TECHNICAL QUARTERLY

"AN EXCHANGE OF IDEAS"

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ELECTRIC CAR CONVERSION: A SUCCESS STORY

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FIG. 1: The 1984 VW Rabbit Chris Harris converted to electric power.

INTRODUCTION

Many Texas Department of Transportation (TxDOT) employees participate in improving the quality of our environment by recycling paper and cans and by carpooling or using public transport. One TxDOT employee, Chris Harris, has gone further than most — he has recycled his car. Mr. Harris, a computer programmer in Traffic Operations Division's Traffic Management Systems Laboratory, converted a gasoline-powered 1984 Volkswagen Rabbit to electric power (Fig. 1). "This type of conversion really is recycling," says Harris. "You reuse not only the body and axles, but the drive train and much of the electrical system as well. All this engineering is proven and reliable. You're just making it better by making it zero emission." He has been commuting from Buda to the Austin Bull Creek complex daily in his zero-emission Rabbit since early October 1994. This article will examine reasons to make such a conversion and how this conversion performs.

Why convert?

Why convert your own car now when the major automobile manufacturers are promising long-range electric cars in the next five to ten years? For one thing, it is less wasteful to convert existing cars than to junk them and buy new. Also, conversion costs less — $7,000 to convert a 1984 VW Rabbit valued at $2,000, compared with a projected $30,000 to $50,000 for the first American mass-produced electric cars.

Conversions are reliable. The technology of all the conversion components — mainly the controller,

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the electric motor, and the batteries — has been proven over the last twenty years in heavy-duty industrial settings. The conventional automotive technologies, such as manual transmissions, that make up the rest of the converted car have had more than eighty years to mature.

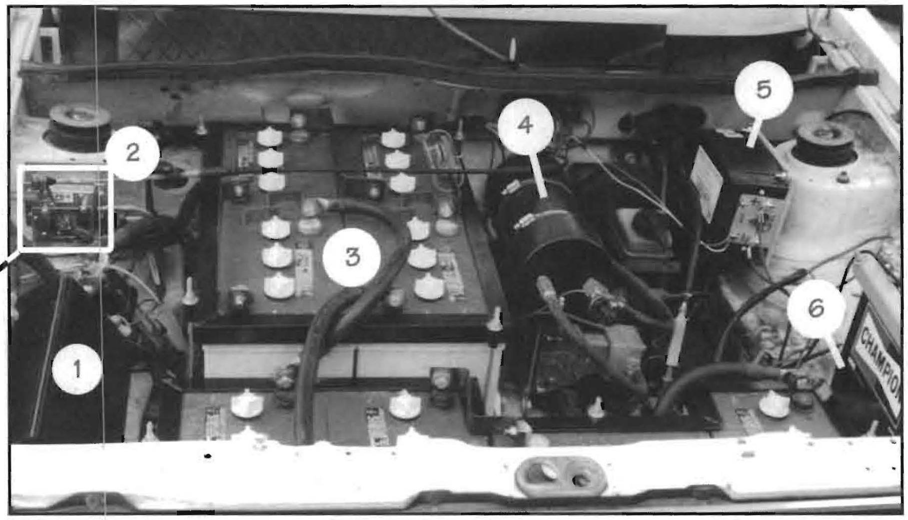

FIG. 2: Under the hood of the electric Rabbit: (1) motor speed controller; (2) throttle potbox (see Fig. 3 for close-up); (3) eight 6-volt batteries; (4) power brake vacuum reservoir; (5) DC to DC converter (replaces vehicle's alternator); (6) 12-volt battery (powers vehicle's original wiring). The electric motor, not visible here (see Fig.4), and transmission are mounted transversely.

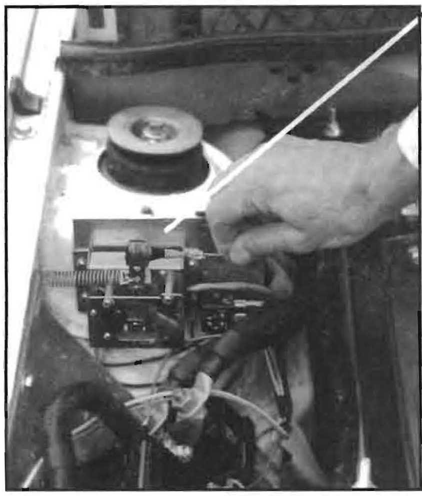

FIG. 3: The throttle potbox is simply attached to the vehicle's original throttle cable and pedal. It sends a variable resistance signal to the speed controller to specify the amount of electricity to be released to the motor.

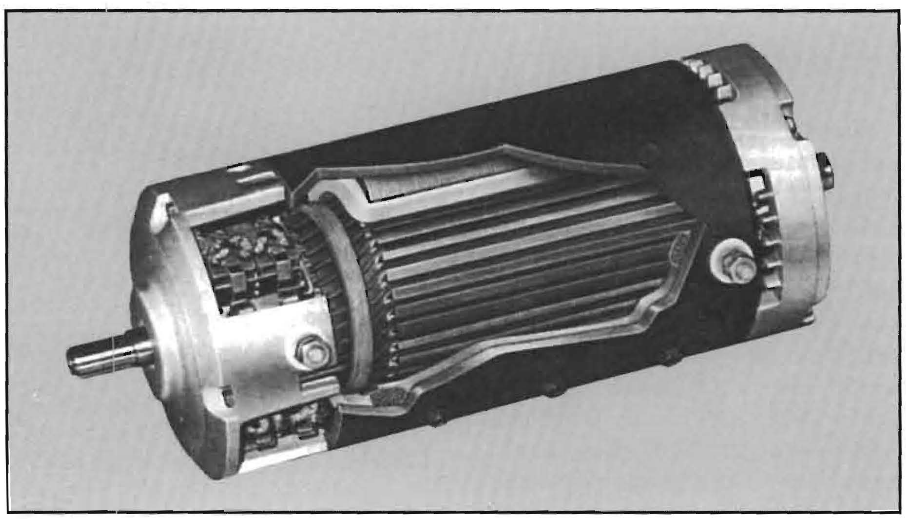

FIG. 4: Cutaway diagram of the series brush DC motor, manufactured by Advanced DC Motors, Inc. The model in this vehicle is rated at 26 kW (19 HP) continuous and 74 kW (55 HP) peak. It is 203 mm (8 inches) in diameter by 381 mm (15 inches) long and weighs 48 kg (106 pounds).

CONVERTING A RABBIT

Who did it?

Electro Automotive is the company from which Harris bought the conversion parts. California-based Electro Automotive has been refining its conversion techniques since the 1973 gas crunch. Harris found out about it in the magazine, ***Home Power,*** which targets people interested in living off the grid.

On his own time and at his own expense, Harris traveled to Santa Cruz, California, in March 1994 to attend a one-week training course in typical conversion. Normally, Electro Automotive reserves this training for professional mechanics, but Harris was able to convince the company he was sufficiently serious and had solid enough technical/mechanical knowledge to take the course. The training helped convince him that the engineering was sound — in fact, he was impressed with it — and that much of the conversion was simple mechanics.

What did it involve?

One of the main concepts of recycling a gasoline car to electric is to use as much of the original system as possible. With this particular conversion kit (Figs. 2 – 4), you take the engine out, bolt the DC electric motor to the original manual transmission, install the batteries, then wire to the existing 12-volt system (for headlights, radio and other non-motive electric devices) tapping into gauges and adding some instrumentation.

FIG. 5: Chris Harris reveals the aft eight of the sixteen 6-volt batteries powering the Rabbit. The batteries are enclosed in a polypropylene box.

Installing the sixteen 6-volt batteries is the bulk of the engineering. The total battery pack weighs about 453 kilograms (1,000 pounds), split equally fore and aft (Fig. 5). This much extra mass requires you to add custom springs and shocks. A vacuum assist, to maintain the original power brakes, is also a necessity.

You retain the same key and still have a steering column lock. The ignition becomes the on switch that enables the 12-volt system and powers up the controller. The controller — really a huge transistor — feeds current to the motor when you press on the accelerator. The electric motor will draw up to 400 amps at 96 volts.

The conversion took Harris about sixty hours spread over several months.

OPERATIONAL PARTICULARS

How does an electric car compare to a conventional gasoline car in factors such as range, maintenance and operating costs? Chris Harris had these observations.

Range

A 96-volt electric car typically has a maximum range of 100 to 130 km (60 to 80 miles) per charge. Harris' own commute is 74 km (45 miles) round trip in hilly terrain (a range limiter), and the car is running low on power by the time he gets home. He expects greater range in the future, as the capacity of the deep-cycle batteries improves after a break-in period of 50 to 100 charge/discharge cycles.

High speed also limits range. Although Harris' converted Rabbit can get up to and maintain 105 km/h (65 mph), Harris averages about 73 km/h (45 mph) on his daily commute. An advantage to electric cars: If you're getting low on power, you can stop for a few minutes, and the battery pack will rebound for 4 to 8 km (3 to 5 miles). Try *that* with an empty gas tank!

Regenerative braking — a system of dynamic braking in which the drive motor is used as a generator to return the kinetic energy of the stop to the batteries — is also a possible future add-on to increase the Rabbit's range.

