TECHNICAL QUARTERLY

"AN EXCHANGE OF IDEAS"

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SCOUR DETECTION DURING HIGH WATER

by **Kathleen Jones**
Research Section
Transportation Planning Division
Texas Department of Transportation

THE PROBLEM

Scour is one of two major causes of catastrophic failure of structures, the other being fracture in steel bridges. [See "Fracture Critical Bridges: What Districts Need to Know," ***TQ6-3*** (July 1991): 1-7.] Scour is difficult to detect because scour pits usually undercut footings, piers, and embankments during floods. Often the current is so swift and turbulent (Fig. 1), that no diver could inspect a structure for scour, no boat could scan the bottom profile, and weighted drop lines drift and snag, making accurate soundings from the deck impossible. As the high, fast water slows and recedes, scour pits are hidden by soft sediment deposits, making the profile of the bottom appear normal when inspection takes place in nonflood periods. For years, people responsible for scour-prone structures have been puzzling over how to detect scour during high water. This spring, two groups of TxDOT employees developed similar, but independently derived, solutions.

FIGURE 1: Turbulence may indicate scour at columns.

LUFKIN'S ANSWER

Situations occur in which a district must know if a structure is endangered by scour during a flood. Lufkin District (District 11) found itself in just such a situation around the first week of March 1992. Months of unusually heavy rainfalls had raised the level of Sam Rayburn Reservoir 12 feet above normal. Six to eight hours of strong north winds had caused high wave action, and the embankment that carries State Highway 147 across the reservoir was in trouble. Over a mile of riprap was out of place: Was the riprap slipping on the surface or was the embankment failing? SH 147 was closed due to heavy water spray across the roadway and to erosion encroaching on the shoulder behind the slipped riprap (Fig. 2a and 2b). More north wind was due, and the district

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FIGURE 2A: SH 147 embankment, Sam Rayburn Reservoir, District 11.

FIG. 2B: Closeup showing erosion.

feared that the road would wash out if the slope were failing.

San Augustine Area Engineer Walter Hearnsberger had the idea of using his bass fishing boat equipped with an Eagle Graph "fish finder" — essentially a recording depth meter — to get a profile of the toe of the embankment. The shape of the profile would indicate whether a serious failure was occurring or not. When the wind slackened, district personnel took the boat out in 25 to 35 feet of choppy, turbulent flood water and ran profiles. The profiles revealed that the embankment was stable, that the slippage was only superficial. The information was relayed to the Division of Bridges and Structures (D-5) who concurred with District 11's interpretation of the profiles. The northern cold front did not move in as predicted. The district erected temporary concrete barriers in the area of the slipped riprap, and reopened the road later in the week.

Until permanent repairs are made, the road is still at risk if the lake rises 4 feet (Fig. 3). Currently, the water level is at 164 feet. There is no slope protection above 168 feet. The department and the Army Corps of Engineers are negotiating how extensive the permanent repairs need to be and which agency will pay for what.

D-5's ANSWER

Lufkin District was fortunate. The embankment was not failing, and they were able to put a boat with profile-checking equipment in the water quickly to prove it. Frequently, in similar conditions with a bridge, the water is so turbulent around the columns or is so close to the bottom of the deck that a boat would be wrecked. The D-5 BRINSAP Special Inspection team, headed by Brian Barnett, P.E., has been working for over a year on safe methods to measure scour during peak flooding without endangering boat crews or divers. About the same time as the Lufkin experience, they devised an

FIGURE 3: SH 147 embankment, July 1992.

inexpensive way, also using a "fish finder," to check for scour.

The device, nicknamed 'Shi-flow' for surface high-flow profiler (Fig. 4), is made from a old water ski. Mounted on the ski are a transducer and a digital depth meter. A coaxial cable is run up the tether from the ski to the bridge deck and is plugged into a digital reader. Since the coaxial cable is much longer than the manufacturer intended, the BRINSAP team had the manufacturer recalibrate the depth finder. The total cost of the Shi-flow was $300. (As a comparison, boat-mounted sonar equipment specifically for profiling costs approximately $30,000.)

Using the Shi-flow is simple. The ski is lowered over the side of the structure nearest the area of suspected scour (Fig. 5). The hydrodynamics of the ski help to hold the device in the region of high flow, so the team is not constantly having to wrestle it back into position — a concern they had in the development stage before they tested the Shi-flow. The profile from the depth reader is checked against a copy of the bridge's official profile. Scour, if present, is recorded for the file. Should the scour appear to endanger the bridge, the team can close the bridge immediately. Since its first test run in March 1992, the Shi-flow has been used on more than 20 bridges around the state. It seems rugged and requires little maintenance.

Inexpensive sport fishing depth finders are not typically used to perform bottom profiles for official initial profiles; however, either in boats or on modified water skis, they are an excellent way to monitor scour during floods, thus protecting the travelling public without greatly endangering TxDOT personnel.

FIGURE 4: The "Shi-flow."

FIGURE 5: Shi-flow being lowered.

TEXAS HIGH-SPEED RAIL

by **Joan Fithian Tatge**
Communications Assistant
Communications Program
Texas Transportation Institute

BACKGROUND

By the first day of the 21st century, Texans will have a third choice for short haul high-speed transportation — that is, if all goes as planned. The plan is in the form of a franchise agreement between the Texas High Speed Rail (HSR) Authority and the Texas High Speed Rail Corporation, and it requires, among other things, $5.8 billion. Some argue that the money alone will prevent the high-speed rail dream from becoming a reality.

On the other hand, the HSR Corporation has met all deadlines to date on or ahead of schedule, so who's to say they won't also meet the December 31, 1992, deadline — $120 million in equity commitments, of which $30 million must be in cash — on time?

Such are the arguments surrounding HSR in Texas. Nonetheless, Texas is going full speed ahead with the project. The 50-year franchise agreement was negotiated, signed, and declared operational as of January 31 of this year. The authority kicked off an environmental impact study at Bryan/College Station's Brazos Center in June of 1992, and the results of the HSR Corporation's ridership study will be complete in late November — all this in accordance with the franchise agreement.

Once the HSR Corporation has reviewed the results of these two studies, they will be used to define the actual route for the high-speed train, to start selling stock in the corporation, and to get to work building what's to become Texas' third mode of transportation. The deadline for that construction milestone is in May of 1997.

All this progress is happening amidst opposing arguments questioning the chosen technology, the need for a high-speed train, its environmental consequences, and — not of least importance — the political appropriateness of such a project. In general, the arguments surrounding HSR can be divided into two groups — the opposition makes its points, and advocates offer counterpoints. . . .

AGAINST HSR

Not only is high-speed rail too expensive, it's not necessary for Texas. Texas highway systems and airports are adequate to meet the state's transportation needs. The legislature decided that Texas needed an HSR system and mandated that the funding be drawn solely from the private sector, but the rail operation will be so expensive that at some point the state of Texas will be forced to bail out the HSR Corporation. Given the current economic circumstances, Texas cannot afford the financial burden.

The burden of HSR goes well beyond the monetary issue. The Texas farmers and ranchers have their livestock to consider. The noise and vibration caused by a train traveling as fast as 200 miles per hour through a pasture is sure to have detrimental side effects. The ostrich ranchers say their birds won't lay eggs under such conditions. Likewise, the dairy farmers argue that their cows will stop producing milk.

Even if the opposition concedes to the necessity of HSR in Texas, why would we chose a foreign technology? The chosen steel-wheel-on-steel-rail technology is not an American technology, and it is not the fastest technology. Magnetic levitation (Maglev) could be developed as a United States technology, and the congress of the United States has authorized the expenditure of $500 million to $700 million dollars to develop a new Maglev technology. Also, Maglev is faster than steel-on-steel.

FOR HSR

Maglev technology is not yet available for intercity applications, and even if Texas chose to pioneer the technology, it would be three-and-a-half times as expensive per item as the steel-on-steel system. The steel-wheel-on-steel-rail system was chosen primarily because two such systems in Japan and France have 31 years, combined, of accident-free operation with daily service.

Steel-on-steel is an exceptional technology available today, but with a long life into the future. Maglev will become possible in 15 to 20 years, but steel-on-steel will still be very viable for intercity short range express hauls. That's what we're using it for in Texas.

The steel-on-steel technology allows for the use of existing right-of way, particularly in metro areas, minimizing the environmental impact. The use of electricity to propel the train allows for clean operation within its corridor. The biggest environmental advantage of the high-speed rail system, however, is clearest when the alternative is considered.

The high-speed rail train can accommodate the equivalent of 10 lanes of passenger vehicles between Dallas and San Antonio. Such an increase in highway lanes would not only be considerably more expensive than the HSR system, but the resulting auto emissions and required right-of-way would be much more detrimental to the environment. The entire Texas HSR system, on the other hand, will require less right-of-way than did the Dallas/Fort Worth Airport.

Although relatively little right-of-way is required for the HSR system, Texas farmers and ranchers remain concerned about the effects of the high-speed trains on their livestock. To date, no studies indicate that the trains will have any effects on the ability of cows and other livestock to produce. In France, where high-speed trains have been in operation for more than a decade, the livestock are virtually unaffected. Despite these facts, the HSR Authority is currently conducting an environmental impact study which will address, individually and collectively, the farmers' concerns and mitigate potential problems.

The environmental implications aren't the only factors to be considered. Although many airlines are opposed to Texas HSR, proponents argue that the system will complement rather than threaten the airline industry in Texas. If the HSR project goes as intended, the airlines will interface with the high-speed train for baggage handling, ticketing and rental cars. The result will be an intermodal transportation system for Texas.

Anyone coming in from an interstate, intercontinental or international flight will have several options when they reach their port of entry into Texas. D/FW, Houston Intercontinental and possibly San Antonio will offer a train, a plane, or a car for short hauls to the final destination. Currently, travelers can only choose to drive or fly.

Such an intermodal system will accommodate Texas' growing population. The 1990 census projects that by the year 2000, Texas will face a considerable population increase. Texas roadways and airports can't accommodate the growth, but the HSR system will supplement those systems by providing a third mode of transportation for Texas travelers. While some would consider building more highways and airports as an alternative to HSR, the cost of such plans is prohibitive.

The HSR system in Texas will cost a total of $5.8 billion over 50 years. That cost is reasonable when compared to the construction cost for 10 lanes of highway between Dallas and San Antonio, or the cost of building another intercontinental airport. Also, HSR is safer than either air or automobile travel, so it will be less costly in that respect.

The low maintenance and high degree of redundant systems serve to further reduce the long-term cost of HSR. The state-of-the-art computer applications at the heart of HSR allow for rapid maintenance when necessary. Since HSR has back-up systems for the back-up systems, it's unlikely that repair will interfere with the train's timely operation.

Time is also a factor. Ridership studies indicate that the primary user of Texas HSR will be the business traveler, both domestic and international. Since trains will be available at airports and in metropolitan areas, the normal time taken to rent a car, or get to the airport and find a parking place will decrease. For the business traveler, that time saved translates into money.

CONCLUSION

The Texas HSR will connect three of the largest cities in the nation and the five major cities in the state. All of the larger cities in Texas, with the exception of Waco, are developing transit systems. So, the entire state of Texas is working towards an intermodal transportation system that will set the precedent, not only for the nation, but for the western hemisphere.

If the HSR project goes as planned, Texas may very well become the center for high-speed rail for this hemisphere. Texas schools will turn out some of the best HSR engineers in the world. Since our technology will be years younger than Europe's, the world will look to Texas for the most recent information.

The transportation industry will have a regular source of high-speed rail information, at least on the steel-on-steel technology used in Texas. So, if Minnesota or some other state decided they were interested in high-speed rail, they would no longer have to look to Europe. The technology in Texas could be easily transferred to their state for their applications.

Meanwhile, two generations have been without train transportation in this country, so the idea of high-speed rail may take some getting used to. But the benefits of an environmentally and economically responsible project combined with the comfort and convenience of the trains will be such that, once Texans get a taste of high-speed rail, they won't want to live without it.

