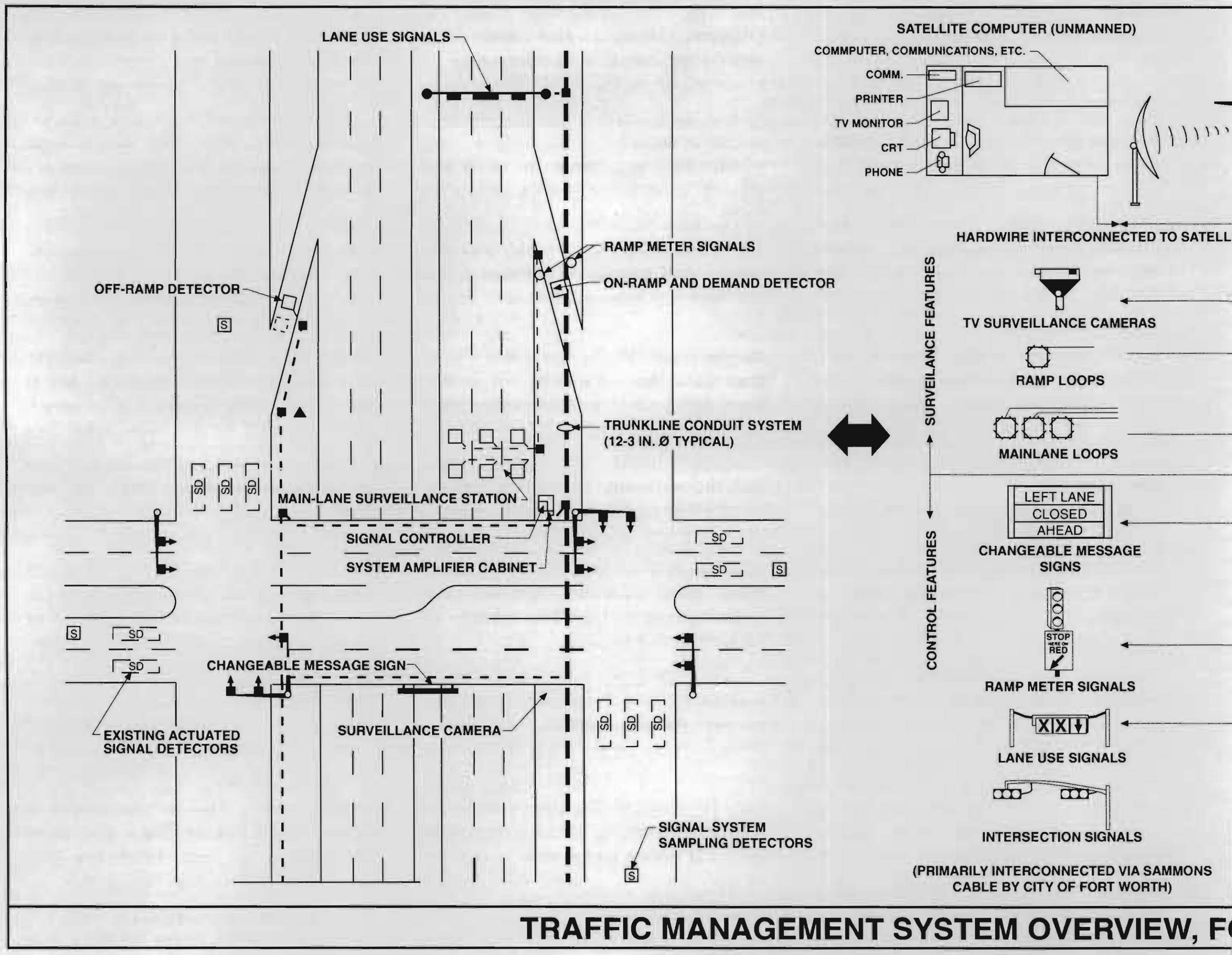


FIGURE 1: Overview of traffic management, Fort W

havior, recommend remedial action for poor driving performance, and patrol the district's highways looking for unsafe conditions.

