9 Paving Operations

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CHAPTER NINE:
PAVING OPERATIONS

Once the subgrade or base course has been checked for true line and grade, the paving operation may begin. The procedures for paving are in general specified by the Contractor for QC/QA PCCP in the Quality Control Plan for the contract. This chapter covers each step in the paving operation and explains why each is necessary for a quality concrete product. The following topics are discussed:

1) Checking the condition of the grade  
2) Checking placement of the steel and joint assemblies  
3) Mixing and placing concrete  
4) Finishing and curing concrete  
5) Cutting pavement joints  
6) Observing weather restrictions

CONDITION OF GRADE

The prepared subgrade or base course is required to be maintained in a smooth and compacted condition up to the time paving begins. A dry grade will absorb moisture from the concrete. Therefore, the grade is required to be uniformly moist when the concrete is placed. Spraying water on the grade ahead of the paving operation may be necessary (Figure 9-1). Care is taken to avoid creating mud or pools of water.

Figure 9-1. Subgrade Preparation
PAVEMENT JOINTS

Pavement joints are vital to control pavement cracking and pavement movement. Without joints, most concrete pavements would be riddled with cracks within one or two years after placement. Water, ice, salt and loads would eventually cause differential settlement and premature pavement failures. These same effects may be caused by incorrectly placed or poorly designed pavement joints.

Forethought should be given to the design and placement of the pavement joints so that the end result is a properly functioning pavement system. Special care is given at intersecting approaches, turn lanes and crossovers so that the joints required at these locations will complement the joints placed in the mainline pavement. Since the mainline pavement is typically placed prior to any auxiliary pavement, the location of all joints is required to be known in advance of the initial pours. If the initial joint placement is correct, the extension of the same joint lines throughout any adjacent pavements is done. “Dead ending” of joints in the middle of adjacent slabs is avoided whenever possible to prevent the risk of reflective cracking.

An example of a well planned joint design is shown in Figure 9-2. The joints in this diagram are continuous from edge of pavement to edge of pavement. Also, the joints in the mainline pavement are aligned to serve the joints in the adjoining pavements.

Figure 9-2. Pavement Joint Design
There are many types of joints used in the construction of concrete pavements but they all control the movement of the pavement and the associated cracking and/or differential settlement.

Unless otherwise indicated, all joints are placed perpendicular to the grade. Longitudinal joints are placed parallel to the center line, and transverse joints are placed at right angles to the center line for the full width of the pavement. Understanding the use and function of the different types of joints is required in determining their placement.

**D-1 CONTRACTION JOINTS**

Typically, a contraction joint is a sawed transverse joint normally placed every 18 ft to control cracking due to pavement contraction caused by shrinkage and temperature fluctuations. The plans for the particular contract are required to be checked to verify the proper joint placement. The minimum/maximum joint spacing is established so that joints in the initial pours will complement adjacent pavements.

Dowel bars are smooth, epoxy coated, steel bars which are placed at all transverse joints to provide load transfer across the joints. Dowel bars allow the pavement to slide freely at the joint during expansion and contraction of the pavement. When the dowel bars are used for expansion joints, the free end of each bar has an expansion tube attached to the bar.

Generally, dowel bars are mounted in a welded wire assembly referred to as a basket (Figure 9-3). This basket holds the dowel bars evenly and securely in place so they do not shift during the paving operation. If paving over a granular grade, sand plates under the baskets may be necessary to keep the baskets from being pushed into the grade.

![Figure 9-3. Dowel Bar Assembly](image-url)
The entire dowel bar assembly, or basket, is secured to the grade with basket pins (Figure 9-4). There is required to be at least 8 basket pins in a 10, 11, or 12 ft assembly.

Suitable tie wires (Figure 9-4) are required to be provided to hold the assembly in the correct position during installation. The tie wires are required to be size W 7.5 or smaller and there shall be a maximum of 5 tie wires for each dowel bar assembly. Dowel bars are coated with an approved material to break the bond with the concrete and should be free of dirt, loose rust, or scale at the time of placement. If there is suspect of damage to the dowel bars by exposure to ultraviolet light, a sample may be obtained and tested for coating thickness.

