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TECHNICAL QUARTERLY

AN EXCHANGE OF IDEAS
Editor:
Kathleen M. Jones

FROM CONCRETE—A FAITHFUL SERVANT

BY CARL F. CRUMPTON

Concrete is the world's most abundantly used building material. Hundreds of thousands of people have made concrete; some of it well and some of it not so well. Even though concrete is common throughout the world, little is known about it. Like snowflakes, no two concretes are the same—and no one concrete is the same.

In winter, the concrete must withstand different extremes in temperature; it may get as cold as 30° to 40°F below zero in Kansas. Freeze-thaw cycles, the nightly freezing and daily thawing of water trapped in the concrete, are even more damaging than very frigid temperatures. At least 68 freeze-thaw cycles occur each winter in Kansas. In anticipation of such conditions approximately 8 percent air is put in the concrete. This entrained air is present as tiny spherical voids less than 8 mils apart (Figure 2). These voids provide space for ice crystals to form, thereby protecting the concrete from the pressures of growing ice. Without this entrained air, freeze-thaw cycles will cause scaling of the concrete surface.

Crumpton is Engineer of Research, Kansas Department of Transportation.

INSIDE...

EFFECT OF ROAD SALT ON CONCRETE

During snowstorms, the maintenance forces plow away the bulk of the snow and spread salt to melt the rest. Kansas is a big producer of halite, or rock salt; thus the use of this mineral as a deicer is natural. For several years a combination of those kissing halide cousins, sodium and calcium chloride, was used until the escalating costs of calcium chloride made its use uneconomical.

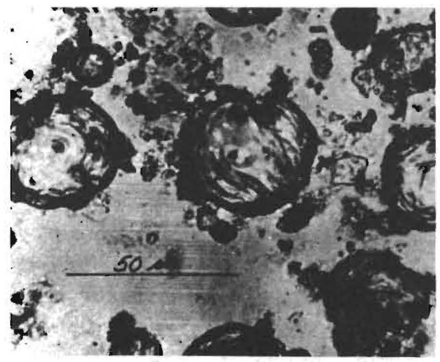

FIGURE 2 Entrained air bubbles produced in fresh cement slurry.

Once spread the salt does not lie inert on the surface—it penetrates. Salt is not showy or spectacular; it is simple, silent, and persistent, slowly permeating the concrete of bridge decks or pavements. When salt water permeates concrete it does more than just make salty concrete. As it penetrates, salt dissolves small amounts of some concrete components such as calcium hydroxide, which is more soluble in salt water than in fresh water. Calcium hydroxide is also more soluble at low temperatures than at higher temperatures.

Sooner or later permeation of the

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salt water reaches an equilibrium and the drying process follows. The evaporation rate may remain high during cold weather. During the winter, relative humidity is usually quite low, and salt is an evaporite mineral. The salty meltwater that has penetrated the concrete starts back toward the surface. The water evaporates, but the salt stays behind. The solution at the evaporative front becomes increasingly concentrated—even supersaturated. Crystallization of the salt within the concrete begins near the exposed top surface where the water is evaporating (Figure 3). As evaporation continues more salt solution is drawn upward from below.

The growth of salt crystals in rock due to evaporation has long been reported to develop sufficient pressures to dislodge flakes or shatter rocks and other objects. Even the 5,000-year-old Sphinx is said to be a victim of salt crystal growth. Concrete is merely a man-made rock and the same principles apply to it.

During crystallization, many factors come into play, including nucleation, surface energy, diffusion rate, reaction rates, and driving forces such as evaporative tension, osmotic pressure, concentration gradient, and capillary rise. Nevertheless, calculations using the Correns equation indicate that the crystallization pressure of halite can be more than 8,100 pounds per square inch at a supersaturation ratio of 2 and at a temperature of 0 °C. The internal crystal growth pressures can be several times higher than the tensile strength of the concrete near the surface where evaporation takes place.

A saturation ratio of 1 or less is enough to dislodge thin flakes from concrete. Concrete scaling without freeze-thaw usually produces oatmeal-sized pieces that are soon removed by traffic, wind, rain, and so forth. In a freeze-thaw environment where salt is used, the two aid and abet one another to cause problems not existing previously.

AN EXAMPLE

My own driveway in Topeka is a good example of the mischief a little salt can do to concrete. For 25 years the driveway stood up well to severe Kansas winters. The driveway was not salted during those years; the snow was shoveled off. Then the city of Topeka began salting the streets to melt snow and ice. During the first winter of Topeka's salting program, my concrete driveway began to scale where salty meltwater dripped from my car. My driveway had made it through 25 winters with no scale until one winter of street salting and dripping salt water. This is an example of what has previously been observed—salt and freeze-thaw make concrete weather far more rapidly than freezing and thawing alone.

Looking at salted concrete with the scanning electron microscope has revealed the same types of salt crystal growths in concrete as reported for halite from caves in limestone and tubes in lava. In those places, helectites, stalactites, stalagmites, columns, crusts and euhedral crystals of common salt have been observed. Inside the air voids in the concrete, fibers, spirals, ribbons, columns, and bundles of fibers have been seen. These studies have shown the importance of that 8 percent air in providing tiny voids for the salt crystals to grow into without disrupting the concrete (Figure 4). My driveway was not air entrained, and thus it succumbed to the pressures of salt crystal growth and freeze-thaw cycling.

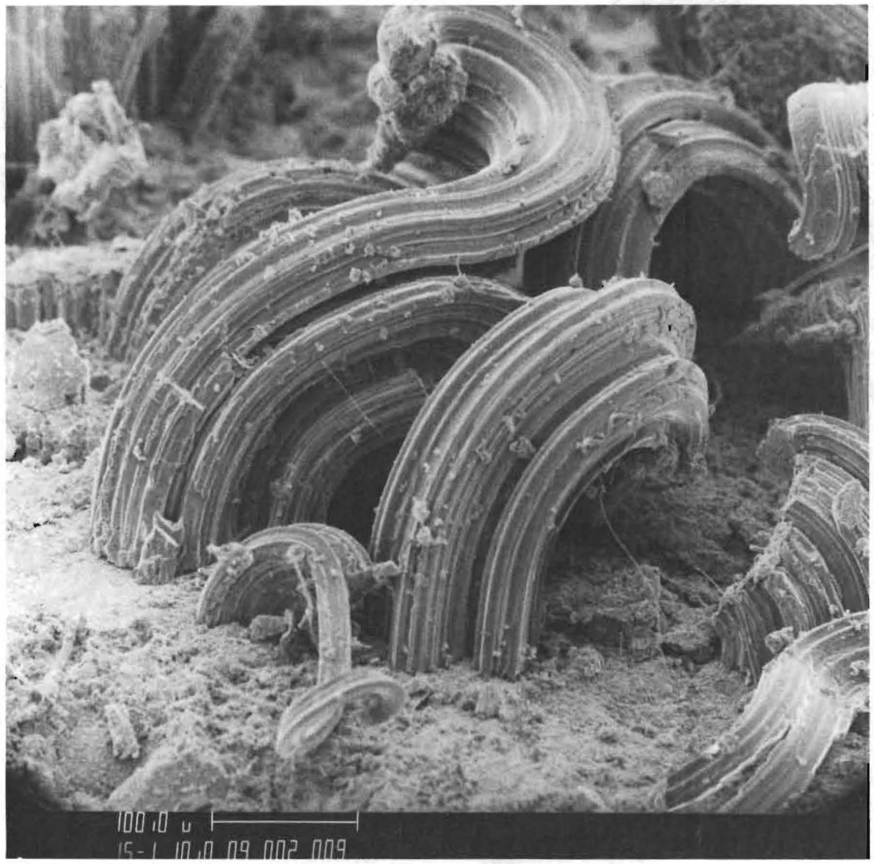


FIGURE 3 Crystalline halite (salt) fibers growing in concrete.