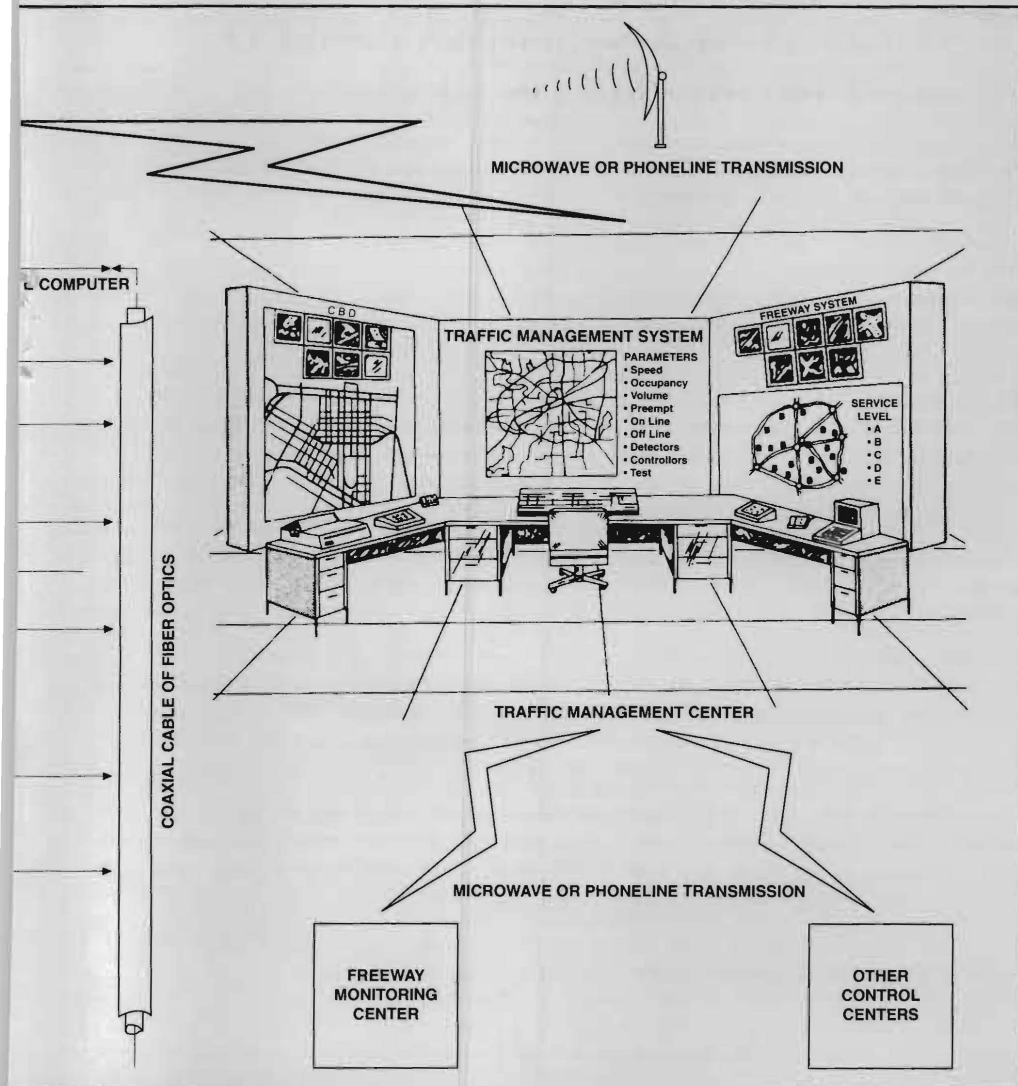
MANAGING TRAFFIC FOR SPECIAL EVENTS

Congestion and traffic conflicts resulting from special events, such as boat races, sports, airshows, and local festivals, are predictable and can be better managed through advance planning and cooperation between agencies. The Fort Worth District has formed committees that work with the police, event promoters, and other agencies involved with or affected by the event. These groups will hold a series of planning meetings prior to an event to discuss entry and exit routes, parking, street closures, media information, public transportation, and traffic control. The Fort Worth District will sometimes support the traffic control efforts by providing electronic variable message signs and special signing. The department tries not to get involved with traffic control for private events, such as store openings and sales.

The Special Events Committee evolved from a larger group called The Fort Worth Area Traffic Management Team. This group is made up of the supervisors of the district's traffic operations, design, maintenance, public affairs, and safety sections who meet regularly with local police, city and county engineers, and a representative of the local bus company. The committee members work on ongoing traffic operations problems and other items of interest to the group. The personal relationships formed in these informal meetings foster a spirit of cooperation and mutual understanding among the team members. The main advantage is a reduction in bureaucratic red tape and quick solutions to many problems on the highways.

IS IT WORTH THE EFFORT AND WHERE DO WE GO FROM HERE?

Operating and maintaining motorist assistance patrols and major incident management teams is an expensive,



ORT WORTH DISTRICT

orth District.

time consuming undertaking. It requires unique personnel, and the work is inherently dangerous. The program will not work if it is not supported by top management, the police, and other local emergency agencies. On the other hand, the service is a lifesaver for stranded motorists, especially at night. It helps keep potentially bad situations from getting worse and quickly eliminates many causes of traffic congestion. Our program is small in comparison to those in Los Angeles and Chicago, but we are convinced that our efforts have saved lives and reduced costly traffic delays in the Fort Worth area. The taxpayers get their money's worth out of these services, and the district is presently trying to obtain funds to expand the areas covered.

Presently, most incidents are reported through calls from local police or other motorists. The local radio stations and traffic reporting services also do a good job of tracking and advising motorists of deteriorating traffic conditions. These informal incident detection methods will soon be supplemented by electronic remote monitoring and motorist information systems installed on the highways (Figs. 1 and 2). This equipment includes closed-circuit television cameras, vehicle detectors embedded in the pavement, large variable message signs, and special radio transmitters. Motorists will be instructed to vacate lanes in advance of an accident through the use of lane signals mounted over the roadway. Ramps may be closed and opened by remote control, and traffic signal timing on the frontage roads can be adjusted to accommodate traffic diverted from the main lanes. However, no matter how sophisticated the equipment is that is used to locate and warn motorists of incidents, it's useless if there is no one available to move them off the road and clean up the mess. It's reassuring to know that we already have that service in operation.

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FIG. 2: Changeable message sign Ft. Worth District.

