TECHNICAL QUARTERLY

"AN EXCHANGE OF IDEAS"

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CONTROLLING VEGETATION UNDER GUARDRAILS

by **Jim Schutt**
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INTRODUCTION

Guardrails are an integral and necessary part of the roadway. They provide protection both to the motorist and to highway structures. However, most maintenance personnel know they are a costly maintenance problem. Grass and weeds can become thick enough to obscure the guardrail or at least to become a real eyesore. A portion of a landscape project site in Austin at Loop 1 (Mopac) and US 183 was utilized to conduct a field study of two products designed to control plant growth. The goal of this study (originally started as part of Research Project 7-944, ***Construction Landscape Program,*** now continuing as an interagency agreement) is to identify promising alternatives to controlling vegetation under guardrails.

CURRENT PRACTICE

Currently, there are three practices used to deal with this problem. They are:

★ using hand-operated trimmers

★ paving under the guardrail

★ applying herbicides.

Each of these methods has proved adequate, but each has drawbacks. The use of hand-held trimmers is costly in the long run because the operation must be repeated at regular intervals in order to keep vegetation under control. The most serious drawback, however, is safety. In many cases, it requires placing a person very close to high-speed traffic. Also, string trimmers have a reputation for throwing small bits of gravel or other debris into the adjacent traffic, with the possibility of entering an open car window.

Concrete or asphalt paving is a low-maintenance option that is widely used in some urban areas. The major disadvantage is that repair to guardrail is more costly. Also, both paving types present joints that will eventually become repositories of wind-blown seeds. When these germinate, it is necessary to trim or spray.

Herbicide is easily applied, but unfavorable public reaction is growing in response to the use of chemicals in the environment. However, since the most widely used herbicides become inert very quickly, seeds present in the soil germinate

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quickly. These will be seeds of the most opportunistic plants — weeds. This pattern of herbicide breakdown and weed germination creates a cycle of spraying that has no end.

STUDY BACKGROUND

The concept behind the use of the two products is to reduce the amount of soil available for plant rooting. The key determinant regarding the type of plant that will grow in a particular place is the amount of soil available. The soil amount determines how much water can be stored and how many nutrients are available to support growth. Deep soils support large plants, while shallow soils generally support much smaller plants. A good example of this is found throughout the Texas hill country where soils of only 25.4 to 76.2 mm (1 to 3 inches) overlaying limestone bedrock support a variety of short, native grasses but nothing else. Can this same concept be adapted to this application? Would it be possible to establish a soil depth that would promote a plant growth habit that would be acceptable under guardrails? These are some of the questions this project was meant to explore.

PRODUCT DESCRIPTIONS

The first product is called Bio-Barrier®. It is manufactured by Reemay Incorporated in Old Hickory, Tennessee. The product consists of a geotextile fabric similar to common weed barriers that is studded with 9.5 mm (3/8-inch) nodules of carbon-black. These nodules are spaced in a 50.8 mm (2-inch) grid over the textile and are impregnated with the herbicide Trifluralin. It is commonly used in agricultural herbicides such as Treflan®. Triflurian has an EPA toxicity rating of class IV (acute oral: LD50 (rats) >10,000 mg/kg), practically nontoxic. The vapor emitted from the nodules degrades in the soil in 1 to 6 months. The product works by preventing root-tip cell division in roots. No herbicide enters the plant and no plant parts are damaged by the herbicide. The chemical is released from the nodules as a vapor and adheres to soil particles. It is effective in the soil for a radius of about 25 mm (1 inch) from the nodule. The estimated, effective life of the product in the ground is over ten years, but this is dependent upon soil factors such as heat, moisture, and soil texture. The cost of the material is about 80¢ per square foot.

The other product studied is called Weed Blocker. It is manufactured by Progressive Polymetrics, Inc. in Van Nuys, California. It is a polypropylene panel, similar in construction to corrugated cardboard, approximately 3.2 mm (1/8 inch) thick. Designed to be installed on the surface of the ground around guardrails and posts, it is supposed to eliminate trimming. It is environmentally safe, impact resistant, and UV stable. The cost of this material is approximately 25¢ per square foot. This product has some obvious drawbacks when installed as it was designed, which is on the ground surface. It does not present what the researchers consider an acceptable visual character. Also, joints between the material and structures may fill with weeds. However, if it were installed under the soil, it might have the effect of creating a "reduced rooting zone."

LAYOUT OF STUDY PLOTS

The study plots were established with two soil types, crushed limestone roadbase and the native soils (a black, sticky-when-wet clay) found on the site. The materials being studied were installed at depths of 50.8 mm (2 inches) and 101.6 mm (4 inches) under each of these soils. The materials were installed both singly and in a combination of the two. This last combination was explored to see if effective control could be attained at a lower overall material cost and to see if grass could be maintained at a consistently lower height. The study plots were located under selected guardrails on the site. After installation, the plots were compacted with a plate vibrator. The plots were not seeded.

STUDY RESULTS

Bio-Barrier Plots

As can be seen from the table of observations and in the photos, the most effective control with Bio-Barrier is being attained under crushed limestone, both at the 50.8 mm (2-inch) and 101.6 mm (4-inch) depth (Fig. 1). In each case, there are some runners of Bermudagrass over the plots, but no rooting. In the 101.6 mm (4-inch) plots, there are occasional, single, weedy herbaceous plants, but these appear to be random. This outgrowth may be a case of a species that is not affected by the material. Bio-Barrier in both the 50.8 mm (2-inch) and 101.6 mm (4-inch) clay plots shows complete control of grasses, but not all herbaceous weeds. This effect is identical to the preliminary findings of the studies currently being conducted at the TTI Proving Grounds at the Riverside campus at Texas A&M.

The Bio-Barrier results are consistent with the research being con-

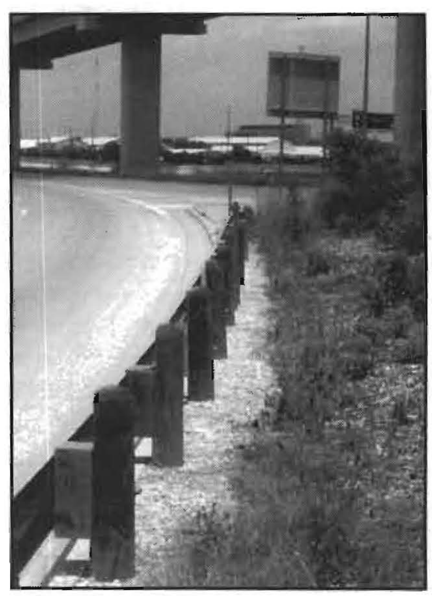


FIG. 1: Bio-Barrier under 50.8 mm (2 inches) of limestone base.

ducted at the field test lab at the TTI Proving Grounds. The results are sufficiently significant to warrant the consideration of extending the use of this material within the roadway. The researchers think that the best use would be in areas where access by mowers or trimmers is difficult or unsafe, particularly along stretches of high-speed roadways. The flexibility of the fabric will allow it to conform to the footings around lighting bases and sign posts. Also, a strip of the material under construction joints in riprap would help prevent weed invasion. Inquires regarding Bio-Barrier should be directed to Reemay Inc., 70 Old Hickory, TN, 37138-3651, (615) 847-7267.

Weed Blocker Plots

Grass in all Weed Blocker plots shows significantly shorter height than the adjacent grasses. This indicates that the material is having the effect anticipated in that it is effectively limiting the resources the plant needs for growth, thereby reducing the size of the plants (Fig. 2). The notable exception is found in plot 6, (50.8 mm [2-inch] clay) where very few grasses or weeds are found. Researchers expected that at least the same results would occur where the two products are used together, but this was not the case. Where Bio-barrier and Weed Blocker were used jointly in 50.8 mm (2-inch) clay, researchers found numerous herbaceous weeds. They think part of the reason for the difference may be that the species of weeds near the other plots were not present near this plot to seed it. However, the results are interesting and bear further monitoring.

