FY2016

CONCRETE PAVING

South Dakota DOT

Connecting South Dakota and the Nation

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Disclaimer

The information in this training manual is intended for training purposes only and does not take precedence over the SDDOT Standard Specifications for Roads and Bridges, the SDDOT Materials Manual, or any SDDOT Policies and Procedures.

CHAPTER

1

INTRODUCTION

Quality control is vital in every construction project. It is the inspector's responsibility to ensure that concrete pavement is constructed according to plans and specifications. An inspector must understand that the roles he and the Contractor play are distinctly different.

Most highway construction in South Dakota is performed by contract. The Contractor has signed a legal agreement (a contract) to perform work that meets standards specified by that agreement. In return for this work, the Contractor is paid by a local, State, or Federal government agency, and in some cases through matching funds from all three.

The contract includes plans and specifications that the Contractor must follow. The Department of Transportation (DOT) needs a competent representative to ensure the project requirements are satisfied. That representative is the project engineer and/or inspector hereafter referred to as "the inspector" in this manual.

It is the inspector's job to see that the construction operations are producing results that meet specifications. The inspector must identify variations and bring these to the attention of the Contractor and the Engineer. The inspector does not have the authority to approve changes in the specifications. Contact the Central Office for a request to change specifications.

Communications and Attitude

Good oral and written communications are critical inspector skills. Communication is essential to ensure that the project is properly managed and documented. The inspector helps the Contractor anticipate problems and helps find ways to resolve them. The inspector is friendly but firm and impartial in making decisions when dealing with the Contractor and the Contractor's personnel.

One of the most important steps in establishing communications is the preconstruction meeting. These meetings are held before the beginning of any major construction project. At the meeting, the inspector becomes acquainted with the Contractor's key personnel. Attendees will discuss the plans and specifications for the project, traffic control techniques, and define lines of authority.

The inspector helps himself and the Contractor by understanding the project from the Contractor's point of view. The inspector does not permit reduced quality in order to increase the Contractor's productivity. An inspector influences the construction process to obtain the best possible results. If an inspector has a suggestion for changing a procedure to improve the quality and efficiency of the work, he/she does not hesitate. This benefits both DOT and the Contractor.

The inspector's attitude is especially important. Offer assistance while being careful not to supervise construction. Inspectors must avoid giving the impression that they control the work. An inspector should never issue a direct order to the Contractor's workers. The inspector must never assume supervision of the work. Their task is to judge the quality of work that is performed by methods that meet specifications. Failure to do this can cause legal problems later.

Qualifications of the Inspector

An inspector's qualifications are expected to exceed those of the ordinary construction worker. The inspector must be honest and conduct him/herself in a fair, straightforward manner. When under stress, the inspector must still be able to maintain personal composure and make good decisions. He/she must have keen common sense for making competent decisions. The inspector must be frank and sincere in relationships with people, and be a skilled diplomat able to handle tough situations without arousing hostility. Above all, he/she must be observant and be capable of keeping neat, concise and accurate records.

Technical study and/or construction experience is necessary to perform well as an inspector. The inspector must be able to perform accurate mathematical calculations. It is essential that he/she know how to read and understand plans, specifications, and other contract documents. The inspector should understand the basic engineering principles of roadway design and should be familiar with the characteristics of construction materials. He or she needs to know the principles of material testing as well as how to interpret the test results.

A paving inspector must have a thorough working knowledge of concrete plants, but also have a broad general knowledge of concrete materials, concrete production and construction procedures and paving equipment operation. Practical experiences with concrete mix productions, roadway construction and concrete laboratory testing is a valuable asset.

If all the qualifications of an inspector could be reduced to four, they would be: 1) technical knowledge, 2) common sense, 3) observational skills, and 4) courtesy

1 **Technical Knowledge:**The inspector should be familiar with the construction materials and concrete paving procedures. Self-motivated education is a necessary goal. The more knowledgeable the inspector is, the better prepared he or she is to perform inspector duties.

   Material which might be of interest to the new inspector of the inspector-in-training include:

   - The DOT Design Manual
   - Latest edition of the South Dakota DOT Standard Specifications for Road Bridges of the edition cited in the plans
   - The DOT Construction Manual
   - Earthwork Manual
   - Highway Plans Reading
   - Concrete Plants Manual
   - Materials Manual
   - Pipe Manual

- Structures Manual
- Erosion and Sediment Control and Storm Water Management Manual
- Construction Math Manual
- Concrete Surface Repair Manual

2 **Common Sense:** While common sense is no substitute for knowledge, it is the means by which an inspector can interpret specifications to enforce their intent. Make a time line of actions to complete for the day. This daily plan helps get the critical tasks accomplished and documented. The timeline is a guide, so be flexible.

3 **Observational Skills:** It is important for an inspector to look carefully at everything going on around him or her. "Seeing," means thinking carefully about what the eyes observe. Place yourself in a position to oversee what is going on. Do not form timeline dependent practices that make your actions predictable. Rely on instinct, when you see something that looks wrong, it probably is. Stop and look at it for a while to see if a problem is being created. Then take appropriate action.

4 **Courtesy:** A major part of the inspector's job is to inform the Contractor when conditions are unsatisfactory or when the specifications are not being met. The Contractor expects the inspector to give him or her valid comments and critical observations. Yet the inspector's manner of presenting his comments can cause a poor relationship. Gruff, bossy and sarcastic comments are unacceptable from any inspector, even if given in answer to a Contractor's aggravating remarks.

Plan Review

Prior to construction, a complete review of the plans and specifications should be conducted so you are familiar with the requirements of the project.

The sequence of priority concerning Specifications is:

- Special Provisions
- Plans Notes
- Supplemental Specifications
- Standard Specifications

Special Provisions govern over the Plan Notes, Supplemental Specifications and Standard Specifications.

Plan Notes govern over Supplemental Specifications and Standard Specifications.

Supplemental Specifications govern over the Standard Specifications.

Proposal Review

The Proposal for a set of plans should be reviewed for the following items:

- Special Provisions
- Supplemental Specifications
- Agreement to Sell Material
- Haul Road Agreement
- Utility Adjustment Plans

In addition to the plans and proposal, the following items should be reviewed:

- Right of Way Agreements
- Temporary Easement Agreements

Sampling and Testing

Sampling and testing are methods of evaluating quality of the work. The inspector must know what samples to take at the paving site. The inspector must make sure that every sample is identified with the data requested on the DOT-1 form. The inspector should use the Materials Manual when sampling and conducting tests. This is no place for personal opinion.

Typical Duties

- Check materials and material storage for conformance to specifications.
- Sample concrete, make cylinders, perform unit weight, slump and air tests. Take appropriate action with these results
- Verify finegrade elevations and pavement depth.
- Verify Contractor equipment operation and note breakdowns and deficiencies.
- Maintain contact with the Project Engineer, other inspectors and checkers; know what is going on along the project. Be proactive!
- Document constantly.
- Operate in a safe manner; follow the Contractor's safety rules.

Records

Another critical function the inspector performs is to keep accurate records and complete necessary reports daily. Records and reports are necessary to determine that contract requirements have been met. Records and reports should be kept current and submitted on schedule. They should be neat and legible.

In addition to the standard DOT forms, the inspector keeps a written or electronic diary of paving activities. An example of a written diary is shown on the next two pages. It should contain such information as weather conditions, important conversations, visitors on the site, verbal orders received, unusual incidents, equipment breakdowns, length of work stoppages, number of personnel and types of equipment affected by work stoppages, and any changes in the appearance of the pavement construction. Any time of significance should be recorded and analyzed in detail. The diary entries are supported by sample data sheets, the paving report, record of visual inspections, field measurements, and so forth. The electronic diary should be kept in the same meticulous manner.

The diary information is a reference that can be used in critical court cases.

Summary

To do a professional job, the inspector must **want** to do a good job, **know** how to do it, and then **go about it** in a professional manner.

Figure 1.1 Example of a Daily Diary Entry

Date: 9/5/07	Weather:	Temp:	High: 102	Low: 67°	X	Sunny (HOT)	P/Cloudy	Cloudy
Day: Wednesday		Wind:	High: 25	Low: 15		Calm	Rain	Other

Project: IM 0905(61)236 PCN 5370 County: Lyman

RECEIVED
OCT 18 2007

Contractors Working: Upper Plains, Wheatherton C C I., Russell Drainage, BPI, Buskerud, PCI, Dakota Traffic Services, Antigo, Interstate Sealant & Conc., Goldsmith & Heck, JAG, Diamond Surface Inc.

Comments: UPCI: I arrived at paver at 6:30 AM. Workers were getting equipment ready for M.L. paving. Equipment used is same as previous. Header & tie steel looked o.k. to start. 1st Load arrived at 7:00 AM. Sampled Test # UP190, Truck# 451, 11.0 cuyds, sta. 161+18. Sampled mix in pile infront of belt placer. Test passed (No Deviations) Contractor present during testing. Contractor cont. to dump concrete. Paver left the header at 7:25 AM. The steel rebar ahead of belt placer is being tied by UPCI Laborer, prior to concrete placement. The rumble strips are to the correct measurements. Tining & curing looking o.k. Very windy today. Haul road dust getting on cure. Water truck did make a pass over haul road by equipment and workers, and also on subgrade to water down before concrete placement. 9:00 AM. Sampled test # UP 191(59), sta. 156+50. Truck# 456, 440 cuyds, sampled mix in front of paver. Test passed (No Deviations). Contractor notified. 6 cylinders made, # 59, A, B, C, D & E. Water truck made a pass to water down haul road and subgrade. 11:00 AM. Sampled Test# UP192 Truck # 453, 946 cuyds, sta. 150+50. Sampled mix in front of paver. Test passed (No Deviations). Contractor notified. I told cure & tining operator to keep the carpet drag & tining & curing close as possible to the finish crew. due to the warm air temp. Air Temp 90°, conc. 79°. AT 1:00 PM. Ran Air test # UP 193(60). Truck # 454, 1375 cuyds, sta. 146+00. Sample taken in front of paver. Test passed (No Deviations). Contractor notified, 4 cylinders made # 60, A, B & C. Water truck made another pass over haul road and subgrade. Trying to keep the rebar cool due to the heat. 3:00 PM. Sampled test # UP 194, Truck # 451, 1804 cuyds, sta. 140+25. Test passed (No Deviations). Contractor present during testing. I checked vibrators, they ranged from 6200 vpm to 7100 vpm. on the computer display. At 4:30 PM, paver just getting into transition of the super elevated curve. Water truck made another pass over haul road & subgrade. At 5:00 PM. Sampled test # UP 195, Truck # 452, 2310 cuyds, sta. 134+75. Test passed (No Deviations). Contractor notified. Last load delivered to paver at 6:20 PM. Header was installed at sta. 131+94. Tie bars were inserted into header, 2' into concrete, & 4' exposed, before paver crossed header at 6:30 PM.

Signature: Mike Hausman Title: Journey Trans Tech

cont. next page

Date: 9/05/07	Weather:	Temp:	High:	Low:	Sunny	P/Cloudy	Cloudy
Day: Wednesday		Wind:	High:	Low:	Calm	Rain	Other

Project: IM 0905(61)236 PCN 5370 County: Lyman

Additional comments from previous page: UPCT: Cont. from prev page.

there was no chunks of hard concrete when paver crossed the header very little hand work needed.

Finish crew was done with hand work, carpet drag tining & curing at 7:00 PM. There was 6 cuyds wasted on Road today. (1) at header, (5) left in last Load. No down time on road today.

Dailey Paving Report # 36, start sta. 161+23, to end sta. 131+94, 2929 ft. Todays yield = 92%. Today's sq yds = 8461.6, prev: 188266.5, RT: 196728.1 sq yds.

Slope cks: sta. 160+00, LT 2.0% 4 mm, RT. 2.0% 5 mm, sta. 155+00, LT 1.9% 5 mm, RT. 1.9% 5 mm, sta. 150+00, LT. 1.9%, 4 mm, RT. 2.2% 3 mm, sta. 145+00, LT 2.0% 3 mm, RT. 2.2% 4 mm. sta. 140+00, LT 1.8% 4 mm, RT. 2.1% 5 mm. sta. 135+00 is starting into transition. LT. 2.0% 3 mm, RT. 1.6% 2 mm.

Depth cks: sta. 157+25, 11' LT. = 10", sta. 149+00, 11' RT = 10", sta. 138+25, 10' LT. = 10"

Cure ck: 2929' x 27.67 = 81045 sqft ÷ 12 barrels x 55 gal each = 122.80 sqft/gal.

Signature: Mike Hausmann Title: Journey Trans Tech

The inspector is the eyes and ears of the DOT. He or she documents the work as it progresses and is the quality enforcer. Take this responsibility seriously and exercise your quality control actions with great vigor.

CHAPTER

2

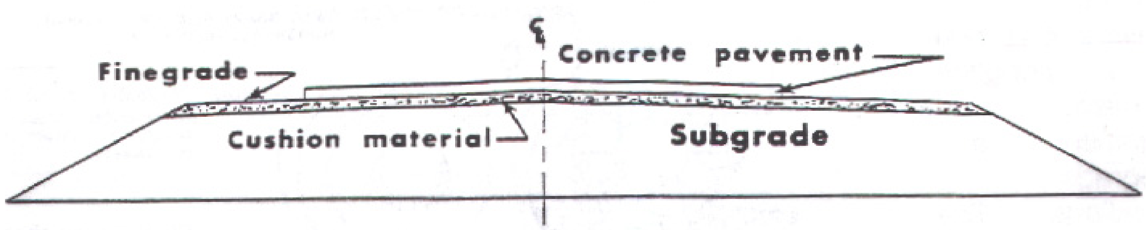
FINE GRADING PRINCIPLES

Finegrading

Finegrading is the trimming of the subgrade or cushion material to the elevations and cross section specified in the plans. The finegrading is the final operation before the concrete pavement is placed.

Asphalt mats placed over concrete pavement acts as a bond breaker to prevent the two concrete surfaces from bonding. The asphalt mat is not subject to finegrading.

Figure 2.1 Diagram of grade and pavement components



Handout 5 in the envelope at the back of this manual are plan sheets for typical sections of a project. It contains a note describing where and how the profile elevations are related to the cross section. Handout 5 is a plan and profile sheet from the same set of plans. The profile sheets give the elevations for the profile of each roadway. The information from the typical section sheet is needed to check the finegrade. Information from both sheets is needed to figure any elevations.

Prior to finegrading, all unstable grade or low areas shall be removed or filled in and recompacted. The finegrade must be trimmed to the correct cross section and elevation, but it must also be firm, which requires rolling. A “steelface” roller provides the smoothest work surface. Other rollers are acceptable.

Concrete must be placed on a smooth, even, uniform surface. Some projects have a Plan Note specifying density in the cushion material. The “South Dakota Materials Manual” Provides directions for running density test under Test No. SD 104, 105, 106, 110, and 114.

Finegrading Principles

One of the following methods is normally used to prepare the finegrade:

- Automatically Controlled Finegrader
- Blade with automatic controls - if specified on plans

The concept of finegrading is shown in Figures 2.2 and 2.3.

Determine the method the Contractor intends to use. The project must be staked differently for each method.

Automatically Controlled Finegrader

Most Contractors use an automatically controlled finegrader. It is fast and capable of trimming the finegrade to a fine tolerance. Regardless of the method used, the finished subgrade surface must be maintained in a smooth compacted condition until the pavement is placed.

Electronic sensors that ride on a stringline maintain alignment and finegrade elevations. The stringline can be set on both sides of the roadway or on one side only.

Note: The type of paver used determines the width of the finegrade.

The pad line needs to be trimmed.

Figure 2.2 Mechanics of Finegrading

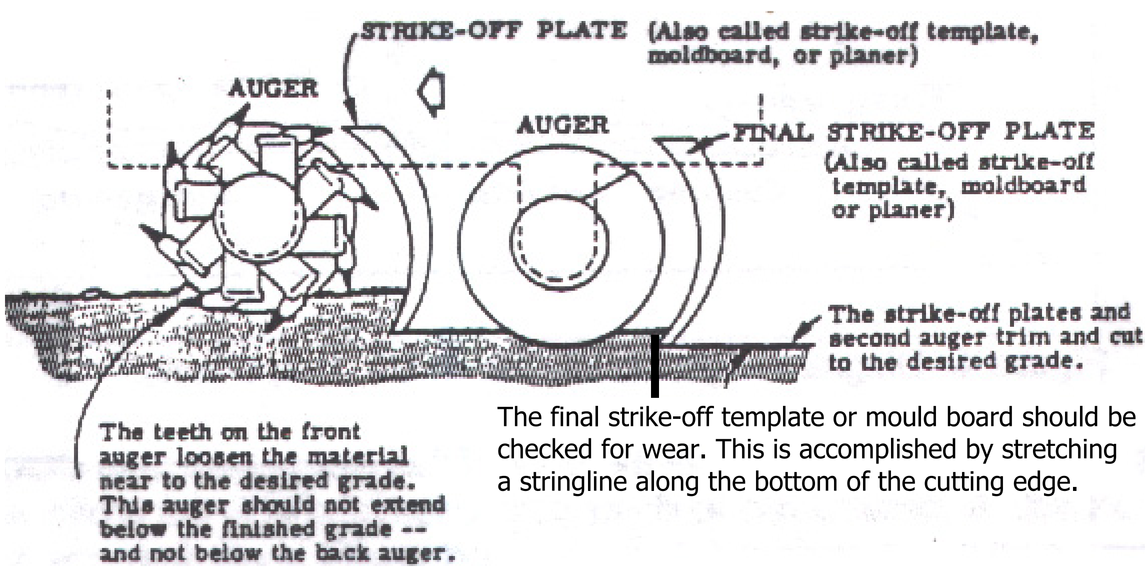
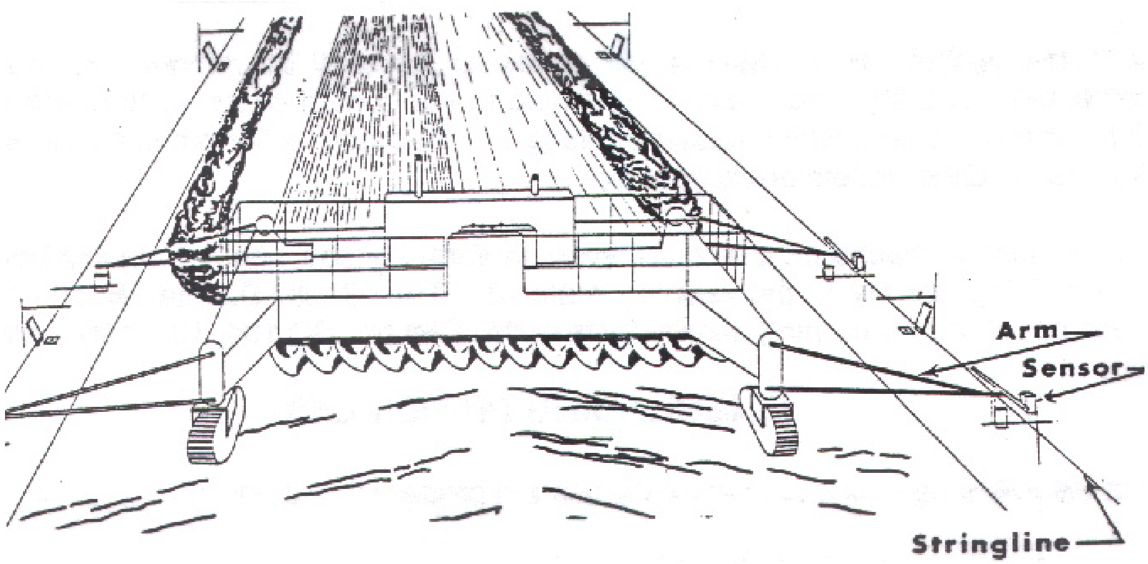


Figure 2.3 Diagram of automatically controlled typical rural finegrader in operation.



When two stringlines are set, elevation can be controlled on each side of the machine, while only one of the lines is needed to control alignment. When only one stringline is set, it is used to control both elevation and alignment. The elevation of the finegrader on the side opposite the stringline is controlled through the use of an electronic slope indicator on the machine.

Staking for Automatically Controlled Finegrader

Staking is a most important preconstruction operation. It provides the reference points from which the Contractor sets the string lines that direct the fingrading and paving equipment. Uniform staking methods enable the Contractor to produce uniform subgrades, subbases and pavements.

Figure 2.4 Type of Finegrader

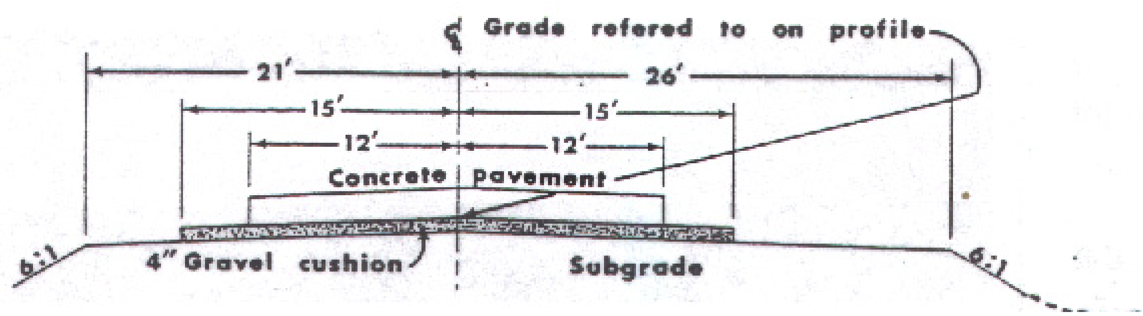
Staking is done by the DOT, a Consultant, or the Contractor. As an inspector, know the purposes and methods of staking so the stakes can be used to inspect the Contractor's work.

Wood 2" x 2" x 14" stakes, called "hubs," are used for staking. Often 3/8" x 10" Landscape Nails are used because of difficulty in driving wood hubs into cushion material. Hubs should be set 2 or more feet outside the subgrade shoulder to eliminate the chance of disturbance. Set one hub for each station and plus 50 feet. Today, each station plus 25 feet is becoming more prevalent. Additional hubs might be required on vertical and horizontal curves. Use the same amount of offset for each of the lines. Normally, the Contractor has a preferred offset and this should be discussed at the preconstruction meeting. This will make it easier to check the finished finegrade and requires the loading of only one grade elevation for the tangent sections.

Generally, it is better to stake a divided roadway with the alignment control on the outside because traffic in the median ditch could knock stakes out of position. However, alignment control is the Contractor's option.

For the typical section in Figure 2.5, it is 21 feet to the inside shoulder and 26 feet to the outside shoulder from the lane centerline. Hubs should be offset 26 to 28 feet. Twenty-eight feet is preferable to get outside of the subgrade shoulder.

Figure 2.5 A typical section of highway



You may set up the paving notes using either the top of the pavement elevation or the top of the cushion elevation. Be sure to advise the Contractor which one is being used.

The plans profile provides the lane centerline elevation, but the offset elevation must be figured by following the crown slope on out for the full distance of the offset.

EXAMPLE: You are on tangent having a centerline elevation of 90.16 feet using a 28 foot offset distance. The crown slope is 0.020 feet per foot.

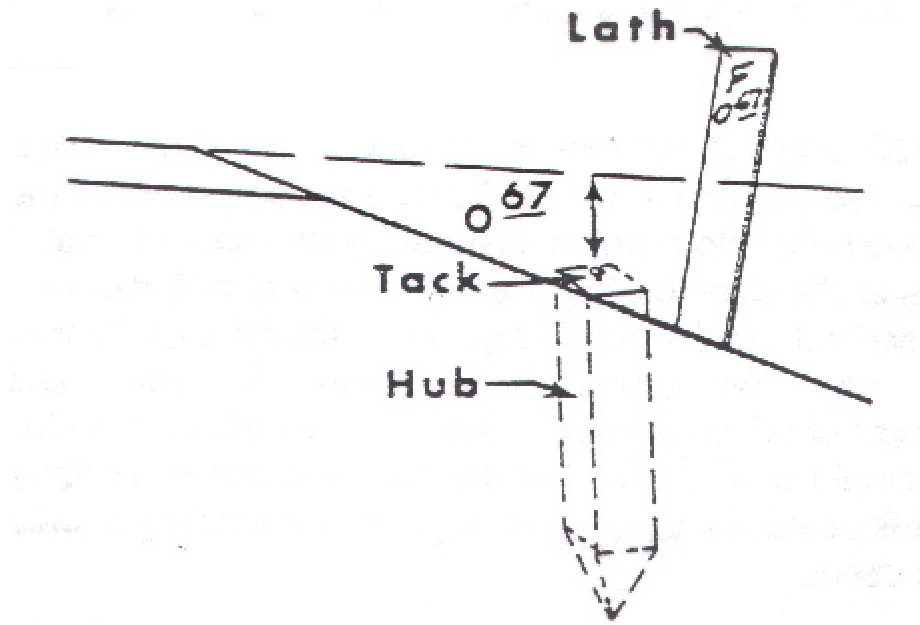
28 foot x 0.020 feet per foot = 0.56 feet

Offset elevation = 90.16 feet - 0.56 feet = 89.60 feet

Hub elevation = 88.93 feet

89.60 feet - 88.93 feet = 0.67 feet

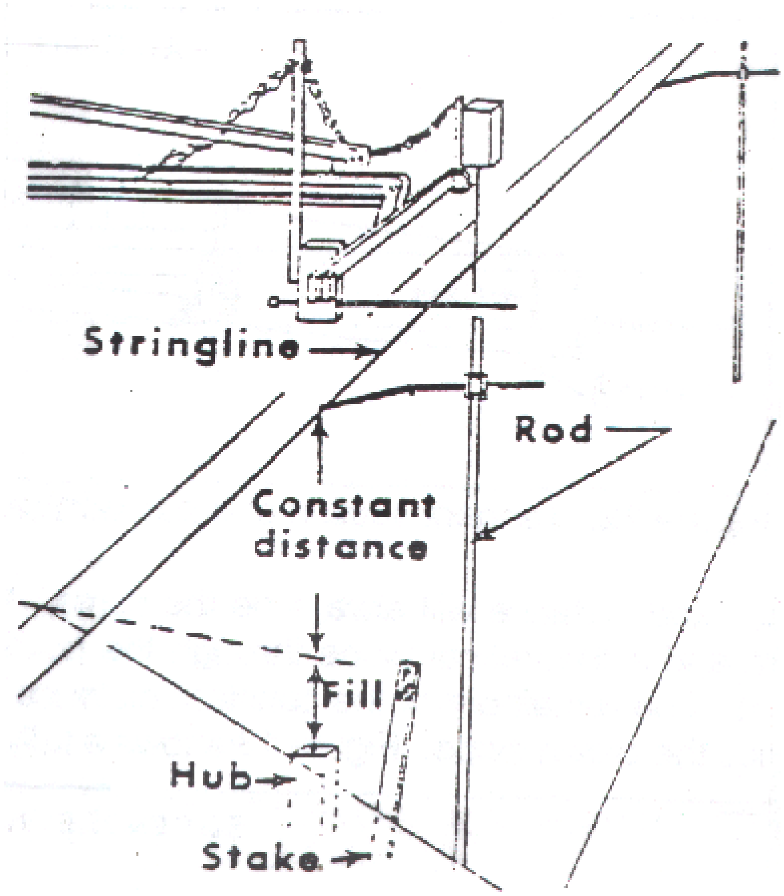
Figure 2.6 Diagram of Hub and Stake



Drive hubs flush with the ground, those hubs on the roadway side to be used for alignment control should be "tacked" to indicate the location of the line on the hub. Hubs on the other side do not need to be tacked unless they are in a curve. Check with the Contractor to see if he wants both sides to be tacked. The letter "F" on the stake stands for fill; the number "67" (Figure 2.6) is the amount of fill. The survey crew place the data, on the stake adjacent to the hub. For this hub, the plane of the finished grade would be reached by measuring up to 0.67 feet from the hub as shown in Figure 2.6.

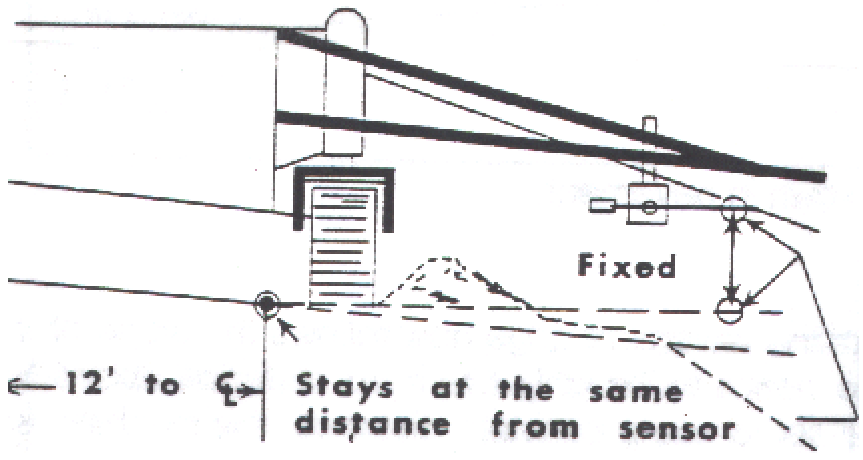
On vertical curves with 3% or greater grade differential and horizontal curves of 45 minutes, 25-foot hub locations are necessary. On vertical curves with 10% or more, hub locations should be decreased from 25 feet down to 12.5 feet apart.

Figure 2.7 Relationship of hub, stake, stringline, and rod to finegrader sensor and concept of constant distance.



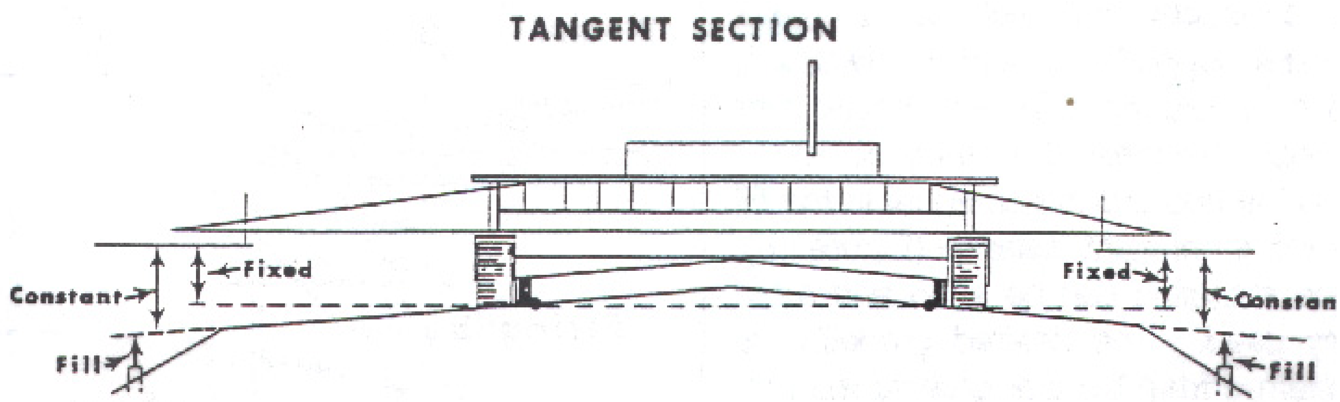
The Contractor will set up a metal stringline support rod near the hub with an arm to hold the stringline directly over the hub. Normally the stringline is set above the hub a distance equal to the fill plus some constant distance (Figure 2.7), so the stringline can be seen and more easily used. The desired gradeline is transferred from the stringline to the machines' cutting edge by electronic sensors attached to the finegrader. As the machine moves down the roadway, the small arm of the sensor (Figure 2.8) riding on the stringline transfers the established grade to the cutting edge. The sensor is actually below the stringline. The point being controlled is located where the edge of the concrete pavement will be located.

Figure 2.8 Diagram portraying fixed distance.



The stringline must be taut between the metal rods. If the stringline can be turned over on itself by hand, it is too loose. Grading the hubs with elevation obtained by carrying the slope out the full offset distance makes it easier for the Contractor to go from a crown section (Figure 2.9) to a superelevated section (Figure 2.12). A small correction must be applied while going through the transition. Grading the hubs in this manner also makes it easier to check the finished finegrade for proper elevation. If the hubs are graded for the elevation of some other point on the roadway, the correction needed to go through a transition is more difficult to figure and apply. It is also more difficult to check the section. The constant distance used to set the stringline is made up of two separate distances, the fixed and constant distances.

Figure 2.9 Tangent section of grade with crown.



The fixed distance will always be the same. It is the distance between the sensor on the arm and a theoretical plane through the points of the pavement edge (shown by dashed line). The remainder of the constant distance is equal to hub offset minus pavement edge times the crown slope. Figure 2.12 shows a fully superelevated section.

Figure 2.10 Superelevation Transitions (from Road Design Manual, 5-16)

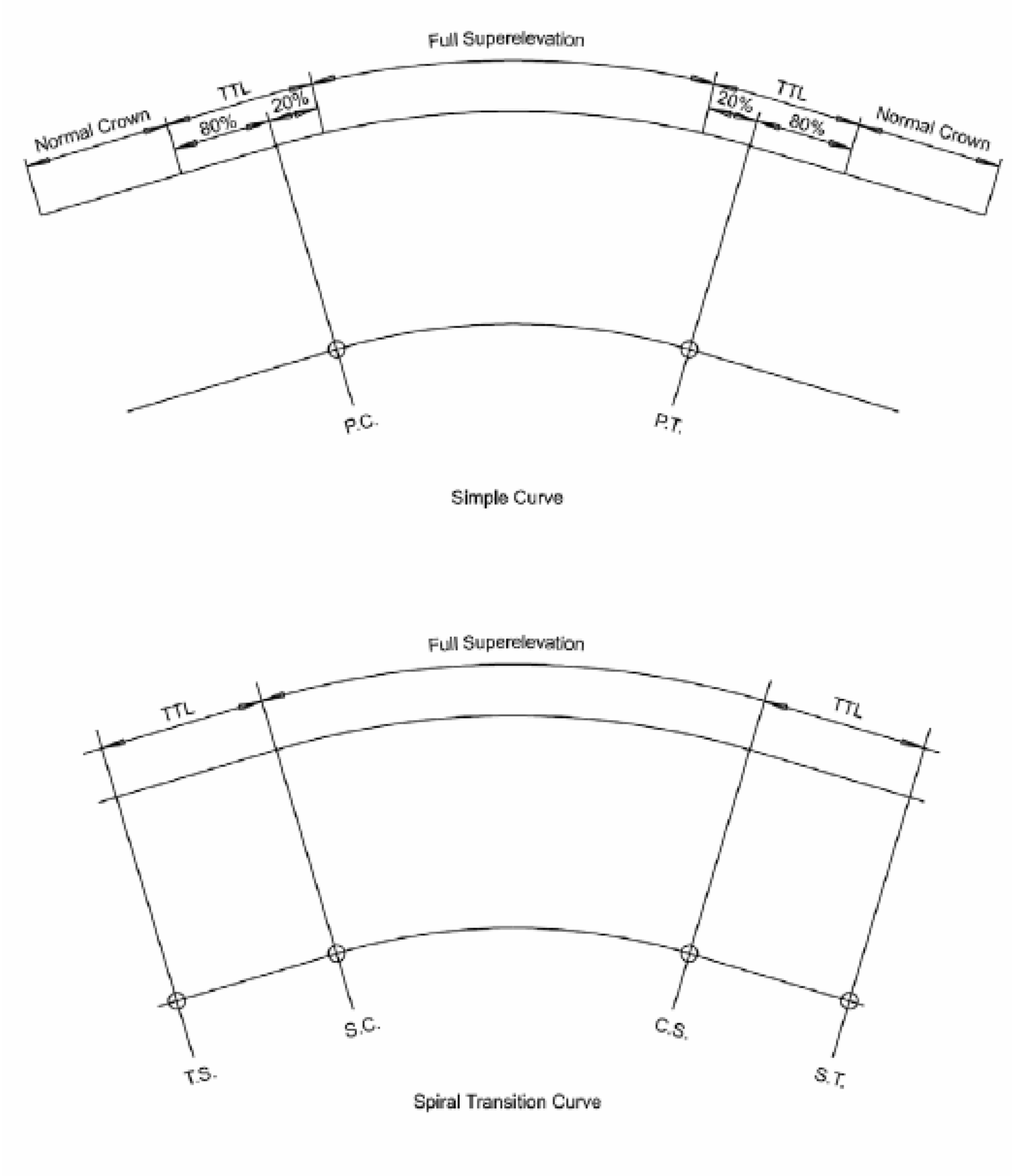


Figure 2.11 Superelevation Transition for 2-lane Hwy (from Road Design Manual, 5-19)

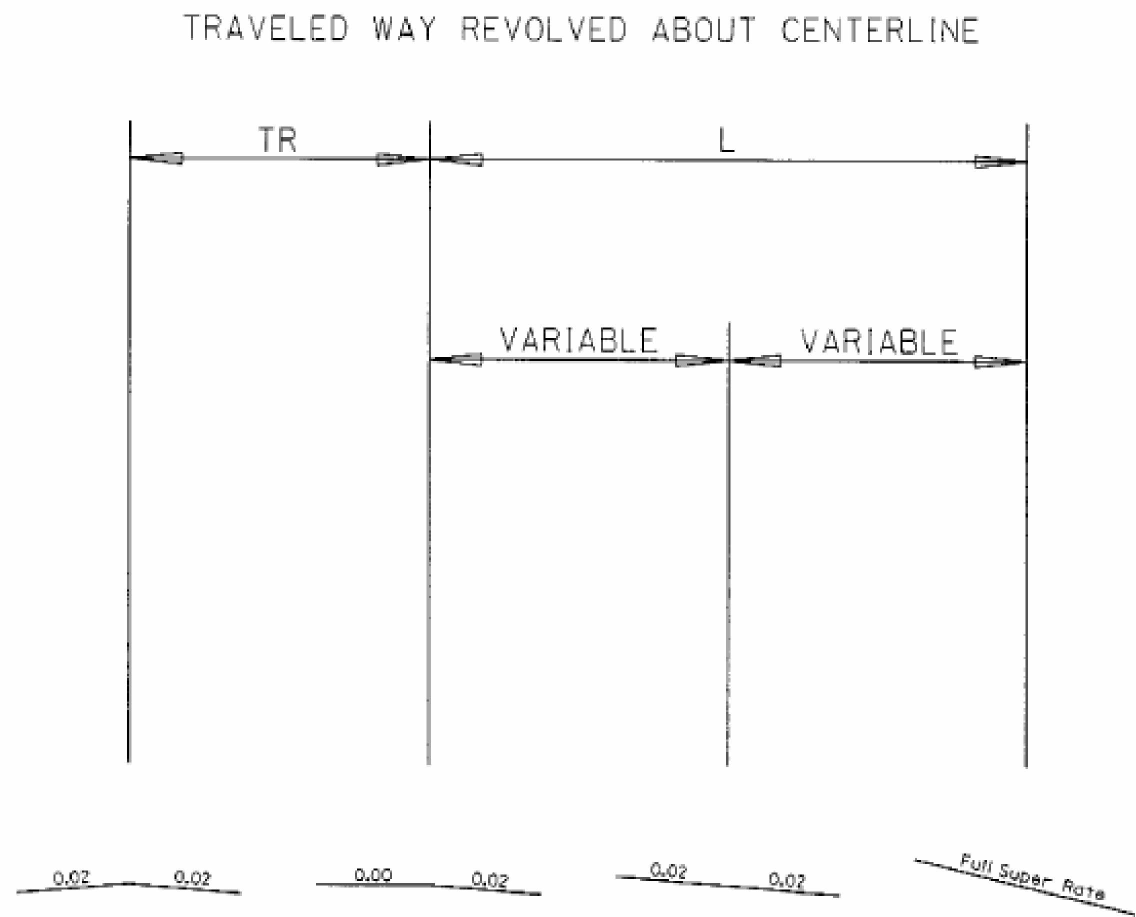
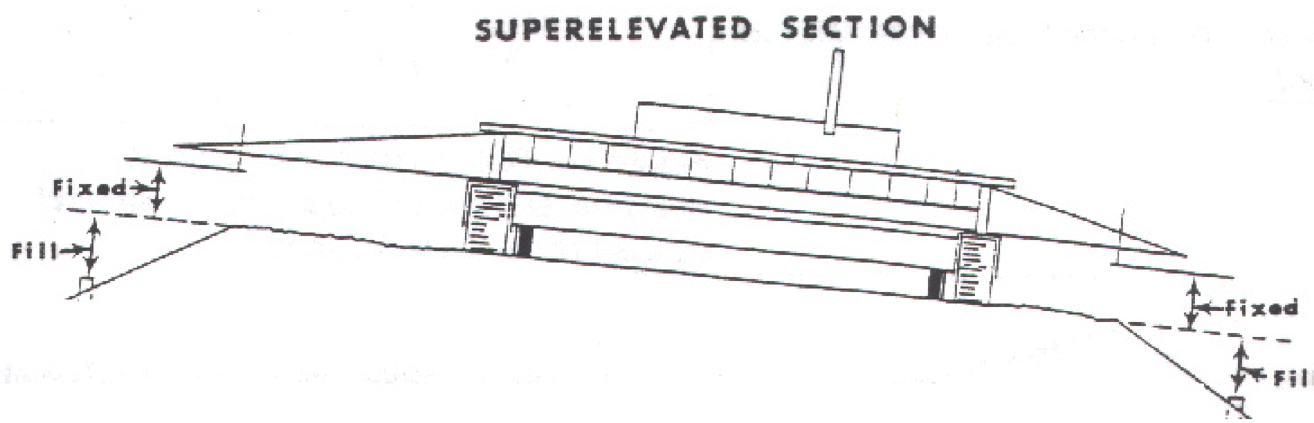


Figure 2.12 Superelevated section, no crown in pavement.



The theoretical plane through the points of the pavement edge now follows the slope of the roadway, which means that the stringline needs to be only the fixed distance above the slope of the roadway. With the stringline set to use a constant distance, the machine will actually cut the grade too high in the superelevated sections. The easiest way to correct this situation is to lower the stringline, eliminating the need for any adjustments, except taking the crown out of the cutting edge. The amount of adjustment that must be made is equal to the hub offset minus (-) the difference between the fixed and constant distances shown in Figures 2.7, 2.8, 2.9, 2.12. This adjustment must be applied in proportion to the length of the transition. It goes from zero at the start to the full amount at the end of the transition, to figure the adjustment for each hub along the length of the transition, divide the total correction by the length of the transition and take this times the distance of each hub from the beginning of the transition.

EXAMPLE No. 1: A 240 foot transition begins at station 121+70. It is 12 feet from centerline to the pavement edge and the cross slope is 0.02 feet per foot. The hubs are set at 50 foot intervals and offset 20 feet inside and 26 feet outside. Inside correction = 20 feet - 12 feet x 0.02 = 0.16 feet

Outside correction = 26 feet - 12 feet x 0.02 feet per foot=0.28

Stationing Distance	**121+70**	**122+00**	**122+50**	**123+00**	**123+50**	**124+00**	**124+10**
From Beginning	0	30	80	130	180	230	240
Inside Adjustment	0	.02	0.06	0.08	0.12	0.16	0.16
Outside Adjustment	0	0.04	0.10	0.16	0.20	0.26	0.28

This adjustment is best made by having the survey crews take it into account while grading the hubs. The amount of fill put on the hubs will be the actual fill minus the amount of the adjustment. It is necessary to subtract the adjustments from the actual fill because the stringline must be lowered to get the cutting edge through both transitions. The full correction must also be applied along the full length of the curve.

EXAMPLE No. 1A: The following table contains the actual fills to be put on the hubs (outside line only) by carrying the slope out to them; the adjustment to be applied to each hub; and the resulting fills to be put on the stakes.

Stationing	122+ 00	122 +50	123+ 00	123+ 50	124 + 00	124 + 10	124 + 50
Actual Fill	F 0.67	F 0.58	F 0.60	F 0.62	F 0.49	F 0.61	FP .58
Adjustment	- 0.04	- 0.10	- 0.16	- 0.20	- 0.26	- 0.28	- 0.28
Staked Fill	F 0.63	F 0.48	F 0.44	F 0.42	F 0.23	F 0.33	F 0.30

Using this method, the Contractor can continue to use the constant distance above the staked fill, eliminating the possibility of making an error by using the wrong adjustment or no adjustment at all. It is also easier to check the finished finegrade in this area, using the constant distance rather than a different factor for each station.

Finegraders that use only one stringline for elevation control have a device that automatically transfers the grade control from the side with the stringline to the other side of the machine. A dial marked off in the percent of cross slope referenced to a horizontal plane, is used to raise or lower the free side. The dial should be setting on zero percent on a tangent section. To go through a transition, it is necessary to tell the operator the changes in cross slope for each station. These can be calculated by dividing the width of the pavement by the difference in the finished grade elevation listed for the edges of the pavement.

EXAMPLE No. 1B: The finished grade elevations for the pavement at station 122 + 00 are 72.38 feet and 72.44 feet; at station 122 + 50 they are 72.88 feet and 73.24 feet. The pavement is 24 feet wide.

Slope at 122 + 00 = 72.44 - 72.38 = $0.06 \div 24$ = 0.25%

Slope at 122 + 50= 73.24 - 72.88 = $0.36 \div 24$ = 1.5%

PROBLEM: A 240 foot transition begins at station 58 + 35. The pavement is 24 feet wide and the normal cross slope is 0.020 feet per foot. The hubs are set at 50 foot intervals with a 22 foot inside offset and a 30 foot outside offset. Using information in

Example 1, 1A and 1B what adjustments should be applied to the fills from station 58 + 00 to station 61 + 50?

The removal of the crown is another item to consider while going through most transitions. The crown must be removed uniformly in proportion to the length of the transition. The operator must be told how much to lower the center of the cutting edge as it moves along the transition. This can be done by setting stakes along the transition with each stake showing how much should be removed at that point. To determine how much the center of the cutting edge must be lowered to give a plain section, take half the pavement width times the crown slope. Then find the smallest increment that the operator can read on his scale for lowering the center of the cutting edge. Dividing this value into the amount the cutting edge must be lowered, results in the number of segments along the transition that can be used as checkpoints during crown removal. Divide the number of segments into the transition length to get the distance between the stakes to be set for the operator. As this is being done, the inspector should verify lack of crown by using a string line.

EXAMPLE: A 24 foot wide pavement has a normal crown slope of 0.02 feet per foot that must be removed in a 240 foot transition. The smallest increment the operator can read on his scale is 0.02 feet.

Amount of crown = 0.5 x 24′ x 0.02(crown slope) = 0.24′

Number of segments = $(0.24') \div (0.02')$ (smallest increment) = 12

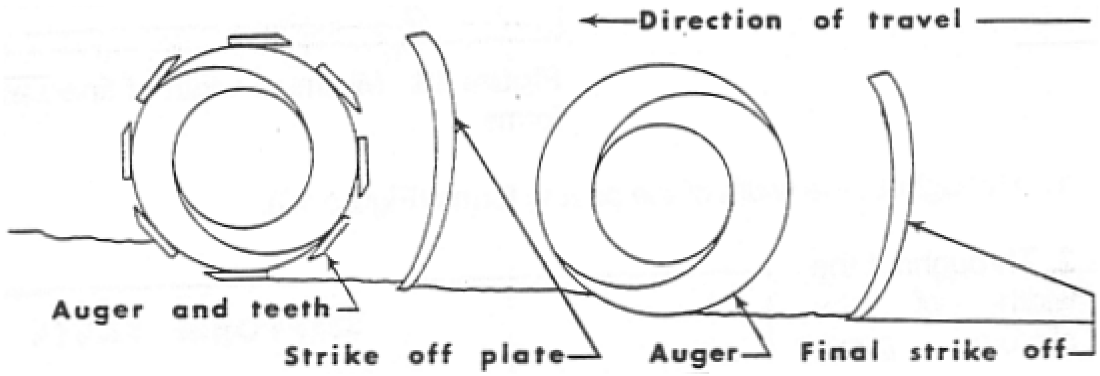
Segment lengths = $(240') \div 12$ = 20′

Grade Control

Fingraders should cut a flat polished surface (Figure 2.13) with auger teeth marks.

Figure 2.13 Note the auger teeth marks on grade surface.

Figure 2.14 Diagram of key elements of finegrade cutting equipment.