![Dowel Bar Basket Detail](image)

**Figure 9-4. Dowel Bar Basket Detail**

Dowel bar assemblies are required to be inspected at least every 2000 ft for vertical and horizontal alignment before paving. If there is a question about the stability of the basket during the paving operation, a dowel bar check may be necessary after the concrete has been placed. If this is required, the concrete is removed from the ends of each dowel bar on the assembly and each bar is checked. This procedure is done quickly because any correction is required to be made while the concrete is still plastic.

Vertical alignment may be checked with a dowel bar checker (Figure 9-5). This device is first placed on the form or grade next to the basket being checked, and the bubble is leveled to conform to the grade. Each dowel is then checked. If the bubble is not in the center, one leg of the checker is lifted until the bubble is in the center. If this correction is more than 1/4 inch, the dowel bars are required to be corrected.
Figure 9-5. Dowel Bar Checker

Horizontal alignment is checked by measuring the distance from each end of the dowel to the form or string line and comparing the two measurements. If the measurements differ by more than 3/8 in., the horizontal alignment is required to be corrected.

The deviation of any bar after the pavement has been finished is required to be no greater than an angle the tangent of which is 1/48. This means that the bar cannot deviate by more than 1/4 in. per foot. This is generally a simple requirement to meet and, if baskets are stored and handled properly, there are very few problems.

The location of the center of the dowel bar assembly is marked outside of the form/slab line so that the dowel bar assembly may be established once the pavement is in place. These locations are maintained during the pouring operations because the markings may easily become disturbed during construction.

The reinforcing steel placed as tie bars in the edges and at the center line of the pavement is placed to insure that the tie bars do not interfere with the operation of the D-1 joint. Tie bars placed over a basket assembly are adjusted longitudinally so that they do not hamper the movement designed into the joint. The longitudinal adjustment required is seldom more that 1 ft (Figure 9-6).

Figure 9-6. Basket Adjustment
LONGITUDINAL JOINTS

A longitudinal joint (Figure 9-7) is required in all pavements wider than 16 feet. If two adjacent lanes are poured at the same time, a longitudinal joint is sawed.

Figure 9-7. Longitudinal Joint

Tie bars (Figure 9-8), when required, are placed perpendicular to the longitudinal joint and parallel to the grade. Tie bars may be machine placed during paving or secured with chairs prior to paving. When tie bars are required along the form line or the edge of a slip-formed lane, bent bars are used. Bent bars are tie bars bent at a 60° angle. These bars are straightened after the concrete sets so that they extend into an adjacent lane. Special care is required to be taken when the tie bars are inserted in the side of a slip-formed pavement to assure no detrimental edge slump is caused by this operation.

Figure 9-8. Tie-Bar for Longitudinal Joint
Some longitudinal joints require the use of a keyway with no tie bars. Keyways (Figure 9-9) may be trapezoidal or semi-circular in shape. They are used when an adjacent pavement is expected to move independently and the two pavements cannot be tied together. The keyway, prevents any differential settlement of either pavement.

![Figure 9-9. Keyway Joints](image)

**TRANSVERSE CONSTRUCTION JOINTS**

A transverse construction joint is used when the paving operation is interrupted for longer than 30 minutes. These joints are commonly used at the end of the paving operation each day and may be retro-fitted to tie an existing slab into a new pavement. Transverse construction joints are required to be located at least 6 ft from an adjacent D-1 contraction joint.

Spacing of the tie bars in the construction joint is required to be 6 in. from any longitudinal joint and 1 ft, center to center, thereafter. The tie bars are required to be epoxy coated and inserted through a header board set to the proper line and grade. Care is taken to assure that the bars are placed parallel to the grade and the centerline.