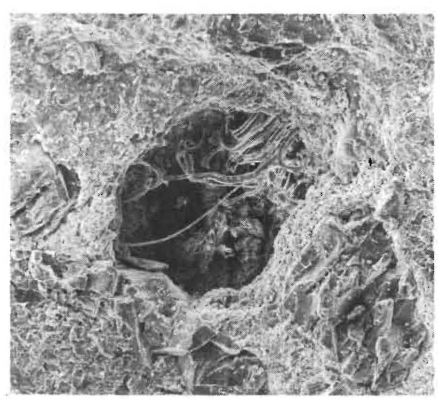


FIGURE 4 Air void in concrete with fibrous halite crystals.

SALT AND REINFORCING STEEL

Suppose the concrete has a perfect void system—is it then safe from salt damage? Not quite. In unprotected conventional bridge decks, the salt will eventually permeate to the reinforcing steel. When salt comes in contact with steel it causes corrosion. Corrosion products can create expansion pressures of as much as 4,700 pounds per square inch and volume increases of as much as 13-fold. California studies have shown that metal loss from a corrosion pit less than 1 mil deep can produce enough corrosion products to crack a concrete cover 875 mils thick.

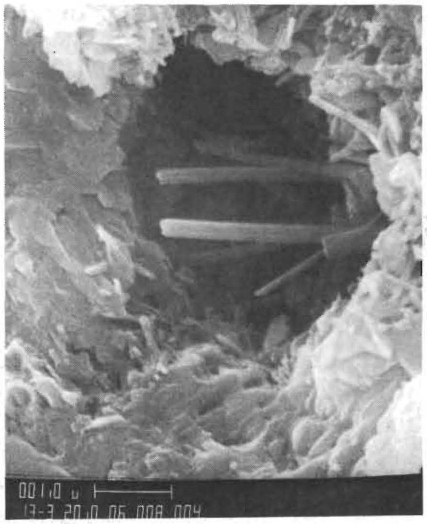


FIGURE 5 A, Swordlike crystals of rust from a corroding reinforcing bar protruding into a concrete cavity.

B, Rust crystals found 2 inches from corroding reinforcing steel.

With the electron microscrope, the Kansas DOT has scanned concrete taken from as near a corroding rebar as possible. Swordlike laths of rust were seen thrusting into the concrete near the steel (Figure 5*A,B*). Other forms of rust seen were boxworks and fretworks of thin-walled, apparently triangular crystals with one of the points of the triangles growing away from the reinforcing steel (Figure 6). Eventually the lathlike and fretwork structures become filled with massive rust. Black, brown, and red layers of such rust gradually build up. These often contain what appears to be drying shrinkage cracks.

X-ray diffraction studies of the layered rust showed the minerals goethite and magnetite. The lathlike and fretwork crystal forms are common for goethite. The bulk of the massive or globular rust appears to be amorphous limonite, which does not show in the diffraction patterns.

Continued on page... 12

FIGURE 6 Boxwork rust crystals growing within portland cement concrete.

DIALOG—ACCESS TO 200 PLUS DATA BASES

For more than 15 years D-10R has been obtaining keyword information searches from a highway/transportation related data base called Transportation Research Information Service (TRIS) via the Transportation Research Board. TRIS is TRB's computer-based information storage and retrieval system. TRIS connects users—engineers, planners, researchers, attorneys (AG's office), administrators—with the most complete transportation research data base available anywhere. For the Texas State Department of Highways and Public Transportation alone, the large number of TRIS searches done by TRB staff have proved invaluable, not only in questions answered, but also in verifying the need for new research and establishing the state-of-the-art of specific areas of research through such literature searches.

Typically, a search takes about ten minutes to do on the TRIS database; however, the turn around time for a request to go from D-10 Research to TRB and the printout be delivered in Austin is from one to two weeks. This lag time is due, in part, to the fact that though TRB personnel maintain the data file on their computer, the information is put on tapes and loaded onto a computer in California (owned by a subsidiary of Lockheed Corp. called DIALOG). When TRB personnel need to retrieve information, they call up the computer in California, connected by modem, and conduct the search. The records are printed out in California and then mailed to TRB in Washington. The information services people at TRB take the document out of the envelope, screen it for relevance and mail it to D-10R. If D-10R has done the search for someone in a district, additional time is required to get the material to the actual requestor.

Recently, in an effort to speed turn around time and broaden SDHPT's access to the latest in technology, D-10 Research Library has been subscribed to DIALOG. The DIALOG system contains a great deal more information than that which is obviously related to transportation: some 200 different data bases from a wide variety of fields. Because problems for which solutions are being sought often require looking outside the realm of the standard, tried and true, data bases on business, management, chemistry, energy, law, or materials sciences, for instance, may contain information which is valuable to the Department, but which was previously inaccessible.

Some of the various data bases which will undoubtedly interest Districts and Divisions are: *Ei Engineering Meetings*—a data base consisting of the published proceedings of engineering and technical conferences and symposia for bioengineering, electrical, mechanical, petroleum, automotive and aerospace, as well as civil engineering; *Compendex*—abstracted information from the world's significant engineering and technical literature; *Menu*—a comprehensive listing of commercially available software for any microcomputer or minicomputer; *Laborlaw*—summaries of decisions on matters relating to labor relations, fair employment, wages and hours, and occupational health and safety; *CA Search*—bibliographic data, keyword phrases, and index entries for all documents covered by Chemical Abstract Service; *Electronic Yellow Pages*—eight different data base directories covering such things as construction, financial services, professional services, retailers, wholesalers, manufacturers, etc.

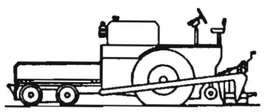
How do **you** get an information search done? Call Debbie Jeffcoat [(512) 465-7684, TEX-AN 886-7684] or Kevin Marsh [(512) 465-7644, TEX-AN 886-7644] and explain the subject on which you want the information search done. That's all. They will search all appropriate data bases for you and send you the results. DIALOG and D-10 Research Library are going to play an increasingly large role in technology transfer for the SDHPT.