REFERENCES

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FACING CHALLENGES — STORM WATER MANAGEMENT

"Pollution from runoff of agriculture, urban areas, and other sources is a leading cause of water quality impairment." [Part IV, EPA 40 CFR part 122, *Federal Register* (April 2, 1992):25]. Highways and bridges are one of these "other sources." While highway runoff from storms may contain oil, nutrients, grease, bacteria, and toxic heavy metals such as lead and cadmium, the impacts of runoff on the local surface and groundwater are extremely site- and runoff-event specific. The pollutant loading may or may not create problems in the receiving waters, depending on the type of receiving water affected (e.g., aquifer, river, lake, recreational-use reservoir, wetland, etc.), the water quality standards associated with the receiving water, highway and bridge design features, local storm characteristics (frequency, intensity and duration), traffic volume, presence and type of vegetation between the runoff and the receiving water, and the relative size of the paved area compared to the entire watershed.

What is the Texas Department of Transportation currently doing about highway storm water runoff? Is it sufficient? How is it being implemented? What can the department do within existing means to improve the effectiveness of water quality control? These questions are the ones the new Storm Water Management Task Force have to answer. The task force has 12 members: Roland Gamble, Division of Environmental Affairs (D-17); John Aldridge, Division of Construction and Contracts (D-6); Ken Bohuslav, Division of Highway Design (D-8); David Gieber, Division of Maintenance and Operations (D-18); Peter Smith, Division of Bridges and Structures (D-5); Jim Henry, Division of Right-of-Way (D-15); Linda Howard, Division of Aviation (D-2); James R. Evans, Tyler District (Dist. 10); Gabe Johnson, Houston District (Dist. 12); John Kight, San Antonio District (Dist. 15); James N. Moss, Amarillo District (Dist. 4); Tom Word, Austin District (Dist. 14); and Bill Minor, Corpus Christi District, (Dist. 16). Chaired by Roland Gamble, the task force is coordinating with the Texas Water Commission in developing a storm water management plan for the department that will comply with the National Pollutant Discharge Elimination System (NPDES) adopted by the Environmental Protection Agency.

Developing a storm water plan for a state as geologically and climatologically diverse as Texas is difficult, but the Storm Water Management Task Force expects to have some preliminary answers in November 1992.

DESIGN CONFERENCE COVERS TOUGH ISSUES

The Texas Department of Transportation's Design Conference, June 22 to 24, 1992, covered a wide range of design topics from environmental issues through an overview of the Intermodal Surface Transportation Efficiency Act (ISTEA) to PS&E development schedules, review, and processing. If you missed it, don't despair! The Division of Travel and Information videotaped the entire conference, and it is available through the Research Library. The conference sessions are listed in *Research Digest 92-14*. Fill out the Digest request form or call Dana Herring at (512) 465-7644, Tex-An 241-7644, to request your loan copy of one or all the sessions. Papers from the environmental presentations are also available from the library.

Here are some highlights.

"During detailed design . . . you are the translators of environmental commitments, and it is your job to ensure that these commitments are carried through the detailed design process."
—From *Environmental Regulations and Commitments*, **Session A1a.**

Among the many changes ISTEA will impose on TxDOT, two affect design practice strongly:

- A statewide transportation plan (STP) must be developed. Transportation improvement programs (TIPs) must be consistent with the long-range STP, include all projects in the state proposed for Title 23 or Federal Transit Act funds, and cooperate with the local MPOs.
- Both the STP and TIPs must have financial plans that demonstrate that the programs can be implemented.

— From *MPO Involvement, TIP and Financial Plans*, **Session B1b**

See "Design Exceptions," **Session A4a** to find out about the Division of Automation's development of RDS to indicate a need for exceptions.

Interested in an update on the guardrail extruding terminal? See *Status of MBGF End Treatment*, **Session A4b.**

Worried about work program timing? Watch *Work Program Timing, Apportionment Limitation, Bank Balance*, **Session B2c.**

Don't know who can approve coordination with an MPO? Find out in **Session B3b**, *Who Can Approve Coordination with MPO.*

PS&E got you in a quandary? **Session C1**, *PS&E Development Schedules* gives an overview.

Beware the pitfalls of pit safety; review *Quarry and Pit Safety Issues*, **Session A4c.**

Session C3 deals with various aspects of cost estimating, while **Session B3** is concerned with letting issues.

WETLANDS: A WAY OUT OF THE MORASS?

by **James F. Berry**
Attorney at Law
Associate Professor of Biology
Elmhurst College, Illinois

This is a pivotal year for the nation's wetlands. Battle lines have been drawn. Development interests, backed by the agricultural community, argue that they are overburdened by unnecessary regulatory restrictions, and environmentalists counter that wetlands are a valuable and irreplaceable natural resource that must be protected at all costs. Conflicting bills have been introduced in the U.S. Congress to either strengthen or weaken the guidelines under which the Army Corps of Engineers claims jurisdictional control over wetlands development. Unfortunately, both camps often fail to recognize that elements of an overall solution may already exist.

The basis for the controversy is the 1989 wetlands delineation manual used by federal agencies to determine whether a permit is required from the Army Corps under Section 404 of the Clean Water Act (CWA) before a wetland can be dredged or filled. Last summer, the Bush administration joined the fray by proposing changes to the manual that would significantly reduce the amount of wetlands subject to protection, despite the President's campaign promise that there would be "no net loss" of wetlands. Critics of the proposed changes (including EPA personnel) have charged that the new manual will cut in half the approximately 100 million acres currently under federal jurisdiction. The Bush administration has shown signs of retreating from some of the new manual's provisions, but many environmentalists still argue that the 1989 manual offers necessary and meaningful wetlands protection and should not be changed.

As the debate intensifies, it is important to note that mechanisms exist for compromise and potential agreement within the current regulatory framework. While a mutually acceptable solution may be years away, these areas of agreement may offer a scheme for achieving a consensus.

MUDDLING THROUGH WETLANDS MITIGATION

Developers and environmental interests have been forced to compromise under the controversial requirements for compensatory mitigation when a wetland is destroyed. Once the Army Corps has established its jurisdiction over a wetland dredge-and-fill action, the application must follow a sequential mitigation process. First, the applicant must design the project to completely avoid damage to wetlands if it is possible to do so. Second, if this is impractical, the applicant must design the project to minimize adverse environmental impacts. Lastly, if wetland losses are unavoidable, the applicant must compensate the government for all destroyed or degraded wetlands through a process of restoring damaged wetlands or creating new ones. On-site, in-kind restoration is generally preferred.

Although the compensatory mitigation requirements seem to satisfy the concerns of all parties, they have been extremely controversial from the beginning. Prior to 1989, the Army Corps took the position that mitigation could virtually always meet the legal requirements for issuing a permit, while EPA's view was that mitigation was a last resort, to be used only when avoidance and minimizing impact failed. In fact, EPA was particularly skeptical about mitigation where a developer proposed to construct new wetlands where none had previously existed, since the science of wetlands creation is far less advanced than that of wetlands restoration.

The conflict came to a head in the famous *Sweeden's Swamp* controversy in 1988, when a developer opted to mitigate losses that would be caused by construction of a shopping center in South Attleboro, Massachusetts, by both restoring and creating new wetlands. EPA vetoed the Army Corps permit pursuant to its power under Section 404(c), and the U.S. Circuit Court of Appeals upheld the veto over Army Corps objections. EPA and the Army Corps then entered into a new period of apparent cooperation that resulted in a controversial 1989 Memorandum of Agreement (MOA) between the agencies, which produced the guidelines in effect today. Many environmentalists criticized the MOA, however, because the Bush administration (primarily through former Chief of Staff John Sununu) had intervened to make the MOA less restrictive than it might otherwise have been.

The appeal of the mitigation process is that it seems on the surface to satisfy the requirements of all concerned. On one hand, it allows the developer to proceed with the proposed project; on the other, it meets the requirement that there be no net loss of wetlands. But developers have argued that it imposes unnecessary additional time and expense burdens on them. Environmentalists argue that mitigation projects are often poorly designed and ineffective, and that critical wetlands values are inevitably lost.

Evidence available to date concerning the effectiveness of compensatory mitigation is not promising. In a 1990 audit of EPA's Region 4 in the southeastern U.S. (where a majority of the nation's remaining wetlands are located), EPA auditors reported that there was little research available to support the feasibility or desirability of compensatory mitigation. The auditors stated that "the mitigation or restoration may be resulting in the sacrifice of valuable natural wetlands for the ill-considered promise of some future, potentially less desirable, wetland replication." The audit blamed interagency squabbling (mostly prior to the 1989 MOA), understaffing, and poor enforcement as major culprits in the failure of compensatory mitigation programs.

Mitigation programs in those states that issue their own wetlands dredge-and-fill permits have also met with limited success. In March 1991, the Florida Department of Environmental Regulation released a report on the effectiveness of mitigation under Florida's wetlands laws, which permit mitigation by wetland creation, enhancement, or preservation. The study found that only four of 63 permits reviewed were in compliance with permit mitigation requirements. Of those sites where mitigation was annually undertaken, only 27 percent of the wetlands were ecologically successful. Other states have had similar experiences.

Despite the dismal track record of these projects, some developers and environmentalists still see them as part of a workable solution. At the heart of the dilemma are two serious problems, both of which have solutions. First, enforcement of the terms of mitigation requirements has been poor. Agencies are chronically understaffed, their staffs are undertrained, and they often lack the statutory tools necessary for effective enforcement. (For example, civil and criminal penalties for noncompliance are nonexistent or difficult to enforce.) Improved staffing and enforcement tools would improve this situation.

Second, the apparent consensus among environmentalists and environmental scientists is that it is extremely difficult or impossible with current techniques to create a biologically valuable wetland where none existed before. This is because natural wetlands are long-term biological adaptations that require a complex balance of proper chemical, physical, and biological factors that cannot be created artificially. On the other hand, many of these same scientists are quick to point out that a degraded wetland may be restored and much of its wetland value replaced through proper management. Hence, wetland restoration may be a workable mitigation procedure where creation is not. Moreover, there is increasing support in some sectors for requiring *offsite* compensatory mitigation, which usually requires the applicant to purchase higher-quality wetlands at some distant site (usually at a ratio of greater than one-to-one) that are put into trust or donated with sufficient support funds for proper long-term management.

ADVANCE IDENTIFICATION OF WETLANDS

A common criticism of wetlands regulation is that the current system lacks predictability. Therefore, an encouraging development is the increasing use by EPA of advance identification of wetlands (ADID), which is authorized by EPA regulations established under Section 404 to protect and manage the nation's remaining wetlands. The principle behind the ADID process is to determine which wetlands in an area are of high value *before* there is an application for a Section 404 permit. This has several important consequences. To the property owner, an ADID provides a degree of predictability to the process by giving an indication (but no assurance) of the likelihood that the property owner can obtain a permit in the future. To state and regional planners, an ADID has the enviable advantage of facilitating the planning process by identifying those areas most likely to be preserved in the long term because of high wetland values.

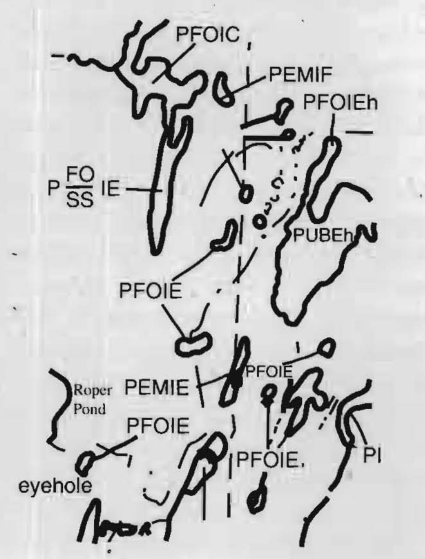
An ADID also has important advantages to regulatory agencies. By identifying high-quality wetlands, the agencies may guard more effectively against illegal dredge-and-fill activities, which are currently a major source of wetlands degradation and loss. In addition, the ADID process requires only a public notice, rather than the cumbersome and time-consuming notice and public hearing requirement for other EPA wetlands activities.

Although each ADID is procedurally unique, the ADID process begins when a governmental unit or private party applies to its regional EPA office requesting an ADID, or when EPA initiates the process. The EPA then follows a series of steps, including site selection, public participation, and technical studies, leading to a determination of which wetlands are — or are not — suitable for dredge-and-fill activities. Once the ADID study is concluded, the results are made available to interested members of the public and governmental units, and EPA initiates long-term monitoring programs with the cooperation of other agencies.

While ADIDs are useful tools in resolving potential wetlands controversies, their use has been limited to larger areas in which valuable wetlands losses appear imminent. Although the regulatory procedures for ADIDs have been in place since 1980, only 21 ADIDs have been completed to date, and 38 others are ongoing. EPA remains committed to developing the ADID process as a tool for wetlands protection, however, and their use is expected to increase.