**TERMINAL JOINTS**

A terminal joint (Figure 9-10) is placed where a pavement ends at a bridge or similar structure. A 2 ft gap is left between the end of the pavement and the beginning of the approach slab.
The ends of the pavement and the approach slab are placed on a sleeper slab that has been previously poured. The sleeper slab is finished smooth and allowed to cure. A polyethylene sheet is placed over the slab prior to placing the pavement or approach slab. This sheet is a bond breaker, allowing the pavement and approach slab to move freely over the sleeper slab as they expand and contract.

The gap between the pavement and the approach slab is filled with HMA intermediate and surface mixtures to complete the joint.

**Figure 9-10. Terminal Joint**

**EXPANSION JOINTS**

Expansion joints consist of a preformed joint filler, generally 1 in. thick, that compresses and allows the pavement to expand. The joints are placed at the locations noted on the plans. The joint filler is required to be shaped to the subgrade, parallel to the surface, and the full width of the pavement. The edges of the expansion joint are to be finished.

**RETRO-FITTED TIE BARS**

When new pavement is to be tied to an existing pavement or a transverse joint is required, tie bars are used to tie the pavements together. Holes are drilled into the existing pavement for the epoxy coated tie bars. An approved chemical anchoring system, generally epoxy, is used to secure
the tie bar in the hole. The size of the drilled hole is required to be in accordance with the recommendations of the anchoring system manufacturer for the size bar being inserted. Once the adjacent pavement has been poured, the joint is sawed and sealed the same procedure as required for a construction joint.

**MIXING CONCRETE**

Concrete may be mixed in any of the following ways:

1) On site mixers (these mixers are rarely used and are not discussed)

2) Central mix plants

3) Ready-mix plants using transit mixers

If transit mixer trucks are used, the concrete is required to be mixed for 70 to 100 revolutions. When central mix concrete is used, the mixing time is required to be no less than 60 seconds.

Water may need to be added to transit mix concrete at the paving site. This may only be done within 45 minutes from the time the water was added at the plant. If adding water to the concrete trucks becomes routine, a correction is required to be made in the amount of water being added at the plant. The amount of water added is noted on the concrete tickets (Figure 9-11) for the concrete record.

Concrete is required to be placed in a timely manner. Once the water is added at the concrete plant, the concrete is required to be placed within 90 minutes if hauled in transit mixers or truck agitators, or within 30 minutes if hauled in non-agitator trucks. The actual time the water was added is stamped on the ticket.

Chemical admixtures, Type B, Type C, and Type E, are allowed only with prior written approval. All other chemical admixtures may be used without written approval. Different brands of cement are not allowed to be used alternately, nor mixed. A Contractor may elect to use class "C" concrete which requires the use of a water reducer or retarder admixture. The water required for a workable mix allows for a lower water-cementitious ratio and faster strength. A retarder is generally used in warm weather to slow the set of the concrete, therefore keeping the concrete workable longer.
**Figure 9-11. Concrete Ticket**

<table>
<thead>
<tr>
<th>FLOOR</th>
<th>DRIVE</th>
<th>STEPS</th>
<th>WALLS</th>
<th>FOOTINGS</th>
<th>CURB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Quantity** | **Mix** | **Description** | **Price** | **Amount** |
---|---|---|---|---|
10cy | REDI MIX CONCRETE | | | |

**Note:**
- EXPANSION JOINT
- Lbs. CALCIUM CHLORIDE
- CEMENT 56-4
- #23 SAND 1260
- #5 SLAG 1560
- TRIP CHARGE 23'2" @ 140
- SAT. OR OVERTIME DEL 325
- WINTER SERVICE

**Time:**
- 5:50 A.M.

**Details:**
- LEFT PLANT: 6:10
- YARDS ORDERED: 1100
- YARDS SHIPPED: 10
- WATER ADDED: 5cy

**Signatures:**
- Driver: Big Bob
- Received By: C. Welham
WEATHER RESTRICTIONS

Sufficient lighting is required for the concrete paving operations. If paving continues after dark, lighting is used so that all operations are visible.

Unless authorized in writing, concrete paving may only start if the ambient temperature is above 35º F and rising. If temperatures are falling, the operation is required to stop when the ambient temperature reaches 40º F.