NONDESTRUCTIVE TESTING AT NEAR-HIGHWAY SPEED LOCATES PAVEMENT PROBLEMS ON IH 45

by **Tom Scullion**
Assistant Research Engineer
Texas Transportation Institute
and
Kathleen Jones
Research and Development Section
Division of Transportation Planning
Texas Department of Transportation

IH 45 just north of Loop 610 in Houston has an average daily traffic (ADT) of over 167,000. This section of widened continuously reinforced concrete pavement (CRCP) has several structures, a 4- to 6-inch asphalt concrete overlay, and an HOV lane in the middle. Its design included a superelevation that was supposed to keep the HOV lane drained. Unfortunately, something was wrong. Ruts stayed wet, and water would ooze from the pavement well after a rain. Maintenance forces reported severe moisture damage to the asphalt layer in places. Where was the water coming from was what the Humble Residency staff wanted to know. Was it in the asphalt overlay? Was it in the base? Previous patching experience seemed to indicate the water was coming up from the base, but was it? Ideally, the asphalt should be removed and the slab beneath evaluated before proceeding with major maintenance. Reality made even doing this option at night impossible. Houston District policy requires that the same number of lanes be provided for the motorists, either by restriping for narrower lanes or by providing an equivalent alternative route, during long-term maintenance operations. This section of IH 45 has no reasonable alternative route, and the bridge widths make squeezing in more lanes by restriping dangerous. In September 1991, pavement surveys were performed for a 4-mile-long, $800,000 maintenance contract to perform milling and to do slab undersealing on this section.

This portion of the project is due to start in April or May 1992. Humble Residency Design Engineer Sally Wegmann was interested in determining if ground-penetrating radar (GPR) could be used to locate areas of extreme stripping, as well as subslab moisture-filled voids which were being surveyed on US 59 (see article on page 4). This information might pinpoint the source of the water and speed up the maintenance project by allowing it to concentrate on specific problem areas.

A combined Texas Department of Transportation (TxDOT) and Texas Transportation Institute (TTI) research team made the survey in November 1991. GPR data was collected at 40 mph, and the data acquisition system was set up to collect one radar trace every 4 feet. The worst lane in both the northbound and the southbound directions was surveyed. David Fink of the Division of Maintenance and Operations' Pavement Management Section (D-18PM) had performed an ARAN survey earlier to determine the worst lanes and to provide a visual record of all the lanes.

Tom Scullion of TTI analyzed the GPR data. The results (Fig. 1) indicated that the worst conditions existed in the last two sections of the northbound lane. These two areas had an estimated 35 and 28 percent asphalt in poor condition, respectively, with 33 and 41 potential void locations. The findings confirmed the district's suspicions and agreed very closely with the ARAN analysis. The GPR data was then used to highlight the actual problem locations in the worst two sections. In this run, the majority of the voids were found in three areas between two bridges (Fig. 2). The ARAN analysis revealed that the first and last locations are at the bottom of the longitudinal grade changes. The district forces plan to use this information to direct their milling and undersealing activities. For more information, contact Sally Wegmann, P.E., (713) 540-3425.

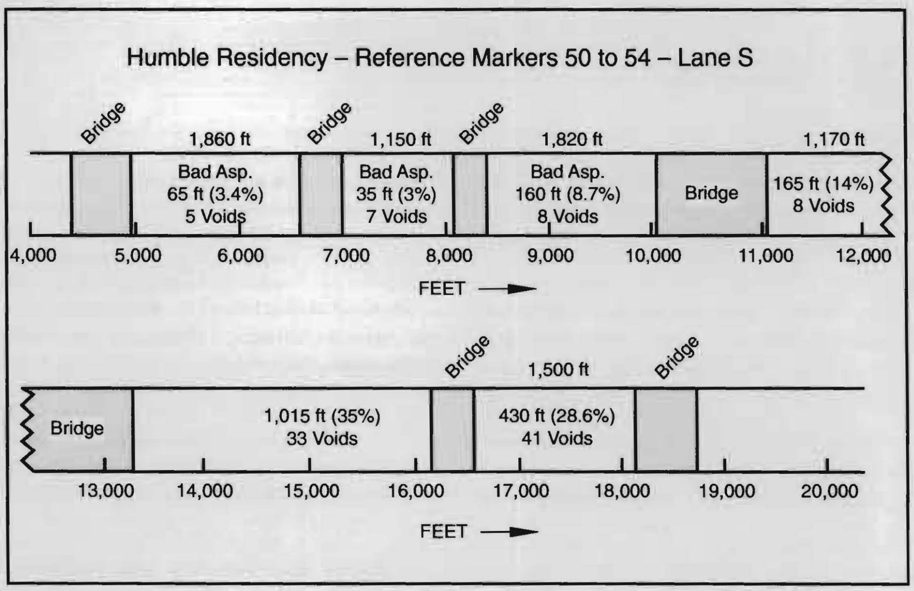

FIGURE 1: Results of ground penetration radar survey on northbound IH 45.