Weed Blocker is proving effective in reducing the height of grasses growing over it in limestone gravel. Only the 50.8 mm (2-inch) depth was tested because it was felt that 101.6 mm (4 inches) of soil would provide ample soil for taller grass growth. The advantage of this material would be that the areas under the guardrail would be vegetated rather than bare gravel. If the grasses were to stay in the 203.2 to 254.0 mm (8 to 10-inch) range or lower, this would provide a more attractive guardrail, without the normal degree of trimming. Two possible disadvantages present themselves. First, the grass may send runners over the curb. Second, there is much variability in the grass heights. This variation suggests that the plots have not reached a steady state. More time will help explain both these conditions. Inquires regarding Weed Blocker should be directed to Progressive Polymetrics, Inc., 5715 Lemona Ave., Van Nuys, CA, 91411, (818) 9020549.

Combination Plots

The plots with the combination of Bio-Barrier and Weed Blocker show better control than just Weed Blocker alone, except for plot 6, and worse results than Bio-Barrier alone (Fig. 3). The plots all show a clear line of change in vegetation height and species. If these grasses get thicker, they may create enough shade to prevent excessive evaporation from

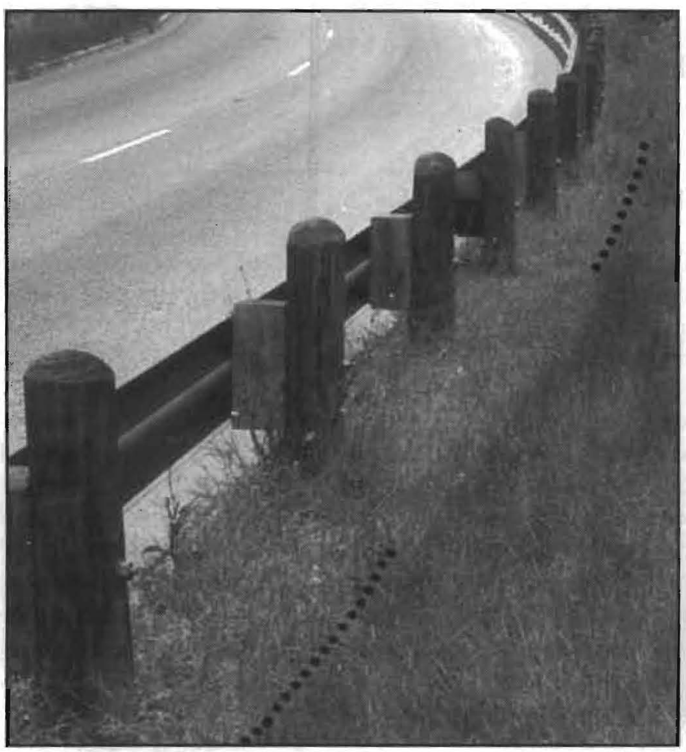


FIG. 2: Weed Blocker under 50.8 mm (2 inches) of limestone base. Dotted line indicates the approximate edge of the material.

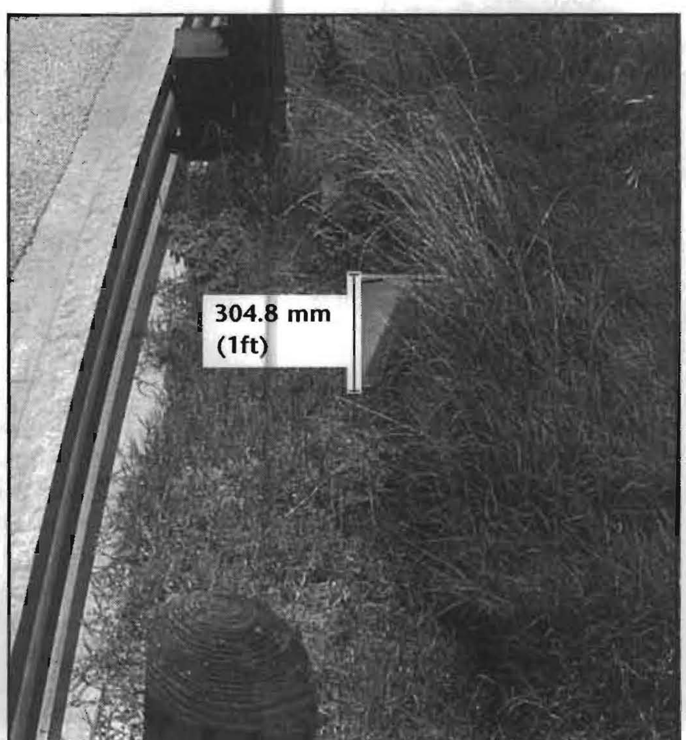


FIG. 3: Bio-Barrier and Weed Blocker under 50.8 mm (2 inches) of limestone base. Note clipboard for scale.

the plots, and the grasses may get too large. More time is needed to determine if these combinations are viable for the long term.

CONCLUSIONS

The following chart summarizes the observations of all the plots. Researchers suspected that there might have been some herbicide spraying in the area. Also, the plots had different amounts and types of grasses growing near them when they were installed. This probably created an unequal beginning point among the plots. For these reasons, monitoring of the plots will continue to see how they each respond to encroaching vegetation. While statistical analysis was not employed to quantify the degree of differences caused by the addition of these products, the visual differences were readily apparent. These approaches offer new options in the method of dealing with unwanted vegetation around guardrails. The best application will be in those areas where access by equipment or personnel is difficult or unsafe or where herbicide application is not feasible.

CONDITION OF PLOTS

Plot	Material	Remarks
1	Bio-Barrier; limestone gravel; 50.8 mm (2") depth.	Very clean plot. No grass growing. Isolated individual weed invasions at some posts, but these are not significant.
2	Bio-Barrier; native clay soil; 50.8 mm (2") depth.	Herbaceous weeds present but no grasses.
3	Bio-Barrier; limestone gravel; 101.6 mm (4") depth.	No grass rooted in the plot. Some grass runners are extending over the plot. No herbaceous weeds.
4	Bio-Barrier; native clay soil; 101.6 mm (4") depth	Herbaceous weeds cover the area but no grasses. Vegetation change clearly follows edge of barrier.
5	Weed Blocker; limestone gravel; 50.8 mm (2") depth.	Grass over Weed Blocker shows overall reduced height though the heights are highly variable. Heights range from 24.5–50.8 mm (1–2") in some places to 203.2–254.0 mm (8–10") in others. Grass adjacent to the plot is 304.8–381.0 mm (12–15") tall.
6	Weed Blocker; native clay soil; 50.8 mm (2") depth.	Few herbaceous weeds. No grass growth.
7	Weed Blocker with Bio-Barrier strips; limestone gravel; 50.8 mm (2") depth.	Grass is definitely shorter over Weed Blocker w/Bio-Barrier strips. Grass is 101.6–152.4 mm (4–6") tall compared to 304.8–355.6 mm (12–14") adjacent to plot.
8	Weed Blocker with Bio-Barrier strips; native clay soil; 50.8 mm (2") depth.	Grass is shorter than that adjacent to plot. Herbaceous weeds are present. Noticeable line where grass adjacent to the plot stops.

BACK TO THE FUTURE OF MOTORLESS TRAVEL

Reprinted with permission from the Texas Transportation Institute's *Researcher* 31(Fall 1995)

It's great for reducing auto traffic, pollution, and stress. Studies show that a growing number of people are taking a bicycle for more than just a Sunday ride. TTI's Assistant Research Specialist Danise Hauser, in a joint project with Texas A&M International's Dr. Pedro Hurtado, is creating a document that will make it easier for the Texas Department of Transportation (TxDOT) to accommodate those who bike or walk for transportation or recreation, providing a safer traveling environment for all roadway users — cars included.

