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1984

# AASHTO HIGHWAY SUB-COMMITTEE ON MAINTENANCE

JULY 9-11, 1984  
GULF SHORES, ALABAMA

Office of Maintenance  
Highway Division



Iowa Department  
of Transportation

## BRIDGE

### 1. Types and evaluation of "Snoopers" for bridge inspection work. (Missouri)

Iowa has four low lifts (Snoopers). They have differing advantages and disadvantages as follows:

Inspector 28-manufactured by Hunt-Pierce-purchased by Iowa in 1973 for \$51,000. This is a basket machine and is best fitted for bridge inspection. It is unique in that there is rotational capability at the end of the first arm. This makes it especially suitable for inspecting trusses and other thru structures.

Super Snooper-manufactured by Paxton-Mitchell-purchased by Iowa in 1974 for \$58,000. This is also a basket machine and best suited for bridge inspection. It has a longer arm than the Inspector 28 which makes it usable on wider bridges. It is also unique in that it uses counterweights rather than the usual Paxton-Mitchell rolling outriggers. We special ordered this feature so we could use it on narrow bridges without blocking both traffic lanes.

Standard Snooper-manufactured by Paxton-Mitchell-purchased by Iowa in 1976 for \$42,000. This is the company's standard platform unit. It is best suited for repair because two people can work together. It is less suitable for work on thru structures because of difficulties in insertion and retraction.

Convertible-manufactured by Paxton-Mitchell -purchased by Iowa in 1983 for \$63,000. This can be operated as either a basket or a platform unit. This makes it more adaptable than any of the other units. The conversion takes about a half a day and is best done in a well equipped shop so we only convert twice a year, in the spring and in the fall.

In summary, we feel that we are fortunate in having the wide variety of units available. Since they are all scheduled out of our Central Office, we are able to send the unit best suited for the need. We would not want to purchase a unit that was not capable of forward movement with the arm extended. This makes it very difficult to get true competitive bidding.

### 2. What arrangements are the various States making in regard to sharing maintenance responsibilities for State line structures? (Illinois)

Iowa is forbidden, by constitutional amendment, from spending road use tax money outside of the boundaries of the state. Our agreements with adjacent states for maintenance of border bridges reflect this. They require that the costs be prorated by the percentage of the bridge within the state.

## MAINTENANCE MANAGEMENT

1. Does anyone have a method of determining staffing needs for traffic signal and lighting maintenance? (Missouri)

Iowa does not have a formal method of determining staffing needs for traffic signal and lighting maintenance. Traffic signal maintenance is generally contracted out to the city that is nearest the location of the signals. Lighting maintenance repairs are handled by the local crew if they are of a routine and non-technical nature, such as fuse and luminaire replacement. A State Lighting Crew handles the more technical repair work. Major lighting rehabilitation work is contracted.

2. At the 1983 meeting, we were advised Pennsylvania contractors had initiated a study of cost comparisons between contract maintenance and State maintenance of functional items. Is that study completed? Are the results available for discussion? (Illinois)

Iowa does not have the report of the Pennsylvania study on contract versus state maintenance of functional items but Iowa has issued a report on contract maintenance as a result of four routine maintenance contracts. This report is available through the Office of Maintenance of the Iowa Department of Transportation.

3. Are States assigning service levels to their highway systems? If so, how are they applied; e.g., winter snow removal, surface and shoulders, mowing, etc? (Iowa)

Iowa assigns service levels to the highway system for planning major improvement or reconstruction. In maintenance, the service level concept has only been applied to snow and ice control. We would like to receive input from other states that are using this concept for other maintenance activities.

4. Are the States contracting for sign replacement and/or rehabilitation on their primary, non-freeway systems? (Iowa)

Iowa contracts replacement and rehabilitation of large guide signs on the interstate system. Plans are to expand this work to the smaller signs on the interstate system. Has any state contracted this work on the primary, non-freeway system?

5. Which States operate striping crews at the district level (decentralized) in lieu of statewide level (centralized)? Discuss pros and cons, identify any States that have changed recently, and reasons for the change. (Louisiana)

Iowa operates striping crews at the district level. We have no centralized striping capability. The district crews are staffed and equipped to adequately maintain our striping program. Iowa contracts all pavement markings on construction or maintenance projects where the striping is obliterated by the project. This program has worked very well with each district scheduling their operations to fit the

maintenance operations of the local crews so back-tracking or repainting is kept to a minimum.

6. I would like to have an update on contract maintenance. What are the results, is quality of work a problem, how do prices compare with State forces maintenance? (Georgia)

Iowa has had a very successful program of contract maintenance of functional items for several years. Quality of the work is good. The cost is sometimes higher than if the same work were performed by state forces but we are not staffed or equipped to handle all of the work needed and contract maintenance has proven a very satisfactory means of accomplishing our program. Routine maintenance of entire sections of a highway was tried by contract and it did not prove satisfactory. The contract price was too high for many of the minor items of work and his response time to unanticipated needs was generally too slow. Administration of the work was also very difficult.

7. Items to be considered in comparing contract maintenance costs with State maintenance costs; i.e., how have other States handled the various overhead and administrative markups normally charged on internal transactions in making comparisons with contract bids? (California)

Iowa's maintenance management system collects all costs of our maintenance operations except for building depreciation. The total cost of our overhead, which includes supervision, time off, training and other support activities, are calculated as a percent of our direct maintenance costs and this percentage is added to our unit costs when computing our total cost for each function. To this we then add a reasonable profit for the contractor.

## EQUIPMENT

1. Are any States requiring a parts delivery schedule for new equipment such as specific time delivery (within 48 hours) of receiving the order? (North Dakota)

If parts delivery schedules are required does the vendor have to post a bond? (North Dakota)

Iowa does not require a parts delivery schedule on new equipment.

2. What criteria are States using to replace light vehicles (passenger cars and 1/2-ton pickups)? (North Dakota)

Iowa schedules replacement of light vehicles (passenger cars and one-half pickups) at 75,000 miles or eight years, whichever comes first.

3. At the 1983 meeting, we were advised that TRB and FHWA were exploring the possibility of establishing a means for a periodic meeting of DOT-equipment managers for the purpose of exchanging ideas and discussing problems regarding maintenance equipment. Has anything more developed on this possibility? (Illinois)

Although Iowa has no knowledge of any progress toward periodic meetings of DOT-Equipment Managers, we feel it is a good idea and we encourage development of such a meeting.

4. Are States purchasing small milling/profiling machines? If so, are they doing the job, are they performing satisfactorily? (Iowa)

Iowa is considering the purchase of a small milling/profiling machine for statewide use by maintenance. Do other states own and operate this kind of equipment and if so, what has been their experience with the equipment?

5. Are any States using ground control spreaders on an operational basis? Comparison of the "closed loop" system versus the "open loop" system. (New Jersey)

Iowa purchased ground oriented controlled hopper spreaders exclusively for several years and found that they generally worked satisfactorily. They were of the closed loop system. Cost of the system and the lack of understanding of the system by equipment operators caused us to revert to a manual hydraulic system two years ago.

6. Rotary snowplows - A comparison of auger-type versus helical ribbon-type and hydraulic-driven versus mechanical-driven. (Nebraska)  

Iowa uses a two-stage auger type mechanical driven rotary snow blower exclusively.
7. Radio communication systems regulations changes. (Mississippi)  

Iowa has not experienced any problems with communication system regulations.
8. Operational history of foreign equipment - Duetz, Kubota, Hesston and Komatsu wheel and crawler tractors. (Mississippi)  

Iowa has very little experience with foreign made equipment.
9. Use of fiberglass fuel tank in lieu of steel. (Mississippi)  

Iowa has no experience with fiber glass fuel tanks.
10. Mechanical litter retrievers. (Mississippi)  

Iowa has no experience with mechanical litter retrievers.

## ROADSIDES

1. How are weeds controlled in crown vetch? (Iowa)

Iowa has had an increasing problem with weeds in crownvetch, particularly Canada Thistle. We presently are using hand application to minimize damage to the crownvetch. This is very labor intensive.

2. Are the States contracting herbicide application? If so, what is the cost experience and public reaction? Are applications complete or done on a spot basis? (Iowa)

Iowa has not contracted any herbicide applications. Being an agricultural state we are concerned with the liability and public reaction we would receive if vegetation on private property were damaged. We are interested in other states' experience.

3. New Jersey has stopped using herbicide sprays containing the chemical Amatrole. Has any other State done so? (New Jersey)

Iowa does not use the chemical Amatrole.

4. Are any States contracting litter pick up (walk type)? their experiences? (New Jersey)

Iowa has not had any contracts specifically for litter pick up. We have had 4 general maintenance contracts that included litter pickup. Specified litter pick ups in the spring and fall went fairly smoothly. However, the contractor was reluctant to go out and pick up litter at specific locations as it occurred during the remainder of the year.

## SAFETY AND TRAFFIC SERVICES

1. Discussion of the use of liquid calcium chloride in snow and ice control activities. We are interested in the amount of liquid calcium added, the method used to add and the conditions under which it is used. (Missouri)

Iowa has experimented with liquid calcium chloride to pre-wet rock salt and 50/50 salt sand mix since the late 1960s. We first tried carrying tanks of bulk liquid calcium chloride on the truck with a pump and spray nozzle to pre-wet the salt as it was discharged from the hopper spreader. The metal parts of the pump and nozzle corroded quickly causing problems with uniform distribution. Spraying liquid chloride on the top of the loaded hopper spreader also proved unsatisfactory due to non-uniform distribution. We are now working with a total system of plastic and fiber glass components that we plan to use to pre-wet the salt and/or salt sand mix as it is discharged from the hopper spreader. Our normal rate of application is about 10 gallons of 32 percent liquid calcium chloride per ton of salt or mix. Problems with residual calcium chloride on the pavement has caused blowing snow to stick to the pavement for several days following the use of the liquid calcium chloride under certain temperature and wind conditions. This has been a drawback to the use of this material.

2. What criteria are used to repaint edgeline stripes? (North Dakota)

Edgelines strips are repainted when they reach an unsatisfactory condition as determine by both day and night visual inspections by local maintenance personnel. Normally, they are repainted on a 2 year basis except for more heavily traveled routes.

3. Are any States considering closing some rest areas permanently? (North Dakota)

Iowa is not considering closing any rest areas. We only maintain 39 safety rest areas along the interstate.

4. How many States are closing rest areas during the winter months? (North Dakota)

Iowa has not closed any rest areas during the winter months. We believe they serve a useful purpose during the winter providing weather information, shelter, and comfort facilities.