INFORMATION REQUESTS

Project 438, "Evaluation of the 4-Cycle Magnesium Sulfate Soundness Test to Control Quality of Aggregates for HMAC and Surface Treatment," began this year. Historical data is needed on projects where the 4-cycle test was used for quality control or used just for informational purposes. Your input is vital, if the project is to accomplish its intended purposes. *If you have any information on the results of the 4-cycle test, especially in the field, please contact Dr. Al Meyer of the Center for Transportation Research, University of Texas at Austin, Austin, TX 78712, (512) 471-7741, TEX-AN 821-7774 or Dr. David Fowler of CTR at UT Austin, (512) 471-1732, TEX-AN 821-1732 or Mr. Harold Albers, Supervising Soils Engineer, D-9 Materials and Tests Division, State Dept. of Highways and Public Trans., Austin, TX 78763, (512) 465-7335, TEX-AN 886-7335.*

Project 490, "Polish Value of Aggregates," is a new project with an objective in the first year of evaluating the polish value test as a requirement for aggregate used in surface treatments. The study needs information and performance data for projects where the polish test was used. Both good and poor performance projects are needed. *If you have any information or data that might be helpful in this evaluation of the polish value test, please contact Dr. Al Meyer, CTR, University of Texas at Austin, Austin, TX 78712, (512) 471-7741 TEX-AN 821-7774 or Dr. David Fowler, CTR, UT Austin, (512) 471-1732, TEX-AN 821-1732 or Mr. Paul Krugler, Supervising Bituminous Engineer, D-9 Materials and Tests Division, SDHPT, Austin, TX 78763, (512) 465-7603, TEX-AN 886-7603.*

Fly ash is used as a partial replacement substance for portland cement in 60 percent of the ready mix concrete used in commercial construction around Texas. Up until recently however, fly ash has not been used much in concrete for highway paving or structures. **Project 364,** "Production of Concrete Containing Fly Ash," in accordance with the FHWA's directive, has developed guidelines and procedures for the use of fly ash in concrete. Dr. Carrasquillo and his team are looking for jobs which can utilize these procedures. All the contractor and the Resident Engineer have to do is agree to have Dr. Carrasquillo come to the job and see if he can design a mix with fly ash that is as good or better than the original mix without fly ash. Even then, the fly ash mix does not have to be used; all Project 364 needs to do is verify that these kinds of mixes can be done with fly ash. *If you have a possible concrete job please contact Dr. R.L. Carrasquillo, CTR, University of Texas at Austin, Austin, TX 78712, (512) 471-7259, TEX-AN 821-7259 or Mr. Fred A. Schindler, Jr., Supervising Concrete Engineer, D-9 Materials and Tests Division, SDHPT, Austin, TX 78763, (512) 465-7372, TEX-AN 886-7372.*



THE NEW HIGHWAY CAPACITY MANUAL

The Transportation Research Board has recently published an updated *Highway Capacity Manual* (NCHRP Project 3-28). This publication, TRB Special Report 209, replaces the 1965 version and will be of particular interest and use to planners, designers, and traffic operations analysts. The 1985 *Highway Capacity Manual* is a three-tiered analysis aimed at three levels of detail, the large scale land usage projections and growth scenarios of the planners, the middle ground of the designers trying to take these projections and limited information to create actual highways that will serve, and the close quarters of traffic operation analysts coping with today's traffic numbers trying to squeeze as much capacity as possible out of existing highways.

The manual has been published in a three-ring binder format to facilitate future updates. Once a year the committee will meet to decide what chapters need to be updated, so there will be no more twenty year waits between versions. In fact, at least one new major project to improve the understanding of capacity relationships on multilane rural highways was underway at the time the publication went to press. Updated chapters will be distributed for inclusion in *HCM* binders as they are published. In this way the *Highway Capacity Manual* will be made more useful in the face of rapidly changing technology.

In keeping with the changing face of technology, several subjects which were either not represented or appeared as minor parts of another chapter now have complete chapters devoted to them. Two of the entirely new subjects are a chapter on pedestrians and one on bicycles. The chapter on unsignalized intersections presents radically different procedures for capacity analysis. Earlier information on vehicle performance and characteristics has been updated through at least 1980. A more analytical approach has been taken to dealing with unprotected left turn lanes. Increased attention is paid to urban transportation and transit problems. In general, significantly revised procedures for capacity analysis are given in every chapter.

Because highway capacity involves human beings who are sensitive to the quality of service they are receiving and capable of reacting to it, this manual stresses field measurements and provides procedures for taking the measurements. A common thread running through the chapters is that all levels of service are now being based on some *measurable* factor of what the driver *experiences*, rather than an abstract concept of "load factor." For example, the measurable factor for freeway systems is traffic density; for two-lane highways, percent of travel time delay; for signalized intersections, delay. Methodology for these measurable factors is orderly and outlined in every procedural chapter. Work sheets are provided, both blank and with examples worked. The blank work sheets are full-sized and suitable for office reproduction. It is hoped that these work sheets will make training, as well as field operations, easier and more productive.

In the last eight years, NCHRP has funded much of the research effort that was necessary to publish the new *Highway Capacity Manual.* While the *HCM* is a national cooperative effort, Texas has had a significant input. Texas Transportation Institute and Texas A&M Research Foundation at Texas A&M University had large portions of the research for the manual subcontracted to them. Dr. Carroll Messer of Texas A&M University authored and co-authored a number of chapters, among them "Multilane Highways," "Two-lane Highways," and "Signalized Intersections." Dr. Conrad L. Dudek of the Texas A&M University System was a Research Principle. Mr. Wiley D. Cunagin, also of Texas A&M, was part of the team of researchers for two-lane, two-way rural highway capacity (NCHRP Project 3-28A). Mr. Harold Cooner of D-8G has served as a panelist on NCHRP Project Panel G3-28B for several years. Numerous others have lent their interest, support and expertise. Final synthesis of the manual was completed under the sponsorship of the National Cooperative Highway Research Program.

The 513 page *Highway Capacity Manual* can be obtained from the Transportaion Research Board, Constitution Ave., N.W., Washington, D.C., 20418. The D-10 Research Library has a copy available on a two-week loan basis.

In the forward of the new *HCM,* "The Committee [on Highway Capacity and Quality of Service] urges all readers to contribute to, as well as draw from, the reservoir of knowledge represented by this document." We hope you will.

PUBLICATIONS OF INTEREST

Costs of Motor Vehicle Accidents in Texas, TTI Research Report 396-1, John B. Rollins and William F. McFarland, College Station: Texas A&M University Press, May 1985, p.141.

Effectiveness of Wildlife Warning Reflectors in Reducing Deer/Vehicle Accidents in Washington State (WA-RD 64.1), James A. Schafer, William P. Carr and Stephen Penland, Olympia, WA: Washington State DOT, Aug. 1984, p.17.

Highway Capacity Manual, 3rd. ed., Helen Mack, NCHRP ed., Washington, D.C.: Transportation Research Board, Sept. 1985, p.513.