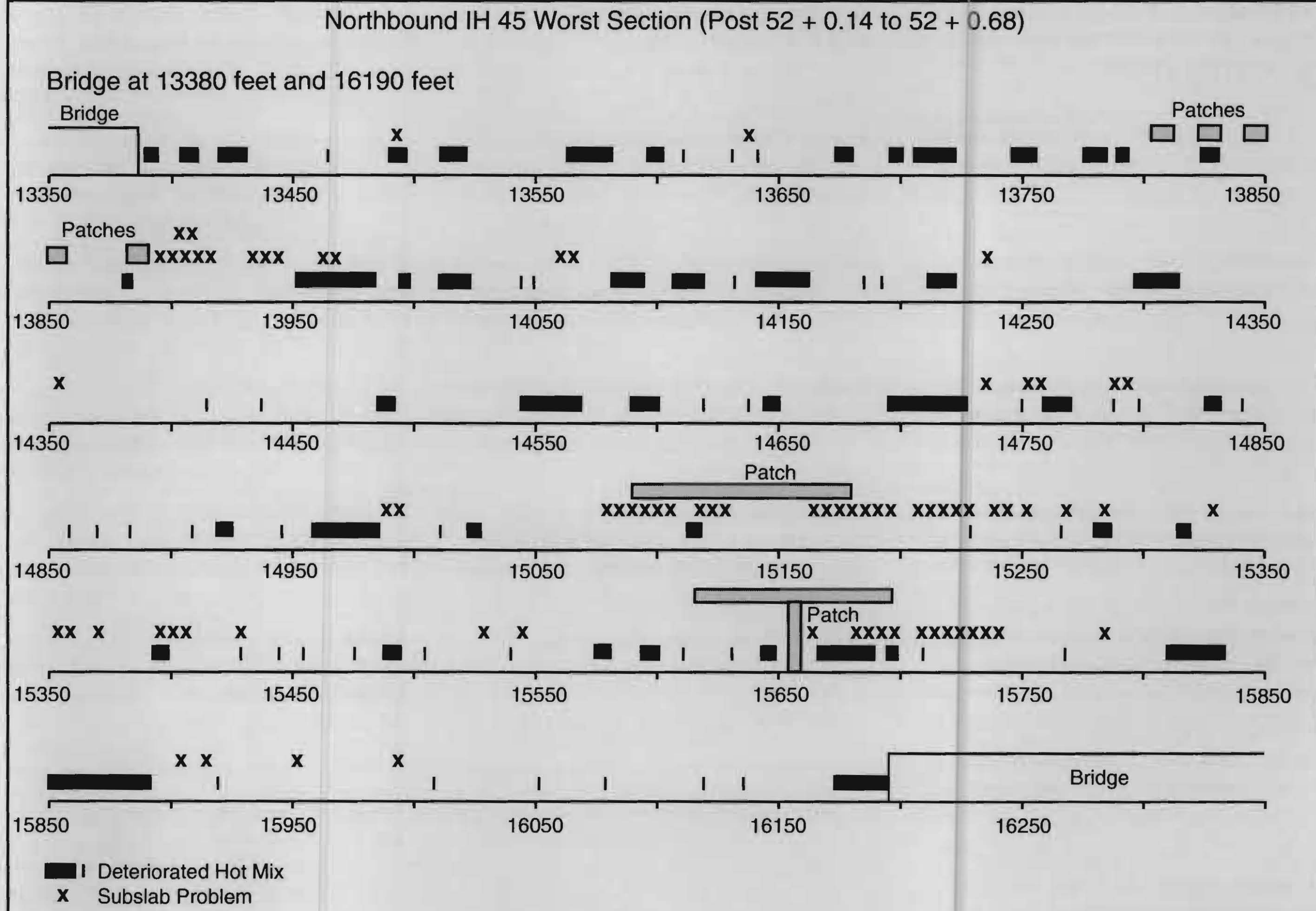

FIGURE 2: Pavement problems pinpointed with GPR.

INTERMODAL TRANSPORTATION PLANNING IN TEXAS

by **John S. Robey, Ph.D.**
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Planning and Policy Division
and
Tom Griebel, Director
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INTERMODALISM—DEFINITION

Intermodal transportation is the systematic use of two or more modes of transportation to maximize the efficiency of the movement of people and goods. The unique feature of intermodalism is the connectivity from one mode — rail, air, highway, or water — to another [Ref. 1, p. 2]. Intermodal transport includes the capability of interchanging freight containers among various transportation modes, in a complete origin-to-destination movement. Usually, intermodalism will involve at least three components: the two line-haul segments and the interconnection (port or terminal) between the line-haul modes [Ref. 3, pp. 8-9].

Multimodalism also involves the use of two or more modes of transportation. Many people use the terms multimodal and intermodal interchangeably. However, the element of connectivity, or linkage, is associated with intermodal transportation, while multimodal merely means that two or more modes are in use [Ref. 2, p. 2].

A good example of an intermodal system may be seen in the operation of the Port of Houston Authority. Other examples include high occupancy vehicle lanes and park-and-ride programs. Another example in Houston involves passenger connections to airports which several taxi companies and the Houston Metropolitan Transit Authority provide; private helicopter service is also available, and it is possible to use remote airport check-in facilities at various locations.

INTERMODALISM AND CREATION OF DEPARTMENTS OF TRANSPORTATION

The concept of a comprehensive department of transportation pursuing intermodal planning is not a new one. As far back as 1974, the Advisory Commission on Intergovernmental Relations published "Toward More Balanced Transportation: New Intergovernmental Proposals" in which it was recommended that the states create a broad intermodal Department of Transportation and that the chief executive officer be "directly vested with strong and effective intermodal planning, policy making and budgeting capabilities..." [Ref. 6, p. 10]. The Council also recommended that independent transportation regulatory bodies be consolidated and that the Federal government revise its transportation funding policies by providing for intrastate regions that "have a strong multimodal department of transportation" [Ref. 6, p. 10].

In 1977, the General Accounting Office in a report to Congress, "Making Future Transportation Decisions: Intermodal Planning Needed," recommended that all modal programs be consolidated into a single program and that the Department of Transportation planning staffs be merged into a single all-mode unit [Ref. 7, pp. i-ii].

By 1983, the National Council of Physical Distribution Management could state, "multi-modal megacarriers are clearly on the way." And in 1985 John Mahoney of the Eno Foundation for Transportation wrote that because of consumer and shipper demand, advances in computerization, and the "revolution" in methods and equipment for transferring freight, intermodalism would become the wave of the future [Ref. 4, p. 171].