Teeth (Figure 2.14) on the front auger are used to loosen the material to a depth just slightly above the desired grade. The next auger loosens and removes the small amount of remaining material, reaching the final grade. Strike-off plates plane (Figure 2.14) the surface of the desired cross section. To assure that strike-off plates are set to finish the finegrade to the cross section called for by typical section inspect as follows:

1. Use the required slope from the typical section in the plans (Handout 5-Sheet F5).

2. Stretch a string tightly between the ends of the strike-off plate.

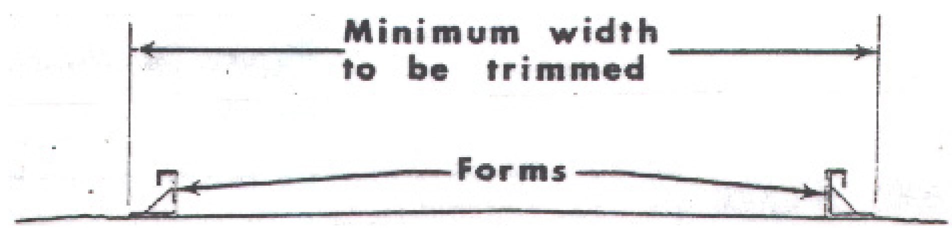
3. Measure the distance from the string to the cutting edge at the center of the machine. The distance measured should be equal to the crown slope 1/2 the width of the cutting edges.

4. Stretch the string along the bottom of the cutting edge to determine if it is straight from the center to the outside edge.

If the distance is not accurate, or if the cutting edge is not straight, the Contractor must make adjustments or replace the cutting edges.

Some projects require that the crown be removed. The Plan Note is usually found on the same sheet as the superelevation tables. Determine if the machine can give a true plane on a project requiring crown removal, by setting the control to lower the cutting edge to just touch the stringline along its full length.

Figure 2.15 Minimum width of finegrading when using forms.

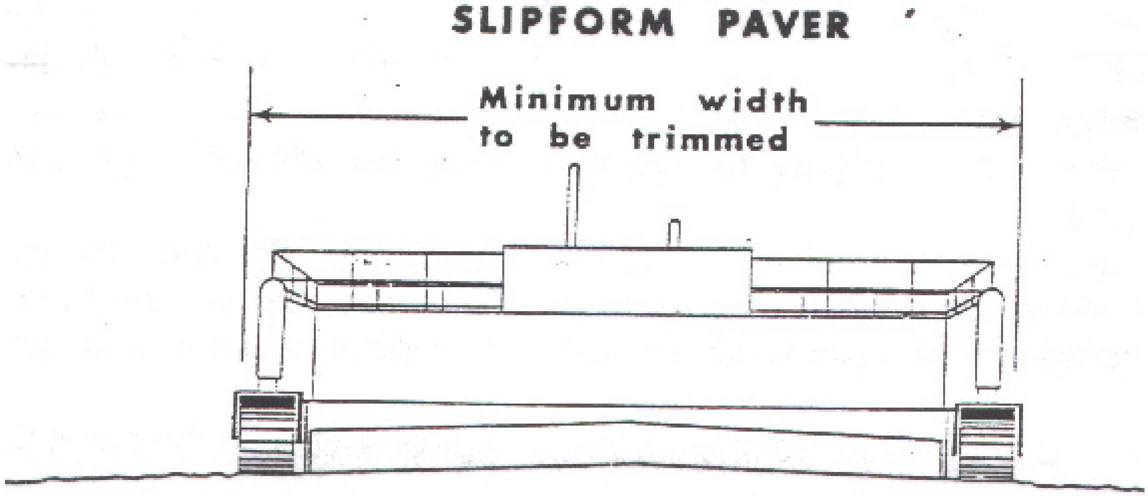


Automatically controlled finegraders must trim the grade to a minimum width:

1. Throughout the width of the paving forms (Figure 2.15)

2. Throughout the width of the slipform paver tracks (Figure 2.16).

Figure 2.16 Minimum width of finegrading when using slip-form paver.



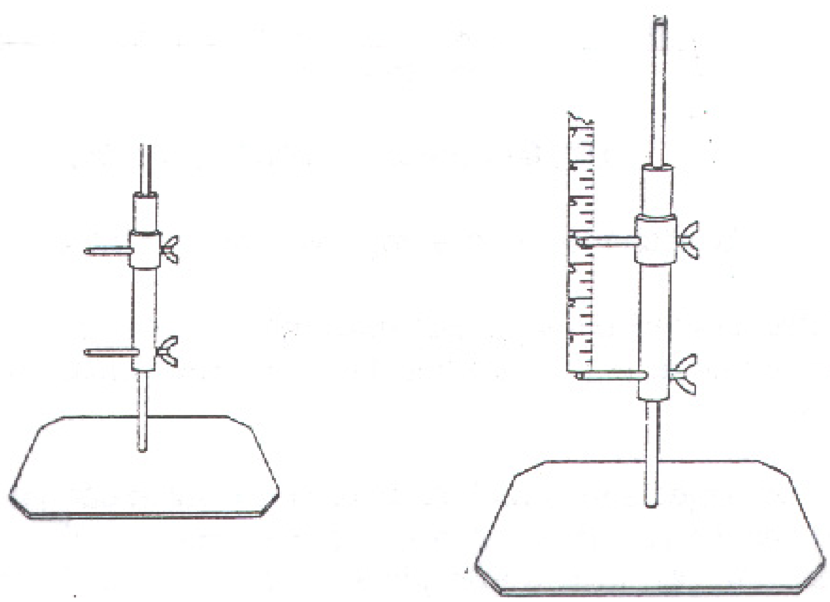
In actual practice, the Contractor may need to go over the area several times to trim it to the proper elevation.

Finegraders generally leave a windrow of gravel on the shoulder after trimming. The Contractor should cut spaces at intervals through the windrow to allow water to run off. This is critical in low areas.

Finegrade Checks

The finished finegrade appearance should be a flat polished surface without deep auger teeth marks following the trimming. A hard polished surface is desirable. To check the grade, use a stringline and a "Grade Checker." A "Grade Checker" (Figure 2.19) consists of a rod fitted with an adjustable two-armed sleeve and set into a metal base plate. The sleeve arms, one solidly attached, the other adjustable, are used to make the crown adjustment. Stretch a stringline between two points. To raise it at the centerline of the roadway and make it take the shape of the pavement in the crowned section, set the arms of the "Grade Checker" so the distance between the top of one to the top of the other is equal to the vertical distance due to the crown adjustment at that station. The stringline takes on the same shape as the pavement surface.

Figure 2.17 Grade Checker



Whenever the crown is removed going around a curve, there is no crown adjustment; the stringline will be a straight line. If the normal crown is to remain in the pavement around a curve, use the same crown adjustment as for a tangent section.

Note A note on the plan sheet for super elevations will indicate whether the crown is removed on any of the curves.

Whenever the crown is removed on a curve, there is a transition area between the tangent section and the curve. Since it is difficult to calculate these crown adjustments, ask the survey crew to provide a list for each station having a transition section.

Automatic Controlled Finegrader Cut Finegrade Checks

Before checking the finegrader, calculate the crown adjustment. This is the difference in elevation, due to the crown slope, between the center of the roadway and a point at the hubs. Crown adjustment is found by multiplying the crown slope times the offset distance.

EXAMPLE: The crown slope is 0.02 feet per foot and the hubs are offset at 28 feet. Thus 0.02 feet per foot x 28 feet = 0.56 feet.

Sometimes the hubs on each side of the roadway will not have the same offset distance, thus requiring additional calculation to find the crown adjustment. First, find the amount the stringline is below level due to the added offset on one side. Multiply the amount by the ratio of one offset distance divided by the total offset distance to get a correction value for the crown adjustment. If using the shortest offset in the ratio, add the correction to the value received by multiplying the crown slope times the shortest offset to get the full crown adjustment. If using the longest offset in the ratio, subtract the correction factor from the crown drop.

EXAMPLE: The hubs are offset 24 feet and 30 feet and the crown slope is 0.02 feet per foot.

Elevation difference between offset lines = 0.02 feet per foot x 6 feet = 0.12 feet

Correction Factor = 0.12 feet x $\frac{24\text{feet}}{54\text{feet}}$ = 0.0533 feet

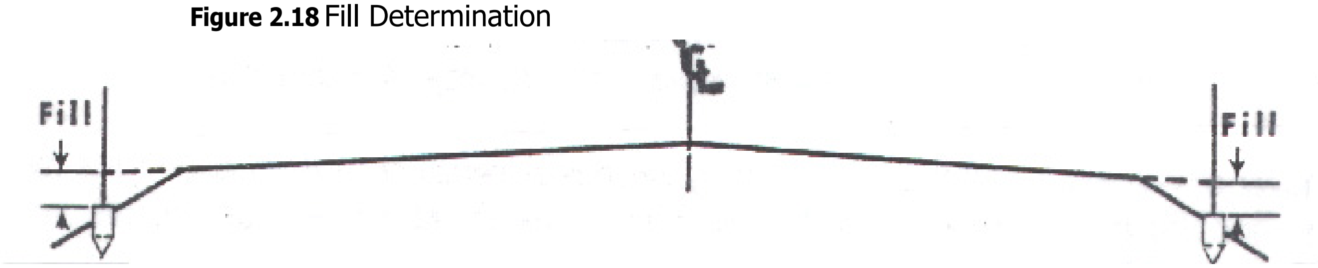
Crown drop = 0.02 feet per foot x 24 feet = 0.48 feet

Crown Adjustment = 0.48 feet + 0.05 feet = 0.53 feet

Crown Adjustment Checks

The Figures 2.20-2.29 show how crown adjustment is found when the hubs have been graded by carrying the crown out to the hubs.

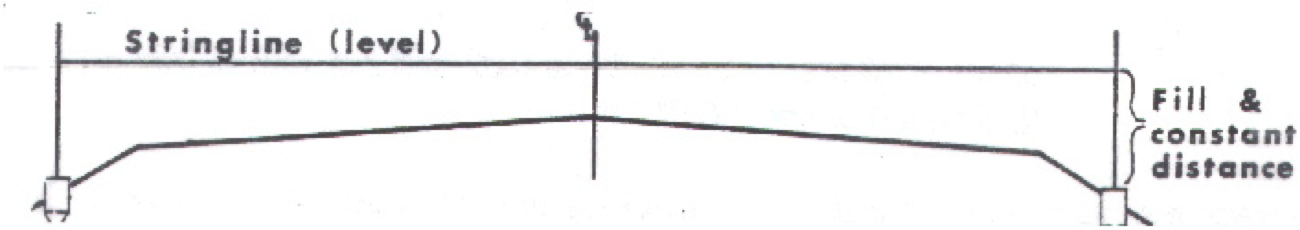
Figure 2.18 Fill Determination



Equal Offsets Method

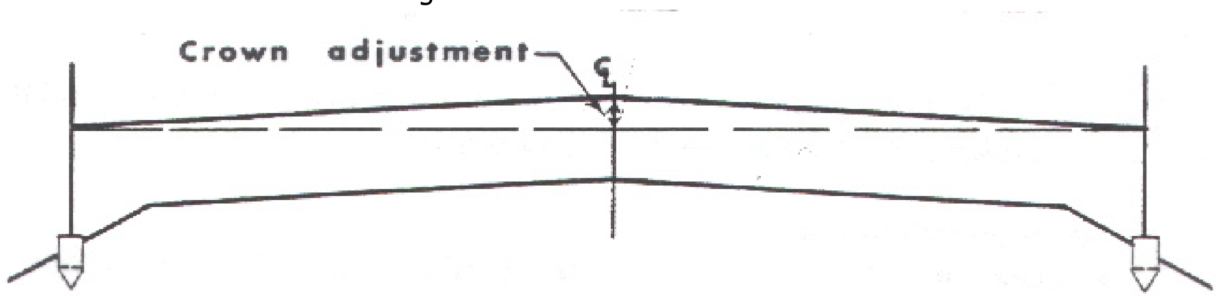
The stringline stretched between the stringline support rods will be level when the hubs are set having equal offsets (Figure 2.21).

Figure 2.19 Level stringline when hubs are set having equal offsets.



For the stringline to form the shape of the proposed concrete surface, it must be raised at the centerline. The amount it must be raised is the crown adjustment.

Figure 2.20 Crown adjustment is the distance between the arms of the grade checker as shown in Figure 2.19.

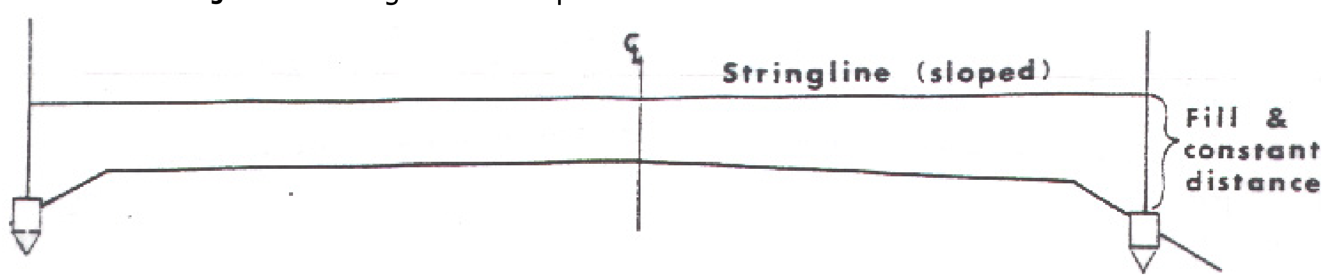


Crown adjustment is the distance between the arms of the grade checker (Figure 2.19, Right Diagram). If the grade checker is set on the roadway centerline and the sleeve moved until the bottom arm touches the stringline, the stringline can be made to take on the shape of the concrete surface by putting it on the top arm.

Unequal Offsets Method

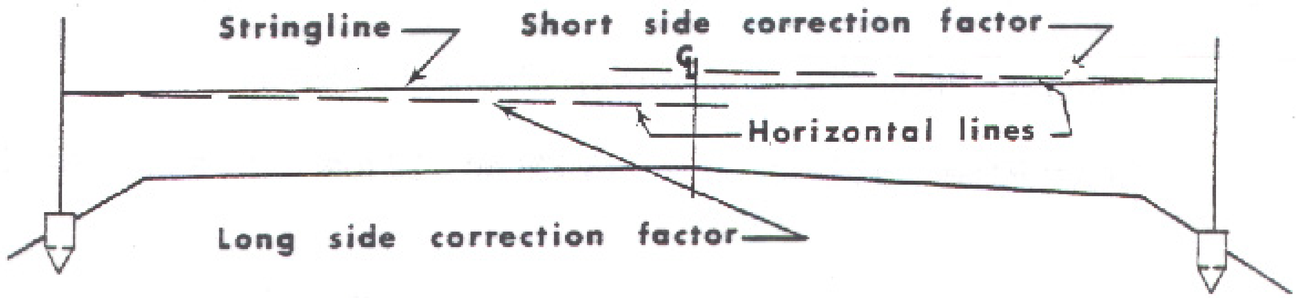
When the hubs are set so the offsets are not equal, the stringline stretched between the pins will be on a slope (Figure 2.23).

Figure 2.21 Stringline on a slope.



The crown of a roadway is always calculated from a horizontal plane. The only reference points for the crown are the marks on the pins at the hubs. A horizontal line drawn from these marks would be above the stringline when coming from the short side and below the stringline when coming from the long side (Figure 2.24).

Figure 2.22 Identification of correction factor. See Figure 2.25 for amount of rise in the stringline.



The amount the stringline is above or below a level line is called the correction factor. Coming in from the short side, the stringline is below the horizontal line by 0.05 feet. This correction factor is found in figures 2.21 and 2.24.

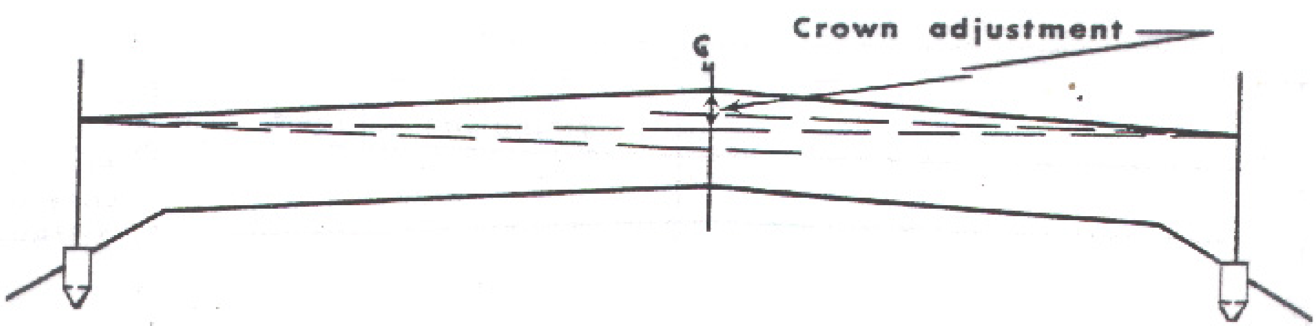
Coming in from the long side the stringline is above the horizontal line. The correction factor from the long side is:

$$0.12 \text{ feet} \times \frac{30\text{feet}}{54\text{feet}} = 0.066 - 0.07 \text{ feet}$$

Adding the two correction factors together 0.05 feet +0.07 feet equals 0.12 feet, the amount the end of the stringline is below level.

Raise the stringline at the centerline so it takes on the shape of the proposed concrete surface. Determining the amount to raise the stringline depends on which hub line you work from; however, the answer is the same either way.

Figure 2.23 Crown adjustment.



Coming from the short side, the crown adjustment (Figure 2.24) is 0.05 feet. The 0.05 feet is the distance the finished pavement is above the horizontal line plus the distance the stringline is below the same horizontal line. It is also the distance the arms of the grade checker are to be spaced.

The method for calculating crown adjustment when coming in from the long side:

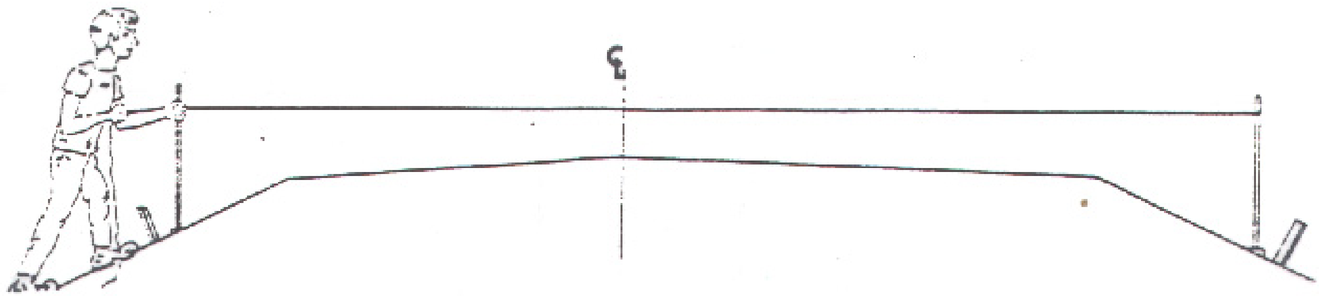
Correction Factor (Figure 2.25) = 0.07 feet

Crown Raise = 0.02 feet per foot x 30 feet =0.60 feet

Crown Adjustment = 0.60 feet -0.07 feet =0.53 feet (same as from short side)

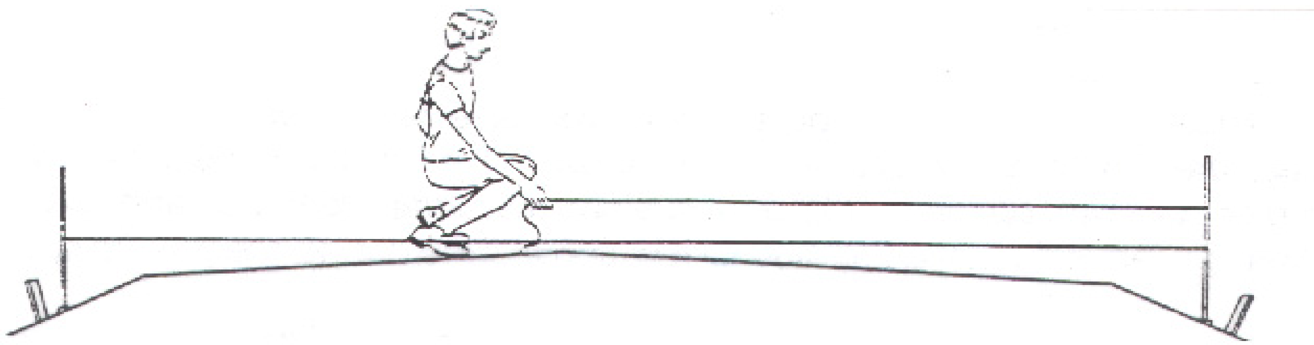
When the "Grade Checker" has been set for the crown adjustment check the finegrade as shown and described in Figures 2.26-2.29 on the following pages:

Figure 2.24 Tying string



Hook a string with loops at each end at the stringline support rod arm so it is stretched tight (Figure 2.26).

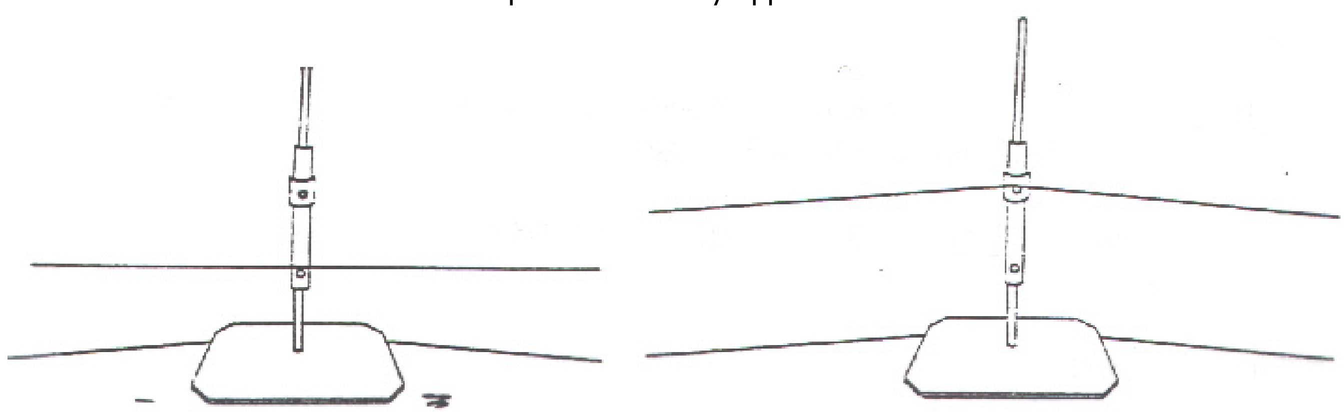
Figure 2.25 Finding roadway centerline.



Find the roadway centerline by measuring the offset distance from one of the hubs (Figure 2.27).

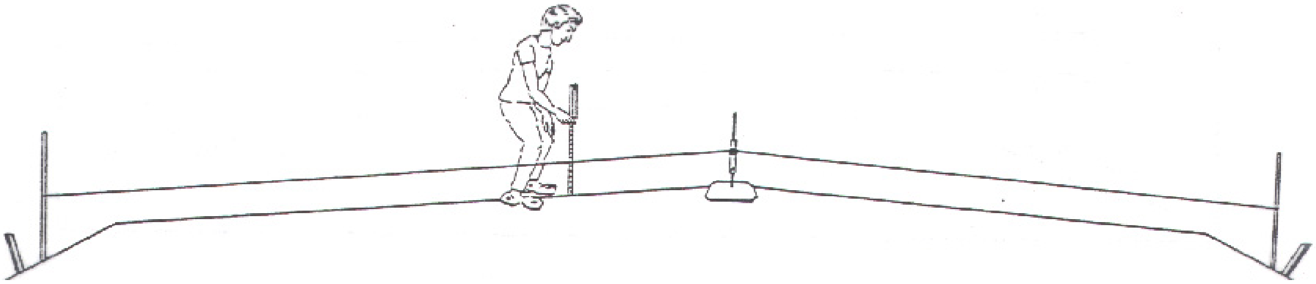
Place the crown (grade) checker at the centerline.

Figure 2.26 Crown or grade checker at centerline with lower arm just touching stringline. Placement depth is marked by upper arm.



Adjust the sleeve of the crown checker so the bottom arm just touches the stringline. Put the stringline on the top arm (Figure 2.28). The string is now at the elevation and has the same slope as the top of the pavement.

Figure 2.27 Checking uniformity of finegrade.



Use a ruler to measure the distance (Figure 2.29) between the string-line and finegrade at intervals along the stringline from one intended pavement edge to the other side. Document the results of the check in the diary.

The distance measured should be equal to the pavement depth. If less than the distance required, the Contractor must retrim the area. If more than the distance required, the Contractor has two options: (1) add cushion material, compact and trim to the correct elevation; (2) leave the area low and fill it with concrete during the paving operation.

If there is a low area where the forms will be placed or slipform paver tracks will run, the area must be brought up to the correct elevation before the forms are set or any slipform paving is started.

Form Riding Finegrader Cut Checks

It is easy to check the finegrade for this operation after figuring the crown adjustment. For a tangent section, the crown adjustment is found by multiplying half the pavement width times the crown slope.

EXAMPLE: The pavement is 24 feet wide and has a crown slope of 0.02 feet per foot.

$\frac{24}{2}$ feet x 0.02 feet per foot =0.24 feet

Method for checking the finegrade:

1 Stretch a stringline tightly across the top of the forms.

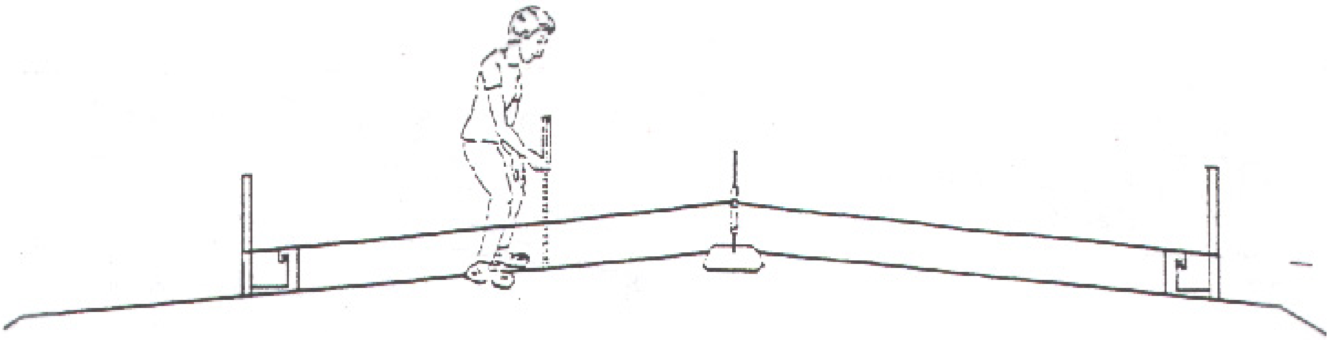
2 Measure the distance from the forms to the center of the lane and set up the grade checker.

3 Adjust the grade checker so the bottom arm just touches the stringline.

4 Put the stringline on the top arm; the crown adjustment is made.

5 Measure the distance between the stringline and finegrade at intervals along the stringline from one intended pavement edge to the other side. Document the results of the check in the diary.

Figure 2.28 Checking uniformity of finegrade between forms.



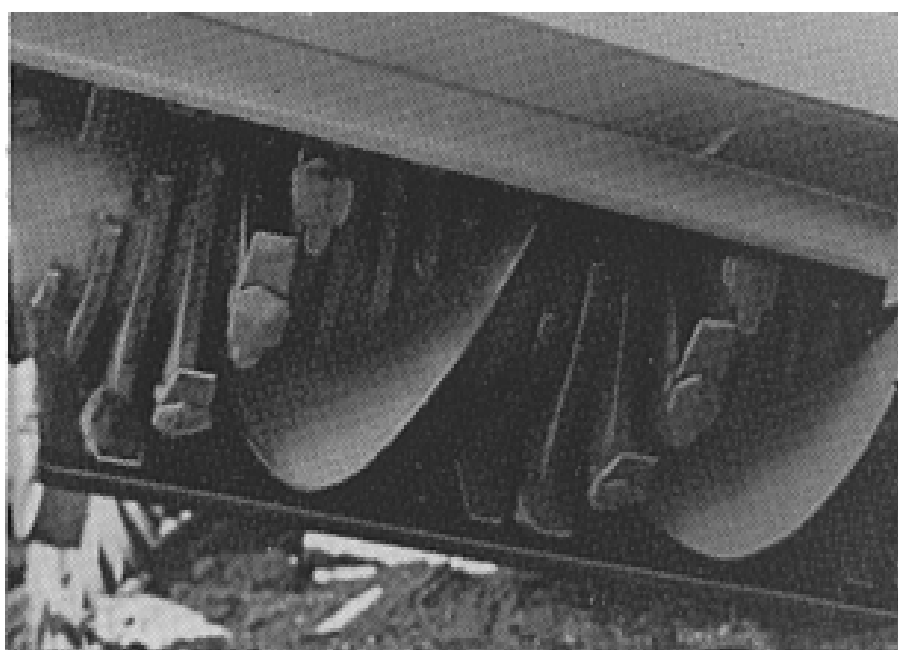
With either method of checking finegrade, the distance measured should be equal to the pavement depth. If the measured distance is less than the distance required, the Contractor must retrim the area. If the measured distance is more than the distance required, the Contractor has two options: (1) add cushion material, compact and trim to the correct elevation; (2) leave the area low and fill it with concrete during the paving operation. One inch plus rutting should be fixed.

RECORD ALL FINEGRADE CHECKS IN THE DIARY. Record the station where the check was made and the measurements taken.

Formed Pavement Finegrading(380.3 C 2 and 3)

Two methods of finegrading are used to prepare the base on which the forms set. On small jobs a motor grader and hand trimming usually suffice; larger jobs require a finegrader. The finegrader is equipped with teeth (Figure 2.31) that loosen the base. An auger that removes the loosened material, and a blade that strikes off the base to the desired grade. The finegrader operator uses a stringline (Figure 2.32) set from the hub grades as a guide to cut the grade in the right location and close to the correct elevation.

Figure 2.29 Teeth and auger finegrader.



When forms are set on the finished grade, each section should be held in place with at least <u>three</u> pinlocked form pins. A form pin should also be placed on each side of the joint between form sections.

Figure 2.30 Stringline guided finegrader

To support the paving equipment, the full length and width of the forms must be in contact with the grade. If not fully supported the weight of the spreading, paving, and finishing machines will cause up and down movement of the form. Rough pavement will result. To get full support the Contractor must tamp material under the form. A portable tamper that rides on the forms can be used. The tamper has arms that hang down on each side of the form. A tamper foot at the end of each arm forces material under each side of the form. To work properly a small amount of material must be placed along each side of the form. After the forms have been tamped, check the effectiveness of the tamping by trying to shove a lath or pin under the form. If it goes under, the form does not have full support and must be retamped.

When the forms are properly tamped, check for correct elevation and location with a ruler and carpenter's level.

Method for checking form elevation:

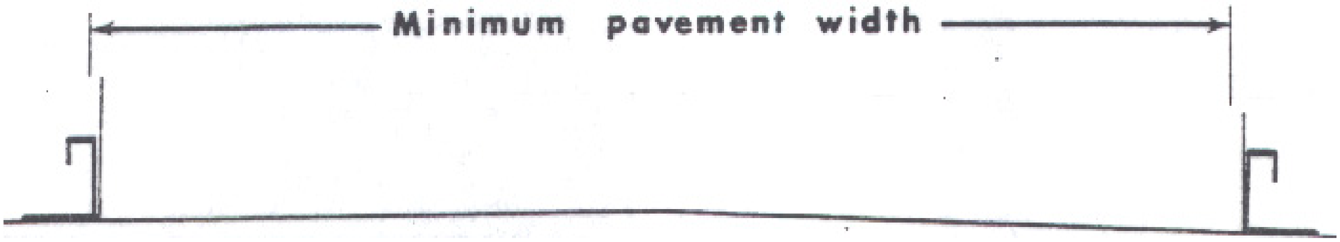
1. Put the ruler on top of the hub.
2. Put one end of the carpenter's level on top of the form and slide the other end up or down against the ruler until the bubble shows that it is level.
3. Read the measurement on the ruler at the bottom of the level. The reading should be equal to the amount of fill shown for the hub. If it is not, the Contractor must adjust the elevation of the form.
4. To check alignment, put one end of a carpenter's level on the tacked hub and measure over to the top of the form to see if it is the correct offset distance.

Check the location of the form by measuring from a point that is directly above the hub tack to the inside face of the form. This distance should be equal to the offset distance.

The two lines of forms must be set to get the correct pavement width. Using a tape, measure the distance between the inside faces of the forms. The measured distance should be at least equal to the proposed pavement width at that point. If it is not, the Contractor must adjust the forms.

When automatically controlled form finegrading is used, the forms are set after the finegrade has been trimmed. Generally, the entire width trimmed has a crown slope. This means the tops of the forms will be tilted outward (Figure 2.33) when set on the finegrade.

Figure 2.31 Forms, placed on finegraded surface, will be slightly tilted outward.



The tilt is slight and does not affect the stability of the form. A minimum pavement width equal to that required by the plans is necessary, so check the width between the bottoms of the forms.

Because this type of finegrader cuts the material to a very close tolerance, it is usually not necessary to tamp the forms. However, in areas where the forms will not set firmly on the finegrade, the Contractor must tamp these areas. Use personal judgement to determine the need for tamping.

Check that the forms are placed where they belong on the roadway. Measure from the hub line used for alignment control to the inside face of the form.

If the finegrade has been checked and is accurate, form elevation should be close to accurate. "Eyeball" the forms for alignment and elevation. If they appear to be off, check them with the straightedge.

CHAPTER

3

FORMS AND REINFORCEMENT

Forms (380.3 B 7)

Forms shall have a depth not less than the prescribed edge thickness of the pavement. Built up forms with horizontal joints shall not be used.

When staked in place, forms shall withstand the pressure of the concrete and the impact, vibration and loading of any equipment they are required to support, without significant springing, settlement, or lateral displacement meeting the following requirements.

The top face of any form shall not vary from a true plane by more than 1/8 of an inch in 10 feet, nor shall the contact face of a straight form vary from a true plane by more than 1/4 inch in 10 feet.

Bent, twisted, or broken forms and those with battered top surfaces shall be removed from the work. Repaired forms shall not be used until inspected and approved. Flexible or curved forms of proper radius shall be used for curves of 100 foot radius or less. Flexible or curved forms shall be of an acceptable design. **Standard Specifications 380.3 B 7.**

Figure 3.1 Form specifications, elevation view.

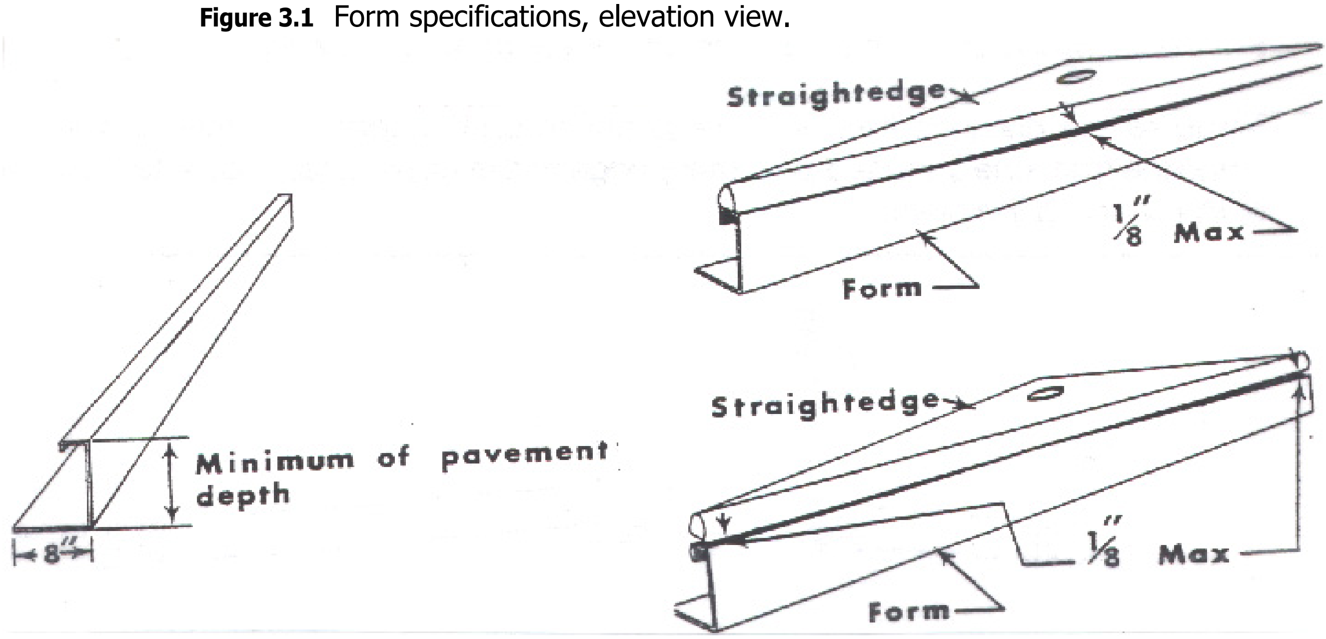


Figure 3.2 Form specifications, plan view.

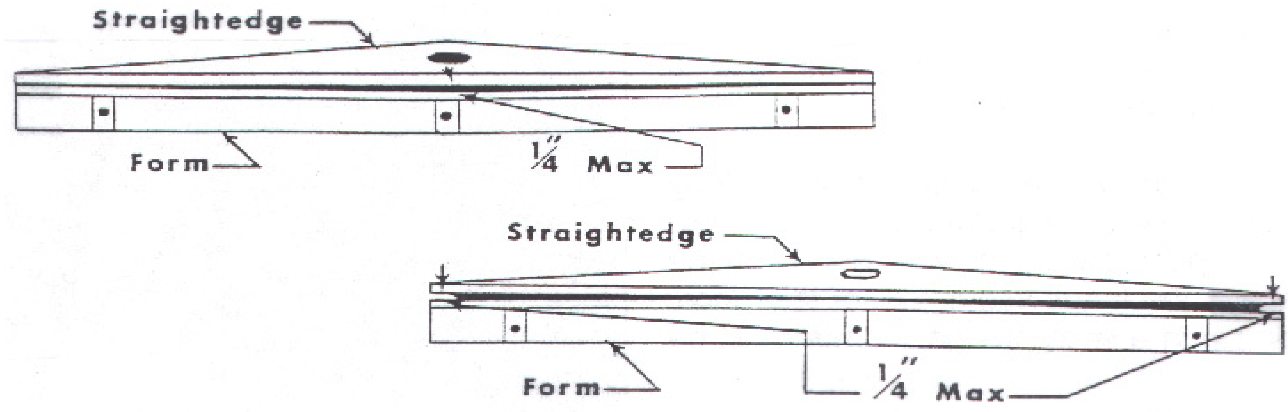


Figure 3.3 Horizontal pinlock connects the form to the form pin.

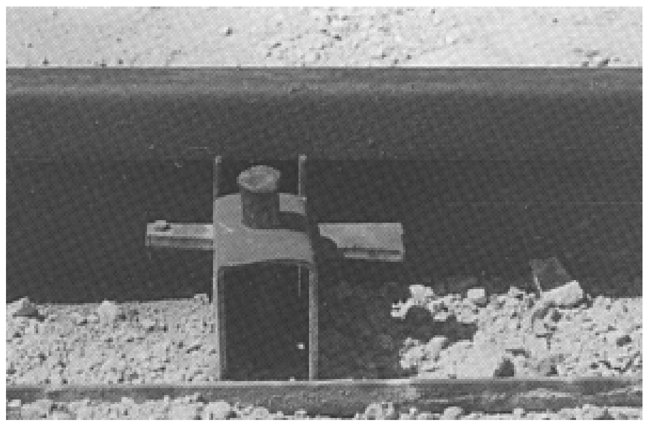


Figure 3.4 The arrow points to the form sliding end piece for locking together adjoining forms.

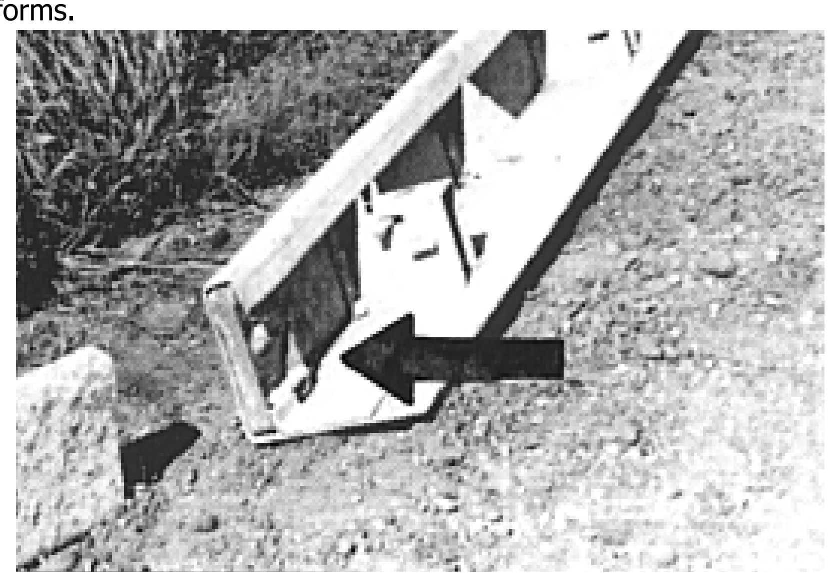


Figure 3.5 A curve having a radius over 100 feet formed by using 10 foot straight sections.

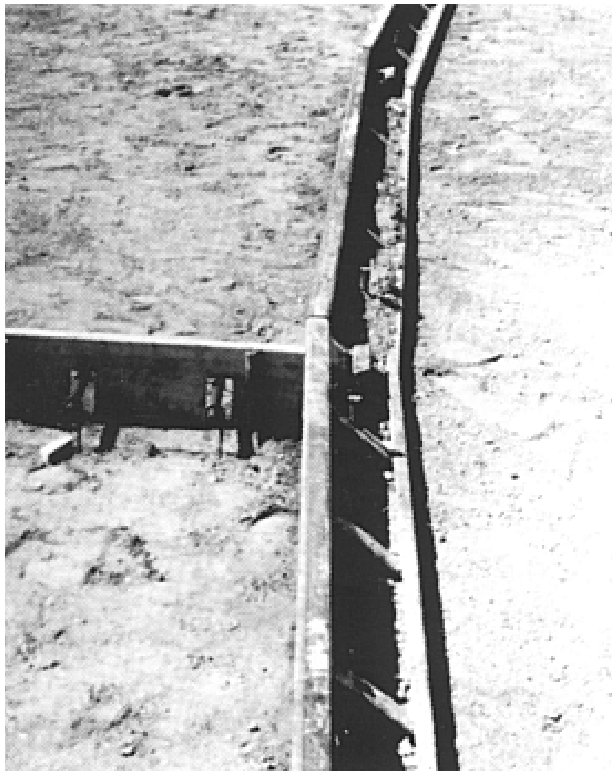
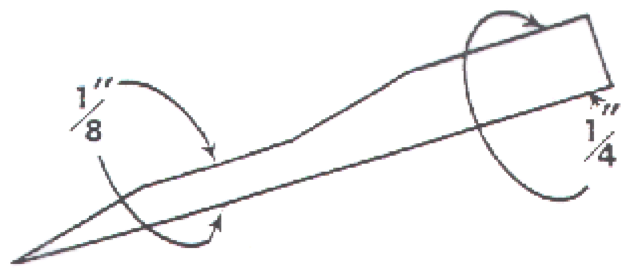


Figure 3.6 A curve having a radius of less than 100 feet formed by using wooden forms to give the concrete the proper radius. Fill the area between wood and metal forms with gravel.

Thorough inspections done before the Contractor starts setting the forms eliminates the need to remove and reset unacceptable forms. Use a "homemade" template (Figure 3.7) to check the straightness of the top and face of the forms instead of measuring for tolerance. Any form not meeting the requirements must be rejected. Checking for straight forms is most important when no profilograph specification is used in areas like shoulders or smaller jobs. Forms may be repaired, but must be reinspected before use.

Figure 3.7 Homemade Template.



Form Placement

Placed forms must be checked for overall alignment. Use the **"eyeball"** method. The forms look straight and the tops give a smooth surface (Figure 3.8).

Figure 3.9 show poorly set forms. They probably were not checked after they were set, and poor pavement will result. If the surface of the forms seems out of tolerance, check it with a straightedge. Forms must be set correctly for smooth pavement.

REMEMBER: The top face cannot vary from a straight line by more than 1/8" in 10 feet.

Figure 3.8 Straight even forms; see damage to finegrade. It should be recompacted and recut, or pavement failure will result.

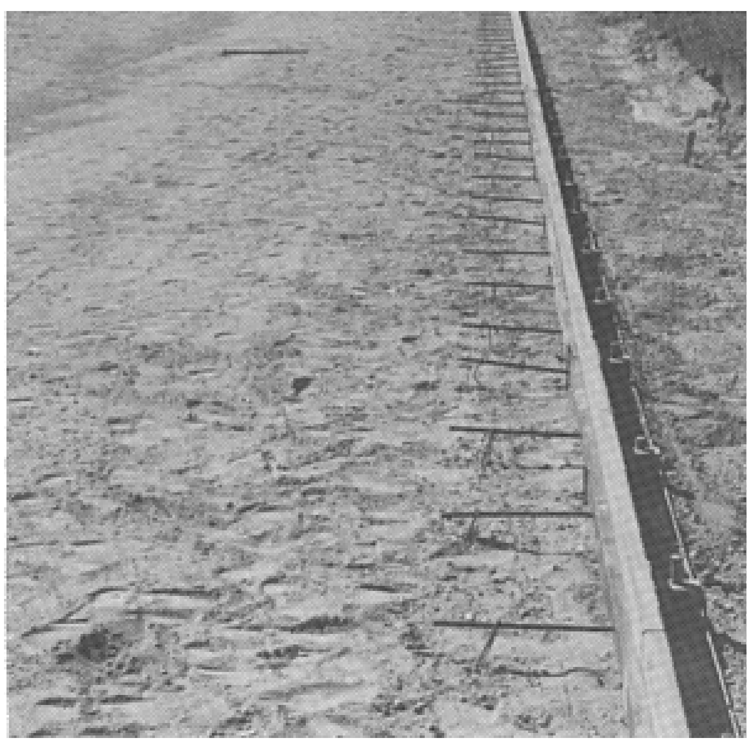


Figure 3.9 Poorly set forms.

Figure 3.10 Poorly set header

Sometimes areas within the lane (Figure 3.11) on urban projects, such as a manhole need to be filled in later. Be sure the forms are placed in the correct locations and set to the proper elevation.

Similarly, for curb and gutter construction, the drop inlets (Figure 3.12) are constructed before actual mainline paving begins. Installation of the frame and grate assemblies must be done in conjunction with the placement of concrete curb and gutter.

Figure 3.11 Forms with keyway around manhole. The orientation of forms insures the corners are at joints.

Figure 3.12 Drop inlet box in place before paving.

Form Removal

Forms shall not be removed until concrete has set for at least 12 hours (**380.3 N**) except for auxiliary forms used temporarily in widened areas. Forms shall be removed without damaging the pavement. After the forms have been removed, the exposed sides of the slab shall be cured by one of the methods discussed later in this manual.

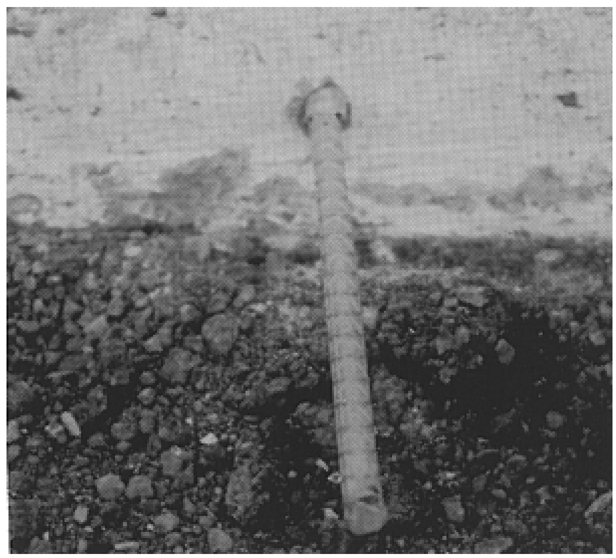
Reinforcement (380.3 J)

All concrete pavement contains reinforcement but the type depends on the pavement design.