Charge

Harris charges the batteries every night for about 10 hours using the on-board charger that automatically steps down to a trickle charge when the batteries are full. He installed a separate 15 amp fused line for the car. Where is the plug (Fig. 6)? Under the gas cap, of course!

Using wind energy to recharge his car (making it independent of the utility company and zero emissions in its generation as well as consumption of power) may be Harris' next step. He is planning a wind survey to see if wind generation will be feasible at his home.

Why wind and not solar generation? For one thing, wind energy generation needs less equipment investment than home solar collection. Solar panels attached to the car itself are impractical because the present state of solar collection technology doesn't yield enough energy to offset the extra weight of the panels.

Maintenance

"Maintenance," says Harris, "is a wonderful aspect of electric cars. Electric motors have one moving part, compared to the hundreds of moving parts in an internal combustion engine. You no longer have starters, spark plugs, oil changes, radiators, water pumps, fuel pumps, cam shafts, pistons, mufflers, etc."

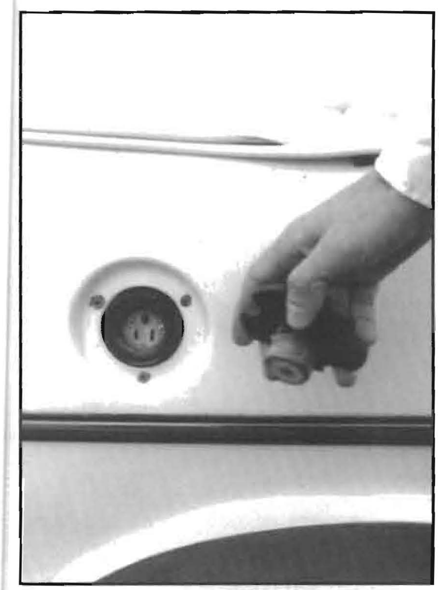

FIG. 6: The electric Rabbit is charged via a 110 VAC receptacle installed under the gas cap.

Two primary items of maintenance exist: batteries and motor brushes. The batteries need to be topped up with water every other month and need to be replaced every 3 to 4 years at a cost of approximately $1,000. (Note that the batteries are 100 percent recyclable!) Motor brushes, which are user replaceable, need to be changed about every 130,000 km (80,000 miles). Secondarily, brakes and tires must be checked more often than on an unconverted car because of the extra battery weight.

Operating Costs

Fuel costs for gas-powered cars run between 3 and 7 cents a mile. Electric fuel costs run 3 to 5 cents a mile, so fuel costs are not significantly different. However, including battery pack changes every 3 to 4 years, electric car total operating costs over 161,300 km (100,000 miles) average 8 cents a mile. Gas-powered vehicles average 28 cents — more than three times as much. Unlike conventional cars, electric car operating costs are consistent regardless of traffic. When an electric car comes to a stop, it consumes no energy, so it runs as efficiently in start-and-stop urban traffic as it does on an open rural highway. Since today's conversion car is most suited to interurban short trips, this efficiency is an advantage.

Handling Characteristics and Amenities

How does Chris Harris' converted '84 Rabbit handle? Pretty much like any '84 Rabbit. It shifts and steers the same. After all, the drive train is the same as the original. The acceleration rate on the flat seems at least as good as the original from zero to thirty. The driver, however, must resist the temptation to jam the throttle to the floor on hills. Doing this eats power and does not speed up the climb. This Rabbit climbs hills at about 73 km/h (45 mph), maximum.

On a cool autumn day, the major difference to a passenger is the sound or, rather, the lack of it. After the driver switches the system on with the ignition key, the controller emits a slight high-pitched whine for a few seconds as it powers up, the brake's vacuum pump makes a soft burp as it actuates, and then all the passenger hears is the soft hum of the electric motor. This hum is masked by road noise above about 24 km/h (15 mph) and is completely silent at stop signs because the motor does not run during stops.

In the heat of summer or the dead of winter, you would notice the lack of air conditioning or heating as well as the lack of noise. Harris is considering adding a small resistance heater that uses the original heater core. Air conditioning is possible, but rather expensive, as well as eating into the range and efficiency of the car. No AC is one reason Harris bought a convertible: "You may be broiling in the sun, but at least you've got a big volume of air moving through!"

FURTHER THOUGHTS

Recycling a good working car as a zero-emission electric car is an idea that's beginning to appeal to more people. A majority of daily commutes in the United States are in the 40 km (25 mile) or less range — perfect for today's electric-converted car. Conversion technology is no longer as crude as it was in the early 1970s. Anyone who is a proficient mechanic can convert a suitable car to run on electric power.

What is a suitable car? Most Volkswagens, Toyotas and Hondas are suitable; many sedans and sports cars are not. You need a car with a curb weight (before conversion) of at most 1,136 kg (2,500 pounds), with fore and aft compartments amenable to battery pack mounting. Lightweight pickup trucks such as the Ford Ranger and Chevy S-10 also make good conversions. In these vehicles, the rear battery pack is optionally mounted beneath the pickup bed.

Harris has this advice for people interested in owning an electric car: "Do it! The technology is available right now for a good, durable electric commuter vehicle; go for it!"

Several firms offer conversion components, kits, and/or services. If you don't want to do the conversions yourself, ready-to-roll electric conversions are available.

TxDOT's Chris Harris has proven that if you have the desire and initiative you can become a part of the clean air solution today by converting a suitable car to electric power for interurban travel. For more information, call Chris Harris at (512) 302-2132.

FORECASTING FREE TRADE'S IMPACT ON TEXAS INFRASTRUCTURE

by **Ray Donley, III**
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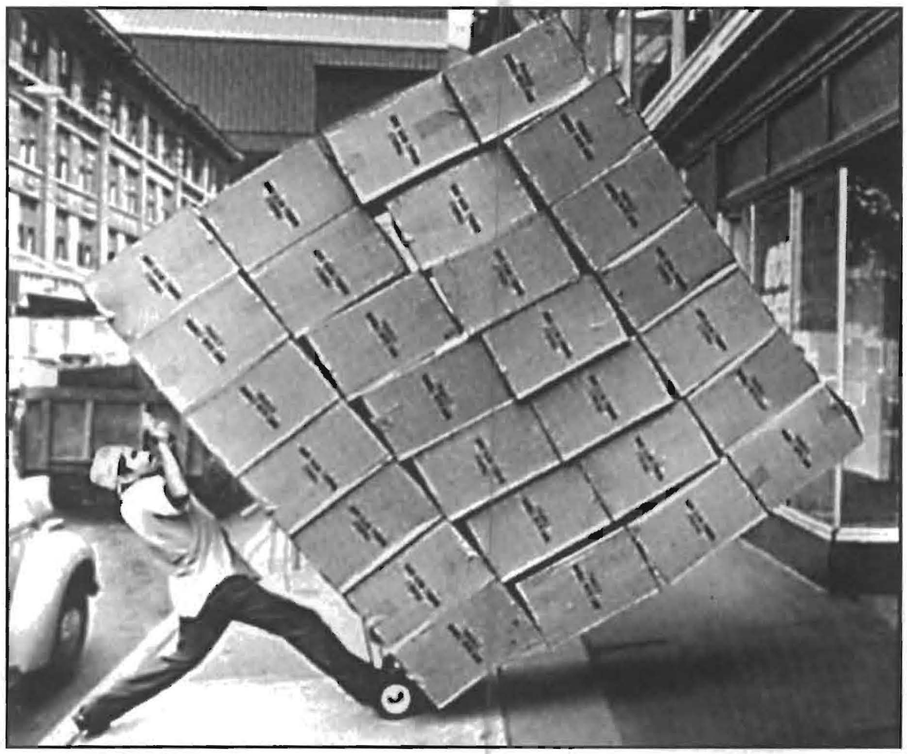


The unexpected peso devaluation has forced many transportation economists to box up and throw out their previous forecasts.

INTRODUCTION

Pity the poor transportation economist trying to make sense of Mexico's recent roller-coaster economy. Just when the North American Free Trade Agreement (NAFTA) had begun to fulfill its promise of prosperity — with major gains accruing especially for the Texas border area — the Mexican peso, as a result of a flood of foreign purchases and capital, stumbled, falling by more than 35 percent since December 20. The spectacular plunge has shaken free-trade optimism and, predictably, has generated gleeful smiles and rounds of "I told you so" from NAFTA naysayers. Never mind that most economists, both in the U.S. and in Mexico, view the downturn as a temporary blip. What has emerged, at least in terms of border transportation planning in Texas, is a reaffirmation that researchers looking into the hyperreality of present social and economic conditions are, in effect, shooting at a moving target.

Such an exercise is essentially what TxDOT-sponsored Research Study 0-1319, ***Multimodal Planning and the U.S./Mexico Free Trade Agreement,*** has been all about. This project, an interdisciplinary study currently being undertaken by the Center for Transportation Research (CTR) and the Lyndon B. Johnson School of Public Affairs of The University of Texas at Austin, is attempting to assess what NAFTA — and now peso shock — might mean for Texas transportation.