ARE THERE OTHER SOLUTIONS?

Compensatory mitigation and the ADID process are but two examples of existing mechanisms under federal regulations by which the development and environmental communities might



A sample from a U.S. Department of the Interior National Wetlands Inventory map.

reach a degree of accord. Several states have added their own innovations, which serve at least to introduce more predictability into the system. For example, the New York Department of Environmental Conservation has mapped all wetlands of 12.4 acres or less, providing both developers and environmentalists with a blueprint of those areas most likely to be subject to both state and federal regulation. Oregon's approach places the burden of wetlands identification and regulation on local Governments by requiring them to implement land-use plans that incorporate the standards of its statewide planning goals, and to resolve issues of conflicting uses so as best to conserve wetlands resources.

It is unlikely, however, that any mutually acceptable overall solution will result purely from government regulation. Some hopeful signs have emerged from outside influences. For example, many individuals on both sides feel that one solution lies in the purchase of privately owned wetlands, which may then be donated to governmental units for protection or placed in long-term conservation trusts. Many states have provided funds for the purchase of valuable wetlands from private owners. One example is Florida's Conservation and Recreational Lands program, which purchases sensitive lands based on a statewide priority list. Even some local and regional governments have purchased wetlands for preservation. Palm Beach County, Florida, for example, recently approved a $100 million bond issue for sensitive lands purchases. In addition, groups like the Nature Conservancy and the Trust for Public Lands often buy or arrange for the purchase of valuable wetlands, which are then usually placed in conservation trusts or otherwise protected over the long term. Unfortunately, it is unlikely that funds will be available for the purchase of all remaining wetlands for many years, so outright purchase remains only a partial solution.

If any good has emerged from the wetlands controversy, it is that the issue is finally being confronted squarely by both sides. A dialogue leading to a solution may emerge from this confrontation, but only if all sides are willing to discuss the issues and share information. Otherwise, everyone will lose.

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A NEW NDT DEVICE UNDER DEVELOPMENT FOR PREVENTIVE PAVEMENT MAINTENANCE

by **Soheil Nazarian**
Assistant Professor
and
Mark Baker
Research Faculty
University of Texas at El Paso

INTRODUCTION

Maintenance engineers rely on visible distress, along with pavement age and traffic levels, to schedule preventive or corrective maintenance. Preventive maintenance is usually a fraction of the cost of major corrective maintenance, but successful preventive maintenance requires diagnosing pavement distress at its earliest stages. Objective engineering information on this sort of "distress precursor" has not been available, in part due to the difficulty of measuring pavement damage at early stages.

The seismic pavement analyzer (SPA) is an experimental nondestructive testing device for monitoring pavement deterioration under development at The University of Texas at El Paso (UTEP) for the Strategic Highway Research Program (SHRP). It can provide early information on damage and changes occurring in the pavement properties. The five types of distress that can be effectively measured with the device and the methodology used to measure each distress are described briefly in this article. The prototype device (Fig. 1) has been tested at UTEP and at several field sites. The results show accuracy and precision equal to or better than theoretically determined results. Districts may wish to try the SPA on an experimental basis.

INTENDED USES

The SPA assists the maintenance engineer in defining the precursor of distress so an effective treatment can be selected. The equipment can be used in several modes. The first mode performs detailed analyses of pavement conditions identified in the network-level surveys. The second mode diagnoses specific distress precursors to aid in selection of the maintenance treatment. The third mode monitors pavement conditions after maintenance to determine its effectiveness.

Five broad elements indicate the initiation of pavement deterioration [Ref. 1]: (1) moisture in the base layer (flexible pavement), (2) fine cracking, (3) voids or loss of support under rigid pavements, (4) overlay delamination, and (5) asphalt aging. The sixth distress precursor is asphalt stripping. Extensive lab and field studies are ongoing to see if the SPA can be used to detect stripping.

Several seismic testing techniques are combined to measure parameters necessary for correct diagnosis: (1) impulse response, (2) spectral analysis of surface waves (SASW), (3) ultrasonic body wave, (4) ultrasonic surface wave, and (5) impact echo.

Operation of the SPA requires a similar level of training to that of the falling weight deflectometer. The data interpretation and reduction is done in the field during testing. An inductive interpretation is used. This approach

FIGURE 1: SHRP prototype seismic pavement analyser built at UTEP detects very early pavement damage for preventive maintenance.

has the advantages of being robust, general, and easy to modify as new models of pavement deterioration become available.

The SPA will complement the falling weight deflectometer (FWD). The FWD is used to characterize the stiffness of each layer by recording pavement responses to simulated truck loads of up to 24,000 lbs. Prediction of strength parameters under actual traffic has not yet been developed for the SPA. On the other hand, the FWD was never intended to be used to locate fine cracks, overlay delaminations, or moisture in pavement layers or to quantify aging in asphalt. The SPA can be used for these distresses because it uses much higher frequency levels in the load than the FWD. Pavements behave much differently under the FWD than under the SPA. Therefore, the SPA should be used *with* the FWD, not instead of it.

MEASUREMENT METHODS

The major components of the SPA are schematically depicted in Figure 2. These parts include receivers (five accelerometers and three geophones), the receiver mounting member, two pneumatic impact sources, and a raise-lower mechanism, which are mounted on a light trailer for towing behind a vehicle. A typical test interval required to locate points of distress on a given pavement section is 1 to 10 feet. The SPA operates at about a point per minute (Table 1). The five testing techniques are described below.

Impulse Response (IR) Method

Two parameters are obtained with the IR method – modulus of subgrade and the damping ratio of the system. These two parameters characterize the existence of several distress precursors. In general, modulus of subgrade can be used to delineate between good and bad support, while the damping ratio can be used to distinguish between loss of support and weak support.

In the IR tests, the low-frequency impact source and geophone G1 are used. The pavement is impacted. At the interface of the surface layer and base layer, a portion of this energy is transmitted to the bottom layers and the remainder is reflected back into the surface layer. The imparted energy is measured with a load cell. The response of the pavement, in terms of particle velocity, is monitored with the geophone and then numerically converted to displacement. The load and displacement time histories are simultaneously recorded and are transformed to the frequency domain utilizing a fast-Fourier transform algorithm. The ratio of the displacement and load (termed flexibility) at each frequency is then determined (Fig. 3).

Three parameters are used to estimate the damping ratio and subgrade modulus — static flexibility (flexibility at a frequency almost equal to zero), peak flexibility, and the frequency at which peak flexibility occurs. The damping ratio, which typically varies between 0 and 100

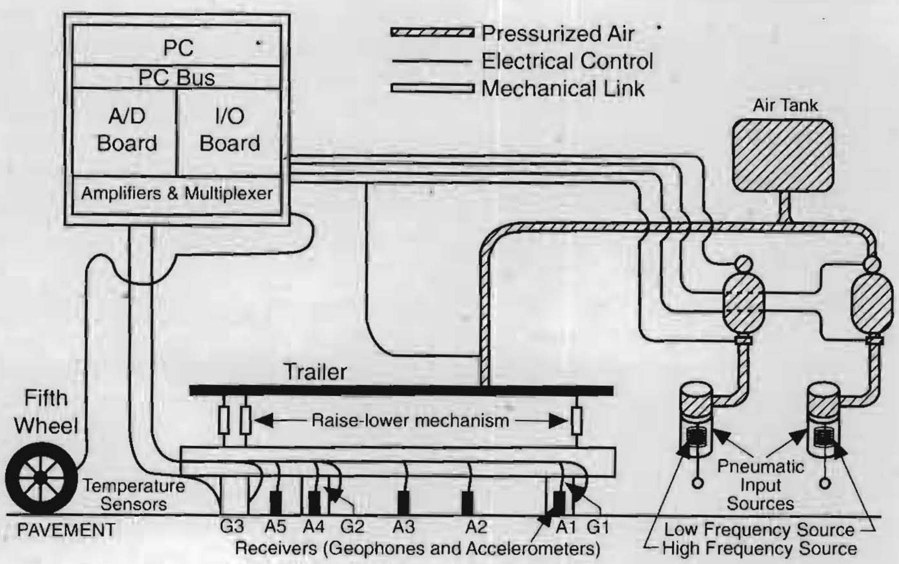


FIGURE 2: Schematic of seismic pavement analyzer.

percent, is an indicator of the degree of resistance of the slab to movement. A slab that is in contact with the subgrade demonstrates a highly damped behavior and has a damping ratio of greater than 70 percent. In this case, the static and peak flexibilities (Fig. 3) coincide at a frequency of zero Hz. A slab containing an edge void would demonstrate a damping ratio on the order of 10 to 40 percent. A loss of support located in the middle of the slab will have a damping of 30 to 60 percent. Edge voids are more readily detected than midslab loss of support.

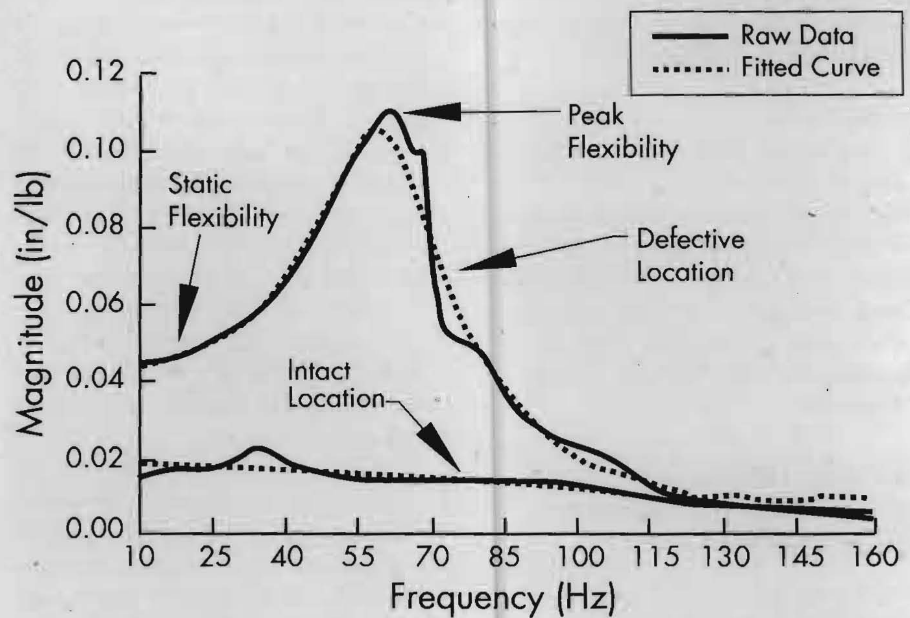


FIGURE 3: Typical flexibility spectra from intact and defective pavement.

SASW Method

The Spectral Analysis of Surface Waves (SASW) method [Ref. 2] is a seismic technique used to determine shear modulus profiles of pavement sections. The key point in the SASW method is the measurement of the dispersive nature of surface waves.

All accelerometers and geophones are used for the SASW tests. A sophisticated computer algorithm uses the signals from several receiver spacings to determine a representative dispersion curve in an automated fashion [Ref. 3].

The last step is to determine the elastic modulus of different layers, given the dispersion curve. A recently developed automated inversion process [Ref. 4] is utilized to determine the stiffness profile of the pavement section. Young's modulus profile is interpreted from dispersion curve data.

Ultrasonic Surface Wave Method

The ultrasonic surface wave is an offshoot of the SASW method. The major advantage of this method is that the properties of the top paving layer can be easily and directly determined without the need for a complex inversion algorithm. The high-frequency source and accelerometers A1 and A2 (Fig. 2) are used.

At wavelengths shorter than the thickness of the upper layer, the velocity of propagation is independent of wavelength. Therefore, if one simply generates high-frequency (short-wavelength) waves, and if one assumes that the properties of the uppermost layer are uniform, an estimate of the thickness of the surface layer can be made by determining the wavelength below which the surface wave velocity is constant.

Ultrasonic Compression Wave Velocity Measurement

Once the compression wave velocity of a material is determined, its Young's modulus can be readily calculated. The set-up used to perform the SASW tests can be used to determine the compression wave velocity of the upper layer of pavement.

Compression waves travel faster than any other type of seismic waves and are detected first on seismic records. Several automated techniques for determining the arrival of compression waves are available typically

TABLE 1: Nontechnical factors affecting SPA performance.