5. Have the States experienced difficulty in enforcing the new truck size and weight provisions of the 1982 Surface Transportation Assistance Act? Are there indications of additional maintenance problems in relation to these increases? (Illinois)

Our enforcement personnel state that there has been no problem with enforcement of the new length and width requirements in the 1982 Surface Transportation Act. Enforcement of weight limits is approximately the same as before the Act became effective. There has been no indication of a major change in maintenance needs due to larger vehicles. Increased weights may have an effect on maintaining the structural integrity of pavements.

6. A discussion of requirements for pavement marking (i.e., removable tape, raised pavement markers, etc.) for use at temporary lane closures (i.e., closure of one lane during pavement or bridge deck repair). Does any State have application standards of this item? (Ohio)

Removable tape is used for developing a taper when a lane closure is required for construction work. For short term maintenance work, no markings are used. Raised pavement markers have been used experimentally on a few projects with good results. Copies of specifications and standards are attached.

7. Are other States requiring the use of towable or truck mounted impact attenuators by maintenance crews for operations which occupy a traveled lane? (Ohio)

Iowa does not require towable or truck mounted impact attenuators for maintenance operations. We are, however, experimenting with one truck mounted unit at the present time.

8. Which States are using thermoplastic striping? Discuss striping criteria (when to stripe, pavement types, etc). Stripe life, and experience to date (good, bad, indifferent). (Louisiana)

Iowa has not used thermoplastic material for routine marking purposes. Experimental work has been done with other "permanent" types of pavement markings such as preformed polymers, durable tape, Epoxy and Epoflex. The polymers and tapes wear well, but have problems with bead retention and reflectivity. Epoxy has only been in place for one year and is performing reasonably well except for a few areas. Experience with Epoflex has been poor to date. Problems include application difficulties and poor adhesion to new concrete pavement. Experimentation with these materials will continue, but the vast majority of markings in Iowa are with conventional traffic paint.

9. Apparently, some States are using fiberglass sign blanks. I would like to know the experience of any State who has used fiberglass, any problems they have encountered, and a cost comparison between fiberglass and other panels. (Georgia)

We are working with Owens-Corning fiberglass on a limited quantity of fiberglass sign blanks. Approximately 500 square feet of material is now being fabricated into sign blanks and sheeting is being applied. These signs will be installed and periodic evaluations will be made jointly by Iowa DOT and Owens-Corning personnel. From information available, the material seems to offer the potential as a competitive alternative to aluminum.

10. How many States are using high intensity sheeting for all their signs? Have some States that went to 100 percent high intensity gone back to using engineering grade material for certain sign classifications? (New Jersey)

Iowa uses high intensity sheeting on all signs with the colors of white, green and yellow as a background. Engineer grade sheeting is still used for orange, blue and brown. No changes are anticipated in this procedure at the present time. A limited quantity of "Super Engineer Grade" sheeting by Seibulite is being tested as a possible substitute for some high intensity.

11. Are any States using reflective sleeves on traffic cones for nighttime visibility? If so, are they using 6-inch or 13-inch sleeves? (New Jersey)

Iowa uses reflective sleeve on traffic cones for nighttime visibility. It is a full length sleeve and is reflective orange in color. For daytime use, the standard orange non-reflective cone is used.

12. New Jersey is currently using 36-inch signs for maintenance work zones but is experimenting with 48-inch signs. What are other States' experiences? Separate systems for Interstate and land service roads? (New Jersey)

Most maintenance work zone signs being used in Iowa are 48". Trailers have been fabricated to transport the signs and mounting skids as units for standard set ups. No differentiation is made on sign size for different systems or classes of roads. We believe that 48" signs are desirable to convey the important messages associated with maintenance work zones.

13. How many States are receiving from 3M a maintenance warranty or guarantee on any material for signs? (FHWA)

The 3M Company has been very cooperative in guaranteeing their material. Defective sign sheet material and pavement marking material have been replaced at no cost to the state. Included is the labor to install the replacement material. If reasonably good performance (10 years +) is not provided by high intensity sheeting, the company has been willing to consider replacement. We have been entirely satisfied with their policy.



Iowa Department of Transportation

SUPPLEMENTAL SPECIFICATIONS  
for

PAVEMENT MARKING

December 20, 1983

THE STANDARD SPECIFICATIONS, SERIES OF 1977, ARE AMENDED BY THE FOLLOWING ADDITIONS. THESE ARE SUPPLEMENTAL SPECIFICATIONS AND SHALL REPLACE SECTION 2527 IN THE STANDARD SPECIFICATIONS.

**945.01 DESCRIPTION.** This work involves furnishing, installation, and maintenance of pavement marking and temporary delineators, such as for -

- (1) Diversions and runarounds where the need for such work is anticipated as part of the traffic-control plan for accommodation of traffic during construction;
- (2) Marking obliterated during construction activities on roads open to public traffic;
- (3) Marking changes made necessary on roads open to public traffic where the changes result from staged construction; and
- (4) Permanent marking of completed pavement surfaces.

This work may include transverse lines and symbols and legend, when shown on the plans, and may also include removal of markings when necessary.

This specification is intended to complement requirements of the plans and other specifications. Permanent preformed polymer marking and durable pavement marking tape are not within the scope of this specification.

Diversions are installations or modifications for the transfer of traffic on four-lane or wider roadways to lanes which would normally carry traffic in the opposite direction, usually providing for continuous but restricted traffic flow from both directions; for divided highways, they usually include crossovers.

Runarounds are temporary roadways specifically constructed to accommodate traffic during construction by removing such traffic from the construction work zone.

**945.02 MATERIALS.** The materials used for pavement marking shall provide markings that are readily visible when viewed in daylight and with vehicular headlights at night.

For final surfaces, the marking material which is to extend diagonally across a traffic lane and which is to be later removed shall be removable preformed polymer marking film described in Paragraph B.

Other markings intended as temporary marking, marking to be removed or covered, or permanent marking shall be one of the materials specified herein, properly applied.

The materials shall meet the following requirements for the respective types.

**A. Reflective Marking Tape** shall have a nominal width of 4 inches and shall consist of a yellow or white, weather- and traffic-resistant film on a conformable, metallic foil backing precoated with a pressure-sensitive adhesive. The film shall contain reflective elements to allow night visibility. The tape shall be flexible and formable, and following application, shall remain conformed to the texture of the pavement surface.

The average thickness of the tape, including reflective elements, shall not be less than 15 mils or more than 50 mils.

Tape used where removal may be required shall be a type recommended by the manufacturer as readily removable without requiring sandblasting, solvent, grinding, or other methods injurious to the pavement.

**B. Removable Preformed Polymer Marking Film** shall have a nominal width of 4 inches and shall consist of a yellow or white, weather- and traffic-resistant, thermoplastic polymer film, precoated on one side with a pressure-sensitive adhesive. The film shall contain reflective elements to allow night visibility and shall be flexible and resilient. It shall be capable of remaining in place during its useful life when properly applied and shall be easily removed from the pavement at any time.

The average thickness of the film, including glass spheres, shall not be less than 45 mils or more than 70 mils.

**C. Traffic Paint** shall meet requirements of Section 4183 for fast-dry paint. Reflectorizing spheres shall be applied to the painted lines to obtain night visibility. The spheres shall meet requirements of Section 4184 for Type 1 spheres, except they shall not be treated with silicone, wax, or oil.

The paint shall be applied without dilution using mechanical equipment intended for that purpose. The reflectorizing spheres shall be applied immediately to the paint with a pressure-atomizing system. The nominal application rates shall be as follows:

Lane Width	Line Type and Color	Wet-Film Thickness	Paint	Spheres
4 1/2"	Yellow centerline, white lane line, or barrier	16 mils	267.4 ft solid line/gal (1070 ft dashes) 4.94 gal/mi dashes	4.25 lb/gal of paint
4"	White or yellow edge line, no-passing zone line	16 mils	300.8 ft line/gal 17.55 gal/mi line	4.25 lb/gal of paint

Where it is not practical to apply fast-dry paint, such as curbs and symbols, a slow-dry paint similar to that described in Section 4183 may be used at the same rate, and spheres may be applied by a gravity system.

**D. Temporary Delineators** shall meet requirements of 4186.07 or shall be equally effective and shall be mounted on suitable posts.

**E. Raised Pavement Markers.** These markers are intended for temporary use to provide positive retroreflectance of pavement lines. They may be used in lieu of or in addition to pavement marking, as required.

Raised pavement markers shall be placed parallel to the line being marked at that location. Placement shall be in accordance with the manufacturer's recommendations subject to approval of the engineer.

**945.04 MAINTENANCE.** Pavement marking and delineators for which the contractor is responsible shall be maintained in good condition, and shall be reconstructed, if necessary, for the period of their intended use. The condition shall be subject to review by the engineer.

**945.05 REMOVAL.** Existing pavement markings that are in the newly marked traffic lanes or are confusing to traffic in the newly marked traffic lanes shall be removed. The engineer may designate other pavement markings for removal to maximize the effectiveness of the traffic-control plan.

All new pavement markings, which are applied according to this specification and which change the color or placement of existing standard pavement markings shall be removed by the contractor on completion of the project. Removal may also be required during progress of the work if lines, no longer needed, cause confusion in delineation of traffic. If the contracting authority is to permanently re-mark the highway, the removal of pavement markings shall be coordinated with the engineer.

Removal will not be required prior to being covered by a construction process. Removal of painted markings may be by sandblasting, by use of strippers followed by high-pressure water, or by propane and oxygen burner. Remaining residues of paint after the removal process is completed shall not be sufficient to be visible during daytime or nighttime to the traveling public. Tape markings shall be removed in accordance with manufacturer's recommendations. In any event, removal processes shall not cause damage to the pavement.

Temporary delineators and posts shall be removed when their need no longer exists.

**945.06 LIMITATIONS.** When temporary marking is required to replace marking obliterated by construction, the marking shall be applied on the same day the previous marking is obliterated.

When temporary marking is required for diversions and runarounds, the marking shall be completed and delineators placed, if required, before the diversion or runaround is put into service, but misleading or conflicting lines shall be removed the same day the new lines are placed.

When temporary marking is required because of changes resulting from stage construction, the application shall be coordinated with other work and with the transfer of the traffic, as directed by the engineer.

Permanent marking shall be completed before the road is opened to public traffic. When public traffic is allowed on the pavement during construction, permanent marking of center lines, lane lines, no-passing zone lines, and edge lines on interstate pavements and those described in 945.03C2 shall be completed on the same day these markings have been obliterated. Other edge lines shall be placed within 3 working days from the day the pavement and shoulder work are completed for the project. Symbols and legend shall be placed within 5 working days from the day the final surface is placed at the symbol or legend locations.

Removal work shall be done promptly. Removal of misleading or conflicting lines resulting from placement of new lines shall be done the same day the new lines are placed.