A NEW PHASE

Researcher Rob Harrison of CTR acknowledges that the study, now in its third and final year, has entered an unexpectedly exciting phase. "The benefits of the North American Free Trade Agreement are now less certain," says Harrison, "given the recent dramatic devaluation of the Mexican peso and the difficulties facing the new Mexican administration, both politically and socially." Because a key element of the study involves forecasting Texas/Mexico trade activity, these new developments must necessarily be taken into account, along with their implications for NAFTA-nation transportation systems.

To be sure, the first 2 years of the study had their share of challenges. In the first year, the researchers — Rob Harrison of CTR, Leigh Boske of the LBJ School, and approximately 20 graduate students enrolled in a year-long LBJ School Policy Research Project course — weighed possible NAFTA impacts while sketching, in broad strokes, current Mexican trade and transport infrastructure. This first-phase investigation culminated in ***Texas–Mexico Multimodal Transportation***, a report that looks specifically at existing and proposed Texas-Mexico transportation systems. For this effort, the project team examined customs services, the four transportation modes (trucking, rail, maritime, and air), and intrastate trucking regulations in Texas, with approximately two-thirds of the report focusing specifically on Mexico's transportation system and public policy.

In the second year, the study turned pragmatic, concentrating on developing a system for weighing incoming trucks at the key border stations of Laredo and El Paso, and in understanding more precisely the decisions of shippers and carriers regarding the primary commodities constituting U.S./Mexico trade. Findings for this phase are reported in ***Logistics Management and U.S./ Mexico Transportation Systems***, the study's second publication.

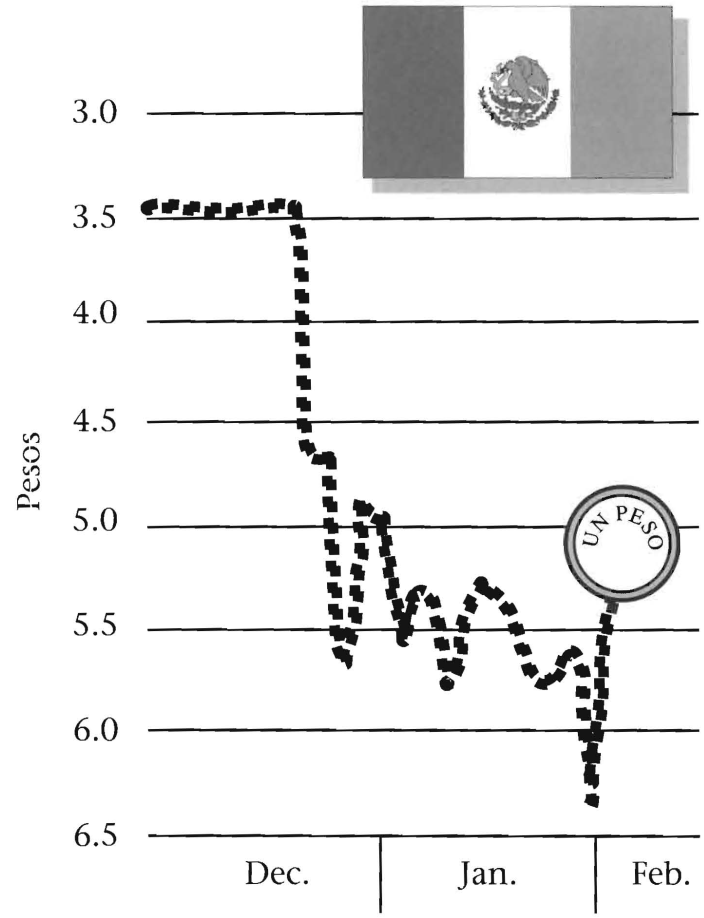
EMERGING MARKETS

In preparing that report, the project directors and graduate students encountered what Boske refers to as "markets in the making." Again, this gets back to the elusive-target metaphor. As he points out, there are in Mexico markets being created "as we speak." Boske asserts that the traditional methods used to identify and forecast trade movements — along with transportation mode choices — are being rendered useless because the markets are both entirely new and evolving.

How, under these circumstances, do you forecast market trends? "Instead of relying on the historical data," explains Boske, "we are getting together with companies, looking into how they make their decisions." Thus, the researchers are identifying modal choice by observing logistic management techniques in both the U.S. and Mexico, and by determining logistics characteristics by key commodities, along with the impact of new technologies on both sides of the border. As part of this effort, current Policy Research Project graduate students will be performing case studies of the logistics practices of U.S. and Mexican firms engaged in cross-border trade. Participating firms include Southern Pacific Railroad, J. B. Hunt Transport, TMM (Mexico's largest maritime company), and ANDSA (Mexico's largest public warehouse). According to the researchers, this approach has provided much greater insight into modal choice models and has facilitated the forecasting so essential for efficient statewide multimodal planning.

Currently, then, the project is developing "logistical profiles" to determine how existing trade corridors will grow and, further, what new corridors and markets may come into existence. Traditionally, U.S./Mexico trade has been characterized by an imbalance favoring the U.S. That is, typically, more goods are sent south of the border than are shipped north. (Texas exports more than $20 billion in trade to Mexico per year, three times as much as California, the second largest U.S. exporter.) However, as Harrison, a transportation economist, observes, "The peso devaluation may change that, as Mexican importers take advantage of lower costs in dollar terms to increase their U.S. market share. This may have an important impact on northbound trade flows and on the balance of traffic between the two nations." And Boske, also a transportation economist, expects that exports may, in fact, increase: "It's possible that the devaluation will increase maquiladora trade, which should also increase exports, since Mexican labor will become cheaper."

FALLING PESO

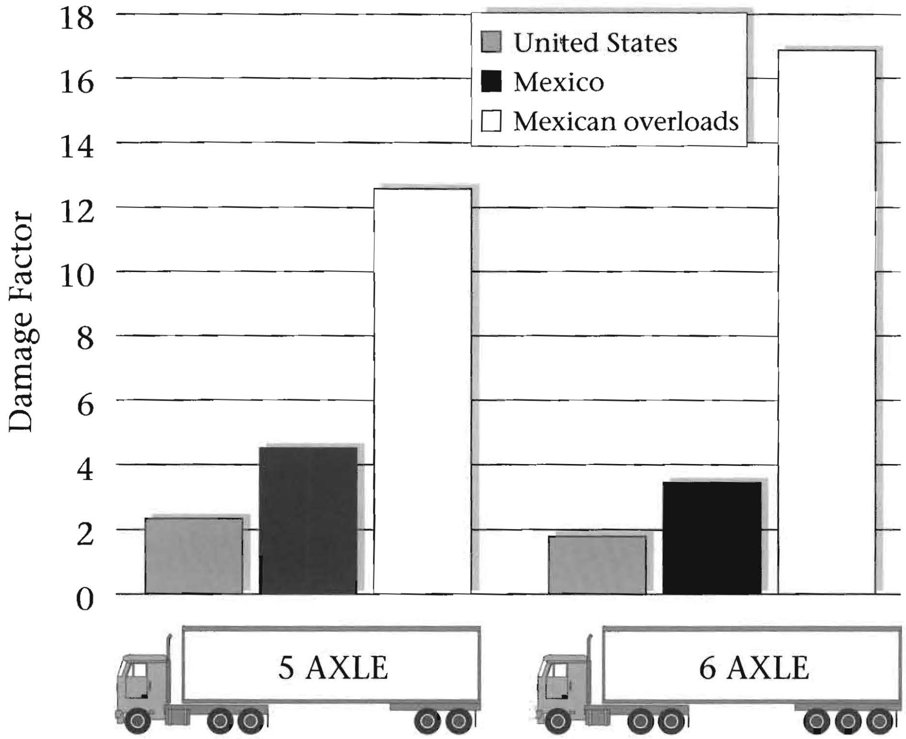


The Mexican peso has fallen by 40 percent since December 20.

Perhaps what has been most surprising about the peso slump has been the fact that not one forecaster of free-trade impacts on the border area considered even the possibility of Mexico's currency devaluation. "They blew it," says Boske of this inexplicable oversight. "A lot of forecasters went out and made all kinds of projections. What they did not do was to take into account the possibility of a devaluation." For that reason, the peso plunge has caught most economics forecasters off guard, forcing them back to their drawing boards.

While the peso situation and evolving markets have captured the immediate spotlight, waiting in the wings is another NAFTA-related concern that is causing equally high anxiety among Texas transportation planners: truck size and weight har-

OVERLOAD DAMAGE



Comparison of pavement damage caused by trucks operating at U.S. legal limits, Mexican legal limits, and under Mexican overload conditions.

monization. Currently, size and weight regulations vary substantially among the three NAFTA-member nations, such that those in force in the U.S. are significantly lower than those imposed in Canada and Mexico. In Canada, size and weight regulations are established at a provincial (rather than federal) level, and permit the operations of short, but very heavy, articulated doubles. These Canadian trucks operate typically around 67,131 kg (148,000 lb) gross weight over eight or nine axles. In Mexico, a five-axle truck is currently permitted a weight of around 50,802 kg (112,000 lb), which, even under post-NAFTA regulations, will still weigh in at over 43,998 kg (97,000 lb) from late 1996 onwards. By contrast, a five-axle articulated vehicle in Texas is limited to 36,287 kg (80,000 lb). The implications of these size and weight differences are profound; ultimately, they could alter both the design standards and maintenance budgets for the Texas highways on which these vehicles will operate.