If cold weather paving has been authorized, the water and/or the aggregate may have to be heated before the concrete is mixed. The temperature of the mix when placed is required to be between 50 to 80º F.

At no time is the concrete placed on a frozen grade. Artificial means may sometimes be used to keep the grade from freezing at night. Any concrete placed that may be subject to freezing is required to be sufficiently insulated. Insulation is usually done by a combination of plastic sheeting, blankets, or straw.

PLACING CONCRETE

Enough equipment and material supplies are required to be kept on hand to allow for a continuous operation. The timing of the delivery of concrete is critical to the quality of the pavement, especially for slip-form paving.

Precautions may be necessary to prevent segregation of the concrete materials while being placed. After placing, concrete is re-handled as little as possible. Any re-handling is done by a machine or with a shovel (not with rakes). Equipment made of, or coated with, aluminum or aluminum alloys is not allowed to be used to place or transport concrete. All workers walking on the fresh concrete during placement are required to keep their footwear free of foreign material that may contaminate the fresh concrete.

Caution is taken by all workers to not disturb joints, dowel bars, and assemblies. Machine mounted vibrators may have to be lifted to avoid certain joints, manholes, and other possible hazards. Hand held vibrators are required to be used to consolidate the concrete in these areas as well as any other area that may not be accessible to the machine mounted vibrators. Consolidating the concrete against the faces of all forms and joints is important.

Vibrators are not to be used in any one spot for more than 15 seconds and may never come into direct contact with the side forms, joint assemblies, or the grade.
All manholes and similar structures are required to be adjusted to the proper grade and surrounded with preformed joint material before paving begins.

Any damage to adjoining pavements during the paving or any other related operation is required to be repaired by the Contractor.

PLACING REINFORCING STEEL

The concrete is deposited on the grade and spread by a mechanical spreader which also strikes the concrete off to the proper elevation for placing wire fabric. Concrete is kept in front of the strike off at all times to prevent depressions in the pavement. Any depressions are required to be corrected before placing the wire fabric.

Reinforcing tie bars for longitudinal joints may be inserted into the concrete automatically by the paver. When paving two lanes at once, a straight tie bar is inserted every 3 ft along the longitudinal joint by the paver. If an adjacent lane is to be connected later to the lane currently being paved, tie bars are inserted into the edge of the pavement at 30 degrees to the perpendicular and bent straight after the concrete has set (Figure 9-13). If more than one of the deformed bars break in a panel during straightening, all broken bars are replaced with retrofitted tie bars.
All reinforcing steel is required to be free from dirt, harmful rust, scale, paint, grease, oil, or anything else that may prevent the concrete from bonding to the steel. Mesh is stored flat before placement so that the proper shape of the mesh wire is maintained during paving.

**STRIKE-OFF, CONSOLIDATION, AND FINISHING**

The paving equipment is designed to properly strike off, consolidate, and finish the concrete accurately to the required elevation and cross section. For this to occur, a sufficient amount of concrete is required to be carried in front of the screed (Figure 9-14) so that the paver is cutting the concrete at all times. All voids and depressions are filled if this procedure is used. The operation is controlled to ensure that an excess of mortar is not carried to the surface. If segregated particles come to the surface in front of the screed, they are required to be mixed back into the unfinished concrete by hand and not allowed to be pushed to the grade ahead of the concrete.
Previously placed mesh is required to be observed for shifting as the final strike off proceeds. If the wire mesh is allowed to drift into a joint, a joint failure may occur.

When approaching a transverse expansion joint, concrete is poured over the joint ahead of the paver to provide stability to the joint assembly. The concrete around the joint is required to be properly consolidated to maintain the integrity of the joint. If the machine mounted vibrators or screeds are lifted to clear the joint assembly, consolidation may be done with hand held vibrators.