Tie Bars

Tie bars (Figure 3.13) are deformed reinforcing bars. They are placed across some longitudinal joints to hold the pavement together and to prevent faulting. Check plan notes and standard plates for the size, length and placement of the tie bars (Appendix 13, 380.10). Deformed tie bars shall conform to the requirements specified in **Section 1010.1** of the Standard Specifications which require epoxy coated Grade 40 or better steel except that rail steel shall not be used for tie bars that are to be bent and re-straightened.

Figure 3.13 Deformed tie bar



Nonreinforced pavement contains tie bars placed across the centerline or any longitudinal joint. Tie bars shall be positioned on approved supports in advance of concrete placement, which is accomplished by placement of tie bars wired to chairs.

Always check the location and depth of the tie bars periodically after concrete placement. Either dig them out or check with a cover meter to verify location depth. Materials and Surfacing currently uses Ground Penetrating Radar (GPR) for finding tie bar locations in hardened concrete on most projects.

Tie bars mechanically inserted in the side of the slab shall be placed prior to the final strike off of the paver. The hand insertion method on the side of the slab and the use of a jig to place tie bars in fresh concrete is not allowed.

Note Tie Bar and Longitudinal Joints Plan Note as written:

The use of automatic tie bar inserters will only be allowed on the vertical edge of longitudinal construction joints. The use of automatic tie bar inserters will not be allowed on sawed longitudinal joints.

Tie bars shall be held in the specified position parallel to the slab surface and perpendicular to the centerline by a supporting device. Tie bars or tie bar baskets shall be securely staked to the roadbed and shall hold the bar at the correct spacing, alignment, and elevation.

Tie bars will not require supports if inserted into the side of the pavement during slip form paving of the longitudinal construction joint operation. Failure to acquire the correct tie bar locations or position in the construction joint shall require the bars to be corrected and a change made to the operation which may include drilling and epoxy bars or other methods as approved by the engineer.

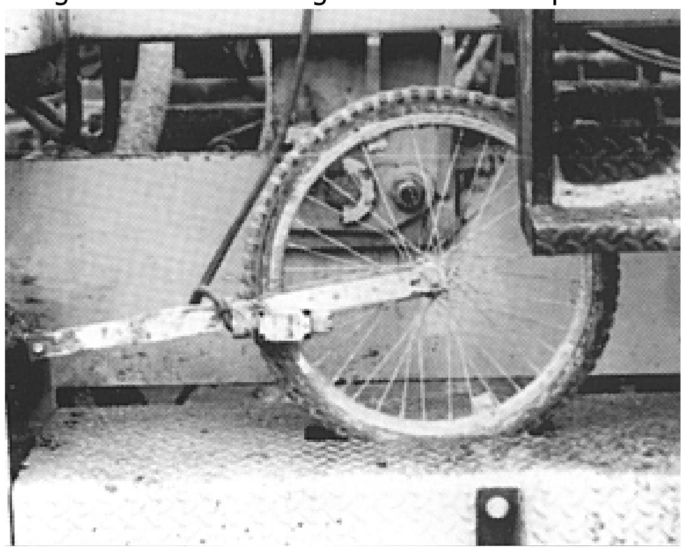
The final position of each tie bar shall be within the following tolerances:

-- Vertical Placement: ± T/6 for any part of the tie bar (T = slab thickness)

-- Transverse Placement (side shift): ± 3 inches when measured perpendicular to the longitudinal joint line

If the tie bar does not meet the requirements and tolerances specified, corrective action shall be performed at the Contractor's expense to the satisfaction of the engineer

Figure 3.14 Wheel riding on track measuring intervals for bar placement.



An inserter unit mounted on the side of a slipform paver consists of a measuring device and a tie bar inserter to place the steel. Sometimes the measuring device is a small wheel that rides on one track of the paver (Figure 3.14). The wheel measures the forward movement of the paver and at the predetermined intervals an electronic impulse is sent to the placement unit. For a side inserter, the tie bars are usually individually fed into it by hand. Care should be taken to prevent forcing a tie bar down onto a dowel basket or within 15 inches of a transverse joint.

Figure 3.15 Side inserter

Figure 3.16 Centerline tie bar inserter (not allowed).

Another method is to drill and epoxy the tie bars in-place as illustrated in the series of figures that follow.

Steel Bar Installation

An epoxy resin adhesive must be used to anchor the steel bars in the drilled holes. The steel bars shall be cut to the specified length by sawing and shall be free from burring or other deformations. Shearing will not be permitted.

The diameter of the drilled holes in the existing concrete pavement for the steel bars shall not be less than 1/8″ nor more than 3/8″ greater than the overall diameter of the steel bar. Holes drilled into the existing concrete pavement shall be located at mid-depth of the slab and true and normal. The drilled holes shall be blown out with compressed air using a device that will reach to the back of the hole to ensure that all debris or loose material has been removed prior to epoxy injection (Figure 3.18). It may be necessary to insert a long round wire brush prior to blowing to loosen the material inside the hole.

Figure 3.17 shows holes drilled, as specified in the plan, into the side of the pavement. Tie bars are laid out for placement in the holes.

Figure 3.17 Holes in slab; Tie bars ready to be placed.

Figure 3.18 Cleaning Holes

Figure 3.19 Crew placing tie bars

Epoxy resin adhesive shall be of the type intended for horizontal applications, and shall conform to the requirements of ASTM C 881, Type IV, Grade 3 (equivalent to AASHTO M235, Type IV, Grade 3). Refer to Manufacturer Recommendations for minimum time before concrete placement (1-2 hours is not unheard of). Verify the epoxy has not exceeded the expiration date.

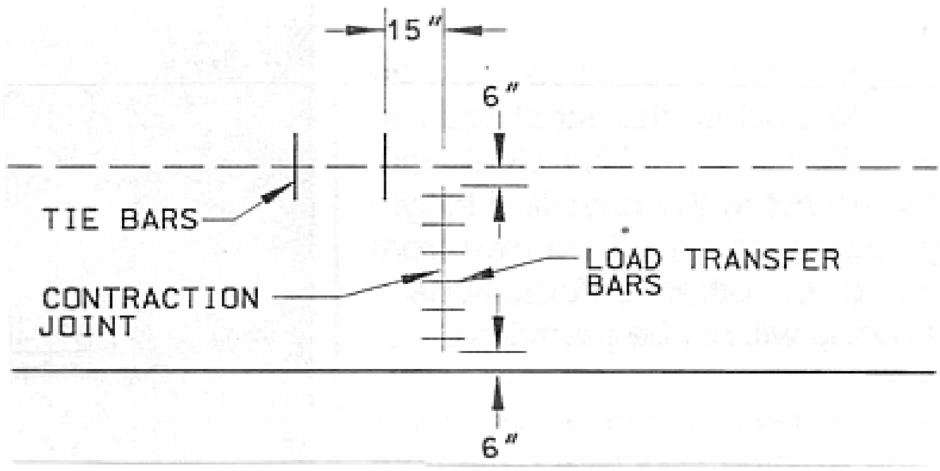
Mix the epoxy resin as recommended by the manufacturer and apply by an injection method approved by the Engineer. If an epoxy pump is utilized, it shall be capable of metering the components at the manufacturer's designated rates. Fill the drilled holes 1/3 to 1/2 full of epoxy, or as recommended by the manufacturer, prior to insertion of the steel bar. Care shall be taken to prevent epoxy from running out of the horizontal holes prior to steel bar insertion. Rotate the steel bar during installation to eliminate voids and ensure complete bonding of the bar. Insertions of the bars by the dipping method will not be allowed.

Pump shall be equipped with an automatic shut-off valve if either component is not being metered at the designated rate.

Figure 3.20 Two tie bars in place between a sealed transverse joint.

Dowel bars shall not be placed closer than 6" to any longitudinal joint or edge of pavement. Tie bars shall not be placed closer than 15" to a contraction joint (Figure 3.21).

Figure 3.21 Diagram showing distances of load transfer bars and tie bars.



Pull Testing

The Contractor shall load test 5% of the first 500 tie bars that are drilled and epoxied in place. No further installation will be allowed until the initial 5% testing has been completed and approval to continue installation has been given by the Engineer. Testing will be required for 0.5% of the bars installed after the initial 500. For each bar that fails to pass the minimum requirements, 2 more bars selected by the Engineer shall be tested. Each bar that fails to meet the minimum load requirement shall be reinstalled and retested. The equipment and method used for testing shall meet the requirements of ASTM E 488. All tests shall be performed within 72 hours of installation. Tie bars shall be installed and approved before concrete is placed in the adjacent lane. **(380.3 L 2)**

Keyway Placement

A keyway is a recessed notch that is formed into the longitudinal joint when an adjacent slab will be placed against it later in the project. The keyway shape (Figure 3.22) transfers the traffic load from one slab to the other. Butting two slabs together may require that a keyway be put into the slab placed first. Refer to Standard Plates for Longitudinal Joint either with or without tie bars (Appendix 13, Standard Plates 380.10 & 380.11) for keyway dimensions and if required to be used.

When two adjacent slabs must be tied together with tie bars, plan sheets (Handout 5-Sheet F8) will indicate the areas (**380.3 L 2**).

When tie bars are used in a keyway longitudinal joint, they are bent into an "L" shape and stuck inside the keyway to eliminate construction interference on the first slab. Inspect the location and elevation of the tie bars and the keyway. To straighten the tie bars, the Contractor should use 0.75 inch diameter length of pipe. Larger pipe or other methods can result in a bad bend in the straightened tie bar. If bars are snapped off, a new bar needs to be drilled and epoxied in.

Figure 3.22 Tie bar and keyway relationship

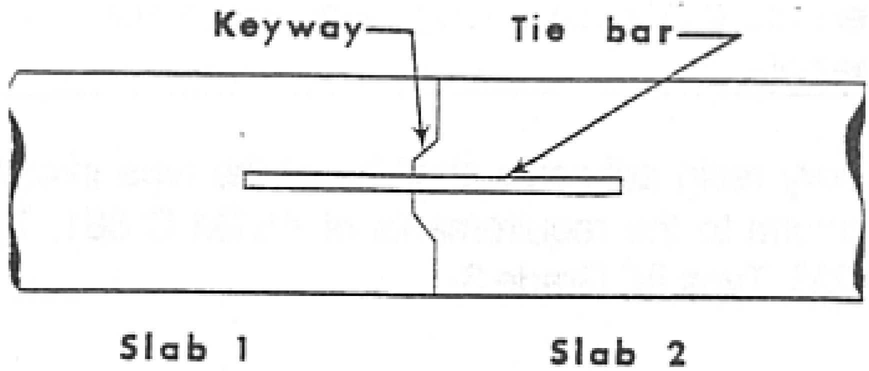


Figure 3.23 Formed extruded keyway with tie bars in place in the keyway.

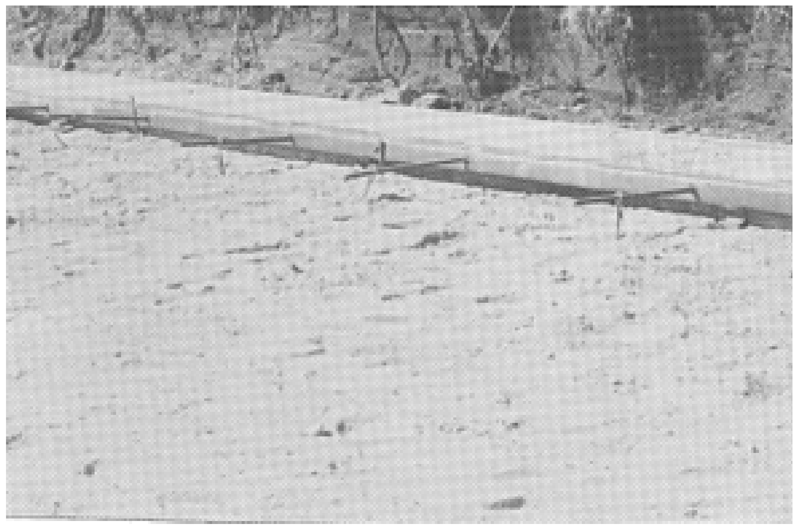
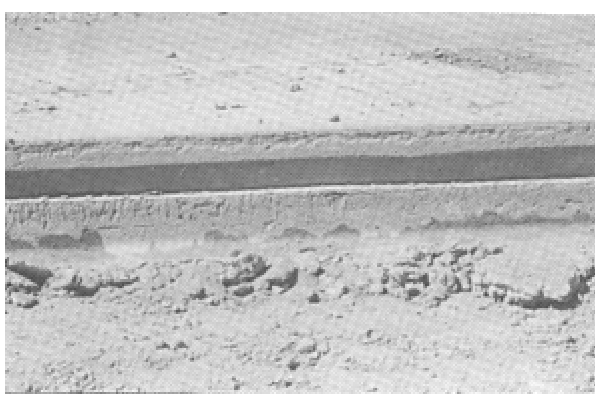


Figure 3.24 Keyway strip in slab.



Some slipform pavers feed a metal keyway into the front of the paver (Figure 3.25). This continuous metal keyway keeps the top edge from slumping down after the slipform process. The keyway is held at the proper height through the paver by a small lip on the inside surface of the side forms of the paver. Tie bars can even be installed during this process.

Figure 3.25 Slipform paver putting in a keyway.

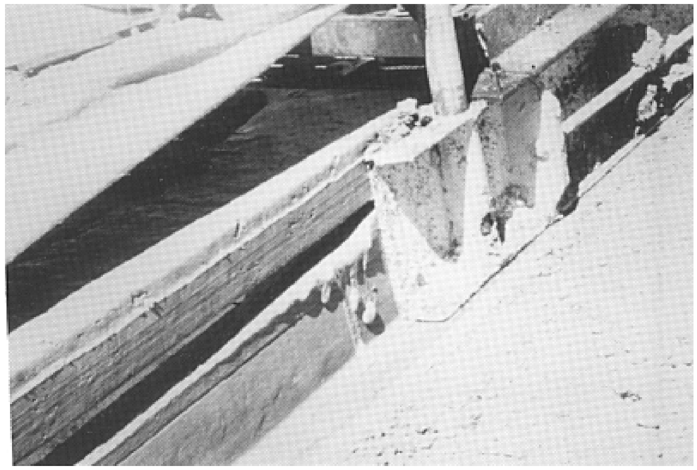
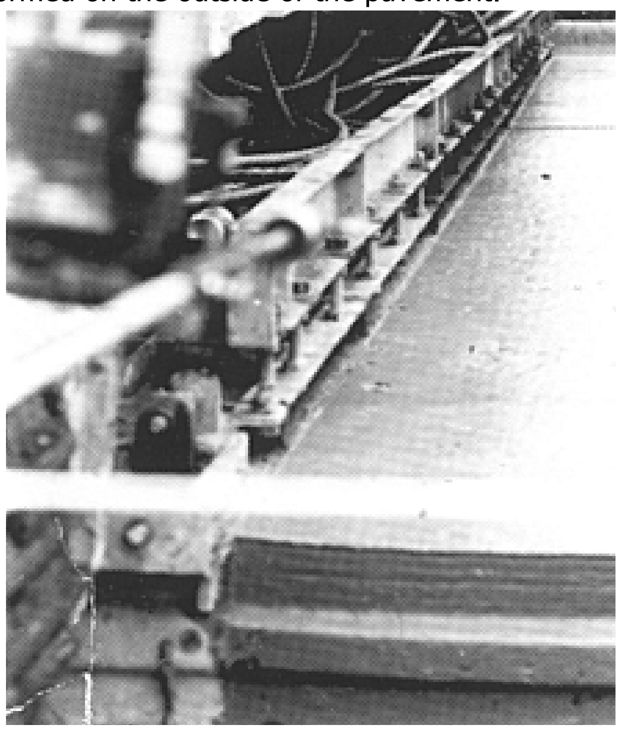


Figure 3.26 Keyway formed on the outside of the pavement.



When the pavement is slipformed and a keyway is formed into the pavement edge without the use of a metal strip, the pavement edge may slump down. Watch for this edge slump and if extra support is needed in isolated areas, boards or forms placed against the concrete will hold it in place. If excessive edge slump (380.301) cannot be fixed, do not allow the slipforming of keyway to continue. Excessive edge slump is 1/8 inch on a crown joint.

Some slipform pavers form the keyway on the outside of the pavement (Figure 3.26). A keyway that protrudes from the joint is called a male keyway. The male keyway does not work as well so an in inverted (female) keyway is recommended. There is a different tie bar spacing requirement for male and female keyways.

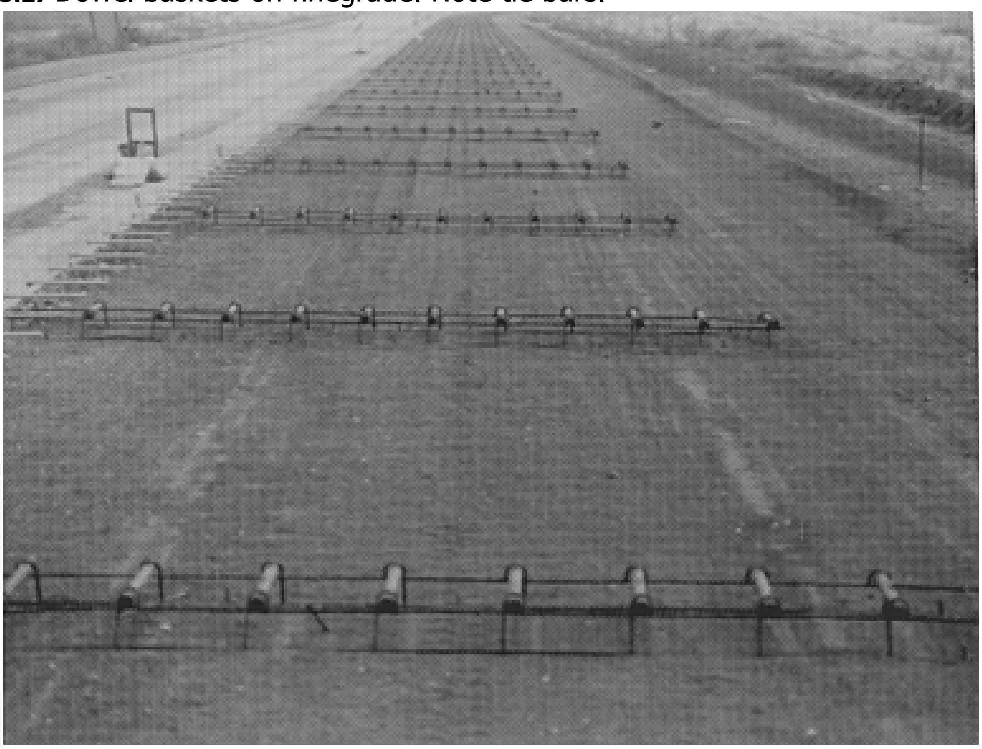
Dowel Bars (380.3 I)

Dowel bars are commonly used to improve load transfer at concrete pavement transverse joints. They must allow free longitudinal movement of the contraction joint to relieve internal stresses. Dowel bar assemblies shall be installed where specified in the plans. Dowel bar assemblies shall be fabricated in single units for the appropriate lane prior to being placed on the subgrade. The pins holding the dowel bar assemblies in place shall be placed on the bars side of the assembly that is downgrade from the paver. The free ends of the epoxy coated bars (minimum of 0.5 of dowel length + 2 inches) shall be given a thin uniform coating of form oil or asphaltic bond breakers, this coating shall be applied within two hours of being covered by concrete. (**1010.1 D & 380.3 I**)

Tectyl 506 is a clear coating that acts as a bond breaker.

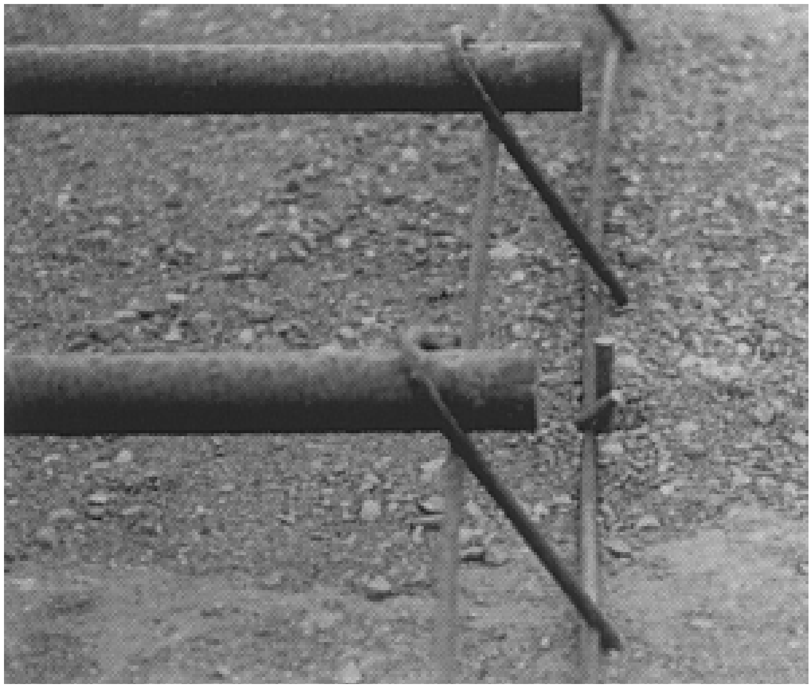
Dowel basket assemblies are now available in pre-dipped asphaltic bond breaker material. Dowel bar assemblies shall be pre-coated on projects which have quantities of portland cement concrete pavement of 50,000 square yards or greater. Pre-coated dowel bar assemblies must be free of foreign materials at the time of placement. Ensure the Contractor avoids thick coatings of lubricant on dowel bars. A thick coating produces large voids in the concrete along dowel bars resulting in joint failure.

Figure 3.27 Dowel baskets on finegrade. Note tie bars.



The location of doweled contraction joints shall be carefully marked by spray paint, redheads, or other techniques on forms or adjacent to the outer edge of where the pavement will be placed to assure accurate placement of the joint during subsequent operations. This marking must be carefully measured and marked to withstand following construction activities. The inspector must ensure that dowel baskets are centered where the joint will be cut. This must be done prior to paving.

Figure 3.28 Dowel basket staked to prevent movement.



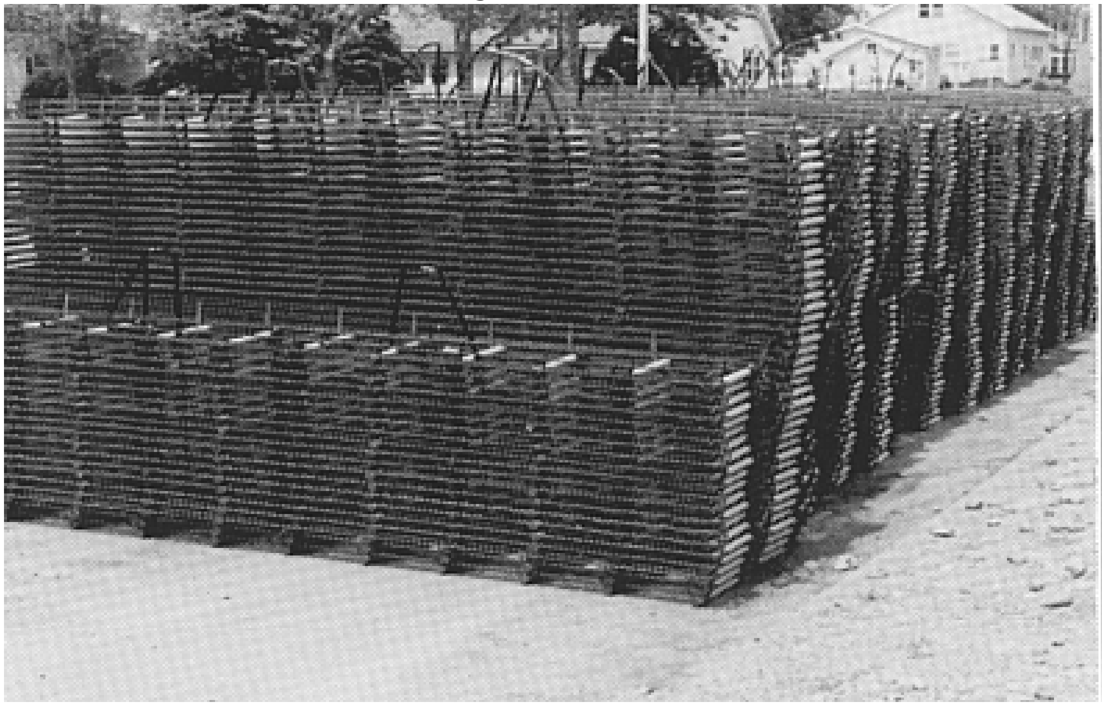
The transverse contraction joints shall be sawed perpendicular to the centerline of the roadway and the dowel bars should be centered on the sawed joint +/-1.0".

Figure 3.29 Dowel basket and joint. Note: misaligned bar.

Dowel bars shall be placed parallel to the subgrade and parallel to the centerline of the pavement. Misaligned dowels either vertically or horizontally are a cause of joint failures. Always check the Standard Plates in the plans for dowel bar tolerances.

Careful dowel basket storage at the project site can prevent damage to the dowel baskets. The storage system shown also features a solid storage base and easy access to baskets when they are needed.

Figure 3.30 Excellent dowel basket storage.



Do not allow dirt or grass covered dowel baskets to be placed. These create voids around the bars. Future joint failures might occur. If dowel baskets are to be stored on site for more than 30 days, cover them as per **480 3 A**.

CHAPTER

4

CONTINUOUSLY REINFORCED CONCRETE PAVEMENT STEEL

Continuously reinforced concrete pavement (CRCP) is a Portland Cement Pavement that has continuous longitudinal steel reinforcement. CRCP does not have intermediate transverse expansion or contraction joints. The pavement is allowed to crack in a random transverse cracking pattern and the cracks are held tightly together by the continuous steel reinforcement. The transverse cracks will most likely be spaced between 2 to 5 feet. The first 250-300 feet from a terminal anchor may not have any transverse cracks.

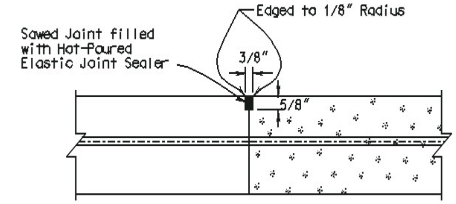
The principal reinforcement in CRCP is the longitudinal reinforcing bars. Transverse reinforcing bars are used to a lesser extent, depending on individual cases. If transverse reinforcing bars are not carried through longitudinal joint locations, tie bars are required to hold the adjoining slabs together.

Figure 4.1 Placement of continuously reinforced concrete pavement (CRCP)

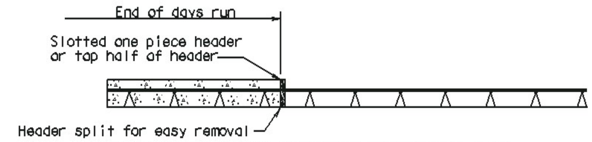
Transverse construction joints are provided in CRCP at locations where construction progress is halted at the end of the day's run or where production delays occur. Although these joints are few in number on any one construction project, their potential for creating problems is high and they must be constructed in accordance with design details. Experience has shown that special bar arrangements (Figure 4.2) are needed at transverse construction joints to handle early stress concentrations and to replace load transfer capacity lost because of the smooth joint faces.

Figure 4.2 Plan view of reinforcing steel layout.

Depth of Pavement	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)
8"	4"	8"	8"	8"	48"	6	19	39	25"	57' 11"	14' 5 3/4"
8.5"	4 1/2"	7 1/2"	9"	7 1/2"	48"	6	20	41	25"	57' 11"	14' 5 3/4"
9"	4 1/2"	7"	5"	9"	48"	6	22	44	25"	57' 11"	14' 5 3/4"
9.5"	4"	6 1/2"	10 1/2"	6"	42"	6	23	47	25"	57' 11"	14' 5 3/4"
10"	3"	6 1/4"	5 3/4"	6 3/4"	42"	6	25	50	25"	57' 11"	14' 5 3/4"
10.5"	3"	6"	6"	6"	42"	6	26	52	25"	57' 11"	14' 5 3/4"
11"	6"	7"	9"	6"	36"	7	21	43	30"	57' 6"	14' 4 1/2"
11.5"	5"	6 3/4"	9 1/2"	5 3/4"	36"	7	22	45	30"	57' 6"	14' 4 1/2"
12"	4"	6 1/2"	10 1/2"	6"	36"	7	23	47	30"	57' 6"	14' 4 1/2"

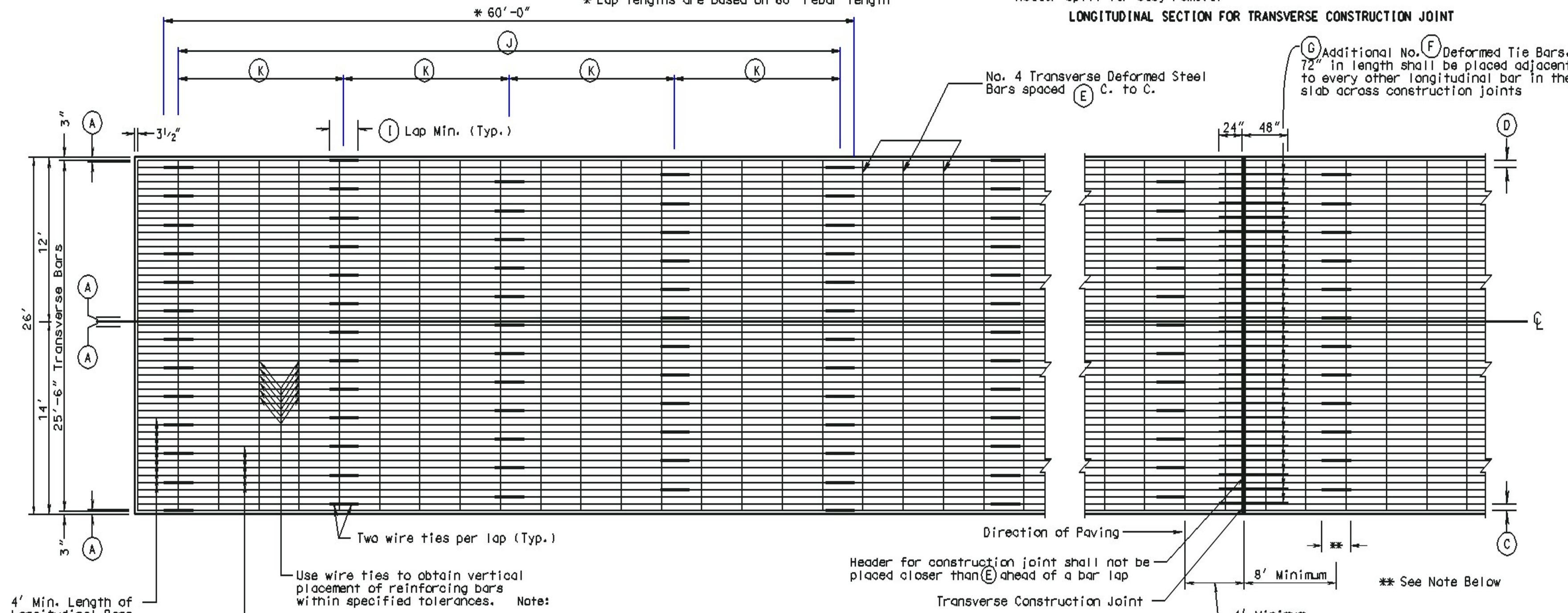


JOINT DETAIL FOR TRANSVERSE CONSTRUCTION JOINT



LONGITUDINAL SECTION FOR TRANSVERSE CONSTRUCTION JOINT

* Lap lengths are based on 60' rebar length



Note:

The center of the first lapping of longitudinal steel bars beyond a transverse construction joint shall be at least eight (8) feet ahead of such joint.

The first lap pattern for the full width of the driving lanes beyond a transverse construction joint must be lapped a minimum distance of 36 inches. In Lieu of this a bar lapping with a minimum distance of (I) inches will be permitted provided that additional No. (F) steel bars, each six (6) feet long, are placed adjacent to and centered longitudinally at each longitudinally lapped bar for full width of the driving lanes and tied with a minimum of two wire ties per bar. This will require the use of (H) No. (F) x 6' deformed steel bars.

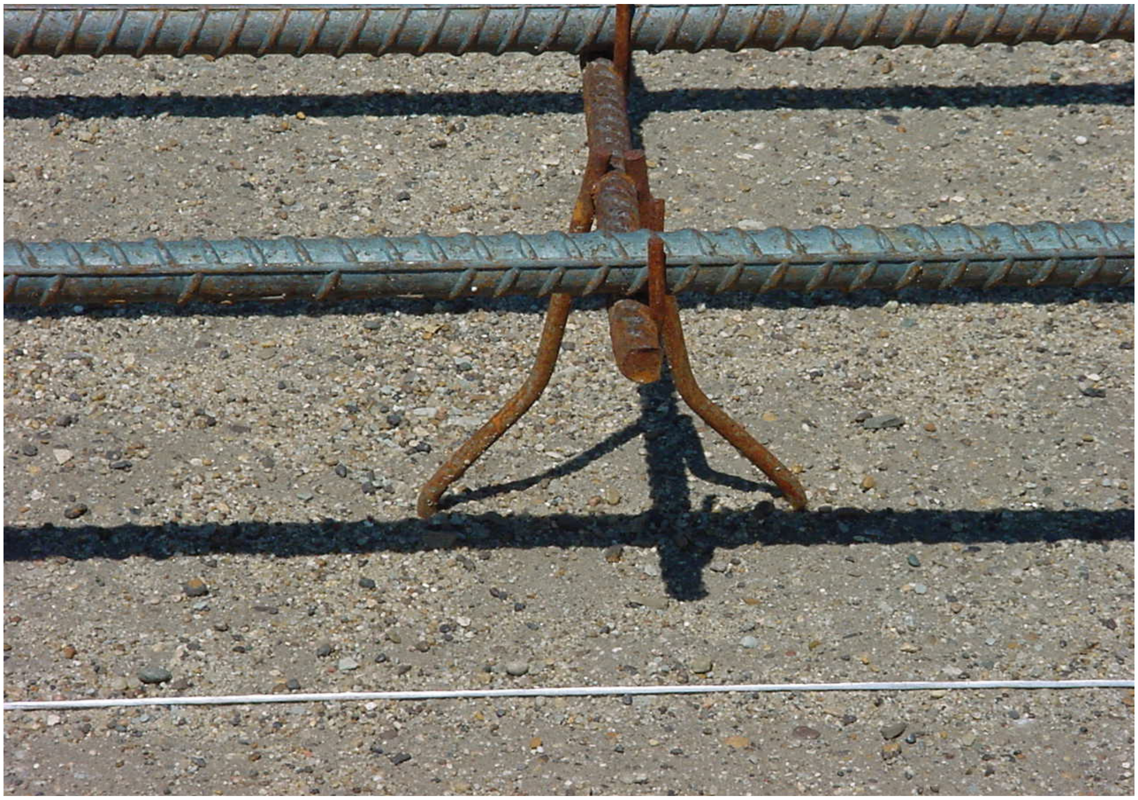
When a transverse construction joint is made, no paving will be done in this area for twelve (12) hours.

The length of the transverse deformed steel bars may vary +/- 2 inches.

The Contractor has the option of extending one side of the transverse bar a minimum of 15" beyond centerline or splicing the transverse steel bars, at centerline only, with No. 4 x 30" deformed steel tie bars.

Attention to design and construction quality control of CRCP is critical. A lack of attention to design and construction details and quality construction practices can cause premature failures in CRCP's. The most critical aspect of the CRCP design is the placement of the reinforcing steel. If the reinforcing steel is not placed correctly, a premature failure in the CRCP is imminent.

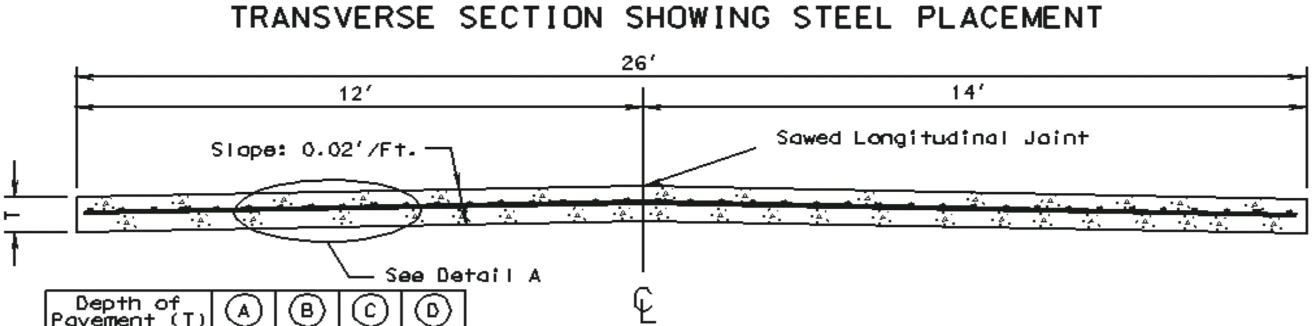
Figure 4.3 Steel supports on transverse bars



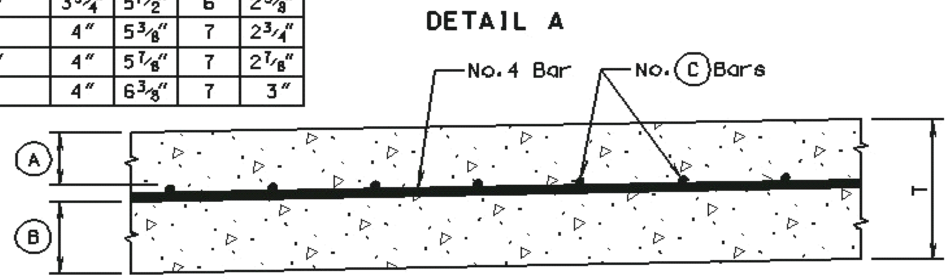
The inspector shall check the longitudinal lap of all splices to assure that the minimum lap of the reinforcing steel is maintained as shown in the plan details (Figure 4.2). The length of the lapped splices of the longitudinal reinforcing bars is critical to good performance. It is imperative that the minimum length requirements be observed carefully and enforced strictly during construction. If adequate bond strength is not developed in lap splices; wide cracks and subsequent failures will develop.

The inspector shall periodically check that the reinforcing steel is placed within the specified tolerance vertically (Figure 4.4). This is accomplished by pulling a stringline transversely across the roadway at the grade of the new pavement and measuring down to the reinforcing steel. Typically, the reinforcing steel will not be high. If the reinforcing steel is too high, the pavement will not be of sufficient depth and the Contractor may be price adjusted for the thin pavement. If the reinforcing steel is low, the Contractor will be required to shim the transverse reinforcing steel to correct the deficiency.

Figure 4.4 Transverse section showing steel placement in CRCP.

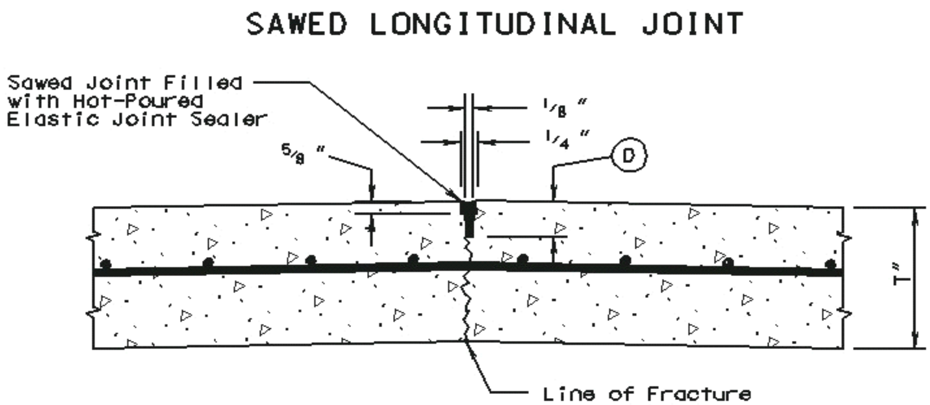


Depth of Pavement (T)	(A)	(B)	(C)	(D)
8"	3 1/4"	3 1/2"	6	2"
8.5"	3 1/4"	4"	6	2 1/8"
9"	3 1/2"	4 1/4"	6	2 1/4"
9.5"	3 1/2"	4 3/4"	6	2 3/8"
10"	3 1/2"	5 1/4"	6	2 1/2"
10.5"	3 3/4"	5 1/2"	6	2 5/8"
11"	4"	5 3/8"	7	2 3/4"
11.5"	4"	5 7/8"	7	2 7/8"
12"	4"	6 3/8"	7	3"



Placement of longitudinal steel bars may vary from + 1/2 inch to − 1/2 inch vertically and 3/4 inch horizontally. Placement of transverse steel bars may vary from + 1/2 inch to − 1/2 inch vertically and 2 inches horizontally.

The transverse deformed steel bars will be positioned on acceptable chairs.



GENERAL NOTE:

Steel bars for concrete reinforcement shall conform to the requirements of Specification M 31 (Grade 60) of the AASHTO Standard Specifications for Deformed Billet Steel Bars for Concrete Reinforcement.

The splicing detail shown in the reinforcing steel layout (Figure 4.2) can be seen in the photographs at Figures 4.1, 4.5, and 4.6. In Figure 4.3, the metal shoes holding the reinforcing steel at the correct level above the finegrade, mat, or bond breaker can be seen. A similar view, but from a different angle can be seen in Figure 4.5.

Figure 4.5 CRCP steel layout

The inspector should also check for steel spacing (Figure 4.2), bent steel reinforcement, broken welds on the chairs supporting the reinforcing steel, bar alignment changes, sufficient number of wire ties on the steel laps, broken clips have wire ties holding the reinforcing steel, and how the steel is lapped. Verifying the lap pattern with the plans (Figure 4.2) is important to preventing failures in the CRCP. The outside longitudinal steel bars should be lapped such that the approaching bar is placed to the inside as the paver approaches the lap. The spreader or paver may catch the approaching bar as the spreader or paver moves forward if the reinforcing steel is not lapped in this fashion.

The inspector should ensure foreign materials such as bits of wood, oily rags, cigarette butts, and soda cans are removed prior to placing concrete. The reinforcing steel shall be clean and free of any dirt before placement of the concrete.

Figure 4.6 CRCP steel layout

The inspector should also be watching the reinforcing steel during the concrete placement by either the spreader or paver. The plastic concrete being pushed ahead of either the spreader or paver puts a large amount of pressure against the reinforcing steel and can cause misplacement of the reinforcing steel. Experience has shown that tieing the steel to far ahead of the paver causes the reinforcing steel to bend due to the pressure from the paving operation.

The inspector should have a cover meter available on the project to periodically check the depth of the reinforcing steel behind the paver. This can be accomplished while the concrete is plastic or hardened. Another option used to verify the depth of the reinforcing steel is to actually dig down to reinforcing steel, while the concrete is still plastic, and measure the depth.

Figure 4.7 Checking reinforcement lap.

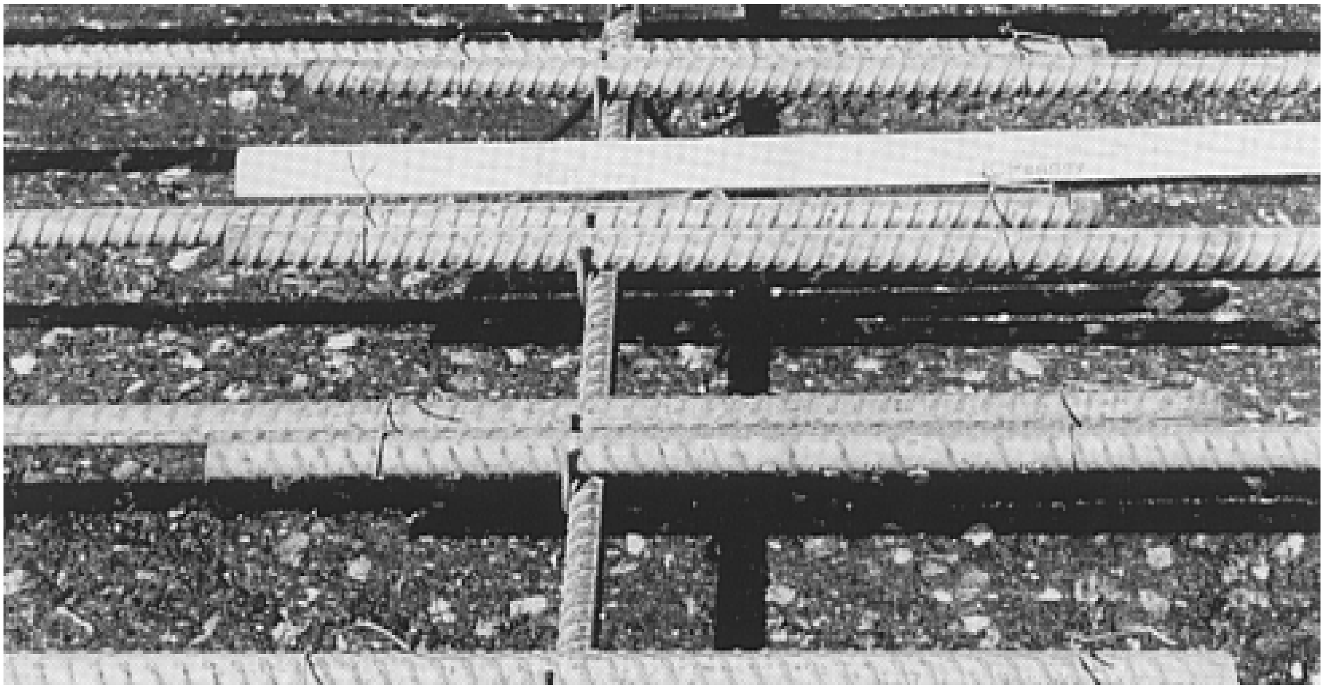
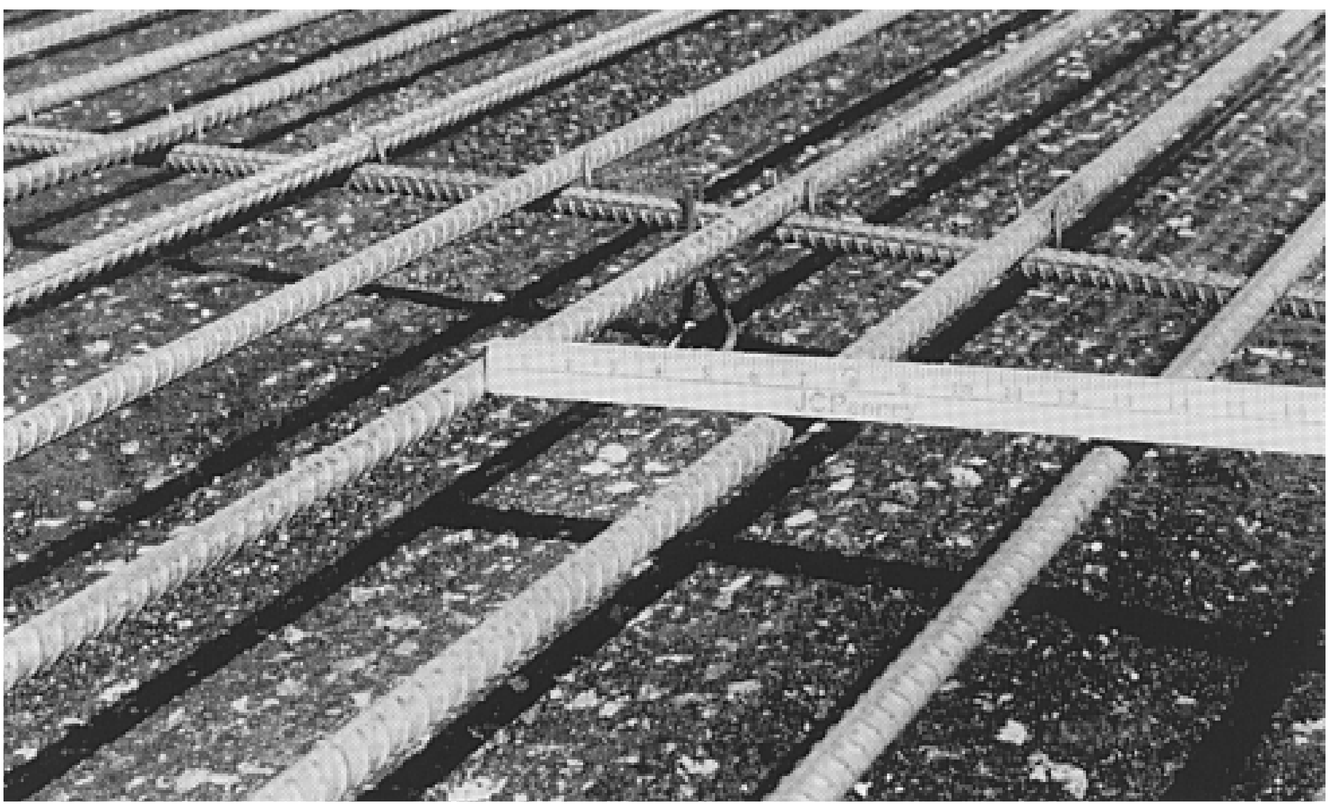


Figure 4.8 Checking steel placement spacing.