IMPACTS ON TEXAS INFRASTRUCTURE

What may most severely strain the Texas highway system is the fact that, within Mexico, such weight limits are all but ignored in operational terms. Since there is no enforcement, Mexican operators choose whatever they feel is the appropriate weight for their cargoes. As a result, Mexican vehicles are often significantly overloaded. Harrison compares south-of-the-border trucking practices to "cattle ranching in Texas 100 years ago — anything goes." The well-documented excesses of the Mexican truckers have Texas transportation planners particularly bracing for November 1995, when Mexican trucks will be permitted to operate entirely throughout the state of Texas. Such overloads threaten to shorten the design lives of Texas highways. Added to this is the possibility of increases in U.S. truck size and weight that may be recommended for legislation through current NAFTA harmonization negotiations.

However, the weigh-in-motion (WIM) systems installed as part of Study 1319 — supervised by another Project 1319 researcher, Dr. Clyde E. Lee of UT's civil engineering department — have revealed interesting data with respect to current border-crossing operations (as opposed to operations entirely within Mexico). These WIM systems show that, at present, most five-axle Mexican combinations crossing into the U.S. are in compliance with current Texas regulations. The researchers speculate that this is in large part due to the efforts of U.S. operators, who have informed their Mexican counterparts that loaded trailers must comply with U.S. load limits. While the researchers have observed significantly overloaded six-axle trucks (or, more precisely, three-axle or tridem trailers) moving through the port of Laredo, such trailers typically stay within the Interstate Commerce Commission (ICC) zone, leading the researchers to believe that, at least at present, few overloaded trucks are straying onto mainstream Texas highways. They caution, however, that tridems represent only a small percentage of all trucks crossing the border, and that they are primarily used to ship commodities to border distributors who reconsolidate the load into legal shipments within Texas.

"We are really observing two worlds in operation," concludes Harrison. "In continental Mexico, we have extremely heavy vehicles operating well above legal limits. And at the border, we observe only those trailers from Mexico that stay within the ICC border zone operating in an overloaded state." He expects that, since the productivity gains (and profits) from overloading are potentially substantial, many Mexican operators, particularly those not reliant on U.S. counterparts for hauls within Texas, will enter Texas in an overloaded state, "unless there is a specific program to counter this."

Certainly, the issue of overloaded trucks will be an important consideration in the Texas statewide multimodal plan. Indeed, says Harrison, such consideration is necessary in order to "preserve the investment made by the state of Texas in its highway system, to maintain adequate safety for all users, and to ensure that other, competitive modes are not disadvantaged by illegal trade practices."

TxDOT employees can get copies of the LBJ reports mentioned in this article on loan from the Research and Technology Transfer Library. Call Dana Herring at (512) 465-7644. Other individuals interested in receiving copies of these reports may contact Ms. Marilyn Duncan, Office of Publications, LBJ School of Public Affairs, The University of Texas at Austin. Two reports documenting the weigh in motion findings will be published through CTR later this year. A third and final LBJ report is scheduled for publication in September.

SHRP CORNER

PERFORMANCE DATA COMING ON-LINE

by **Reginald Harrison**
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Long-Term Pavement Performance (LTPP) is a practice-oriented research federal aid program. Begun as part of the Strategic Highway Research Program (SHRP), the LTPP is a 20-year program (1987-2007) continuing under the GOE line item of ISTEA. LTPP has brought about major changes in how states approach problem solutions and technology transfer. The consensus around the nation is that LTPP will bring uniformity of engineering applications, which will facilitate rapid dissemination of technology and spin-off products to all highway agencies worldwide. The key to success is the states' support. The ultimate goal is to increase pavement life by developing better performance-based predictive models that can be used across the country in design and pavement management.

The objectives for the LTPP studies are to evaluate existing design methods, improve design and rehabilitation methods, develop predictive equations for significant distress and performance measures, and determine the behavior of different paving materials under different loads, environments, subgrade soils and maintenance practices.

The FHWA and C-SHRP (Canada's companion program to SHRP) will conduct a critical review of the LTPP SPS experiments over the next 20 months. The purpose of the review is to evaluate whether the experiments will fulfill their objectives and to identify any course adjustments that might be needed to ensure maximum effectiveness.

Beginning in 1994-95, data analysis activities will increase. Control on data release activities will be relaxed to allow access to more data. For the next 5 years, data analysis efforts will concentrate on short-term and implementable items.

As more data is collected, analyzed and released, the LTPP Information Management System (IMS) will become available for general use. The LTPP IMS is a national data base where data collected on LTPP sections is stored. It was specified as one of the main objectives of SHRP and is the most significant product of the LTPP research.

Components of LTPP IMS include:

- National Information Management System (NIMS) — the central location for all collected data (housed and managed by the Transportation Research Board [TRB])
- Regional Information Management System (RIMS)
- International Information Management System (I-IMS)
- Off-line Databases
    - Central traffic database
    - Climatic database

The IMS breaks GPS and SPS data into seven data modules:

- Inventory
- Material testing
- Monitoring — profile, FWD, transverse profile, friction, and distress
- Maintenance
- Rehabilitation
- Traffic
- Climatic

TYPES OF USES FOR LTPP DATA

SHRP researchers expect the primary use for LTPP data will be for predictive equations used in:

- Pavement design procedures
- Pavement Management Systems
- Sensitivity analysis to determine the effects of loading, environment, material properties, and specific design features on performance

Other LTPP data uses include:

- Relating back-calculated layer moduli to those from laboratory testing
- Studying roughness using profile data
- Examining rutting mechanisms using cross-profile data
- Studying traffic data
- Using 'time-history data' from deflection measurements in back calculations
- Relating engineering properties of materials and environment
- Studying seasonal variations in base and subgrade moisture and temperatures, layer moduli, structural number, and k-values
- Evaluating existing design procedures
- Understanding deterioration of existing pavements

Currently, GPS data from all modules is available. The early 1995 SPS data release will be limited to SPS-1 to 8. State departments of transportation can access this data from NIMS by data request form, via Internet, or via the data sampler and data request demo. Individual workshops are also available.

EPOXY-COATED REBAR: TIPS FOR MAXIMIZING PERFORMANCE

by **Jeff Schmitz**
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INTRODUCTION

Designers and field personnel need to keep in mind the limitations of the materials they use on a project. Sometimes it is not clear what those limitations might be. Take, for instance, epoxy coating for reinforcing steel. Depending on the information source, a designer might assume that epoxy coating is a guarantee against all corrosion during the structure's expected service life. Other literature could lead a designer to avoid using epoxy-coated rebar for fear of severe corrosion at defect sites. The Texas Department of Transportation (TxDOT) wanted to know if either of these extremes were accurate or if the truth lay more to the middle. To study the matter, TxDOT funded a research project, ***Structural Integrity of Epoxy-Coated Reinforcement (CTR 0-1265)***, at the Center for Transportation Research, The University of Texas at Austin. Dr. J. O. Jirsa, Dr. Ramon Carrasquillo, and H. G. Wheat direct the research.

Study 0-1265 has been evaluating the performance of coated reinforcement under accelerated corrosive environmental conditions (Figs. 1 – 3). The study, in its fourth of five years, has found that defects in the epoxy coating reduce the performance of this rust-preventing barrier. However, epoxy-coated rebar is still more cost-effective to use in a structure than plain black bar because epoxy-

Fig. 1: Hot water immersion was one of several types of accelerated testing performed in 0-1265.

Fig. 2: Macro-cells had salt water ponded on top of them every other week. This set of cells was broken open after a year.

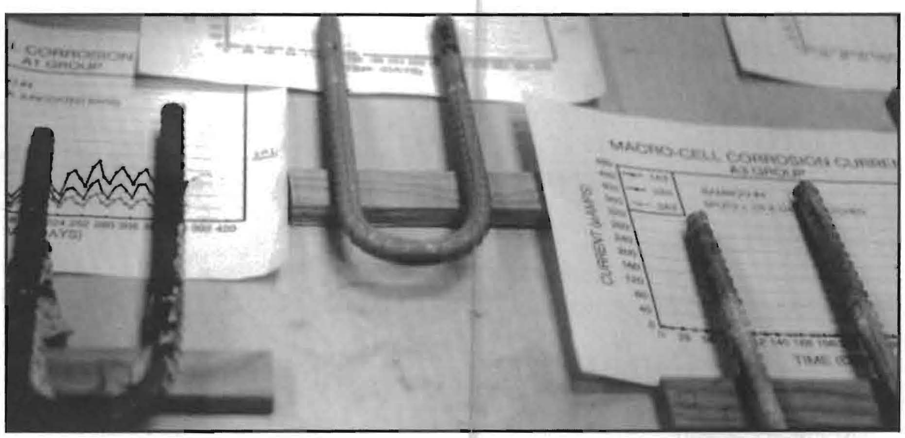

Fig. 3: Each set of macro-cells included plain black bar (the control) and epoxy-coated bar, some with induced damage (both patched and unpatched).

coated bar reduces maintenance costs associated with rebar corrosion. TxDOT is incorporating many of the project findings into Standard Specification Item 440.9, "Epoxy Coating of Reinforcing Steel." This article will outline information from study 0-1265 that is in Item 440.9.