In 1989, the American Association of State Highway and Transportation Officials (AASHTO) published a report, *New Transportation Concepts For a New Century.* This report emphasized the need for intermodal connectivity and recommended the consideration of alternative modes when developing transportation plans [Ref. 8, p E-4 and pp. 1-2].

In October 1990, the Texas State Department of Highways and Public Transportation formally committed itself to an intermodal future in the department's *Strategic Plan ... Responding to the Transportation Challenge 1990-2010 and Beyond.* The department's vision was stated as "...one of promoting the development, enhancement, and linkage of all modes of transportation into a viable, complementary network..." [Ref. 9 p. 1]. One of the goals for the department in the *Strategic Plan* was to "position the state to fully capitalize upon air, rail, sea, and highway transportation opportunities that maximize mobility and encourage economic growth in the most economical, effective, and efficient manner" [Ref. 9, p. 2].

In 1991, the 72nd Texas Legislature brought some reality to these forecasts and passed House Bill 9 creating the Texas Department of Transportation (TxDOT). This legislation brought under the responsibilities of the department those of the former Texas Department of Aviation. The department retains responsibility for highways and public transportation, and could assume those required for operation of the Texas Turnpike Authority as well [Ref. 10]. In addition, the Chair of the Texas Transportation Commission sits on the governing board of the High Speed Rail Authority. These actions will bring a degree of coordination among the various transportation modes and foster the concept of intermodalism. With the creation of a Department of Transportation, Texas (and virtually every other state) has taken a big step toward making the concept of intermodalism a reality.

INTERMODALISM AND DEREGULATION

The creation of a comprehensive state department of transportation encompassing multiple modes of transportation has been only one step in an effort to achieve intermodalism. In 1975 the Secretary of Transportation issued a statement of "National Transportation Policy" in which it was recommended that unreasonable barriers to intermodal cooperation be eliminated [Ref. 2, p. 22]. The first industry to tackle deregulation was the airlines. Almost all air freight is intermodal in that it moves to and from an airport by way of some form of surface transportation. Deregulation has given shippers a wider range of combinations of transportation modes to choose from.

The Motor Carrier Act of 1980 loosened entry requirements for the trucking industry and the number of new entries more than quadrupled. Many restrictions on types and routing of cargo were eliminated. Also, the trucking industry was allowed to own more than one mode of transportation. The effect of this deregulation has been to encourage intermodalism [Ref. 2, p. 23].

The Staggers Rail Act of 1980 provides much of the same flexibility for the railroads. Railroads can now abandon unprofitable lines, and a wider choice of intermodal connections are available. The railroads gained greater freedom to merge with one another. Perhaps most importantly, the Interstate Commerce Commission freed all rail-piggyback carriers from restrictive regulations that had blunted the development of intermodality [Ref. 2, p. 23-24].

The Shipping Act of 1984 made it easier for water carriers to engage in collective rate making, enter into contracts for the inland portion of an intermodal rate, and allowed shippers to enter into confidential contracts with carriers [Ref. 11, pp. 175-176].

These deregulation efforts, and the creation of comprehensive state departments of transportation, have gone a long way toward fostering the concept of intermodalism.

INTERMODALISM AND THE FUTURE

In December 1991, President Bush signed the new transportation reauthorization bill, the Intermodal Surface Transportation Efficiency Act of 1991. This legislation makes it clear that future policy will provide for the most cost effective split among the various transportation modes. This optimization process is aimed at saving taxpayer dollars by providing for a system that "...shall consist of all forms of transportation in a unified, interconnected manner, including the transportation systems of the future, to reduce energy consumption and air pollution while promoting economic development and supporting the Nation's preeminent position in international commerce" [Ref. 12, p. 4].

The future for some companies includes the possibility of becoming a full-service intermodal company with the capacity for end-to-end traffic movement under one management. Deregulation of the various modes of transportation could lead to the creation of "super companies." These companies could offer unique combinations of the various modes of transportation to their clients. "Hub and spoke" intermodal systems may improve service to smaller communities [Ref. 2, pp. 25-26].

In Texas, intermodalism will have an international aspect. The possibility of a Free Trade Agreement may make the concept of connectivity a bit more complex as the regulations of two different countries must be merged as well as the modes themselves. The largest shipper is the US government and it is not yet clear what the international role of intermodal transportation will be in an era of decreased political tensions and constricting defense outlays.

New modes, such as electronic transmission of documents and employees who telecommute, will have an impact on intermodalism. John Mahoney writes in "Intermodal Freight Transportation" that while it "has much further to go" the day will come when we will see the movement of cargo through space [Ref. 4, p. 172]. Intelligent Vehicle Systems have already been developed and are being tested. The development of the transatmospheric aerospace plane will also add a new dimension to intermodalism. In the near future, crafts may be capable of flying at speeds in excess of 25 times the speed of sound, or approximately 18,750 miles per hour.

CONCLUSION

In their study on the status of intermodalism in Texas in 1985, Professors Boske and Walton of The University of Texas were forced to conclude that due to a lack of a unified state department of transportation, cooperative mechanisms, and funding "....little intermodal planning exists" [Ref. 2, p. 63]. This is no longer true. The creation of TxDOT is the beginning of the end for the single mode planning and mind-set that has existed in the past. As Executive Director Arnold Oliver said in a recent meeting of division directors and district engineers, "... the department must start multimodal and intermodal planning. We have the authority to be the lead agency and this planning must be done" [Ref. 13, p. 10].