"We are responding to a TxDOT directive to all district staff," says Hauser. In this document, TxDOT Executive Director Bill Burnett stated that "accommodation for both bicycle and pedestrian traffic must be considered on all projects, including those under construction, where reasonably possible."

Even before 1991 ISTEA legislation mandated support of multimodal transportation, bicycles were recognized in the state of Texas as vehicles legally entitled to operate on all roadways and shoulders, except controlled-access freeways. Currently, however, districts do not have a consolidated document that provides the decision-making framework needed to determine when and where bicycle and pedestrian facilities are appropriate, the type of facility that should be provided at those locations, and the design characteristics of the facility. Successful communication of this information will provide TxDOT with comprehensive guidance on how to plan, design, and implement facilities that enhance mobility and safety for all roadway users as they adhere to standard traffic operations, known to many as our "rules of the road."

Through extensive review of legislation and literature, and by conducting surveys, interviews, and regional panel discussions, researchers have established the state of the art in bicycle and pedestrian facilities. "Several states have constructed bicycle and pedestrian facility guidelines, using the Oregon, Florida, and North Carolina guidelines as models," says Hauser. "Our task is to create a document which is based on the best practices and is also appropriate for Texas conditions."

One of the key steps in this process is TAMU's development of a simplified assessment procedure — one that TxDOT personnel can use to determine the economic feasibility of different types of bicycle facilities under varying roadway conditions. Dr. Pedro Hurtado, a recognized expert on interrelationships between transportation and economics, is completing this portion of the study and has presented preliminary findings to project director Paul Douglas, in TxDOT's Multimodal Operations Office, and the study's technical panel.

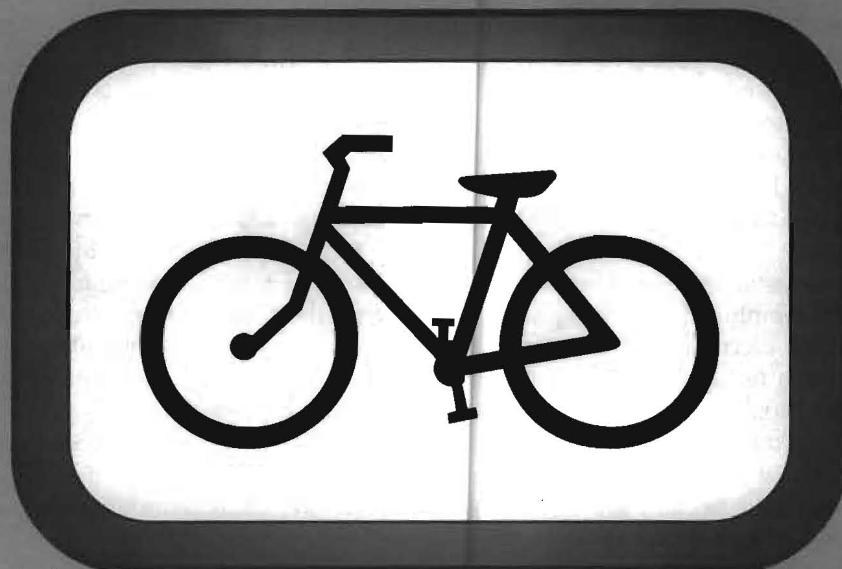
"We need to know what factors, besides the cost of the concrete, should go into the selection of a biking facility," says Douglas. How many cyclists are likely to travel the facility? Is the road leading to an elementary school or to a strip shopping center? What is the cost of the right-of-way necessary to build a separate facility? How can we cost-efficiently incorporate a bike accommodation in a project that is already underway, one that didn't have those elements built into the original design plans?

According to Douglas, it's *quantifying* the "when reasonable" part of the decision that is difficult, and this usually must be done on a project-by-project basis. "We're happy with the direction Dr. Hurtado is going — his preliminary concepts of the cost/benefit analysis are right on track with what we had envisioned," says Douglas.

While the findings from all these research activities are important in creating a usable document, also relevant is the incorporation of final technology transfer work. Researchers will present a preliminary draft of the guide to TxDOT district personnel in a series of workshops. Hauser points to the necessity of this task: "We hope that an informal review environment will allow for a wide variety of comments — the kind needed to 'fine-tune' the guidelines — so that they are as user friendly as they are accurate."

So as we move closer and closer to the 21st century, Texans can rest assured that when they choose that good old 19th-century motorless mode to work or school, they will be enjoying the state of the art in alternative transportation facilities.

For more information on Project 0-1449, contact Danise Hauser, (409) 845-4352, E-mail: d-hauser @tamu.edu. Guidelines will be available next year.



DOES SAFETY MEAN SEPARATION?

What types of facilities are most common in Texas, the U.S., and Europe? Which are most successful and why? An important aspect of Project 0-1449 has involved finding the answers to these questions so that the economic feasibility, design, and implementation information in the guidelines is based on historical success and not simply on theoretical hypotheses. Thus far, surveys of TxDOT bicycle coordinators and a wide variety of state and national experts and officials have identified four facilities most commonly used to accommodate bicycle transportation:

- ★ wide curb lane (4.2–4.8 m [14–16 feet], wider than standard 3.6 m [12-foot lane])
- ★ striped bike lane (extra operating space is striped exclusively for bikes)
- ★ wide, paved shoulder
- ★ multiuse paved path (separated from the roadway)

Each of these facilities has unique advantages and disadvantages that will be detailed in the guidelines. Interestingly, the designated bike lane and separated path, the facilities most requested by the general public, actually tend to increase conflicts between bicyclists and other users, including motorists. This may lend support to the integration concept — that is, by simply widening the standard lane, bikes can be safely accommodated. "With more people using bicycles as an alternative means of roadway transportation," says Hauser, "TxDOT's need for research of this type becomes even more pronounced."

REINFORCED SAND DUNES MAY STANCH COASTAL EROSION

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from ***Emerging Technology***
2(June/July 1995): 8

When mixed with sand, an adhesive gel often found in food products may create an erosion-proof sand dune that can help stabilize shorelines. New York-based Pfizer, Inc. has donated the undeveloped technology to the Texas Engineering Experiment Station (TEES), a state agency for engineering research that is affiliated with Texas A&M University.

"Coastal erosion, a natural process complicated by rising sea levels, has created a multimillion-dollar problem for coastal property owners. The market for cost-effective, environmentally acceptable solutions is ready and waiting," says Billy Edge, head of the ocean engineering program at Texas A&M and a researcher for TEES.

The Biodune composite consists an aqueous polymer gel added to 97% beach sand and water. The composite is sprayed with a truck-mounted pneumatic gun into the sloping surface of a threatened dune that has been covered with a biodegradable mat. The resulting surface is firm but resilient, natural in appearance, and resistant to erosion from waves and tides. The polymer gel is made of nontoxic chemicals that are found in nature and used as food additives.

Reportedly, recent tests of Biodune in Florida and North Carolina indicate that the product is compatible with the natural ecology of vegetation growth and marine life. Sea-turtle nesting and hatching in Florida were monitored daily for two years with no adverse effects. The gel biodegrades in four to five years, long enough for vegetation to establish erosion control.

The U.S. has more than [6437 m] 4,000 miles of shoreline with critical erosion, and the problem increases every year. Studies show that spending on erosion control costs government and private agencies more than $100 million annually.

