

# roads bridges transit technology news

Local Transportation Information Center  
Iowa State University Engineering Extension Service

April 1987

## Using electricity to save bridge decks

Summary of a report by Richard C. Ransom, P.E., city engineer for the City of Cedar Rapids, and Marvin Houg, P.E., project engineer for Howard R. Green Company, Cedar Rapids

Repair the existing bridge deck.

Do it economically and quickly.

Make it last.

These were the demands faced by the City of Cedar Rapids and Howard R. Green Company when the decision was made to rehabilitate the bridge deck instead of placing a new deck on the 8th Avenue Bridge over the Cedar River.

The 8th Avenue Bridge was originally built in 1938, and remodeled in 1970. The deck is 662 feet end-to-end by 52 feet curb-to-curb with a 3 foot median. The superstructure is a 659 feet, 8 span deck plate girder bridge with a maximum span of 116 feet.

The original work outlined by the city called for an investigation to determine the extent of deterioration, cracking, and delamination, as well as to document the maintenance patching that had been done on the decks.

Using data gathered in the field, a study was performed to evaluate several methods of repair. The repairs to be considered were full depth concrete repair, partial depth patching of spalls (pop-ups), joint and crack sealing, surface treatment, and thin bonded high density concrete overlays.

While not originally considered as an alternative, the Howard R. Green Company began looking at one other method of repair—cathodic protection. It became apparent from the information gathered that there was a high corrosion potential of the reinforcing steel in the bridge deck. In addition, the test of the concrete cores revealed a high level of chloride ion content in the concrete, both problems when considering traditional methods of bridge deck repair.

Because of the presence of chloride ions, a large portion of the deck showed serious problems with concrete deterioration due to the corrosion of the reinforcing steel. While the chloride ions do not directly cause corrosion of the reinforcing steel, they do break down the alkaline environment around the reinforcing steel. The combination of salt, concrete, steel, moisture, and oxygen leads to a process that causes the bars to rust. The reinforcing steel, when changing from a state of iron to iron oxide, occupies a larger space and causes the concrete above the reinforcing steel to pop up or spall.

After a complete study was made, it became obvious that while repairs could be made to the delaminated areas, the deck would still have a high potential for continuing corrosion, due to the high concentration of chloride ions. After an economic evaluation of the alternatives and considering all factors, the city decided to go ahead with repair work

(continued on p. 2)

### In this issue

Using electricity to save bridge decks

Iowa DOT's underseal project

A program to kill weeds using a limited amount of chemicals

Tort liability quiz

Some of Iowa roads built by poll tax workers

Using public transit system to reduce drunk driving woes

The preparation of this newsletter was financed through the Technology Transfer (T2) Program. The T2 Program is a nationwide effort financed jointly by the Federal Highway Administration and individual State Departments of Transportation. Its purpose is to translate into understandable terms the latest state-of-the-art technologies in the areas of roads, bridges, and public transportation, to local and county highway and transportation personnel.

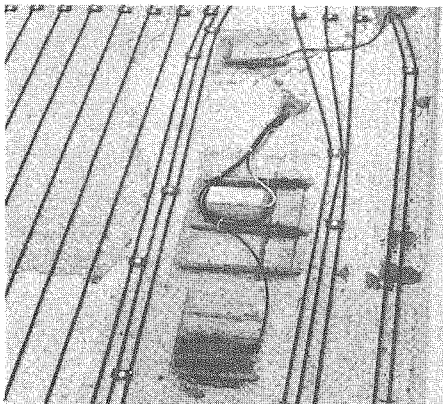
The T2 Center at Iowa State University is sponsored by the Iowa Department of Transportation and provides information and counsel to the municipalities and counties in Iowa. This newsletter is

designed to keep you informed about new publications, techniques, and training opportunities that may be helpful to you and your community. Individuals wishing to receive future copies of this newsletter at no cost may send their requests to: John Moody, Local Transportation Information Center, Engineering Extension, Iowa State University, Ames, Iowa 50011.