During application of permanent marking, the surface shall be clean and dry and the atmospheric temperature shall be above 35 degrees F. The contractor should apply temporary marking under similar limitations, and he may be required to conduct this work in conjunction with other work at any time that these conditions near the end of the day are questionable.

If, due to unavoidable circumstances, the contractor is not able to complete the temporary or permanent pavement marking or removal specified for that day, he shall provide or continue to provide traffic control with procedures used during working hours until the pavement marking is completed.

**945.07 METHOD OF MEASUREMENT.** The engineer will calculate the quantity of Pavement Marking, satisfactorily applied, for each initial application. In addition, when heater-scarification is required, replacement of a previously placed center, lane or no-passing zone line, of obliterated by heater-scarification work in the adjacent lane, will be measured for payment. Other re-applications to maintain a line will not be measured. The number of stations of each type of line will be determined using beginning and ending points and adjusting for breaks at sideroads, median crossings, station equations, or other locations shown on the plans. The calculation for dashed and dotted lines will be adjusted to exclude skips as specified. Lines wider than 4 1/2 inches will be included by an appropriate ratio to a 4-inch line. The number of symbols (including legend), as defined in 945.03, will be determined by count.

The engineer will count the number of Temporary Delineators constructed.

The engineer will count the number of Raised Pavement Markers installed.

Removal of pavement marking will be computed by the engineer in the same manner as the application.

**945.08 BASIS OF PAYMENT.** For the number of stations of 100 feet of Pavement Marking applied, including both temporary and permanent marking, the contractor will be paid the contract price per station.

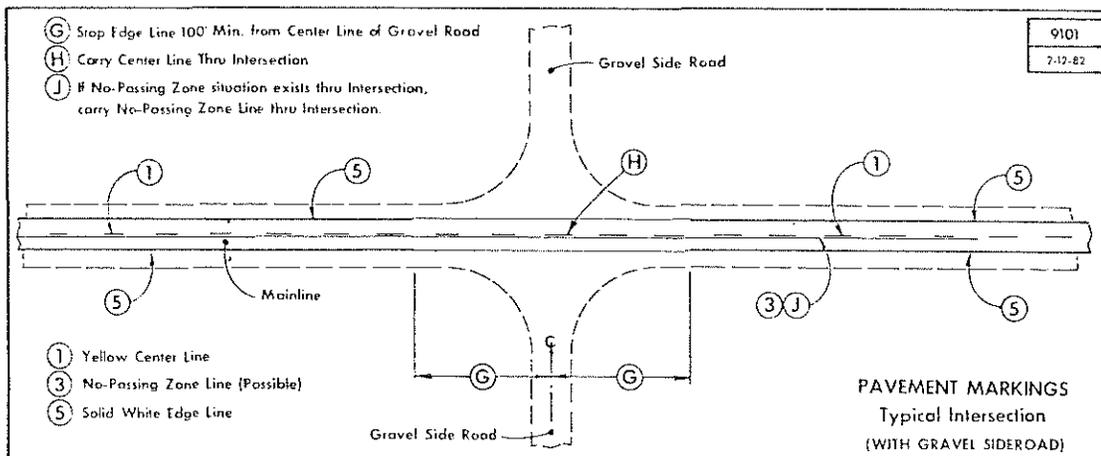
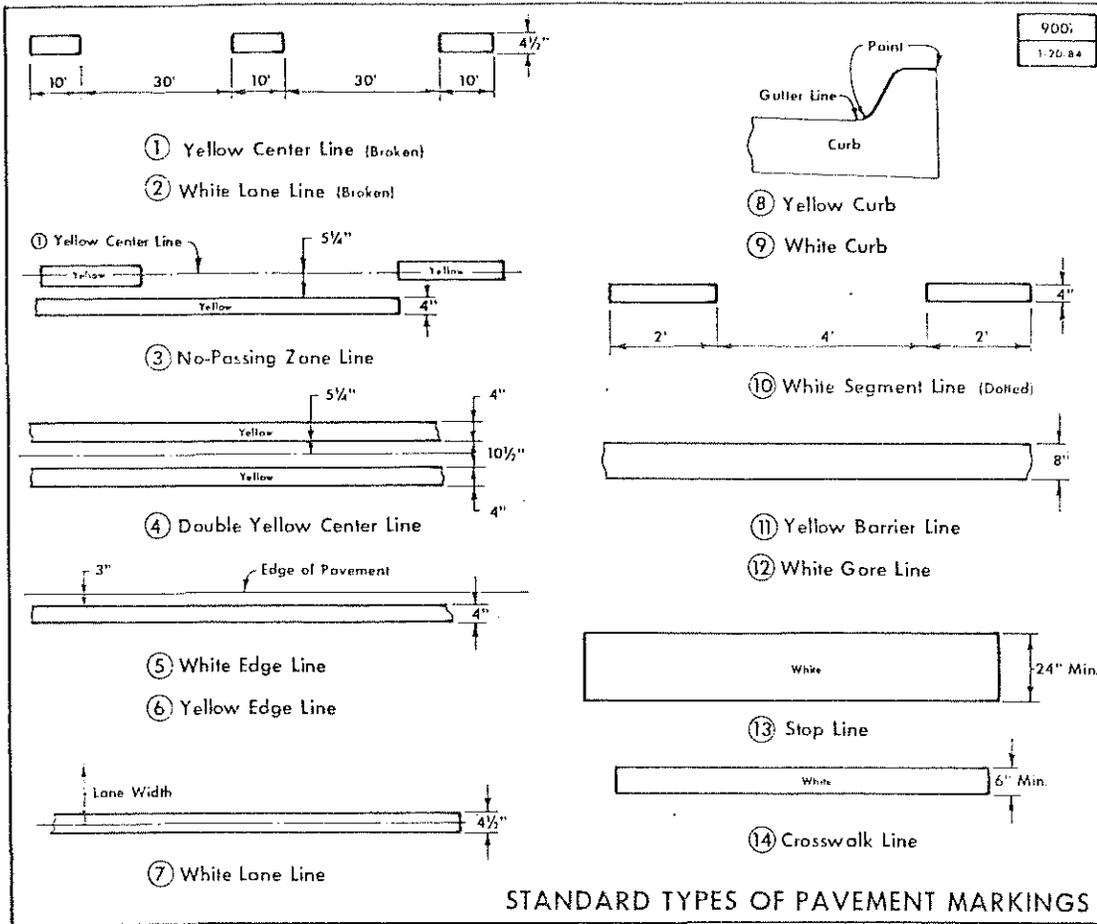
For the number of Symbols (and legend) applied, the contractor will be paid the contract price for each.

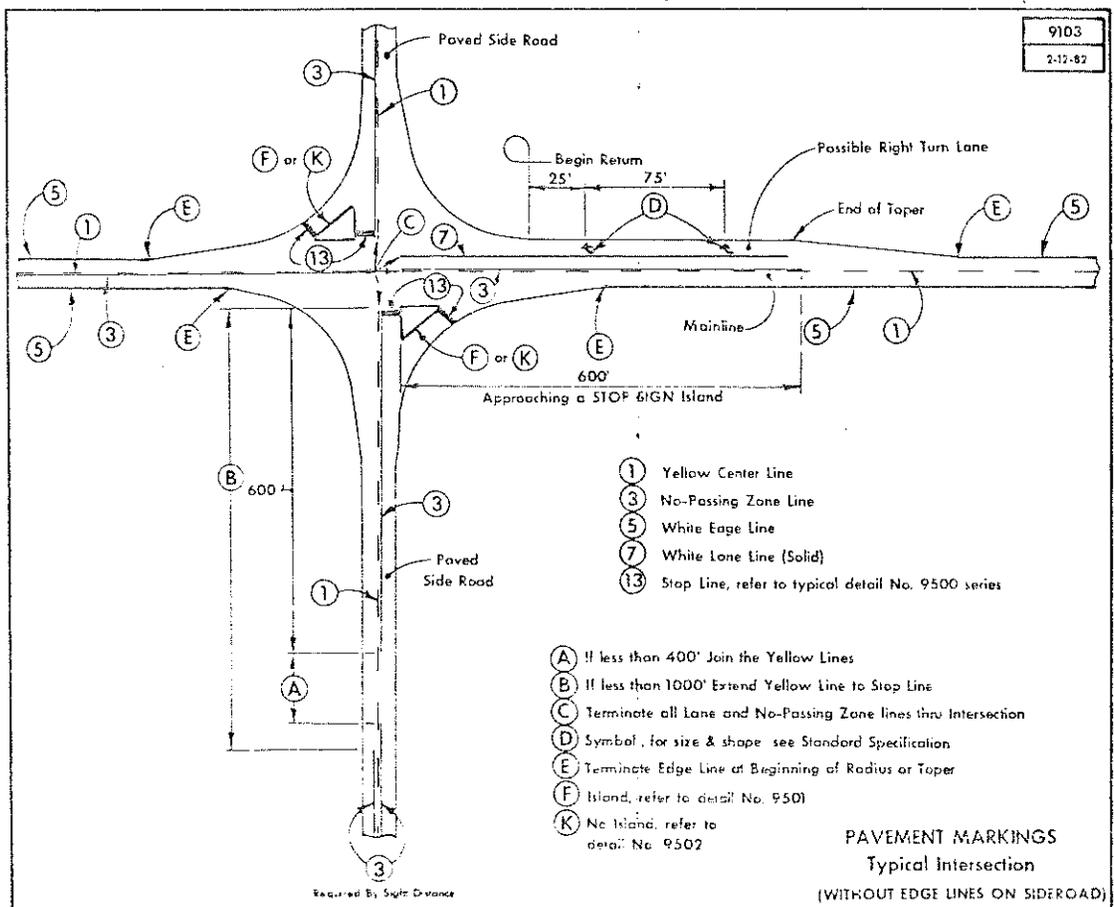
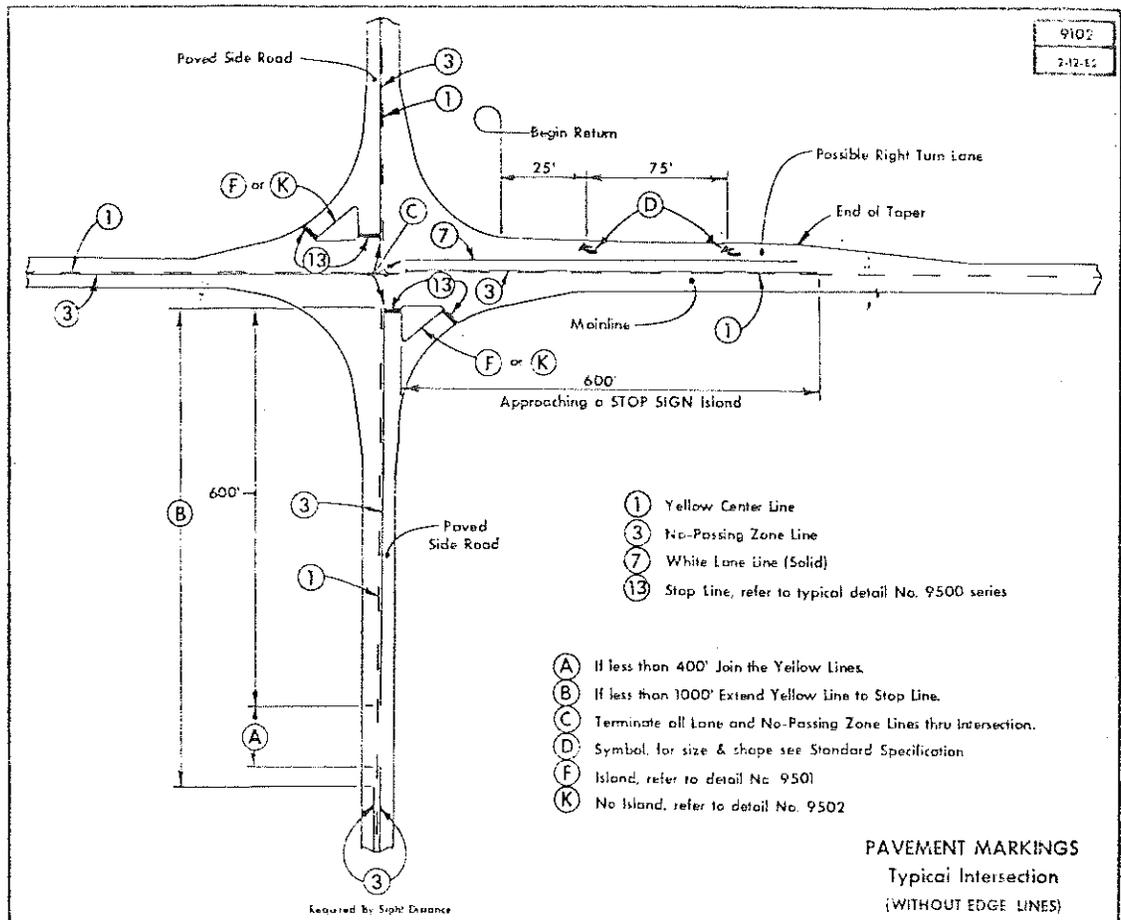
For the number of Temporary Delineators constructed, the contractor will be paid the contract price for each.