The finishing, texturing, curing, and longitudinal sawing is the same as any other PCCP. The same construction practices shall be followed and the inspector will be expected to monitor and measure the required items. Normally, CRCP will be required to meet smoothness requirements as specified in the contract.

Figure 4.9 Checking the height of the reinforcement.

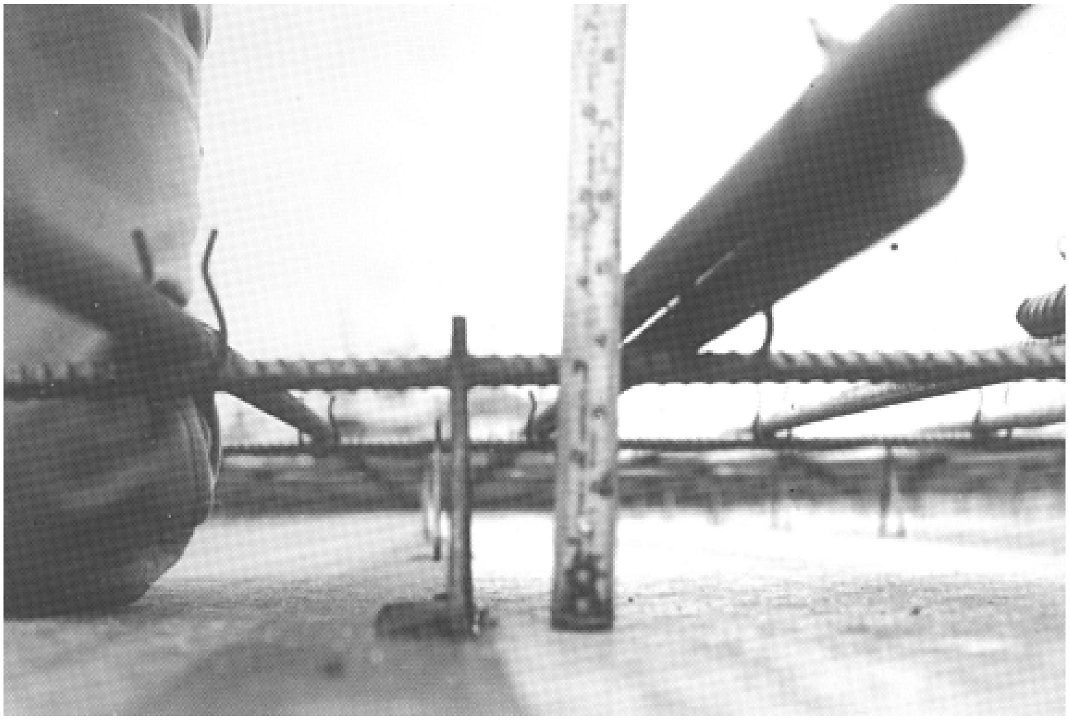
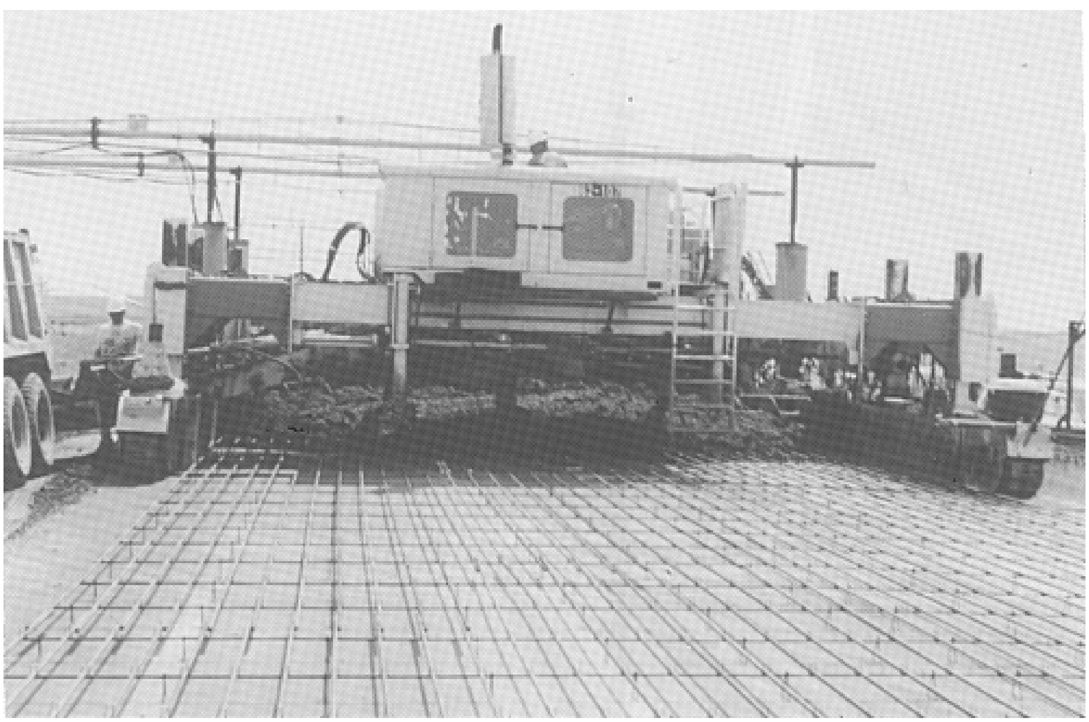


Figure 4.10 Spreader distributing concrete over an asphalt mat. The asphalt mat has a lime slurry sprayed on the surface.



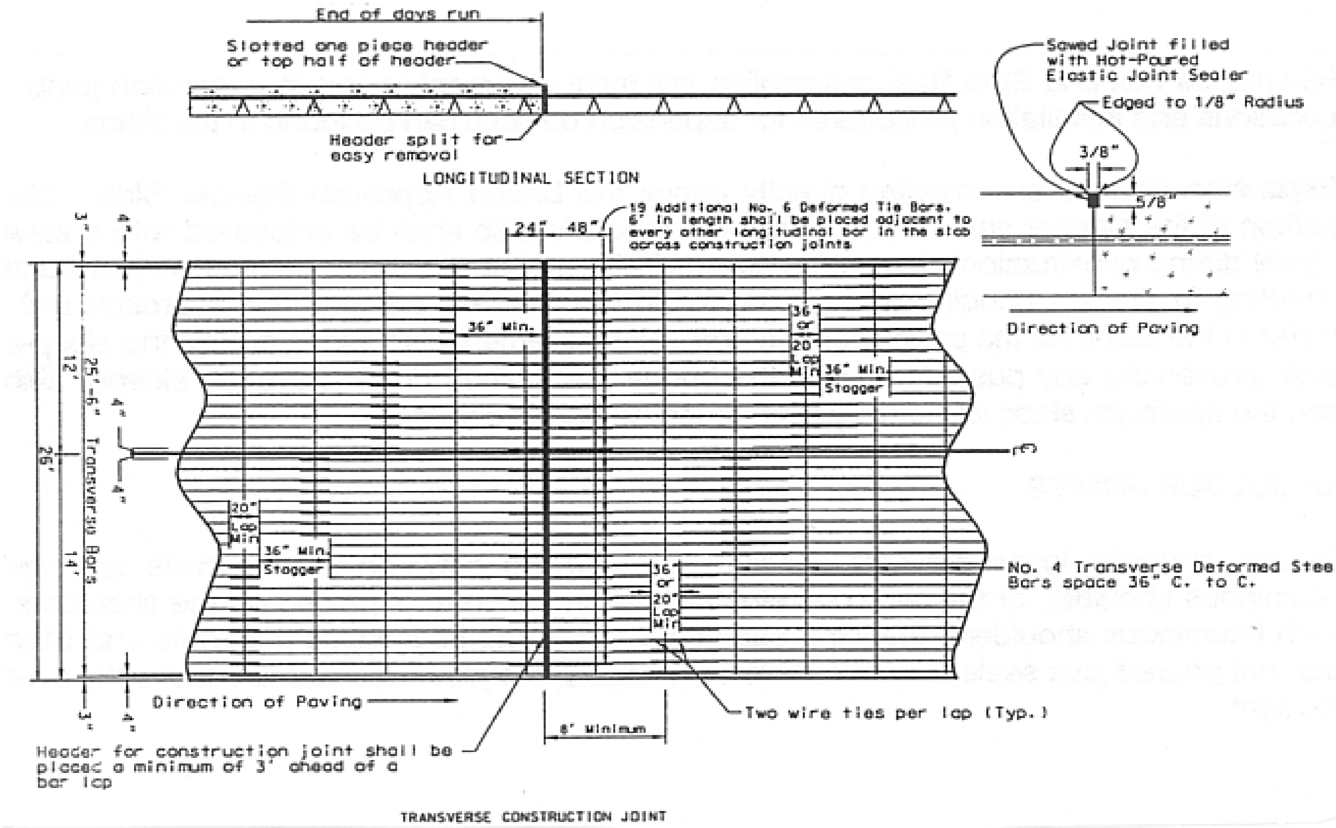
Some CRCP is an overlay of an existing pavement. The existing pavement can be either asphalt or concrete. If the existing pavement is asphalt, the roadway is milled to proper profile and cross slope and overlaid with CRCP. If the existing pavement is concrete, an asphalt mat or gravel bond breaker is placed over the existing concrete pavement to prevent the new pavement from bonding with the existing pavement (Figure 4.10). A lime slurry is sprayed on the asphalt overlay to minimize the amount of heat absorbed into the asphalt overlay and reduce the number of shrinkage cracks of the new CRCP that may be induced with the higher asphalt temperatures. Reducing the heat on the reinforcing steel and the mat helps prevent the concrete from setting up evenly. During periods of extreme heat the shoes supporting the reinforcing steel may sink into the asphalt overlay. If this occurs, placing pieces of tin under the shoes reduces the depth that the shoe will sink into the asphalt overlay and helps maintain the reinforcing steel at the proper height.

In some paving situations it becomes necessary to introduce a temporary gap in the mainline paving for a haul road crossing, an intersection where cross traffic must continue to flow, or for other reasons. These gaps in CRCP generally are referred to as "leave-ins" or "leave outs", depending on whether pavement is placed in the gap area before or after mainline construction. If paving in the gap area precedes mainline construction, the gap pavement is considered to be a "leave-in"; if it follows mainline construction, the gap in the pavement is considered to be a "leave-out".

Of the two gap pavement alternatives, the leave-in is by far the more preferable. Experience has shown that, if all details of leave-out construction are not handled in strict accordance with the plans, or if unexpected large ambient temperature drops occur before the leave-out concrete has hardened sufficiently, movement in the free ends of the hardened mainline concrete abutting the short stretch of freshly placed leave-out concrete will cause overstressing, producing excessive cracking and permanent loss of bond between the concrete and steel in the leave-out area. As a result of the difficulties that have been experienced, SDDOT does not permit the use of leave-outs.

Transverse Construction Joint with Continuously Reinforced Concrete

Figure 4.11 Longitudinal section of continuously reinforced pavement showing header.



Normally, the joint is formed by placing a slotted header board across the reinforcing steel to allow the longitudinal steel to pass through the joint. The longitudinal steel through the construction joint is supplemented by placing additional 6 foot # 6 deformed tie bars adjacent to every other longitudinal bar in the slab across the construction joint. The additional bars shall be 2 feet into the pavement and 4 feet through the slotted header into the area to be paved the next day. Assure complete vibration after installing reinforcement bars.

Always check the plan details. Normally, a longitudinal steel splice should not fall within 3 feet of the stopping side or closer than 8 feet from the starting side of the construction joint. The first lap pattern for the full width of the driving lanes, beyond a transverse construction joint must be lapped a minimum distance of 20". Provided that additional # 6 steel bars, each 6 foot long, are placed adjacent to and centered longitudinally at the full width of the driving lanes and ties with a minimum of two wire ties per bar.

Figure 4.12 Header in place.

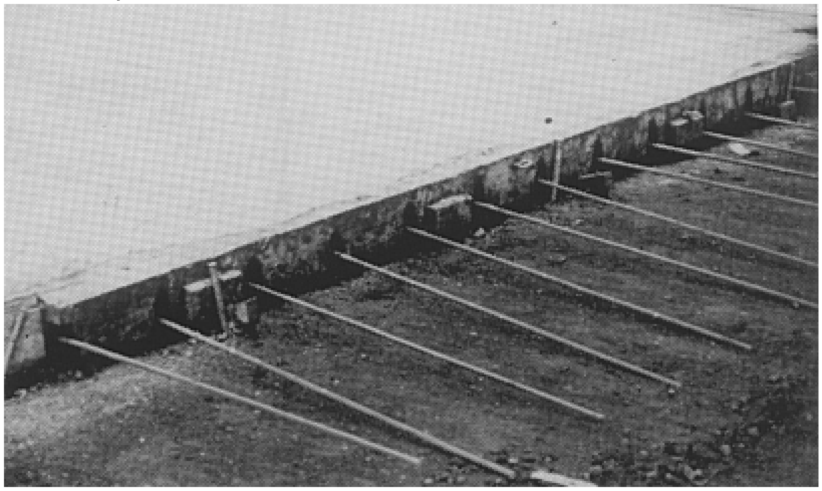
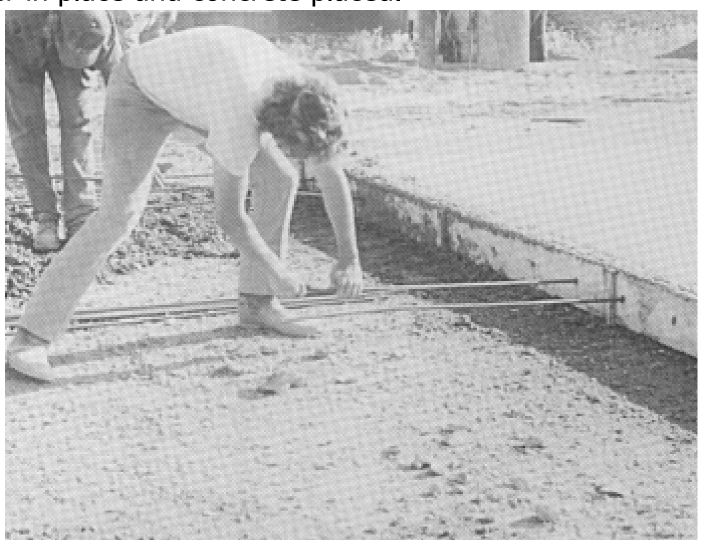


Figure 4.13 Header in place and concrete placed.



Extra care is needed to ensure both concrete quality and extra consolidation at these joints. The inspector must ensure that the header is placed correctly. A straight edge should be used to determine correct placement of the header. The inspector should assure that there is adequate vibration around reinforcing bars through the construction joint and vibrate a sufficient distance back from the construction joint to assure that all of the concrete has been properly consolidated.

Pavement Terminal

When the continuity of a CRC Pavement is interrupted at junctions with bridge structures or other pavements, the free end of the CRC pavement can be expected to undergo outward movements of up to 2 inches. To accommodate these movements a pavement terminal anchor is used. One side of the terminal anchor is tied to a section of nonreinforced concrete while the other side is used to allow movement of the CRCP. The terminal anchor is cast in a reinforced concrete sleeper slab that provides support to the ends of adjoining pavements (Figure 4.11). The steel flange helps protect the corners against spalling and aids in load transfer across the joint. End movement is accommodated by a compressible material placed on the side of the web adjacent to the CRC pavement. The terminal anchor is galvanized to prevent corrosion of the steel.

Figure 4.14 Pavement terminal anchor and sleeper slab

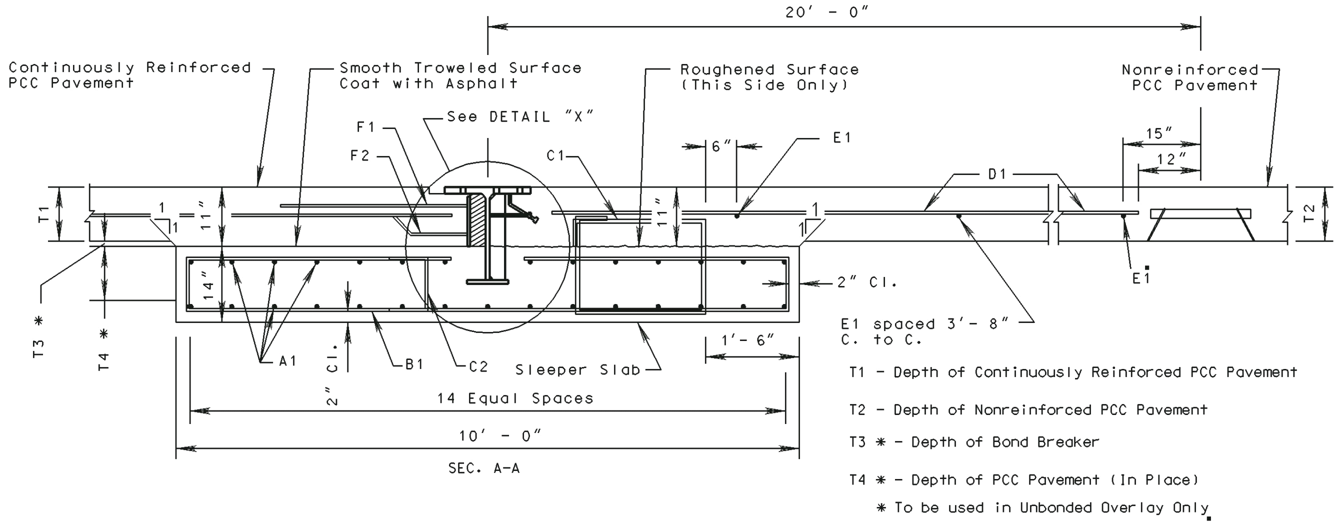
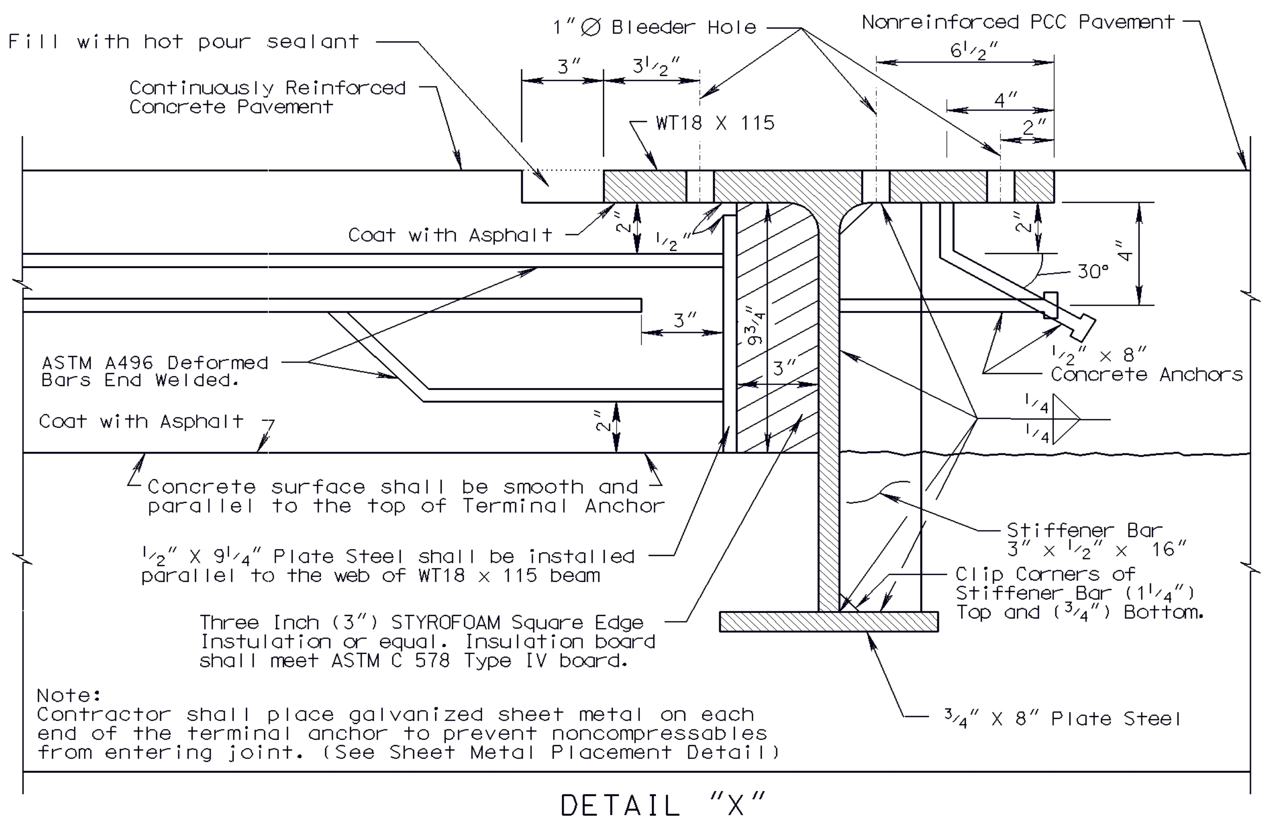


Figure 4.15 Detail "X" depicted in Figure 4.14.



The most commonly used terminal treatment for SDDOT is the modified WT18 x 115 steel beam with 1/2" x 8" concrete anchors (Figure 4.14). A steel plate is welded to the bottom of structural tee to anchor the beam to the sleeper slab. Stiffeners are added to the nonreinforced concrete side to prevent flexure at the flange/web interface. Concrete anchors are added to hold the beam in place. The steel beam (Figures 4.11, 4.12, 4.13, and 4.14) is set into a reinforced concrete sleeper slab and provides for the movement of the continuously reinforced concrete pavement. The concrete anchor side of the beam is placed adjacent to the nonreinforced PCCP (Figure 4.15). This terminal is known as the Portland Cement Concrete Pavement Terminal.

The top flange of the beam is flush with the pavement surface (Figure 4.11). Expansion material shall be placed as shown on the plan detail (Figure 4.13) and a bond breaker shall be placed between the CRCP and the sleeper slab (Figures 4.13 and 4.16).

Figure 4.16 Pavement terminal beam

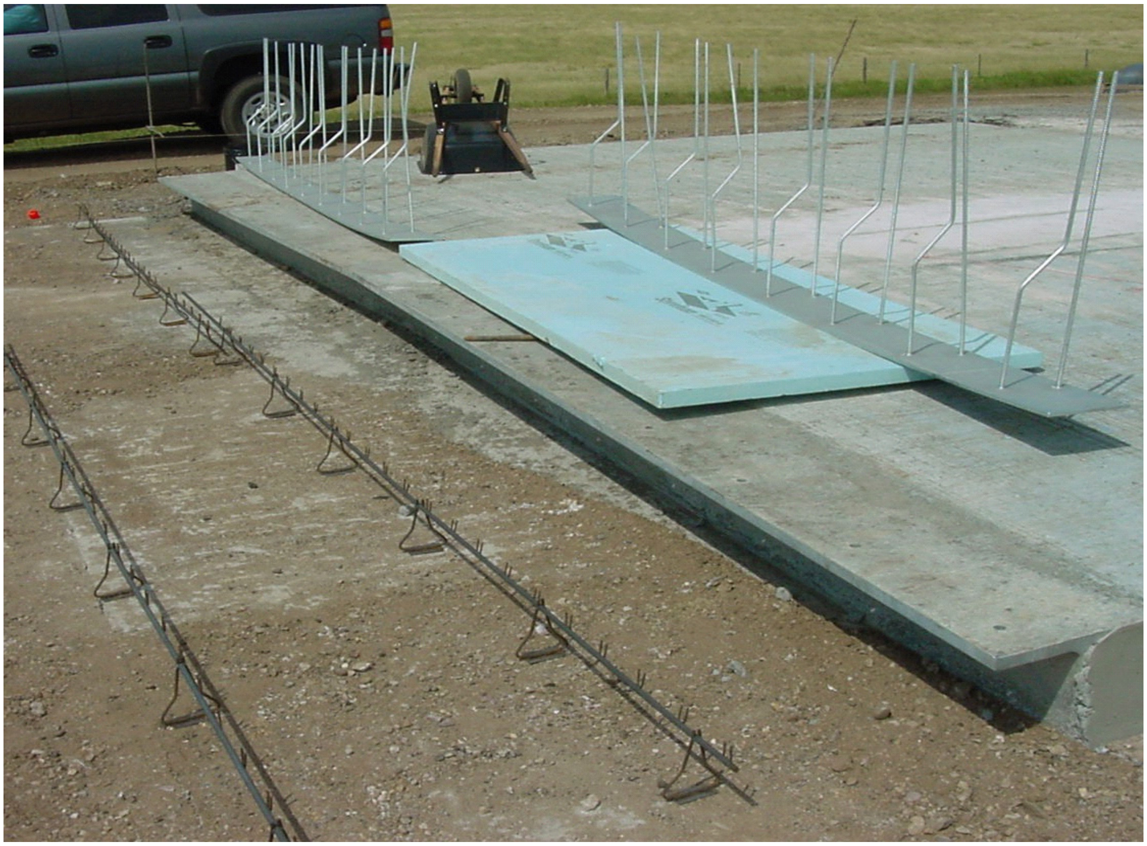
Figure 4.17 Setting pavement terminal.

When an inspector is checking a PCCP Terminal Anchor, the inspector should check to ensure that the steel components and reinforcing steel meet the material requirements of the project plans. Make sure that all steel components meet the details shown in the plans. In Figure 4.16 the steel plates were delivered bent. These plates are not acceptable and were sent back to the fabricator to be straightened. The subgrade and gravel shall be compacted the same as the roadbed material. The inspector shall verify that the sleeper slab is placed correctly and the steel beam matches the cross slope and road profile of the new pavement (Figure 4.14). Rarely are the steel beams ever placed level, because nearly every roadway has some grade or profile. The inspector shall verify that the reinforcing steel is placed as shown in the plan details with the proper clearance.

On superelevated sections, the terminal anchor is straight with no crown fabricated into the beam and shall be placed in the same cross slope and grade line as that particular station in the superelevated section. Some crown will be fabricated into the beam.

Figure 4.18 Close up of concrete anchors on the nonreinforced side.

Figure 4.19 Nonreinforced side completed and asphalt bondbreaker placed.



The inspector shall make sure that the following important terminal anchor details are completed in the field (See Figure 4.13):

1 The concrete surface of the sleeper slab on the CRCP side shall be smooth and parallel to the top of the WT18 X 115 beam. If the surface is not smooth and parallel the terminal anchor will lock up and will not function properly.

2 The 1/2″ space between the bottom of the flange and the 1/2″ X 9 1/4″ steel plate on the face of the CRC shall be maintained. If this is not the case, the sleeper slab shall be ground so that the distance can be obtained.

3 All surfaces that are required to be coated with asphalt in the plan details shall be done so completely.

4 The 1/2″ X 9 1/4″ steel plate shall be installed parallel to the web of the WT18 X 115 beam.

5 The concrete on the nonreinforced side of the terminal anchor shall be thoroughly vibrated to prevent voids occurring under the flange of the beam.

Any one of the issues 1-5 could cause the terminal anchor to lock up if not done properly and require a very expensive repair.

The main objective to placing any PCCP Terminal Anchor is to prevent a bump. This requires much thought and planning to account for the various transitions, crown slope, road way profile or grade, superelevated curves, horizontal and vertical curves, and vertical clearances.

CHAPTER

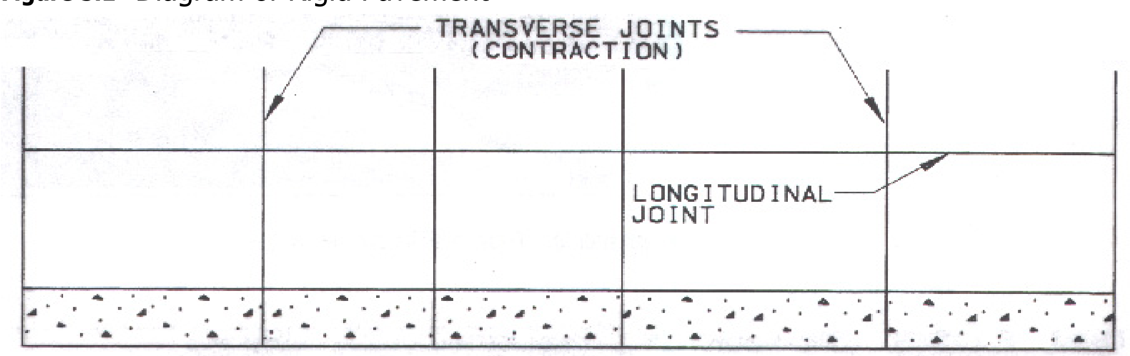
5

CONCRETE PLACEMENT

Concrete Paving

Concrete paving is the phase of construction in which Portland Cement Concrete (PCC) is placed on the prepared surface of a roadway. Concrete Pavement is simply concrete and any steel required by the design with expansion and contraction joints placed at specified intervals across the surface.

Figure 5.1 Diagram of Rigid Pavement



Control of concrete pavement construction involves establishing a procedure for performing the details of the operation, inspection to ensure that the procedures are followed, and check tests to determine that the materials used and the resulting construction meet established standards.

Methods of Paving

There are two methods of paving; formed paving and slip form paving. Each method is discussed on the next several pages in this manual.

FORMED PAVING (Stationary Side Form Method) (**380.3 C 2**) is the construction method in which forms are placed on the roadway to be used as tracks for the paving equipment and to hold the concrete in place. This method is commonly used on urban and small paving projects with irregular areas.

Figure 5.2 Form Riding Paver

SLIP-FORM PAVING (Slip-Form Method) (**380.3 C 3**) is the construction method used to spread and finish concrete in one operation, eliminating the need for forms. This method is commonly used on major PCC paving projects.

Figure 5.3 Slip Form Paver

Pre-Pave Checks

The pavement inspector should check the following before any concrete is placed.

1. Check the vertical and horizontal alignment of the stringline if slipform paving; or the forms, if stationary side form paving. Also, verify the width of the slab that will be constructed.

2. For stationary side form paving, the forms should have full base support and should be locked in place with the correct number of pinlocks. The form pins must be placed at

an adequate depth to prevent the forms from rocking. Also, the forms must be side locked with keys so proper alignment will be maintained.

3. Check the gradeline and cross-slope of the base. High areas must be cut down and low areas must be brought to the proper grade and properly compacted. Check for loose material and debris which the Contractor must remove from the base prior to concrete placement.

4. Confirm adequate moisture levels in the subgrade; dry areas will absorb water from the concrete and could affect quality.

5. Wood forms should be moistened so they will not absorb water from the concrete.

6. Stationary forms should be treated with a parting agent such as oil or lacquer to facilitate their removal.

7. Dowel baskets and tie bars must be checked for position and alignment. The Contractor must make any necessary adjustments prior to concrete placement.

8. Reinforcing steel must be free of mud, oil or other organic materials that may reduce bond.

9. Weather conditions should be closely monitored. Care must be exercised when placing concrete in very cold or very hot weather, as well as in conditions where sudden rains are possible.

10. A sufficient amount of covering material should be at the job site to cover and protect the green concrete against rain. The covering should be in a bed roll and mounted on the curing machine or located as near as possible to the curing machine.

11. Backup equipment such as hand vibrators, floats, and straight-edges should also be kept on hand, ready to be used.

Equipment Checks

The inspector is responsible for having the Contractor adjust and check all equipment prior to placement of concrete.

The following items should be checked on the pavement construction equipment:

1. The wheels or tracks of the paving machines must be kept free of mortar or concrete.

2. Hoses and connections should be checked to ensure hydraulic fluid will not leak onto the concrete.

3. The spreader should be clean, with no concrete buildup.

4. On slip-form paving jobs, the width of the slip-form paver and the width of the trail forms should be checked. On stationary formed paving jobs, the width between inside faces of forms must be confirmed.

5. The strike-off plate should be checked with a stringline to ensure that it has consistent and proper depth.

6. Vibrators on the paving machine should be checked for spacing and frequency. Replacement vibrators should be available. The vibrators should be checked to see that they can be raised and lowered.

7. The transverse screeds should be checked with stringline to make sure that they are aligned properly. The slab behind the screeds should be checked during placement to ensure the screeds are performing properly.

8. The finishing float(s) should be checked with a stringline to ensure it is plumb.

9. The carpet drag should be wet down (if necessary) before use and cleaned at the end of the day to prevent build up of concrete. There should be two feet of carpet in contact with the pavement surface.

10.The tine machine should be checked to see that it will groove the slab at the proper spacing and the proper depth. The tines should be checked to see that they are not bent and are clean.

11.The nozzle head on the curing machine should be open (clean) to give uniform spray. The curing machine should be equipped so as to keep the curing compound agitated. A wind screen or break may be required.

Concrete Delivery

High quality pavement construction requires that concrete be uniform from batch to batch. To achieve uniformity the batching plant must be in good operating condition. Close control must be exercised over the handling and batching of the materials used in the concrete.

Paving projects are required to utilize fully automatic batching equipment to produce the concrete. Manual operations are permitted when the automatic controls fail, but the problems must be resolved and automatic control restored before work may commence the next day (**380.3 B 1**).

Central Batch Plant

In a Central Batch Plant operation, concrete batches up to 11 cubic yards (depending on the plant) are weighed and mixed at the plant site. The concrete is then transported by dump trucks, live bottom trucks, or agitator trucks. Do not allow the concrete to be mixed, placed, or finished when the natural light is insufficient, unless the plans specifically allow the Contractor to pave at night.

Figure 5.4 Central mix plant.

Redi-mix Concrete

In a Redi-mix concrete operation, the ingredients for the concrete are weighed up and put in a Redi-mix truck. The concrete is then mixed and transported by the truck to its placement location.

The concrete compartment on haul units of any type must be thoroughly cleaned and flushed with water as necessary to prevent an accumulation of hardened concrete in the concrete compartment (**380.3 F**). This is done prior to filling the compartment with another load of concrete.

Dump Trucks and Non-Agitating (Live Bottom) Trucks

Dump trucks can be used only when the time needed to get from the plant site to the project is short. For delivery time requirements, live bottom trucks/trailers are treated as a dump truck. Since there is no way to keep concrete agitated in the truck boxes, be aware that aggregate may start to segregate if haul is over rough roads or terrain. During hot weather the concrete could start to set up and should then be rejected if the specified time limits (**380.3 F**) are exceeded. When not continuously agitated in the hauling unit, concrete shall be 1) discharged within 45 minutes, and 2) discharged and screeded within 60 minutes after the cement has been placed in contact with the aggregates. When the concrete temperature is $80°F$ or above, the time limits shall be reduced to 1) discharge within 30 minutes, and 2)discharged and screeded within 45 minutes (**380.3 F**).

Figure 5.5 Dump truck

Figure 5.6 Live Bottom Truck/Trailer

Redi-Mix Trucks and Agitating Trucks

In a Redi-mix operation, the Plant Inspector should enter the beginning revolution counter reading and the beginning mixing time on the batch ticket. Concrete must initially be mixed between 70 and 100 revolutions at mixing speed. If water is added to the truck, an additional 30 revolutions at mixing speed is required.

Important The Contractor is not allowed to add water to the concrete after it leaves the mixer.

Although an old technology, agitator trucks are still used. Blades are used to keep the concrete mixed during delivery. Agitator trucks do not have the capability of mixing concrete, only keeping it mixed. The blades turn at a speed just fast enough to keep the concrete from segregating. Blades must be turning continuously when there is concrete in the truck. If the blades are stopped for any reason before the concrete is placed on the project, treat the concrete as though it were hauled in a dump truck for delivery time requirements.

Figure 5.7 Agitator truck being loaded at Central Batching and Mix Plant.

When continuously agitated in the hauling unit, concrete shall be 1) discharged within 90 minutes, and 2) discharged and screeded within 105 minutes after the cement has been placed in contact with the aggregates. When the concrete temperature is $85°F$ or above, the time limits shall be reduced to 1) discharge within 45 minutes and 2) discharged and screeded within 60 minutes, (**380.3 F**).

Weather Considerations to Delivery Time

Any concrete not discharged within the specified time limits should be rejected. Document the reason for rejecting the load(s) of concrete.

Past experience indicates that time limits can be extended with favorable weather. For example, favorable weather might include an air temperature of $60°F$, no wind, and high humidity. Concrete can stay plastic longer and have a delayed set time during favorable conditions.

Conversely, if air and concrete temperatures are high, the humidity is low, and the wind is blowing hard, concrete may need to be rejected before the time limit has expired. Document the conditions fully, giving reasons for exceeding the time limit or rejecting the concrete before the time limit expired.

Concrete in which initial set has begun must be rejected. Do not allow the Contractor to add water to Redi-mix and rehaul it to the paving site.

Batch (Haul) Tickets (380.3 B 2)

Computer tickets that indicate a batch of concrete's components and are supplied by the concrete producer are commonly referred to as "Batch Tickets". Tickets that indicate generally the same information, but are produced by the project inspector(s) are commonly referred to as "Haul Tickets".

Batch or haul tickets are used to monitor the material and ensure time requirements are met when concrete is being produced. The W/C ratio shown on batch tickets should be checked against calculations to verify it's accuracy at the start of a project and occasionally thereafter.

Concrete batched by computerized equipment shall have an automatically produced printed ticket accompanying each load to the placement site. For concrete batched using automated, but not computerized equipment, hand-written tickets will suffice.

The following items should be included on each ticket:

- Truck Number*
- Total Volume of Load in Cu. Yds.*
- Actual Weight or Volume of each Component of the mix*
- Revolutions
- Date and Time Batched*
- Mix ID*
- W/C ratio*
- Admixtures*
- Project Number
- Plant Inspector's Name or Initials

  * Required on automatically generated tickets.

Example of batch ticket.

Ticket: 333 6/28/2005 4:10:40 PM
Customer Name: S.D.D.O.T. Job Name: South Dakota DOT
Delivery Address:
Job Description: Paving HWY 18
Instructions:
Formula: #2 Hwy 18 Slump: 1.5
Load Size: 9.00 yards Resold Amt 0.00 Mix Time: 76
Daily Qty: 2,997.00 Order Qty: 0 Del Qty: 23,185 yards
Driver: Temper Water Quantity: 0
Truck: 0 Water to Cement Ratio: 0.38

Product Name	Target	Actual		Error	%MC
1" Rock	12,800	12,740	lbs	-0.5%	0.9
Sand	11,560	11,520	lbs	-0.3%	2.3
Chips	4,260	4,280	lbs	0.5%	1.4
Cement	3,960	3,965	lbs	0.1%	0.0
Flyash	990	995	lbs	0.5%	0.0
Water	187	186	gallons	-0.5%	
Air	184	184	fluid ozs	0.0%	
Water Reducer	296	296	fluid ozs	0.0%	

Production Total: 2,997.00 yards

Water to Add at Site: 1 gallons

Concrete Placement

Placement of concrete (**380.3 G**) to form the pavement involves spreading, consolidation, and striking-off.

The two types of paving methods presented in this manual are the formed method and the slipform paving.

Formed Paving Method

With this method, forms are used to contain the concrete and may also be used as a set of tracks for the paving equipment. Forms must be checked for alignment. If the face of the top of the forms is out of line, crooked or rough pavement results.

A variety of machines are used to place and finish the concrete; they are commonly equipped with these items (not necessarily in this order):

- An auger or other comparable device to spread concrete across the pavement width.
- Strike off equipment.
- Vibrators to consolidate the concrete.
- A screed to shape the concrete to the cross section called for by the plans.
- A float to give the surface a smooth finish.

Slipform Paving Method

Slipform pavers are commonly used in larger paving operations. Slipform pavers vary in type and operation. They are often modified by the individual Contractor; however, every slipform paver must have the following:

- A method of spreading the concrete across the pavement width.
- Strike off equipment.
- Vibrators to consolidate the concrete.
- A screed to shape the pavement surface to the cross section called for by the plans.
- A paver mounted metal section which forms the pavement sides as the paver moves.
- A float to give the surface a smooth finish.

Figure 5.8 This diagram shows the working parts of two types of slip-form pavers.

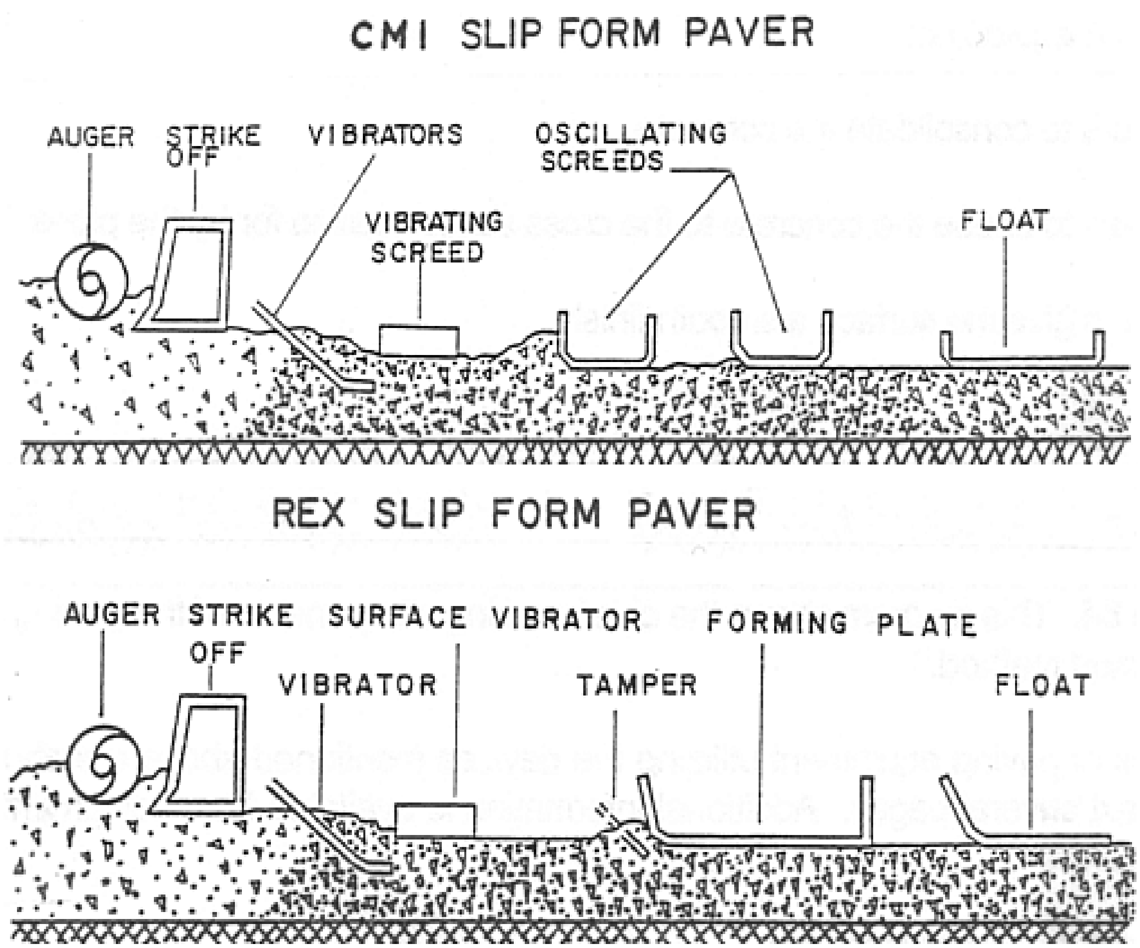
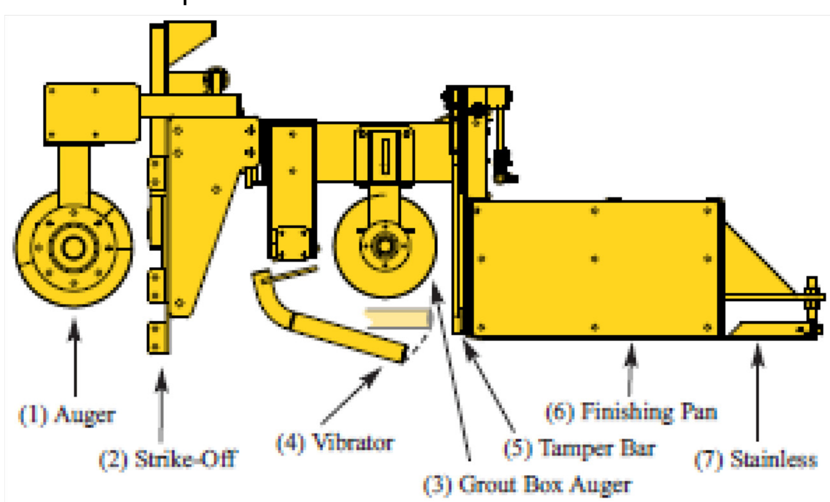
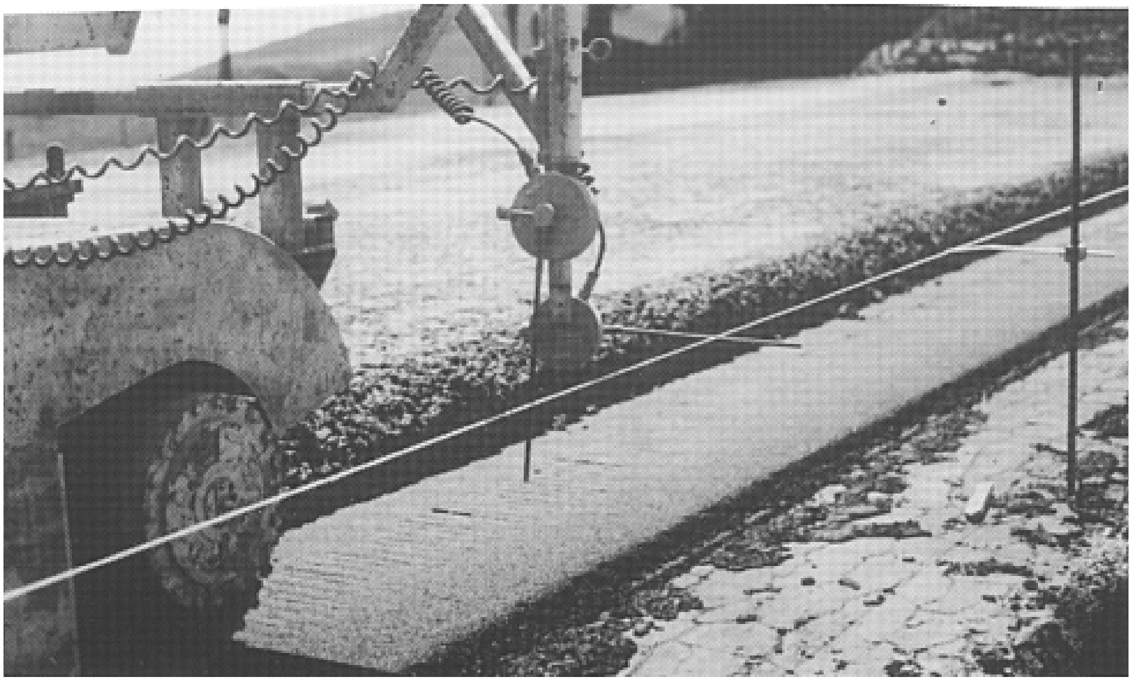


Figure 5.9 Gromaco 2800 paver



Electronic sensors follow a fixed stringline, which is used for elevation control, and must guide the forward movement of the slipform paver.

Figure 5.10 Shows vertical and horizontal sensor alignment arms.



Spreading

Before any concrete is spread, all surfaces of finegrade must be moistened (**380.3 G**); this cost is incidental to concrete placement. A dry granular finegrade pulls water out of fresh concrete, reducing its strength. Asphalt, lime, and cement treated finegrades should also be misted to keep them cool. This helps to reduce the possibility of a flash set. The surface of the finegrade is usually moistened with water sprayed from a hand-held hose or a fine misting water truck (Figures 5.11 and 5.12). The Contractor should keep the misting process a few hundred feet ahead of the concrete placement operation. Puddles of water should not be left on the finegrade. The extra water is absorbed by the concrete and reduces its strength.

Figure 5.11 Spraying water on finegrade.