MOVEABLE MEDIAN BARRIERS FROM "DOWN UNDER"

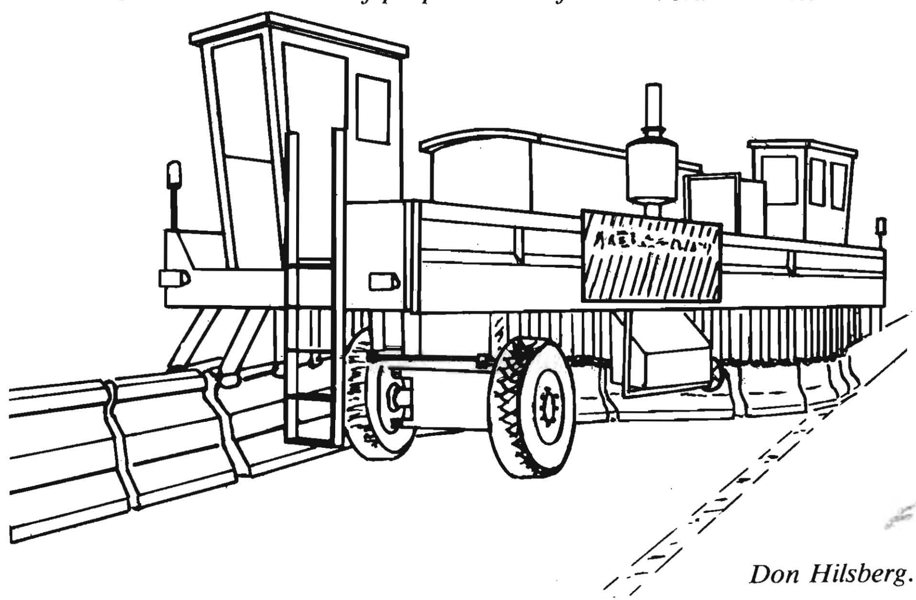
Movable median barriers which provide solid, positive protection to work areas or contraflow (reversible) lanes are a new concept being pioneered by Quick-Steel Engineers, Ltd. of Botany, Australia. The first commercial use of the Quickchange™ Barrier System was in August, 1984, in France; the initial use of it in the U.S.A. may well be in Texas.

The Quickchange™ barrier is comprised of pinned, hinged, meter-long sections of concrete safety-shape barrier. The linked sections are transferred lane to lane by engaging a towed, trailer-mounted conveyor (Fig. 1) or by using a self-propelled vehicle with canted wheels that straddles the barrier system (Fig. 2). With either the trailer or self-propelled unit, the lead module of the barrier is fed into the polyurethane rollers of the conveyor. The modules are lifted clear of the pavement surface and conveyed through an elongated "S" by the polyurethane conveyor rollers as the unit is driven forward, shifting the lane right or left a desired width. Lane widths of six to sixteen feet can be accommodated. The barrier can be repositioned at the rate of approximately 7 to 10 miles per hour.

The speed with which this barrier system can be repositioned is one of its most attractive features. In France, a barrier section approximately eight-tenths of a mile long was used as work-zone protection on a freeway construction site near Paris. When no work was being performed, the barrier was moved to the right shoulder, allowing traffic full use of all freeway lanes. During the work periods, it was moved and placed one lane to the left, thereby providing positive protection to the workers and motorists. Not only can the barrier be used to protect the workers, but also it can provide positive traffic separation in contraflow lane situations preventing cross-over head-on collisions which pylons, cones and changeable signs cannot do. At the present time, the barrier will lock only when it is straight and down and cannot be locked in an "S" configuration; however, a variation is being designed.

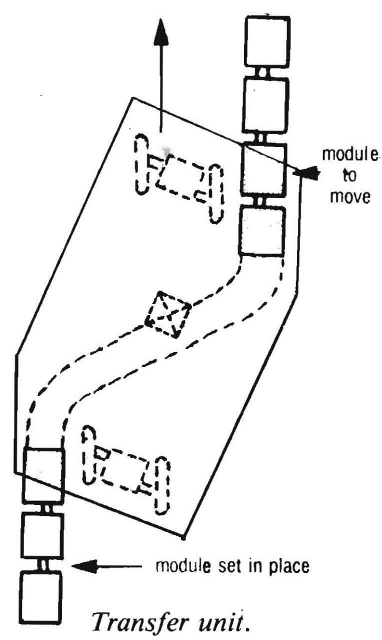
A practical movable median barrier requires a hinge design that can

FIGURE 2 The self-propelled transfer unit used in Paris.



Don Hilsberg.

FIGURE 1 The towed transfer unit.



Transfer unit.