"Biodune is more permanent and effective than beach renourishment," says Michael H. Auerbach, senior associate director for safety and regulatory affairs with the Pfizer food-science group. "The technology is more environmentally acceptable than seaways and other artificial structures. It doesn't damage the beach, it allows vegetation to grow, it looks natural and it's biodegradable." Auerbach is coinventor of Biodune and holds the patent with Wayne Borden, director of process research and development for the food-science group.

"Many states no longer allow seawalls, because vertical structures direct wave energy straight down and accelerate beach destruction, even if the buildings are protected," Auerbach says. He believes that most states will allow the use of Biodune, however, because it is environmentally benign.

In 1989, a Biodune prototype near Wilmington, N.C., stood firm against Hurricane Hugo despite significant losses to surrounding dunes. A condominium property lost [4.6 m] 15 feet of its natural dunes compared with only negligible losses where the Biodune prototype met natural sand.

Researchers say Biodune costs about $200 per [304.8 mm] foot. The price tag on seaways can range from $250 to $500 per [304.8 mm] foot. Beach nourishment costs $300-$600 per [304.8 mm] foot and requires a longer stretch of beach than most owners possess. In severe cases, developers may use both beach nourishment and Biodune, since the former replenishes the beach and the latter then protects the dunes that lie behind the beach.

TEES will seek a licensee for the Biodune technology. With modification, the technology has the potential to be applied not only to erosion problems in coastal zones but also to inland waterways.

For more information contact Billy Edge, Texas Engineering Experiment Station, 332 Wisenbaker Engineering Research Center, College Station, TX 77843-3134; (409) 845-5510.

Biodune allows vegetation to grow, looks natural and is biodegradable, say researchers. It will work better than beach renourishment, sandbag sills, and permanent structures such as seaways, groins, and bulkheads. Photo by Jack Lewis courtesy of TRV Photo Library.

SHRP CORNER

TXDOT EVALUATES GROUND-PENETRATING RADAR AS PAVEMENT STUDY TOOL

by **Gerald Freytag, P.E.**
Pavement Engineer
Yoakum District
Texas Department of Transportation

BACKGROUND

Although it may be considered something new and is listed as a SHRP product, ground-penetrating radar (GPR) has been used by TxDOT since 1993. The Texas Department of Transportation's (TxDOT) Pavements Section of the Design Division is using radar to determine pavement layer thicknesses and to detect voids or moisture that may be hidden under or within a pavement. TxDOT has blazed ahead into the implementation of this technology and is drawing its own conclusions about the value of GPR.

A GPR unit consists of a specially equipped van, which has an antenna mounted on the front directed at the pavement surface. This radar unit is one of the newer 1 gigahertz, air-launched systems that can collect data at speeds of up to 80 km/h (50 mph). A pulse of electromagnetic energy, a radar wave, is transmitted by the antenna into the pavement. The transmitted wave is partially reflected at each layer interface. The reflected waves are captured by the antenna and displayed on a screen in the van as a series of peaks (amplitudes) at different arrival times. Each amplitude represents a reflection from the surface of each distinct pavement layer. The time delay between these peaks is the time required for the radar wave to travel through the layer to the top of the next layer and back. Therefore, this time of travel is related to the thickness of the upper layer. Each material making up a pavement layer has its own dielectric (nonconductive to direct electrical current) properties. The amplitude of reflection at each interface is a function of the change in dielectric from one layer to the next. With highway materials, the property that mostly influences the dielectric of a layer is the moisture content. The thicknesses of each layer are essentially measured and recorded with each pulse sent from the antenna as the unit moves along the roadway. The GPR can penetrate up to about 355.6 mm (14 inches) of pavement.

WHAT IT CAN DO

GPR has been used successfully to identify section breaks, layer thicknesses, and material defects. Pavement layer thicknesses are acquired in project- and network-level surveys. Having knowledge of the thicknesses within a project helps the engineer determine quantities of material to be removed or manipulated during construction. The network-level pavement management effort needs thicknesses for use with falling weight deflectometer (FWD) data so that parameters related to the load capacity of the pavement can be calculated. Layer thickness information is usually part of the roadway inventory log, and GPR could be used to obtain the thickness values quickly and accurately.

Layer thickness has usually been

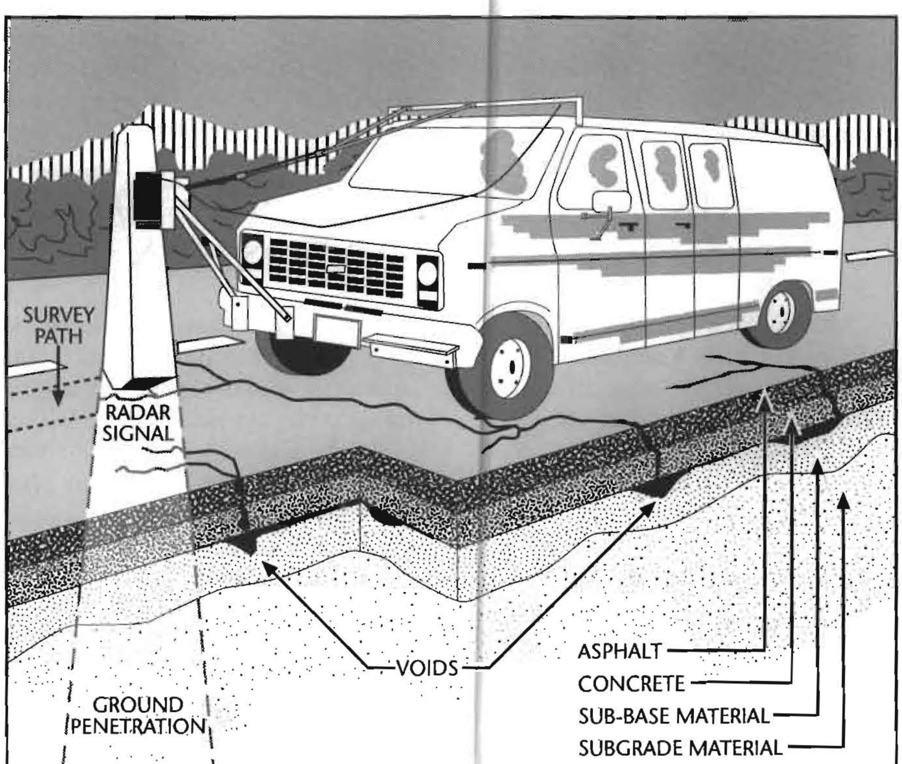

FIG. 1: A schematic of air-launched, ground-penetrating radar.

determined by obtaining cores from the pavement. This method is slow, expensive, and often hazardous to the person coring and to passing traffic. Because the vehicle-mounted GPR can operate at speeds of 80 km/h (50 mph), traffic flow is not disrupted. A profile of layer depths results from a GPR survey, which equates to hundreds if not thousands of individual core depths. Besides gaining layer thicknesses, a trained operator can detect voids under concrete pavements, delaminations of concrete in bridge decks, and moisture that is trapped within asphaltic concrete pavement (ACP).

TxDOT began its experience with GPR in 1989 when it funded a research project with the Texas Transportation Institute (TTI). In 1994, TxDOT bought its own unit and, along with TTI, currently has GPR available for pavement investigation needs statewide.

GPR-related products from SHRP include a signal processing software package that produces a plot of the layer thicknesses after receiving information from the antenna. TTI, however, has developed its own software to process the signal and has been using it successfully for the past two years. This software requires less expertise in identifying radar signals than the SHRP product and is considered more suitable for TxDOT's use.