PROBLEMS CAUSED BY DEFECTS

A defect-free coating of epoxy theoretically will prevent a bar's corrosion. Today's flexible rebar epoxy is not completely impermeable, and defect-free coatings are difficult, if not impossible, to achieve. Any discontinuity in the coating — from a visible chip to a nearly invisible pinhole-sized "holiday" — becomes the most likely location for the start of corrosion (Fig. 4).

Once started, corrosion can spread along the bar with very little resistance if the epoxy coating near a defect is poorly bonded to the steel. Water and oxygen can then fill the void between epoxy and steel, producing a prime environment for further corrosion. Normally, the high alkalinity of concrete inhibits the corrosion process, but where there is a gap between epoxy and steel, concrete's high pH level can provide no benefit. Even so, 0-1265 researchers found that epoxy-coated rebar generally showed 1.5 to 2 times less section loss than uncoated steel in aggressive chloride environments.

MINIMIZE POSSIBLE CAUSES OF DEFECTS

Minimizing the defects in the coating is one way to maximize the service life of structures containing epoxy-coated rebar. The epoxy coating on bars can be damaged in numerous ways during application/fabrication, transportation, handling and construction.

Application/Fabrication

During application, several factors can contribute to an inadequate epoxy coating. Mill scale, grease or other residue, and sharp edges all affect the quality of the coating and its adhesion to the bar. Bars that are dirty prior to coating are at risk of having a poorly bonded coat; residues such as oil, grease, paint, and salt interfere with the molecular adhesion of the coating to the steel. TxDOT Item 440.9(2) requires reinforcing steel to be free of surface contaminants and to be cleaned by abrasive blasting to near white metal before coating.

Likewise, bars with sharp edges also are more likely to have coating inadequacies. Coating flows away from sharp edges, resulting in a deficient thickness at those locations. TxDOT Item 440.9(3) requires a minimum coating thickness of between 7 to 12 mils measured with a magnetic thickness gage in accordance with Test Method Tex-728-I.

Because correct application is vital, TxDOT's Materials and Tests Division (MAT) prequalifies all epoxy producers and applicators. TxDOT has already seen marked improvement in the quality of epoxy-coated rebar delivered to Texas job sites as a result of this research program. A list of approved applicators is available from MAT.

During fabrication, bar bending is a source of problems in two ways. Bar manufacturers normally coat the steel before performing any bending. As a result, the flexible coating is susceptible to damage during fabrication. The inside of the bar bend can be damaged during the bending process. Conversely, the coating on the outside of the bar bend can stretch, loosening its bond to the steel, or crack. Item 440.9 requires the applicator to pad the mandrel to minimize damage to the inside of the bend during bending.

Transportation and Handling

During transportation, storage and handling, epoxy-coated bars receive various degrees of punishment. Careless handling can severely damage a bar's coating. Workers may drag bars carelessly across the ground, gashing the coating. Also, bars bundled together without padding in transit rub and rasp against each other en route to their destination. Item 440.9 requires that all systems for handling coated reinforcement have padded contact areas and that bundled coated reinforcement be stored in protective cribbing and not be dropped or dragged.

Construction

At the construction site, bars face still more dangers. During phased

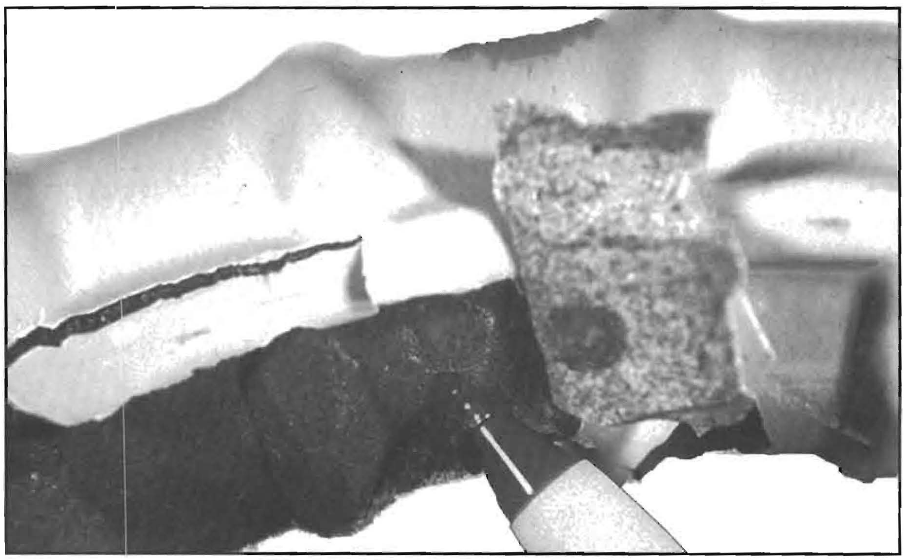

Fig. 4: This pit was the result of a holiday. Notice how the corrosion has spread underneath the epoxy coating (probably from the patch visible as a darker area on the top between the deformations).

construction, bars protruding from a Phase I pour must be protected until Phase II is cast. Because ultraviolet light can degrade epoxy, coated bars stored on-site require UV protection. Bar bending and straightening is a hazard in the field, just as in fabrication. Torch cutting and welding will burn the coating, so Item 440.9 prohibits torch cutting and limits welding. Haphazard vibration is also dangerous. If the vibrator's steely head strikes the bars, it may chip the coating from the steel. This damage is particularly undesirable because it cannot be monitored or repaired. Rubber-covered vibrator heads can reduce the possibility of damage. Inspectors may want to discuss vibration methods with the contractor before a concrete pour begins (Fig. 5).

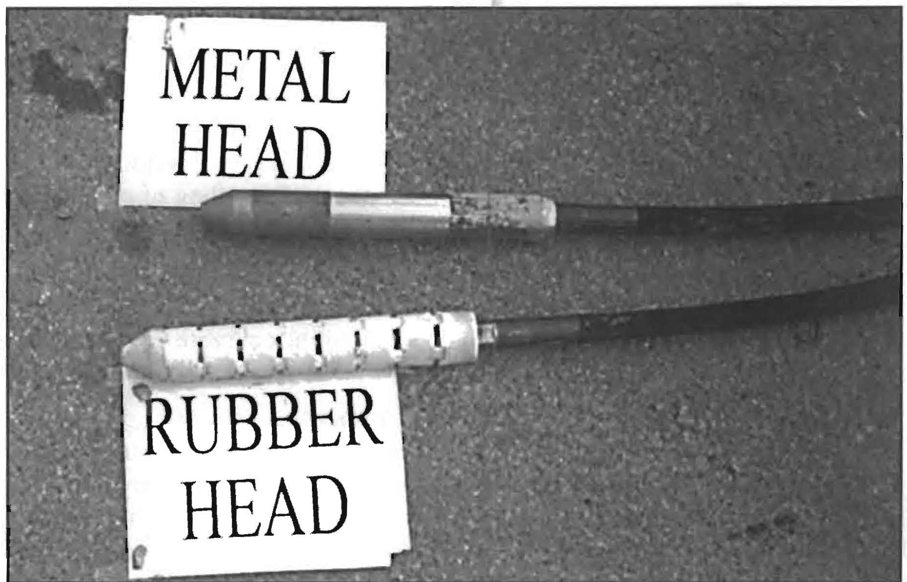

Fig. 5: Rubber-headed vibrators cause less damage to epoxy-coated rebar.

MEANS OF DETECTING AND REPAIRING DEFECTS

In Texas, the applicator is responsible for certifying that the coating meets specifications. TxDOT inspectors randomly sample the rebar as a double check. They both use visual inspection for detecting sizable defects. Tiny pinholes (holidays) in the epoxy coating, however, can also allow corrosion to occur. Visual inspection cannot find holidays; detection requires a more sophisticated method. Specialized devices, aptly called holiday detectors, monitor the quality of the coating by locating voids or flaws therein. Holiday detectors can be either in-line or hand-held. Both types operate based on the conductivity of the defects — an exploring electrode travels along the bar's surface, while a grounded end completes the electrical circuit. When the exploring electrode contacts a void, a small current triggers an audible signal to indicate the void's presence. TxDOT Item 440.9(4) requires that the applicator use a 67.5-volt DC in-line holiday detector or approved equivalent to check coating continuity after curing. TxDOT inspectors use the hand-held detectors on the random samples.

While holiday detectors are not fool-proof safeguards against undetected voids, they are the only test equipment currently available. In general, Project 0-1265 tests have shown that holiday detectors produce rather inconsistent results. The hand-held devices are cumbersome to use on bar bends, and closely spaced defects are difficult to detect separately. Operators significantly affect the quality of detection. If the exploring electrode is not kept in constant contact with the bar, the holiday detector is likely to miss voids in the epoxy.

According to TxDOT Item 440.9(4), no more than two holidays can be present in any linear foot of epoxy-coated bar, and all visible damage to the coating must be repaired. Cut ends and damage due to bending must be patched as well. If repairing a bar is necessary, an epoxy material compatible with that used to coat the bar is required for patching. Inspectors must see that the patching procedures recommended by the epoxy powder manufacturer are followed, that the damaged area is properly cleaned before patching, and that the patch is at least as thick as the original coating. Tests performed during Project 0-1265 showed that patching material is not as effective as the original coating. In an aggressive, accelerated testing environment, these patched areas showed corrosion after only a few weeks.