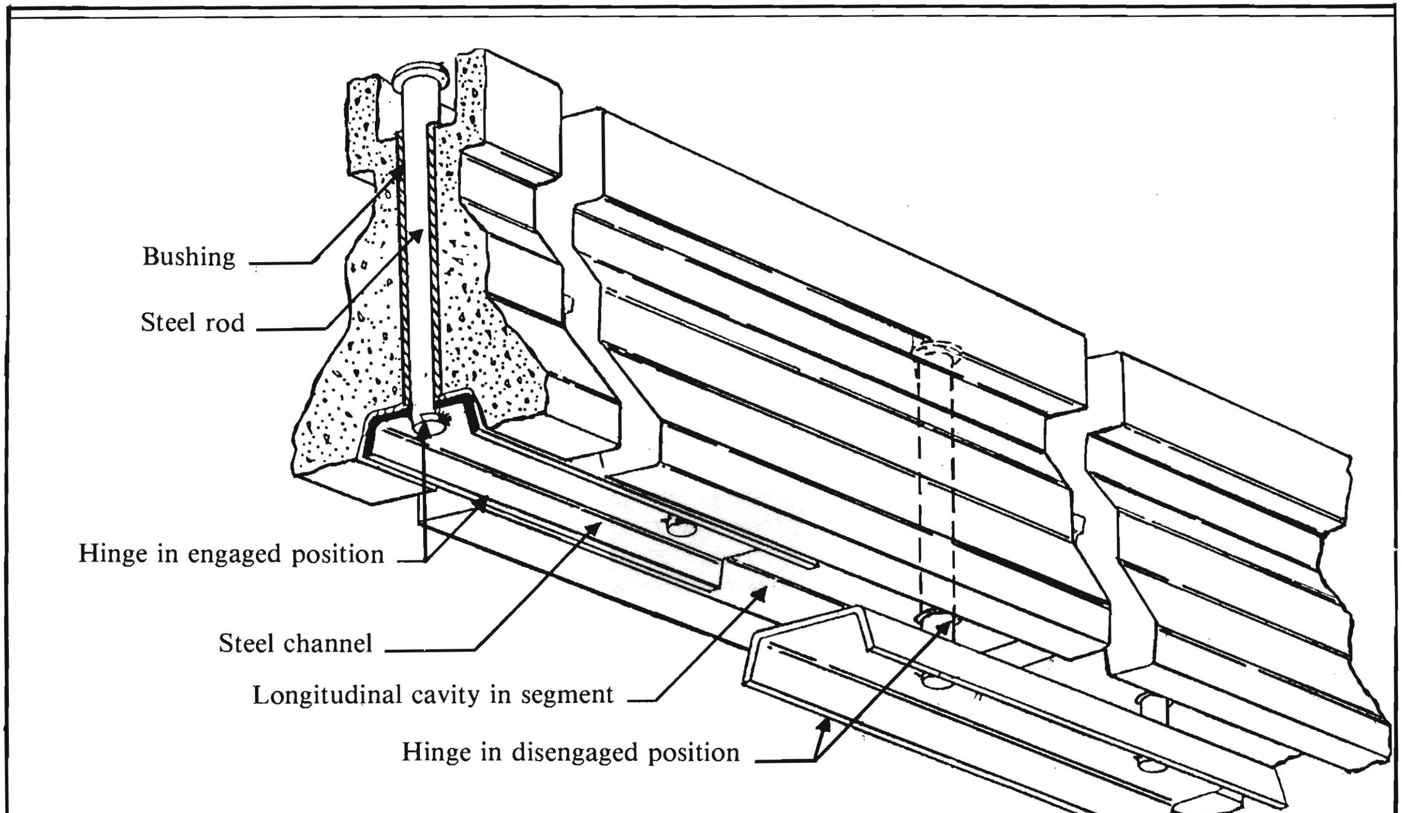
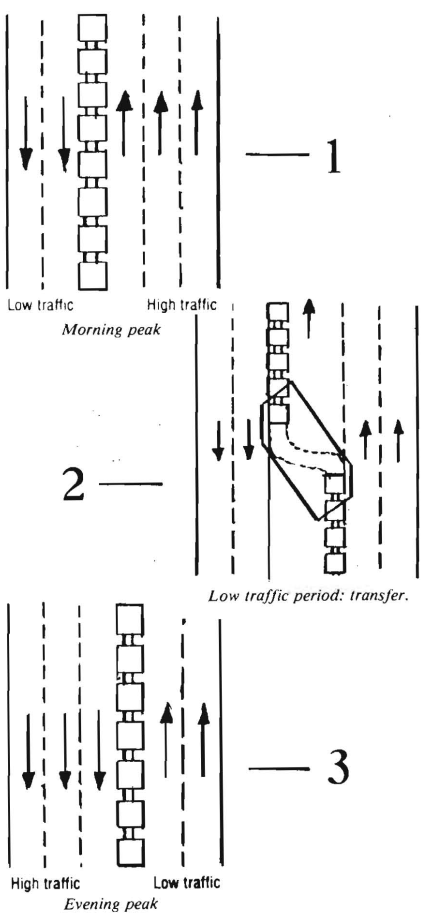


FIGURE 3 Barrier segment



Quickchange ™ barrier used for contraflow lanes.

withstand crash impacts, but does not require extra labor and time to lock and unlock it. To meet this need, John Quittner of Quick-Steel Engineers, Ltd., has developed a simple mechanical means to lock the joints between segments. The mechanism is a steel channel assembly fitted longitudinally into the bases of the barrier sections (Fig. 3). When a pair of sections are picked up by the conveyor, steel rods attached to the steel channel slide down polyurethane-lined bushings, disengaging the steel channel from the longitudinal slot. In the disengaged position, the steel channel assembly allows free movement in both the horizontal and vertical planes. At rest on the pavement, the steel channels lock the segments against lateral movement. Force is transmitted from an impacted barrier segment to adjacent segments by shear and bearing through a shoulder on the concrete barrier segment into the steel channel assembly and distributed to the remainder of the segments in the string in the same manner. Although the barrier is classified as a rigid one, its articulation does allow a little "give" on impact which tends to lessen the angle of deflection of a vehicle striking it; as a result, vehicles theoretically have less chance of being redirected into traffic.

Initial crash tests were performed February 1984, near Sydney, Australia, by Quick-Steel and by Carson Manufacturing (Barrier Systems, Inc.) of Sausalito, California, who is the North American licensee for the Quickchange™ system. The crash tests, which used 3,000 and 4,000-pound automobiles similar to American-made mid-sized cars of the late 1970's, were favorable; none of the cars rolled, became airborn or were redirected into a traffic lane.

District 2, Fort Worth, is currently in the process of writing specifications that will enable a movable median barrier system to be bid in a construction project within the next year.

Copies of the initial testing, "Report of Engineering Evaluation Tests on Quickchange™ Movable Median Barrier, Sydney, New South Wales, Australia," are available from the editor of ***TQ.***

CONTROLLING DEER MOVEMENT ACROSS HIGHWAYS

An estimated 200,000 deer/vehicle collisions occur in the United States annually. Texas has had an average of 4,400 animal/vehicle collisions each year in the last five years, a large percentage of which involve deer (Table 1). Taking the direct cost to be only those costs concretely associated with an accident: property damage, medical expenses, lost worktime from injuries, legal costs, damage awards, and loss of vehicle use, the weighted average direct cost of animal/vehicle collisions in Texas is $7300 for fatal accidents, $6700 for injury accidents and $1200 for non-injury, property damage only accidents. These weighted averages are based on rural and urban accidents on all types of roadways combined and are rounded to the nearest hundred in 1983 dollars. If the national economic loss caused by this type of collision were computed using these figures, it would be in the hundreds of millions of dollars. Clearly, an effective way to control deer movement across highways would significantly cut down on the number of animal/vehicle collisions and would therefore be an economic as well as a safety advantage.

Washington State DOT has recently completed an evaluation of a new reflector system designed to reduce the number of deer/vehicle accidents. This system, designed in Austria, is called Swareflex Wildlife Reflector. It consists of a series of 6.5-inch by 2-inch red reflectors mounted along the roadway. Light from the headlights of an approaching car is reflected at right angles to the roadway toward the shoulder while the car is passing, causing the deer to freeze in place in the same way that "deer shining" does. The reflectors are effective only at night, but, historically, nighttime is when most accidents involving deer happen.

Swareflex reflectors have been tested in a few other states, mainly by comparing the number of deer killed along the roadway after reflector installation with the number of deer kills recorded prior to reflector installation. Though this type of comparison has usually shown a reduction in deer/vehicle collisions, this method does not take into account the considerable annual variations in rates of deer/vehicle collisions. These variations are probably due to changing deer population densities, changing traffic patterns, weather changes that affect migration, small sample size and other factors. Therefore, WSDOT designed an alternating covered-uncovered study to elim-