Item	Remarks
Measurement Speed	One minute per point
Traffic Control Required	Yes, similar to that used for FWD testing
Skill Level of Operator	Operation Mode: A conscientious technician Research Mode: A research engineer
Frequency of Measurement	Routine Maintenance: Similar to FWD Diagnostics: Every 1 to 6 ft depending on the project Research: Determined case by case
Necessary Ambient Condition	Concrete: Ambient temperature not to exceed 85°F Asphalt: Ambient temperature not to exceed 120°F
Operating Cost per Measurement	20 cents per point plus $10 per hour

by triggering on an amplitude range within a time window [Ref. 5].

Impact Echo

The impact echo method, a special case of ultrasonic body wave, can be effectively used to locate defects, voids, cracks and zones of deterioration within concrete. The method has been thoroughly studied and effectively used on many projects by researchers at the National Bureau of Standards.

DESCRIPTION OF PAVEMENT CONDITIONS AND MEASUREMENT METHODOLOGIES

The significance of each type of distress is addressed in this section, as well as the types of measurements that are associated with detecting each condition. An extensive discussion on the expected level of accuracy and the minimum levels of pavement conditions that can be realistically measured can be found in Nazarian et al. [Ref. 7].

Moisture in Foundations

Typically, the softening of one or more of the foundation layers and degradation of material quality in terms of stiffness and strength are the initial manifestation of excess moisture within the pavement system. Field studies [Ref. 8] have shown that wheel loads on saturated sections are many times more damaging than those on dry sections, if the saturation is long term.

Two different tests are proposed for detecting moisture in foundation layers: (1) impulse response and (2) SASW. The impulse response method is used based upon the theory that the material becomes *less rigid* (more flexible) as the water content increases. This is true for most paving materials, except concrete and some stabilized foundation layers. High flexibility indicates the need for maintenance.

Voids or Loss of Support

The existence of a void or loss of support beneath a slab at a joint or elsewhere can be detected using the impulse response method, and it can be verified using the impact echo method. The impulse response technique is well suited for detecting the initiation of voids or the existence of loose material under a joint, as well as for measuring the flexibility of the pavement system. In an intact rigid pavement section, the system will demonstrate high rigidity (low flexibility). As soon as a void is initiated, the rigidity will decrease, and the slab will act quite flexibly.

Measuring the flexibility of the slab at different locations pinpoints the voids or loss of support. One advantage of the impulse response method over some other methodologies is that a very small separation (void) will result in a large increase in flexibility. Therefore, the method is well-suited for preventive maintenance.

Overlay Delamination

The significance of overlay delamination is well known. The degree of interfacial bonding influences the state of stress within the overlay. Interfacial bonding has been singled out as the most significant factor that affects overlay performance. In the case of delamination, the overlay acts independently of the rest of the pavement system. This allows excessive movement at the bottom of the overlay relative to the top where the wheel load is in contact with the pavement.

The impulse response and the impact echo are the prime candidate methods for determining the location and existence of delamination, like locating voids and loss of support. Field tests showed that a delaminated layer could be easily detected; however, determining the depth of the delamination for shallow defects was difficult.

Fine Cracking

Hairline cracks, although they are discontinuities in the pavement structure, are not generally a problem until they become wide enough to allow water to enter into the structure. Water in the crack will carry dissolved oxygen into the asphalt at the crack face, creating an aged asphalt on the crack face and accelerating crack deterioration. The intrusion of incompressible materials into the cracks during cold periods creates high compressive forces on the crack or joint face during warmer periods, causing spalling. As the cracks become wider and develop spalling at the surface, much more water enters.

Two methodologies are used for detecting fine cracks: (1) impulse response and (2) the ultrasonic body wave. The philosophy behind the use of the impulse response method is that a cracked section is less rigid than an intact one. The limitation of this method is that the crack has to propagate through the thickness of the paving layer.

The ultrasonic body wave method is used to determine the existence of cracks even if they do not extend through the thickness of the layer. In this method, stress wave energy is generated at one point and detected at several other points. Any cracks in the material located between the source and any receiver will delay the direct propagation of waves. With cracks, the travel time will increase. Also, the amplitude associated with the wave will decrease. Differentiation between a strong material containing cracks and a weak material is not possible at this time.

Pavement Aging

The aging process in the field is complex. Due to aging, the asphalt layer becomes stiffer and more brittle. By measuring shear wave velocity using the ultrasonic SASW method and Poisson's ratio (determined by shear and compression wave velocities), one can follow the effect of the aging process on the behavior of the asphalt layer. Laboratory testing showed that the variation in modulus of an AC layer with temperature was independent of the aging process. However, the stiffening of an asphaltic concrete mix due to aging was also demonstrated.

Continued on page 15

ACCURATELY LOCATE SUBSURFACE UTILITIES IN THE RIGHT-OF-WAY

Fifteen to thirty percent of all existing as-built utility plans are in error by 2 feet or more. During highway construction, contractors often accidentally dig up misplaced utilities, causing disruption in telephone or electric service or, worse, loss of life. Technology may soon make this problem as obsolete as anthrax. Subsurface utility engineering, a new, nonproprietary technology being promoted by the Federal Highway Administration, accurately locates underground utilities. Using three steps, **designation, location,** and **data tracking,** Subsurface Utility Engineering (SUE) can locate utilities during the *design* phase of a project, eliminating many costly construction delays that occur as a result of unexpected conflicts with underground utilities or tanks. The cost of this service on a federal-aid highway project is eligible for FHWA participation.

HOW DOES SUE WORK?

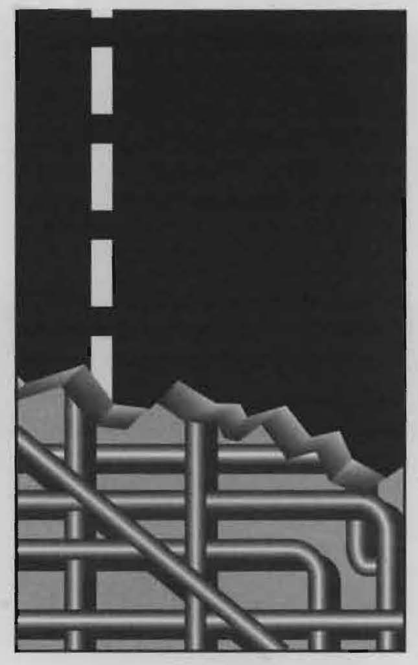
Subsurface utility engineering consists of three major components:

• **Designation** — Electromagnetics, sonics, and other energy forms are used to determine the existence and the approximate horizontal position of underground utilities.

• **Location** — Test holes are excavated at critical points along the designated utility. Vacuum excavation technology is used because it is not very disruptive to traffic, utilities or other land use. The test holes allow precise measurement of the depth and horizontal position of utilities.

• **Data Management** — Fast, effective use is made of the designation and location data by linking to CADD or similar systems to map the information getting into the design process as fast as possible. The cost-effectiveness of a design may hinge on its impact on underground utilities and structures.

The final result is a set of plans containing accurate locations of sub-



surface facilities which minimize conflicts and risks.

WHAT ARE THE COSTS?

Costs for a state acquiring these services, including mapping the information, are estimated as follows:

• **For Designation**

– On a linear foot basis, the cost is about $0.70 per linear foot to "sweep" a project (ROW to ROW), as required, from beginning to ending point.

– On an hourly basis, the cost is about the same as the hourly rate for a survey party.

• **For Location**

– About $600 per hole. The number of holes required depends on the complexity of the project. This price includes surveying, as well as mapping the acquired information.

WHAT ARE THE BENEFITS?

The preliminary engineering costs may run higher when using subsurface utility engineering, but construction may be completed more cheaply and with fewer delays because of:

• Fewer conflicts with utilities;

• Reduced delays in construction schedules due to unexpected conflicts with utilities;

• Elimination of added construction costs due to unforeseen utility adjustments (paper changes are cheaper than field changes);

• Fewer contractor claims based on utility delays;

• Elimination of safety hazards and service disruptions due to utility lines being unexpectedly severed.

SUE is appropriate on any highway project likely to impact underground utilities, and the cost of this service is eligible for FHWA participation in federal-aid highway projects.

WHO'S USING IT?

Fifteen states, including Virginia, Pennsylvania, Delaware, North Carolina, Utah, Rhode Island, Arizona and Missouri, are either using subsurface engineering or have started pilot programs. In a Richmond project, the Virginia Department of Transportation experienced a $7 savings for every $1 spent on subsurface engineering in avoided utility relocation costs. Use of subsurface utility engineering has also reduced VaDOT's highway design time by 20 percent. Florida Department of Transportation has documented $3 of construction savings for every $1 spent on SUE during design of the project.

GOT THE PICTURE?

A 13-minute video, "Subsurface Utility Engineering — A Technology for the 1990s," V-328, produced by the FHWA, is available on loan from the D-10 Research Library [(512) 465-7644, Tex-An 241-7644]. This tape provides introductory material on this engineering discipline.

For more detailed information, call Mr. Paul Scott, FHWA, Office of Engineering at (202) 366-4104.

1993 RESEARCH PROGRAM OUTLINED

Department personnel and university researchers submitted 449 research problem statements for consideration for the 1993 Texas Department of Transportation research program. Depending on the problem statement's subject, these preliminary problem statements were evaluated and scored by one of four Research Area Committees. The Area Committees then takes a closer look at the highest scoring one-third and ranks these problem statements according to department needs, combining similar problem statements into one. The chairman of each committee recommends to the TxDOT Research and Development (R&D) Committee which problem statements should become proposals. The R&D Committee approved 29 research proposals for funding in 1993. They are as follows:

AREA I: "Planning, Economics, Environment, and Transit"

RESEARCH AGENCY	STUDY NUMBER	STUDY TITLE
*TTI	1317	*The Impact of a U.S./Mexico Free-Trade Agreement on the Texas Highway Network.*
TTI	1318	*Disposal of Hazardous Waste Materials from TxDOT Activities.*
CTR	1319	*Multimodal Planning and the U.S./Mexico Free-Trade Agreement.*
TTI	1320	*The Economic Significance of Transportation Expenditures in Texas.*
CTR	1321	*Use of Congestion Pricing for Reducing Urban Congestion, as a Revenue Source and Compliance with the Clean Air Act.*
CTR	1322	*An Evaluation of the Status, Effectiveness and Future of Toll Roads in Texas.*
TTI	1323	*Evaluation of the Weight Tolerance Permits Authorized in House Bill 2060.*
CTR/TSU	1324	*Enhanced Public Education Campaign for Ethnic Groups and Special Audiences.*
CTR	1325	*Value of Access Rights.*
TTI/TSU	1327	*Social, Economic and Environmental Effects of Elevated and Depressed Freeways.*
TTI	1329	*Leasing of TxDOT's Rights-of-Way.*

AREA II: "Materials, Construction, Maintenance, and Pavement Design"

RESEARCH AGENCY	STUDY NUMBER	STUDY TITLE
TTI	187	*Task 13: Monitoring of Reclaimed Asphalt Pavement Test Sections. This is a follow-up study to research study 1272, Routine Maintenance Uses for Milled Reclaimed Asphalt (RAP).*
TTI	1332	*Short-Term Guidelines to Improve Asphalt Rubber Pavements.*
TTI	1333	*Recycling Second-Generation Asphalt Rubber Pavements.*
TTI	1334	*Improved Prime Coat Methods.*
TTI	1335	*Movement of Superheavy Loads Over the State Highway System.*
UTEP	1336	*Application of M_r Modulus Test to Texas Base Material for Pavement Design.*
TTI	1341	*Using Ground-Penetrating Radar for Pavement Evaluation.*

AREA III: "Traffic Operations, Geometric Design, and Right-of-Way"

RESEARCH AGENCY	STUDY NUMBER	STUDY TITLE
TECH	187	*Task 12: Monitoring of Prevention of Single-Vehicle Run-Off-the-Road Accidents. This is a follow-up of research study 1257, Prevention of Single-Vehicle Run-Off-the-Road Accidents.*
TTI	1345	*Development of Guidelines for Traffic Management in Response to Major Freeway Incidents.*
TTI	1346	*A Comprehensive IVHS Plan for Texas.* *The Division of Maintenance and Operations is rewriting the problem statement to detail TxDOT's specific needs. The problem statement will then be resubmitted to the universities for proposals.*
TTI	1347	*Design Criteria for Suburban High Speed Curb and Gutter Sections.*
UTA	1350	*Impacts of Traffic Signal Installation at Marginally Warranted Intersections.*
TTI	1373	*Evaluation of Rural Guide Signing.* *This proposal is a follow-up to study 1261, Assessment and Improvement of Motorist Understanding of Traffic Control Devices.*

AREA IV: "Structural Design"

RESEARCH AGENCY	STUDY NUMBER	STUDY TITLE
TTI	1359	*Corrosion Effects of Cement-Stabilized Backfill on Galvanized Steel Earth Reinforcement.*
TTI	1360	*Repair Procedures for Fatigue Damage in Steel Highway Bridges.*
CTR	1363	*Anchorage and Development of Groups of Reinforcing Bars.*
CTR	1364	*Design of Large Structural Members Utilizing Partial Prestressing.*
CTR	1370	*Repair of Impact-Damaged Prestressed Concrete Beams.*

***UNIVERSITY ABBREVIATIONS**

TTI	=	**Texas Transportation Institute, Texas A & M University**
CTR	=	**Center for Transportation Research, The University of Texas at Austin**
TSU	=	**Texas Southern University**
UTEP	=	**The University of Texas at El Paso**
TECH	=	**Texas Technical University**
UTA	=	**The University of Texas, Arlington**

NDT DEVICE from page 12...