We stand at the brink of a new and exciting era in transportation in Texas. Continued deregulation and careful intermodal planning of coordinated activities within the new Texas Department of Transportation will help ensure that transportation in Texas reaches its maximum potential during these exciting times.

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BREAKAWAY TIMBER UTILITY POLES UPDATE

BACKGROUND

Under a Federal Highway Administration (FHWA) sponsored research project with the Texas Department of Transportation and the Texas Transportation Institute, a breakaway timber utility pole design has been developed (Fig. 1). This breakaway design is considered experimental and information on its performance under actual field conditions is now needed.

The Kentucky Utilities Company, in cooperation with the Kentucky Transportation Cabinet and the University of Kentucky installed ten of the breakaway poles in Lexington. The Massachusetts Electric Corporation and the New England Telephone Company installed nineteen of the breakaway poles near Boston. Whereas Kentucky retrofitted existing poles with the breakaway device, Massachusetts replaced existing poles with new poles that contained the breakaway device when delivered to the site. These poles were evaluated for two years, starting in 1989. As of April 1992, poles in Massachusetts have been hit by five errant vehicles. Drivers of the vehicles (the only known occupants) were uninjured; the wires were saved; and service was uninterrupted (Table 1). No poles have been hit in Kentucky.

The FHWA is looking for other states and utilities to install the breakaway poles so additional experience can be gained on the operation of the breakaway device. If this safety device continues to perform satisfactorily in these trial installations, the FHWA's goal is eventually to advance the device to an "operational" status.

DESIGN RECOMMENDATIONS

Design recommendations for breakaway timber utility poles are set forth in the FHWA research report titled "Safer

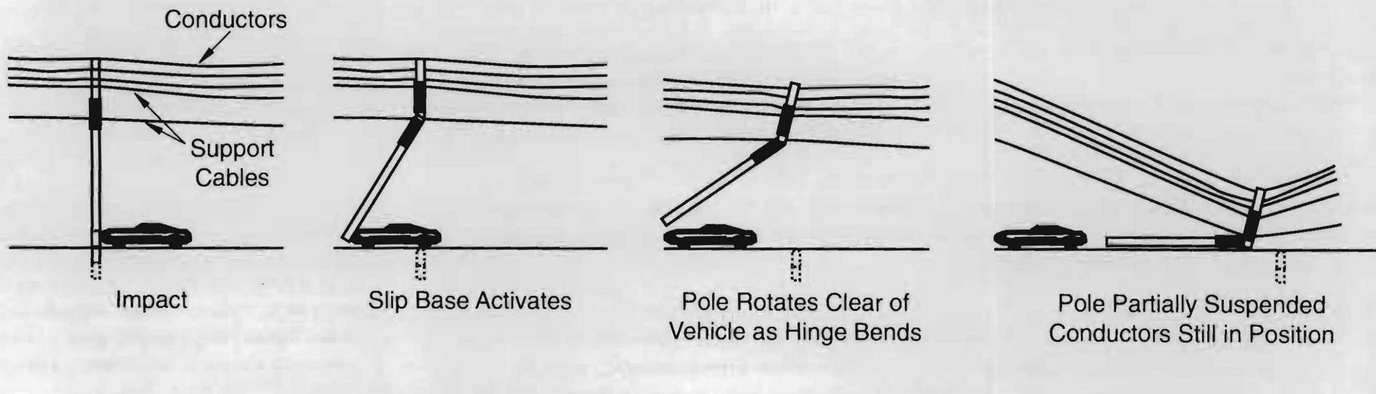

FIGURE 1: Breakaway timber utility pole design concept.

TABLE 1: Accident data.

Accident Number	Time	Date	Weather Conditions	Location (State/ Route)	Vehicle Model and Year	Personal Injury	Vehicle Damage	Required Time for Pole Repair	Service Interruption Time
1	3:10 am	9/24/90	Normal	MA/140	Chevy Geo, 1990	None*	Severe	3 hours	0
2	Before Sunrise	12/12/90	Wet	MA/20	Toyota Wagon, 1990	None**	Severe	4 hours	0
3	9:00 am	4/21/90	Severe (Rain, 50 mph wind)	MA/20***	Ford Aerostar, 1986	None	Severe	2 hours	0
4	9:26 am	5/12/91	Normal	MA/113	Toyota Pickup, 1990	None	Totaled	1/2 hour	0
5	10:00 am	9/25/91	Wet	MA20***	Pontiac Pheonix, 1981	None	Totaled	1 hour	0

* Assumed. Unidentified driver fled accident scene (car was a stolen vehicle).
** Driver appeared intoxicated.
*** Same pole as Accident #2.

Timber Utility Poles: Volume 1 – Summary Report" (FHWA/RD-86/154, September 1986).

The recommended breakaway design, as shown in Figure 2, consists of a slip base, a hinge, and upper support cables.

The breakaway timber utility pole is designed to activate when an automobile hits the pole at speeds ranging from 20-60 miles per hour. It is generally expected to be a reusable product. Only the hinge's four metal straps, the slip base's keeper plate, and some bolts, nuts, and washers should need to be replaced. The middle section of the pole should be in suitable condition to upright and put back into service.

Locations

Selection of a location for a breakaway timber utility pole should include consideration of the following:

- A breakaway timber utility pole should *not* be installed at a location where it is more feasible to remove the existing utility pole, to place the utility line underground, or to relocate the existing utility pole to a location away from the roadway where it is less likely to be struck.
- A clear recovery area must be available behind a breakaway timber utility pole to allow the pole to swing free of objects which may hinder its operation and to allow an errant vehicle to come to a safe stop without hitting a secondary object or going down a steep embankment.