SUCCESSFUL FIELD TRIALS

TxDOT districts have been seeing firsthand the benefits of using ground-penetrating radar in pavement failure investigations. A survey performed in the Yoakum District helped assure that the correct rehabilitation strategy was chosen for a portion of Interstate 10 in Colorado County. Visible failures, believed to be caused by stripping, were not widespread but were steadily increasing in number. The survey helped the district verify that moisture was present in the lower portion of a thick ACP overlay. With water present, stripping of the asphalt from the aggregate within the ACP would be likely to occur. The district was able to determine that the potential for stripping existed throughout the area as evidenced by the plots generated during the GPR survey. A total removal and replacement of the old overlay would be necessary, but the district could do so with confidence that the correct alternative was taken.

Houston District also has used GPR successfully to locate both voids and problem stripping areas. (See ***TQ7-1***, "Successful Void Detection on US 59 Using GPR" and "Nondestructive Testing at Near-Highway Speed Locates Pavement Problems on IH 45.")

GPR antennas may be ground coupled, instead of air launched, which means that they must remain in contact with the ground and be moved at a slow speed. This 25-to-30-year-old radar technology operates at low frequencies and achieves deep ground penetration. Small, portable units have been used by TTI to locate unmarked graves during a route survey for a relocated highway. Also, they have been used for detecting buried pipes and storage tanks.

CONCULSION

TxDOT pavement engineers have not waited for a cue from SHRP to begin using this tool of nondestructive testing. Forward thinking in TxDOT has provided ground-penetrating radar ready for widespread use across the state soon. If you think that you may have an application for GPR or if you need more information on this topic, call Carl Bertrand of the Design Division (Pavements Section) at (512) 465-3675.

AIR TRANSPORTATION — OPPORTUNITIES FOR INTERMODALISM IN THE ITS ERA

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Dr. Adib Kanafani
University of California, Berkeley,
ITS Intermodal News (Fall 1995): 4-6

INTRODUCTION

It can be said that most transportation is intermodal, for there are a few cases where a trip can be made exclusively on one mode. Of all modes of transportation, aviation is probably the most dependent on intermodal interface. In fact, aviation functions only in an intermodal context, since it is not possible to engage in flight without interfacing with other means of ground transportation. Airport access interface is certainly a most important element of intermodalism in aviation. But there are other less obvious, but no less important, aspects of intermodalism associated with it. This essay attempts to define the context for intermodalism in aviation and to identify some of the opportunities that Intelligent Transportation Systems (ITS) offer for enhancing intermodal interface.

Using the analogy of economic linkages, we can identify two types of intermodal effects, forward and backward effects. The first, or the forward effect, results when engaging in air transportation results in demand for ground transportation activities primarily associated with the interface with airports. It is dominated by the airport access activities of travelers and shippers. The second, or backward effect, results from the ground transportation activities necessary to support the aviation sector. The transportation demand of

Continued on page 12

SIGN CREWS, WE NEED YOUR INPUT!

THE ORIGINAL PROBLEM

Texas Department of Transportation sign crews have to rely upon the Texas ***Manual on Uniform Traffic Control Devices*** (MUTCD), the TxDOT ***Traffic Control Standard Sheets,*** or instructions from supervisors to determine the most effective placement of guide signs on conventional (not access-controlled) highways. However, these documents address only a few signing situations. Many others are not addressed. Because of this lack, districts treat many signing situations differently throughout the state. These differences can confuse motorists.

The signing principles and illustrations provided in the MUTCD typically treat a single type of sign (regulatory, warning, conventional guide, freeway guide) and not situations where sign crews need to install more than one type of sign near another type. In addition, the MUTCD is primarily a text document intended for traffic engineers. It contains limited illustrations addressing placement and other issues that are of greatest concern to field crews.

THE SOLUTION

The research team of Project 0-1373, ***Evaluation of Rural Guide Signing,*** is working on a draft of a field book of guide signing practices for conventional highways. This guide, ***Conventional Guide Sign Field Book,*** provides field personnel with information beyond that contained in the Texas MUTCD or the standard sheets. The field book addresses types and uses of conventional guide signs, height and lateral placement, placement on intersection approaches, placement on intersection departures, and special signing applications. It also covers situations where sign crews may need to use regulatory or warning signs in the same area as conventional guide signs. It emphasizes illustrations over text and focuses primarily on placement considerations. Figure 1 is an example.

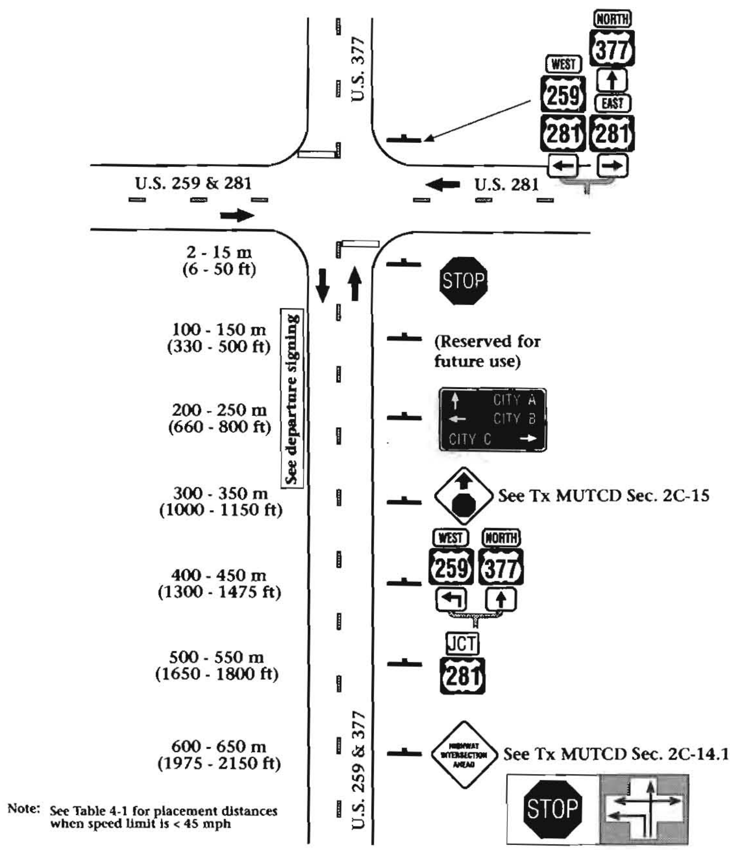

*FIG. 1: Example of approach lane and stop control where the approach route goes through and left (Fig. 4-16 from the **Conventional Guide Sign Field Book** draft, page 4-29).*

THE CURRENT PROBLEM

The research team has been developing the field book for over a year, working closely with a panel of TxDOT engineers. Now they need input from the intended users of the document — sign crews. The research team wants to know what information is useful, what subjects should be improved upon, and what should be added or eliminated.

Copies of this draft field book have been sent to every district. Currently, individuals in several districts are reviewing the draft. The research team originally had planned to hold a series of three regional meetings to discuss the field book directly with sign crews. Unfortunately, those meetings have been canceled due to a lack of research travel money. Project 0-1373 ends this fiscal year, so the research team needs your comments quickly.

WHAT YOU CAN DO

District personnel — particularly sign crews — interested in signing should review a copy of the ***Conventional Guide Sign Field Book.*** To get one, call research supervisor Gene Hawkins, P.E., of the Texas Transportation Institute at (409) 845-9946. Read the field book. Then, send your comments by mail or by fax to Gene Hawkins, P.E., TTI, TAMU, College Station, 77843-3135; fax (512) 416-3161 — soon. To make this book useful to **you**, the research team needs your opinions and ideas!

SWELLING SOILS: NEW FIELD TEST PROCEDURE TO PREDICT PAVEMENT DAMAGE

Reprinted, with minor editing, from TTI's ***Researcher*** 31(Fall 1995)

INTRODUCTION

Lime ... Sulfate ... Heave ... Electrical conductivity ....