VALIDATION

Field and laboratory studies established the levels of change in pertinent material properties associated with different distress precursors. The repeatability and accuracy of each testing technique were also established. In all cases, the techniques have adequate levels of accuracy to identify precursors of distress significant to pavement deterioration.

These conclusions are based upon results obtained from three actual field sites (US 69 in Angelina County near Lufkin, US 59 in Lufkin, and US 59 in Polk County north of Houston) and several laboratory model tests. Researchers used a full-scale rigid pavement facility in Florida to demonstrate the ability of the device to determine the location of voids beneath a slab. Some of the voids were saturated and retested. Detailed descriptions of each study can be provided upon request.

AC Field Tests

The cross section of US 69 consists of two 12 foot wide driving lanes and two 8 foot wide pavement shoulders. The pavement section reportedly consisted of a 6 inch thick AC layer. Based on construction drawings, the AC layer consisted of three different lifts placed at different times. A base course of 10 inches of flexible ash base rested directly on the subgrade.

A 300 foot long section of the road was selected. One point was arbitrarily marked as Station 0. From that point, measurements were performed every ten feet and a station number was assigned to it. As such, a total of 30 stations were selected. The FWD device was used to measure deflection basins at each point. This study was extended between Station 6 and Station 24. All tests were carried out in the eastbound lane and in the wheel path.

Visually, very minor cracks were evident between Stations 0 through 3. The pavement between Stations 3 and 16 was in good condition and no type of distress was evident in this range. Between Stations 16 and 23, the pavement was cracked, after which the pavement was once again in good condition.

The SPA data agreed with the visual evidence and much of the FWD data.

US 59 in Polk County, Texas, is a composite: AC over PCC. A typical cross section is shown in Figure 4. The highway consists of two 12 foot wide lanes, a 10 foot wide shoulder along the outside lane. and a 4 foot wide shoulder along the median. The pavement at this section consisted of about 7 inches of AC, over a 7- to 9-inch tapered layer of PCC on a subgrade soil. The section had experienced extensive distress. It had been extensively repaired before the overlay was placed. The reason for testing this pavement section was to determine if the deterioration and loss of support under the slab could be measured.

Three different slabs were tested (Fig. 5). The three sections were selected based upon the results obtained from the FWD deflection basins measured early in the morning on the date of the tests. The pattern and location of the predicted cracks (both exposed and unexposed) were in good agreement with those of a repaired crack in the PCC layer before the placement of the overlay. The SPA correctly predicted weak pavement along the center of slab 14. It also correctly indicated other variations and loss of support in the other slabs.

Small-Scale Testing

Researchers constructed and tested four small-scale models. The dimensions of the models ranged from 4 feet to 8 feet. When possible, standard paving materials and construction methods were used. In one model, researchers installed two saturation systems inside the base course to

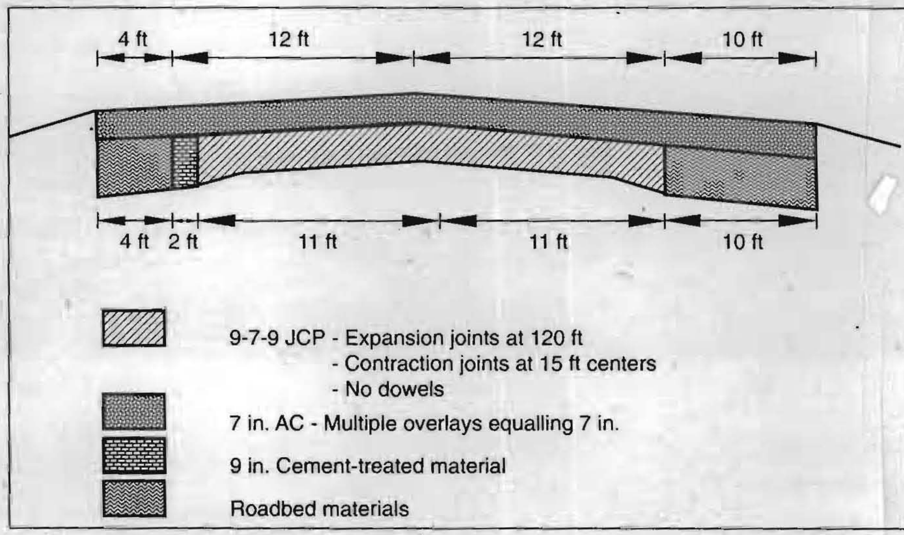


FIGURE 4: Typical cross section of US 59 (Polk Co.) test sections.

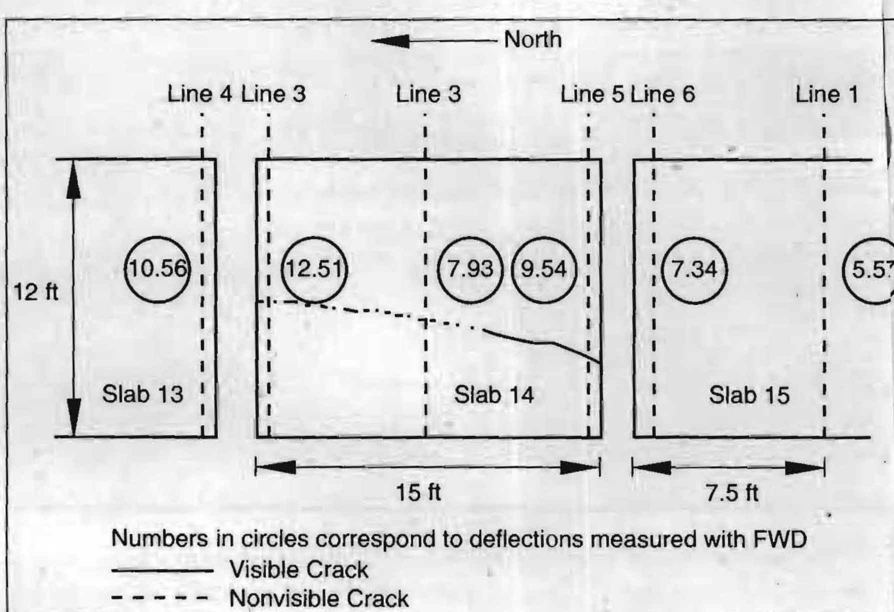


FIGURE 5: Plan view of slabs tested.

simulate the penetration of moisture from the paving layer and the flooding of a road. Testing showed that the modulus of a typical base will reduced by a factor of 2 due to a change in moisture content of about 2 percent. In a second model, voids were placed at the edges of a slab. This test showed that edge voids can be readily detected; however, testing also demonstrated that the softening of the foundation in the middle of the slab was more difficult to detect.

SUMMARY

In recent years, the focus of pavement engineering has shifted from design and construction of new highways to preventive maintenance and rehabilitation. Maintenance scheduling is usually based upon visual condition survey and, to a lesser extent, on appropriate in-place tests. When deterioration is visible, major rehabilitation or reconstruction is often required. If the onset of deterioration can be measured accurately in the early stages, the problem can be resolved or stabilized through a preventive maintenance schedule. Preventive maintenance is usually far less costly.

The University of Texas at El Paso, through the Strategic Highway Research Program (SHRP), is developing an inexpensive seismic pavement analyzer (SPA) that can accurately identify five of six types of precursor distress that contribute to pavement deterioration. These precursor distresses are: pavement moisture, fine cracking, voids or loss of support under rigid pavements, and asphalt aging. Subsurface stripping of an AC layer (the sixth type) is not yet measurable by SPA.

The SPA can be used experimentally as a maintenance tool to identify problems at an early stage and then to verify that the preventive treatment has worked. For more information, contact Bob Briggs, D-8 Pavement Management, (512) 465-3677 or Tex-An 241-3677.

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TEXAS AERONAUTICS: A BRIEF HISTORY

Contributed by **Nona Gold**
Division of Aviation
Texas Department of Transportation

THE BEGINNINGS

Aeronautics — which includes the aviation and aerospace industry, airports and airways, aeronautical research and education, aerial applications and air transportation — has played an important part in Texas history since man's first powered flight.

In the 1940s, a great civilian air age began in the United States, and Texas wanted to become a major part of it. The Texas Aeronautics Commission's first annual report, published December 31, 1946, stated, "Texas is now the leading state in aviation today, having 592 designated airports . . . (and) 7,756 civilian aircraft." It also noted that "Texas is second only to California in the number of licensed pilots." The report made mention of the average cost of building a basic utility airport. In Texas, at that time, it was a mere $10,000. The Texas Aeronautics Commission (TAC) took delight in pointing out this was "under the national average of $35,000."

The new TAC studied the aviation needs of the state and immediately drew up two proposed amendments to the Texas Aeronautics Act. One authorized counties, cities and other political subdivisions to establish and operate airports and air navigation facilities, and to obtain the financial assistance made available by the federal and state governments for those purposes. The other permitted political subdivisions to enforce airport zoning regulations limiting the height of structures and objects in the vicinity of public airports. Both amendments were subsequently enacted by the 50th Legislature.

The activities of the TAC expanded gradually over the next few years, with emphasis directed toward providing a number of aviation services to the public. The publication of the first *Texas Airport Directory*

Continued on page 22...

CENTRAL PERMIT SYSTEM: RELEASE 2

by **CPS Team**
Division of Automation
Texas Department of Transportation

The Central Permit System (CPS) is a Texas Department of Transportation (TxDOT) computer system designed to issue oversize/overweight permits for the entire state. The initial startup of the system, which replaced the manual system in August 1986, consisted of only District 14. Other districts were gradually added to the on-line system.

Prior to CPS, permits were issued manually from more than 200 field locations within the state. Approximately 500 full-time and part-time employees had been needed for the manual system. Permits are now issued only from the Central Permit Office (CPO), which is located in the TxDOT Camp Hubbard complex in Austin, Texas. Centralization has drastically reduced the number of employees needed to issue and maintain the permit system. In addition, service to the trucking industry has greatly improved, and permit policies are now more uniform.

The primary purpose for issuing oversize/overweight permits is to provide safety and convenience for the citizens of Texas and the traveling public, and to recover funds for the extra maintenance necessitated by overweight loads. To obtain an oversize/overweight permit, a trucker places a call to the CPO (1-800-299-1700), and gives a permit officer information on the company, truck, load, and trip. This information is entered into the system, and a permit can be issued on-line. Permits can be purchased using a MasterCard/Visa, Escrow accounts, or cash. Also, permit requests may be made by faxing a copy of the self issue permit form to the CPO.

The original CPS consisted of some 45 workstations interconnected on an IBM network. This system has been modified numerous times to satisfy new legislative mandates and to improve the operation. This has caused the present system to expand until there is no longer any room for additional features. The new version of the software, Release 2, is expected to optimize the system, and to move to a more efficient network provided by Novell. Release 2 will incorporate the use of centralized files, such as a repeat customer/equipment file, which will save on data entry keystrokes, thus reducing permit issuance time. In addition, the new system will provide better flexibility, more growth capacity, better security, and audit tracking.