SUPPLIERS

The hardware (including the epoxy compound) for all installations to date has been purchased from:

Mr. Robert F. Shepherd,
Timber Products Consultant
Box 162-A
Rindge, New Hampshire 03461
Telephone (603) 899-2809

COSTS

The approximate installation costs per breakaway timber utility pole were as follows:

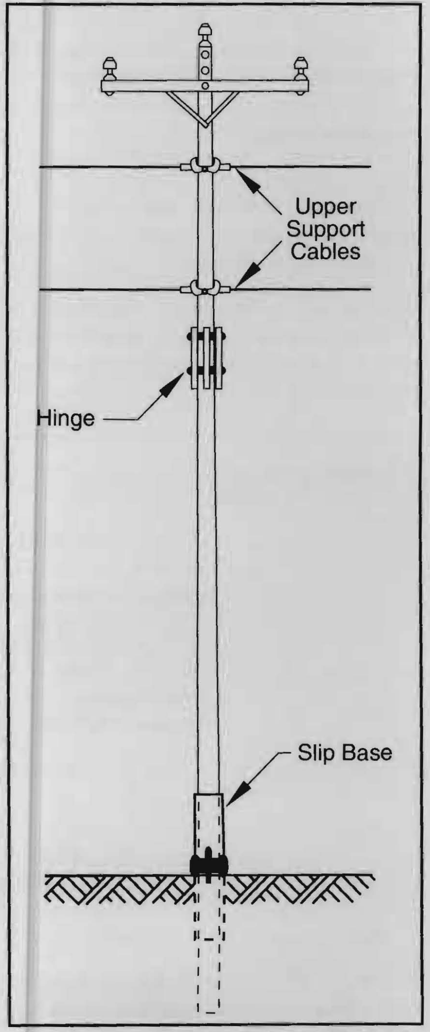

FIG. 2: Breakaway hardware.

Kentucky Retrofit Design

$1,300	Materials
1,700	Labor and Equipment
$3,000	Total Cost per Pole

The typical retrofit installation took 6 to 8 hours.

Massachusetts New Pole Design

$4,500	Materials
3,200	Labor and Equipment
1,250	Insurance
$8,950	Total Cost per Pole

New pole installation also required 6 to 8 hours.

Massachusetts believed the additional cost of a new pole was justified in order to eliminate the unknown variables associated with an older existing pole. Also, unlike Kentucky, Massachusetts was required to provide insurance on the poles. The installation times for Kentucky and Massachusetts were comparable.

EVALUATION

The first timber utility pole in Kentucky to be converted was retrofitted with breakaway hardware in January 1988. The tenth and last pole to be converted to date was retrofitted with breakaway hardware in October 1989.

Retrofitted poles in Kentucky were inspected quarterly for two years until the end of the evaluation period in September 1991. During that time, no severe weather conditions occurred and there were no accidents. No problems were observed, other than the need to adjust some pole alignments where they had leaned slightly at the top. Bolts were checked and all were of the specified torque.

The first installation in Massachusetts, where an existing timber utility pole was replaced with a new breakaway timber utility pole, occurred in October 1989. The nineteenth and last breakaway pole to date in Massachusetts was installed in August 1990.

Breakaway poles in Massachusetts have been inspected quarterly since the first pole was installed in 1989 and will continue to be inspected until the end of the evaluation period in early 1992. They have withstood severe wind loads (estimated 80 to 90 mph winds which snapped three non-breakaway poles nearby) and five accidents. A final evaluation report is being prepared and should be published by late 1992.

OTHER STATE INSTALLATIONS

For further field evaluation, plans are being finalized for the installation of more breakaway utility poles in Washington State. FHWA Technology Application funds have been made available to help pay for the installation of about 10 poles. The FHWA will pay for the materials and a 2-year evaluation. The state and/or utilities will pay for the labor and equipment necessary to make the installations. Plans have not been finalized, but Washington DOT is thinking about ordering all the breakaway hardware, installing the breakaway hardware on new poles at the off-site location, and installing the poles in a manner similar to that done in Massachusetts.

Texas and Virginia have also expressed interest in installing and evaluating breakaway timber utility poles.

VIDEOTAPE

The FHWA has distributed a 15 minute videotape which depicts the procedure used in Kentucky to retrofit existing utility poles with a breakaway device. Copies of this videotape may be borrowed from the D-10 Research Library, Catalog # V-171.

Call Dana Herring, D-10 Research Librarian, (512) 465-7644 or Tex-An 241-7644.

***FHWA CONTACTS** for additional information about breakaway utility poles:*

Janet Coleman
FHWA
Office of Technology Applications
State & Local Programs Branch, HTA-12
400 7th Street, SW
Washington, D. C. 20590
Phone (202) 366-9210

Paul Scott
FHWA
Office of Engineering
Federal-Aid Program Branch, HNG-12
400 7th Street SW
Washington, D.D. 20590
Phone (202) 366-4104

GDOT SURFACE-TOLERANT COATINGS

This project was initiated in response to the trend toward more stringent environmental regulations affecting steel surface preparations. Sand blasting is potentially harmful to workers and to the environment. If the old paint which is blasted contains lead, the blast residue may be characterized as a hazardous waste, depending on the concentration of leachable lead. Fourteen different surface tolerant systems are being evaluated under this project [Georgia DOT Research Project 8806]. Four of these systems are "rust transformers" which react chemically with iron oxide (i.e. rust). The other ten systems are surface tolerant coatings as in Table 1.