What do these four things have in common? The answer is soil — but a complete explanation of how and why it matters is a little more involved. Recently published Texas Transportation Institute (TTI) Research Report 1994-5, ***Reduction of Sulfate Swell in Expansive Clay Subgrades in the Dallas District,*** contains a thoroughly researched, detailed explanation, along with some innovative solutions to an acknowledged problem with Texas clay soils.

THE PROBLEM WITH LIME AND SULFATE

Before a pavement structure is placed, the soils underneath must be stabilized to improve mechanical stability and durability. Compaction is the most common form of soil treatment, but for soils high in clay, compaction alone is not enough. Lime is added to the clay in order to make it strong enough to carry construction traffic during wet weather. Adding lime greatly reduces downtime due to muddy conditions during construction. This process, known as lime stabilization, can double or even quadruple the long-term strength of the soil.

When clay soils are high in sulfates, however, the lime may react with the clay and the sulfates to form an expandable mineral called ettringite, which can increase to 200 percent of its original size. The resulting expansion can crack roadways, causing great structural and economic problems. The damage, called heave, often looks as if a gopher has tunneled right through the road.

To help solve this problem, Sanet Bredenkamp and TTI Research Engineer Dr. Robert Lytton completed a subtask of Study 7-1994, ***Highway Planning and Operation for Dallas District Phase III.*** Sponsored by the Texas Department of Transportation (TxDOT), this portion of the project resulted in a key field testing device and procedure that measure the sulfate content of soils, allowing for easier identification of sites with a high potential for expansion due to reaction with lime. The researchers also recommend for high-sulfate soils some alternative methods of soil stabilization using fly ash, an industrial waste material. Figures 1 and 2 show the expansion of the Dallas soil samples with and without lime.

ESTIMATING SULFATE IN THE FIELD

The field test procedure uses a permittivity probe and regression equation models to determine whether a clay soil is likely to suffer from sulfate-induced heave. "We based the test on parameters of electrical conductivity because it's easy to measure. Ours and other studies have demonstrated a direct correlation between electrical conductivity and sulfate content in soils," says Lytton, the research supervisor on the subtask. High electrical conductivity generally points to a sulfate-rich soil.

The recommended seven-step procedure avoids the expense of laboratory equipment and time-consuming analyses with a simple measurement device in a plastic box the size of a regular tool kit. Developed as part of

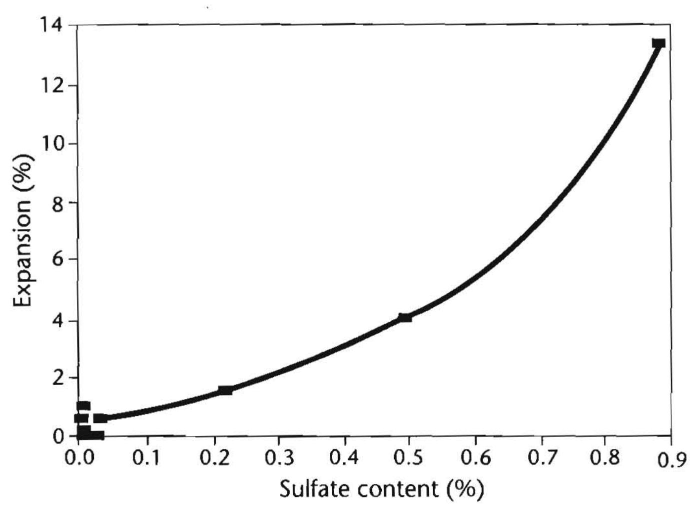

FIG. 1: Expansion of soil samples containing 6% lime versus sulfate content.

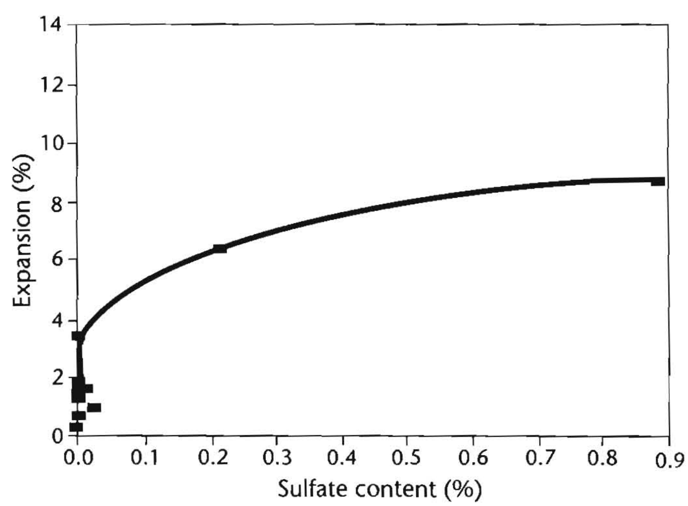

FIG. 2: Expansion of soil samples containing no lime versus sulfate content.

the study, the field testing kit consists of a portable probe, a scale for weighing, distilled water, and a bowl attached for mixing and measuring the soil sample.

First, use the kit to determine the moisture weight of the soil sample. Then, after mixing a carefully measured 1:0.5-ratio slurry of soil and water, use the probe to measure the electrical conductivity of the soil-water paste. Estimate the amount of sulfates in the soil using a graph that relates electrical conductivity to sulfate content. This value can also be entered in one or both of the equation models, which provide an estimate of the amount of sulfate-related swell likely to occur both before and after lime stabilization. Research Report 1994-5 explains in depth both the procedure and the equations.

FLY ASH ALTERNATIVES TO HYDRATED LIME STABILIZERS

Left with the question of what to do once it has been determined that a soil is likely to expand with lime stabilizer, the research team investigated several alternative stabilizers. The most commonly used lime stabilizers contain hydrated calcium limes. According to Lytton, "Because it is the calcium that reacts with sulfates to form ettringites, we have proposed the use of locally available low-calcium fly ashes — Sandow, Montecello and Big Brown — as alternative stabilizing agents for sulfate-bearing soils." The laboratory expansion test results showed that high-sulfate soil taken from the field test site at FM 1382 in Southwest Dallas County performed better if stabilized with a low-calcium fly ash. Big Brown did not perform as well as Sandow or Montecello.

"We plan to use this field testing device and the fly ash alternative because it's a low cost, viable solution to a problem that has been around since the 1950s," says Bill Hale, Southeast Dallas County Area Engineer and an active project advisor. "This is a good example of research results that will really provide the department some benefits in terms of both the low-cost testing device and the taxpayer savings from prevention of pavement damage."

For more information, order TTI Research Report 1994-5 from RTT Librarian Dana Herring at (512) 465-7644 or call RTT Implementation Engineer Moon Won, P.E., at (512) 465-7648.

LATERAL AND ROTATIONAL STIFFNESS OF HIGHWAY BRIDGES

DESCRIPTION

This project, part of the Federal Highway Administration's Demonstration Project 83, ***Structure Foundations,*** is a multistage effort to improve the state of the practice for designing bridges for extreme events, such as ship impacts, scour, and seismic events. It will:

- ★ Identify and evaluate contemporary design methods, then select a currently recommended design method and publish an FHWA Technical Advisory describing the method
- ★ Outline a comprehensive R&D program to develop an improved design method
- ★ Conduct a national conference and several smaller workshops to disseminate technical information about the best current method(s) and status of the R&D program
- ★ Initiate further technology transfer activities to implement the new methods

BACKGROUND

A bridge design method consists of a design process coupled with an appropriate analysis model. Current design methods for bridge substructures and superstructures for special events are not well defined in existing design specifications and technical references. As a result, designs vary widely from very conservative and costly to extreme and unsafe. AASHTO specifications provide little guidance for special design event loading combinations or for the load magnitudes when combinations are applied.

PROJECT MANAGER

Chris Dumas, HNG-31, (202) 366-8080.