Release 2 will run on a local area network (LAN) with a gateway to the department's mainframe. The topology for the new system will be token-ring, running Novell's NetWare 386 operating system. The new system will consist of two file servers, five dedicated machines, and approximately fifty workstations. Each workstation will be running the Novell shell using DOS 3.3, on a Grid 386/SX PC. Each workstation will be equipped with a modem and the permit application software, which includes special software to interface with banks' computers for on-line credit card charges. The state has benefited tremendously by using the rapid deposit transfer system with on-line credit card charging. The money is deposited immediately in the bank, and the state starts receiving interest on these funds the next business day.

The gateway to the department's mainframe is being established by using a single machine running OS/2 with an Advanced Program-to-Program Communication (APPC) interface. As soon as a permit is issued at the workstation, it is immediately sent to the mainframe. The Department of Public Safety (DPS) has a direct link into the permit file on the mainframe, thus enabling them to review or print permit data for law enforcement purposes. DPS can review permit data by running a mainframe transaction using the permit number, vehicle identification number (VIN), truck license, or trailer license.

Communications is another important component of CPS, which is critical for the on-line operation. Telephone lines going into the CPO are interfaced with an automatic call distributor (ACD) for controlling incoming calls and a voice response unit (VRU). The VRU is used for broadcasting specific messages to callers, routing calls to specific permit agent groups, and for receiving information from callers.

Developing Release 2 has been a joint effort by D-18 CPO, D-3 Accounting, and D-19 personnel. Release 2 will save an estimated 3 minutes of 1-800 WATS service for each permit issued. The new permit system should result in a cost savings of approximately $520,000 annually. The CPS presently generates approximately $30,000,000 annually for the state.

Carpenter Technology Corp., Reading, Pa., has won a 1991 R&D 100 Award for AerMet 100, an iron-base alloy that combines strength and fracture toughness with resistance to chloride stress-corrosion cracking. Originally developed for aircraft landing gear, the alloy also is a candidate for aircraft structurals, armor, jet-engine mainshafts, and high-strength bolts. The annual competition is sponsored by *R&D* magazine, a Cahner's publication.

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

HOW TO CONTROL BRIDGE PAINTING-RELATED POLLUTION

Bridge painting and paint removal mean big environmental problems, says Wayne Kober, Chief of the Environmental Quality Division of Pennsylvania's Department of Transportation. How big? PennDOT owns more than 5,500 steel bridges and spends more than $7.5 million a year painting them. With paint life ranging from 12 to 15 years, this means that contaminating lead-based paint applied before 1981 will still be coming off the bridges until at least 1996. Even on bridges painted with an inorganic zinc system, however, Environmental Protection Agency regulations call for carefully controlled surface preparation and paint application.

PennDOT's problems are repeated across the country — in cities and counties as well as states. Few highway agencies have put together complete guidelines to solve bridge painting pollution problems. PennDOT has, and Kober recently made the information available to share with you.

DECIDING WHEN TO PAINT

One key to controlling bridge painting pollution and the resulting costs and paperwork is to limit painting until it is really needed. Rather than paint on a 12-year cycle, for example, PennDOT engineers inspect state-owned bridges on a two-year cycle. Their reports identify painting needs.

How can this help you? When painting *is* needed, limit the amount, if possible. Decide which of three levels is right for a specific bridge:

- Spot painting — small isolated areas on the bridge structure.
- Zone painting — selected bridge members or areas.
- Total painting — all metal portions of the bridge.

Use of the first two levels helps postpone the need to totally remove a bridge's paint and replace it.

POLLUTION PROBLEMS

One of the biggest environmental problems — with your bridges as well as PennDOT's — is what to do about spent abrasives used to clean old paint, dirt, and rust from the bridge. If you use slag or sand, capturing them in a containment system as required by the EPA, you'll quickly generate hundreds of tons of waste. Disposal can cost from $200 to $300 a ton, Kober reports.

PennDOT workers recently switched to a recyclable abrasive. Steel shot can be used 200 times, Kober says, once rust and paint have been filtered out. This results in about two 55-gallon drums of lead waste compared to 200 tons of sand with lead in it.

Before the recyclable abrasive is used, crews use high-pressure washing to remove loose grime and rust. Next, they shoot the steel abrasive through a blast nozzle. The abrasive removes paint and other materials and falls onto a containment deck to prevent both water and air contamination. Steel abrasives are separated from other materials using a combination of scalpers and cyclones contained in a proprietary unit. The system returns the abrasives for reuse after this separation step.

In test applications, pollution control containment systems included vertical drapes on the downward side of the bridge — needed to hold materials removed. Floating booms installed downstream scooped up paint and debris that escaped the containment system. Other tests used horizontal drapes. Today, PennDOT also uses an underdeck that both provides work access to the bridge *and* collects debris.

Remember that air and water quality checks are needed during and after bridge cleaning. Stream, lake, or creek sediment samples should be included, as should soil checks for soil within an area where wind or workers could have deposited debris. *Before* and *after* samples can help you show the EPA the exact effects of your projects.

CREW SPEED

Does use of recyclable abrasives slow bridge paint removal crews? Because workers learning to use new equipment requires time, the answer is a resounding yes. In studies conducted for PennDOT by S.G. Pinney & Associates, a consulting firm, abrasive blasting using sand produced rates averaging 51 square feet an hour. Workers initially averaged only 12.5 square feet an hour by vacuum blasting with recyclable abrasives.

Bridge Painting: The Environmental Impact

How much does bridge painting really affect the environment? One Federal Highway Administration study found that waterlife was most affected by surface cleaning compounds used to prewash the bridge before blast cleaning. Various compounds ranged from innocuous to somewhat toxic in species examined. Heavy concentrations of lead also caused toxicity. Paint erosion and lead from vehicle exhausts contribute to toxicity even when no painting is needed.

Soil contamination follows much the same pattern — hazardous lead levels are much more likely to exist near a bridge, but usually drop away within 30 feet.

Air quality is affected both by normal traffic and by painting. With adequate containment, quality levels are generally met.

As more studies are completed, expect ever-tighter restrictions on how you remove paint and repaint your bridges. A head-in-the-sand approach definitely won't work — even in the smallest department.

In other tests, workers achieved better results using the steel abrasive with familiar blasting equipment and recycling the material manually rather than automatically. Productivity rates climbed to as much as 40 square feet per hour per blaster.

FLOATING LEAD

Pinney & Associates analyzed water at test sites, too. They found that most lead-containing material removed from the bridges floated on the water's surface for long distances. This meant that floating booms could be used effectively to capture material that escaped the containment system.

Such material captures were less effective in four situations:

- High or swift water flow decreased boom effectiveness because the boom was built in sections.
- Sectional boom construction allowed funneling of debris between sections in these conditions.
- Boom operator and/or inspector inattention.
- Deterioration of boom webbing.

BRIDGE PAINT REMOVAL CHECKLIST

PennDOT studies conducted by S.G. Pinney and Associates provide several important guidelines:

- ✓ **Open abrasive blasting was the only method tested that cleans all surfaces tested.**
- ✓ **Open abrasive blasting was most cost effective. Use of metallic abrasives minimized debris.**
- ✓ **Vacuum blasting was too slow, costly, and inefficient.**
- ✓ **Power tool cleaning was too slow and costly.**
- ✓ **Air quality was not affected by washing beams before blasting.**
- ✓ **Soil lead levels can be better controlled with good housekeeping practices in regard to containment and cleaning.**
- ✓ **Water contamination stems largely from fines generated during cleaning. Good containment systems and the use of floating booms control this effectively.**
- ✓ **Stream sedimentation is seldom affected unless collected debris is spilled.**
- ✓ **Downwind drapes can help control air quality during open blasting. Tighter controls are needed if businesses or residences are within 200 feet of a low-lying bridge or within 500 feet from a high structure.**
- ✓ **Contract specifications should include the containment method and the desired results.**
- ✓ **Wet abrasive blasting should be considered where air quality considerations are essential.**
- ✓ **Engineers and inspectors should be trained in environmental guidelines, as well as containment methods, materials, and techniques.**

AIR QUALITY CONTROL

You need to monitor air quality during paint removal and reapplication, too. Several PennDOT observations can tell you how to control air pollution.

Dust plumes are densest near the work areas. However, when bridges lie low over the water, dust initially follows the riverbed rather than going in the direction of the wind. Trees and river banks may contribute to the effect. As a result, be sure containment systems are designed to catch such debris movement.

Containment system design affects dust plume density, with greatest concentrations affected by limitations of exits. Billowing drapes, for example, allow both material escape and potential pollution.

THE COST OF IT ALL

Containment raises paint-removal costs as much as 50 percent, according to several state DOT studies. Disposal of waste can add another 10 to 25 percent, the studies show. Costs of waste disposal were based on nonhazardous disposal. If wastes are found to be hazardous, expect cost increases of about 35 percent.

What *should* painting — including containment and disposal of nonhazardous wastes — cost? Both New Jersey and Virginia report bid prices of about $400 per ton of bridge steel.

Seven PennDOT tests showed that bridge surface preparation costs ranged from $2.89 to $11.31 per square foot. Use of metallic abrasives costs only $2.91 a square foot and generates little waste. The other low-cost preparation method — using sand — creates large amounts of debris, greatly raising costs due to the cost of sand disposal.

Environmental, as well as monetary, costs need evaluation. The Pinney studies analyzed five preparation options, evaluating each for its effect on:

- Air quality.
- Water quality.
- Sediment.
- Soil.
- Achieving SP10.
- Worker acceptance.
- Amount of waste generated.
- Adaptability to truss bridges (common in Pennsylvania).
- Availability of equipment.
- Cost.

Using *good, fair,* and *poor* ratings, blast cleaning with metallic abrasives received the only overall *good* rating.

IN MICHIGAN

The Michigan DOT tightened its bridge painting environmental control requirement last year, going from a three- to a one-class system. The new system assumes that people may be exposed to materials removed in any operation.

During preparation, workers use drop cloths or tarps on scaffolds, unpaved shoulders, and ground areas up to 20 feet from the work area. They attach draping to bridge fascia and secure these at the seams and on the ground.

Under the bridge, a temporary platform or a barge collects material. A floating boom picks up material that escapes draping extending from the bridge to this platform.

Workers use wet abrasive blasting (avoiding dust) to remove lead-based paint, working only within the completely contained area. Once they complete blasting, they wash the bridge, steel, deck, and substructure. Then, the bridge must dry for at least three days. Crews then use dry abrasive blasting, still working within the containment system.

After material collection, DOT technicians analyze waste to determine whether it's hazardous or not. Nonhazardous waste disposal cost is included in the painting contractor's bid.

NEW JERSEY'S WAYS

New Jersey's requirements for containment, collection, and disposal of spent abrasives revolves around individual containment plans for each project. The plan includes:

- Materials to be used.
- Structural element sizing and connections.
- Maximum loading.
- Maximum deflection.
- Hanger and supporting member design.
- Assembly/disassembly procedures.
- Analysis of load changes.

Contractors must submit an emergency management plan detailing procedures should any part of the containment system fail. And, the contractor must submit records of abrasives purchased, delivered, and used, as well as quantities of waste disposal.

DOT engineers may conduct air and water quality checks and other tests. If they find environmental pollution, the contractor must correct the problem.

IN NEW YORK

New York's lead paint-removal plan focuses on containment to within 10 feet of the work area. Floating booms pick up material that escapes containment and floats on the water's surface.

Workers collect waste until 3 tons or 25 percent of the paint is removed — whichever occurs first — storing it in approved closed or covered drums at a temporary storage site. Engineers sample drums according to ASTM E105, to determine lead levels. If tests show levels above 8.66 ppm, the material is hazardous. If levels are between 5 and 8.66 ppm, materials are retested. Levels below 5 ppm result in a nonhazardous rating.

The painting contractor disposes of nonhazardous wastes. The DOT uses

WHAT'S HAPPENING IN TEXAS

The Texas Department of Transportation (TxDOT), in cooperation with the Federal Highway Administration, is sponsoring a research study, *Solidification/Stabilization of Spent Blast Media in Portland Cement* at the Center for Transportation Research (CTR 1315). The study is dedicated to developing cost-effective means of recycling used blast sand as a nonhazardous, environmentally safe fill for dolphins (bridge pier protection systems).