SUMMARY

Epoxy coating is a cost-effective method of corrosion protection for reinforcing steel, but coated rebar requires special treatment to keep its protective coating intact. Study 0-1265, ***Structural Integrity of Epoxy-Coated Reinforcement,*** has identified conditions that lead to early deterioration of epoxy-coated reinforcement. To reduce the likelihood of damage to epoxy-coated bars, TxDOT personnel should be aware of several precautions recommended in research study 0-1265 and noted in Item 440.9. Such precautions include:

During Application and Fabrication

- Thoroughly clean bars before coating
- Minimize sharp edges on bars
- Apply coating per manufacturer's requirements
- Use padded mandrels for bar bending
- Make sure coating is fully cured before fabrication

During Handling, Storage, and Transportation

- Prevent excessive sagging when lifting bars (avoiding abrasion and possible cracking of the coating) by using a strong back, spreader bar, multiple supports or a platform bridge
- Pad all contact areas on handling systems
- Use suitable banding material
- Use protective cribbing for storage — store off of the ground, allow for air circulation, and protect from ultraviolet light

During Construction

- Avoid dragging or rough handling of bars
- Avoid field bending or straightening if possible
- Prohibit torch cutting of coated bars
- Allow only the welding or mechanical coupling of coated bars that is *specifically* shown in the plans
- Patch all visible damage
- Vibrate concrete carefully and thoroughly around coated bars

TxDOT has already seen marked improvement in the quality of epoxy-coated rebar delivered to Texas job sites as a result of this research program. However, careless handling during transportation, storage and construction can induce damage, seriously decreasing an epoxy-coated bar's resistance to corrosion, and in turn, shortening the service life of a structure. If treated properly, as outlined in TxDOT Item 440.9, epoxy coating can help prevent corrosion of reinforcing steel and lengthen the service life of a structure.

BIBLIOGRAPHY

1. Kahhaleh, K. Z., H. Y. Chao, J. O. Jirsa, R. L. Carrasquillo, and H. G. Wheat. ***Studies on Damage and Corrosion Performance of Fabricated Epoxy-Coated Reinforcement*** (FHWA/TX-93+1265-1). Austin: Center for Transportation Research, The University of Texas at Austin, January 1993.
2. Texas Department of Transportation. ***Standard Specifications for Construction of Highways, Streets and Bridges 1993.*** Austin: Texas Department of Transportation, March 1993.

DON'T MISS THE METRIC CONSTRUCTION WORKSHOPS

Metrication for the United States is not an option: it is a necessity. The longer the metrication effort is put off, the greater the cost is due to losses in the international market. Conversion to the metric system will automatically improve both international acceptance and competitiveness. Therefore, after September 30, 1996, all projects funded by the Federal Highway Administration (FHWA) must be in metric units, unless a specific exception is granted.

The Texas Department of Transportation (TxDOT), the Associated General Contractors of Texas (AGC), and the FHWA are sponsoring five one-day metric seminars in April. These workshops will provide basic training in the metric system, guidance from industry and others involved in the metrication effort, a presentation of TxDOT's plans for metrication, and an opportunity to offer suggestions, concerns, and questions. This workshop was developed for contractors, TxDOT senior construction staff, suppliers, and local government agencies. Courses in metrication will be offered to TxDOT inspectors this fall.

DATE	LOCATION	TIME	HOTEL	PHONE
April 17	Dallas	9:00 a.m. to 3:00 p.m.	Doubletree at Lincoln Centre	(214) 934-8400
April 18	San Antonio	9:00 a.m. to 3:00 p.m.	Hill Country Hyatt Hotel	(210) 647-1234
April 19	Houston	9:00 a.m. to 3:00 p.m.	Westin Galleria Hotel	(713) 960-8100
April 25	McAllen	8:00 a.m. to 2:00 p.m.	Holiday Inn	(210) 686-2471
April 26	Odessa	9:00 a.m. to 3:00 p.m.	Holiday Inn	(915) 362-2311

TABLE 1: Schedule for Texas Metric Construction Workshops.

The agenda for these seminars include:

- an overview of TxDOT metrication policy
- sessions on surveying, project development, and construction
- an overview of the industry's perspective

If needed, each attendee must make his/her own lodging arrangements. There is no registration fee, but places are limited. If you have questions or need registration information or assistance, please contact Ms. Debbie Koehler of the AGC by phone at (512) 478-4691 or by fax at (512) 478-7936.

THINK METRIC!

A METRIC MACRO FOR WORDPERFECT

by **Bruce Hallock**
Information Specialist
Traffic Operations Division
Texas Department of Transportation

MET.WPM is a WordPerfect 5.1 (DOS) macro that converts selected English measurements to their metric equivalents and places the English value in parenthesis following the metric. Use the macro right in your WP document anywhere you have typed an English measurement in your text (for example: 6.25 feet, 12.5 miles, 3 lbs., 79 °F).

Be sure to put the macro in the subdirectory designated in "List Files" for macros.

To use the macro, Press Alt-F10, type *met* and press Enter. Then just follow the prompts.

The macro prompts you to block the English value (alternatively, you may block first and avoid the prompt). Be sure to block both the NUMBER and the UNITS. (For example, if you want to convert 6.25 feet to meters, block both the "6.25" and the word "feet," like this: 6.25 feet.) If there's a space following the units, it's okay to include the space in your blocking; however, do not include any punctuation such as a comma or period (unless the period is part of the units abbreviation).

The macro will recognize standard abbreviations, plurals, and singular forms of each English unit. It will not recognize symbols such as: ′ and ″. It will recognize °F if a space separates this unit designation from the number.

The macro will prompt you for the number of decimal places you want in your metric equivalent (4 is the maximum; 2 is the default). After you enter the desired number of decimal places (don't press Enter after typing the number), the metric equivalent will appear in your text, followed by your original English expression in parentheses, like this: 1.91 m (6.25 feet).

As it is, the macro will convert the following:

- inches to m, cm, or mm (prompts for choice)
- feet to m (meters)
- miles to km (kilometers)
- square inches to mm^2 (square millimeters)
- square feet to m^2 (square meters)
- acres to ha (hectares)
- gallons to L (liters)
- cubic inches to mm^3 (cubic millimeters)
- cubic feet to m^3 (cubic meters)
- cubic yards to m^3 (cubic meters)
- ounces to g (grams)
- pounds to kg (kilograms)
- tons ("short tons" — 2,000 lb.) to Mg (megagrams or metric tons)
- footcandles to lx (lux)
- miles per hour to km/h (kilometers per hour)
- inch-pounds to N•m (newton meters)
- foot-pounds to N•m (newton meters)

Continued on page 14 ...

METRIC NOTES

The Metric Task force reminds TxDOT employees that the following rules should guide the conversion process:

- Use ASTM E380 as the authoritative reference for application of metric or SI units. Use and present conversion factors exactly as shown in ASTM E380
- Round the results of the conversion process to reflect the precision of the converted value
- Use "soft" conversions — metric equivalents — until new national standards are established and accepted to prevent retooling twice if local standards differ
- Accommodate contractors who wish to supply material in metric on an English-unit job

USING E-MAIL WITH CAUTION

When you talk to folks face to face, you use gestures and other ways of communicating to let people know when you're serious and when you're not.

When you write a letter or memo, you usually check every word carefully to make sure you're not offending anyone.

But when some people use e-mail they sometimes forget that others don't know when they're kidding and when they're not. People forget that words can wound people and hurt relationships if not used judiciously.

Here are some rules of "netiquette," offered by James L. Horton, designed to help you convey meaning without unintended emotion:

- Don't write in all caps because it looks as if you're screaming at the other person.
- If you want to make a point but not offend, use a symbol — such as a smiley face — to indicate friendliness.
- Avoid jokes unless you let the other person know you're kidding.

He cautions: "Never send anything by e-mail that you don't want everyone in your company to read. Remember that e-mail can be forwarded to others or downloaded and shown around."

Source: James L. Horton, APR, president, Slater Hanft Martin Communications, 111 5th Ave., New York, NY 10003, writing in Public Relations Tactics, 33 Irving Place, New York, NY 10003.

- degrees Fahrenheit (works with whole numbers only) to °C (degrees Celsius)

NOTE: This macro uses the conversion factors found in TxDOT's Metrication Guide.

Disk copies of MET.WPM are available to TxDOT employees through the Research and Technology Transfer Library. Call Dana Herring at (512) 465-7644.

If you are entering the macro code from the following figure, remember that it must be entered using WordPerfect's Macro Editor. Codes in braces {} cannot simply be typed in — they have to be entered as macro programming commands {THOSE IN ALL CAPS} or by using function keys {Those With Initial Caps}. Control commands are entered by holding down the Ctrl key and pressing the appropriate character {^]}. Spaces and tildes are very important.