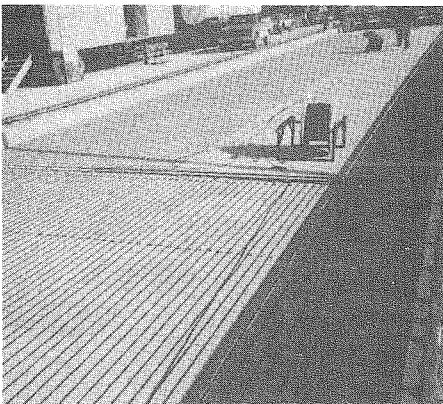
The opinions, findings, or recommendations expressed here are those of the Local Transportation Information Center and do not necessarily reflect the views of the Federal Highway Administration or the Iowa Department of Transportation.



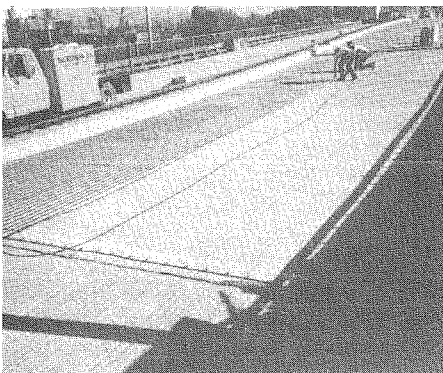
Delamination areas shown prior to placement of Class A repair



Instrumentation for cathodic protection zone



Installation of cathodic protection anode material



Installation of cathodic protection anode material

(continued from page 1)

incorporating a cathodic protection system into the deck.

There are various types of cathodic protective systems available. The one selected as a result of a letting, was developed by Raychem Corporation. The deck was divided into 14 zones for the placement of the cathodic protection with each zone about 3,000 square feet or less. Within each zone, the cathodic protection system includes an anode material, a reference electrode, a macrocell rebar probe, and a system negative; the anode material is placed at 4 inches on center over the entire width of the deck and for the full length of the zone. The cathodic protection system is attached to two rectifier units at the end of the bridge. The purpose of the rectifiers is to convert AC current to DC current. The cathodic protection system or anode material on the deck uses this DC current to reverse the flow of electrical current that develops when corrosion occurs, thus stopping the deterioration process.

Before installing the cathodic protection system it was necessary to repair the existing deck. The Iowa DOT specifications for Class A repair of bridge decks were followed for this work. After scarifying the entire deck for a depth of 1/4 inch it was necessary to define the areas to receive the partial depth repair and patch these areas first. Unlike the normal procedure of placing the Class A patches with the overlay, it was decided to place the patches first. This procedure provided a clean and even surface for the cathodic protection system to be attached. After placement of the cathodic protection system, the entire deck was overlaid with 1 3/4 inches of low slump concrete in compliance with the Iowa DOT requirement for bridge deck overlays.

At the same time the deck was being repaired, the expansion devices were also replaced. The existing devices were finger plate joints. The joints were warped in places and had missing or broken fingers. The finger plate joints were replaced with strip seals, which may result in a slightly rougher joint in cold weather but require less maintenance.

The project was let on August 6, 1986. The successful bidder was a joint venture of the Waterloo Construction Company, Inc. and Dickinson Company, Inc. The work started on September 3 and was completed on November 14. The cathodic protection system was started on November 19, 1986.

The total cost of the project was \$383,173.75, with the cost of the cathodic protection system being \$127,326.04, or about \$3.93 per square foot of bridge deck. No cathodic protection system was used

(continued on page 3)

---

*Technology News* is published by the Local Transportation Information Center Engineering Extension Service Haber Road Iowa State University Ames, Iowa 50011  
 Program Manager—Stan Ring  
 Coordinator—John Moody  
 Editor—Mary Holz-Clause  
 Editorial Assistant—Julie Anderson  
 Barbara Hohbach

---

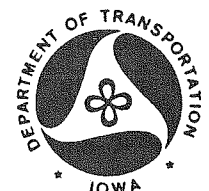


**Transportation Info-Line**

Call toll-free  
 1-800-262-8498  
 (in Iowa)  
 In Ames call  
 294-8815



U.S. Department of Transportation  
**Federal Highway Administration**



(continued on page 2)

on the sidewalks due to costs and other problems. Penetrating epoxy sealers were placed on the median, curbs, barriers, and sidewalks.

It is expected that the use of the cathodic protection system will prolong the life of the bridge for another 15 to 20 years. This installation is the second one used in Iowa, with the first having been installed by the Iowa DOT on Highway 30 near Ames.

Because of the successful use of the cathodic protection system on the 8th Avenue Bridge, it is expected that the Edgewood Road Bridge, also over the Cedar River, will use cathodic protection. This bridge was let in March, with construction expected this summer.