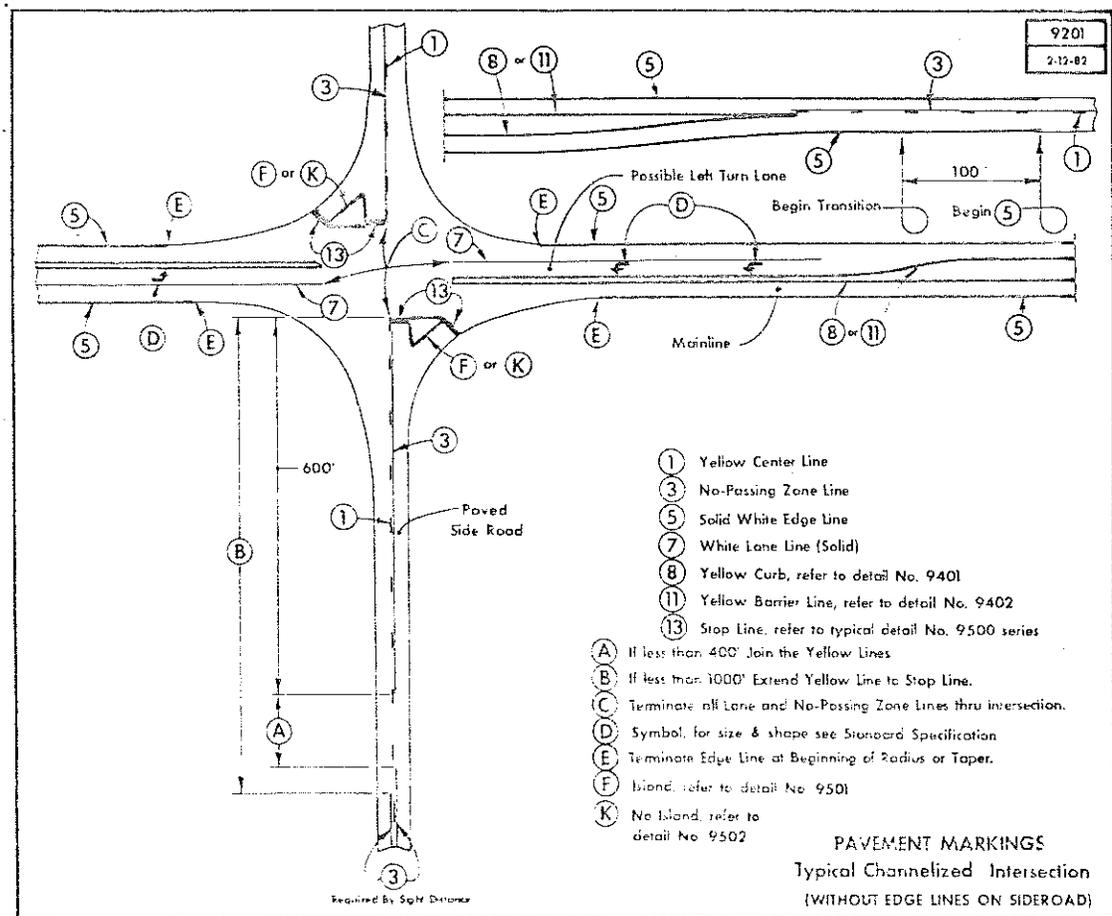
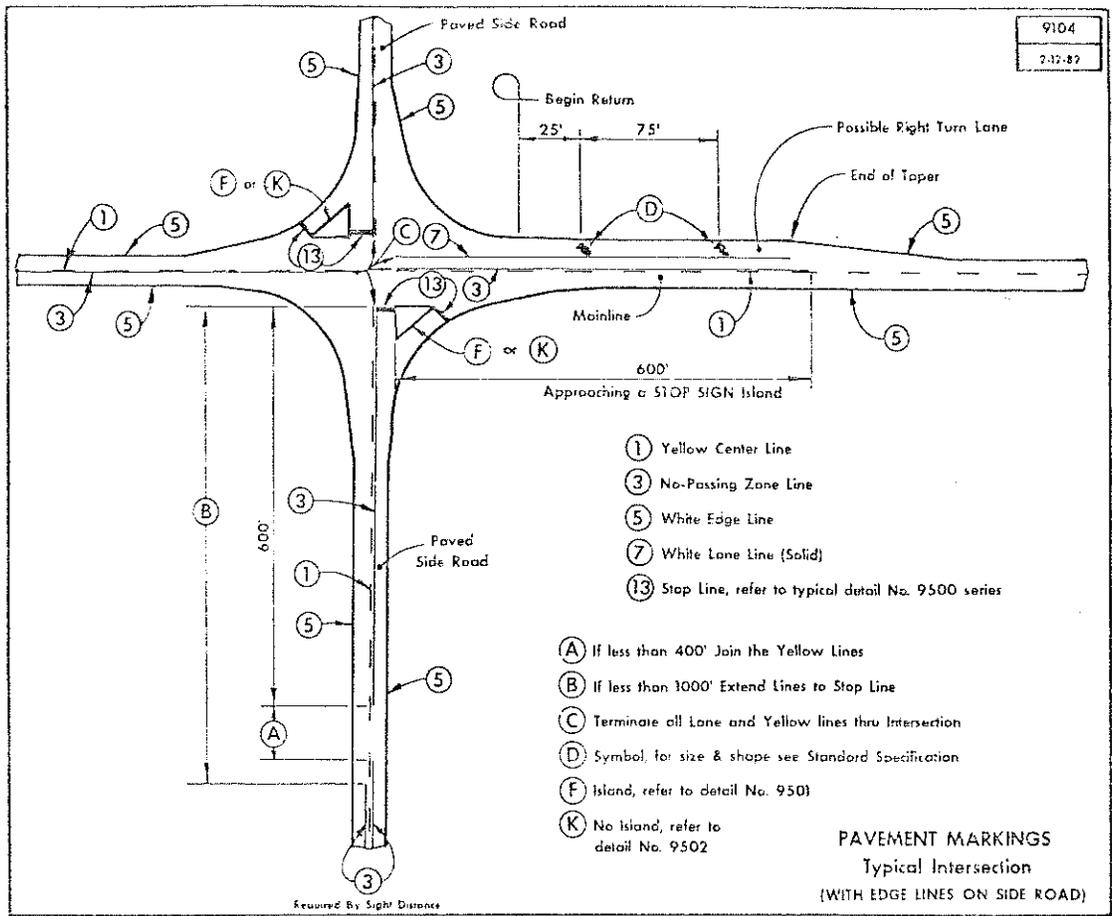
For the number of Raised Pavement Markers placed, the contractor will be paid the contract price for each.

For the number of stations of Pavement Marking removed, the contractor will be paid the contract price for Pavement Marking applied. For the number of symbols (and legend) removed, the contractor will be paid the contract price for each.