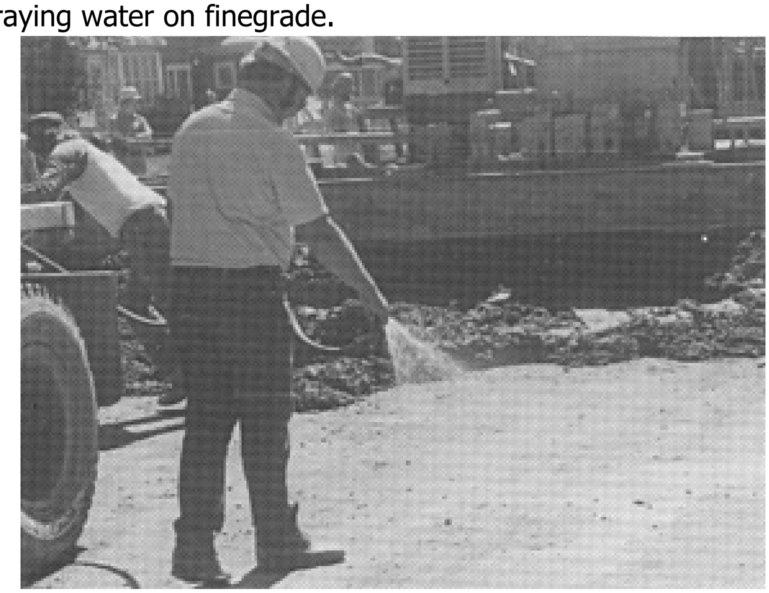
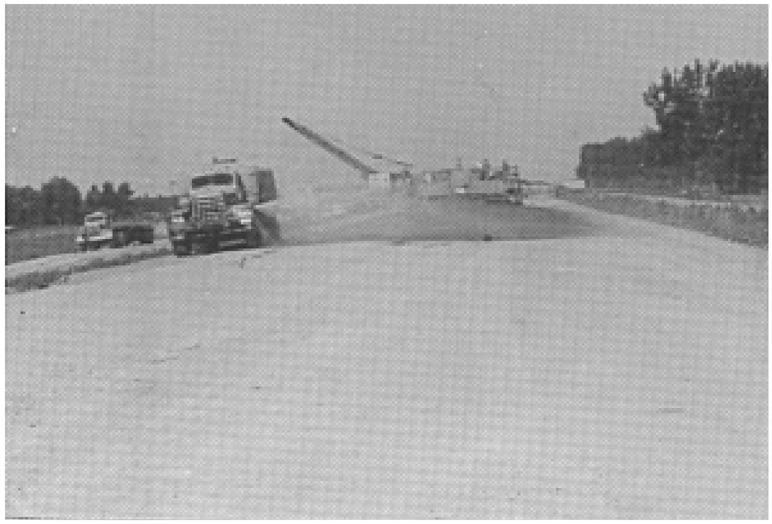


Figure 5.12 Moistening ahead of the paving operation. Distances depend on weather conditions.



Concrete shall be unloaded into, or in front of, an approved mechanical concrete spreader. The use of the mechanical spreader may be waived provided the hauling equipment is equipped with a discharge system capable of distributing the concrete uniformly without segregation across the width of paving - and meets the approval of the Engineer.

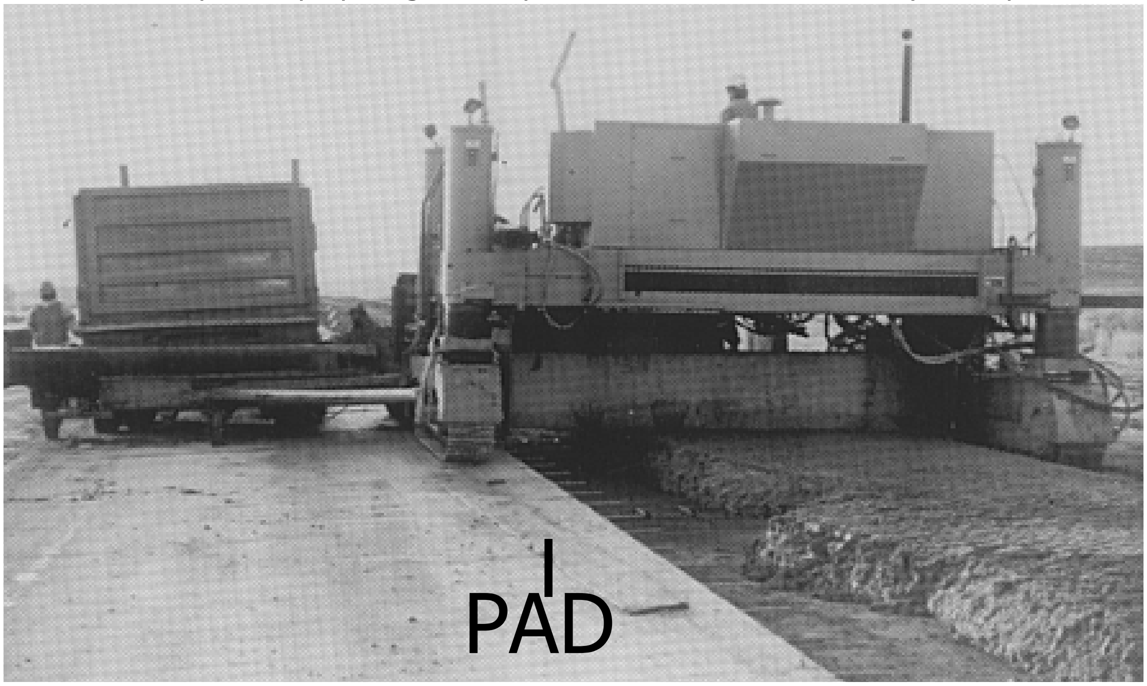
To retain uniform and non-segregated concrete, considerations should be taken in placement of the concrete in front of the spreader. The chance of segregation is increased if the concrete must be moved significant distance to its final placement. When moving concrete manually, do so by shovel scoops (do not throw the concrete). Workers should not walk in the freshly placed concrete (380.3 G). Areas containing mostly rock or mortar must be removed by the Contractor; do not allow the material removed from one area to be placed elsewhere in the pavement - IT MUST BE WASTED.

Figure 5.13 Concrete dumped in front of spreader. Note: Deflector shield must be used to prevent segregation.

The concrete deposited on the finegrade is spread to its final location by 1) a "butterfly" or 2) a "screw" spreader. The butterfly spreader, a huge paddle that moves back and forth across the roadway, levels off the concrete and fills in any low areas. The screw spreader, a big auger, allows the concrete to be augured toward the outside or the center of the roadway. Segregation must be watched for anytime concrete is being pushed or moved, even when it's an attachment to paving equipment. The inspector must be alert to damage to prepositioned tie bars and dowel baskets during the placement, spreading, and forming of the pavement by the paver.

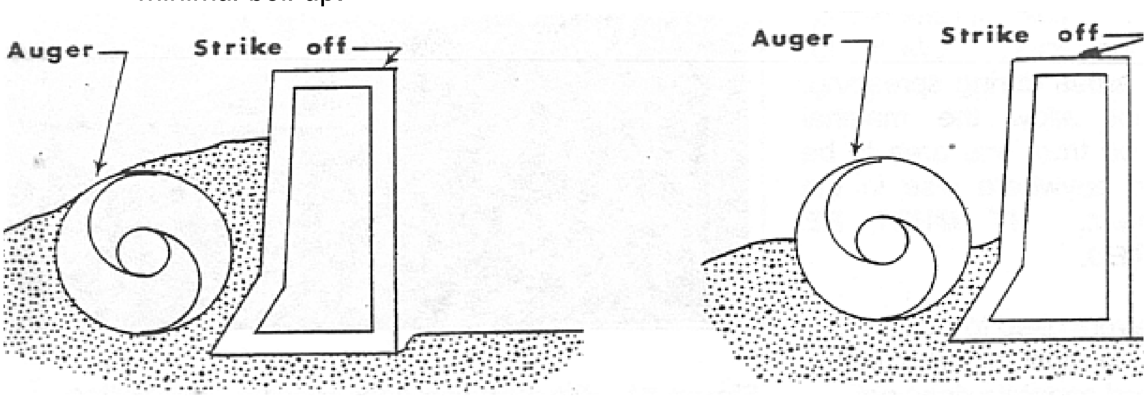
When a "screw" spreader is being used, placement of the concrete on the finegrade must coincide with the desired rotation of the augers. If concrete is placed in the center, the augers should usually turn outward. If it is placed on the side, the augers should turn inward and outward for equal periods of time. It is important to run the augers correctly, so they do not heap the concrete into big piles.

Figure 5.14 Dump truck preparing to dump load of concrete onto conveyor of spreader.



Concrete being pushed ahead of the spreader should be held to a uniform height across its full width. When piled high, the weight of the concrete causes boil up behind the strike-off plate (surge), increasing the depth of the pavement. When the spreader is pushing a small amount of concrete, there is almost no surge behind the strike-off. Either situation is acceptable as long as it is constant. Excessive material, however, will throw the machine off-line. Overloading the paver will result in a waste of materials, excess finishing work, and a poor riding pavement.

Figure 5.15 Left: High head of concrete on the auger results in boil up (surge) behind the strike-off. Right: A "good" roll of concrete ahead of the auger results in minimal boil up.



Care should be exercised to maintain a constant and continuous movement of the paver. Any starts and stops of the paver can cause the machine to ride up over the mix and result in bumps in the pavement and a poor riding surface. The forward speed of the paver should be as uniform as possible, but should be varied according to the speed of concrete placement.

Consolidation

Concrete must be consolidated to be strong and durable. Using vibrators is the easiest way to consolidate concrete. The three types of vibrators available for use are:

- Spud Vibrators
- Internal (immersed) Tube Vibrators
- Pan (surface) vibrators

Consolidation is achieved 1) when the surface is smooth and 2)coarse aggregate is barely visible or immediately under the surface. The vibrators should be adjusted so the mortar or cream on top of the finish comes together. As shown in figure 5.16, the two areas of influence must overlap. Vibrators shall not come in contact with a joint assembly, the grade, or a side form. The vibrator shall not be operated longer than 10 seconds in any one location (**380.3 G**). This could cause over vibration and the coarse aggregate will settle to the bottom of the mix causing segregation. Excessive vibration will also leave vibrator trails in the concrete mix. Look at cores to verify consolidation.

Figure 5.16 A vibrator problem causes a longitudinal deviation.

Figure 5.17 Internal vibrators on a slip form paving machine.

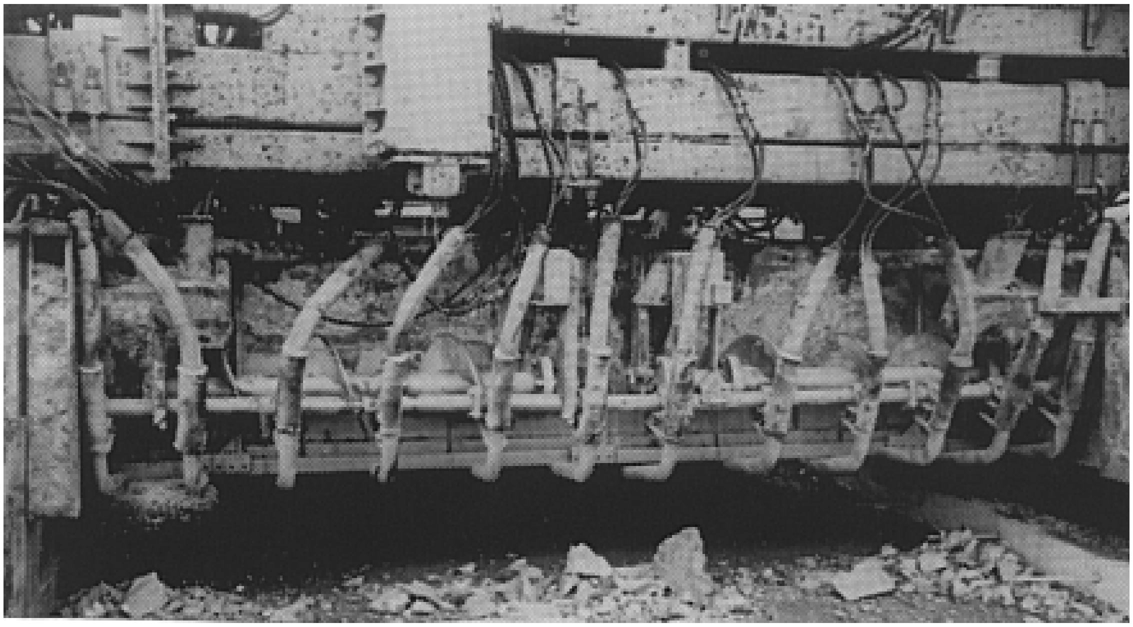
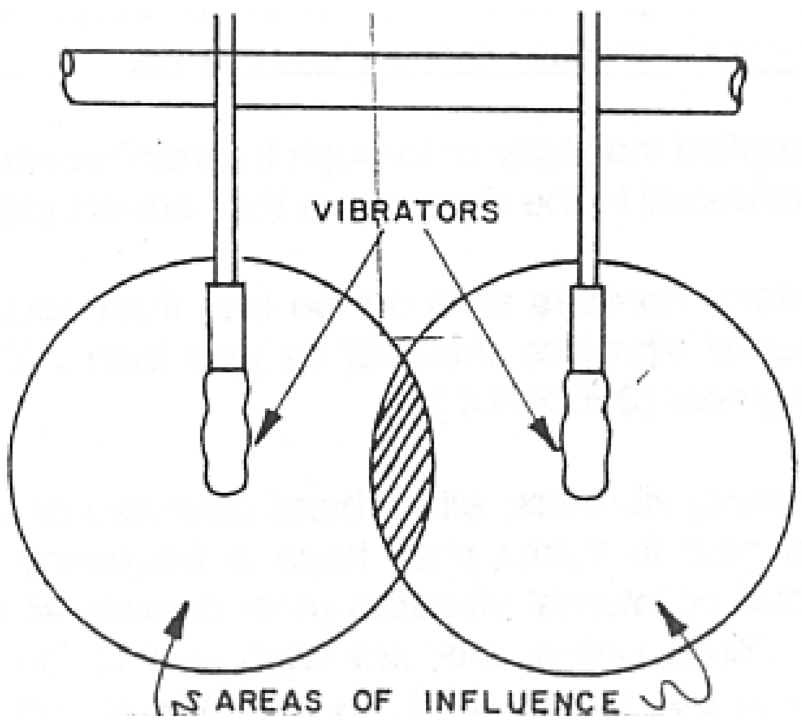
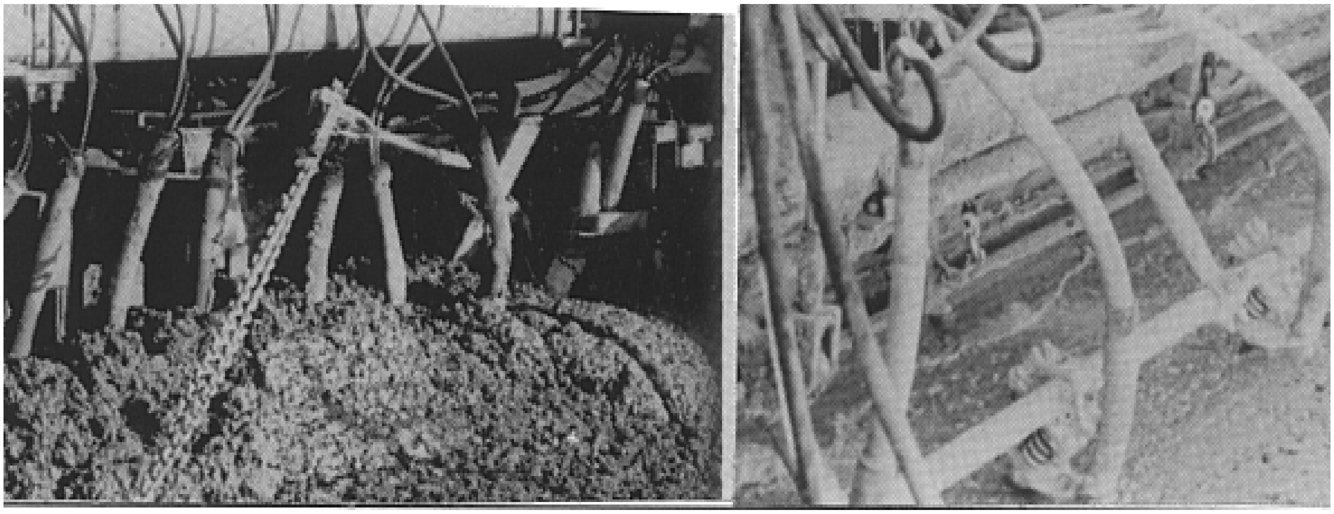


Figure 5.18 Internal tube vibrators areas of influence.



Internal vibrators are individual tubes with a "cam shaft" arrangement inside. As the cam shaft rotates, the tube vibrates. Porous concrete becomes consolidated and smoothed when the vibrators move through it. When internal vibrators are used, check to see that they are close enough together so all the concrete shows visible vibration. A maximum of 24-inch spaces between vibrators is recommended. Internal vibrators must operate at a frequency of not less than 7000 impulses per minute, unless used next to forms **(380.3 B 5)**.

Figure 5.19 Vibrators in concrete.



Consolidation throughout the pavement slab is important, including the form line when stationary form paving. If the paver vibrators do not affect the edges of the slab, a hand operated internal (spud) vibrator should be used to eliminate honeycombing. Internal vibrators used <u>next to forms</u> shall have a frequency of not less than 3500 impulses per minute. **(380.3 B 5)**

A surface vibrator, more commonly found on hand pour jobs, is a metal plate or "pan" with vibrator units mounted on the top. The frequency of the surface vibrators shall not be less than 3500 impulses per minute. Whenever a surface vibrator is used, make sure the entire pan is resting on the new concrete. If it is not, vibrations will be uneven, many in some places and none in other places. Hand spud vibrators shall not be used to consolidate the concrete prior to the use of a surface vibrator.

Vibrators shall not be operated in excess of specified minimum frequency to such a degree that flotation of aggregate particles or an accumulation of laitance on the surface of the concrete occurs. Vibrators shall not be used to level or spread the concrete; they are only for the purpose of consolidation.

For a contract which has a minimum of 50,000 sq yd of pavement that is 12 feet or more wide, an electronic internal vibrator monitoring device shall be provided. The device shall be capable of displaying the operating frequency of each internal vibrator, and shall be visible to the paving operator. The vibrator monitoring device shall have a minimum range of 4,000-10,000 VPM.

Visual inspection of the pavement surface behind the paver float will disclose a vibrator problem. Check the frequency of the vibrators by using a tachometer (minimum range 4,000-10,000 VPM) supplied by the Regional Materials Engineer. If the normal equipment does not provide uniform consolidation, supplemental mechanical vibrators shall be used.

The procedure to test vibrator frequency is as follows:

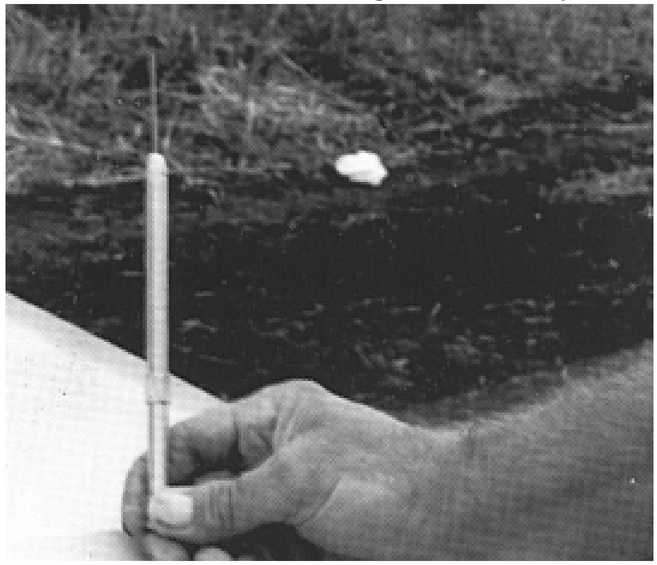
1 Stick the end where the wire comes out up against the vibrator.

2 Slide the wire <u>out</u> until the wire swings in the widest arc.

3 Read the scale beside the pointer to find the vibrator frequency.

Check all the vibrators before starting paving and again a few times during the project. Record the results in the diary. During paving, the vibrators must be interlocked with the travel mechanism of the machine so vibration stops whenever the forward motion of the paver is stopped. Continued vibration when the paver is stopped will pull grout to the surface making an area of segregated concrete.

Figure 5.20 Vibrator tachometer. The wire sticking out at the top end.



Strike-Off

Concrete shall be struck-off, consolidated, and finished to the cross-section and elevation specified in the plans **(380.3 J)**. The strike-off plate need not be set for the exact cross-section, but it should be close. Too much variation will adversely affect the amount of concrete desired for the screed.

As discussed under "Equipment Checks" earlier in the chapter, inspect the strike-off plate on the paver prior to the start of paving -and- periodically throughout the project. The method for checking is similar to checking the finegrader- stretch a stringline between the ends and measure up from it at one foot intervals. Be alert for excessive wear of the center of the strike-off plate.

The method of strike-off for a slipform paver varies slightly from form paving because it uses a preset stringline instead of forms to establish the finished surface elevation.

Screeds

The concrete must be formed and rough finished to the cross section needed. This is done with the screed. There are many types of screeds and here are a few examples you might see for concrete paving: a portion of the slipform paver, a form riding Bidwell type paver, oscillating screeds as part of a paver, a roller screed, and a truss screed.

Figure 5.21 Diagram of oscillating screed movement in relation to long arrow showing direction of machine movement. These are common for bridge deck overlays.

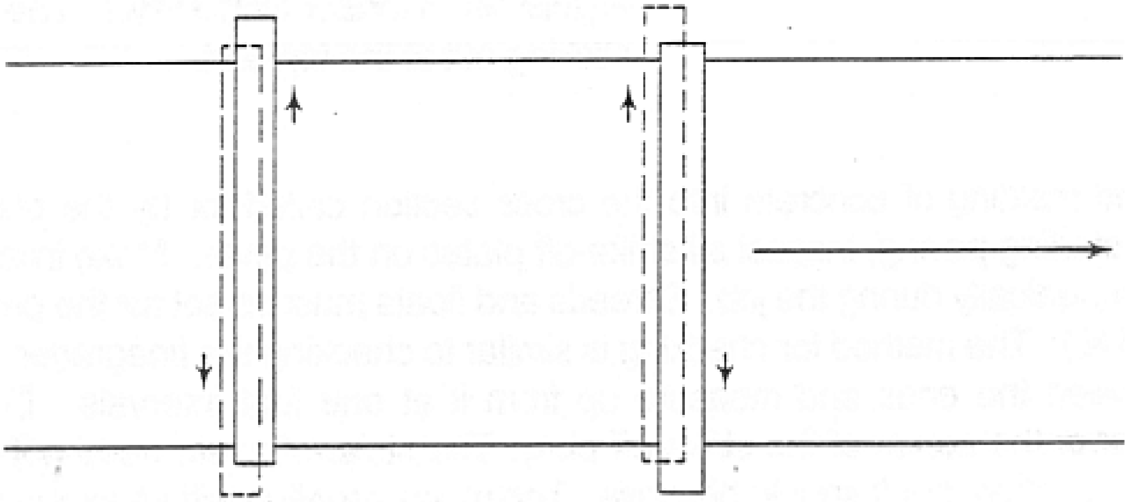
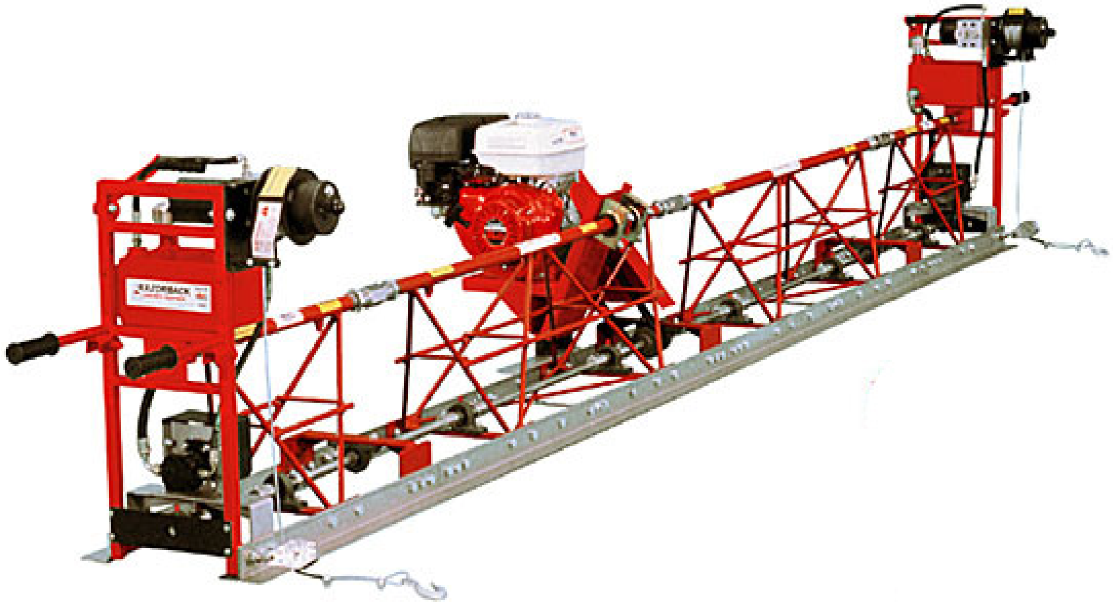


Figure 5.22 Picture of a Roller Screed used for smaller formed placements. A person manually pulls the roller to screed the surface.

Figure 5.23 Picture of a Truss Screed which is used for small formed placements. These screeds normally have cable and a winch that moves the screed forward.



All of these screeds must have some concrete in front of them so the low spots can be filled. For an oscillating or roller screed the concrete should form a roll and actually roll ahead of the screeds during their forward movement. The roll should be uniform across the length of the screed. If the concrete looks like "slop" ahead of the screed, check the slump--it is probably too high. If the concrete looks like it is mostly rock, check the slump--it is probably too low for the screed to get a good finish. If the concrete looks good but still does not roll, check the air content--it might be high.

Keeping a uniform roll or head in front of the screed allows the pressure on the screed to remain constant. A smooth surface should result. When the roll varies in size, the pressure keeps changing and ripples result. If the machine goes too fast, the screed will go up and over the concrete and leave a rough surface. Consistently poor rolls with a form riding paver indicate that a strike-off is probably out of adjustment. If a poor roll occurs only occasionally, the Contractor should shovel some concrete into the void area to eliminate a probable low spot. Check to make sure the screed is tilted in the correct position. Urge the Contractor to keep a uniform roll ahead of each screed. Point out that not doing so will require more finish work and a number of areas will probably require "grinding" to bring the pavement within surface tolerances.

Float

The float is a solid plate that puts the finish to the surface of the pavement. The front edge curves upward to prevent it from digging into the concrete, usually the front of the float is set about 0.062 inches to 0.125 inch higher than the trailing edge. The concrete is squeezed under the plate, making the surface of the pavement slightly more dense and smooth. The Contractor should make adjustments if a dense and smooth surface is not being achieved.

Figure 5.24 Front of float set higher than rear of float.

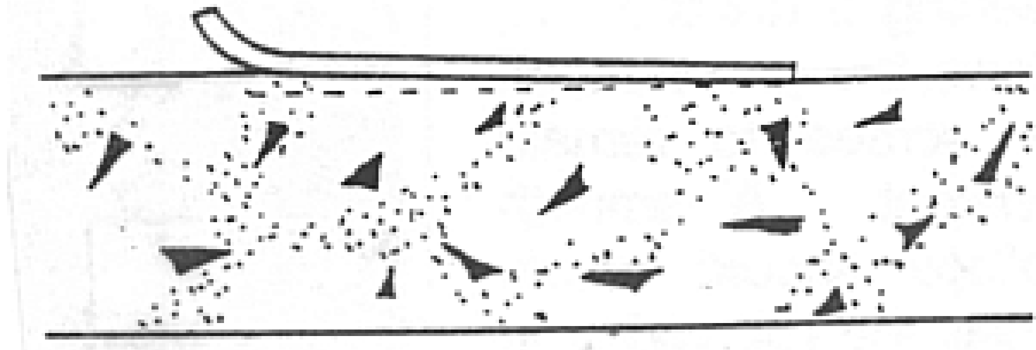
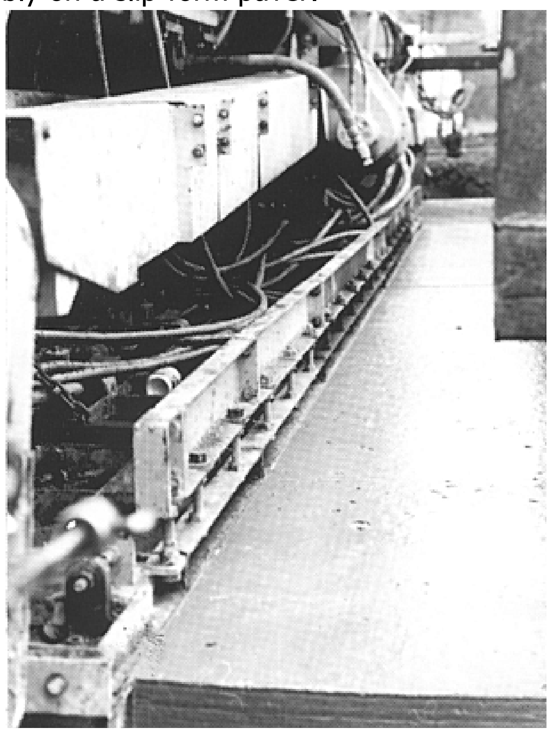


Figure 5.25 Float assembly on a slip-form paver.



Depth (Pavement Thickness) Checks

Stringline alignment and tautness should be checked throughout the day. This simple activity can prevent incorrect pavement depths. Concrete depth can be checked after it is floated to assure that pavement thickness is consistent with the plans. This measurement is very easily taken with a "depth checker", and is the responsibility of the Contractor. For projects with contract quantities less than 4000 square yards, cores will not be taken, unless requested by the Area Engineer. A minimum of four depth checks shall be made on the plastic concrete and recorded on the DOT-98 form(M.S.T.R., Materials Manual).

Figure 5.26 Depth Checker

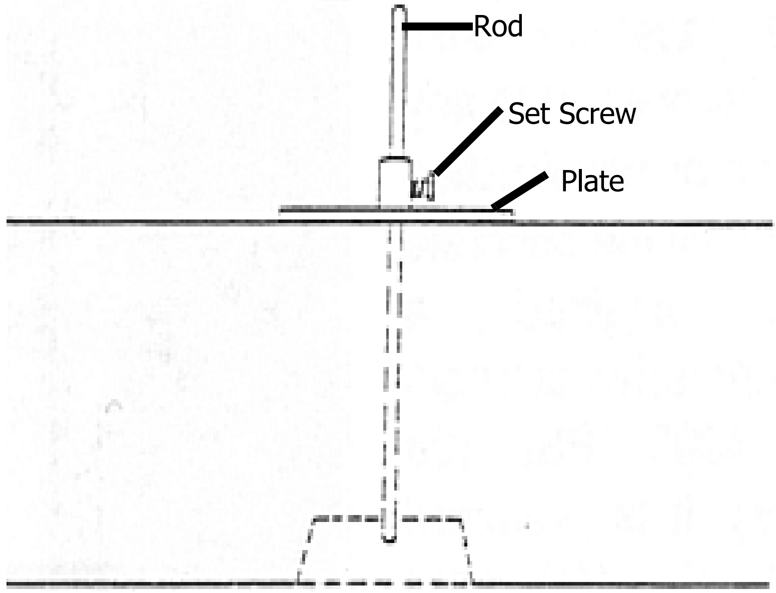
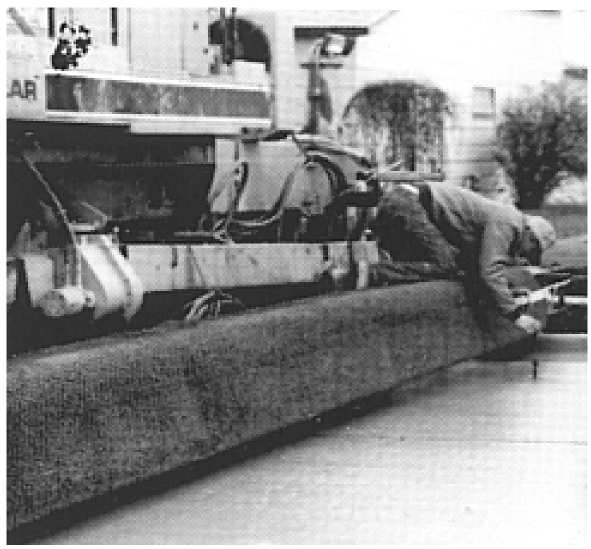


Figure 5.27 Depth check in progress.



Measured depth should be slightly more than called for by the plans because concrete shrinks as it cures. If the depth is less than required, the Contractor will need to adjust the equipment. If the depth is more than required, the Contractor may want to reduce the thickness.

Crown Check

The crown (cross section) of the finished concrete should be checked periodically using a level or smart level. If the cross slope is not correct, the Contractor must adjust the crown with the power controls. Record the results of the checks and any adjustments the Contractor made in the diary.

Slab Protection

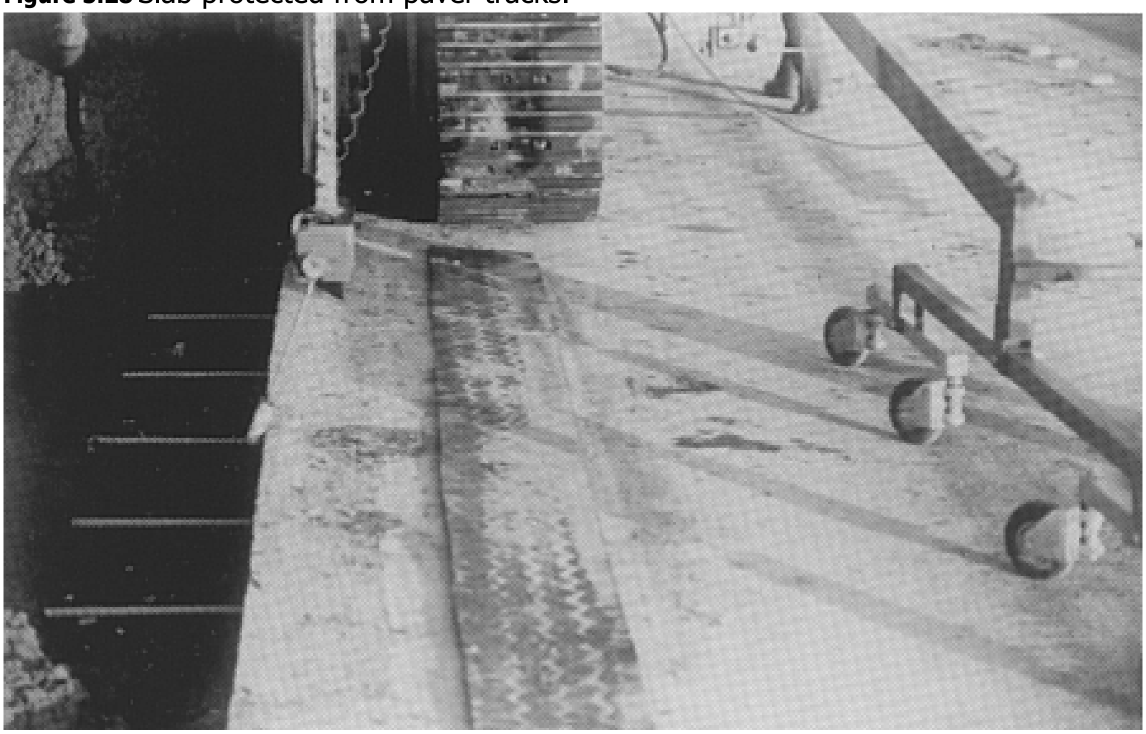
The pavement shall not be opened to any traffic or construction use until the concrete has attained a compressive strength of 4000 PSI. Strength tests may be made with the Swiss Impact Hammer (SD409), but it is preferred that early break cylinders be used to determine the strength of hardened concrete for purposes of opening to traffic. The pavement shall be cleaned prior to opening to traffic.

When concrete is placed adjoining a previously constructed pavement, the paving machines, mechanical spreaders, and other heavy equipment shall not be operated on the existing pavement until the existing concrete has attained a compressive strength of 3000 psi. Equipment operated on a previously constructed pavement that has attained a compressive strength of at least 3000 psi, but less than 4000 psi, shall be tracked type equipment. Hauling units shall not be allowed on the concrete until it has attained a compressive strength of 4000 psi. Working platforms, finishing, tining, curing, and other lightweight equipment may be operated on the edge of the existing concrete 72 hours after the concrete was placed. **380.3 K**

the preferred method is concrete cylinders for determining when to open the roadway to traffic.

Operating track type equipment on the concrete surface can cause chipping at the contraction joints of adjoining lanes and possible spalling at longitudinal joints. Placing some type of plywood sheeting or rubber belting ahead of the tracks prevents chipping, spalling, or surface scarring.

Figure 5.28 Slab protected from paver tracks.



Paving in the area of a transverse construction joint header cannot be permitted until 12 hours after installation of the header (**380.3 L 5**). Ensure chairs are placed under the 4 foot of steel extending through the header. When the Contractor removes the header lumber, ensure the green concrete is not chipped. The finegraded area ahead of the header should be cleaned if waste concrete is present.

Concrete Tests

Fresh concrete must meet certain requirements before it can be spread and incorporated into the slab. Air, slump, and strength (cylinders) tests must be made and the concrete temperature checked to assure that specifications are being met. Procedures for running these tests are explained in the DOT Materials Manual. Use SD 403 for the air content test, SD 404 for the slump test, and SD 405 for the strength (cylinder) test. Record these tests on the DOT-23 form.

Air Test

Air content (SD 403) is a major factor affecting concrete durability. Concrete used for paving shall contain 6.5% plus 1% to minus 1.5% entrained air. If the air content falls much below 4%, there is no entrained air in the mix. Entrained air is essential for the durability of the concrete and its resistance to the freeze-thaw cycle. The inspector should not allow this concrete to remain in place.

Air tests must be taken every time cylinders (SD 405) are made to supply background information for the Central Laboratory. To keep a tight control on the air content, not less than one air test must be run every two hours. Document tests on the DOT-23 form. The number of additional tests taken is a personal judgment.

Figure 5.29 Air Meter, Type B.

If temperature and weather conditions are changing, more tests are needed to keep air content at required levels. As ambient temperature increases, the amount of air entrainment added to the concrete will need to be increased.

Slump Test

Slump is used to monitor the uniformity of the concrete (SD 404). The slump limit for <u>formed</u> (Stationary Side Form Method) paving is 1 to 3 inches (**380.3 A**). Try to keep the slump near 2 inches. Concrete with this slump level can be worked and usually gives the best-finished result.

The maximum slump for the Slip-Form Method of paving (**380.3 A**) is 2″. To keep the edges of the slab from "SLUMPING" try to use a slump between 1″ and 1 $\frac{1}{2}$″ inches. A minimum of one slump test must be run every two hours to monitor the consistency of the concrete. A slump test is needed each time cylinders are made. Use personal judgment in determining how many additional tests are needed. If the consistency of the concrete stays uniform, fewer extra tests are needed. Variations in concrete consistency require enough tests to remedy the situation. Record test specimens, additional air checks, additional unit weight tests and additional slump tests on a DOT-23 form (see Handout 2).

Figure 5.30 Slump Test- "Low slump."

Unit Weight and Temperature Tests

Unit weight and temperature need to be done at the same frequency as the air tests. The concrete temperature at the time of placement shall be between $50°$ F and $90°$ F according to SD408 and SD 411 (380.3 G)

Figure 5.31 Unit weight and temperature

Strength Test

The minimum number of strength tests (SD 405) required consists of making a set of cylinders (4 cylinders - MSTR 5.2A3) for the first 250 cubic yards of concrete on site; thereafter, one set of cylinders per 1500 cubic yards of concrete received. After the first day, no more than 2 sets of cylinders per day will be required.

Always make concrete cylinders for early breaks. This information is vital for opening sections of road to traffic and for evaluating the mix. The paving Contractor could have the entire project paved prior to knowing the strength of the concrete if we wait for the 28 day breaks only. Cylinders, cores, and Swiss Hammers are all ways to check compressive strength; but cylinders are the most common and accepted procedure.

CHAPTER

6

FINISHING, CURING, AND TEMPERATURE REQUIREMENTS

Finishing operations following the placement and consolidation of concrete by the paver include:

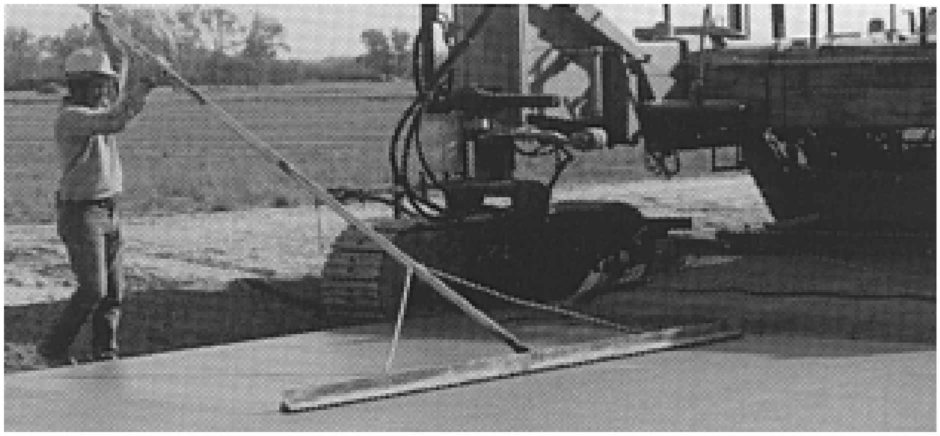
- Surface Checks
- Edging
- Surface Texturing

These finishing operations create a surface that complies with the cross sections shown on the plans and a nonskid surface of uniform texture.

Surface Smoothness Checks

To assure smooth riding pavement the Contractor must check the surface. A straightedge having a 10 foot blade and a handle 3 feet longer than 1/2 of the pavement width is used. Straightedge blades must be checked for straightness. The Contractor can compare straightedges to the true plane of a master straightedge. This is done by applying chalk to the edge of the master straightedge. The master straightedge is then slid back and forth repeatedly on the working straightedge. High areas will be marked by chalk. The Contractor must adjust his straightedges to true planes before using them. However, from time to time you also need to check the master straightedge. Another method is to place a coin of the same value on each end of the blade and stretch a stringline over the coins. Another coin of the same value as those on the blade should just pass under the stringline at intervals along the blade. Significant variations will necessitate straightening or replacing the blade before use.

Figure 6.1 Surface check with straightedge behind the paver.



Method for use of the straightedge:

1 With the handle held low push the straightedge toward center of the slab.

2 When the blade reaches the center, lift or rock the blade over any pushed up mortar. If the blade is lifted, set it down gently, otherwise a mark that cannot be seen in fresh concrete will exist in the final surface.

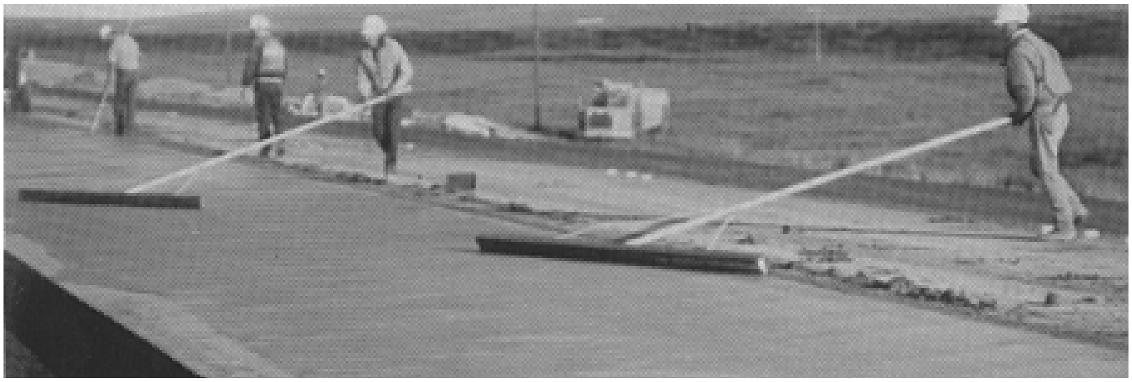
3 Raise the handle and pull the straightedge back to the pavement edge. Any mortar pulled along should be wasted along the side of the slab.

4 It is easy to spot high and low areas, watch the blade! Do not let the Contractor fill the low area or any open texture in the concrete surface with the "soup" floating on the surface. It is mostly colored water that will evaporate leaving the existing low spot. Good mortar can be worked up with the straightedge to fill the low spot. To prevent the rough spot, the straightedge operators should not rest the straightedge on the concrete.

Hand Finishing

A float must be used when the concrete surface is too rough or porous for the straightedge to be effective. A float looks like a straightedge, but the blade must be at least 6 inches wide and at least 5 feet long. After smoothing an area with a float, check it with a straightedge. The use of long-handled floats shall be kept to a minimum and shall not be used to float the entire surface of the pavement. Care shall be taken so the crown is not worked out of the pavement during the operation (**380.3 J 5**). Excess water and laitance shall be removed from the surface of the pavement by a straightedge 10 feet or more in length. Successive drags shall be lapped 1/2 the length of the straightedge. Finishers often want to add water when the surface gets dry or hard to work. Do not allow this practice except in extreme conditions, and then only in isolated areas. To prevent a rough spot, the float operators should not rest the float on the concrete.

Figure 6.2 Floats being used on pavement surface.



Too much water dilutes the mortar at the surface causing the surface to lose some of its durability. When used, water should be applied with a fog spray from a hand held sprayer, not by the bucket full or with a paintbrush.

Surface Texture

Straightedging and floating make a smooth surface with little skidding resistance for traffic. To increase skid resistance, the surface needs texturing.

Figure 6.3 Carpet drag

Carpet Drag

A carpet drag is drawn longitudinally over the surface of concrete before it has attained its initial set (**380.3 J 6**). The carpet, which must cover the entire width of the slab, is mounted on a bridge which spans the width of the slab. At least two foot length of the carpet, the width of the pavement must be in contact with the concrete surface.

The condition of the drag shall be maintained so the resultant surface is of uniform appearance with corrugations approximately 1/16 inch in depth. Drags shall be maintained clean and free of encrusted mortar. Drags that cannot be cleaned shall be discarded and replaced.

Artificial grass carpet with these specifications is used:

1 Facing material-molded polyethylene pile face.

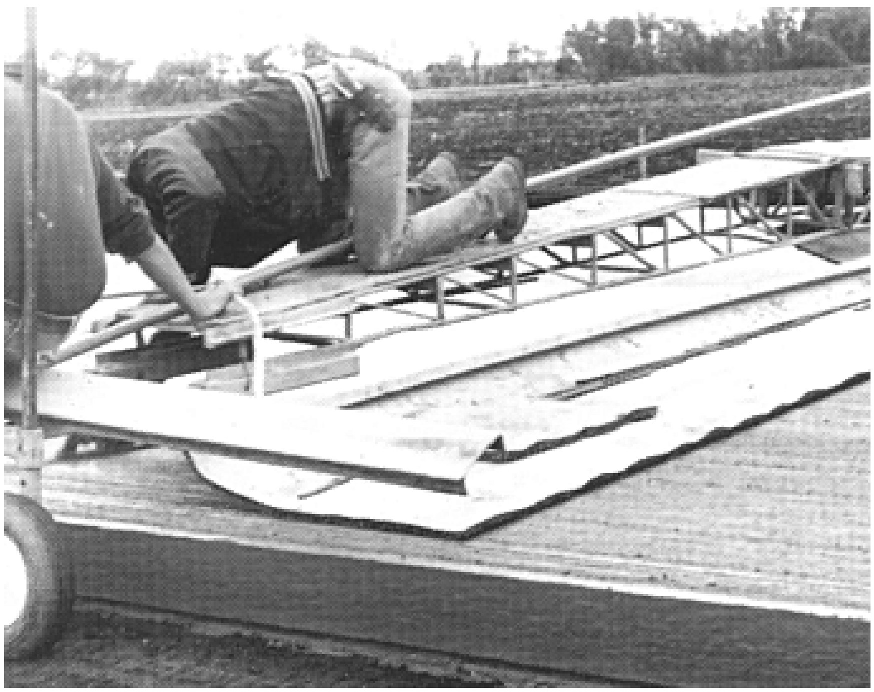
2 Blade length - 7/8″ plus or minus 1/8″.