If individuals would like to view the cathodic protection system, contact Dick Ransom, Cedar Rapids city engineer, at (319) 398-5026 or Marvin Houg of the Howard R. Green Company at (319) 395-7805.

Copies of the technical report entitled *Using Electricity to Save Bridge Decks*, are available from John Moody, Local Transportation Information Center, EES Building, Ames, Iowa 50011, or by calling (515) 294-8818. The toll free number is (800) 262-8498.

## Ames uses transit to reduce drunk driving woes

Ames' public transit system, Cy-Ride, and the Iowa State University Government of the Student Body (GSB) have teamed up to provide an alternative to drunk driving. The service, called Night Ride, provides free rides on the weekends from 10:30 p.m. to 2:30 a.m. while the university is in session.

Night Ride is available to all Ames citizens and provides services within the city limits. Bob Bourne, Ames transit manager says, "Although the majority of the Night Ride passengers are students, we've had people from ages 4 to 90 use Night Ride. Frequently, women concerned about security at night also use the transit service."

The service, which was started in September 1984, carried 7,860 passengers from September to

December, 1986, and 7,882 individuals during that same time in 1985.

Due to the winter weather, the highest ridership is usually during the second semester (January through May). In 1986, more than 9,500 passengers rode Night Ride.

The maximum response time is designed for 20 minutes. However, in the northern areas of Ames, it may take up to 30 minutes for the minivan to respond to the call.

Funding for Night Ride comes from the GSB transit trust fund that was established from mandatory student fees. Due to record enrollments, excess funds have been collected and placed in the trust. The GSB may use this fund only for transit and with the approval of the GSB Senate.

## Safety belt extenders

Safety belt extenders are available for people who have difficulty fitting their seat belts around them. Extenders are approximately 9 inches long with attachments on both ends. Many manufacturers have the extenders available at no cost. Individuals are encouraged to contact a dealership selling their make of vehicle. If an individual has trouble finding an extender or a longer belt, they may contact a customer representative listed below.

**AMC/AMTEK**  
Manager of Owner Services  
14250 Plymouth Road  
Detroit, Michigan 48232

**American Honda Motor Co., Inc.**  
Office of Consumer Affairs  
100 West Alondra  
Gardena, California 90247

**Automobile Importers of American**  
Suite 1002  
1735 Jefferson Davis Highway  
Arlington, Virginia 22202

**Chrysler Corporation**  
Owner Relations Department  
P.O. Box 1718  
Detroit, Michigan 48288

**Ford Motor Company**  
Owner Relations-Operations  
Manager  
P.O. Box 1805  
Dearborn, Michigan 48121

**General Motors Corporation**  
Director of Consumer Relations  
3044 West Grand Blvd.  
Room 8-264  
Detroit, Michigan 48201

**Volkswagen of America, Inc.**  
Customer Relations  
888 W. Big Beaver Road  
P.O. Box 3951  
Troy, Michigan 48007-3951

**Volvo North America Corporation**  
Building B  
Consumer Affairs Department  
Rockleigh, New Jersey 07647

## Underseal evaluation project

In the summer of 1985, the Iowa DOT undertook a project to study undersealing of Portland cement concrete pavements on eastbound I-80 in Poweshiek County. The project experimented with new pumping equipment using a cement-fly-ash grout to fill gaps under the pavement caused by traffic stress and erosion. Previously the DOT used an older "mud pump" method of injection.

The project's goal was to find an optimal hole pattern for grout injection and decide if it is possible to underseal pavement that has longitudinal subdrains under the road shoulders without plugging the drain system.

The investigators tested a section of highway first installed in 1964 that had been updated with longitudinal drains buried 24 inches deep in the fall of 1978. The subdrains were being removed in 1985, and replaced with subdrains at a depth of 48 inches; the underseal test project was conducted simultaneously.

Seven joints and two midpanel cracks in the driving lane were undersealed on June 3 using four different hole patterns, drilled at a depth of 12 inches. Monitoring holes to relieve pressure were drilled 8 inches deep above the subdrains at the road shoulders. Grout composed of Portland cement, Council Bluffs flyash, and water was pumped into the holes at a pressure of 20 to 25 pounds per square inch by a CHEMGROUT CG-625 mounted trailer. Grout plant and pumping were stopped when grout showed at the joints or when slab lift was noted. The injection holes were stopped with a dry cement-sand mixture and the grout was allowed to cure for 2 hours.