It's easy to add other conversions. Call Bruce Hallock, Traffic Operations Division (phone: 512/416-3100), if you need help.

```
MET.WPM
{;}Created by Bruce Hallock, TxDOT Traffic Operations Division
     Phone: 416-3100~
{;}INSTRUCTIONS: Block both the English value AND the units indicator,
     then activate the macro or vice-versa.~
{;}Version: 2/24/95~

{Home}{Home}{Typeover}
{IF}{STATE}&512~{Reveal Codes}{END IF}
{LABEL}Block~{IF}{STATE}&128~{GO}Eng~
     {ELSE}{INPUT}Block both English value & units, press ENTER.~
     {GO}Block~{END IF}
{LABEL}Eng~{DISPLAY OFF}{Macro Commands}aEng{Enter}
{Block}{Goto}{Goto}{Del}y
{DISPLAY OFF}{Switch}{Home}{Home}{Down}{HPg}{VARIABLE}Eng~
{Home}{Left}{Block}{Word Right}{Left}{Macro Commands}aEngVal{Enter}
{Right}{Block}{End} Replace}n {Replace}{Replace}
{Goto}{Goto}{Block}{End}{Macro Commands}aEngUnits{Enter}

{CASE CALL}{VARIABLE}EngUnits~~
     inch~inches~inches~inches~in.~inches~
     foot~feet~feet~feet~ft.~feet~
     mile~miles~miles~miles~mi.~miles~
     ounce~ounces~ounces~ounces~oz.~ounces~oz~ounces~
     lb~pounds~lb.~pounds~lbs~pounds~lbs.~pounds~pound~pounds~
          pounds~pounds~
     ton~tons~tons~tons~shortton~tons~shorttons~tons~
     gallon~gallons~gallons~gallons~gal.~gallons~gals.~gallons~
     cubicinches~CuIn~cu.in.~CuIn~cubicinch~CuIn~cubicin.~CuIn~
     cubiCfeet~CuFt~cu.ft.~CuFt~cubicfoot~CuFt~cubiCft.~CuFt~
     cubicyards~CuYds~cu.yds.~CuYds~cubicyard~CuYds~cu.yd.~CuYds~
     acre~acres~ac.~acres~acres~acres~
     squarefeet~SqFt~sq.ft.~SqFt~squareft.~SqFt~squarefoot~SqFt~
     squareinches~SqIn~sq.in.~SqIn~squarein.~SqIn~squareinch~SqIn~
     footcandle~fc~footcandles~fc~
     mph~MPH~m.p.h.~MPH~milesperhour~MPH~mileperhour~MPH~
     inch-pound~InLb~inch-pounds~InLb~in.lb.~InLb~in.lbs.~InLb~
     foot-pound~FtLb~foot-pounds~FtLb~ft.lb.~FtLb~ft.lbs.~FtLb~
     degrees~Fahr~degree~Fahr~deg.~Fahr~degreesfahrenheit~Fahr~
     degreefahrenheit~Fahr~degreeF~Fahr~degreesF~Fahr~½F~Fahr~
     {OTHERWISE}~Sorry~~{GO}DeciPlaces~

{LABEL}Inches~{CHAR}Key~{Del to EOP}
{^]}How do you want the conversion expressed?{^\}
{^P}{NTOK}5~{NTOK}2~{^]}1{^\} - {^V}M{^Q}eters (m)
```

```
{^P}{NTOK}5~{NTOK}4~{^]}2{^\}  -  {^V}C{^Q}entimeters  (cm)  {^]}(Not
normally used){^\}
{^P}{NTOK}5~{NTOK}6~{^]}3{^\}  -  Mi{^V}l{^Q}imeters  (mm)
{^P}{NTOK}0~{NTOK}24~{^]}Selection  0{^\}{Left}~
{CASE}{VARIABLE}Key~~
        1~M~M~M~m~M~
        2~C~C~C~c~C~
        3~L~L~L~l~L~
        {OTHERWISE}~Inches~~


{LABEL}M~{ASSIGN}ConvFactor~0.0254~{ASSIGN}Units~m~{RETURN}

{LABEL}C~{ASSIGN}ConvFactor~2.54~{ASSIGN}Units~cm~{RETURN}

{LABEL}L~{ASSIGN}ConvFactor~25.4~{ASSIGN}Units~mm~{RETURN}

{LABEL}Feet~{ASSIGN}ConvFactor~0.3048~{ASSIGN}Units~m~{RETURN}

{LABEL}Miles~{ASSIGN}ConvFactor~1.609344~{ASSIGN}Units~km~{RETURN}

{LABEL}Ounces~{ASSIGN}ConvFactor~28.34952~{ASSIGN}Units~g~{RETURN}

{LABEL}Pounds~{ASSIGN}ConvFactor~0.4535924~{ASSIGN}Units~kg~{RETURN}

{LABEL}Tons~{ASSIGN}ConvFactor~0.9071847~{ASSIGN}Units~Mg~{RETURN}

{LABEL}Gallons~{ASSIGN}ConvFactor~3.785412~{ASSIGN}Units~L~{RETURN}

{LABEL}CuIn~{ASSIGN}ConvFactor~16387.064~{ASSIGN}Units~mmsupr3~{RETURN}

{LABEL}CuFt~{ASSIGN}ConvFactor~0.02831685~{ASSIGN}Units~msupr3~{RETURN}

{LABEL}CuYds~{ASSIGN}ConvFactor~0.7645549~{ASSIGN}Units~msupr3~{RETURN}

{LABEL}Acres~{ASSIGN}ConvFactor~0.404687~{ASSIGN}Units~ha~{RETURN}

{LABEL}SqFt~{ASSIGN}ConvFactor~0.09290304~{ASSIGN}Units~msupr2~{RETURN}

{LABEL}SqIn~{ASSIGN}ConvFactor~645.16~{ASSIGN}Units~mmsupr2~{RETURN}

{LABEL}fc~{ASSIGN}ConvFactor~10.76391~{ASSIGN}Units~lx~{RETURN}

{LABEL}MPH~{ASSIGN}ConvFactor~1.609344~{ASSIGN}Units~km/h~{RETURN}

{LABEL}InLb~{ASSIGN}ConvFactor~0.1129848~{ASSIGN}Units~N•m~{RETURN}

{LABEL}FtLb~{ASSIGN}ConvFactor~1.355818~{ASSIGN}Units~N•m~{RETURN}

{LABEL}Fahr~{ASSIGN}ConvFactor~0.55555~{ASSIGN}Units~½C~
        {ASSIGN}EngVal~{VARIABLE}EngVal~-32~{RETURN}
```

```
{LABEL}Sorry~{Page Down}{Block}{Goto}{Up}{Left}{Del}y
     {Switch}{VARIABLE}Eng~{DISPLAY ON}
     {STATUS PROMPT}SORRY, don't recognize "{VARIABLE}EngUnits~"~
     {WAIT}40~{STATUS PROMPT}~{QUIT}

{LABEL}DeciPlaces~
{Switch}{CHAR}DeciPlaces~How many decimal places do you want? ~

{DISPLAY OFF}{Switch}{Home}{Home}{Down}{HPg}
{Columns/Tables}tcl{Enter}3{Enter}{Exit}
{VARIABLE}EngVal~{Down}{VARIABLE}ConvFactor~{Down}
{Columns/Tables}mfA1*A2{Enter}
fld{VARIABLE}DeciPlaces~{Enter}mc{Exit}
{Block}{End}{Macro Commands}aMetricVal{Enter}
{Page Up}{Backspace}{Block}{Page Down}{Page Down}{Del}y{Switch}

{VARIABLE}MetricVal~ {VARIABLE}Units~ ({VARIABLE}Eng~)
{Block}{Search Left}({Search Left}{Left}
{Replace}n( {Replace}({Replace}
{Search}){Search}{Block}{Word Left}{Word Left}
{Replace}n ){Replace}){Replace}
{Word Left}{Search}){Search}
{Left}{Left}{Block}{Word Right}{Replace}n  {Replace} {Replace}

{ON NOT FOUND}{GO}Square~~
{Search Left}supr3{Search Left}
{Backspace}{Backspace}{Backspace}{Backspace}{Backspace}{Font}sp3{Right}
{QUIT}

{LABEL}Square~{ON NOT FOUND}{QUIT}~
{Search Left}supr2{Search Left}
{Backspace}{Backspace}{Backspace}{Backspace}{Backspace}{Font}sp2{Right}
{QUIT}
```

Figure 1: Code for Bruce Hallock's metric macro for WordPerfect 5.1 (DOS). Please note that there are ***two spaces*** *between the "{Replace}n" and the next "{Replace}" in the ninth line from the bottom.*

ADA QUESTIONS? CALL 1-800-USA-ABLE

This is a toll-free hotline to get answers to questions on the technical guidelines of the Americans with Disabilities Act (ADA). Operated by the Architectural and Transportation Barriers Compliance Board (Access Board), the number is in service between 9 a.m. and 5:30 p.m., Monday through Friday.

The Access Board created guidelines that the USDOT adopted as standards for accessibility in transportation, building, facilities, and vehicles.

URBAN TRAFFIC CONGESTION STILL INCREASING NATIONWIDE

by **Bernie Fette**
Communications
Texas Transportation Institute
Texas A&M University

A report from the sixth year in a 10-year study by the Texas Transportation Institute (TTI) shows traffic congestion getting worse in most of the nation's largest urban areas.