3 Total fabric weight - 70 oz per square yard, minimum.

Note The inspection of the carpet by visual inspection.

In the figure 6.4, rebar is laid across the carpet to ensure two feet of the carpet are in contact with the surface. Ensure weight is evenly distributed and not too much weight is used. Do not permit dirt or aggregate to be used as weight. The carpet backing must be of a strong and durable material, not subject to rot. The carpet must be maintained in good condition, to provide uniform looking texture. It must be kept clean, free of dried mortar, and replaced when necessary. It should leave corrugations approximately 1/16″ deep.

Figure 6.4 Hand repairs from carpet drag bridge.



Note Other drag materials have been used to provide the desired surface. Use of alternative materials should be cleared with the Project or Area Engineer.

When a well maintained carpet drag begins to catch and pull rocks to the surface, it may indicate any of these problems:

1 The concrete is not properly vibrated. Inspect the vibrators for malfunction.

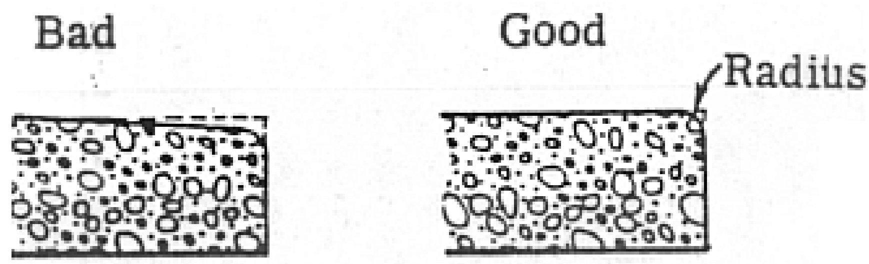
2 The mix may be indicating poor workability or difficulty consolidating. Consult the Concrete Engineer; it may be desirable to adjust the concrete mix design.

3 The carpet drag may be too far back from the paver.

Edging at Forms and Joints

After the final finish, and while the concrete is still plastic, the edges of the pavement along each side of the slab, and on each side of transverse approved tool rounded to the specified radius (**380.3 J 7**).

Figure 6.5 Comparison of edging techniques.



Edging will be permitted along longitudinal construction joints provided the radius does not exceed 1/4 inch. A well-defined and continuous radius shall be produced and a smooth, dense mortar finish obtained. The surface of the slab shall not be unduly disturbed by tilting of the tool during use. **(380.3 J 7)**

Any tool marks appearing on the slab adjacent to the joints shall be eliminated by brooming, belting, or burlap dragging the surface without disturbing the rounding of the corner of the slab. All concrete on top of the joint filler shall be completely removed. All joints shall be tested with a 10 foot straightedge before the concrete has set and correction made if one side of the joint is higher than the other or if they are higher or lower than the adjacent slabs.

Tining

Following the carpet drag, before curing compound is applied, the plastic concrete surface is given a transverse or longitudinal metal-tine finish (check to see what is specified on the plans). This produces a rough textured surface with slots to allow water to move off of the surface to prevent hydroplaning, and increase traction and skid resistance (**380.3 J 6**).

A tire gauge can be used to check this since worn tines do not groove adequately, tine ends should be checked with a ruler for wear. The Contractor should replace worn tines. Record all groove depth checks and spacing on DOT-55 form (SD 418).

It is important to begin tining at the proper time. If the slump is too high or tining is done too early, the concrete fills the grooves and aggregate is pulled to the surface. If the slump is too low or too much time has elapsed grooves may not be made in the surface. Experience indicates that good results can be obtained if tining begins when the concrete surface loses its water sheen. The tining machine is separate from the paving train but may be linked to the curing cart. It is important that the machine be available when the concrete is of exactly the right consistency.

Figure 6.6 One inch tined surface.

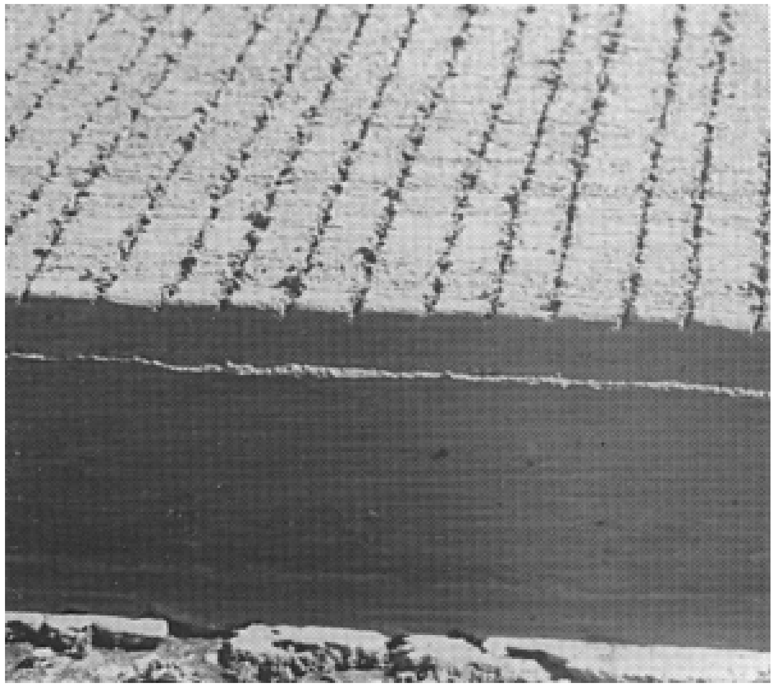


Figure 6.7 Longitudinal tining - blank at centerline.

Transverse Tining

Figure 6.8 Tining machine in operation. The wooden slats, (strips of light metal or belting material may be used) to cover joint areas to be sawed.

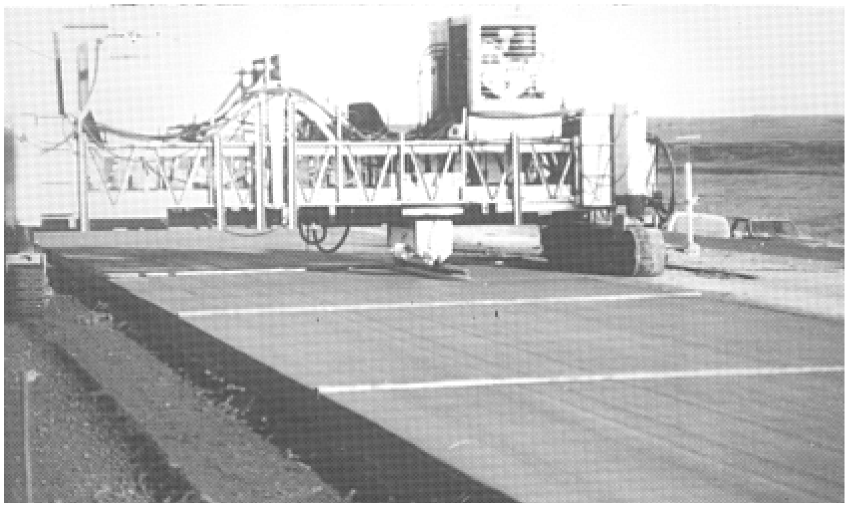


Figure 6.9 Note the length of tines.

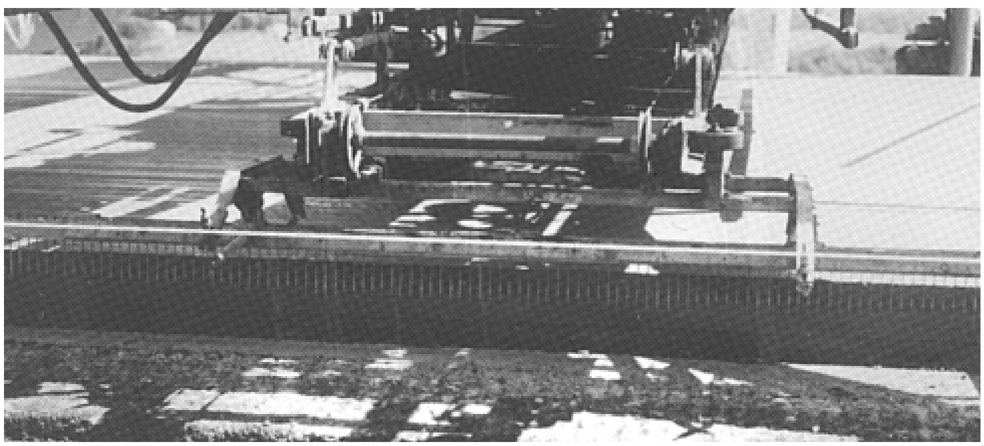
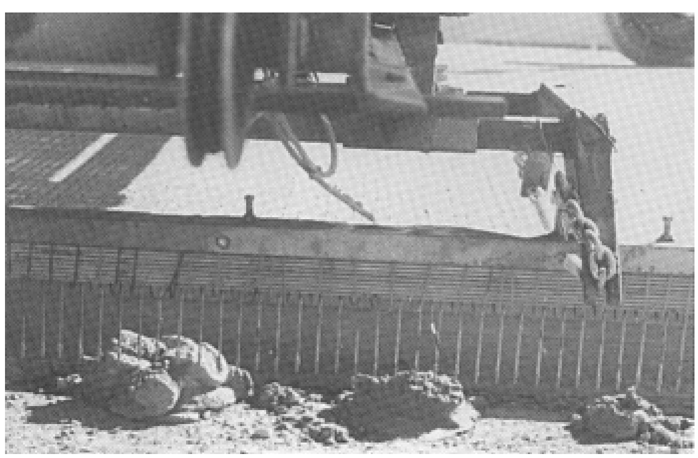


Figure 6.10 Tines picking up aggregate indicates poor consolidation.

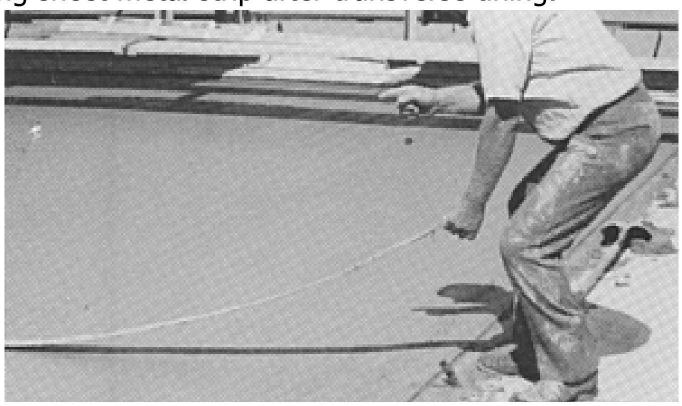


The tining machine must bridge the entire concrete slab. The carrier of the tining device should be adjusted so the tines follow parallel to the concrete surface top or on a skew, parallel to the transverse joints and such that each pass of the tines can be made in one complete stroke. Transverse tining over a joint is not allowed because spalling occurs. Lay a strip of thin wood, metal, or rubber belting approximately 4 inches wide across the slab to prevent tine penetration where the transverse joint is to be sawed to prevent this spalling.

It is absolutely critical that the tining crew knows where the joint is to be sawed so the wood, metal, or rubber strip is place exactly over the center of the dowel basket covered with concrete. This can be checked almost immediately with the cover meter.

Accurate spacing between the tines and between adjacent passes of the tining machine must be accomplished in the first pass. Correcting irregularities in the tining with a second pass is not allowed because it is practically impossible to set the tines back into the same grooves. The narrow areas created between the grooves chip out with traffic. Spacing that is too wide between adjacent passes of the tining machine is more acceptable than spacing that is too close.

Figure 6.11 Removing sheet metal strip after transverse tining.



Immediately following the carpet drag, the surface of the concrete pavement shall be given a transverse metal tine finish with a separate self-propelled mechanical device. Early checks should be done to prevent future issues. The metal-tine finish shall provide a groove width of 1/8 inch and a groove depth of 3/16” deep $\pm\frac{1}{16}$ inch. The spacing between the individual tines shall meet the following: Section **380.3 J 6 a**.

Successive passes of the tining shall not overlap.

Inches (ten foot tining rake)

2-5/16	2-5/16	1-1/4	2-7/16	2-1/16	1-1/4	13/16	1	1-5/16	1-1/8	2-5/16
2-1/2	2-7/8	2-3/4	1-1/8	2-3/4	2-1/8	1-15/16	13/16	7/8	2-5/8	3-1/16
3-1/16	7/8	9/16	9/16	1-5/8	2-3/8	1	1-1/4	1-9/16	2-15/16	1-1/8
1-15/16	2-3/16	2	2-13/16	1	2-11/16	13/16	1-7/8	9/16	2-5/16	1-7/8
2-1/2	1-5/16	3-3/16	1-3/8	15/16	7/8	1-5/8	9/16	1-3/4	2-7/8	3
1-5/8	1-5/8	7/8	9/16	5/8	2-13/16	1-5/8	2-7/16	13/16	1-1/4	11/16
2-3/4	2-5/16	1-1/8								

Longitudinal Tining

Do not blank out the transverse joints with thin wood, metal, or rubber belting when longitudinal tining is used on a project.

The longitudinal tining equipment shall have the ability to be raised and lowered, and shall have vertical and horizontal string line controls to ensure straight grooves that are parallel to the longitudinal joint.

The tine bar shall have a single row of tines and shall provide a groove width of 1/8 inch +/- 1/64 and a groove depth of 3/16 inch +/- 1/16. The spacing between the individual tines shall be uniformly spaced at 3/4 inch intervals.

830.3 N 6 b

Stationing

Permanent station numbers are stamped into fresh concrete before or after tining. If they are stamped before tining, cover the numbers with a metal plate so the tining operation will not damage the numeral imprint. A set of plastic or metal numbers supplied by the Region Materials Engineer is used. Every 500 feet, stamp the station on the slab. Stamp divided highway station numbers on the side opposite the median. **Undivided, two-way traffic pavements** should be stamped on the right side in the direction of the stationing. Use hubs to find the stationing. Stamp the numbers 6 inches in from the pavement edge. Stamp the stations on each lane of divided highways. Place a light weight square metal plate over the stamp to protect it from tining if stamping is performed before tining is completed.

Figure 6.12 Tining and Stationing.

Curing

During hydration (the chemical reaction between water and cement) a glue-like paste is formed, binding the aggregates together and causing the concrete to gain strength. In a process called curing, concrete is protected for a period of time so the water needed for hydration remains in the concrete.

Fresh concrete that is not cured dries out rapidly causing:

- Low strength
- Checking and cracking of the surface

Fresh concrete always contains more water than needed for hydration because extra water is needed to make placement possible. After placement and finishing, most of the extra water comes to the top, where it evaporates. Before evaporating, the surface appears to glisten. No part of the concrete shall be left exposed for more than 1/2 hour between stages of curing or during the curing period (**380.3 M**). Curing material should be placed just after the water sheen disappears and must be kept in place for at least 72 hours and replaced if disrupted before 72 hours elapse.

Materials most commonly used for curing concrete are:

- White pigmented linseed oil based or wax based liquid (Impervious Membrane Curing Compound)
- Cotton, Burlap mats and White Polyethylene Sheeting
- White Opaque Polyethylene Sheeting

When sampling the impervious membrane compound, sample each lot number from the agitated source rather than the storage source (M.S.T.R, Materials Manual).

Note Make sure to note the station of placement and date of placement for each lot number in the diary; and on the DOT-1 if possible.

Impervious Membrane Compound

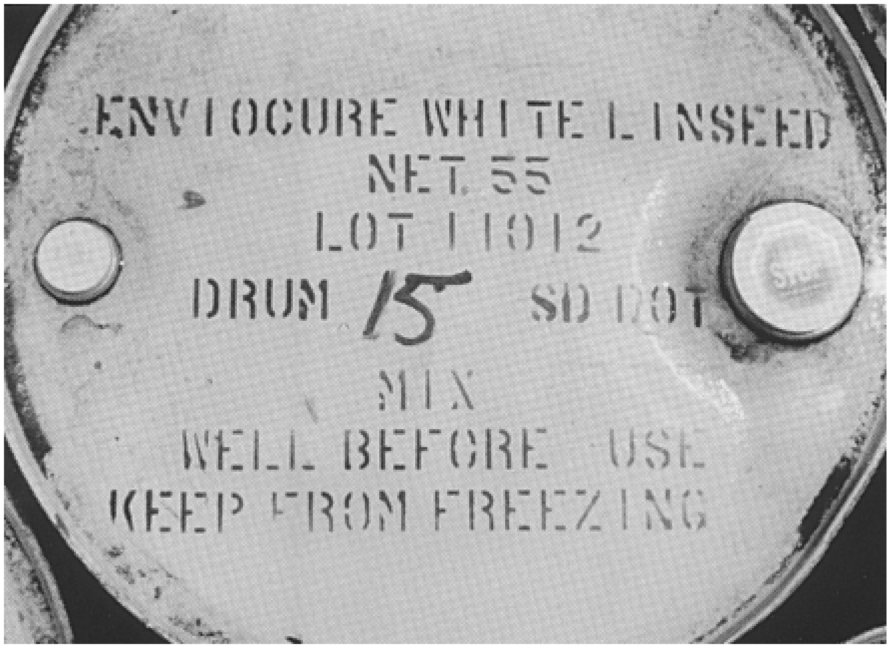
Membrane curing compound is a liquid applied to concrete with a sprayer (**380.3 M 2**). The sprayer equipment should be equipped with a tank agitator and shall be full atomizing. Curing compounds differ in type and pigment. Those used on city projects usually require a linseed oil base due to heavy use of de-icing chemicals. Check plans and specifications for the type to be used on the project.

Since pigments settle:

- The liquid should be well mixed before using
- May require 30 minutes of mixing
- Recommend paddle-type mixer
- Continual agitation of the liquid in the sprayer is necessary

Linseed oil based curing compound plugs up hand sprayers.

Figure 6.13 Container of Impervious Membrane Curing Compound.



Some techniques inspectors use in checking curing preparations include getting the lot numbers, shelf life of cure, and other required information when counting the barrels of cure. This action prevents having to check the barrels or containers a second time. A fast but rough estimation of sufficiency of the quantity of the cure on hand is to divide the length of the project by the quantity of cure. Another technique to determine if the Contractor plans to properly apply the curing compound is to measure the distance between the barrels or tubs of material set alongside the grade.

The minimum application rate shall be one gallon per 150 square feet for carpet drag or broom finished surfaces and one gallon per 125 square feet for metal tined finished surfaces. Curing compound may be applied in one or two applications in accordance with the directions of the manufacturer. If applied in two applications, the second application shall be applied within 30 minutes after the first. Documentation is necessary on DOT-98. **380.3 M 2**

Note An application rate calculated at less than the rate required is desired.

<u>EXAMPLE</u>: The surface of a 28 foot wide pavement 8 inches in depth is being cured. 475 gallons were used on 2015 linear feet of pavement.

First, determine the total width to be covered (pavement surface and sides):

28 feet+8 inches + 8 inches = 29.34 feet

Next determine area L x W:

Area = 29.34 feet x 2015 feet = 59,120.10 square feet

Finally, determine application rate:

$$\text{Application} = \frac{59{,}120.1 \text{ sq.ft}}{475 \text{ gallons}} = 124.46 \text{ sq ft/ gal}$$

Note Remember, when curing the sides at the same time, the sides of the slab must be included in the computation for area.

Curing compound must be applied uniformly to effectively protect the concrete. If the application is streaky, the sprayer must be adjusted and non-uniform areas given a second application. If rain falls on the curing compound before the film is dry, another application is necessary. The curing compound shall not be applied during or immediately after rainfall.

A second application must also be given to the area of the slab that is scuffed up when starting from a previous concrete placement or disturbed during green cut sawing. Curing compound shall not be applied to the inside faces of joints to be sealed, unless the compound is completely removed by subsequent sawing operations. If the film is broken in any way during the 72 hours curing period, another application is necessary (**380.3 M**). The concrete shall not be exposed for more than 1/2 hour between stages of curing or during the curing period.

Upon removal of forms, the sides of the exposed slab shall be protected immediately with the same curing treatment provided for the surface. When the wind interferes with uniform application, the Contractor shall provide for wind protection around the sprayer. The sides of the pavement and the surface must be cured. When using the formed method, curing compound must be applied to the sides as soon as the forms are removed, usually with a small hand sprayer.

Figure 6.14 Curing compound being applied to slip-form paved surface. Note coverage of the slab sides.

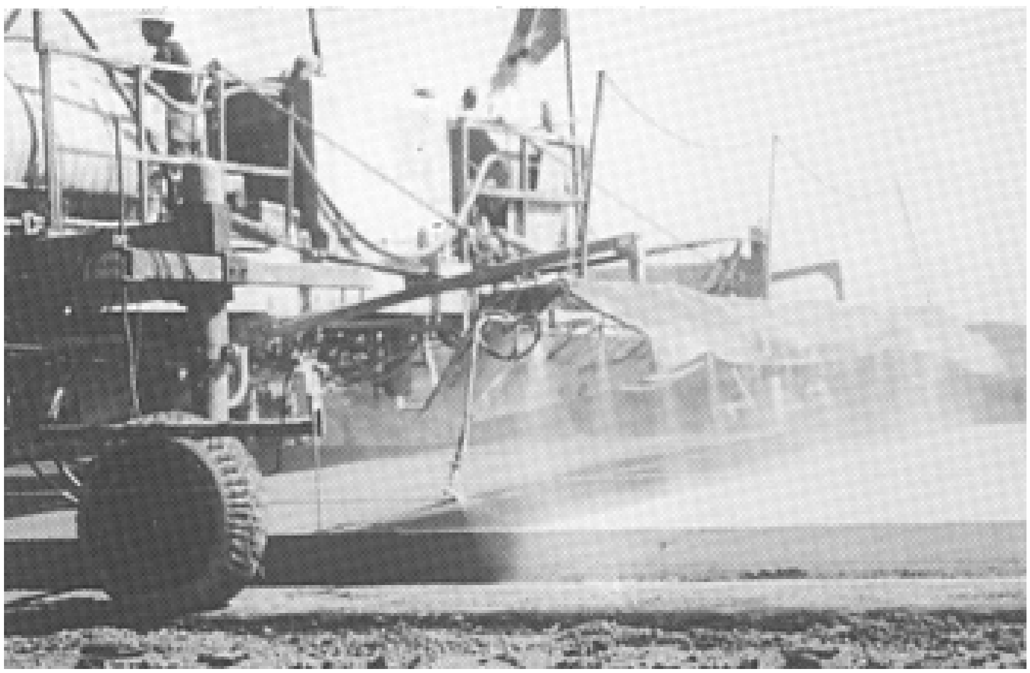
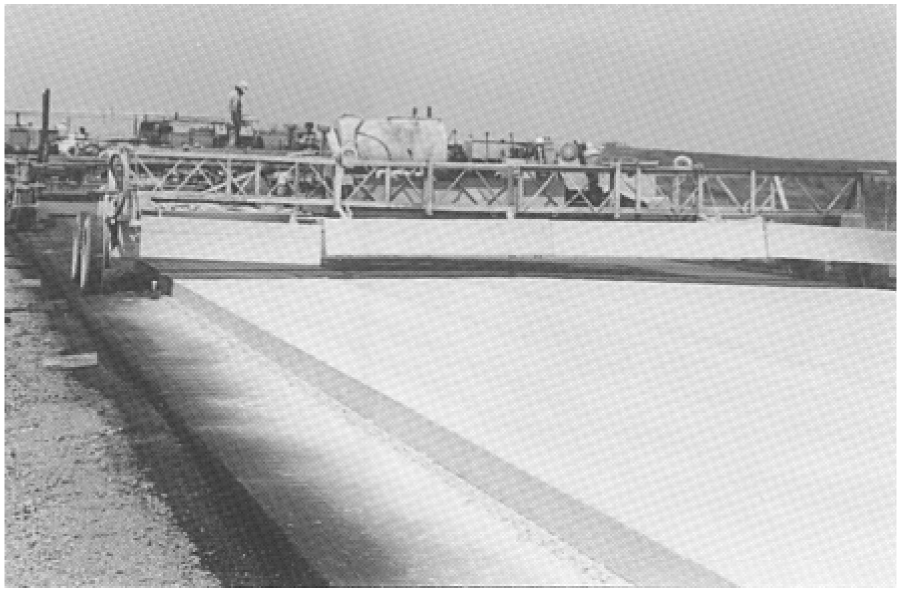
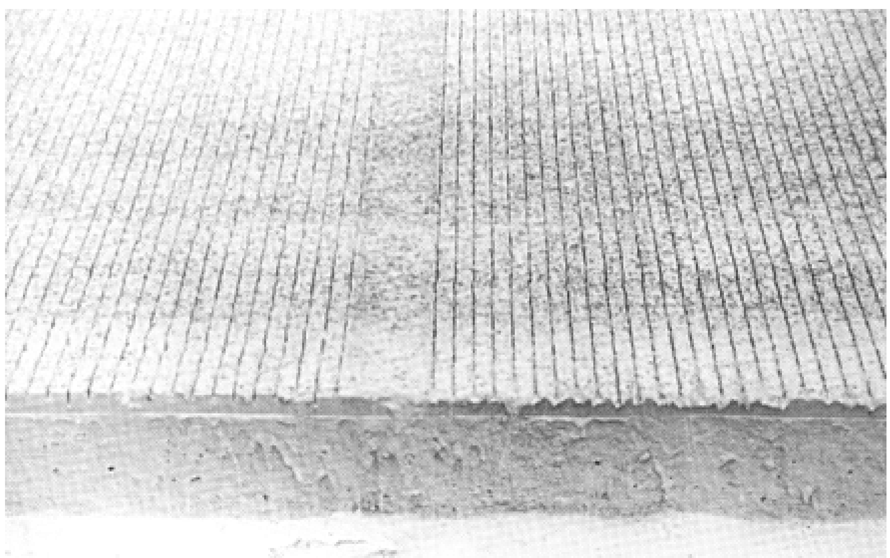


Figure 6.15 Curing machine. Note: The wind skirt on the back, the curing compound tank and agitating machine at the left on top of the curing machine bridge.



Inspect the coverage. If any areas do not have uniform coverage, adjust the equipment and respray.

Figure 6.16 Slab covered with curing compound.



Cotton and Burlap Mats and White Polyethylene Sheeting

The surface of the concrete pavement and both pavement edges shall be covered with cotton burlap mats (**380.3 M 1**). Prior to placement, the mats shall be thoroughly saturated with water. Ensure the Contractor has a plan for laying these down on the pavement surface. Dragging is not a choice, nor is laying dry material on the surface and wetting it. Immediately after placement, the mats shall be covered with white polyethylene sheeting. The mats shall be kept moist by periodic application of water. After removal of the mats, the impervious membrane shall be applied.

White Opaque Polyethylene Sheeting

Plastic sheeting (**380.3 M 3**) is effective but is hard to handle in wind. Ends should lap 18 inches. The lapped ends must be weighted. Care must be taken that the weights do not mark the slab. The sheeting shall maintain close contact with the surface covered, and it must be kept in place for at least 72 hours. Sheets with holes, even small ones, must be repaired before they can be used. The sheeting shall be sized so each unit as laid will extend beyond the edges of the slab at least twice the thickness of the pavement. Using dark plastic sheeting is prohibited except during cold weather and after its use is approved by the Engineer.

Figure 6.17 Plastic sheeting covering slab. Note how the sheeting extends beyond edge of pavement and is secured by lumber, sandbags, and gravel.

Cold Weather Concreting/Protection

In cold weather, the slab temperature is a consideration. When the ambient temperature is below $35°F$ or expected to drop below $35°F$ before the concrete attains 1500 psi., the following precautions should be taken:

1. The Contractor should have a sufficient supply of insulating blankets, burlap mats, plastic sheeting, or other suitable blanketing material to help prevent the water in the concrete from freezing.

2. The water for mixing should be heated, not to exceed $160°F$.

3. The stockpiles may need to be heated, not to exceed $100°F$.

4. If forms are used, they should be heated.

5. The concrete should never be placed on a frozen base or subgrade because the rate of hardening will be retarded, and uneven settlement may occur when the subgrade thaws.

6. The concrete temperature at time of placement shall be between $50^{\circ}F$ and $90^{\circ}F$. **(380.3 G)**

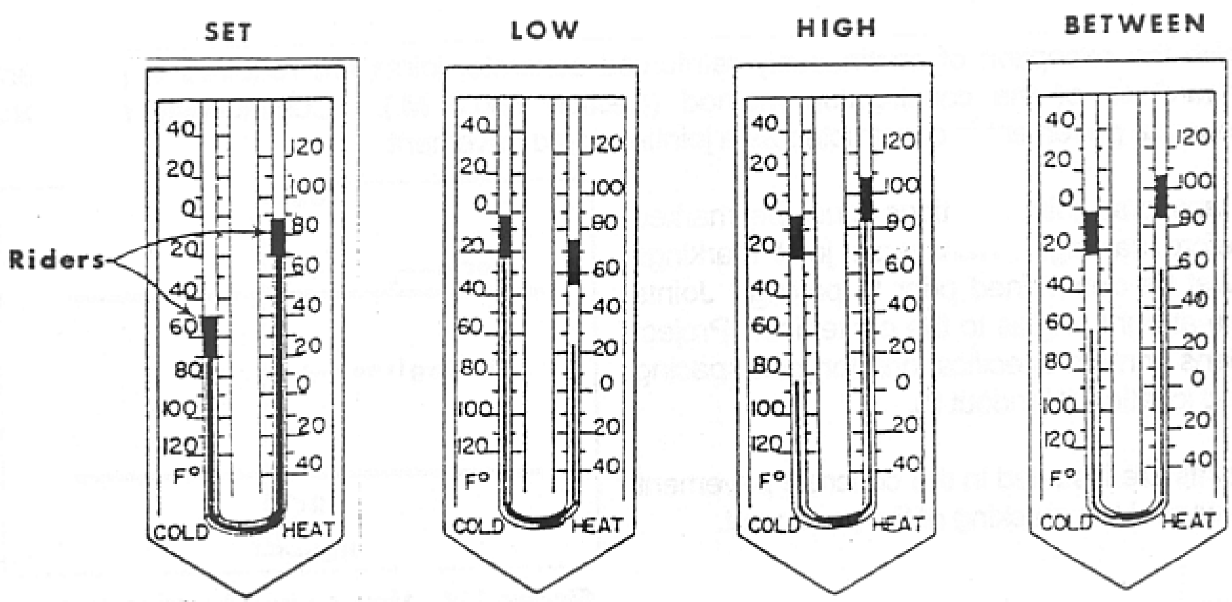
Record all temperature checks on the diary, DOT-23 form and DOT-227 form.

Strength can be tested with a concrete cylinder cured similar to the pavement or a Swiss Impact Hammer.

Temperature Monitoring

When air temperature drops below $40^{\circ}F$, slab temperature should be checked. The Region Materials Engineer can provide the "HI-LOW" thermometer needed. The tube on this thermometer is "U" shaped and has temperature reading on both sides. The right side records the "high" and the left side records the "low". The black riders at the end of each mercury column do the recording. the temperature is read at the bottom of the riders.

Figure 6.18 HI-LOW thermometer readings



The high-low thermometer must be set each time it is used. Using a magnet, move the riders until they touch the mercury. As the temperature rises, the mercury will push the right rider up. When the temperature falls, the right rider stays at the high reading as the mercury moves away from it. Also, as the temperature falls, the rider on the left side is being pushed up. When the temperature is neither the high nor the low for the day, the mercury will not be touching either of the riders.

- Pre-plan the placement of the thermometers.
- Usually the lowest temperature is found at the edge and the highest temperature in the middle of the mass or where the concrete is the thickest.
- Place at least one thermometer in each area; several are desirable along the length of the slab.
- When insulation is being used directly on and around the concrete, place the thermometer between it and the concrete.
- Maturity meters may be used to record the concrete temperatures.

Hot Weather Concreting

In very hot weather water evaporates quickly from concrete, and the result may be shrinkage cracks in the pavement surface. In addition, when concrete is placed in layers, cold joints or discontinuities in the concrete can develop, if one layer is allowed to harden before the next layer is placed.

Delay in placing concrete during hot weather contributes to a loss of slump and increase in the concrete temperature. This decreases the concrete's workability because the concrete has begun to take its initial set.

The following precautions should be taken when the concrete temperature is above $85°F$:

1. Concrete must be transported and placed as quickly as possible. If placement is delayed, concrete will begin to take its initial set and will be unworkable.

2. There should be enough workers on the job site to handle and place the concrete immediately after delivery.

3. It may be necessary to reduce the temperature of the concrete. Cooling the concrete components can do this.

- cooler cement
- ice in place of mixing water
- sprinkle coarse aggregate stockpile

4. The maximum temperature of the concrete mix is $90°F$.

5. Apply curing compound quicker than normal and may require a heavier dose.

CHAPTER

7

JOINTS AND JOINT SEALING

With the exception of continuously reinforced concrete, joints are required in pavement regardless of the construction method (**380.3 K**). Continuously reinforced concrete pavement is constructed as a jointless rigid pavement.

Transverse joint locations must be marked before sawing. Transverse joint markings must be determined prior to paving. Joints are at right angles to the centerline. Project plans contain specifications for joint spacing and location (Handout 5 - Sheets F16 and F17). Joints are installed in the concrete pavement to control the cracking of the pavement. The distance between joints is measured along the centerline of the lane. At a curve, make a correction in the measurements along the edge of the pavement to hold the correct centerline distance.

Figure 7.1 Orange ribbon nailed to ground in front of hub marks joint location for slip-form paving.

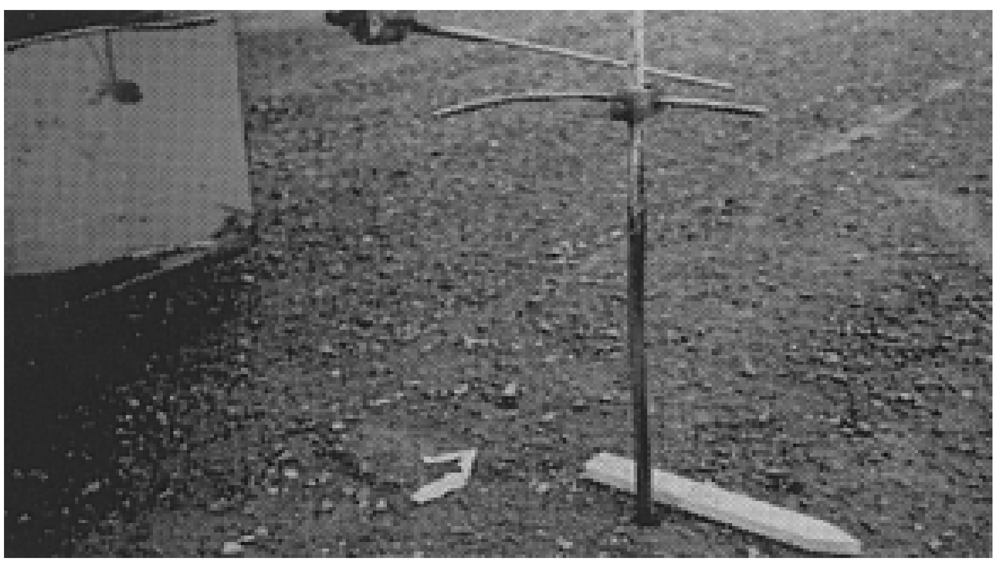


Figure 7.2 Paint extending toward centerline from orange ribbon nailed to ground marks the intended joint location.

Method for figuring the corrected distances:

1 Obtain the survey centerline curve radius from the plans.

2 Obtain the distance that the lane centerline is offset from the survey line. Subtract it from the radius length if the lane is inside the survey centerline or add it if the lane is on the outside of the centerline. The result is the radius for the lane center line.

3 Find the radius for each of the form lines by adding or subtracting 1/2 the pavement width to the radius of the lane centerline.

4 Set up a proportion between the form line radius and the lane radius time the joint spacing. The result is the corrected distance to use on each side.

Another method to figure cord corrected distance is:

Degree of curve x offset distance x 0.0175/100 = Correction per foot

Transverse Contraction Joints

Transverse contraction joints (**380.3 L 3**) are constructed across the slab at specified intervals as shown on the plans. The joints form areas of weakness to control cracking as concrete shrinks or contracts. Joints are sawed into the concrete. They are 1/4 the depth of the slab unless otherwise shown on the plans. Check plan sheet (Handout 5) for width.

Figure 7.3 Joints are sawed into concrete after it has hardened.

Sawing Joints

Joints shall be sawed as soon as the concrete has hardened sufficiently to permit sawing without excessive raveling, usually 4 to 24 hours. The time will vary with each mix and weather conditions. Joints must be sawed, regardless of the time of day or condition of the weather, before uncontrolled shrinkage cracking takes place. The need to accomplish green sawing is especially important when placing concrete adjacent to a slab previously sawed or under traffic.

The widening of sawed joints shall not begin until after the 72 hour curing period (**380.3 L 3 & 380.3 Q**). Water trucks are considered construction traffic and therefore not allowed on the slab until 4000 psi has been reached. The sawing of any joint shall be omitted if a crack occurs at or near the joint location prior to the time of sawing. Use a cover meter to locate dowel baskets if saw line markings have been erased, obliterated, or if you suspect they have been moved or otherwise lost.

Transverse contraction joints shall be created by sawing. The initial saw cut shall commence when the concrete has hardened sufficiently to permit sawing without raveling. The widening cut shall not commence until completion of the concrete cure period. Joints shall be sawed before uncontrolled shrinkage cracking takes place. If necessary, the initial sawing operations shall be performed on both day and night, regardless of weather conditions. The initial sawed joint will not require reapplication of curing compound.

If a soft cut style saw is used, the soft cut may remain approximately 1” from the edges of the concrete slab to control spalling at the edge. Additionally, if a soft cut saw is used, the Contractor shall complete the initial saw cut for the entire width and to the required depth before the end of the 72 hour curing period.

Figure 7.4 Soft cut saw

Figure 7.5 Concrete saw.

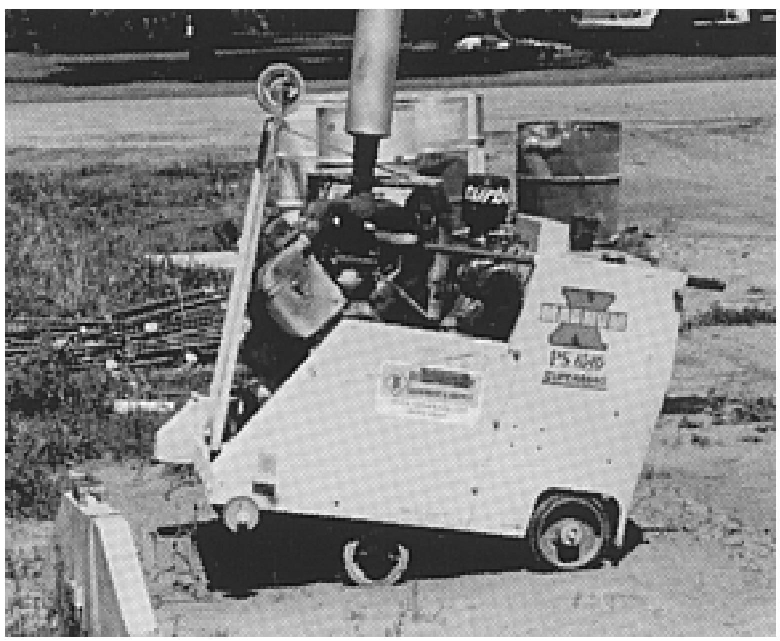


Figure 7.6 Beveled edge transverse contraction joint showing the width and depth to top of the sealant.

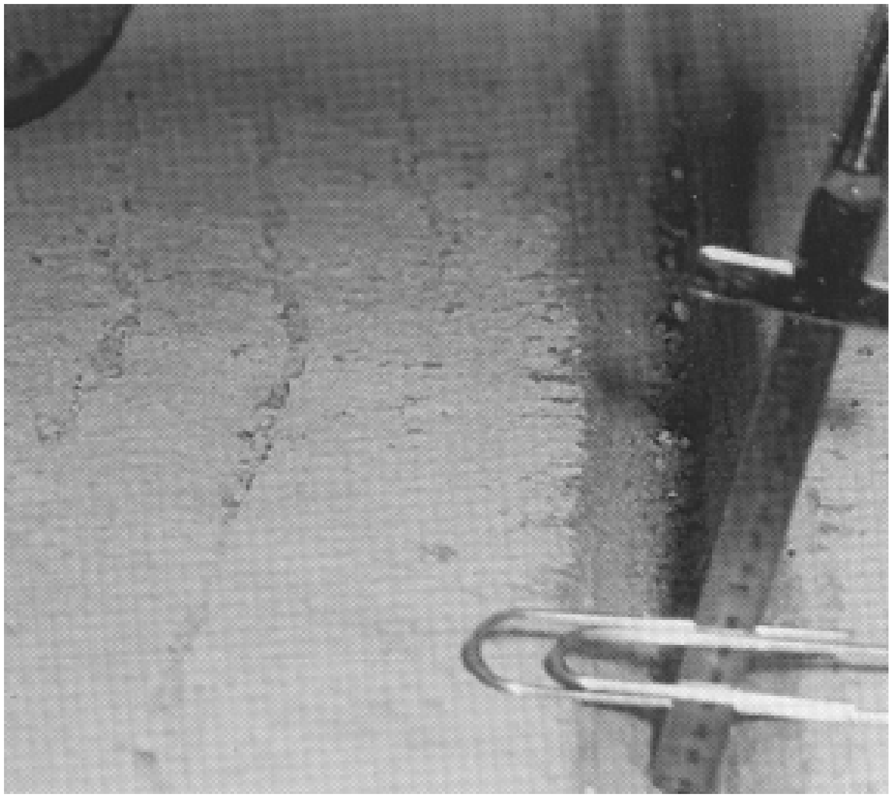


Figure 7.7 Beveled edge transverse contraction joint.

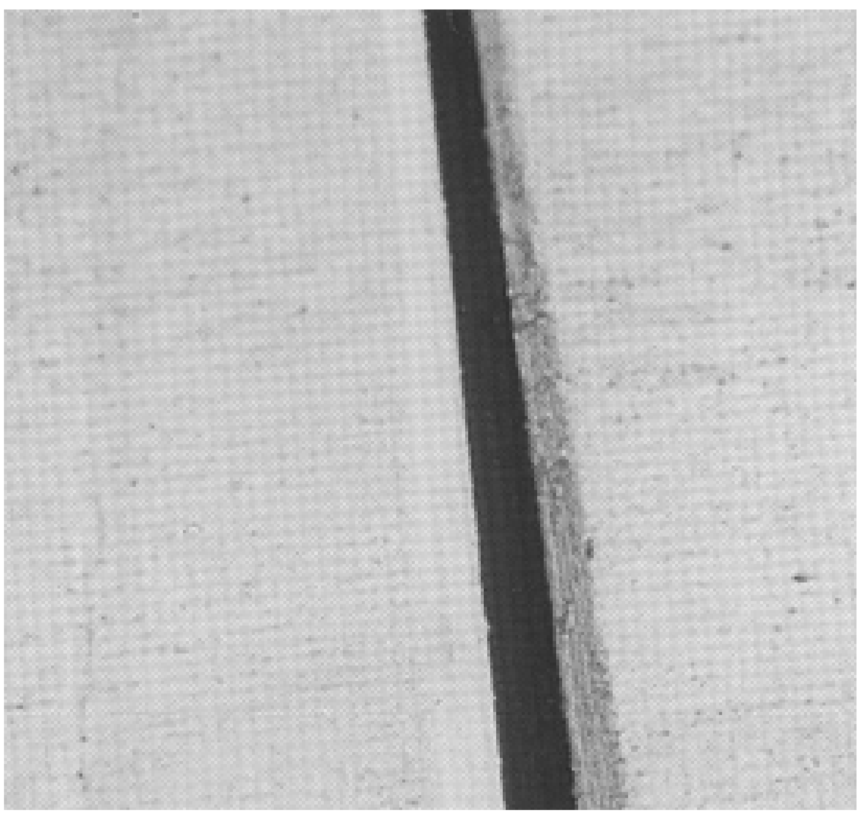


Figure 7.8 Beveled edge transverse contraction joint.

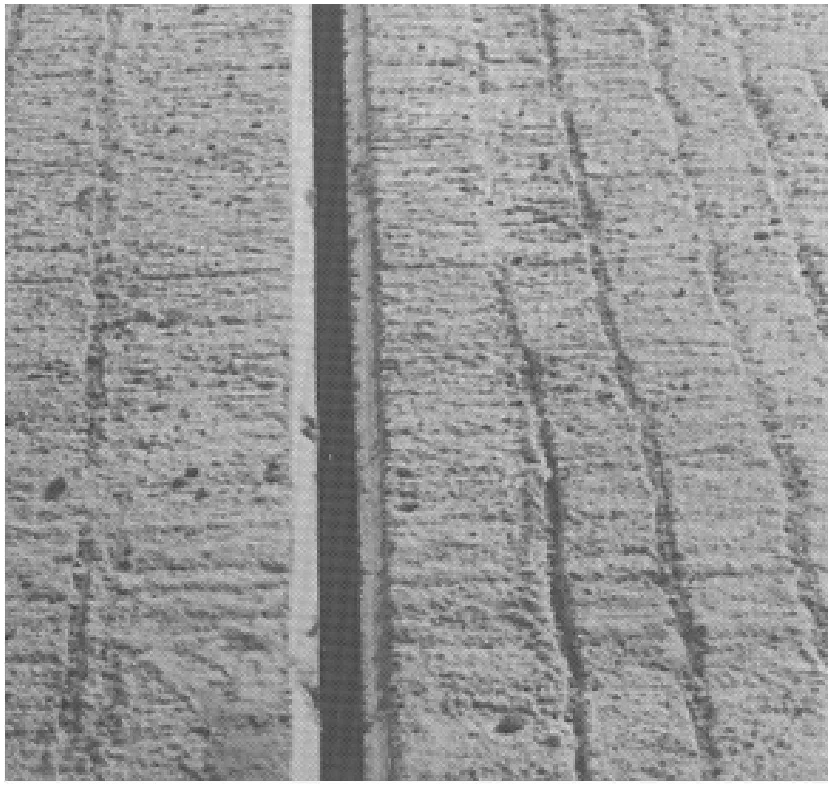


Figure 7.9 Beveled edge transverse contraction joint after the pavement surface has been ground.

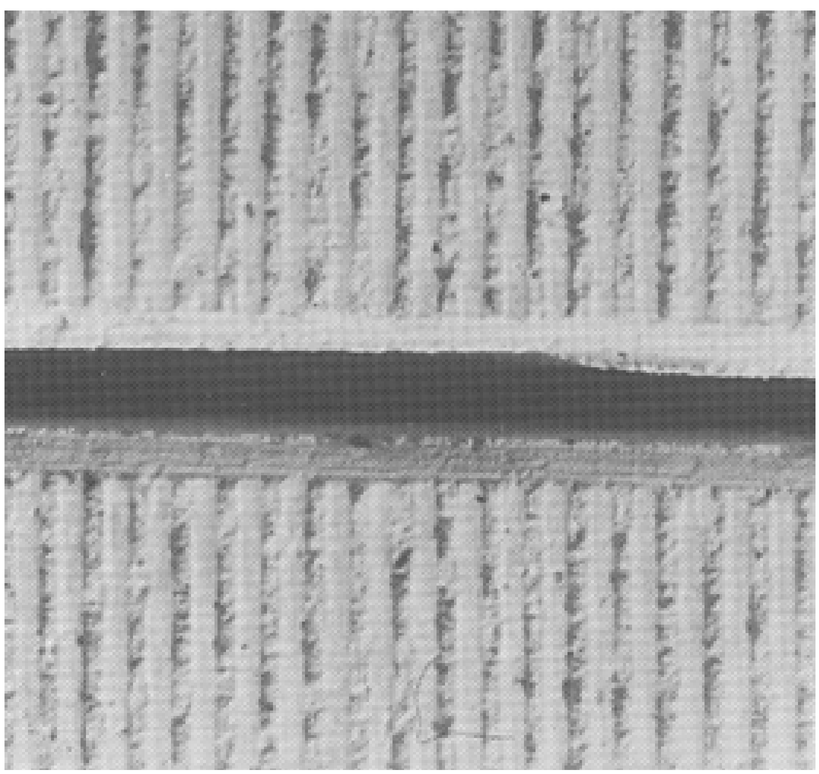


Figure 7.10 Sawed joint. Note the disturbance of the curing compound covering the slab.