To check the injection patterns on July 10, the slabs were tilted about the centerline with an endloader and investigators observed the grout spread. The investigators looked for damage to subdrains and ad-

herence of subbase, or the gravel bed under the pavement, to the underside of the slab.

The investigators found that hole patterns didn't affect grout distribution. However, holes must penetrate at least 2 inches below the underside of the slab. To be effective, the holes must be above voids, which are usually located on both sides of joints and cracks. With approach panels being the slab before the joint and leave panels defined as the panel after the crack going according to traffic direction, the researchers found the voids under approach panels were quite close to joints or cracks and voids under leave panels spread farther from the fissure. The gaps are largest along the centerline and in the middle of the panel near the joint or crack.

Neither gaps nor deposited grout was found in an 18 to 30 inch band next to the shoulder. Limestone particles or "fines" found in this area are believed to be caused by dewatering from the subdrain system.

Grout consistency was found to be an important factor. A proper grout mix will fill gaps within a 6 to 10 inch radius. High efflux time, or the time the grout is allowed to set before injection, caused cones or pile-ups of grout contrary to the desired underseal effect of uniform support. An efflux time of 12 to 16 seconds is considered the most effective.

Investigators found that undersealing did not notably damage subdrains, but grout must be injected carefully to ensure it does not enter into the drains. A low number of injection holes, at least 3 feet from the edge of the pavement is recommended, and it was found that relief holes in the shoulders are crucial for observing if grout is moving into the drains.

While hole patterns were not found to be highly significant, the investigators advocated drilling one hole in the approach panel, 1½ feet from the fissure and 4 to 8 feet from the

centerline. Two leave panel holes are recommended, 3 feet from the fissure and 3 feet from pavement edges. To prevent grout pile-ups at the bottom of the slab that may block injection, holes should be 1 in. in diameter.

While undersealing after subdrains are in place may risk plugging the system, there are some possible advantages. The drains keep the subbase water free and allow grout to set and adhere properly.

To reduce the risk of plugging subdrains, the investigator recommended several preventative measures such as running water through the pipes while undersealing, cutting a continuous trench above the drain to expose the bottom of the pavement, or placing a filter fabric barrier next to the pavement when the drains are first installed. This last step would block the flow of grout beyond the edges of the pavement.

The investigators concluded that similar research must be done on roadways with different bases to see if the recommended hole pattern is truly advantageous.

## Bridge load restrictions

The Federal Highway Administration is urging local governments to make area bridges safer for motorists by posting load restrictions.

R. A. Barnhart, federal highway administrator, says that state and local crews inspecting these bridges have done a good job detecting deficiencies, but local governments have neglected to post limits on the under-strength bridges. The federal highway administrator stresses that an under-strength bridge is a safety risk and a liability hazard to the government. Motorists must know whether a bridge can safely support the loads normally carried over it.

(continued on page 5)

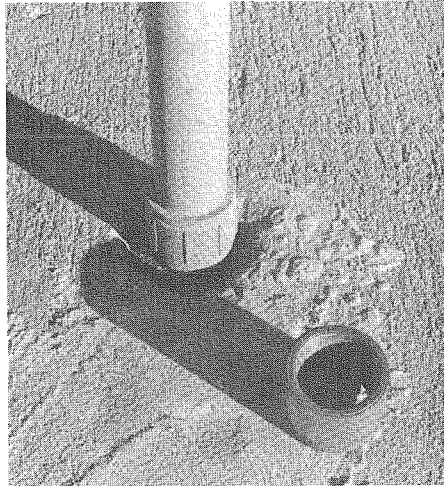
# tips from — the field —

## Break-away island sign

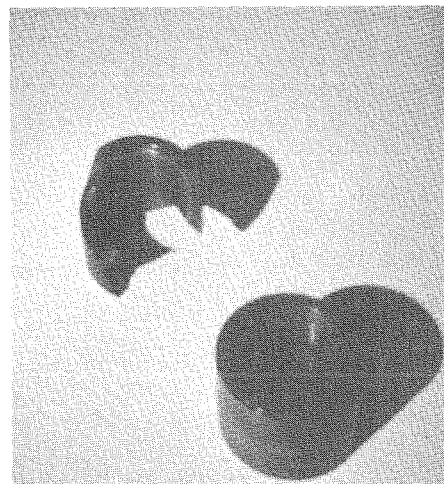
Most cities and states use signs on the islands in the middle of roadways, and are familiar with the problems of bent posts, damaged signs, and extensive damage to vehicles caused by collisions with these road signs. The Clive Public Works Department has found a partial solution to the problem in using a plastic coupling that allows the sign to snap off when hit by a vehicle.