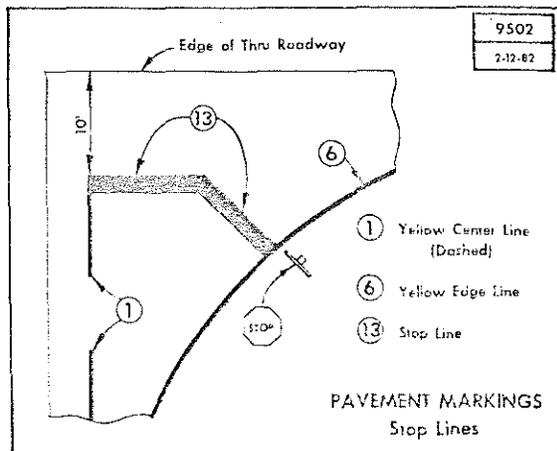
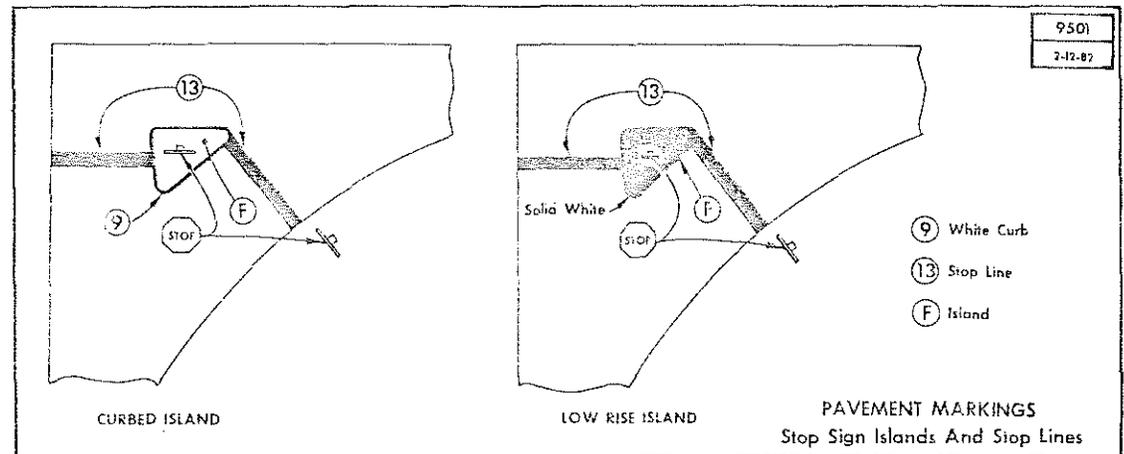
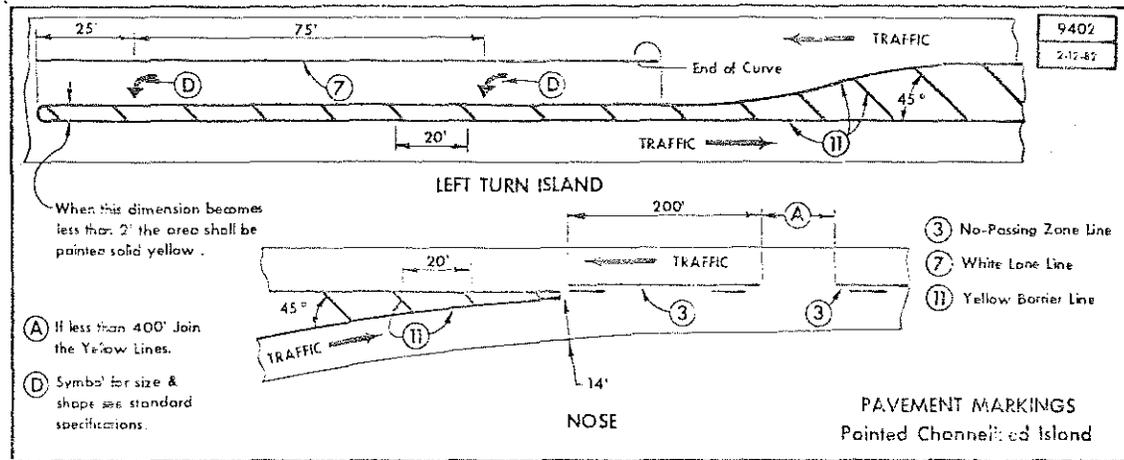
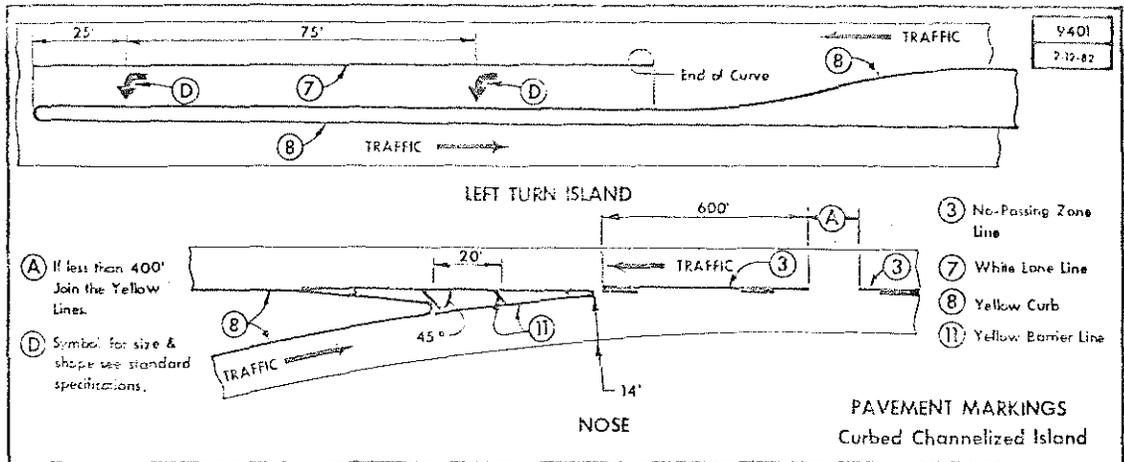
Such payment shall be full compensation for application of temporary or permanent pavement marking, maintenance, and where required, removal of pavement marking, constructing and removing temporary delineators, placing and removing raised pavement markers, and for furnishing all materials, equipment, and labor therefor, including traffic control that is not paid for separately.











## PAVEMENTS

1. How many States using spring load restrictions use deflection criteria for determining when restrictions should go into effect and when they are to come off? What type of equipment is used to measure deflections? (North Dakota)

Iowa does not use deflection criteria for determining when embargoes should go into effect and when they are to be removed. We depend on the history associated with that roadway.

2. The repair of potholes continues to be a difficult problem from both the technique and public relations standpoints. Have any of the States developed promising changes in materials, equipment, or techniques for spring repair of potholes? (Illinois)

The use of Sylvax in periods of cold weather has proved to be a beneficial patching material (no tack and minimal preparation). ACC "heaters" which can be used for reheating milled material or to reheat plant mix provides an opportunity for a hot mix patch which can be placed the year around.

3. Discussion on repair methods for patching joints in PCC pavements. How many years' service life are being obtained? (Ohio)

Our current patch design has been used since 1982 and consists of dowling the patch to the adjacent pavement (attach supplemental spec 950). This patch design has not been in use long enough to be able to determine what the service life of the patch will be; however, we find that early failure of our patches are related to improper preparation of the vertical edges by the contractor and improper installation of the dowel bars along with improper preparation of the subgrade.

4. What types of materials and procedures are being used for crack and joint sealing in the snow belt States? Is this work being done by State forces or by contract? (Iowa)

Iowa's procedure is explained in the attached special provision, SP-541.

5. What type of experiences are the States having with profiling of PCC pavements? Is it costs effective, does it last, other problems? (Iowa)

This question is being asked by Iowa. We are interested in other states experiences.

6. Which States cut 4-inch expansion joints in Interstate pavement to control pavement growth? Discuss pros, cons, and FHWA reaction. (Louisiana)

Iowa began this practice in the early 1970s on the interstate system. Pressure relief joints (PR) were not cut in all pavements.

The cutting of these joints caused the release of the contraction joints (original jointing was at 76'6" centers 10" PCC pavement with 6" x 6" mesh). Intrusion of water and incompressibles into the joints in turn set up at times pumping conditions, spalling and probably contributed to faulting over the years.

Iowa does not recommend the practice unless the pavement exhibits excessive growth (past history related to aggregates or actual blowup history on the slab). Other than when these conditions prevail we feel it is better practice to allow the pavement to relieve internal stresses naturally (via occasional blowup) rather than induce artificial relief when we cannot predict or design relief methods which are functional.

Iowa cuts pressure relief joints in advance of bridges with the intent of preventing pushing of the bridge backwall or other damage to the bridge. At these locations we find that the contraction joints in the pavements are opening within 1,000± feet of the PR joints a significant amount and have instructed our maintenance forces to keep these joints sealed.

7. For those States cutting 4-inch expansion joints, describe contraction joint sealing procedures, if any (frequency, materials, methods). (Louisiana)

Iowa places a preformed urethane foam plank glued to both sides of the pavement into the joint. We do not seal over this material at this time although we are investigating the possibility of doing this.

We have had very large voids under the pavements via leakage at these joints.

8. I would be interested in information from anyone using a cold mix recycling operation (this would be the reprocessing of asphaltic concrete materials removed during pavement profiling). What process is used, what type liquid is used, and the results? (Georgia)

Iowa has no experience in this field although we feel we have some bituminous shoulders which may be candidates for this recycling technique.

9. There has been considerable research done on the establishment of load transfer in existing jointed concrete pavements. I would be interested in any State's experience in attempting to establish load transfer. (Georgia)

Iowa has not done any of this work.

10. Are the States that are using synthetic fibers as fillers in crack sealing material satisfied with its performance? (New Jersey)

Iowa has not done any work using these materials.

11. How many States are measuring pavement deficiencies and rating pavements on a network level? Twice a year? Annually? Every 2 years? (New Jersey)

Iowa began the development of its pavement management system in the late 1970s. Pavement deficiencies with respect to structural rating is done on a yearly basis. Surveys such as the crack and patch surveys are performed every two years.

12. Discussion of asphalt additives for stability. (Kentucky)

The State of Iowa has used the asphadur additive (use of a batch plant is required) but with the development of AC13 which includes a stability additive and can be used in a continuous type plant, we have allowed both materials to be used along with other equal materials which may be developed.

13. Minimum thickness of asphalt overlay on PCC pavements, experiences, etc. (Kentucky)

Iowa placed 2" overlays in the late 1950s and early 1960s on narrow 18' and 20' pavements with 3" lip curbs for "curb elimination". During this period of use, it was discovered that the 2" single lift application of ACC mix tended to delaminate and shove. Due to these experiences, Iowa went to a two lift (3" thick) resurfacing design for PCC pavements and has had good performance.

14. Discussion of demonstration project for concrete pavement restoration techniques in Ohio. (Missouri)

Iowa is not familiar enough with this project to provide any discussion.



## Iowa Department of Transportation

### SPECIAL PROVISIONS FOR CRACK AND JOINT CLEANING AND SEALING (PORTLAND CEMENT CONCRETE PAVEMENT)

March 15, 1984

**541.01 DESCRIPTION.** This work shall consist of routing or sawing and cleaning of random cracks and existing transverse and longitudinal joints in portland cement concrete pavement and sealing the prepared cracks and joints with an approved sealing material.

**541.02 MATERIALS.** Joint sealer and backer rope shall meet requirements of 4136.02A (see General Supplemental Specifications).

**541.03 EQUIPMENT.** Routing or sawing equipment, where required, shall be mechanical and power driven, capable of cutting the cracks to the required dimensions without excessive spalling of the adjacent surface.

Routing or sawing equipment, where required, shall be power driven (wet or dry) capable of sawing the sealant reservoir to the dimensions shown on the plans.

Water cleaning equipment shall be capable of delivering water with a pressure of 2,000 psi from a nozzle to the crack or joint being cleaned, to remove existing joint sealer, debris, and loose material from the crack or joint.

Sand blast equipment shall be capable of removing the existing sealant, saw slurry, silt or other foreign material from the vertical face of the crack or joint to the specified depth, leaving a clean, dry, newly exposed concrete surface.