STATUS

The 2nd Technical Working Group meeting was held September 26–29, 1994, in San Francisco, California, to select the best current methods, outline critical R&D needs, and define the format and objectives of the national conference scheduled for November 1996 in Atlanta, Georgia.

Source: USDOT WorldWide Web site.

You
missed
the TxDOT
Bridge Designers'
Conference?!
(Feb. 6–8, 1996)

Don't despair. The videotapes are in and available from the RTT Library. Call Dana Herring at (512) 465-7644.

Editor's note:
This was the best one yet!

Air Transportation — Opportunities for Intermodalism ... continued from page 8

this major economic sector represents a nontrivial proportion of the total transportation picture in the economy. Both of these intermodal effects stand to gain significantly from the opportunities brought about by ITS. To appreciate the importance of those intermodal effects, it is helpful to look at some indicators of their magnitude.

The magnitude of the forward effects of air transportation can be measured by the traffic volume handled by the system. In the U.S., there are currently about 500 million annual enplanements. A rough estimate is that this generates about 40 billion passenger miles or 20 billion vehicle miles annually in travel to and from airports. While this is a small fraction of the total urban transportation volume, its significance increases when one considers that it occurs during high volume periods and on the more congested urban corridors. A single major airport, such as San Francisco, serves over 30 million passengers annually, who generate close to 400 million vehicle-miles on an already congested freeway network. Forward intermodal effects of aviation do not stop with passenger access to major airports. Of over 60 million annual aircraft operations in the U.S., nearly 40 million are general aviation operations. These too have a significant intermodal effect. Nor can we overlook the fact the U.S. airports enplane about 15 million tons of cargo each year, which must generate close to a billion ton-miles of truck traffic to and from these airports.

The backward intermodal effects, although less obvious, are likely to be far more significant. As a major sector of the economy, aviation generates a huge demand for goods and services, which in turn generates a demand for transportation, most of which is probably on the ground. While it is difficult to estimate the precise magnitude of the aviation sector in the U.S. economy, it is not difficult to see that it is in the hundreds of billions of dollars. Consider as an illustration that airline revenues alone amount to about $80 billion annually and that the value of aircraft production is estimated at about $40 billion annually.

Air transportation is clearly an important sector of the economy, and one that places significant intermodal demands on transportation. It is probably fair to say that most of the transportation activity generated by air transportation is in fact on the surface transportation system.

Of all the modes of transportation, aviation is probably the most dependent on intermodal interface. Air transportation has led other transportation modes in the use of information technology and automation — two major elements of ITS. New opportunities exist in the intermodal connection of the two.

OPPORTUNITIES IN ITS

There are many opportunities in the emerging area of ITS for enhancing the productivity of the air transportation system by improving the intermodal connections on which it is so dependent. For the purposes of this discussion, we characterize ITS technologies by focusing on the word *intelligent*. In this context, transportation technologies are intelligent if they have the capability to use internally built features in order to sustain a high level of efficiency in the face of changing exogenous influences. Thus, a traffic control system that automatically adjusts its internal parameters in response to changing exogenous traffic conditions can be considered intelligent. An information system that advises travelers in real time of changes in traffic conditions, thereby permitting them to respond accordingly, can be considered intelligent. A highway link on which vehicles automatically adjust their longitudinal and lateral positions to respond to exogenous factors in such a way as to maintain a high level of efficiency and safety can be considered intelligent. In their current evolutions, ITS technologies rely on two ingredients to achieve this intelligence: information technology and automation. These two ingredients channel into the transportation system a vast array of new technologies in areas such as computation, control, sensing and automotive design. The introduction of these two ingredients into surface transportation is moving at a rapid pace. Air transportation has in fact led in its use of these elements of ITS. Both automation and information technologies are fairly common in aviation. The new opportunities are in the intermodal connection between the two.

INFORMATION TECHNOLOGY

One of the important features of information technology as it is applied in ITS is its ability to integrate transportation systems spatially and temporally. This will permit the optimization of systems across physical elements, geographical and political jurisdictions and over periods of time. This same capability can be used to integrate systems across modes, thereby permitting optimization over larger domains of the transportation system. For example, the same information systems that provide travelers realtime feedback about highway congestion could be providing relevant information about airport congestion for those in the airport access system.

Another feature of information technology as used in ITS is that it permits the operators access to knowledge useful in optimizing operations in the economic sense. This means the ability to implement sophisticated pricing mechanisms that better match established public policies, or to implement regulatory procedures that are tailormade to actual situations. Here too, this feature can be extended to encompass all relevant modes, permitting better economic optimization. For example, a pricing mechanism can combine tolls for highway use with parking fees at or in the vicinity of an airport. In an era of increasing interest in airport passenger facility charges, a road and parking toll could be bundled with such airport use charges or, indeed, with the price of air travel as a whole. Bundling can have advantages to both producers and consumers of services. There are many such opportunities in information technology. Below is a short list of ideas that appear from preliminary analysis to have potential. There are certainly many others.

Integrated ATMIS and Airport Ground Information System

Advanced traffic management and information systems ATMIS, represent an important component of ITS. Important developments are taking place, and ATMIS technologies are being implemented in urban transportation networks at an accelerating rate. On the other side, airport ground information systems are today fairly advanced versions of ATMIS in which ground transportation information is made readily available to airport users. But these two systems remain disjointed. Urban ATMIS systems rarely include information about airport conditions. Airport information systems are static and do not reflect actual traffic conditions on the access system. Integrating these two systems would result in a significant increase in the value of information in each of them.

Integrated ATMIS and Flight Information System

As a next step beyond the above, one would want to integrate flight information into urban ATMIS information bases. This would add a significant capability for urban users of air transportation. Most efficiency gains would probably occur in the pretrip planning stage for passengers and in air freight distribution management.

Integrated Air and Ground Freight Management Systems

In the freight area, the next step would be the complete integration of air and ground freight management systems. This would encompass the integration of flight and ATMIS information systems at both the origin and the destination. Allowing optimal allocation of resources in freight and flight systems in a realtime environment would permit significant efficiency gains.

Bundled Service and Pricing for Air and Ground Transportation

ITS technologies can be used to enhance the economics of transportation systems. Automated billing and toll collection have become possible with the advances in AVI and AVL technologies. Indeed these are in operation at a number of airports in the U.S. including DFW, IAH, and DEN. With the integrations possible with information technologies, it becomes possible to bundle urban and air transportation services for the purposes of billing and toll collection. The economic advantages of bundles prices for service can accrue to both users and suppliers of services. ITS technologies can also permit integration that has not been possible due to institutional barriers.

Enhancing Prediction of Systems Demand

Inasmuch as travel and shipping activities are intermodal in nature, it would enhance the predictive ability of system planners and operators to be able to predict demand across modes. For example, an urban ATMIS system in an area that includes a major airport would benefit from the ability to predict air traffic flows as they materialize in the air transportation system. Conversely, airport operators would benefit from being able to predict flows into the system as they may evolve over the ground access system.

Improved Airport Distribution Management

Some of the ATMIS capabilities being developed for urban transportation or for commercial vehicle operations would yield significant operational benefits to large airports. These airports have an extensive and complex network of service roadways that often suffer from congestion. Better management of congested interface systems such as airport garages or curbside facilities can be achieved by applying ATMIS technologies, and by integrating the airport system with the rest of urban networks.