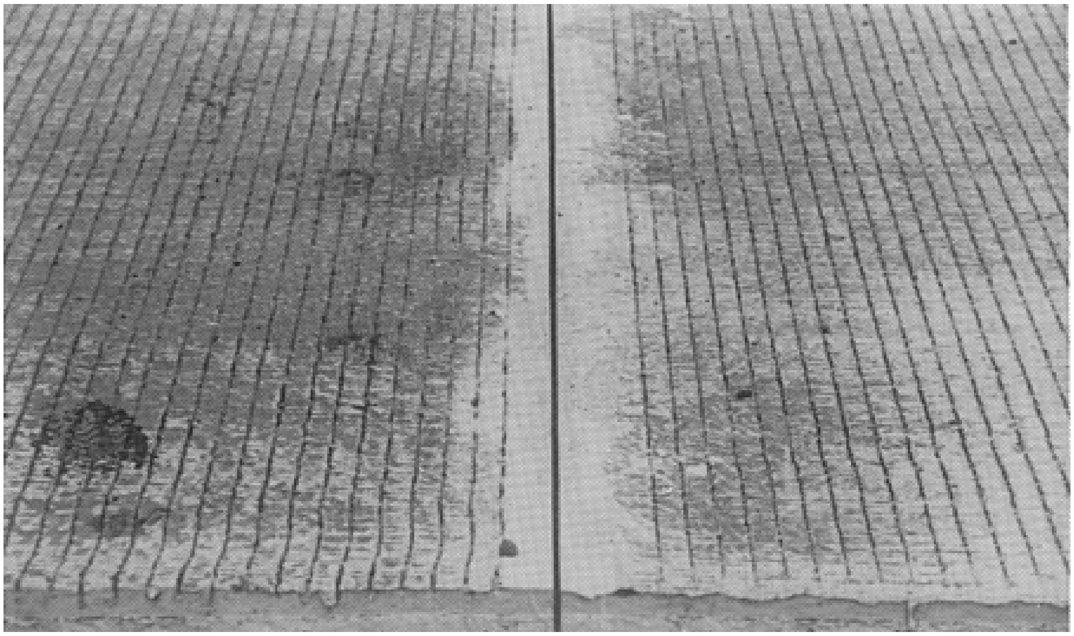
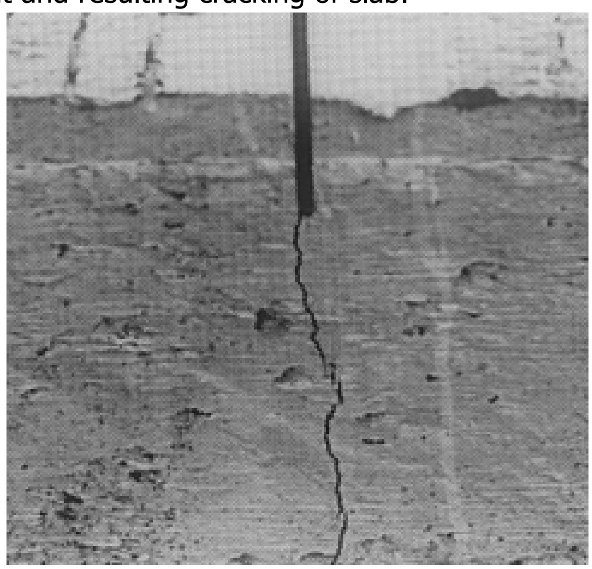


Figure 7.11 Sawed joint and resulting cracking of slab.



Determining when to saw the concrete is the responsibility of the Contractor. The temperature of the concrete when it was placed and the weather conditions influence the decision.

Note If a joint starts to crack during sawing, stop sawing. Move ahead a few joints and start again. Repeat until the random cracking stops (**380.3 L 4**).

To eliminate premature cracking, the Contractor must change the sawing sequence. Every second or third joint should be sawed until the end of the day's concrete placement. Bypassed joints can then be sawed. Joints must be sawed to the dimensions shown on the joints details sheet of the plans (Appendix C, 380.05 and 380.06). Inspect to assure that joints are cut to at least minimum dimensions. The saw operator should have a ruler to measure depth of the saw cut. If the initial saw depth is not achieved, random cracking may occur. Periodically measure the depth of the saw cuts. When a saw blade wears, adjustments need to be made to the depth. Spalls along joints during construction should be sounded and marked. Check with the Project Engineer about immediate repair.

Longitudinal Joints

Longitudinal joints (**380.3 L 1 & 2**) run parallel to the centerline, either down the centerline of the slab or between two separately constructed slabs. Longitudinal joints must be constructed by sawing to the depth, width and lines shown on the plans. They are to be sawed 1/3 of the depth of the slab, unless shown otherwise on the plans. The sawed joint will not require reapplication of curing compound. Inspect the joints about every 500 feet and record findings in the diary.

Longitudinal joints must be straight because they are so visible to the traveling public. The Contractor can use several methods to make a straight joint.

1 Outriggers on the saw fit over the edges of the pavement to hold the saw to the centerline.

2 A stringline can be stretched as a guide for the saw.

3 Painting a line over measured and marked joint location.

When the joints are to be sawed, the Contractor must provide equipment adequate in number of units and power to complete the sawing to the required dimensions and at the required rate. One standby saw and an ample supply of saw blades are also required. If membrane curing compound is used, all areas disturbed by the crew walking, or moving machinery during sawing activities require a second application.

Repair or Correction of Uncontrolled Cracking

Figure 7.12 Random Cracks 1

Repair or correction of uncontrolled cracks (**380.3 L 4**) shall be as directed by the Engineer and at the expense of the Contractor.

Random cracks: **380.3 L 4** The sawing of a joint shall be omitted if a crack occurs within 3 inches of either side of the joint location prior to the time of sawing. Sawing shall be discontinued when a crack develops ahead of the saw. Any procedure which results in premature and uncontrolled cracking shall be revised immediately by adjusting the sequence of cutting the joints or the time interval between the placing of the concrete or removal of curing media and the cutting of joints.

Figure 7.13 Random Cracks 2

Longitudinal Random Cracks

Longitudinal random cracks penetrating the full depth of the pavement shall be repaired to the satisfaction of the Engineer. This may involve but not limited to, cross-stitching, removal and replacement, epoxy injection, or routed and sealed.

Transverse Random Cracks

If an uncontrolled crack develops within 6 feet of the contraction joint, a minimum of 6 feet of pavement removal and replacement will be required. Removal and replacement of the pavement shall be done at the Contractor's expense. If cracking occurs on both sides of the joint, more than 3 inches from the joint, the dowel bar assembly and a minimum of 3 feet of pavement each side of the joint shall be removed and replaced. Removal and replacement of the pavement shall be done at the Contractor's expense.

If an uncontrolled crack develops on one side of the contraction joint in the mid panel area between 6 feet from the joint and the midpoint of the panel, the entire panel shall be replaced on that side of the joint within the lane containing the cracking. Removal and replacement of the pavement shall be done at the Contractor's expense.

No section of pavement less than 6 feet in length will be allowed to remain in place.

The Department will provide drawings and specification of repair procedures to the Contractor. If extreme conditions exist which make it impractical to prevent erratic cracking by early sawing, the contraction joint groove shall be formed in a manner approved by the Engineer prior to initial set of the concrete.

Spall Repair

Figure 7.14 Joint Spall

Joint grooves with spalls greater than 1/2” in depth shall be patched with an approved epoxy mortar. Loose concrete shall be removed from the spalled area and the spalled surface shall be thoroughly cleaned. After cleaning and forming, the spalled surface shall be primed and an epoxy mortar of troweling consistency shall be placed in the spalled area and finished as the original pavement surface. The epoxy binder components shall be preportioned and mixed as recommended by the manufacturer. After the epoxy binder is thoroughly mixed, dry silica sand shall be blended into the mixture to give the epoxy mortar a trowelable consistency.

After the epoxy mortar has cured, the forming material shall be carefully removed. The finished joint shall have vertical faces and the joint width shall be maintained. Patching of spalls shall be done only when the temperature of the air and pavement are above 40°F.

Expansion Joints

Expansion joints are installed across the pavement near each end of all bridge structures. The practice allows expansion of the concrete pavement without pushing against the ends of the bridge. Refer to the plans for details.

Figure 7.15 Compression Seal Joint

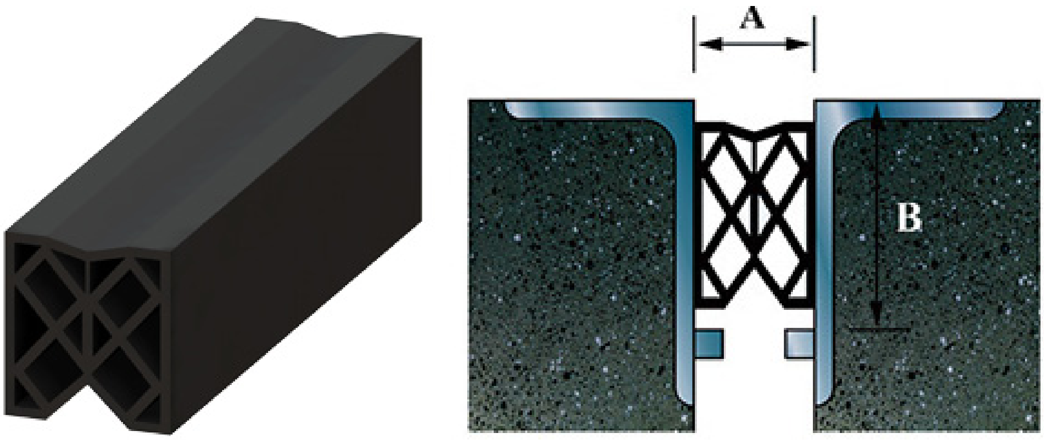


Figure 7.16 Compression Seal Joint installed.

Figure 7.17 Foam Compression Seal Installation

Figure 7.18 Foam Compression Seal

Bituminous Mix and Strip Seal assemblies are most commonly used in expansion joints. Locations and installation procedures for expansion devices can be found in the plans.

Expansion devices are installed directly above the Bridge Approach Sleeper Slab. The portion of the sleeper slab directly below the movable slab shall be smoothed with a steel trowel during construction. It must be covered with a coat of asphalt paint or polyethylene sheeting to prevent bonding of the concrete in the sleeper slab and the approach slab. Refer to the plans for the prescribed method. The pavement slab slides across the sleeper slab, preventing any pushing against the bridge end. The bridge approach sleeper slab and the approach slabs are usually built under the bridge contract.

Shoulder Joints

Sealing shoulder joints prevents moisture from getting between the concrete and the bituminous shoulder, or the two concrete slabs when concrete is placed on the shoulders. With bituminous shoulders, the joint reservoir is cut in the bituminous materials and filled with hot poured joint sealer. With concrete shoulders, the joint reservoir is cut directly over the joint.

Transverse Construction Joint

Transverse construction joints (**380.3 L 5**) shall be made at the end of each day's production or where an interruption is of a sufficient duration that has or will cause the concrete to start setting. The delivery of the concrete has specific limits concerning time and can be used as a guide. The plan details allow the Contractor a couple of different options. Normally, the Contractor will place additional reinforcement through the construction joint. Supplemental hand vibrators shall be immediately available to provide satisfactory consolidation at joints. If the concrete is not consolidated properly it may lead to premature failure. Always assure that all of the concrete is properly vibrated.

Paving in the area of a transverse construction joint will not be permitted for 12 hours after installation. (Appendix 13 - 380.07 & 380.08)

Headers for Transverse Construction Joint

Specifications (**380.3 L 5**) require that a transverse construction joint or "header" be placed whenever the paving operation stops for the day or is interrupted resulting in the in place concrete being no longer plastic and cannot be vibrated. When a transverse construction joint is made, it will be a minimum of 5 feet from the nearest contraction joint. See the Plan Note for specific placement. Paving must not be permitted in the area for twelve (12) hours. Early removal of the header could break the bond between the steel and the concrete.

Headers are placed whenever concrete placement is discontinued. Because they form a joint, headers should be placed perpendicular to the centerline. The top surface of the header must be set in line with the pavement. Setting the header high or low creates a corresponding high or low spot in the pavement because of finishing. The alignment and cross section can be checked by using a stringline. Enough stakes to hold the headers in their proper position must be used. Reinforcing bars used for non-continuously reinforced slabs must be of the size, length, and spacing shown on the plans. They are held parallel to the surface and centerline of the slab and in position by chairs or some alternate method. Ensure no effort is made to compress the slab as the header is approached. This is sometimes done so the paver can be pulled back over the slab after paving is completed for the day.

Figure 7.19 Header in place when paving ceased.

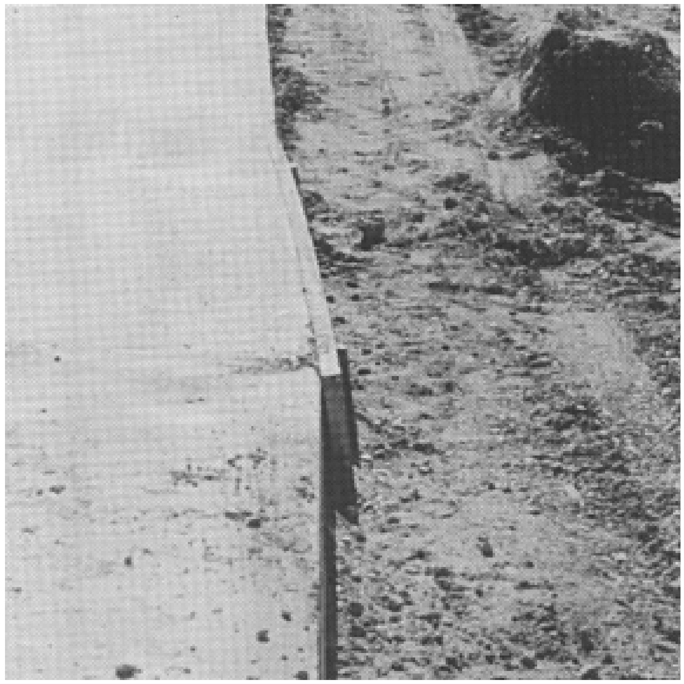
Figure 7.20 Dowel Bar Header

Reinforcing bars used for continuously reinforced concrete slabs must continue through the header. Reinforcement details will be as shown on the plans.

Transverse construction joints with tie bars require that a groove 3/8 inch wide by 5/8 inch deep be sawed in the concrete and sealed with hot poured elastic joint sealer. Tie bars 6 feet in length are to be placed through the headers. The size of the bars used must be in accordance with the plan detail. These bars are to be set with two (2) feet of the bar in the concrete just placed, with a spacing of 12 inches center to center beginning 6 inches from the pavement edge. Ensure chairs support the 4 feet of the steel protruding from the header. The concrete must be vibrated after the steel has been placed from the location where the vibrator for the finish machine is shut off to the header.

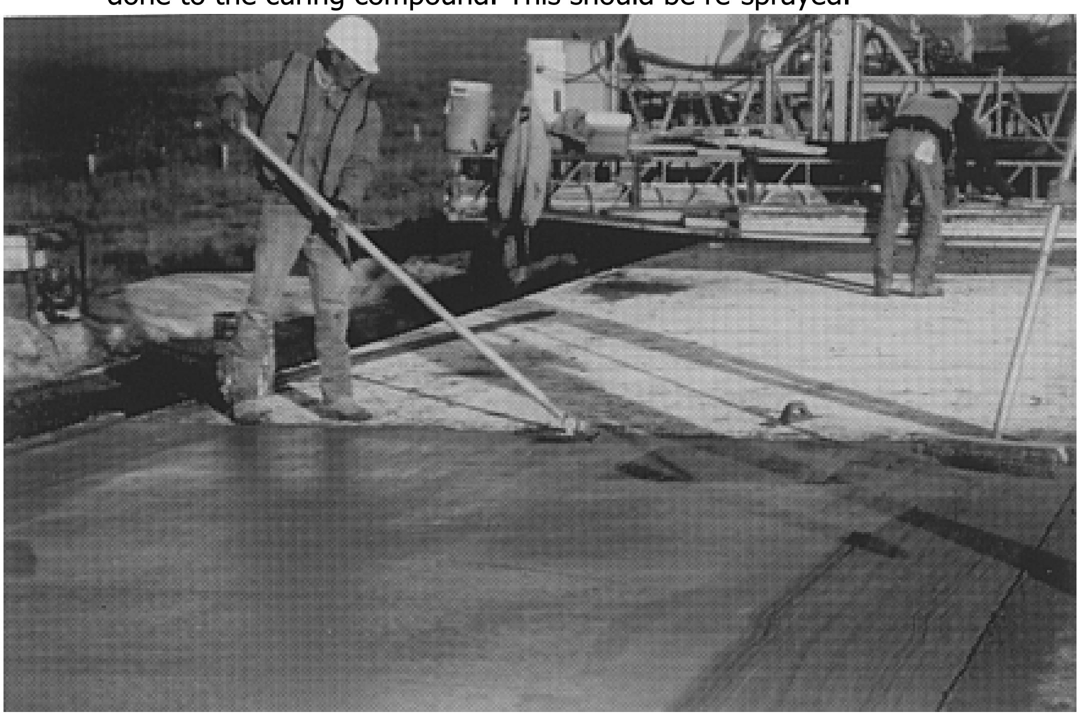
It is difficult to line up concrete placement when taking off from the previous day's pavement with a slip form operation. The figure 7.21 illustrates the result of placements that did not line up. Even completed shouldering will not cover up the "wobble". This can be sawed and removed. Require the extra effort needed to make a connection that keeps the pavement straight.

Figure 7.21 Misaligned slab at header.



The concrete on either side of the headers is usually one of the weakest spots in the pavement because handwork is used to place it. Insist that the Contractor thoroughly vibrates the concrete in these areas with a hand held vibrator. Workers should be careful not to stand on or hit the steel sticking through the header. The bond between the steel and the previously place concrete is easily broken.

Figure 7.22 Finishing start of concrete placement at the header. Note the damage being done to the curing compound. This should be re-sprayed.



Joint Sealing

Joints are sealed to prevent water from getting to the finegrade (**380.3 P**). Water in the subgrade can cause soft spots, joint faulting, and heaving which result in rough pavement. Joints to be sealed shall be thoroughly clean and dry. All materials such as old sealant, oil, asphalt, curing compound, paint, rust, and other foreign materials shall be completely removed. Sand blasting and other tools as necessary shall accomplish cleaning. Just prior to sealing, each joint shall be blown out using a jet of compressed air, at a working pressure of not less than 90 psi, to remove all traces of dust. Air compressors used for cleaning joints shall be equipped with traps capable of removing all free water and oil from compressed air. **380.3 P**

Joint sealer application will not be permitted when the air temperature near the joint is less than $40°F$ or is $40°F$ and falling. The sealant shall be applied without spilling on the exposed surface. Sealant on the surface of the concrete pavement shall be removed immediately and the pavement surface cleaned. **380.3 P**

Failure of the joint material in either adhesion or cohesion will be cause for rejection. The plans specify the type of seal to be used on the joints. Two types of seals are presently used:

- Hot Poured Elastic Joint Sealer
- Low Modulus Silicone Sealant

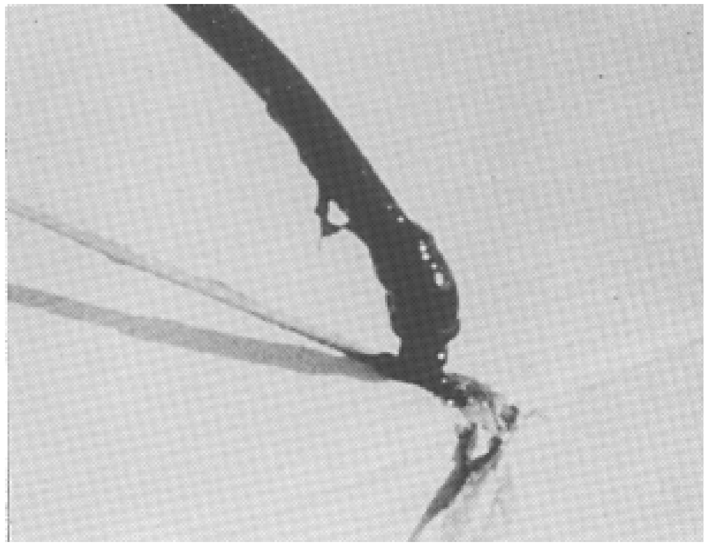
Joints shall be sealed immediately after completion of the curing period, before the pavement is open to traffic, unless decided otherwise by the Engineer. If sealing is accomplished prior to the 72 hour curing time, the moisture from the concrete hydration process will damage the silicone sealant and cause premature silicone sealant failure.

Hot Poured Elastic Joint Sealer

Hot poured sealant (**380.3 P 1**) is used on sawed longitudinal and on transverse construction joints (headers), and urban transverse joints. Joints must be cleaned before sealing. Sealant will not stick to dusty concrete. Sand blasting and other tools as necessary shall accomplish cleaning. Heat the sealing material to the temperature recommended by the manufacturer, never above or below the recommendation. If the temperature is too low, the material will not flow to properly fill the joints. If too high, the elastic quality of the sealer could be damaged. Check the sealant heating equipment tank with a thermometer to ensure the sealant is at the correct temperature. Place hot seal at manufacturer recommended temperature.

Joints must be dry before sealing because sealer will not stick to wet concrete. The sealing nozzle must fit inside the joint opening to assure that the joints are completely filled with sealer. A ski on the nozzle rides on the surface to keep the nozzle at the correct depth in the joint. Approved pressure sealer equipment with nozzle inside the joint ensures sealing material is forced from the bottom of the joint to the top.

Figure 7.23 Hot pour sealant nozzle placing sealant in joint. Note the sealant dripping from the side of the sawed joint at the edge of the slab.



In urban curb and gutter areas, transverse joints will usually be sealed with hot pour.

Figure 7.24 Hot pour

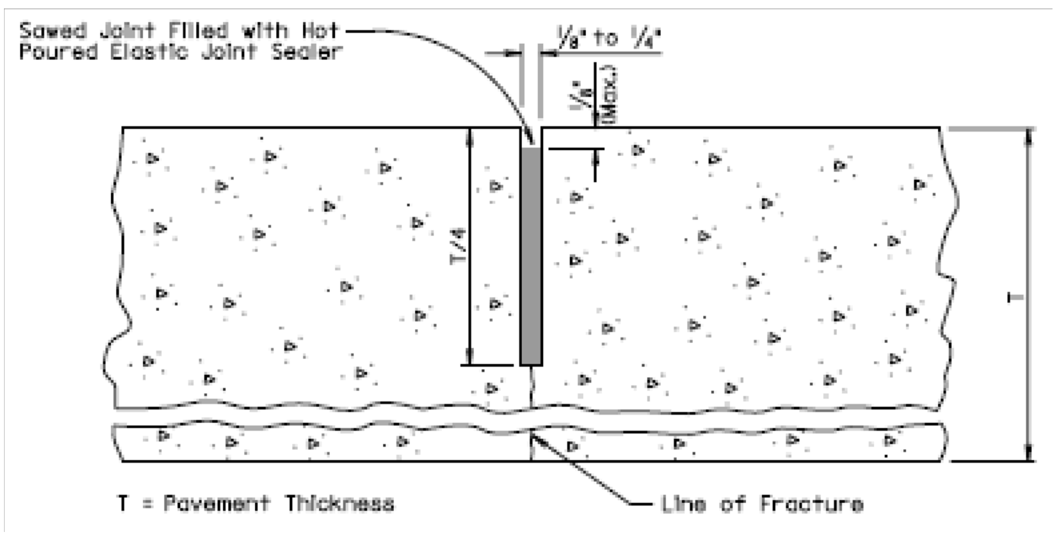
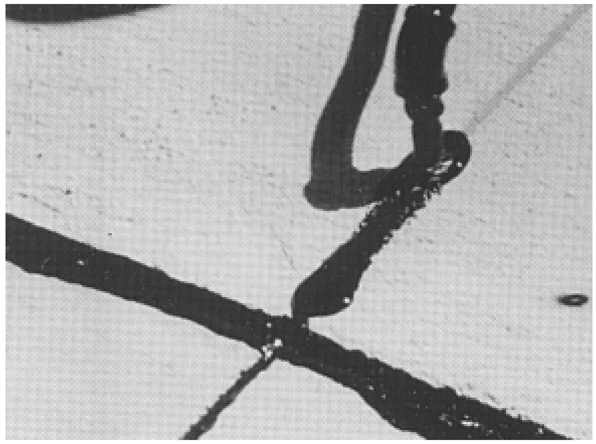


Figure 7.25 Overfilled joint results in spillage along the sides of the joint. The lower left part of the joint is filled properly.



Longitudinal Joints --Overfill slightly to assure fully sealed joints since joint sealer shrinks slightly as it cools. The amount of overfill can be determined with observation.

Transverse Joints --Fill slightly below the surface.

Silicone Sealant

Joints must be thoroughly clean (**380.3 P 2**) and dry prior to sealing. All materials such as old sealant, saw residue, oil, asphalt, curing compound, paint, rust and other foreign substances must be completely removed or sealant will not adhere properly to the joint. The procedure for checking sandblast cleaning of contraction joints in SD 422, Materials Manual. Spray a light coat of paint approximately 1 foot in length on both vertical faces of a contraction joint. This test site can be located anywhere in the contraction joint. When the joint has been cleaned, visually and physically examine the joint for cleanliness. That portion of the joint below the top 3/4 to 1 inch need not be clean. Document observations in the diary. Joints should be cleaned immediately before the sealing operation if possible. Joints that are cleaned too far in advance and become recontaminated must be recleaned. Not changing silicone barrels soon enough will cause air bubbles in silicone.

Cleaning New Joints

The concrete must be given plenty of time to cure, dry, and develop strength such that the joint reservoir can be sawed without damage to the concrete such as raveling, spalling, etc. The time between sawing the initial cut and joint sealant reservoir cut will depend upon such factors as mix design, cement type, time of year, temperature, etc. It is recommended that the concrete be allowed to cure and dry a minimum of 7 days in good drying weather before widening the joint and installing silicone sealant.

If the new joint is to be washed (recommended by the sealant manufacturer) to remove dried laitance from saw-cutting, the joint washing should be done in one direction such as from the crown to the side of the pavement to prevent recontamination. Cleaning shall be accomplished by sand blasting and other tools as necessary. Joints to be sealed with silicone sealant shall be sand blasted utilizing a mechanical device that holds the sand blaster at the appropriate angle and distance from the joint to ensure proper cleaning. The device shall have a mechanism attached that will correctly guide the device in the joint.

Immediately before installation of the backer rod, remove remaining traces of dust and sand with a jet of compressed air. Use a pressure of at least 90 psi. Air compressors shall be equipped with traps capable of removing all free water and oil from the compressed air (**380.3 P**). Check for cleanliness by running a finger along the face of the joint (SD 422 test procedure). If any dust sticks, the area must be recleaned. If the joint is wet due to weather, it must be allowed to dry or be dried with compressed air before applying sealant.

Backer Rod Installation

Backer rod must be approximately 25% larger than the joint opening and must be made of a non-moisture absorbing resilient material (**870.1 B**). The DOT Central Laboratory has a display of acceptable backer rod samples. For example, a 3/8 inch joint requires 1/2 inch backer rod. The success of the sealant depends on correct depth placement of the backer rod. The plans should specify these items.

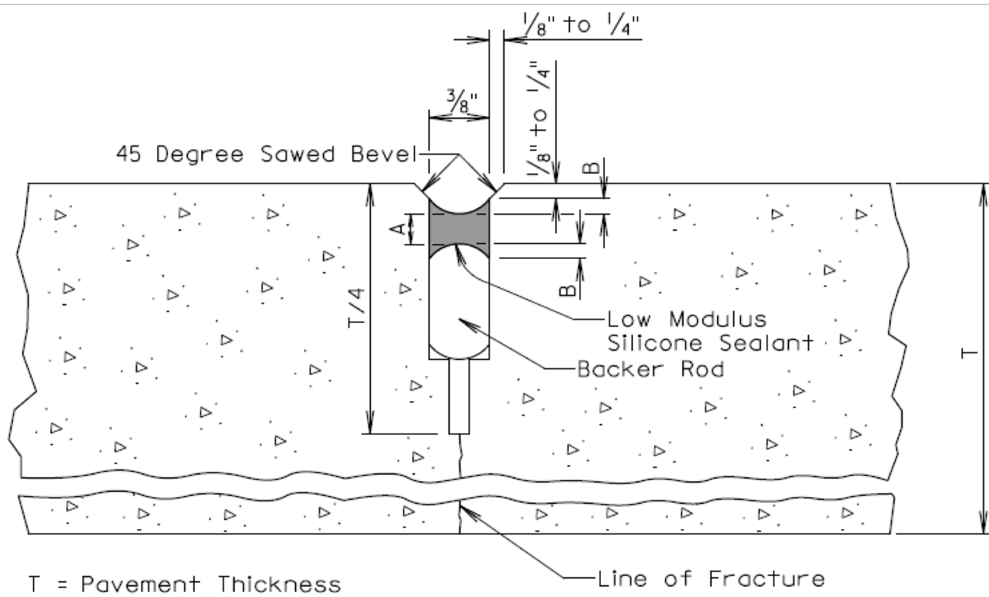
Backer rod serves three main purposes:

1 Limits the depth of the sealant.

2 Acts as a bond breaker to prevent the sealant from adhering to the bottom of the joint.

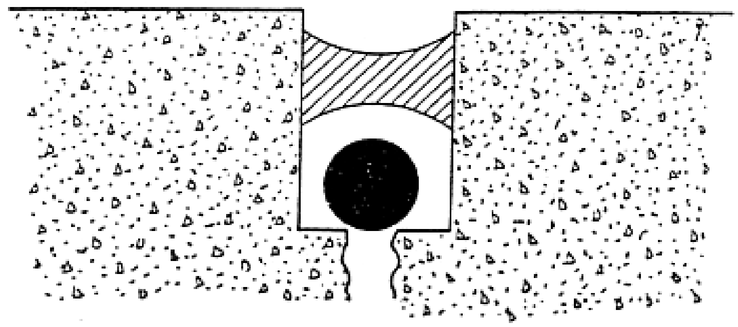
3 Provides a form giving proper shape to the sealant.

Figure 7.26 Diagrams of silicone sealant materials and sawed joint specifications. Backer rod provides a form giving proper shape to the sealant.



LOW MODULUS SILICONE SEALANT ALLOWABLE CONSTRUCTION TOLERANCES			
A (Min.) (In.)	A (Max.) (In.)	B (Min.) (In.)	B (Max.) (In.)
3/16	5/16	1/8	1/4

Figure 7.27 Diagram depicting joint activity and expansive characteristics of silicone sealant. After slab contraction, the backer rod no longer has a function.



Do not cut or split the backer rod and stuff it in a joint. The gases given off by the rod causes bubbles in the silicone sealant when it is installed. Another cause for the bubbling of silicone could indicate the supply of silicone from the drum is nearly empty and it has gotten air in the line causing bubbles.

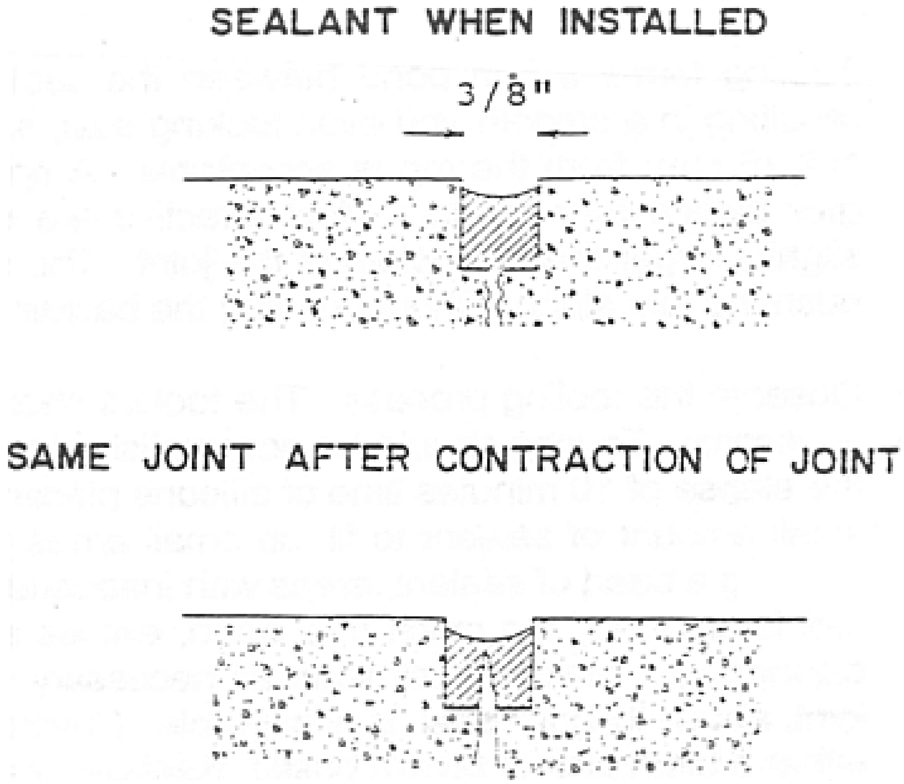
Note that the sealant bonded to the face of the joint wall is approximately twice as thick as the sealant in the middle of the joint. Since the bond between the sealant and the face of the joint is the weakest part of the sealed joint, a greater area is bonded to the wall. Note further that the width of the original sealant is two times the depth of the sealant in the middle. If the sealant were thicker, the amount of force trying to break the bond between the sealant and the wall of the joint would increase. A 2:1 width to depth ratio yields the best results.

Figure 7.27 depicts the importance of the backer rod breaking the bond between the sealant and the bottom of the joint.

The effective width of the joint was reduced because the sealant bonded to the bottom of the joint. With a backer rod, the effective width was equal to the original width of the joint. Without the backer rod the effective width is equal to the width of the crack below the joint. The sealant in the figure is stretched beyond its limits and is failing in cohesion.

A wheel that straddles the joint is commonly used to place a backer rod at the proper position in the joint. A projection on the middle of the wheel fits into the joint and pushes the backer rod down. Running the wheel over the backer rod a second time is necessary to eliminate unevenness. Stretching the backer rod very slightly during installation will ensure proper depth and seating when the wheel passes over it. If the backer rod is not tight in the joint, it should be removed and replaced. This can be caused from over stretching the backer rod during installation. Remember, the proper depth of the sealant is one half the width of the joint. Refer to the Standard Plate (380.04) for the correct tolerances. Check the installed backer rod for accurateness and uniformity of depth.

Figure 7.28 The use of backer rod in the joint prevents failure of the sealant material during slab construction.



Applying Silicone Sealant

The air temperature near the joint must be at least 40°F during application of the joint sealant (**380.3 P 3**). Sealing operations shall be suspended after October 15th, unless the Contractor has received permission from the Region Engineer to continue sealing.

Caution Changes from one type of silicone sealant to another type requires the extrusion pump and hoses be cleaned of the previous sealant. This might mean waste of 5 to 10 gallons of sealant. Ensure this is done. Mixing silicone sealants can result in failure of the sealant being used.

Note The joint must be absolutely clean and dry before applying the sealant.

Sealant must be applied from inside the joint to bond firmly to the joint faces and be free of voids. Do not allow the application wand to be held outside the joint during placement of the sealant. This avoids problems with entrapped air and possible spillage on top of the slab. The nozzle should not extend far enough down into the joint to push the backer rod down. Guides should be placed near the tip of the nozzle to prevent it from pushing down on the backer rod. In new construction, where the pavement is deeply tined, it is recommended that the sealant be placed below the tining grooves. Thus, if spalling occurs at the tining groove and joint face, a watertight seal will be maintained.

When the plans call for non silicone sealants especially asphalt-based materials in the longitudinal joints and silicone in the transverse, the silicone sealant should always be installed first in order to prevent contamination of the joint faces. Preferably, the silicone sealant will be installed in the longitudinal joint a foot or so both directions from the transverse joint. This should reduce the possibility of a weak point at the intersection of transverse and longitudinal joints.

Tooling Sealant

Tooling forms a firm bond between the sealant and the joint wall faces. Any method resulting in a smooth and even looking seal, slightly concave, and recessed approximately 1/4" from the top is acceptable. A spatula, pieces of rubber hose, or backer rod give satisfactory results. Most effective are specially designed tools having a diameter slightly larger than the width of the joint. The sides of the joint can be used as a guide to push the tool along without pushing the backer rod down.

Observe the tooling process. The toolers should be trained and should follow the silicone applicator. Tooling should be accomplished before a skin forms on the silicone or prior to the elapse of 10 minutes time of silicone placement. The tool should be creating a bead or small amount of sealant to fill up small areas where the sealant is thin. If the tool is not creating a bead of sealant, areas with inadequate depth of sealant are likely to occur. If the tool is creating too much of a bead, excess sealant will spill onto the slab and must be cleaned up. Make adjustments as necessary. A thin film of sealant along the wall of the joint, above the joint seal, is acceptable. Check the depth of the freshly applied sealant with either a tire tread gauge or broom bristle. Resistance will be felt against the backer rod. From the resistance to the height of the material on the bristle or tire tread gauge, the height of the sealant in the joint reservoir is determined. Traffic must be kept off the newly sealed areas until the silicone sealant is tack free.

Curing and Testing Silicone Sealant

Silicone sealant cures by reaction with atmospheric moisture. The rate of curing depends on the atmospheric conditions. Normally the sealant is fully cured in 7 days.

Seasonal Restrictions: Silicone sealing operations shall be suspended after October 15, unless the Contractor has received written permission from the Region Engineer to continue sealing. After the October 15 seasonal restriction, only the initial cut shall be performed at all joints. Then the following spring the joints shall be widened, backer rod installed, and sealed with silicone according to Section 380.3 P.

When the sealant is sufficiently cured, samples should be cut out (Materials Manual, SD 421). One lot consisting of 5 samples, located by use of the Random Number Chart in SD 311, shall be taken for each half mile of roadbed.

Note More frequent sampling should be done at the beginning of the project to correct errors in the depth and shape factor early.

The quality of the bond of the sealant to the sides of the joint can be evaluated while taking samples. Cut a 3 inch lineal strip of sealant on 3 sides (cutting along the joint face walls), leaving the end attached to the in-place sealant. Mark 2 lines one inch apart on the 3 inch piece. Pull the 3 inch strip straight up until the lines are 2 inches apart. If the sealant is properly bonded, it should not pull away form the sides farther than the original cut. Repair the sealant where the specimen has been removed with a caulk gun and tube of the same sealant.

Report results on DOT 10 form - Inplace silicone sealant checks for bonding, width, depth, and shape on PCC pavements.

CHAPTER

8

CURB AND GUTTER AND DAILY INSPECTIONS

Curb and gutter is constructed by placing concrete in fixed forms or using a slipform type extrusion machine. Normally, curb and gutter is constructed following the completion of the mainline paving. If the curb and gutter is placed ahead of the paving, the Contractor shall provide a method to drain water into each inlet by using a small PVC pipe or other approved methods.

Figure 8.1 Fixed forms for curb and gutter.

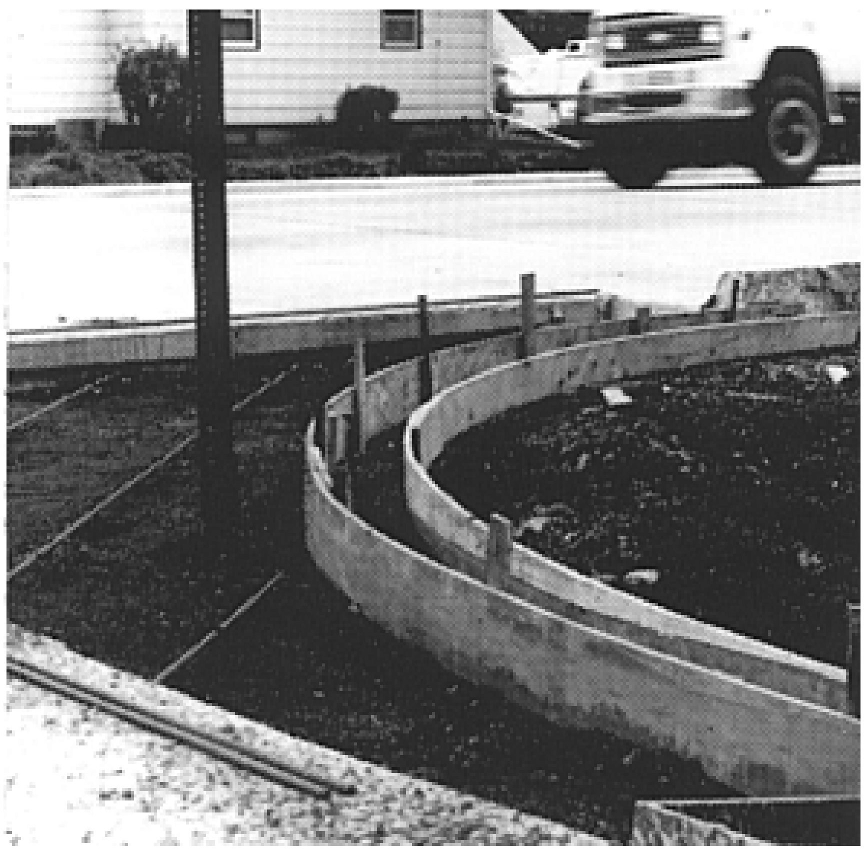
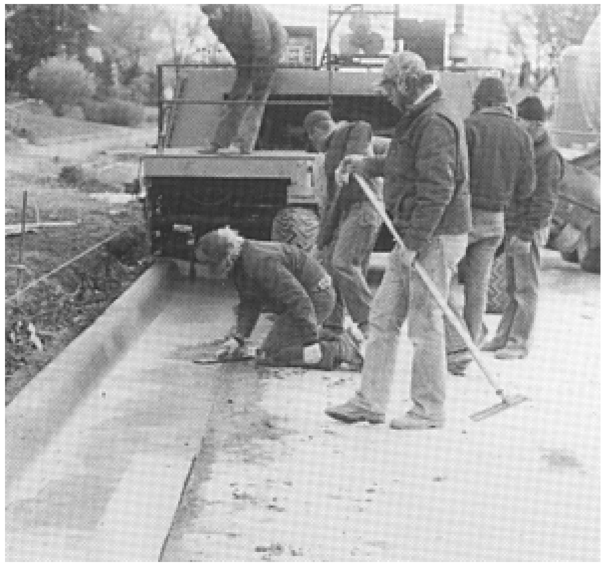


Figure 8.2 Slip-form paving curb and gutter.



The basic requirements (base preparation, form setting, stringlines, finishing, etc.) for either of the two curb and gutter construction methods are similar to those for mainline paving. However, transitions in the curb and gutter for radius and fillets at intersections, approaches for driveways, etc., require handwork.

Exposed curb and gutter surface must have a smooth and even finish. The radius on the edge of the gutter and the top face edges must be shaped to the radius shown on the plans.

Joints must be built into the curb and gutter. Placement usually corresponds with joints in adjoining slabs. Check the plans and consult the Project Engineer. See Standard Plates 650.01 through 650.04.

The surface of the curb and gutter is brushed or broomed to provide texture, finished tool marks are removed, leaving a slight roughness in the surface. After finishing, the curb and gutter must be protected and cured in accordance with the provisions of Section **650.3**, except the minimum curing time shall be seventy-two (72) hours.

Figure 8.3 Fixed form curb and gutter prior to hand finishing.

Figure 8.4 Hand edging and finishing curb and gutter.

Paving Report (DOT-98)

At the end of each day's paving, a hard copy or electronic DOT-98 form, Daily Paving Report, (Handout 1) must be completed. The Daily Paving Report is used to keep track of the activities of each day's paving.

1. The evening before or the first thing done the beginning of the new paving day is to fill in the heading: County, Project Number, PCEMS Number, Report Number, and Date of the Report. Do not sign until the end of the day.

2. **PROGRESS TODAY:** enter the beginning station first thing in the morning, and at the end of the day, the ending station. Circle the appropriate event.

GROSS LINEAL DISTANCE: the distance from the start to end stationing.

EXCEPTION: any distance involved in bridge lengths or equations that might reduce or increase the amount of paving done that day.

NET LINEAL DISTANCE: the difference between the stopping station and the starting station, plus or minus any exceptions.

SQUARE YARDS REGULAR SLAB: the paving space used on the mainline pavement. This is a theoretical quantity calculated by multiplying the net lineal distance times the width of the pavement, divided by 9 square feet in a yard.

SQUARE YARDS EXTRA WIDTH: complete only if required by the Project Engineer.

SQUARE YARDS TODAY: the total of the square yards of regular slab.

SQUARE YARDS PREVIOUS: taken from the SQUARE YARDS TO DATE line of the previous day's report.

SQUARE YARDS TO DATE: the total of the SQUARE YARDS PREVIOUS added to the SQUARE YARDS TODAY.

SQUARE YARDS PLANS: the amount of paving required for the project. Get this quantity from the paving sheet in the plans.

PERCENT COMPLETE: derived by dividing the SQUARE YARDS PLANS quantity into the number of SQUARE YARD TO DATE.

3. **TIME DISTRIBUTION:** used to determine the actual time spent paving.

TIME START AND TIME STOP: enter the actual starting time of the paving machine placing concrete to form a slab and the time when all operations for the day are completed.

TIME DELYAED: the amount of time involved in breakdowns either at the plant or at the paving train.

NET PAVING TIME: the TIME DELAYED subtracted from the total time between TIME START and TIME STOP for the day.

REASON FOR DELAY: explanation of the reason for delayed time.

4. **BATCH DISTRIBUTION:** (Batches Loaded on Trucks) to determine how many batches or cubic yards of concrete were used in a day's paving. Get this information from the Plant Inspector.

WASTE: the number of batches or cubic yards of concrete rejected or wasted and not used in the pavement. Get plant waste figures from the Plant Inspector. For every thousand feet of paving approximately 1 yard of waste can be accounted for.

TOTAL USED: the difference between the amount of concrete loaded at the plant and the amount of waste.

5. **YIELD:** to determine if enough concrete is being used to construct the pavement according to plans.

THEORETICAL CUBIC YARDS: the number of cubic yards of plans dimension pavement possible with the total batches used.

ACTUAL TODAY CUBIC YARDS: The number of square yards paved today, taken from "Progress Today". Enter the number found on the "Square Yards Today" line.

PERCENT: or percent of yield is found by dividing the THEORETICAL SQUARE OR CUBIC YARDS into ACTUAL TODAY SQUARE OR CUBIC YARDS. To keep a running tally of the yield for the entire project, add an additional column to the right of the YIELD column. This should be less than 100% and is normally 90% to 95%. When the percent of yield exceeds 100%, the pavement may not be thick enough.

6. **WEATHER:** enter the weather conditions encountered during the paving operation several times each day. Data is used to assess effects of weather in relation to test specimen changes.

7. **PAVEMENT DEPTH CHECKS:** to assure that pavement depth is consistent with plan requirements. Record the time, station, distance right or left of centerline, and the results (depth of concrete) of the check.

8. **CURE CHECK**

9. **VIBRATOR CHECK**

10. **REINFORCEMENT CHECKS**

11. **REMARKS:** used to record any extraordinary conditions encountered.

Date and sign the hard copy of the Daily Paving Report before turning it in at the end of the day. Currently paving reports can be completed in the MS&T System or keep paper reports in the project file.

Ramps and Tapers

When another slab of concrete tapers into the slab being paved, a "lug-out" smoothes the transition and eliminates a small pointed triangle of concrete that is easily cracked from traffic loading. It allows the thin end of the taper to become a part of the mainline paving. As the paver passes the area, forms are set along the taper line far enough to make a lug-out approximately 18 inches wide preferably to the nearest transverse joint.

Concrete placed in the lug-out and along the edge of the mainline pavement must be thoroughly vibrated to create a good bond. A keyway is required at the header of the taper used as a contraction joint. See Handout 5 for notes on placing of the concrete taper. A transverse contraction joint should extend from the lugout across the slab. Each time new concrete placement begins, equipment must be backed over the earlier concrete placement. Care must be taken not to strike the new concrete or drop material tools, or parts of machinery on it. The figure below illustrates several things that should not be allowed. Equipment should not have been cleaned on the slab. Areas where workmen have walked and a short stretch of new curing should have been given a second coat.

Figure 8.5 Taper lug-out showing forms still in place.