Air compressors shall provide moisture- and oil-free compressed air and shall be of sufficient size to blow sand and other foreign material from the crack or joint prior to placing the sealant material.

Equipment used for heating and placing hot-pour sealant material shall be an oil-jacketed, double boiler type, heating kettle or other thermostatically controlled equipment of a type approved by the engineer, capable of heating the material to 400°F. and pumping the material into the prepared crack or joint.

Auxiliary equipment, such as brooms, scrapers, etc., shall be provided as necessary to perform the work.

**541.04 CONSTRUCTION.** A special surface patch will be required when joints or cracks have edge spalls greater than 3 inches in width. These areas will be designated by the engineer. Special surface patches shall be constructed with ACC according to Supplemental Specification for Pavement Repair or Special Provision for PCC Special Surface Patches, as indicated on the proposal. When not indicated on the proposal, no special surface patches are anticipated. When ACC special surface patches are constructed, they shall be constructed across the joint or crack, and only the remaining length of the joint or crack is to be cleaned and sealed.

Cracks and joints shall be cleaned of existing joint sealer and foreign material to the depth of the bottom of the backer rope. The edges shall be sand blasted throughout the proposed depth of the joint sealer, leaving a clean, dry, newly exposed concrete surface on the vertical edges. The angle of approach of the sand-blast nozzle to the vertical face of the reservoir shall be approximately 30 degrees.

Joints and cracks less than or equal to 3 inches in width shall be sealed without surface patching. Joints and cracks over 3 inches in width are not to be cleaned and sealed. Joints and cracks with edge spalls greater than 3 inches in width shall be cleaned and sealed, and a special surface patch shall be placed in the spalled area; these patches are to be either PCC or ACC, as shown on the proposal, according to a separate specification. If not shown on the proposal, special surface patching work is not anticipated.

The bond breaker at the bottom of the joint or crack shall be a backer rope. It shall be dry when installed. If the width of opening exceeds the maximum size available, methods shown on the plans for alternate bond breakers at the bottom of the joint or crack may be used.

Joint sealer placement shall be governed by a shape factor (width:depth), ranging from 1:1 to 2:1, which shall be used to determine the depth of the joint sealer. The minimum depth of joint sealer shall be 1/2 inch for joints and cracks 1/2 to 1 inch in width. The width of opening of Class I cracks and Class III joints will have to be increased to meet the 1:1 ratio. The depth of Class II cracks, Class IV joints, and Class V joints and cracks will have to be increased to meet the 2:1 ratio.

Joints and cracks shall be dry and blown clean with compressed air prior to placing the backer rope and joint sealer. Joints and cracks shall be filled to the level shown on the plans.

Sealer material shall be heated, handled, and applied according to the manufacturer's recommendations.

**A. Class I Cracks.** These are random cracks having an average opening of less than 1/2 inch. They shall be routed or sawed to provide a sealer reservoir as shown on the plans. Sides of the sealer reservoir shall be near vertical.

**B. Class II Cracks.** These are random cracks having an average opening of 1/2 inch to 1 1/2 inches. Routing or sawing may be required to provide a sealer reservoir and to remove fractured concrete adjacent to the initial crack.

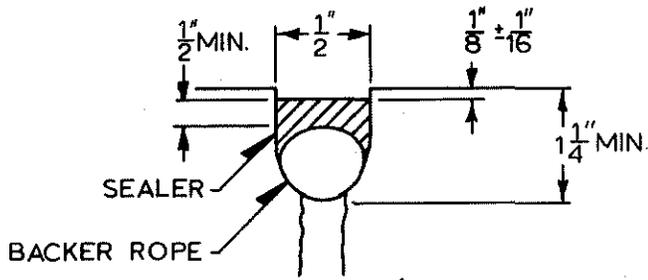
**C. Class III Joints.** These are existing joints having an average opening of less than 1/2 inch. They shall be routed or sawed (wet or dry) to provide a sealer reservoir as shown on the plans.

**D. Class IV Joints.** These are existing joints having an average opening of 1/2 inch to 1 1/2 inches. Routing or sawing may be required to provide a sealer reservoir and to remove fractured concrete adjacent to the joint.

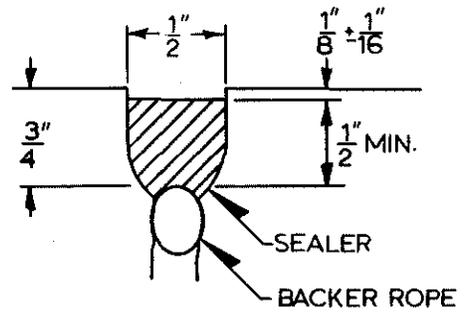
**E. Class V Joints and Cracks.** These are existing joints and cracks having an average opening from 1 1/2 to 3 inches. Routing or sawing may be required to provide a sealer reservoir and to remove fractured concrete adjacent to the joint or crack.

**F. Special Surface Patches** may also be required, as described above, when shown on the proposal.

CLASS I CRACK  
 (RANDOM CRACK LESS THAN  $\frac{1}{2}$ " IN WIDTH)

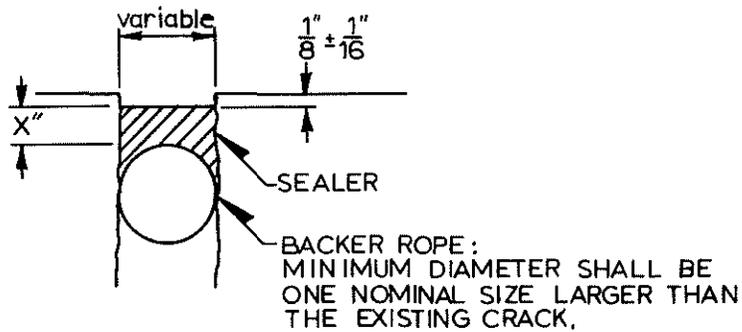


ALTERNATE 1



ALTERNATE 2

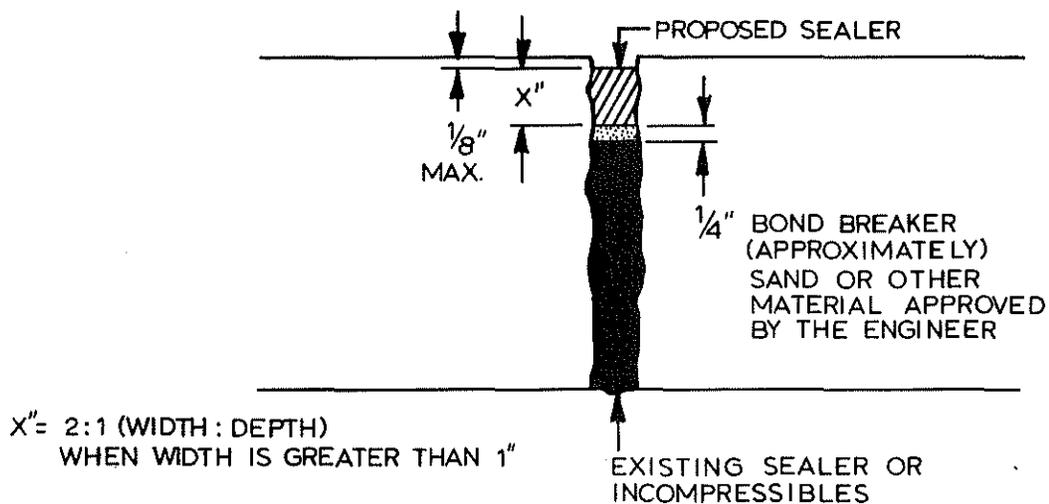
CLASS II CRACK  
 (RANDOM CRACK  $\frac{1}{2}$ " -  $1\frac{1}{2}$ ")



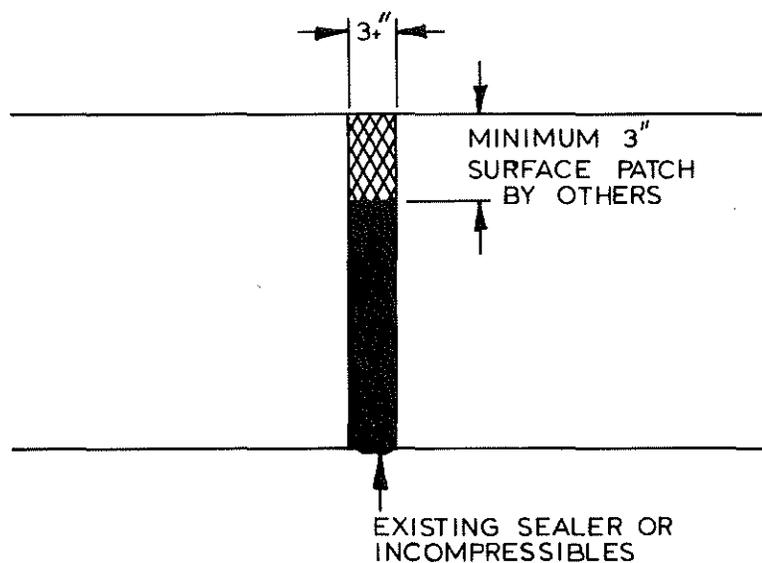
$X'' = \frac{1}{2}$ " MINIMUM WHEN WIDTH IS 1" OR LESS

2 : 1 (WIDTH : DEPTH) WHEN WIDTH IS GREATER THAN 1"