All of these systems were applied onto used 4 by 6 by 3/16 inch test panels which had been exposed in a coastal environment for 10 years. There were 12 duplicate panels prepared for each of the 14 systems; three surface preparations (hand, brush blast and commercial blast) and four different exposure conditions (coastal, salt-fog, industrial and control). The coatings were applied by conventional chamber at 70 degrees F and 70 percent relative humidity.

After 16 months of marine and industrial exposure and one year of salt-fog testing, the systems can be ranked according to performance. The four rust transformers are the worst performers in industrial exposure. Systems 1, 2, 4 and 7 are the best performers in industrial exposure. In marine exposure, the best systems are 2, 4, and 7 and the worst systems are 5 and 6. In the salt-fog cabinet, system 3 was the best and systems 5 and 8 were the worst.

The Georgia DOT standard lead-free alkyd (system 1) was among the best in industrial exposure. The standard alkyd system will tolerate a poorly prepared surface as well as the best surface tolerant coatings on the market. The standard alkyd system is also much less expensive than the surface tolerant coatings.

For more information, contact Pam King at (404) 363-7615.

Georgia DOT Research News 17 (Fall 1990): 1-2.

TQ information is experimental in nature and is published for the development of new ideas and technology only. Discrepancies with official views or policies of the TxDOT should be discussed with the appropriate Austin Division prior to implementation.

TABLE 1: Surface tolerant-systems.

System	Generic Type	Number of Coats
1	Georgia DOT lead-free alkyd	3
1	Al filled moisture cure urethane primer-urethane topcoat	3
1	Zn filled moisture cure urethane primer-urethane topcoat	3
1	Al epoxy mastic primer-epoxy topcoat	3
1	Al epoxy (62% solids)	3
1	Al filled asphaltic primer-alkyd topcoat	3
1	Combination of solvent-borne resins primer– Georiga DOT alkyd topcoat	3
1	Surface tolerant water-borne primer– Georgia DOT alkyd topcoat	3
1	2-component water-borne cementitious primer– Georgia DOT alkyd topcoat	3
1	1-component water-borne cementitious primer– Georgia DOT alkyd topcoat	3

FRACTAL ANALYSIS ASSISTS AGGREGATE CLASSIFICATION

Medical technology is known for solving countless problems. Thanks to some help from the Mayo Clinic, transportation researchers may soon be able to add pavement rutting to the list.

The problem of rutting in pavements has been studied extensively through cooperative research with the Texas Department of Transportation (TxDOT) and the Federal Highway Administration (FHWA), at Texas Transportation Institute (TTI). Recent work focused on the influence that aggregates have on rutting in asphalt concrete pavements. Joe Button, associate research engineer in TTI's Asphalt Materials Program, has headed much of this work.

Several factors contribute to rutting on driving surfaces. One factor is air pressure in tires. Pavement design procedures are usually based on truck tire pressures of 75 to 90 pounds per square inch, but trucks often run tire pressures greater than 100 psi. Another factor is the content of the driving surface itself. The researchers knew that angular (crushed) aggregates are more resistant to rutting than smooth-surfaced rounded aggregates, but presently there is no convenient and reliable method to quantify angularity of aggregate particles. This is where Bob Lytton, head of TTI's Materials, Pavements and Construction Division, and Professor Len Li stepped in.

Li, a visiting scholar at Texas A & M University from mainland China, had spent 1989 at the Mayo Clinic in medical imaging research. Being aware of both the rutting study and Professor Li's work and the connection the two might have, Lytton got the researchers together.

Li suggested they photograph the aggregate samples and send them to the clinic in Rochester, Minnesota, for analysis. Li believed the clinic could help classify the aggregates by applying the same analysis they used to study textures in human organs.

The Mayo researchers used a mathematical process known as fractal dimension analysis in their work for TTI. The test can provide a precise description of a textured image. Stated another way, the fractal dimension of a surface corresponds close with the quality of "roughness."

In their experiment, TTI researchers used photographs of jagged-édged crushed limestone for one example and smooth river gravel for the other. According to their hypothesis, the images of crushed limestone would have a higher fractal dimension than those of the river gravel, and the difference between their fractal dimensions would be significant. Going a step further, the fractal analysis could actually measure the degree of angularity in the aggregate.

The analysis was found to clearly identify and quantify texture in the aggregates and the researchers concluded that fractal analysis holds a great deal of promise as a simple and practical technique for studying and quantifying aggregate surface textures.

Although the Mayo Clinic's assistance was essential in the advancement, TTI researchers believe the expertise may not be needed again directly. They hope to develop the necessary components for conducting fractal dimension analysis at TTI laboratories in the future.

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D-10 LIBRARIAN RECEIVES GOVERNOR'S RECOGNITION

Alvin R. Luedecke, Jr., P. E., Division Director of Transportation Planning, presents Dana Herring with Governor's letter.

Dana Herring, D-10 Research Librarian, received recognition from Governor Ann Richards for her hard work and support of libraries in Texas. The recognition, given in conjunction with the celebration of National Library Week (April 5-11, 1992), states:

> *I am proud of your work at the Texas Department of Transportation and of the great contribution you make to the effectiveness of state government. The organizing, storing, and disseminating of information is one of the most crucial functions of government, and it is you and other library personnel who help Texas succeed in this area.*

Transportation Planning Division director Al Luedecke, Jr., P.E., made the presentation to Ms. Herring on April 23, 1992.

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