AUTOMATION TECHNOLOGIES

This is an area where aviation is far more advanced than surface transportation. Nonetheless, benefits from integration will accrue to all systems. The advanced navigation and communication technologies used in flight operations can be combined with the emerging technologies of AHS to provide a capability for automating integrated systems that carry large volumes of traffic. For example, one of the more promising advances in air traffic control technology is the concept of free flight. This complex system would permit aircraft to cooperatively generate user optimal flight paths. Similar control architectures are being developed and tested for the AHS system. The synergies from a technical exchange between the two systems are very promising indeed. Two other intermodal applications of automation technology that come to mind are:

Airport Ground Interface Systems

Increasingly complex systems for interfacing between the airport and its access tributaries are inevitable as volumes continue to increase. Automation can play an important role in streamlining this interface. Large scale distribution can be serviced via automated traffic systems that provide access to terminal facilities and that optimize the utilization of scarce airport space.

Service Traffic Automation

Efficiency and safety can be enhanced by automating the vehicular traffic on the air fields. Some of the technologies developed for urban ATMS systems can be used to manage the complex patterns of flow of service vehicles on a large airfield. At the same time, developments in the use of GPS in the management of airfield flows can be extended for use in surface transportation.

Suggestions for the ITS effort

It is evident that there is a significant intermodal potential in ITS. However, for this potential to materialize, it will be necessary to expand the perspective of current ITS efforts and to broaden their scope into a multimodal one. Current ITS efforts reflect a mode-centered paradigm, as reflected by the customary functional classification of programs. There are ATMIS activities that are centered on highway traffic; CVO activities that are focused on truck operations; and APTS activities that are concerned primarily with bus transit. At the same time, efforts to deploy ITS technologies at airports proceed with little or no interface with these other programs. What is needed to make the intermodal attention go beyond lip service? Here are some suggestions that represent a partial list of what might be done:

Institutional Commitment: The institutions involved in ITS must make substantive moves toward intermodalism. This applies to public and to private sector agencies, but the brunt of that responsibility must fall on the government in this early stage of ITS development. Despite all intentions and proclamations, it is fair to say that modal fragmentation persists. For example, aviation and surface transportation institutions are still widely separated, working in different arenas and with different paradigms. At the national level, intergovernmental, multimodal efforts require substantive political commitment attention and will depend ultimately on budgeting procedures that facilitate multimodal programming.

At the local level, public agencies must integrate their efforts to demonstrate intermodal ITS technologies. At this level, institutional incongruities among the different modes need to be overcome. Metropolitan planning organizations or urban congestion management agencies typically have little to do with airport authorities. Recent history suggests that coordination at the most basic level in areas such as airport access planning is lacking. Industry commitment is also essential for a successful development of an intermodal effort. Industry is an important partner in research and development and in testing and demonstration.

Technical Integration

Intermodalism should be integrated in the R&D efforts of ITS as early as possible. While ITS developments have been underway for nearly a decade now, important foundation work is still being laid out. The integration of intermodal aspects at this early stage is important to ensure success in eventual deployment. Two areas come to mind as requiring immediate attention. The first is the area of system architecture, where important work is underway that lays the foundation of the technology configuration, integration and implementation. Current architecture efforts are focusing on highway transportation with some attention being paid to integrating automobile and bus transit technologies. Taking intermodal requirements into account may result in changes in the system architecture that are possible to make now, but virtually impossible to implement later on.

The second area is that of standards. It is clear that system integration across modes is going to require compatibility of components and protocols. Advanced communications and control devices are being developed for many ITS technologies. AVI stands out as an important example where different standards may be emerging for different transportation systems. Currently there are developments in AVI on the highway system, the rail system and at many airports. In order for these component AVI systems to contribute to a seamless intermodal application, they need to be compatible. Without coordinated standards, development is only a matter of luck if these systems end up being compatible.

IMPLEMENTING TXDOT'S ROADWAY SMOOTHNESS SPECIFICATION

Reprinted, with editing, from TTI's *Researcher* 31(Winter 95-96):

Staying in tune with driver needs includes maintaining smooth highways. Smooth road profiles offer lower user costs and favorable perceptions of ride quality, not to mention longer-lasting roads with lower repair costs. Through its work on Research Project 0-1378, ***Development of Ride Quality Specification Criteria for ACP Overlays,*** the Texas Transportation Institute (TTI) is helping the Texas Department of Transportation (TxDOT) implement the specification it has set on roadway smoothness.

"We initially evaluated the applicability of the existing specification for asphalt concrete," says Emmanuel Fernando, research supervisor of the project, "and found that, used in conjunction with guidelines to establish when surface preparation is appropriate, it may be used successfully on asphalt overlay projects."

The research team evaluated a number of automated profilograph models that can be used for acceptance testing of the final pavement surface. They also evaluated ProScan, a hardware/software package used to analyze data from manual profilographs.

Developed by Dr. John Devore of Kansas State University, the entire ProScan system consists of a paper transport unit, a hand scanner, a computer, the ProScan software, and a user's guide. During the scanning process, ProScan divides a profilogram — the output or "trace" produced by the manual profilograph — into 0.16 km segments and saves the reduced data to the computer's hard disk. The resulting printed report gives the profile index for the scanned roadway segment and shows the precise location of surface defects.

Compared with the time-consuming and subjective manual analysis method traditionally used to evaluate profilograph data, ProScan has proven to be significantly faster and more consistent.

"In our evaluation, it took our raters, on average, four hours to manually reduce 3.54 km of profilograph data. We were able to reduce the same data in ten minutes with ProScan," says Fernando. "The faster the acceptance tests can be done, the earlier the roadway can be opened to traffic."

In the next phase of this project, researchers will shift their emphasis to the long-term goal: developing a smoothness specification based on true roadway profile, rather than the profilograph.

The construction profiler, a new instrument currently under development by TxDOT, will supersede the profilograph by producing a true profile measurement of final surface smoothness. TTI researchers expect to have a prototype of this instrument ready early next year.

"The construction profiler will provide a more accurate profile measurement of the final surface when compared to the present manual system and automated profilographs," Fernando says. "We're working with TxDOT toward revolutionizing the measurement and specification of roadway smoothness to improve the riding quality of our highways."

For more information on project specifics, contact project director Ken Fults at (512) 465-7741. To order TTI Research Report 1378-1, contact Dana Herring, RTT Librarian, at (512) 465-7644.

METRIC AWARENESS

Tracy Friggle, P.E., of the Construction and Maintenance Division has replaced Rich Rogers, P.E., as Chair of the Metric Task Force. Call her at (512) 416-2522 with questions about metric implementation.

PROFILOGRAPH AND PROSCAN TRAINING VIDEOS AVAILABLE

At the request of TxDOT, TTI evaluated two of the three automated profilographs — the CS8200, manufactured by James Cox and Sons, Inc., and the Ames Model 4000, developed by Richard Angove of Ames, Iowa — to determine how closely their data analyses matched that of the manual profilograph.

Following the evaluations, TxDOT approved the use of ProScan as well as the two computerized profilographs and requested that TTI prepare training videos on the Cox and the Ames systems. These videos will help contractor and TxDOT personnel learn how to use the automated devices for evaluating profile indices to determine compliance with the smoothness specification.

The videos were first presented in a training school held in September 1995 at the office of the Texas Hot-Mix Association. A third video on the McCracken automated profilograph is in production.

TxDOT personnel: to order copies of the videos, contact RTT Librarian Dana Herring at (512) 465-7644. All others contact TTI's Information and Technology Exchange Center at (409) 845-4853 (E-mail:dhott@tamu.edu).

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 TxDOT should be discussed with the appropriate Austin Division prior to implementation. *TQ* articles are not intended for construction, bidding or permit purposes.

INSIDE TQ

Spring Research Management Committees (RMCs)

will be held in a split format:

May 13 (1:00 PM) —
May 15 (12:00 PM)
RMC 1, 4, 6, 8, 9

May 15 (1:00 PM) —
May 17 (12:00 PM)
RMC 2, 3, 5, 7

Call Debbie Hall at (512) 465-7684 or Tom Yarbrough, P.E., at (512) 465-7685 for more information.

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