A 2-inch diameter galvanized pipe is embedded below the surface of the concrete where the pipe threads can not be damaged by cars crossing the island. This short pipe is later connected to the actual sign post pipe with the breakaway island sign coupling, which is a PVC schedule 80 coupling that can be found in most plumbing shops. City of Clive Director of Public Works Willard Wray said some island signs have taken as many as 40 hits without necessitating post or sign replacement.

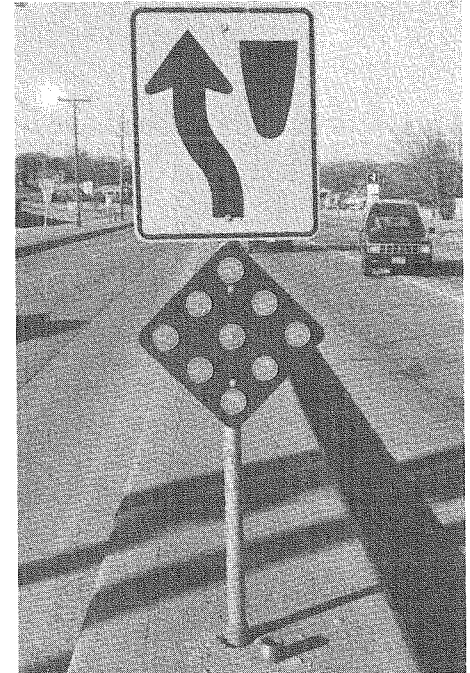
The couplings are inexpensive, and less money and labor are used replacing signs and reinstalling them. The couplings take only minutes to replace.



Close up view of the base of the island sign



Break-away coupling



Break-away island sign

## Answers—Hiring practices:

1. True, 2. False, 3. True, 4. False, 5. False (Answer with a policy statement asserting that the company hires only on demonstrated ability to do the job).

From: *Interview*, by Marvin Gottlieb, Longman Inc., 95 Church St., White Plains, N.Y. 10601.

(continued from page 4)

However, the local governments fear that they will be liable if an accident occurs since the deficiency was acknowledged but not corrected, according to Barnhart. But, he says, historically court awards involving under-strength bridges reflect just the opposite. The best defense for local governments is posting the bridges and making a prioritized list of corrections to be made as funds become available. Besides, says Barnhart, the reason for posting the bridges in the first place is to avoid accidents.

## Test yourself—a quiz on hiring practices

Most of us are aware that U.S. federal law prohibits hiring decisions made on the basis of sex, race, color, age, religion, national origin, or disabilities. But do you know what you can and cannot do during the job interview?

The following items cover some pertinent aspects of the interview. Answer "true" or "false."

1. You may describe the job tasks to a disabled person and ask if he or she feels capable of doing the job.

2. You may suggest that a candidate is not suited for a job because of a physical disability.

3. You may ask whether a candidate is a citizen of the U.S. and, if not, whether the visa will permit him or her to work.

4. You may suggest to an older person that he or she is not suitable because the pace is too hectic.

5. If a female applicant volunteers that she has plans for a family, you may then discuss the situation with her.

## New plan will kill weeds with limited use of chemicals

Weeds (not ghosts or dust) will be busted this summer in Tama County.

A new program called Weed Buster has been adopted by the Tama County Board of Supervisors to help rid county road rights-of-way of weeds and reduce the amounts of chemicals currently used in weed eradication.

Tama County Supervisor Mike Wentzien and Auditor John Adams originated the idea to "... try to find an alternative method ..." to chemical spraying. The new system involves contracting hand laborers to clear out weeds, similar to farmers hiring corn detassling crews.

Wentzien said he has been speaking with 4-H clubs, arranging for them to do the work as a group project. In the proposed plan, the board of supervisors will pay workers by the number of ditch miles they weed,

and members can work on their own time as long as they fulfill their contract within a set time frame.