Planned work includes analysis by atomic emission spectroscopy of blast sand from Texas bridge repainting projects (before-and-after samples); mix designs using portland cement and other cementitious materials; leaching tests of hardened mixes; a technical report recommending the best mix designs; tests for the solidified material; and safe handling procedures. Two bridge cleaning and painting projects are being set up as field evaluation sites. Training aids and workshops will be prepared based on the findings. The results from this study should enable the writing of clear and precise specifications for recycling that will be included in all bridge projects. Various state agencies with environmental jurisdiction are represented at the technical meetings.

Another research study, *Disposal of Hazardous Waste from TxDOT Activities* is scheduled to start in 1993 at the Texas Transportation Institute (TTI 1318). The principle objective of this study will be to develop integrated waste management plans for reduction, handling and disposal of by-products of TxDOT construction, operation, and maintenance activities. Information databases with fully developed, user friendly software, user manuals, example applications, and tutorial short courses for the development and modification of straightforward waste management plans are the desired outcome.

contracted haulers for hazardous wastes.

OFF THE DOT'S BACK

North Carolina's DOT, like many others, places much of the environmental protection responsibility on the painting contractor's back. The department funded research of paint removal material, however, and developed an asphalt concrete mixture that uses silica sand abrasive.

The contractor develops the containment method. However, a containment plan and surface preparation operations must receive approval from the DOT engineer in charge of the project.

The department can monitor air quality in environmentally sensitive or urban areas and can stop work when pollution exceeds standards.

Workers place blasting debris in specified bulk bags which are then delivered to a state asphalt plant.

IN VIRGINIA

Contractors carry many environmental responsibilities in Virginia, too. They begin by submitting a complete capture, containment, and collection plan which must be approved by the DOT. Contractors must dispose of both hazardous and non-hazardous waste.

State DOT specifications limit lead paint removal abrasives to aluminum oxide, silicon carbide, steel grit and shot, and zirconium oxide. Abrasives must be recycled on site. Contractors test debris for toxicity in Virginia.

Reprinted with permission from ***Better Roads*** *62 (May 1992): 16-18.*

TEXAS AERONAUTICS
continued from page 17

followed an all-out effort to gather information about existing airports in the state. The TAC also launched a full-scale air education program, and in 1949 presented it to 5,000 Texas public school teachers. Texas was the first state in the nation to sponsor a Mobile Air Age Education Unit, which included a complete library of aviation materials, charts, and maps. A TAC employee trailered the unit to teacher training institutions throughout the state, giving demonstrations and lectures.

The use of aircraft in agriculture had increased considerably, and the TAC worked closely with county agricultural agents to improve effectiveness and safety. During this time, the agency also encouraged agricultural aviation through soil conservation district aerial tours. In 1951, the TAC along with the Texas Flying Farmers and Texas A&M University cosponsored the first annual Agricultural Aviation Conference at A&M. That conference created such a demand for field day demonstrations in other parts of the state that the three sponsors could not fill all the requests.

That same year, the TAC formulated a five-point program defining its responsibilities with respect to the aviation needs of Texans. It included agricultural aviation, aviation services (helping communities obtain airline service and navigational aids, conducting safety meetings, and the like), airports and operations, air education, and civil mobilization (civil defense).

While Harlingen Airfield would have been among the 592 designated airports the TAC reported in 1946, the plane in the foreground, though vintage 1940s, would not have been among the 7,756 Texas aircraft — it's a Japanese Zero. (CAF Airshow, Harlingen, Texas, courtesy of the Division of Travel and Information.)

THE FABULOUS FIFTIES

By 1955, most communities with airport facilities and most Texas pilots were familiar with the TAC's programs and services. A TAC engineer was available to give technical assistance to those communities wanting to build a new airport or improve existing facilities. There were nearly 1,200 airstrips in Texas, of which about half were open to the public.

The early part of that decade was really the heyday of general aviation, even though there were some minor economic pains in 1951. Prior predictions of an airplane in every garage and a pilot in every household had generally been discounted, but the latest forecasts were only slightly less optimistic. The Postmaster General, for example, predicted mail would soon be carried long distances by guided missiles. Aviation experts predicted regular supersonic air travel by the early 1960s. There seemed to be no obstacles in the path of adolescent aviation.

THE SIXTIES & SEVENTIES SAW MAJOR IMPROVEMENTS

In 1961, President Kennedy requested the administrator of the Federal Aviation Administration (FAA) to develop a statement of national aviation goals for the next decade. Although the government was primarily concerned with Russian advances in space technology, officials did not want the United States to fall behind in the field of aviation. Texas, with its numerous airports and aviation production facilities, was one of the leading states in this area, and its governing officials certainly did not want to lose that lead.

So in the same year, the Legislature amended the original Texas Aeronautics Act in several important ways to ensure the state would always play a major role in the nation's air transportation system. The number of Commissioners was increased from three to six, and the guidelines for their appointment were changed. The revision also resulted in changes in the TAC's powers and duties, with amendments providing for the acquisition of land and navigational aids or facilities given to the state to be held in trust for future control or administration. One of the more important changes, however, was the granting of authority to the TAC to certify air carriers operating within the state. This act, in effect, guaranteed Texas would be committed to the development of an intrastate air transportation system that would complement and supplement the national system.

The Legislature did not appropriate any money for regulatory activities until 1969. Though funding was not available, the TAC was able to issue the first certificate of public convenience and necessity in 1963.

The TAC also established a surplus property program. Its purpose was to locate federal property for acquisition by local communities in maintaining or improving their public airports.

The Texas Aeronautics Act was amended again in 1965 to make state grants available for airport development, and by the end of 1966, a total of $186,000 in state funds for airport construction and improvement projects was granted to 22 communities.

By 1969, there were a number of intrastate air carriers operating under TAC certificates.

Amending the original act once again, the Legislature in 1969 expanded the TAC's powers so it could approve or disapprove the rates of its certified air carriers and require the filing of reports and other needed data on the industry. The TAC also was given authority to establish the minimum requirements for a certificate of public convenience and necessity. Previously, national guidelines had been followed.

In 1977, the agency actively sought and gained legislative approval of an amendment to the Aeronautics Act that would allow the TAC to exempt certain classes of carriers from what it considered unnecessary burdens of regulation. To some observers a voluntary relinquishment of regulatory authority by a governmental body was an unknown phenomenon. The TAC in 1979 further relaxed regulatory requirements, providing for a more competitive market place that resulted in lower fares and increased service for air travelers in Texas.

In coordination with local representatives, both private and elected, the TAC has developed and maintained, with the assistance of the Texas Transportation Institute, a long-range airport system plan originally conceived in 1972. This continually revised plan projects the airport development needed to satisfy state and local economic and social goals. The staff works with elected officials to implement the plan consistent with available federal, state and local funds.

WHERE IS THE TAC NOW?

The TAC became the Texas Department of Aviation in 1990. In 1991, the Texas Department of Aviation joined with the former State Department of Highway and Public Transportation to create the Texas Department of Transportation. As TxDOT's Division of Aviation (D-2), it will continue to expand its services and its emphasis on professionalism and safety as aviation activity in Texas experiences leaps and bounds throughout the remainder of the century.

D-2 looks to its statutory requirements when planning for the future. They serve as goals for its projects and programs, and they include the TxDOT's efforts to:

- encourage, foster and assist in the development of aeronautics in this state;
- cooperate with municipal, state and federal officials in promoting, developing and maintaining a statewide air transportation system;
- assist in developing and maintaining a statewide system of modern airports and air navigation aids for public use;
- promote and encourage safety in all phases of aviation; and
- and to promote and encourage aeronautical education.

The services that are designed to meet these goals are carried out by the division's four sections – Planning and Programming, Project Management, Aviation Services, and Grant Administration.

Planning and Programming Section

The Planning and Programming staff is responsible for maintaining the Texas Aeronautical Facilities Plan from which federal, state, and local capital improvement programs are developed. The staff holds public meetings statewide with local officials to determine each area's air transportation needs. Available state and federal financial assistance is programmed for projects identified through the planning process. A wide variety of technical services are provided to federal, state, and local government agencies and to individuals.

Project Management Section

Acting as "agent" for the airport sponsor, professional engineers of the Project Management Section provide project management services for communities receiving state and federal airport improvement grants. Project managers oversee the entire process from consultant selection through design and construction. Staff engineers review and approve the work of the consultant engineer selected by the community. Project managers have the responsibility to ensure that projects are completed and certified in accordance with state and federal regulations and guidelines. The engineering staff also provides technical assistance to public and privately owned public-use airport sponsors as requested.

LASER-PRINTER TIPS THAT WORK

If you're using a laser printer, here are some tips regarding the toner cartridges:

- **Always have a backup cartridge available. This assures that you won't have any downtime. Sell the used cartridge or have it recharged.**
- **Store those extra cartridges in a dark, cool place. Place them flat, not standing on end. Properly stored, the cartridge can keep for up to two years if the foil wrapper hasn't been removed.**
- **Add life to a cartridge by removing it occasionally from the printer, holding it horizontally and rocking it gently from side to side. This redistributes the toner power more evenly.**

Source: Margaret Luellen Briggs, writing in Secretary's Letter, 8 Depot Square, Englewood, NJ 07631 as seen in Communication Briefings (Sept. 1992):3.

Aviation Services Section

The responsibilities of the Aviation Services Section are conducted in two areas:

- **Airport Services** — Technicians conduct over 400 inspections of airports annually to ensure their safety, serviceability, and grant compliance. Airport inspectors analyze in detail airport pavement conditions. Technicians assist communities in developing and implementing airport and vertiport hazard and compatible land-use zoning ordinances. Drafting duties are also performed in this area. The staff serves as the air transportation staff in the state's emergency command center during declared emergencies; and
- **Educational Services** — The staff provides specialized training and educational programs, aeronautical publications, and safety information to individuals and groups involved in aviation services and the air delivery of persons and cargo. Personnel also locate and make available federal surplus property for use on publicly owned airports. Production and distribution of all division publications are coordinated by this section. Reproduction and mail services are also coordinated in this area.

Grant Administration Section

The Grant Administration Section is responsible for the timely execution, management, and payment of all contracts in accordance with state and federal laws. The section is also responsible for coordinating accounting, payroll, budget preparation, inventory, and purchasing activities for the division. The coordination, finalization, and distribution of reports required by both state and federal laws are also coordinated in this area.

Most of the state's commuter airlines provide what is known as "hub-and-spoke" service. This means passengers are transported from small- and medium-sized communities to larger cities. The former TAC first started collecting traffic figures on its intrastate carriers in 1966, and over the years the numbers have shown an increase that is nothing short of phenomenal. Certificated carrier enplanements in Texas reached 2,874 in 1966. In 1981, that figure passed the 8 million mark and in 1991, approximately 49 million.

Aeronautics is an important piece of transportation as a whole in Texas, and good transportation is a key to the economic well-being of the people of Texas. The joining of the Texas Department of Aviation and the State Department of Highways and Public Transportation to form the Texas Department of Transportation creates a truly multimodal transportation agency. Cohesive multimodal planning should provide better overall transportation for the public

*From **The Texas Aeronautics Commission: A History Since 1945** [edited] published by the TAC, Austin, 1981.*

PUBLIC RESPONSE TO BRIDGE COLORS

Two test bridges were selected in Charlottesville, Virginia, to determine people's reactions to bridges covered with white, yellow, green, blue, red, brown, black, or aluminum-colored paint. One bridge was painted a different color each month, and the other was kept the same color for comparison. After each painting, interviews were held with (a) motorist seeing the bridges, (b) persons living near the bridges, and (c) people with formal aesthetic training. More than 1,300 interviews were held for the 10 different bridge colors. The results show that white, yellow, light blue, and green are definitely preferred over brown, black, and aluminum by all groups. Red and dark blue were liked by aesthetically trained people; others thought less highly of them. On the basis of this study, it is recommended that more extensive use of popular colors be considered for highway bridges in the United States. A technique to aid in making a color selection for a given bridge has been developed to photographically color-alter the picture of a bridge so that color comparisons can be easily and inexpensively made.

From Transportation Research Board: TRR 507 (1974).

TQ SURVEY RESULTS

We were very pleased with the response received in the survey conducted through the last ***TQ***. We want to share these results with you as well as our future plans based on what you, the readers, have indicated as your needs.

Almost all respondents (95%) wished to remain on the mailing list and for those of you who indicated that a correction was necessary, you should see a difference on the mailing label of this issue. Most respondents (84%) were satisfied with the content and understandability of the articles. Based on these indications we will not drastically alter the content or style of articles; however, we will be making some changes.