Hand methods of placing, compacting, and finishing (Figure 9-15) may only be used in the following situations:

1) For breakdowns of the finishing machine, and then only the concrete already mixed or being mixed
2) For widened portions at bridges, intersections, etc.
3) For certain widened portions of curves
4) For sections of pavement less than 600 ft long
5) For other places as allowed by the Specifications

When hand methods are required, the concrete is placed above the required grade and properly vibrated and struck off to obtain the desired results. If the width of the pavement is less than 4 ft, a simple board may be used to strike off the concrete after hand vibration. Wider pavements require a vibratory strike-off board. Bridge deck type finishers may also be used.
FLOATING

After proper strike-off and consolidation, the pavement is finished further by floating. This procedure may be done with a mechanical float which consists of large rollers which spin as they are moved across the surface. If specifically allowed, a hand float (Figure 9-16) of no less than 14 feet in length may be used. Hand floats are checked for distortions that may cause a rough riding surface.

Floating is required to be continuous from edge to edge. When hand floating, a work bridge may be required for the finisher to walk upon.

Smaller floats of no less than 5 feet in length may be used to correct surface blemishes or irregularities.

![Figure 9-16. Floating](image)

CHECKING FINISH AND SURFACE CORRECTIONS

When the final floating is complete, a long handled 10 ft straightedge is pulled across the concrete to remove any surface irregularities, surplus water, or inert material that may be present from the previous operations. This is the last opportunity to make corrections to the pavement and is an important process to assure pavement smoothness.

Once the straight-edging is complete, an initial surface texture is created by dragging a double thickness of burlap over the pavement. Now the pavement is ready for tining.
The final finish for the pavement is achieved by tining which is a process of placing grooves in the pavement to aid in skid resistance. This is done by a machine (Figure 9-17) using a comb with steel tines. Tining may be done manually on ramps, connections, and other miscellaneous areas where machines cannot be utilized.

Figure 9-17. Machine Tining
The grooves for tining are required to be between 3/16 and 1/8 in. in width and between 1/8 and 3/16 in. deep.

Spacing of the tines is random and may be any of the following spaces:

1) 5/8 in.  10) 1 in.  19) 1½ in.
2) 1 in.  11) 3/4 in.  20) 7/8 in.
3) 7/8 in.  12) 7/8 in.  21) 3/4 in.
4) 5/8 in.  13) 1¾ in.  22) 7/8 in.
5) 1¼ in.  14) 7/8 in.  23) 1 in.
6) 3/4 in.  15) 3/8 in.  24) 7/8 in.
7) 1 in.  16) 1 in.  25) 1 in.
8) 1 in.  17) 1 in.
9) 1 in.  18) 1¼ in.

The required spacing of the tines was previously 3/4 in. for all tines. This spacing created an irritating humming sound when vehicles drove on the pavement. The spacings described above break the rhythm and make the humming sound disappear.

Timing is very important for the tining process (Figure 9-18). If done too soon, the grooves may be too deep or close up. If done too late, the grooves may not be deep enough. When the latter occurs, grooves are required to be cut into the concrete by machine after the pavement hardens completely.

![Figure 9-18. Tining Depth](image)

**EDGING**

All edges of slabs and formed joints are required to be rounded to the radius indicated in the plans. This procedure is accomplished using a finishing tool called an edger (Figure 9-19).
Any tool marks left behind by the edger are removed before the burlap drag is used. All joints are checked with a straightedge to verify that no side of the joint is higher than the other. Corrections are required to be made immediately.

![Figure 9-19. Hand Finishing Pavement Edge](image)

**EDGE SLUMP**

When the slip-form method is used, special attention is placed on the edge slump (Figure 9-20). The edge slump is defined as how far the edge of the wet concrete pavement slumps down after the slip-form paver has passed.

For 6 in. from the edge of the pavement, a maximum 3/8 in. edge slump from a typical cross section is required; however, if the edge is joined by another pavement slab, the edge slump may not exceed 1/4 in. If edge slump requirements cannot be met additional trailing forms to support the edges longer may be needed to prevent the excessive edge slumping.