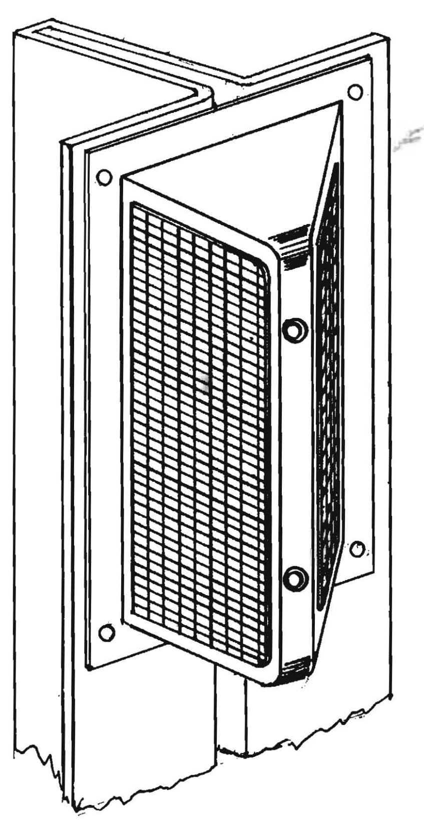
ANNUAL NUMBER OF ANIMAL/VEHICLE COLLISIONS IN TEXAS

Statewide (Urban, Suburban and Rural)

Year	80	81	82	83	84
Total	3945	4381	4536	4407	4804
Accidents Involving Fatalities	9	16	12	11	13
Accidents Involving Injuries	529	662	639	681	794
Non-injury Accidents	3407	3703	3885	3715	3997
Number of People Killed	10	21	12	15	13
Number of People Injured	671	883	860	945	1026

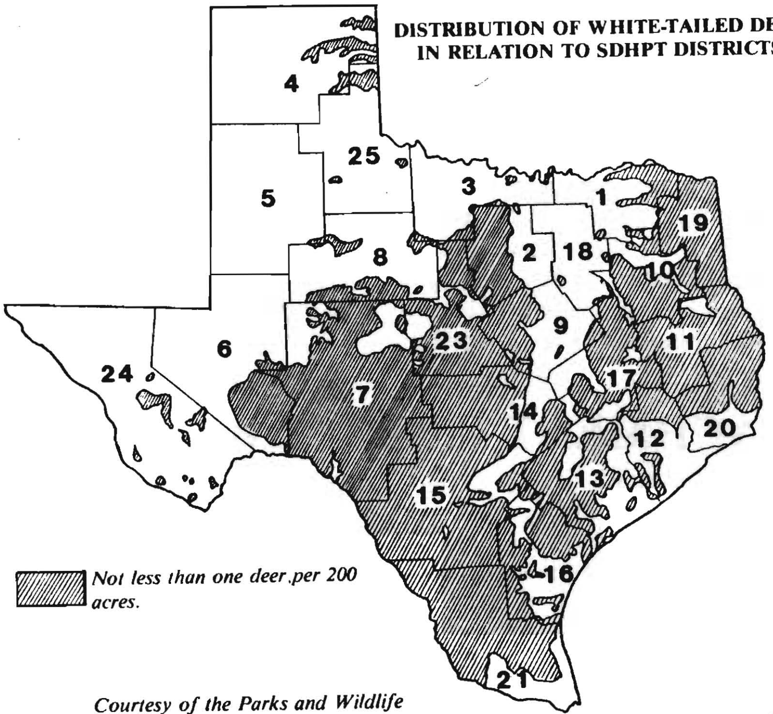
TABLE 1

Courtesy of the Texas Department of Public Safety.



Wildlife warning reflector.

DISTRIBUTION OF WHITE-TAILED DEER IN RELATION TO SDHPT DISTRICTS



Courtesy of the Parks and Wildlife Department.

Don Hilsberg.

inate most of these obscuring variables.

WSDOT established four test sections along SR 395 in an arid, transitional, ponderosa pine forest-grassland region north of Spokane, Washington. Each test section was placed in an area with a known high mortality rate of white-tailed deer (WSDOT maintenance personnel report deer kills on a special form). Reflectors were placed at 66-foot intervals on straight road sections and 33-foot intervals on curves as suggested by the manufacturer. Standard post-mounted delineator posts were used and the reflectors were mounted on them with tamper-proof hardware. During the study the reflectors proved fairly durable, even in heavy snow conditions. The researchers alternately covered and uncovered the reflectors at two week intervals during the late fall to early spring period from 1981 to 1984.

A total of 1,619 deer were killed on Washington highways from 1981 to May 1984. This total includes 594 (37 percent) that were killed on SR 395. Of the 594, 363 (61 percent) were killed during the mid-October to mid-April test periods since 1981. The 138 deer killed outside the test sections at known times of day included 114 (83 percent) killed at night and 24 (17 percent) killed during the day. Seventy-three (20 percent) were killed within the 2.3 miles of test sections.

Fifty-eight deer of the seventy-three were killed at night in the test sections during the mid-October through mid-April testing periods. These included 56 white-tailed and 2 mule deer. Fifty-two (90 percent) were killed when the reflectors were covered. Only six were killed when the reflectors were uncovered. The difference in deer/vehicle collisions rates when the reflectors are covered as opposed to uncovered is statistically significant (p .005), indicating that the reflectors were effective on SR 395 during this time period.

Since the number and cost of deer/vehicle collisions warrants consideration of effective preventative measures, Districts with large deer populations might be interested in experimenting with an alternating covered-uncovered study of wildlife reflectors at some time in the future. The reflectors cost between $11.95 and $15.16 each, without post or installation, so an accurate appraisal of current deer crossing areas is advisable to maximize the cost-benefit. A break down by county of frequency of accidents involving animals is available from the editor of ***TQ***. An example of the Swareflex wildlife reflector should be available for inspection at D-10R by the time this issue reaches publication.

A LOOK AT ROTARY MOWERS

Though they're half again as expensive, rotary disk mowers are cutting in on conventional mowers' turf. They can mow twice as much roadside grass using four gallons of gas less a day, says Ron Evert, Dane County [Wisconsin] Highway Department shop superintendent. They save labor by traveling nearly three times as fast and by using disposable blades.

About three years ago, Dane County personnel were looking around for some type of mower that would be more efficient than the sickle-bladed conventional mower. They discovered a line of mowers on a new concept—the rotary disk. The company producing rotary mowers demonstrated it and Dane County was impressed enough to lease one for a year to try it out fully. They bought four rotary disk mowers the next summer and four more the summer after that. While conventional mowers cost about $1600, these new rotary mowers run $2300-$2800. Both are pulled by a 40hp farm tractor, but because the rotary disks spin faster than the older type, the tractor can run at 6mph instead of 2mph. The higher speed at least doubles the amount of grass cut and also permits the tractor to use a higher gear, conserving gas.

Overall operating costs are about the same, says Evert, but the labor savings are significant. The 12 disposable blades, which cost about $1.50 each, have two cutting edges. When one cutting edge is dull, the blade can be reversed. When both edges are dull the blade is thrown away. Spinner [sickle] type mower blades cost $28 and take about an hour to remove, sharpen and replace.

"We've also found that we have fewer flat tires with this mower," says Evert. "We're not sure why, but we think it's because the tractor is driving on a mat of grass. Also these blades will shred plastic and other refuse along the road that would wrap up in the other type mower. The rotary mower appears to be relatively maintenance-free. The only situation that the rotary mower has had difficulty with is terrain where the tractor is on the flat and the mower is raised cutting a steep side slope; in this position, sometimes the mower gears do not get enough oil. Hydraulically operated rotary mowers, which are now becoming available, do not have this problem.