The program will go into effect this summer in at least two Tama County townships. Wentzien said the program will be used in conjunction with spraying. Workers will chop out most of the weeds, and mark heavily-infested areas with flags or mark township maps so sprayers can treat pinpointed areas. With the program, sprayers should be able to go through a whole township in 1 day instead of an entire week.

The county just "... got tired of pumping 3,000 to 4,000 gallons of weed control ..." chemicals into ditches each year, Wentzien said. He also said the program would lighten the county weed control budget, because the savings on chemicals would offset the labor costs.

Crews will be trained in weed identification, and will be sent out in late May or early June and again in early August. Wentzien said thistles are their main target.

Another positive aspect of the program is that paying wages to local crews will be "... putting tax money back into ..." the community and "... not down a rathole ..." as with chemicals, Wentzien said.

The program has aroused a lot of enthusiasm in the community, spurring community pride. Residents "... care how their farms look, and don't want these weeds spreading ...," Wentzien said.

In addition, fewer chemical weed killers are put into ditches, which are manmade waterways that funnel runoff into lakes, streams, and underground reservoirs.

## Iowa law required road work as payment to vote

Much of the Iowa road system was created by using manual laborers who worked on the roads as payment of their poll tax, a tax that required individuals to pay a fee to have the right to vote. A 1913 legislative mandate required "... that all able bodied men be assessed a poll tax of two days work or cash equivalent." In the same legislation, it was also noted that "... able bodied poor supported by the county may be compelled to work on the roads at five cents per hour."

Most of Iowa's extensive road system created by the poll workers was administered by the township trustees. (Before 1904, the state highway commission did not exist, and county engineering support was limited.)

More than 100,000 miles of rural dirt roads were built before the turn of the century. In comparison, today there are only 112,00 miles of municipal and rural roads in Iowa.



Poll tax workers building Iowa's early roads

---

### Software clearinghouses

**PC-TRANS** is a service supplied by the Kansas University Transportation Center. It offers an electronic bulletin board, telephone hotline, newsletter, and software availability services. For subscription information, call 913-864-5655.

**McTRANS** is an FHWA-sponsored national clearinghouse for transportation software located at the Technology Transfer center in Florida. Membership is free and the public domain software offered has minimal prices. Call John Moody at (515) 294-8818 for a membership application.

**HEEP** is a highway engineering exchange program promoting the exchange of computer programs, systems and concepts for its members in the fields of civil engineering, transportation and management.

Membership is available at no cost to federal, state or local governments. For more information write: Norm Baker, Iowa DOT, 800 Lincoln Way, Ames, Iowa 50010. An international HEEP meeting will be held in Des Moines on October 5-9, 1987.

*Manual on Countermeasures for Sign Vandalism.* 152-page implementation package, report no. FHWA-IP-86-7. This manual describes countermeasures for reducing highway sign vandalism and the costs associated with the repair and replacement of vandalized signs. Guidelines are also presented for planning, implementing, and evaluating anti-vandalism programs. The manual is intended for use by state and local personnel involved in sign system maintenance and other individuals with an interest in reducing sign vandalism.

One loan copy is available by calling John Moody, (515) 294-8818. Individual copies may be ordered from FHWA Office of Implementation, Turner Fairbanks Research Building, 6300 Georgetown Pike, McLeon, Virginia 22101.

*Films For Highway Safety and Traffic Engineers.* 184-page implementation manual, report no. FHWA-IP-86-25. This document provides abstracts on audiovisual aids of potential interest to highway safety and traffic engineers. Each film abstract includes a description of the film's contents; the source for purchase, rental, or loan; the format in which it is available; the length of the film or number of slides; and where available, production year, and identity of the target audience.

One loan copy is available by calling John Moody, (515) 294-8818. Indi-

vidual copies may be ordered from FHWA Office of Implementation, Turner Fairbanks Research Building, 6300 Georgetown Pike, McLeon, Virginia 22101.

*Urban Transportation Planning in the United States: A Historical Overview.* Revised edition, February 1986, DOT-I-86-09. This report focuses on key events in the evolution of urban transportation planning including developments in technical procedures, philosophy, processes, and institutions. Planners must also be aware of changes in legislation, policy, regulations, and technology. These events have been included to provide a more complete picture of the forces that have affected and often continue to affect urban transportation planning.

One loan copy is available by calling John Moody, (515) 294-8818. Individual copies may be ordered from FHWA Office of Implementation, Turner Fairbanks Research Building, 6300 Georgetown Pike, McLeon, Virginia 22101.