![Figure 9-20. Edge Slump](image)
PAVEMENT DATES AND STATIONS

Date and station numbers on the pavement are required and this operation is done immediately after tining, while the concrete is still plastic. Cast iron dies are used to place the date and the plus station at the beginning of each days run. Full stations are also stamped every 100 ft (Figure 9-21).

![Figure 9-21. Pavement Stamping](image)

Station numbers are to be stamped on the right side of the pavement with the nearest digit approximately 8 in. from the edge of the pavement (Figure 9-22).

In the case of multiple lanes, the station numbers are placed along the outside edge of the pavement, readable from the same direction as the flow of traffic.

![Figure 9-22. Pavement Stamp Location](image)
CURING

Curing is as important to the integrity of the pavement as anything previously discussed. For proper curing, the pavement is required to retain moisture and be kept from freezing. The entire required curing period of 96 hours is carefully monitored.

The methods used to retain moisture in the concrete include:

1) Wet burlap
2) Wet straw
3) Waterproof blankets
4) Ponding
5) Curing compound

WET BURLAP

When wet burlap is used, two layers are placed over the concrete pavement. The first layer is placed as soon as marring of the fresh surface may be avoided. The second layer of wet burlap is applied over the first before 9:00 a.m. of the next day. The burlap is required to be kept wet for the entire curing period (Figure 9-23).

WET STRAW

When straw is used, a layer of wet burlap is initially placed as mentioned above. Before 9:00 a.m. of the next day, the burlap is removed and replaced with 3 in. of straw. The straw is then thoroughly saturated and kept wet for the remainder of the curing period.

WATERPROOF BLANKETS

When waterproof blankets are used, the pavement is covered throughout the entire curing period. The blankets are securely held down. All overlaps and edges are sufficiently sealed to keep the moisture from escaping. When using this method, the pavement is fogged or covered with wet burlap until the blankets are in place, which is required before 9:00 a.m. of the following day.

PONDING

When ponding is used for curing, the initial burlap is removed by 9:00 a.m. of the following day and the surface is immediately covered with two inches of water for the remainder of the curing period.
Curing compound is a white membrane that is sprayed onto the pavement immediately after final finishing and after the surface water has disappeared (Figure 9-24). After sufficient agitation, the compound is uniformly distributed over the surface to form a waterproof membrane. If the membrane is marred from foot traffic or equipment during the curing period, additional curing compound is required to be applied to the affected areas. Curing compound is applied at a rate of not less than one gallon per 150 ft$^2$.

Figure 9-24. Curing Compound
When forms are removed, the edges of the pavement are required to be banked with earth 12 in. wide or covered by one of the curing methods listed above.

If there is a danger of freezing during the curing period, the concrete pavement is further protected by a suitable covering of straw or blankets. During this period, temperature checks are made under the covering at the pavement surface and recorded for the contract record.

**SAWING JOINTS**

After paving, the locations of the dowel bar assemblies are marked on the pavement and the initial saw cut is made for the joint (Figure 9-25).

*Figure 9-25. Sawing Joints*
Timing is critical when making this saw cut on contraction joints (Figure 9-26). If sawed too soon, the joint spalls and ravel. If sawed too late, the pavement may have already cracked randomly. For this reason, the sawing of joints often starts within 2 to 12 hours of the time of placement, depending upon the ambient/material temperature, humidity, and wind conditions. The initial sawing of a pavement continues, night and day, regardless of weather conditions until complete. If random cracking is observed ahead of current sawing operations, the sawing operation is advanced until the random cracking is controlled. The joint is required to be sawed straight for the full depth, width, and length of the joint.

Figure 9-26. Sawing Window of Time

Longitudinal sawed joints are cut with a power concrete saw concurrently with the contraction joints. The plans and/or Standards Drawings are required to be checked for the proper depth, width, line, and type of seal.

Transverse construction joints are sawed and sealed in accordance with the Standard Drawings and/or Specifications after the paving.