ALTERNATE BOND BREAKER  
FOR  
CLASS II CRACK  
CLASS IV JOINT  
CLASS V CRACK OR JOINT



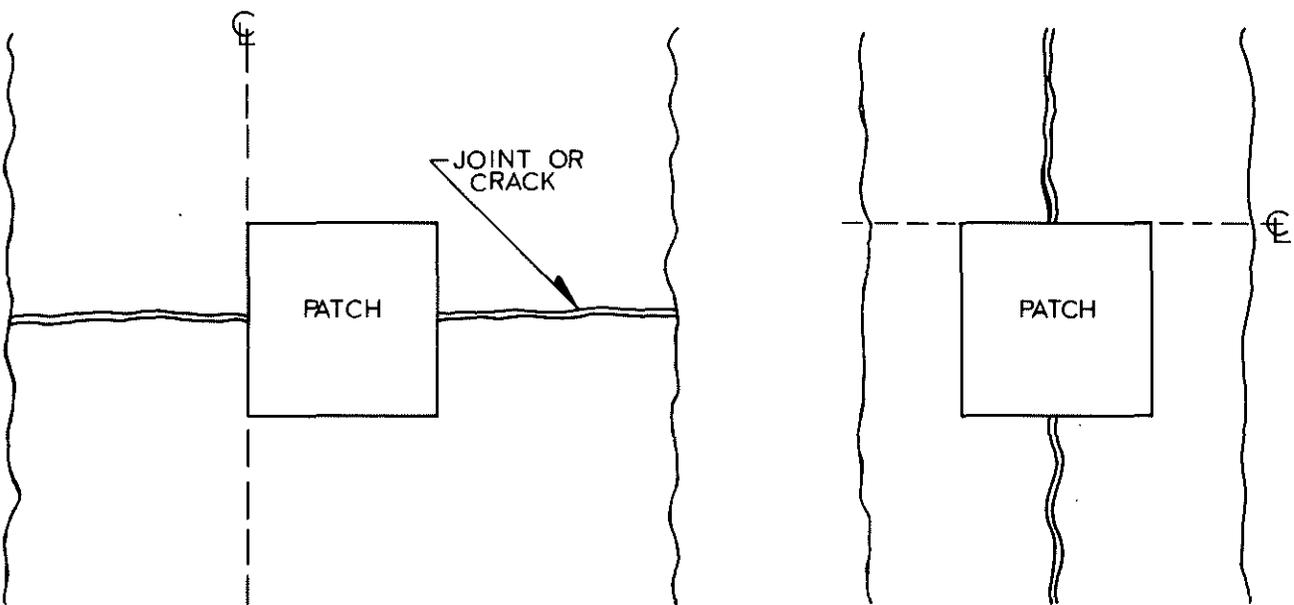
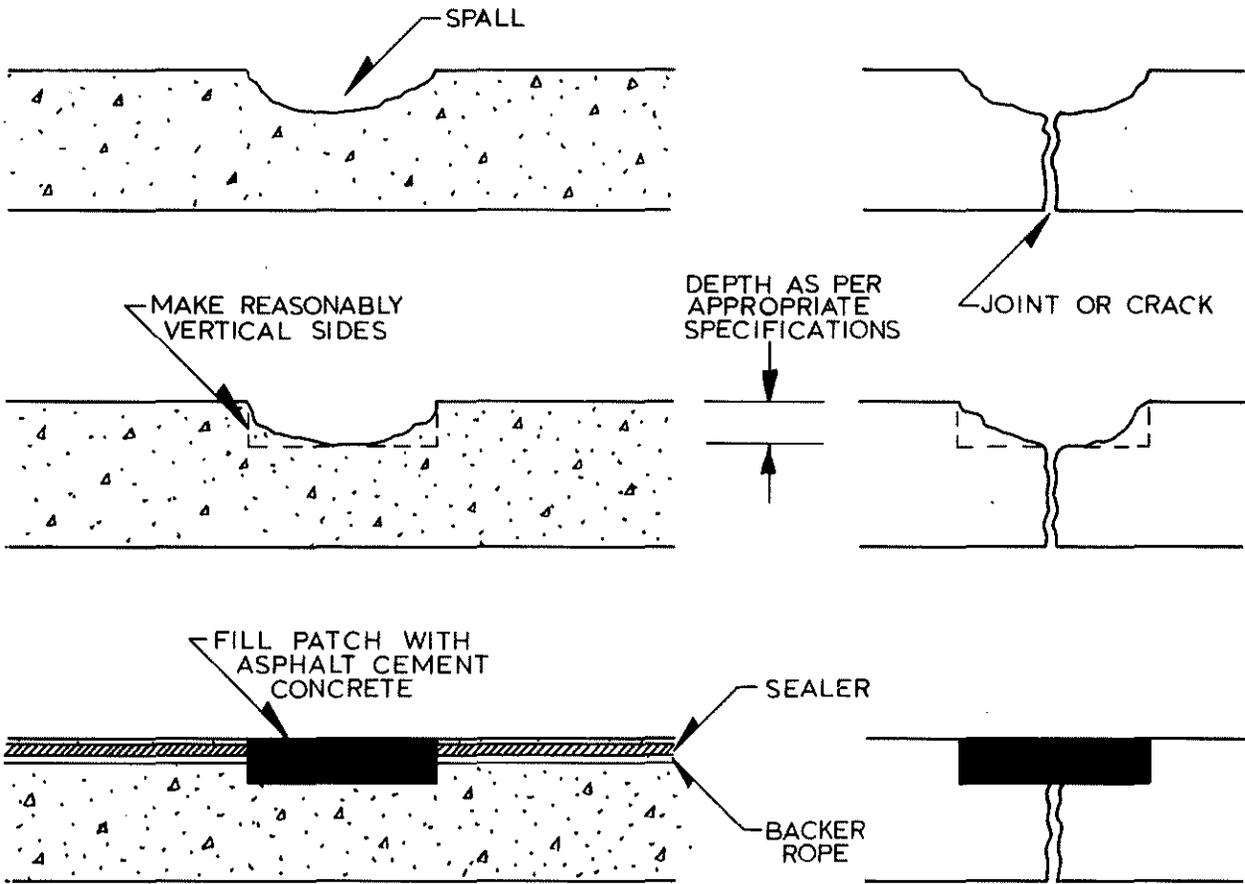
GREATER THAN 3" OPENING



DO NOTHING

# CRACK OR JOINT DETAIL SPALLS 3" OR GREATER WITH ACC

541-7





Iowa Department of Transportation

SUPPLEMENTAL SPECIFICATIONS  
for

PAVEMENT REPAIR  
(Full-Depth PCC Patches)

February 14, 1984

THE STANDARD SPECIFICATIONS, SERIES OF 1977, SHALL APPLY. THIS IS A SUPPLEMENTAL SPECIFICATION MODIFYING REQUIREMENTS FOR FULL-DEPTH PCC PATCHES IN SECTION 2212, AND THESE REQUIREMENTS SHALL PREVAIL OVER THOSE IN THE STANDARD SPECIFICATIONS.

**950.01 DESCRIPTION.** This specification applies to full-depth PCC patches for contracts to which this specification is applied, whether the type of patching material is designated in the contract documents or is the contractor's option. It is not intended for resurfacing projects.

This work shall consist of the following: Removing the pavement in the area designated by the engineer to be patched; restoring the subbase or subgrade and, if shown on the plans or required by the engineer, removal of a portion of the subbase or subgrade and furnishing and placing engineering fabric and granular fill material; furnishing dowels or restoring reinforcement, if required; furnishing and placing PCC patching material, and covering with ACC, if required; constructing transverse subdrains through the shoulder and restoring the shoulder area; and controlling traffic during the construction and curing period, as shown on the plans. This work is intended to provide a new, permanent traffic surface in the patch area.

Work under this specification may include the following:

1. Full-depth PCC patches, Type 1, for patches 32 feet and shorter;
2. Full-depth PCC patches, Type 2, for patches longer than 32 feet;
3. Full-depth PCC patches, Type 3, for continuously reinforced patches of any length.

The plans may include a tabulation of patches showing location and approximate area. The patch thickness and the type of patch material may be included. The plans will identify the existing pavement type, type of coarse aggregate, thickness, and reinforcement. A detail, typical of each type of patch, will be shown.

Patches placed on multi-lane sections of highway shall not have calcium chloride in the concrete and shall be cured for 36 hours. Exceptions may be made, where early opening is necessary, as designated on the plans or by the engineer.

Patches placed on two-lane sections of highway shall have calcium chloride in the concrete and shall be cured for a minimum of 5 hours.

When the plans indicate the work is to include reconstruction of gore areas, this work may be done as a separate operation. The contractor may elect to use the mixture described in 950.02, with or without calcium chloride, if the concrete is cured as specified for the mixture used.

**950.02 MATERIALS.**

**A. Portland Cement Concrete.** It is the intention to obtain concrete with a high strength for early opening to traffic. The concrete shall meet requirements of 2301.04E, Mix No. M-4 or CIV-M, with the following modifications:

1. **Slump.** measured in accordance with AASHTO T 119, prior to addition of calcium chloride solution, shall be between 1 and 2 1/2 inches as a target range, allowing a maximum of 3 inches. If calcium chloride solution is not to be added, the slump shall be as specified in 2403.03E; that is, between 1 and 3 inches as a target range, allowing a maximum of 4 inches as a tolerance. These may be modified by the engineer.
2. **Air Entrainment.** The entrained air content of the concrete will be determined according to AASHTO T 152, prior to addition of calcium chloride if to be added. The air entrainment shall be 5.0 percent with a tolerance of plus or minus 2.0 percent. When calcium chloride is not added, the air entrainment shall be 6.5 percent with a tolerance of plus or minus 1.5 percent.
3. **Temperature.** The temperature of the concrete, prior to the addition of calcium chloride if to be added, shall be within 10 degrees F of the temperature set by the engineer. In no case shall the concrete temperature be less than 70 degrees or more than 100 degrees F. Heating of water or aggregate or both may be necessary to meet this requirement, and this heating will be considered incidental.
4. **Cement** shall meet requirements of Section 4101 for Type I cement.
5. **Calcium Chloride.** Where calcium chloride is required (see 950.01), it shall be furnished and added to the mix, at the job site, as follows:

PROPORTIONS FOR 35% CALCIUM CHLORIDE SOLUTIONS

Type of Solid Calcium Chloride	Pounds Solid per gallon of water	Solution produced per gallon of water
Type 1 - Regular Flake (77% material)	7	1.35
Type 2 - Conc. flake or pellets (94% material)	5	1.18

The solution shall be added at the rate of 2.75 gallons per cubic yard of concrete. Alternate calcium chloride solutions of different concentrations may be approved by the engineer, provided appropriate adjustments in the total concrete composition are made.

**Cautions.** The mixture of water and solids should be agitated until the calcium chloride is completely in solution, and agitation shall be continued, as necessary, to maintain uniformity.

Pavement shall be broken and removed in such a manner that protruding longitudinal steel is not unduly disturbed. Reasonable care shall be taken to preserve the 18-inch length of longitudinal steel; it shall not be bent more than the minimum necessary for concrete removal. Should a significant number of longitudinal bars or wires be rusted beyond salvage, the engineer may extend the patch limits.

Unless otherwise specified on the proposal, each patch will be full-lane width, and the length, measured parallel to the centerline, will not be less than 8 feet.

\* A 30-pound air chisel may be used if its use does not result in significant undercutting of the pavement.

When repairing PCC pavement, even though the pavement may have been resurfaced with ACC, material shall be removed for the full pavement depth, unless otherwise designated. Excavation will be required for the patch thickness and, if required, the granular fill.

The plans will include an estimate of the number of anchor lugs to be removed. When an anchor lug is encountered within an area to be patched, the anchor lug shall be broken down to approximately 6 inches below the bottom of the pavement, all exposed anchor-lug reinforcing shall be removed, and the concrete shall be replaced with granular fill, compacted as required in 950.05, to the level of the bottom of the patch.

All material removed and not designated for salvage shall be disposed of in accordance with 1104.08.