*Stabilization—Holding the Road.* This ½-inch VHS videotape describes a comprehensive treatment that can improve the road surface significantly, and be relatively dust free. Various binders and additions are discussed with how to do it reworking the roadway surface.

One loan copy is available by calling John Moody, (515) 294-8818.

## Yet another test on tort liability wisdom

R. L. Carstens, professor emeritus of civil engineering

Correct answers to the following three questions suggests that you know your way through the tort liability jungle. Correct answers are given on page 8 of this issue.

1. Where ball-bank indicator tests suggest a recommended speed of 25 mph (20 mph less than the posted speed limit), you may choose to use a 25 mph speed advisory plate with the existing curve sign.

True  False

2. Signs smaller than standard sizes are generally appropriate for lower-volume roads in rural areas.

True  False

3. Testimony offered in trial under oath by a nationally-recognized traffic engineering expert can be considered authoritative as a guideline for the use of traffic control devices.

True  False

## conference 1 2 3calendar

**APWA North American Snow Conference**  
Pittsburgh, Pennsylvania  
April 8-10, 1987

Call Stan Ring at (515) 294-6778 for details or registration information.

**Iowa Airport Conference**  
Starlite Village, Fort Dodge, Iowa  
April 21, 1987

This conference features exhibitors as well as conference speakers and tour of the new flight service station. Call Jim Cable at (515) 294-6777 for information.

**Community Impacts of Deregulation Symposium**  
University of Kansas,  
Lawrence, Kansas  
April 22-23, 1987

The pros and cons of deregulation in the electric utilities, banking, telecommunication, and transportation (buses, airlines, and railroads) industries in the midwest will be examined to determine the effects on the economies of communities and their local governments. The fee for the two-day symposium is \$60. Registration is limited to 70. For more information contact Loretta Carraher, conference coordinator, Institute for Public Policy and Business Research, University of Kansas, Lawrence, Kansas 66045, (913) 684-3123.

**Governor's Annual Safety Conference**  
Holiday Inn Gateway Center,  
Ames, Iowa  
May 6, 1987

**ITCSA Conference**  
Holiday Inn Gateway Center,  
Ames, Iowa  
May 7, 1987

**Iowa Engineering Society Annual Meeting**  
Gateway Holiday Inn and Scheman Continuing Education Building,  
Ames, Iowa  
May 7-9

This meeting emphasizes continuing education and numerous exhibits. Call IES office at (515) 223-0309 for information.

## Answers to tort liability questions

Your practices in respect to the use of traffic control devices, if deficient, can be used to discredit your actions even though the deficiencies may seem irrelevant to a particular case. The three questions asked address points that may arise in connection with highway-related lawsuits.

1. **False.** In respect to recommended speeds on a curve, the turn sign must be used on any curve where the recommended speed is 30 mph or less. A curve sign infers a recommended speed higher than 30 mph. Although inconsistent use of speed advisory plates and curve and turn signs is quite common, this usage can be used in a court case to cast doubt upon the knowledge and ability of the practitioner guilty of such incorrect usage. Also common is use of the wrong sign when no speed advisory plate is used but prevailing speeds suggest use of a turn sign instead of a curve sign or vice versa.

2. **False.** Standard size signs should be used consistently except in low-speed urban locations. The use of 24-inch stop signs or 30-inch stop ahead signs (or other minimum size signs) in a rural area will be used against you in a lawsuit to support an allegation that you were negligent in the use of traffic control devices.

3. **False.** One must realize that one side is right and one side is wrong in many court cases. Witnesses testifying in support of the side that is wrong often resort to unethical practices to try to develop their side's case. The writer has heard more absurdities and untruths from witness stands than in any other setting. To adopt such testimony as a guideline for practice will often compromise safety and will rarely lead to an efficient allocation of resources. Your own judgment is likely to be a much better guide.

---

### And justice for all

Appointment, promotion, admission, and programs of University Extension at Iowa State University are administered equally to all without regard to race, color, creed, sex, national origin, disability, or age. Call the Affirmative Action Office at 515/294-7612 to report discrimination.



engineering extension service  
iowa state university, ames, iowa 50011

Rose Pence  
Technology Transfer Newsletter  
1 EES Building, Haber Road  
Iowa State University  
Ames, Iowa 50011-3074

Address correction requested.  
Route to:

---

---

---