If a slurry is created by the sawing operation, this material is required to be flushed with high pressure water to remove the slurry to the entire depth of the joint. Care is taken not to damage the pavement while flushing because the concrete is still "green" and vulnerable to damage from excessive force. If the slurry is not removed from the joint, this material hardens and the joint is required to be re-sawed.
SEALING JOINTS

Just prior to sealing, the joint is blown with a jet of compressed air, or otherwise cleaned, to remove all foreign material and prepare the joint faces for the sealer. After cleaning, a backer rod is installed and the joint sealer is applied. The depth of the backer rod and thickness of joint sealer is critical for a properly functioning joint. The depth at which the backer rod is set establishes the bottom of the joint sealer. The surface of the sealer is required to be below the surface of the pavement so that traffic does not damage the sealer. Also, the thickness is critical so that the elasticity of the sealer is maintained. This is an instance where more is not better. Specifications and/or Standards are required to be checked to determine the proper placement (Figure 9-27).

Figure 9-27. D-1 Contraction Joint
All joints are required to be sealed prior to opening a section of pavement to any traffic, other than construction traffic, or before the end of the current construction season. The steps in constructing a D-1 contraction joint include the following:

1) A 1/8 in. cut is made in the pavement for the full width and proper depth of the joint.

2) The final cut is made to prepare the joint for the backer rod and sealant and the joint is cleaned (Figure 9-28).

![Figure 9-28. Cutting and Cleaning the Joint](image)

3) The backer rod is installed at the proper depth (Figure 9-29).

![Figure 9-28. Installing Backer Rod](image)
4) The sealant is installed to the proper depth and thickness (Figure 9-29).

Figure 9-29. Installing Sealant

PROTECTION OF PAVEMENT

Rain may be very detrimental to unhardened concrete pavement and measures are required to be taken to protect the pavement from this occurrence. Pavement operations are ceased if rain appears likely to occur. The Contractor is required to have materials available at all times to protect the pavement in the event of an unexpected rain. If rain begins to fall, all available manpower is utilized to place a protective covering, usually plastic sheeting, on the pavement (Figure 9-30). Planks or forms are also required to be available to protect the edges of the pavement when slip-form paving.

Figure 9-27. Protective Covering
Until final acceptance of the new pavement, the Contractor is responsible for protecting the pavement against damage caused by any type of traffic, equipment, etc. This protection may require barricades, watchmen, lights, crossovers, or a number of other measures. All damage to pavement prior to final acceptance is required to be repaired or the pavement is replaced.

**OPENING PAVEMENT TO TRAFFIC**

**CONSTRUCTION VEHICLES**

Construction vehicles or equipment, having a gross weight exceeding 3t, are not permitted on the new pavement for 10 days after the pavement is placed or until the test beams indicate a modulus of rupture of at least 550 psi. Joint cutting saws are permitted on the new pavement.

**NON-CONSTRUCTION VEHICLES**

The pavement may be opened to traffic after 14 days or when test beams indicate a modulus of rupture of at least 550 psi. One set of beams are required to be made per one mile stretch of two lane pavement, with a minimum of one set per day.

If fly ash is used as an additive, or if type IP or IP-A cement is used, only the strength requirement applies to when the pavement may be opened to traffic. The 14-day rule for opening to traffic does not apply. For this reason at least two sets of beams are required to be made when fly ash is used.

The concrete pavement may also be opened to traffic based on results obtained from the Maturity Method ([ITM 402](#)). The Maturity Method is used to determine the in-place flexural strength of the concrete. The hydration of cement and gain in strength of concrete are dependent on both the curing time and temperature. Thus, the strength of concrete may be expressed as a function of time and temperature. This information is used to determine the strength of concrete without conducting destructive tests. In general the method is a three step process consisting of:

1) Laboratory procedure ([ITM 402 (7.0)](#))
2) Field procedure ([ITM 402 (8.0)](#))
3) Validation procedure ([ITM 402 (9.0)](#))

**REMOVAL OF FORMS**

Generally, paving forms may not be removed from fresh pavement until the concrete has been allowed to set for at least 8 hours. Forms may be removed at the ends of contraction joints as soon as joints may be sawed without raveling. Mechanical form pullers may not be used from the pavement side of the forms.