Due to high interest in topics of construction, design, environmental issues, bridges and computer applications, we will attempt to focus on at least one of these areas or to combine these topics in every issue. You have also indicated, however, that your interests are very diversified, with at least 14% and usually over 25% of you interested in all offered topics (Fig. 1). Therefore, we will try to diversify our offerings to match your needs.

Your interest in the type of article was also very diverse (Fig. 2). We will incorporate as much variety as possible. Thanks for the time taken to complete our questionnaire. We will repeat this type of survey in the future to ensure that we are providing information you need; however, if you have suggestions, call us! We'll be glad to hear from you. Complete survey results are available from the Research Library.

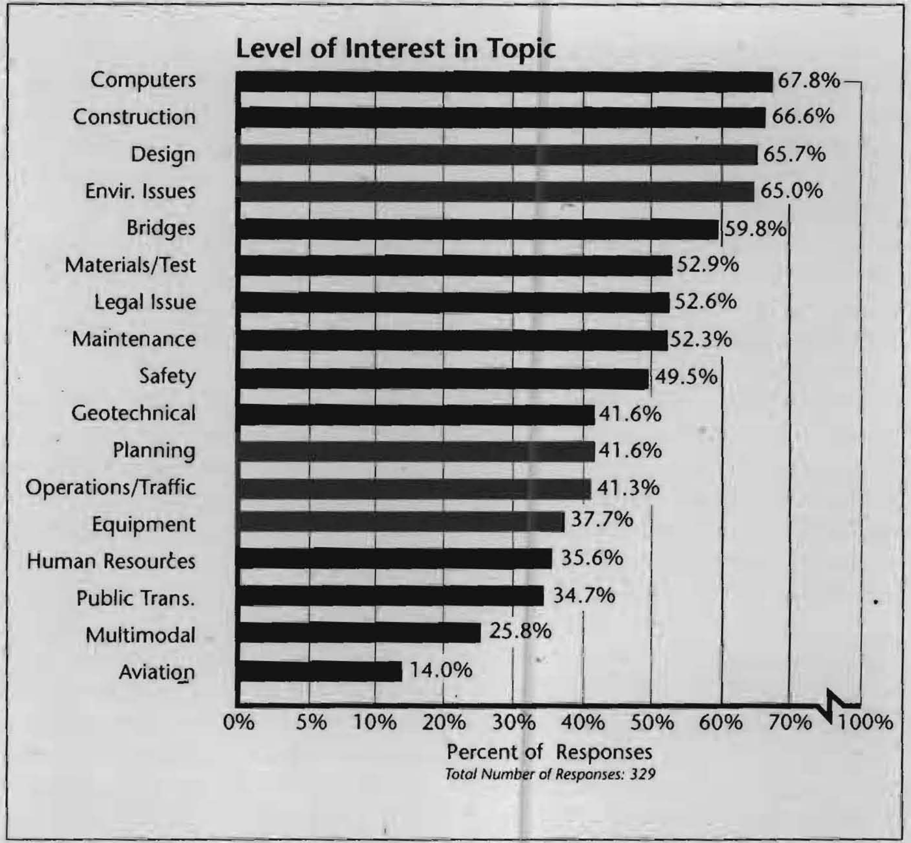

*FIGURE 1: **TQ** readers indicate multiple interests.*

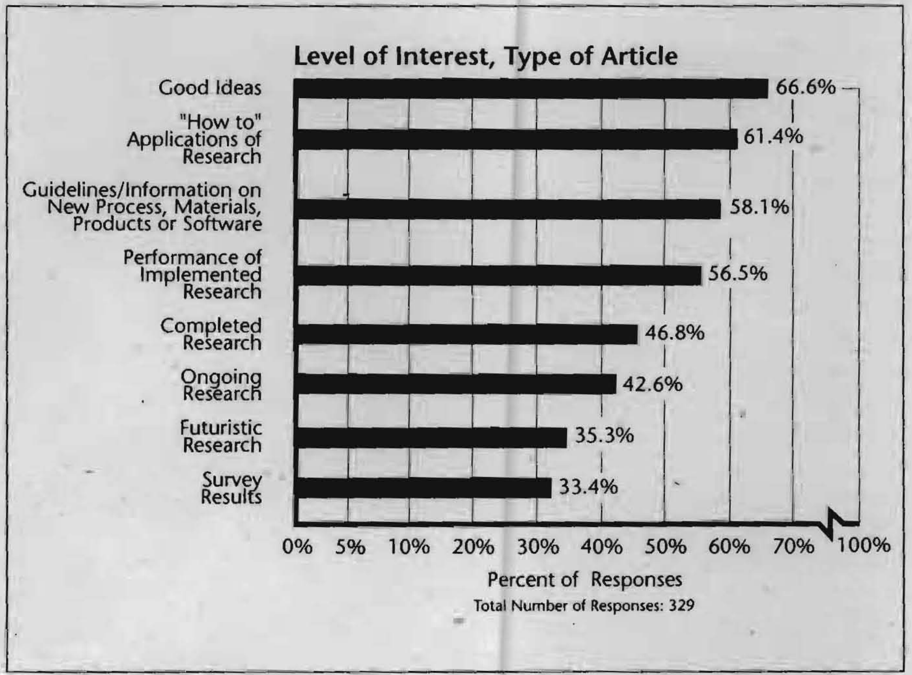

*FIG. 2: **TQ** readers favor innovative ideas and practical application articles.*

CERTIFICATION OF ASPHALT SPECIALISTS: QUESTIONS AND ANSWERS

Excerpted from presentations made by Roger G. Welsch, P.E., TxDOT Deputy Director, and Ken Fults, P.E., Soils and Aggregate Engineer, TxDOT Division of Materials and Tests, at the annual meeting of the Texas Hot Mix Asphalt Paving Association, 24-25 September 1992, El Paso, Texas.

Quality control, quality assurance — how can we apply these concepts to our road construction, particularly asphalt concrete paving, to ensure the public gets the best roads for its money? The Texas Department of Transportation (TxDOT) thinks that certification of inspectors — asphalt specialists — is the answer.

Q *How did TxDOT come to this decision?*

A Uniformity and consistency of inspection and testing procedures are central to quality control and quality assurance. The department is moving away from "cookbook specs" which control each step of a construction method and toward allowing contractors much more freedom to choose methods of construction, so long as they produce the desired result. With freedom to innovate, contractors can create more flexible, cost-effective methods of building quality roads. TxDOT and contractors can be partners in providing the public's infrastructure, not adversaries. However, this type of specification places a greater burden on inspectors. Contracted inspection services have to be certified: How can we not require certification for our own TxDOT inspectors?

Q *When will TxDOT have an end-result-type specification for hot mix asphalt (HMA)?*

A A draft version exists right now. In September 1990, TxDOT, with the help of Dr. Jon Epps, Dr. Ray Pavlovich, the Texas Hot Mix Asphalt Paving Association (THMAPA), and others from the paving industry, began the long process of developing Quality Control/Quality Assurance (QC/QA) specifications for HMA. By the end of 1992, QC/QA data had been collected from thirteen other states and from six projects within Texas. The task force had visited four other states and had drafted Texas HMA QC/QA specifications.

Q *When will TxDOT put these specifications into practice?*

A In 1993, 4 or 5 project will be let under the draft specifications, with the option to include incentive/disincentive requirements. Data will be collected on these projects, and the specifications will be revised according to the findings. Five to six projects will be let in 1994 under the revised specifications with the incentive/disincentive requirements. Based on these projects, the specifications will be revised again if necessary. 1995 will see the full implementation of QC/QA specifications for HMA statewide.

Q *When will the certification of inspectors — asphalt specialists — begin?*

A January 10, 1993, is the proposed starting date. The certification programs will be held at the new Hot Mix Asphalt Center, administered by THMAPA.

Q *What is TxDOT's policy on certification?*

A The policy is:

1. There will be no grandfathering of state or industry personnel.

2. Only certified personnel will be allowed to perform tests on QC/QA projects.

3. Only personnel qualified under the Certification Program administered by THMAPA will be eligible for TxDOT Certification.

4. There will be no subsidized programs. Everyone will pay the same

Uniformity and consistency of testing is central to quality control and quality assurance.

fees — city, state, or private industry — and have the same chance at certification.

Q *How did the THMAPA get involved in accreditation?*

A TxDOT asked THMAPA to help. A private organization has more freedom in hiring and firing evaluators and in leasing buildings and equipment. Also, the state would have to have provided subsidies to other government agencies.

THMAPA administers the program, provides evaluators, and recommends to TxDOT which candidates should be certified. TxDOT provides oversight and support, leases testing equipment to the Hot Mix Asphalt Center, certifies the program's evaluators, and does the actual certification of asphalt specialist inspectors.

Q *Are there different levels of certification?*

A Yes. There are three levels of certification:

- Level IA — Plant Operations
- Level IB — Roadway Operations
- Level II — Design and Management

Q *What are some of the particulars of Level IA?*

A Level IA details:

- Program length — 1 week.
- Prerequisites — reading comprehension and basic math. (Six months testing experience is extremely helpful.)
- Maximum number/session — 24.
- Course material — sampling and sieving, molding and Rice gravity testing, extractions, and nuclear density testing.
- Cost — $700 to $800 per person.

Q What's in Level IB?

A Level IB details:

- Program length — 2-1/2 days.
- Prerequisites — reading, math, and nuclear safety.
- Maximum number /session — 40.
- Course material — Nuclear densities, roadway core densities, profilograph operations, random samples, and segregation.
- Cost — $300 to $400 per person.

Q *What does Level II entail?*

A Level II:

- Program length — 1 week.
- Prerequisite — Level IA.
- Maximum number /session — 16.
- Course material — 2 days lecture, 2 days lab, specific gravity determination, and mix design.

Q *How did TxDOT arrive at the costs?*

A TxDOT entered into a five-year contract with THMAPA. Total costs for building and equipment leasing, instructor salaries, materials costs, and supplies were estimated for the five years. This number was divided by five and then by the estimated number of inspectors that could be certified per program per year. The program is designed to break even, not make a profit or lose money.

Q *How many TxDOT employees should become certified?*

A A district will need at least two Level IAs for every hot mix plant in operation. Level IA certified personnel should go ahead and get Level IB certification as well so they can perform two functions. District Areas that perform their own mix designs need one Level II person available.

Q *Do district area engineers need Level II certification to approve a contractor's mix design?*

A No, an area engineer does not need Level II certification to approve a contractor's mix design. However, if the area engineer has questions about the mix, testing and documentation must be done by a Level II certified person.

Q *Why can't our folks test out?*

A The Certification Program for Asphalt Specialists is just that — a certification program. It is ***not*** a training program — it ***is*** the test.

Q *What about recertification and decertification?*

A Recertification will take place every three years. A person needs to show documentation that he/she has been running these tests on a regular basis for that time period to be automatically recertified.

A review committee of TxDOT employees and contractors will handle decertification on an individual basis. If charges of neglect or abuse are brought against an inspector, that individual makes his/her case before the committee. The committee deliberates on the evidence and makes a decision. TxDOT has final say in the decision. If the committee finds the inspector guilty of neglect, the inspector's certification will be suspended for 180 days. A second proven charge of neglect will result in permanent decertification. If the inspector is found guilty of abuse (defined as knowingly altering data or misperforming a test to change the results), the inspector will be decertified for a year. If that inspector is proven quiltyof abuse a second time, he/she will be decertified permanently.

Q *Why bother getting certified now if full implementation isn't going to happen until 1995?*

A The Hot Mix Asphalt Center can only handle a small number of candidates at a time. Waiting until the last minute to become certified could mean being stuck without the credentials to inspect HMA jobs well into 1995 or 1996.

TxDOT is committed to QC/QA. Considerable time, money, and effort have been spent and are being spent to develop a system that is acceptable to and streamlined for the state, the industry, and the public. For more information, attend the 1992 Short Course Session 18 or request a copy of the Short Course video for that session when the videos become available in January 1993.

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Texas Department of Transportation

TECHNOLOGY TRANSFER

Editor/Tech. Writer:
Kathleen Jones
(512) 465-7947

Librarian:
Dana Herring
(512) 465-7644

Our Tex-An Exchange # is 241.

TECHNICAL QUARTERLY
c/o Kathleen M. Jones
TxDOT
P. O. Box 5051
Austin, TX 78763-5051