Study 0-1131, ***Measuring and Monitoring Urban Mobility in Texas,*** sponsored by the Texas Department of Transportation (TxDOT), measures traffic congestion in 50 urban areas across the nation, including seven in Texas. The report reflects data from 1991, the most recent available on a nationwide basis.

Researchers calculated congestion levels according to the Roadway Congestion Index (RCI). Developed by TTI research engineer Tim Lomax, the index considers daily vehicle-miles of travel per lane-mile of freeways and principal street systems. Ratings of more than 1.0 indicate undesirable levels of congestion.

For the sixth year in a row, Los Angeles headed the list of the ten most congested urban areas in America with an RCI rating this year of 1.56, followed by Washington, D.C., with 1.39. New York, number ten on the list, earned a rating of 1.14.

Congestion in the Texas cities studied increased steadily from 1982 to 1986, but has decreased or remained relatively constant since 1986. At the top of the national list, San Diego has experienced a 56 percent increase since 1982; and San Francisco, Salt Lake City, Sacramento and Washington, D.C., had increases of 30 percent or more. In contrast, Houston's RCI has decreased every year since 1984.

In estimating the economic costs of traffic congestion, the study measured traffic delay and excess fuel consumption as its two primary components. The total cost of congestion for the 50 urban areas studied was approximately $44 billion, 89 percent of which was attributed to travel delay. The average economic burden of congestion placed on these urban areas in 1991 was $785 million, compared with $750 million in 1990.

Congestion puts the squeeze on urban mobility.

Fourteen urban areas had congestion costs exceeding $1 billion, with Dallas and Houston ranking in the top ten. Congestion in the seven Texas cities resulted in a cost of $3.9 billion, representing a six percent increase since 1990. TTI's study also quantified additional capacity required to stop the growth of congestion. This factor estimates the added burden that would be placed on public agencies if additional roadway mileage represented the only solution to traffic congestion.

Los Angeles would require 528 additional lane-miles of freeways and principal streets every year to maintain current mobility levels if traffic volumes grew at the rate measured between 1987 and 1991. According to the study, these figures demonstrate that the construction of additional lane-miles as the sole method to alleviate congestion is not feasible in most areas, but must occur in combination with other improvements and traffic management programs.

According to the study, increasing traffic congestion is the result of the roadway system's failure to meet the new demands of an increasing population and changing employment opportunities. The authors attribute the decline in new facilities constructed in the past 20 years to reduced funding, increased construction costs, and public resistance to building and widening roadways.

A negative perception of mobility levels, however, has renewed interest in the transportation infrastructure, they say, and has increased the desire of the transportation community, general public, policy makers, and others to understand the causes of and solutions to urban congestion.

"While building more roadways is one option in addressing this problem, improved operations and demand-management programs represent important solutions as well," Lomax says. "Those improvements can take a number of forms, including better signal timing, prompt management of accidents and other traffic incidents and more reliable traffic information for travelers. Techniques such as these are being developed and pursued by TTI, TxDOT and local agencies throughout the state."

For more information, call Dr. Tim Lomax at (409) 845-9960.

Did You Know ... ?

Unused *Texas Highways* magazines are being distributed to local Adopt-a-School programs to help educate children about the great state of Texas.

BRIDGE DESIGNERS' CONFERENCE COVERS TOUGH ISSUES

This year's Texas Department of Transportation (TxDOT) Bridge Designers' Conference offered practical advice on a wide variety of topics such as automated plan drawing, innovative precast construction techniques, and decision-making about bridge rehabilitation versus replacement. The Bridge Section in TxDOT's Design Division (DES) sponsored the conference held 7–9 March 1995. One highlight of the conference was a field trip to the US 183 segmental bridge project. Adding an international flare to the conference, Niels Gimsing, P.E., of the Technical University of Denmark gave a fascinating presentation on the Danish Great Belt bridge/tunnel project.

The conference sessions were taped. These sessions will be available through the Research and Technology Transfer Office Library (RTT) and will be listed in an upcoming ***Research Digest.*** Fill out this request form when you see it or call Dana Herring, RTT Librarian, at (512) 465-7644, to order your loan copy of one or all sessions. Here are some highlights from the sessions.

All plans must be in metric units in the 1996 lettings. Do you measure up? View *Standards and Metric Conversion,* **Richard Wilkison, P.E., Design Division.**

Texas is developing technology to optimize prestressed concrete design and construction using the new TxDOT U-beam with higher strength concrete and larger strands. For details of the first bridges incorporating economy, aesthetics and high-tech materials, view *Status of Texas High Performance Concrete Bridge Projects,* **Mary Lou Ralls, P.E., Design Division and Dr. Ramon Carrasquillo, P.E., UT at Austin.**

Pondering prioritization? Review *Statewide Prioritization of Bridge Projects,* **Ralph Banks, P.E., Design Division.**

A little rusty on corrosion? Watch *Corrosion Update,* **Lloyd Wolf, P.E., Design Division.**

How is that beautiful segmental bridge in Austin progressing? See *The US 183 Elevated Segmental Bridge Project,* **Bobby Steeds, P.E., Austin District and Dean Van Landuyt, P.E., Design Division.**

Want to know about an innovative, cost-saving construction technique? Find out in *Precast Bent Caps — A Construction Case Study,* **Art Clendennin, P.E., Corpus Christi Distsrict.**

Concerned about expansion joints? Watch *Sealed Expansion Joint Failures — Study Results,* **Dr. Karl Frank, P.E., UT at Austin.**

Should you fix that old bridge or tear it out? Watch *Bridge Rehabilitation vs. Bridge Replacement — A Complex Decision,* **Mark Bloschock,P.E., Design Division.**

Beat fatigue. See *Optimizing Diaframs in Steel Bridges — Research Results and Implementation of Research Results,* **Dr. Peter Keating, P.E., Texas A&M Unversity and Gregg Freeby, P.E., Design Division.**

Learn about what's hot and what's not. See *Specifications and Materials,* **Robert Sarcinella, Materials and Tests Division.**

Curious about the design and construction of a bridge with over a mile of free span? See *Cable-Stayed Bridge Structures — The State of the Art,* **Niels Gimsing, P.E., Technical University of Denmark.**

TXDOT IS NEWS

As the agency responsible for the state's transportation system, TxDOT impacts the lives of most Texans. Close scrutiny of its activities by members of the news media is expected and welcomed.

To be responsive to the media's needs, TxDOT has a comprehensive public information program. This PIO program is the backbone of the department's media relations effort. However, any TxDOT employee might receive a media inquiry, so all employees should know how to handle questions from news people.

All media inquiries should be handled in a prompt, efficient and professional manner.

When contacted by a reporter, any TxDOT employee should:

- Be aware of any district/division policy regarding media relations.
- Know that employees are ***not required*** to talk to the media, but at the very least must refer the reporter to an appropriate department representative who can provide the information requested.
- Confine comments to areas of official responsibility when representing the department.
- Notify the Public Information Officer in his or her district of the inquiry as soon as possible. Division employees should contact either their PIO or the Public Information Office at (512) 463-8588.

Did You Know ...?

Approximately $875,000 worth of research will be conducted by TxDOT through state universities this fiscal year to learn the best ways to use recycled materials in roadway construction. Projects will examine the use of glass, roofing shingles, plastics, crushed concrete, plant materials, and more. These projects are being funded in part by grants from the Texas Natural Resources Conservation Commission and the FHWA.

DEALING WITH THE NEWS MEDIA OR "WHAT TO DO WHEN MIKE WALLACE CALLS"

Relax.

Determine your message.

- Prepare your message and rehearse it.
- Make it short, sweet and quotable.

Avoid saying "No."

- You can't always give them what they want, but be responsive, honest and professional.

Avoid saying "No comment."

- It's often perceived as "I'm guilty."

Don't be afraid to say "I don't know."

- Know your limits. Don't speculate.
- Tell the media you'll get the answer for them right away. Then do it.
- Agree on a deadline and stick to it.
- If you run into problems getting the information, let the reporter know.

Don't suggest what to write.

- Give the reporter the facts.
- Remember — you may be quoted. Be succinct.

Don't say it or you will read it.

- Be careful of "off the record."
- You can always add information, but you can't take it back.
- Sometimes less is more.

Know your audience.

- Emphasize your point, then reemphasize it repeatedly.
- Think of the interview as a three-way conversation among you, the reporter and the readers/listeners.

Consider the setting for your interview.

- Make sure it doesn't damage your point. Images are important.

Never tell a reporter, "You can't print that."

- They can and often will.

WRAPPING UP THOSE MEETINGS

Ever attend a meeting or run a meeting where you had lots of discussion but no closure on any ideas?

If so, you might want to consider these suggestions from Harvey Mackay author of two *New York Times* No. 1 best-sellers:

- **Recap** what you consider to be the key points made. Summarize the pros and cons of each point you've discussed.
- **Ask for** what you want. *Example:* "I would like your approval to get started on this project by the 15th."
- **State** the benefits of what you're proposing. This shows why they should have the good sense to go along with you.

If you don't ask for what you want, you won't get it.

Source: ***Successful Meetings,*** 355 Park Ave. S., New York, NY 10010.

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