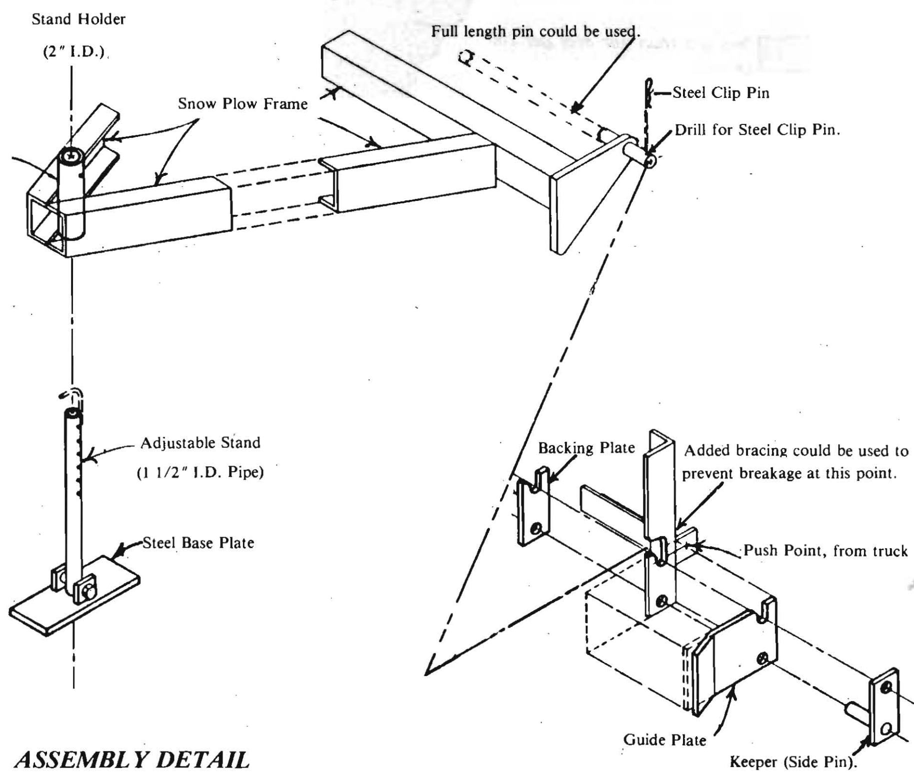
Based on, "Rotary Disks Slash Mowing Time," Crossroads (Summer 1985: 2).

QUICK-HITCH ATTACHMENT FROM IOWA D.O.T.

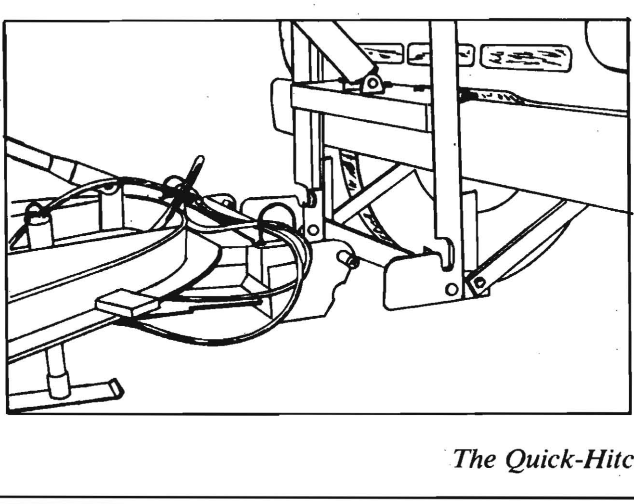
Winter; it's hard to think about snow with high's still in the mid-eighties, but winter is coming and winter means snow and snow plows in a lot of states, occasionally even in Texas. To make connecting a snow plow to a truck faster, easier and safer, Iowa D.O.T. personnel have developed a device called the Quick-Hitch Attachment.

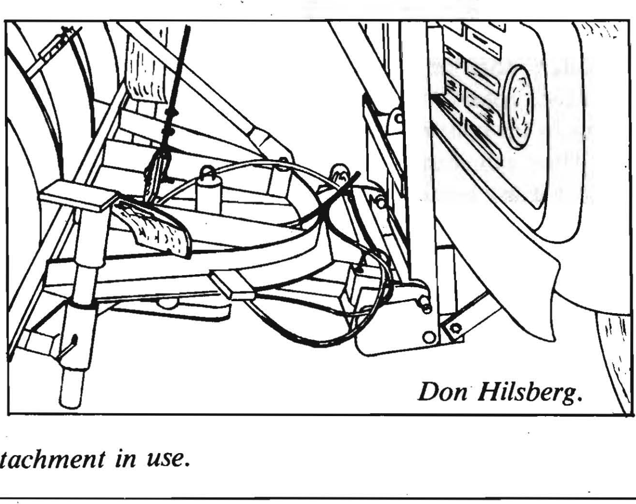
The Quick-Hitch is designed to make a one-person task out of connecting and disconnecting a snow plow attachment. An added benefit is that it decreases the risk of human injury because the apparatus does much of the lifting previously done by a worker. This version of the Quick-Hitch is the one most widely used by Iowa D.O.T. personnel. Other versions had been in use prior to the detailing of this system.

The Quick-Hitch basically relies on gravity and horsepower. Once the center support stand of the plow attachment has been set with a jack so that the plow mounting pins are