**950.05 RESTORING SUBBASE OR SUBGRADE.** When granular fill is specifically designated on the plans or when required by the engineer, the exposed subbase or subgrade shall be removed and replaced as follows:

Remove 4 inches below the bottom of the new patch, and replace with granular fill material placed over an engineering fabric, as approved by the engineer. When unstable material or excessive moisture is encountered in the subgrade, the engineer may order an additional thickness of granular fill, and his order may include additional depth for the transverse subdrains.

When a stabilized subbase is damaged during removal operations and granular fill is not required, the subbase shall be restored, or it shall be leveled with a taper for drainage and filled full depth with patching material, at the contractor's expense. For other patches, when granular fill is not required, overdepth removal up to 4 inches below the bottom of the patch shall be replaced with the patching mixture; if greater than 4 inches, granular fill material and engineering fabric shall be placed, including the transverse subdrain, at the contractor's expense.

The exposed subgrade or subbase shall be compacted by a minimum of four complete coverages with a vibratory compactor.

Granular fill shall be placed with a field optimum moisture content established by the engineer at the beginning of the work. Granular fill shall be placed in lifts not exceeding a nominal compacted thickness of 4 inches; compaction shall be by a minimum of two complete coverages with a vibratory compactor and such additional coverages as are necessary to assure maximum consolidation. The compaction procedure for granular fill normally will be established by the engineer using the initial granular fill area as a trial section.

**950.06 RESTORING REINFORCEMENT.** Existing tie bars shall be cut off at the center line or lane line. When there is a common line of tie bars 30 feet or more in length for patches in adjacent lanes, tie bars shall be reconstructed so there are at least two bars per 10 feet; a bent bar shall be placed in a keyway and later straightened.

**A. When Dowels Are Required** by the plans, dowels will be required as follows:

1. CD joints shall be constructed, skewed 1:6. Dowel assemblies shall be used.
2. The CD joints shall be located so as to meet joints in the adjacent lane. If that location is within 5 feet of the transverse edge of the patch, the existing joint should not be matched.
3. Additional CD joints shall be placed as necessary to result in joints 15 feet apart and from the edges of the patch. To properly space these joints, minimum spacing is to be 10 feet, and maximum spacing is to be 20 feet.
4. For patches on interstate highways, the edges of the patch across the traffic lane shall be doweled by placing individual, smooth dowels into predrilled holes and fastening with epoxy, as detailed on the plans. The drilling alignment shall be controlled by a suitable jig designed for that purpose. These dowels shall be epoxy-coated as specified in 4151.02B. At one edge of the patch, the dowels extending into the patch area shall be coated with a bond breaker as specified below; at the other edge, they shall not be so coated.

When specifically required by special provisions, the edges of the patch across each traffic lane shall, instead, be doweled by placing No. 7 deformed bars into predrilled holes and fastening with epoxy, as detailed on the plans. These bars shall be cut from reinforcing bars which are epoxy coated as specified in 4151.03B. They shall not be coated with a bond breaker.

Except for the individual dowels for the edges of patches, dowels shall be furnished in approved assemblies suitable for skewed joints as shown on the plans. All dowels shall have an epoxy coating applied by the electrostatic spray method in conformance with the requirements of AASHTO M 254, Type B, with a minimum coating of 6 mils after cure. The coating material shall be a powdered epoxy approved by the engineer. The dowel bars may be taken from epoxy-coated stock. The ends of dowels shall be saw cut and shall be free of burrs and projections. The ends need not be coated. The assemblies shall be dipped in MC-70, RC-70, RC-250, CRS-2, HFMS-2, HFMS-2h, or HFMS-2s prior to delivery to the grade. Alternate bituminous- or paraffin-base bond breakers may be approved by the Office of Materials. Application methods of alternate materials are also subject to approval.

The individual dowels and dowel assemblies shall be placed and secured in proper position before the concrete is placed.

**B. When Dowels Are Not Required** by the plans, joints will be required as follows:

1. C joints shall be constructed, skewed 1:6.
2. The C joints shall be located so as to meet joints in the adjacent lane. If that location is within 5 feet of the transverse edge of the patch, the existing joint should not be matched.
3. Additional C joints shall be placed as necessary to result in joints 15 feet apart and from the edges of the patch. To properly space these joints, minimum spacing is to be 10 feet, and maximum spacing is to be 20 feet.

**C. When Restoration of Longitudinal Reinforcement is Required**, restoration shall be as follows:

After the granular fill, if required, is in place, new reinforcement shall be set. Protruding longitudinal reinforcement ends shall be made as true as practical and shall be cleaned of loose concrete and concrete which would interfere with close placement of new reinforcement.

Longitudinal reinforcement shall be restored using bars or mesh of the same size and spacing as in the original pavement, and of the quality specified for continuously reinforced pavement. The plans will describe the reinforcement in the pavement. At the contractor's option, wire mats may be replaced with bars tied to each longitudinal wire, and the bars shall be of a size at least equal to the wire size.

**950.13 LIMITATIONS OF OPERATIONS.** Unless the road is closed, traffic shall be permitted to use the pavement during construction operations, and all operations shall be so conducted as to provide a minimum of inconvenience to traffic. Operations shall be confined to one traffic lane of the highway except for minor encroachment in the adjacent lane, such as for sawing and installing forms.

The work schedule shall be adjusted so that all the excavating, backfilling, compacting, and finishing of each patch will be completed in one day. Patches to be cured for 36 hours and to be covered with ACC shall be covered with ACC during the working day the curing is completed. If unforeseen conditions should result in excavated sections being left overnight, a sufficient number of flaggers shall be assigned to warn and direct traffic, from the time construction operations have stopped until they have resumed again. No extra payment will be made for the necessary flaggers.

When pressure-relief joints are required as a part of the contract work, the pressure-relief joints shall be constructed on both sides of the patch area at least 48 hours before removal operations are started in that area. As much as practical, pressure-relief joints will be located at least 100 feet from a patch area, or as designated on the plans.

The work schedule for patches with calcium chloride shall also be adjusted so that all barricades and equipment will be removed from the roadbed from 30 minutes before sunset to 30 minutes after sunrise. During nonworking hours, all travel lanes and shoulder shall be free of debris or obstructions and shall be kept clear for use by traffic.

Patches without calcium chloride shall be cured as specified herein. The traffic control shall be as detailed on the traffic control plan. During the curing period, a Type II barricade shall be erected in front of patches being cured where there is a possibility of turns by traffic into the closed lane. However, such barricades need not be spaced closer than 150 feet. For each day, the lane closure shall be so established and the sequence of operations shall be such that the lane closure is of the minimum length and for the minimum time necessary for an efficient operation.

After commencement of the work, the contractor shall work continuously during working hours, except for unavoidable delays, to the completion of the project. The engineer may limit advance sawing. Except where an accelerated work schedule is required, no work will be permitted on Sundays and holidays.

Patches may be opened to traffic as soon as conditions permit their safe use, but in no case before the end of the curing period. During the closure period, the contractor shall maintain signs, barricades, and lights, and he shall be responsible for all safety measures.

If a DMjoint occurs at the end of the working day, the area following the joint shall be filled with a suitable hot or cold paving mixture (not granular material) so the lane can be opened to traffic, and that material shall be removed when the remaining area of the patch is being prepared.

Joints and patch edges to be sealed in accord with 2301.30 may be cleaned and sealed as soon as the vertical surfaces appear to be dry by visual examination. Sealing shall be scheduled for completion within 5 working days after the patch is placed.

Articles 1107.08 and 1107.09 shall also apply.

**950.14 METHOD OF MEASUREMENT.** The engineer will measure the quantities of the various items involved in full-depth pavement repair as follows:

**A. Full-Depth Patches.** The number of individual, full-depth patches placed will be determined by count; patches in each traffic lane will be individually counted. Also, the areas of Type 1, Type 2, and Type 3 PCC patches will be computed in square yards from measurements of the areas of pavement removed and replaced, except that each patch which is less than 2 square yards in area will be considered as 2 square yards. The length will be measured parallel to the centerline. Areas associated with anchor-lug removal will be included.

**B. Granular Fill.** When granular fill and engineering fabric are placed in patch areas, as specifically required by the plans or the engineer, the engineer will compute the area of granular fill placed, as provided in Paragraph A, above. The engineer will not include areas where granular fill material was used in transverse drains or was used at the contractor's option.

The engineer will compute separately areas where granular fill was placed to a depth greater than specified herein, at his direction.

**C. Subdrain Pipe.** Where subdrain pipe is required for outlets of transverse drains, the engineer will compute the length of subdrain pipe used from the length of subdrain pipe shown on the plans and a count of transverse drains in which the subdrain pipe is used.

**D. Removal of Anchor Lugs.** The engineer will count the number of anchor lugs removed in each traffic lane.

**950.15 BASIS OF PAYMENT.** For construction of the various items involved in pavement repair, the contractor will be paid as follows:

**A. Full-Depth Patches.** For the number of individual, full-depth patches placed, the contractor will be paid the contract price for each, and for the number of square yards of full-depth PCC patches placed, in each of the following categories, the contractor will be paid the contract price per square yard.

1. Full-Depth Patches, by Count.

This payment shall be full compensation for sawing or cutting necessary for each patch area and for traffic control associated with that patch.

2. Full-Depth Patches, by area, will be identified by the following categories.

a. Full-Depth PCC Patches, Type 1, for patches 32 feet and shorter;

b. Full-Depth PCC Patches, Type 2, for patches longer than 32 feet;

c. Full-Depth PCC Patches, Type 3, continuously reinforced, of any length, when restoration of longitudinal reinforcement is required.

This price shall be full compensation for removal and disposal of the old pavement, restoring the subgrade or subbase; furnishing and installation of tie bars, dowel bars, and dowel assemblies as required, restoring longitudinal reinforcement for Type 3 patches, furnishing and placing the patching material, including tack coat and ACC when required, curing, joint sealing, and backfilling the disturbed area.

**B. Granular Fill.** For the number of square yards of granular fill furnished and placed, the contractor will be paid the contract price per square yard. This price will be full compensation for furnishing and installing granular fill material and engineering fabric, the additional excavation necessary for this placement and disposal of excavated material, construction of transverse drains, and backfilling the disturbed shoulder area.

When the granular fill has been placed to a greater depth than specified herein, at the engineer's direction, payment per square yard for those areas will be increased by 20 percent for each inch of increased depth. This increased payment shall be full compensation for additional excavation and granular fill material, associated compaction, and if so ordered, additional depth for the transverse subdrain.

**C. Subdrain Pipe.** For the number of feet of subdrain pipe furnished and placed as subdrain outlets, the contractor will be paid the contract price per foot.

**D. Removal of Anchor Lugs.** For the number of anchor lugs removed, the contractor will be paid the contract price therefor. Such payment shall be full compensation for removal and for furnishing and placing granular fill material, as specified.