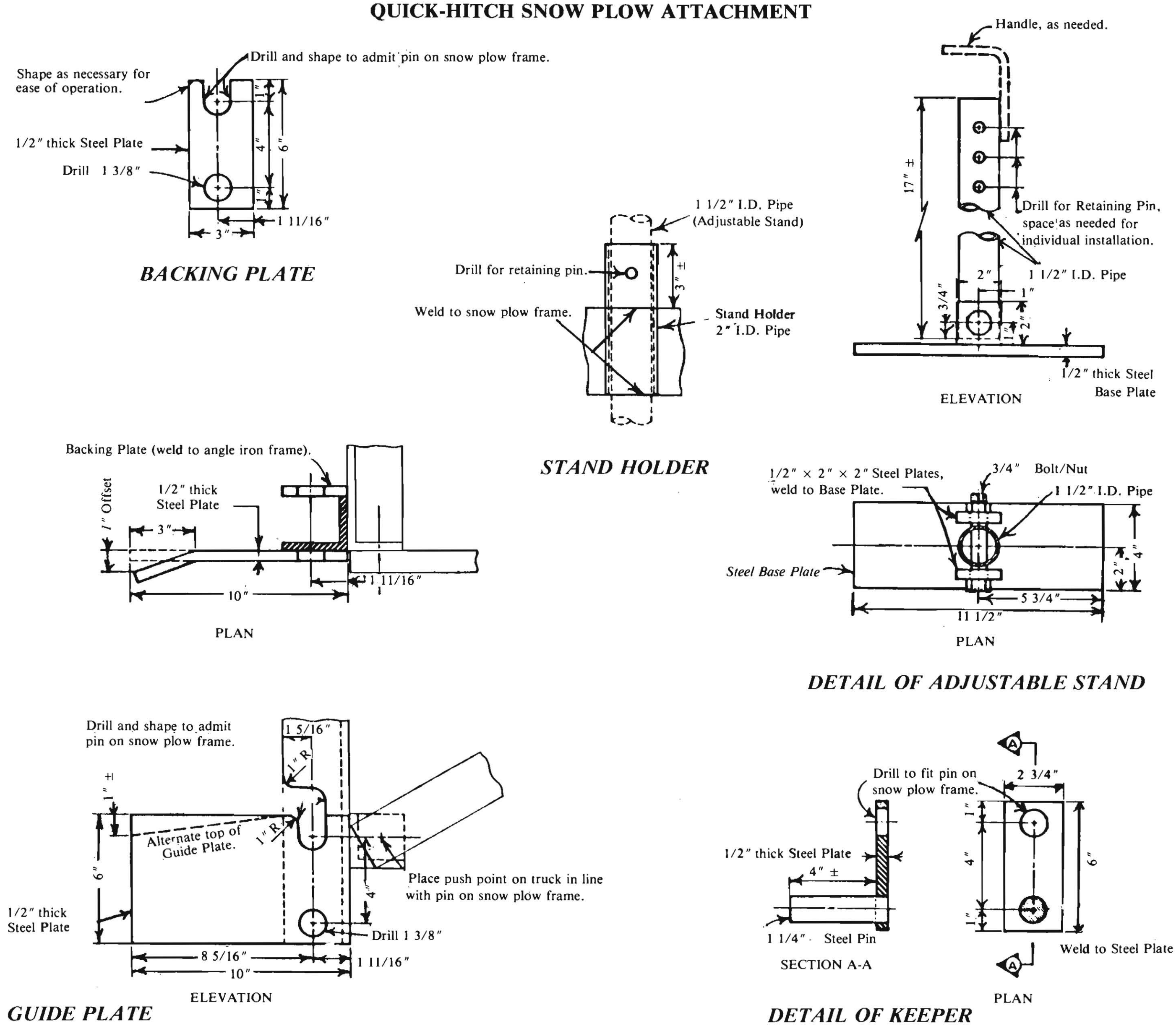
ASSEMBLY DETAIL





The Quick-Hitch Attachment in use.

QUICK-HITCH SNOW PLOW ATTACHMENT



approximately one inch above the guide plates on the truck, the mounting procedure is as follows:

1. Drive truck into plow until firm contact is established.
2. Hook up lift cable.
3. From inside the truck cab, raise the plow all the way up. (Plow will roll into keeper slots).
4. Shut off truck.
5. Put on keepers (side pins).
6. Connect hydraulic hoses.

The dismounting procedure is similar. Again, the plow support stand must be adjusted so as to hold the the plow mounting pins approximately one inch above the guide plates on the truck. When detaching the plow, the support stand will strike the ground first, causing the tipping action mentioned in number three below:

1. Lower the plow support stand to a predetermined position.
2. Remove the keepers (side pins).
3. Lower plow to ground. Plow will tip up and out of the slot.
4. While holding the plow control lever to the "plow down" position, back truck up, forcing the plow lift ram downward.
5. Drive truck forward until sufficient slack in lift cable is gained to allow cable to be disconnected.
6. Disconnect lift cable and hydraulic hoses.

Iowa D.O.T. personnel have found the Quick-Hitch to be particularly beneficial in locations where snow plows have to be stored out-of-doors. It was developed by Mike Kinyion and Chet Klucas of the Ames Maintenance Shop, Iowa D.O.T. and detailed by Roland Johnston of the Road Design Department.

Concrete *Continued*

THIN, BONDED OVERLAYS

The early signs of salt-induced corrosion are concrete delaminations and surface spalls (Figure 7). Without some type of protection, many decks need extensive repairs after 10 or 15 years of service. In 1966 the Kansas DOT began using bonded concrete overlays. For one 15-year-old bridge deck, the deteriorating concrete, down to the level of the steel, was removed from 45 percent of the surface. The steel was blasted clean and new concrete added to the entire deck surface with a cement sand grout to bond the new concrete to the old. The new concrete added 2 extra inches to the old deck thickness. Now almost 19 years later the deck with its thin, bonded overlay is still performing very well.

The decision to use that type of repair was based on research done on another bridge 5 years earlier in 1961. That deck surface was in nearly perfect condition at the end of 5 years. Scores of other overlays have followed since then with great success and years of extra life added to each old deck.

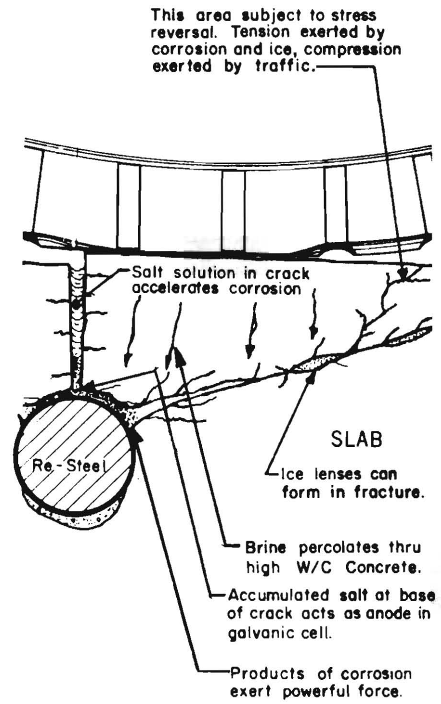


FIGURE 7 Combined effects of deicing salt and freeze-thaw cycles in creating concrete spalls.

There are several reasons why thin, bonded concrete overlays work even though there may still be salt at the level of the steel. Temperature, moisture, and oxygen content at the level of the steel are all reduced. Salt and moisture already present begin to move upward. The ingress of salt, water, and oxygen is severly retarded. More important, however, is the fact that thin, bonded concrete overlays have worked—for up to 24 years.

Despite high temperatures, low temperatures, free-thaw cycles, deicing salts, traffic pounding, and so forth, many concrete roadways have outlived their design life. They are still in everyday use and have not become the concrete outbacks of the highway infrastructure. Despite being beyond their design "old age," they are still bearing more than their anticipated share of traffic.

Reprinted from TR NEWS no. 118 (May-June 1985):3

Articles, techniques or ideas about any facet of highways or public transportation are welcomed. If you have a new way to handle an old problem, a helpful hint for making better use of a standard procedure or product or new application of a common item, send it to us. It doesn't have to be an earthshaker to be useful and appreciated.

If you have an idea to share, a comment to make or materials to request, use the tear sheet in this issue or call Kathleen Jones at (512) 465-7947 or TEX-AN 886-7947.

TECHNICAL QUARTERLY

State Department of Highways and Public Transportation, Transportation Planning Div. (D-10R), Technology Transfer, Bldg.1/Flr.5, P.O. Box 5051, Austin, TX 78763-5051

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