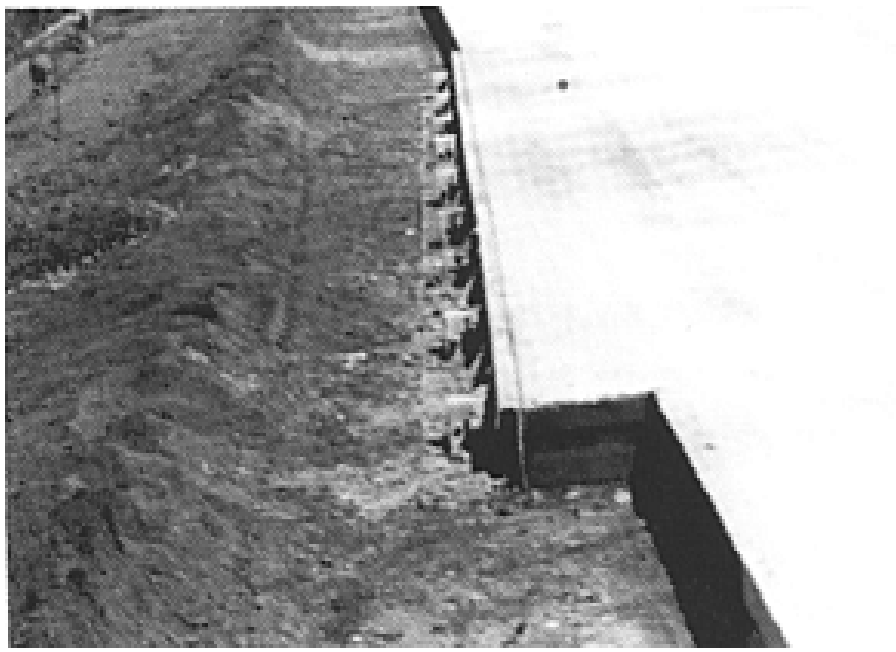


Figure 8.6 Motorcycle and material from paver cleaning left on slab poured the previous day.

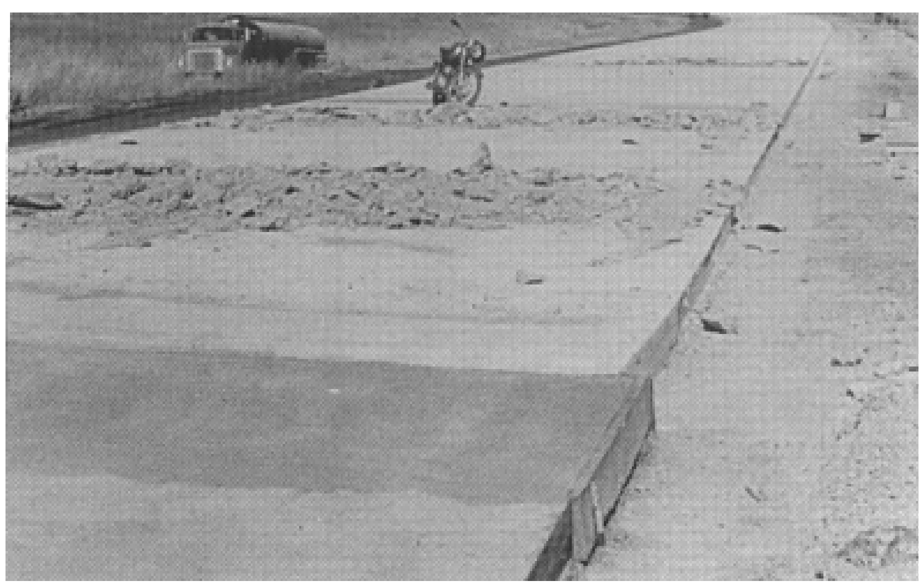
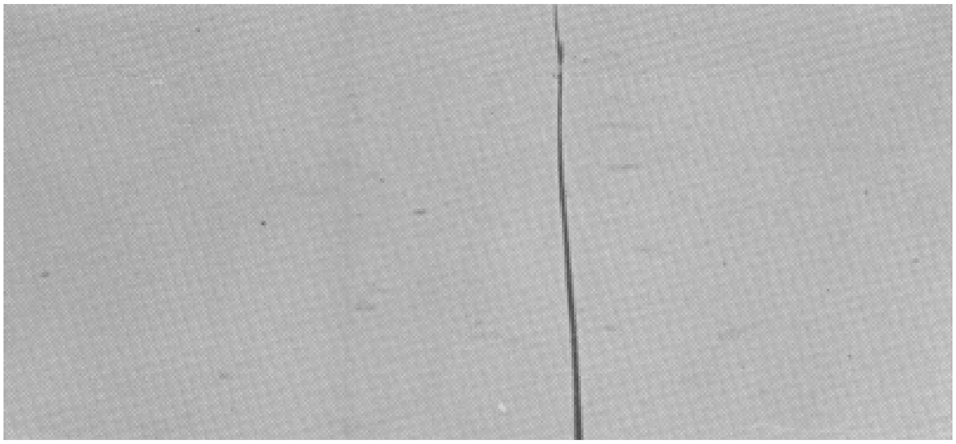


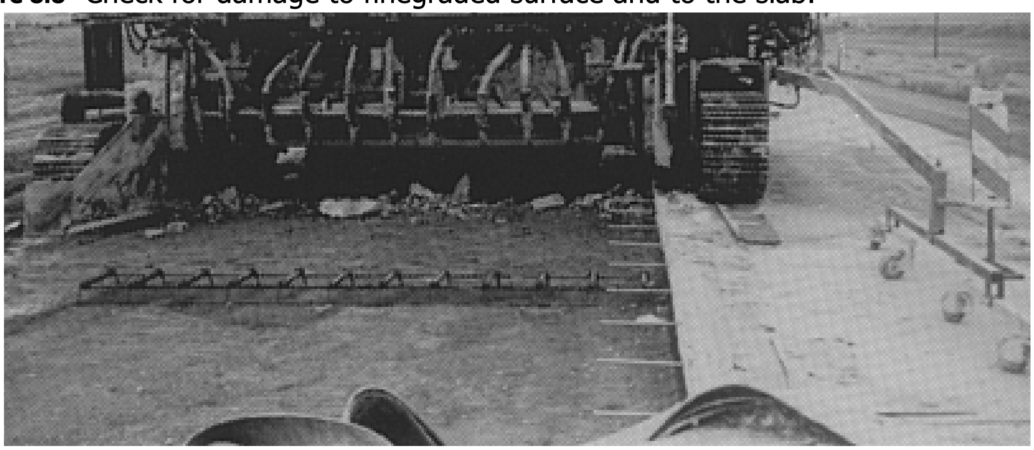
Figure 8.7 Unacceptable concrete sawing job, widened joint, sawed crooked and saw blade width not uniform.



Surface Tests

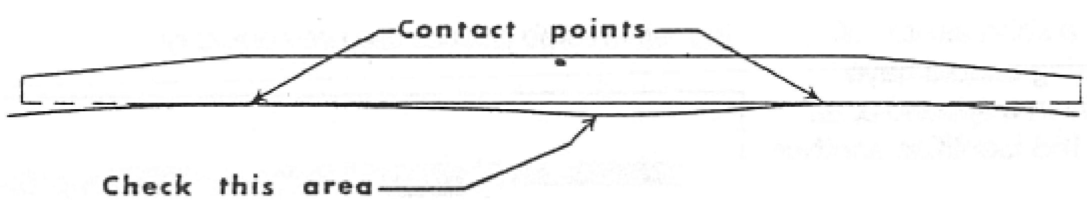
One final surface check (**380.3 O 1**) is needed after the concrete has cured. Surface smoothness (longitudinal and transverse) must show no areas with a variation over 1/8 inch in 10 feet unless otherwise noted on the plans or provisions. Check plan notes for permissible surface deviation (SD 417).

Figure 8.8 Check for damage to finegraded surface and to the slab.



The Contractor's personnel will conduct the profilograph runs. The profilograph is run on each wheel path on each lane. Areas showing high or low spots of 1/8 inch or more in a 10 foot distance are marked.

Figure 8.9 Checking pavement with 10 foot straight edge.



All areas of pavement marked as rough must be checked with a 10 foot straightedge and a gauge. The shim tolerances are 1/8 inch shim and 1/4 inch shim. To check, set the straightedge on a rough area with the gauge laying flat on the pavement at a right angle to it. The pavement is considered out of tolerance when the gauge can be freely slid under the straightedge. Areas not found to be acceptable should be marked and ground with a diamond grinder or other satisfactory means of correction.

Profilograph Tests

On select PCC Pavement projects, in lieu of the 10 foot straightedge test for longitudinal surface deviations, the pavement is to be tested with a profilograph according to either the Special Provision for PCCP smoothness (0.2” band) or by **380.3 O 2** (zero band). The Contractor furnishes and operates an approved 25 foot “California Style” profilograph. The Contractor’s profilograph must be calibrated with the DOT’s profilograph prior to use. Refer to the Materials Manual for profilograph calibration requirements. The bicycle tire must be inflated to 25 psi. A rural project’s profile index (smoothness measurement) uses a zero width blanking band- all longitudinal surface deviations are included in the calculation. An urban project’s profile index uses a 0.2” width blanking band- minor longitudinal surface deviations are filtered out of the calculation. SDDOT has standard sheets available for tracking Contractor’s profile measurements and calculating the smoothness incentive.

Figure 8.10 Profilograph

Figure 8.11 Profilograph settings

SSI Profiler V1.70 - Report of Pavement Smoothness

Licensed to South Dakota DOT, of Pierre, SD

Data File:	C:\SSI Profilograph\Data Files\IM 29-4(58)110 TEST 2.PTD
Stations:	0+00.0 to 26+40.0
Date [Paved/Corrected]:	12/30/1899
Date Tested:	9/15/2009 1:46:00 PM

Project Parameters

Project No:	IM 29-4(58)110
County:	MOODY
Contractor:	
Pavement Type:	CONCRETE
Traffic Direction:	NORTH
Number of Lanes:	2
Direction of Paving:	NORTH
Tested by:	BRAD TAYLOR
Paving Action:	
Special Provisions:	
Weather:	

Filter Settings

Filter Type: Butterworth Filter
Filter Length: 2.000
Filter Gain: 1.00

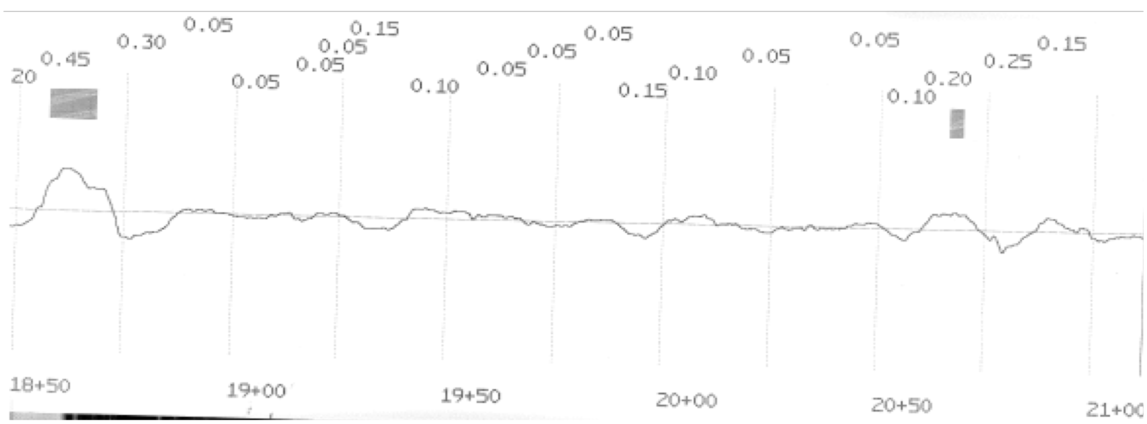
Scallop Parameters

Minimum height:	0.035 in
Minimum width:	2.000 ft
Resolution:	0.050 in
Blanking band:	0.000 in

Localized Roughness Settings

Defect template height:	0.300 in
Defect template width:	25.000 ft
Defect template depth:	0.300 ft

Figure 8.12 Profilograph trace



Profiler Tests

The department has begun to do IRI (International Roughness Index) smoothness measurements on concrete pavements. These are being done on the higher speed rural sections. For ramps and slower urban sections, a profilograph using the 0.2 blanking band will still be used. There are two types of profilers, the lightweight profiler (Figure 8.13) and the high-speed profiler (Figure 8.14). The lightweight profilers are mounted on an ATV and can test the concrete pavement the day after placement. Some concrete paving contractors own lightweight profilers to do their own quality control work. The department will use a high speed profiler for acceptance testing at the end of a project after all concrete has achieved adequate strength to open to traffic. The Contractor is to notify the smoothness engineer and schedule the testing. The results of the acceptance testing will be provided by the smoothness engineer and incentive/disincentive cash amounts identified. Rough paving areas identified by the profiler are to be ground using diamond grinding equipment or accepted with a monetary deduction.

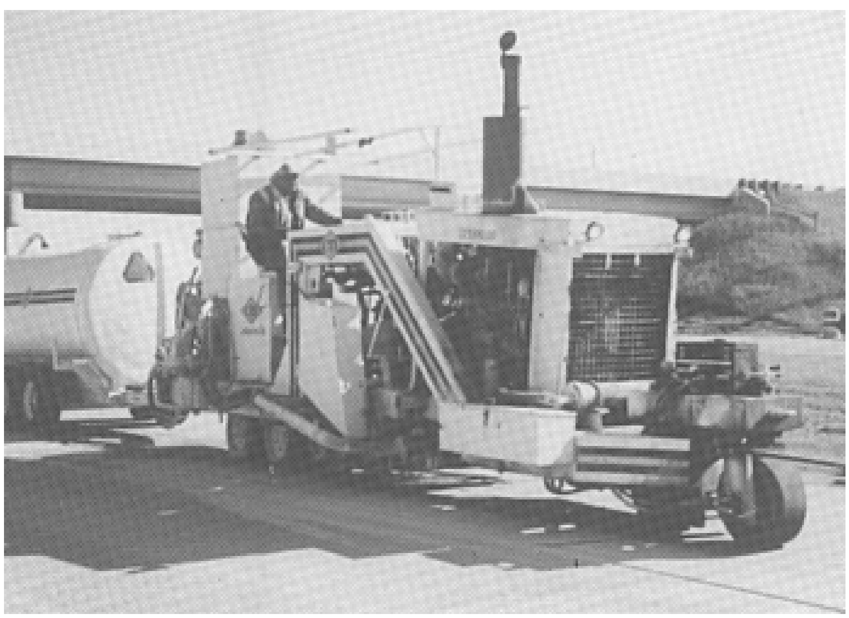
Figure 8.13 Lightweight Profiler

Figure 8.14 High Speed Profiler

Bump Correction by Grinding

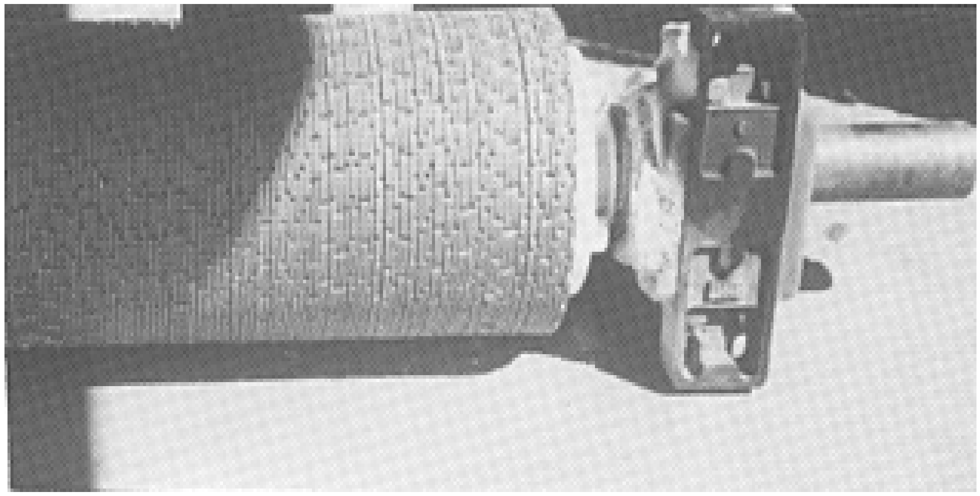
The Contractor must correct any surface deviations by grinding or accept a price reduction on affected areas (**380.3 O**). Grinding must be done with a machine having a circular diamond blade mounted on a horizontal shaft. This type of machine cuts bumps off rather than wearing them down. As it cuts, small ridges are left in the concrete which help in skid resistance. When the area has been ground, it must be checked again with a straight-edge or profilograph machine.

Figure 8.15 Pavement Grinder.



After grinding has been completed a final spot check will be needed and the profilograph may need to be re-run. Because removing bumps detracts from the appearance of the road, encourage the Contractor to pave and finish with a minimum of rough spots.

Figure 8.16 Grinder Head.



CHAPTER

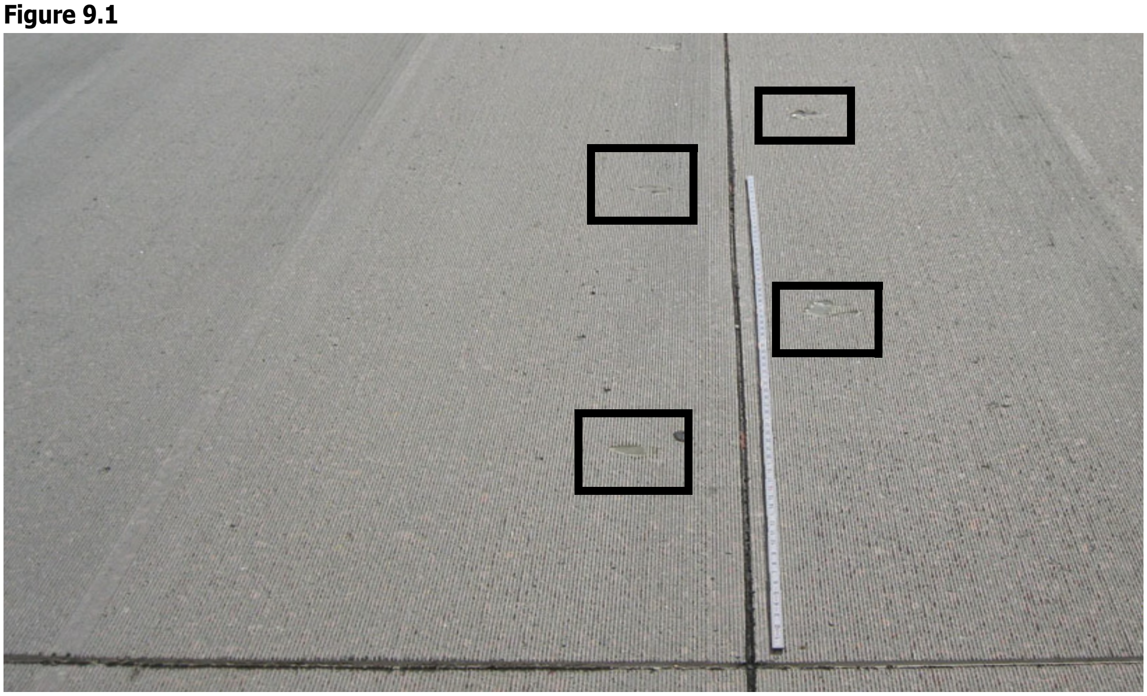
9

PAVEMENT REPAIR

Concrete pavement sometimes needs repair. This may be due to initial construction related issues or due to age and use many years after construction. There are a lot of different repairs that can be done to concrete pavement, determining the correct repair for the situation may be challenging. Each method listed here have pro's and con's that have to be weighed in selecting the appropriate repair.

Tie Bar Stitching

Figure 9.1

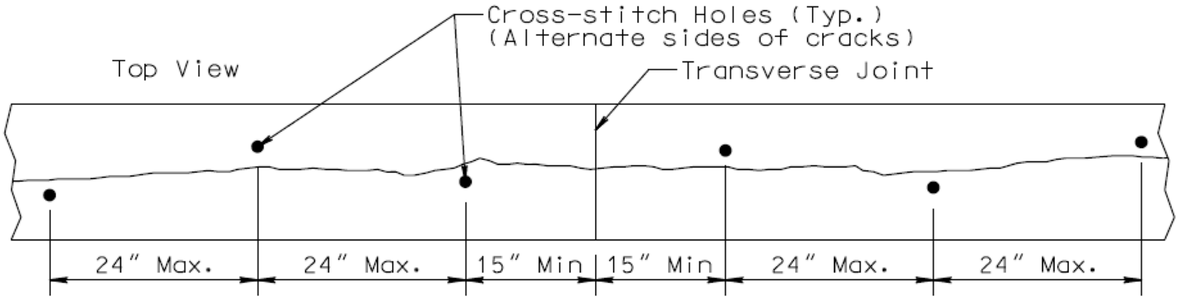


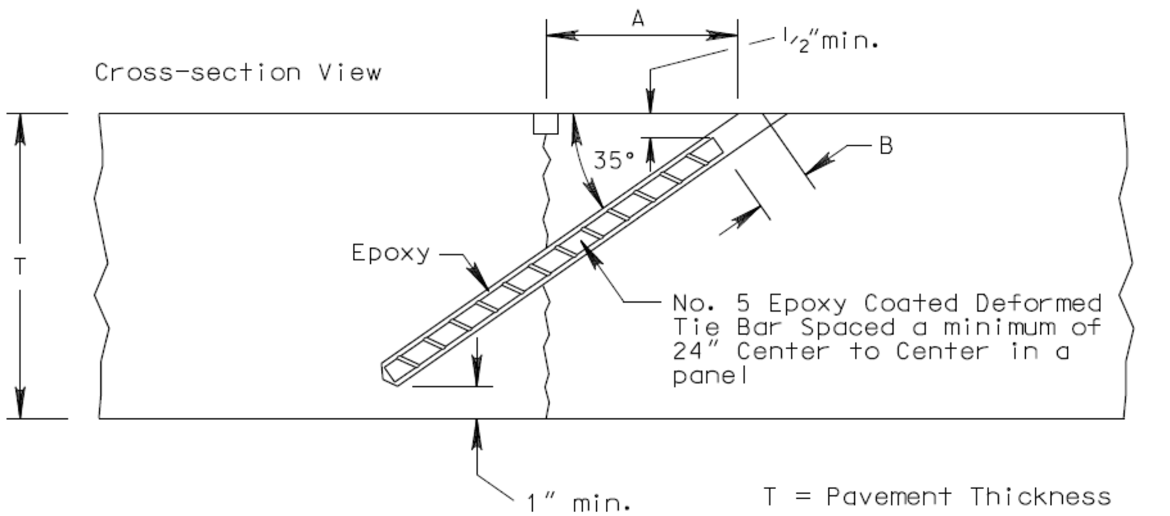
Stitching of a longitudinal uncontrolled crack is needed when during construction the centerline tie bars were not placed, or placed improperly.

Typical Notes for Retrofitting Tie Bars (Stitching)

Figure 9.2 Stitching detail

STITCHING DETAIL





T = Pavement Thickness

T	A	B	Length of Tie Bar
8″	5″	1 1/2″ +/−	10″
8 1/2″	5 1/4″	1 3/8″ +/−	11″
9″	5 5/8″	1 1/4″ +/−	12″
9 1/2″	6″	1 5/8″ +/−	12 1/2″
10″	6 3/8″	1 1/2″ +/−	13 1/2″
10 1/2″	6 3/4″	1 3/8″ +/−	14 1/2″
11″	7″	1 1/4″ +/−	15 1/2″
12″	7 3/4″	1 3/8″ +/−	16 1/2″
12 1/2″	8 1/8″	1 1/4″ +/−	17 1/2″

Stitch Bar Spacing 24″ Max.

Joint Spacing	# of Bars
3′ to 4.5′	2
5′ to 6.5′	3
7′ to 8.5′	4
9′ to 10.5′	5
11′ to 12.5′	6
13′ to 14.5′	7
15′ to 16.5′	8
17′ to 18.5′	9
19′ to 20.5′	10
21 to 22.5′	11
23′ to 24.5′	12
25′ to 26.5′	13
27′ to 28.5′	14
29′ to 30.5′	15

GENERAL NOTE:

The tie bars shall alternate from opposite sides of the joint to produce a cross-stitching pattern

June 5, 2014

SDDOT

RETROFIT TIE BAR (STITCHING) INSTALLATION IN JOINT (REHABILITATION)

PLATE NUMBER
SPECIAL

Sheet 1 of 1

The Contractor shall install No. 5 epoxy coated deformed tie bars into drilled holes in the existing concrete pavement. An epoxy resin adhesive must be used to anchor the steel bar in the drilled hole. A rotary drill or other approved drill shall be used that will not damage the concrete surface. The diameter of the disturbed surface from drilling shall be less than 2 inches. A rigid frame or mechanical device will be required to guide the drill to ensure the proper angle of the steel bars in the drilled holes.

The steel bars shall be cut to the specified length by sawing and shall be free from burring or other deformations. Shearing will not be permitted.

Epoxy resin adhesive shall be of the type intended for horizontal applications, and shall conform to the requirements of ASTM C 881, Type IV, Grade 3 (equivalent to AASHTO M235, Type IV, Grade 3).

The diameter of the drilled holes in the existing concrete pavement for the steel bars shall not be less than 1/8 inch nor more than 3/8 inch greater than the overall diameter of the steel bar. The holes shall be drilled at an angle alternating from opposite sides of the joint to produce a cross-stitching pattern. The drilled holes shall be blown out with compressed air using a device that will reach to the back of the hole to ensure that all debris or loose material has been removed prior to epoxy injection. Damage to pavement shall be repaired to the satisfaction of the Engineer at the Contractor's expense.

Mix the epoxy resin as recommended by the manufacturer and apply by an injection method approved by the Engineer. If an epoxy pump is utilized, it shall be capable of metering the components at the manufacturers designated rate and be equipped with an automatic shut-off. The pump shall shut-off when any of the components are not being metered at the designated rate. Fill the drilled holes sufficiently with epoxy prior to the insertion of the tie bar such that the epoxy will be level with the top of the concrete pavement after insertion of the tie bar. Rotate the steel bar during installation to eliminate voids and ensure complete bonding of the bar. Insertion of the bars by the dipping method will not be allowed. The top of the drilled hole shall be filled with epoxy or excess epoxy removed such that the epoxy is level with the existing pavement.

No bars shall be installed within 15" of an existing transverse contraction joint. Any bars not functioning or damaged shall be repaired or replaced at the Contractor's expense.

Cost for the epoxy resin adhesive, tie bars, drilling of holes, debris or loose material removal, applying the adhesive, installing the tie bars into the drilled holes and all other items incidental to the installation of the tie bars shall be included in the contract unit price per each for "Tie Bar Retrofit, Stitching".

Tie Bar Repair

Figure 9.3 Tie Bar Repair

Figure 9.4

Dowel Bar Retrofit

Description

The work consists of installing epoxy coated 1-1/2 inch diameter by 18 inch long plain round dowel bars into existing concrete pavement joints. The existing Portland cement concrete pavement shall be removed and the dowel bars shall be retrofit across the pavement joints.

Materials

Dowel bars shall meet the requirements of Section 1010 of the Standard Specifications. All surfaces of the dowel bars shall be epoxy coated, including the ends of the bars.

The dowel bars shall be further coated, prior to installation, with a bond breaking compound. The bond breaking coating shall be either form oil, white pigmented concrete curing compound, asphaltic or other bond breaker conforming to Section 1010.

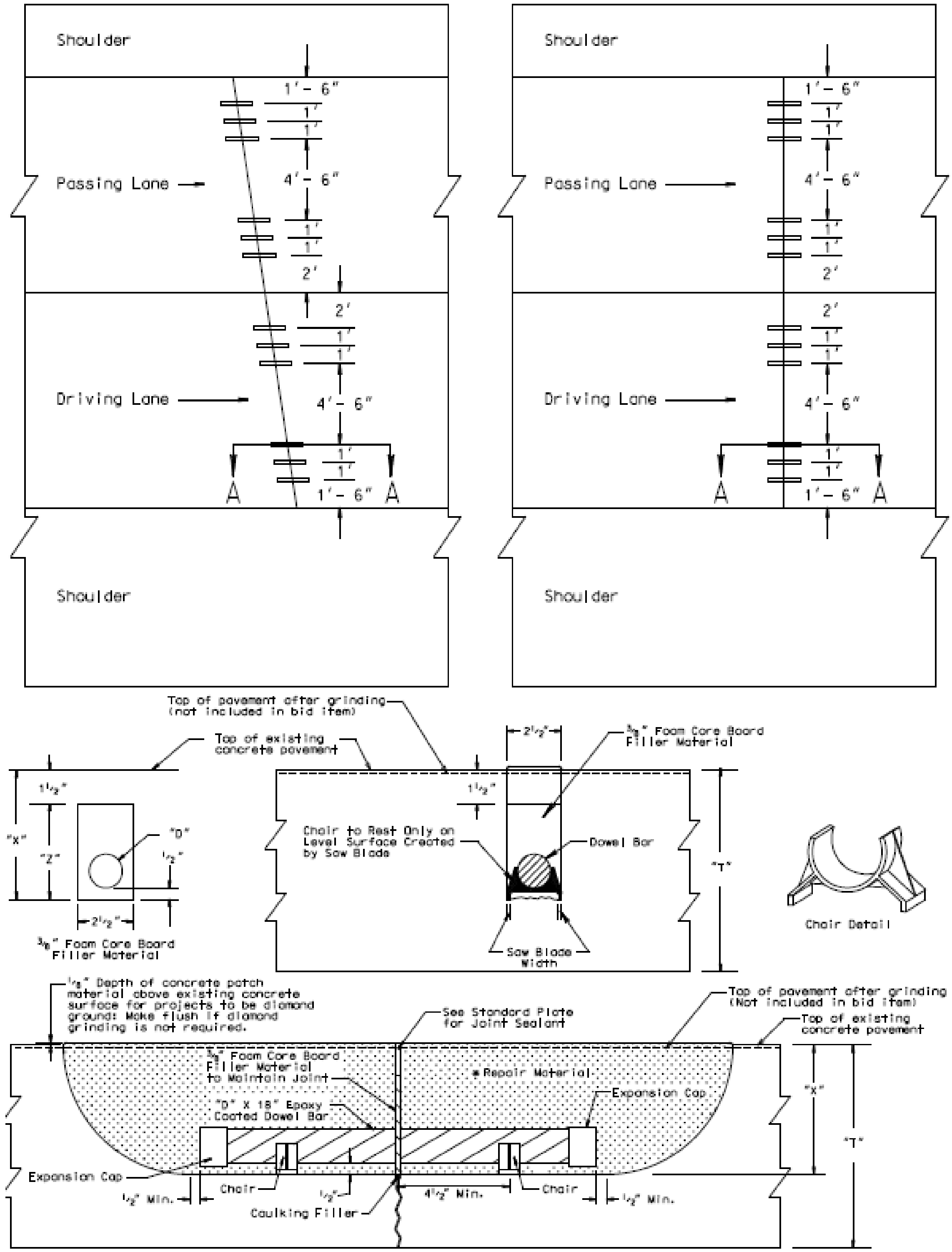
The dowel bars shall have tight fitting end caps made of nonmetallic material that allows for 1/4 inch bar movement at each end of the bar. The Contractor shall submit an end cap sample to the Engineer for approval prior to installation.

Chair devices for supporting and holding the dowel bar in place shall be completely epoxy coated or made of nonmetallic material. The Contractor shall submit a chair sample to the Engineer for approval prior to installation.

The foam core board filler material shall be a 3/8 inch thick (minimum), closed cell foam faced with poster board material or plastic faced material on each side. This material is commonly referred to as Foam Core Board by Office Suppliers or a dense closed cell foam insulation material faced with plastic or foil.

The Portland cement concrete pavement that is removed to install the dowel bars shall be replaced with one of the following approved patching products: Patchroc 10-60, Five Star Highway Patch, or L & M Durapatch Highway, or an approved equal. The use of Set 45 will not be allowed.

Figure 9.5 Details for Dowel Bar Retrofit



Patch Material Requirements:

- Compressive Strength, 3 hr, minimum 3000 psi, (ASTM C-109)
- Compressive Strength, 24 hr, minimum 5000 psi, (ASTM C-109)
- Final Set Time-minimum 25 minutes
- Shrinkage, 4 days, 0.13 percent maximum, (ASTM C-596)

With Maximum Aggregate Extension:

- Flexure Strength, 500 psi, 24 hr, (California Test 551)
- Bond to Dry PCC, 400 psi, 24 hr, (California Test 551)
- Bond to SSD PCC, 300 psi, 24 hr, (California Test 551)

The patching product may be extended up to 100% with aggregate (defined as 10 lbs. of aggregate to 10 lbs. of patching material) as recommended by the manufacturer. The aggregate extender shall meet the requirements of Section 820 of the Standard Specifications. Section 820.2 D shall not apply to the aggregate extender. The Contractor's supplier of the patching product shall provide a concrete mix design, including all additives, to meet a minimum compressive strength of 4000 psi in six hours. This mix design shall be performed with the materials that will be used on the project.

The Contractor shall verify the results of the suppliers mix design prior to beginning work. If the suppliers mix design is not satisfactory, the Contractors shall provide the Department with a mix design that meets the requirement prior to the beginning of work. This mix design shall be performed with the materials that will be used on the project.

Construction Requirements

The Contractor shall install the dowel bars in the existing Portland cement concrete pavement as shown in the plans and according to the following requirements:

Saw cut the pavement to place the center of the dowel bar at mid-depth in the pavement. Multiple saw cuts parallel to the centerline may be required to properly remove the material from the slot. The saw cuts for the six slots at each transverse joint shall be made such that the dowel bars are placed within the following tolerances:

- Centerline of individual dowel bars shall be parallel to the top of pavement within ±1/8 inch in 18 inches.
- Centerline of individual dowel bars shall be parallel to the other dowel bars within ±1/16 inch in 18 inches.
- Centerline of individual dowel bars shall be parallel to the roadway centerline ±1/2 inch in 18 inches.

Any jackhammers used to break loose the concrete shall not be larger than the 30-pound class. If the pavement is damaged by the 30-pound jackhammer, the Engineer will require the Contractor to use a 15-pound hammer.

All exposed surfaces and cracks in the slot shall be sand blasted and cleaned prior to bar installation.

The dowel bars shall be lightly coated with the bond breaking compound prior to placement. The bar chairs shall provide a 1/2 inch clearance between the bottom of the dowel bar and the bottom of the slot and chair. The dowel bars shall be placed to the depth shown on the plans, parallel to centerline and the top of the roadway surface, and at the middle of the slot, all within the specified tolerances. The chairs shall hold the dowel bar securely in place during placement of the patching mix.

- Longitudinal dowel bar placement for skewed joints shall be within ±2 inches.
- Longitudinal dowel bar placement for perpendicular joints shall be within ±1 inch.

The 3/8 inch thick foam core board shall be placed at the middle of the dowel bar to maintain the transverse contraction joint. The foam core board shall fit tightly around the dowel bar and to the bottom and edges of the slot. The width of the foam board in its final position shall be 1/16 inch wider than the slot to minimize movement of the foam board and prevent incompressible material from entering the contraction joint during concrete placement. The top of the foam core board shall be flush with the top surface of the concrete pavement.

The Contractor may need to increase the width of the foam core board for pavements with skewed joints. The skew angle may vary for different pavement sections.

The Contractor shall thoroughly moisten all surfaces on the sawed slot immediately prior to filling with patching compound. Care shall be taken to prevent standing water in the slot. All excess water shall be removed with compressed air.

The Contractor shall fill the slot (with the installed dowel bar, chairs, and foam core board in place) with an approved patching material. The patching material shall be vibrated with a small hand held vibrator capable of thoroughly consolidating the patching compound into the slot and around the dowel bar. The top surface of the filled slot shall be trowel finished and cured. The curing compound shall meet the requirements of Section 821.1 B.

The patching material will be tested by the Engineer once for each 4 hours of production or a minimum of once per day. The patching material shall have a minimum compressive strength of 4000 psi in 6 hours. Department compression testing may be performed up to 24 hours after the cylinders are made. If the compressive strengths are not being met, production shall cease and the Contractor shall resubmit a concrete mix design correcting the strength problems. Price adjustments will be made for low concrete strength when the concrete fails to meet minimum strength of 4000 psi within the 24 hour testing period.

The transverse contraction joints shall be sawed and sealed as required in the plans.

Any individual dowel bar retrofit not functioning or damaged shall be repaired or replaced at the expense of the Contractor.

Method of Measurement

Dowel Bar Retrofit will be measured by each dowel bar installed and accepted.

Basis of Payment

Dowel Bar Retrofit will be paid at the contract unit price per each dowel bar. Payment shall be full compensation for equipment, materials, labor, and all incidentals required.

Figure 9.6

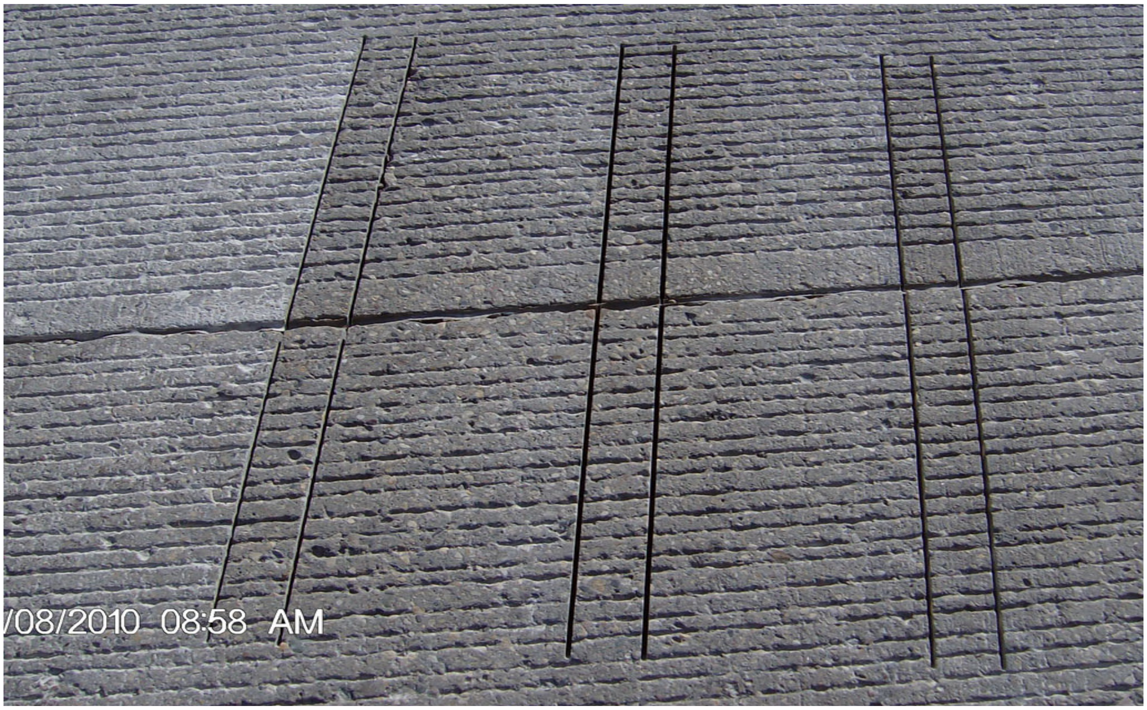


Figure 9.7

Figure 9.8

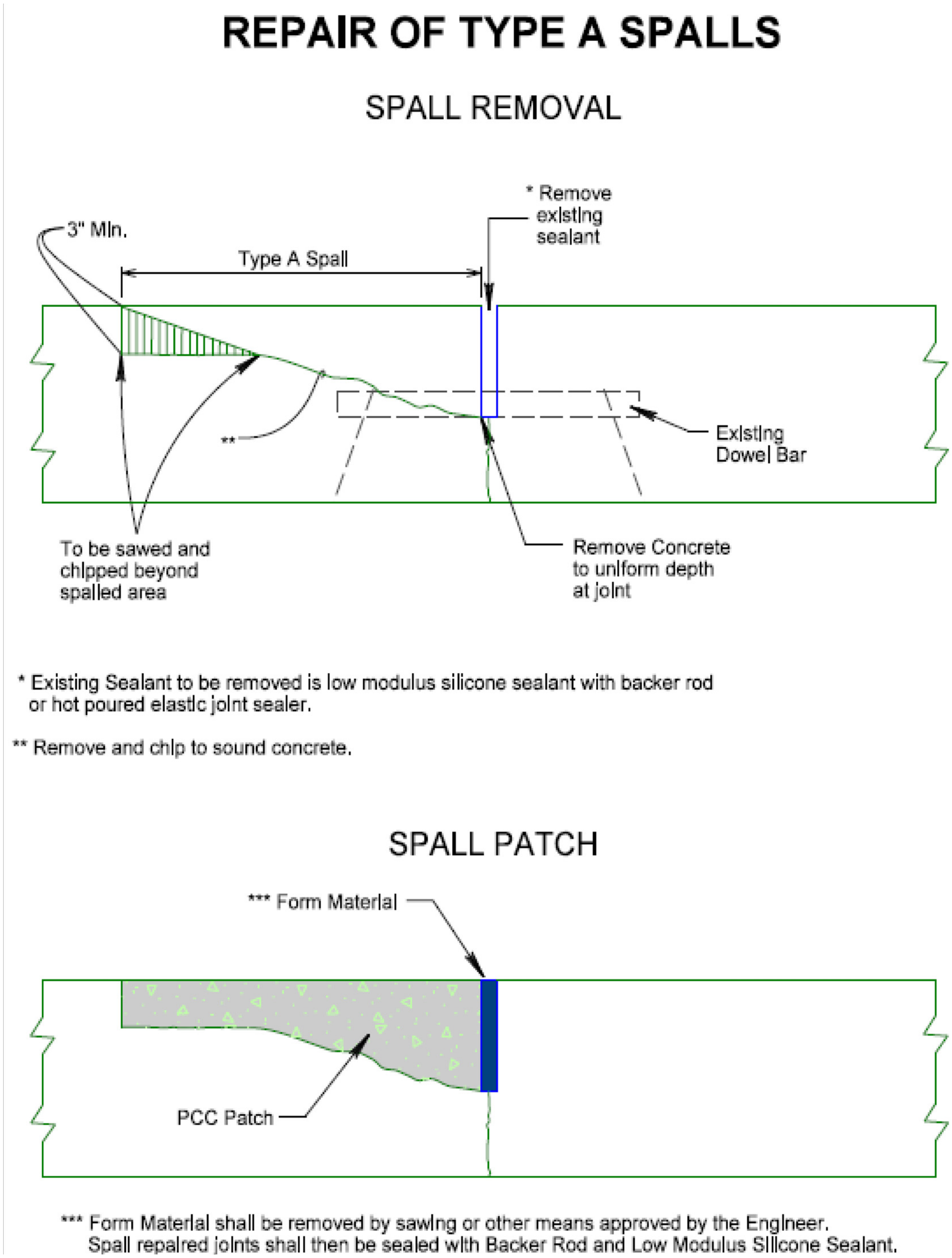
Spall Repair

Construction Requirements (390.3.)

Joints on which seal removal or spall repair has begun shall be completed and sealed during the same construction season. Seal removal or spall repair will not be permitted after October 15. Sealing will not be permitted when the ambient air or pavement temperature falls below 40° F (4° C). The pavement shall be dry when placing the concrete patch. In place sealant shall be removed from transverse joints prior to spall removal.

Spalled areas greater than ½ inch (13 mm) deep at the joint shall be removed and repaired. When both Type A and Type B spalls are shown on the plans, Type A spalls are over 0.2 foot (60 mm) wide, and Type B are spalls 0.2 foot (60 mm) wide or less and greater than 0.06 foot (18 mm) wide. Spalls less than 0.06 foot (18 mm) wide shall be filled with silicone sealant when filling the joints.

Figure 9.9



Type A Spalls

Edges of areas to be repaired shall be sawed to a depth necessary, minimum of 1-1/2 inch (38 mm), to ensure the area can be chipped down to sound concrete without damage to the vertical walls or corners. Areas to be repaired shall be chipped down to sound concrete, minimum of 1-1/2 inch (38 mm), with jack hammers, 30 lbs. (14 kg) maximum, and chipping hammers, 15 lbs. (7 kg) maximum. Vertical edges and corners shall be maintained. The bottom of chipped areas shall be left rough to obtain a good bond between the patch and the old concrete.The area shall then be sandblasted, and the sand blown from the joint and the patch area.

Partially exposed dowel bars shall be coated or covered with an approved bond breaker.

Improperly aligned bars shall be removed. Dowel bars, with the full length totally exposed to the removal side of the joint and below the center of the dowel, shall be cut off flush with the concrete. Dowel bars with more than 50 percent of the length exposed on both sides of the existing joint and has concrete removal below the center of the bar shall be removed.

Prior to placing the patch, the joint shall be formed to a width less than the final opening. The area shall be chipped to a uniform depth, to facilitate forming to the depth of removal or depth of dowel bars, whichever is less. Joints that are open at time of pouring due to thermal contraction shall be formed the full repair depth. Forming material shall be one unit for the length of the spall repair area.

A layer of bonding mortar shall be broomed into and over the surfaces to be patched. The patch shall be placed before the bonding mortar dries and consolidated by vibration. The patch shall be screeded and floated from existing pavement to existing pavement. The entire width shall be straight edged. Grout shall be worked into the saw cuts extending past the corners of the spalled area. The surfaces of the patch shall be given a broomed finish.

At placement, the patch material shall be between 50° F and 90° F (10° C and 32° C) and shall be maintained above 40° F (4° C) for 72 hours. Traffic will not be permitted over the area during this period.

The patched area shall be wet cured or sprayed with curing compound at a minimum rate of one gallon per 150 square feet (one Liter per 4 square meters). Joint forming material shall not be removed for 72 hours. Upon removal of the forming material, the joint shall be sawed, cleaned, and sealed.

Type B Spalls

The spalled concrete shall be removed and the areas chipped down to sound concrete. The resulting areas shall be left rough to obtain a good bond between patch and concrete. The area shall then be sandblasted and the joint formed as specified for Type A spalls. The entire area shall be given a coat of straight epoxy resin (without aggregates). Epoxy resin mortar shall immediately be tamped in place and troweled off. Placement of epoxy will be permitted only within the temperature range recommended in AASHTO M 235, for the class of epoxy used. Form removal, joint sawing, and traffic over the patch area will not be permitted for eight hours after placement.

Saw and Seal Joints: Transverse joints shall be sawed to the uniform width and depth specified. The Contractor shall have backer rod available for variable width joints up to 1-1/2 inches wide. Prior to sealing, the joints shall be cleaned in conformance with Section 380. Traffic will not be permitted over repair areas until joints are sealed and seal material has cured.

Method of Measurement

Saw and seal joints will be measured to the nearest foot (0.1 meter). The areas that have spall repairs will not be measured.

Repair of Type A spalls will be measured to the nearest 0.1 square foot. Surface measurements will be taken to the nearest 0.1 foot.

Repair of Type B spalls will be measured to the nearest 0.1 foot or to the nearest 0.1 square foot, as shown on the plans.

Basis of Payment

Saw and seal joints will be paid for at the contract unit price per foot. Payment will be full compensation for removal of old sealant, cleaning, and resealing the joints.

Repair of Type A spalls will be paid for at the contract unit price per square foot. Payment will be full compensation for sawing, sealing, materials, labor, equipment, and incidentals required.

Repair of Type B spalls will be paid for at the contract unit price per foot or to the nearest square foot, as shown on the plans. Payment will be full compensation for sawing, sealing, materials, labor, equipment, and all incidentals required.

Full Depth Repairs

NONREINFORCED PCC PAVEMENT REPAIR - GENERAL

PCC Pavement Repair shall be done prior to Planing or Grinding PCC Pavement.

Locations and size (length or width) of concrete repair areas are subject to change in the field, at the discretion of the Engineer, at no additional cost to the state. Payment will be based on actual area replaced.

Existing concrete pavement shall be sawed full depth at the beginning and end of the PCCP repair areas. When either the beginning or end of a PCCP repair area falls close to an existing joint or crack, the PCCP repair area shall be extended to eliminate the existing joint or crack. Where possible, new working joints shall be adjacent to existing working joints.

Saw cuts that extend beyond the repair area shall be minimized and filled with a non-shrinkage mortar mix at the Contractor's expense.

Existing concrete pavement in the replacement areas shall be removed by the lift out method or by means that minimize damage to the base and sides of remaining in place concrete. All removed material shall be removed from within the right-of-way by the end of the workday. Damage to adjacent concrete caused by the Contractor's operations shall be removed and replaced at the Contractor's expense.

If the pavement replacement area is entirely on either side of the existing contraction joint, the location of one of the working joints will be at the original location. Any existing dowel bar assemblies/steel bars shall be sawed off and removed.

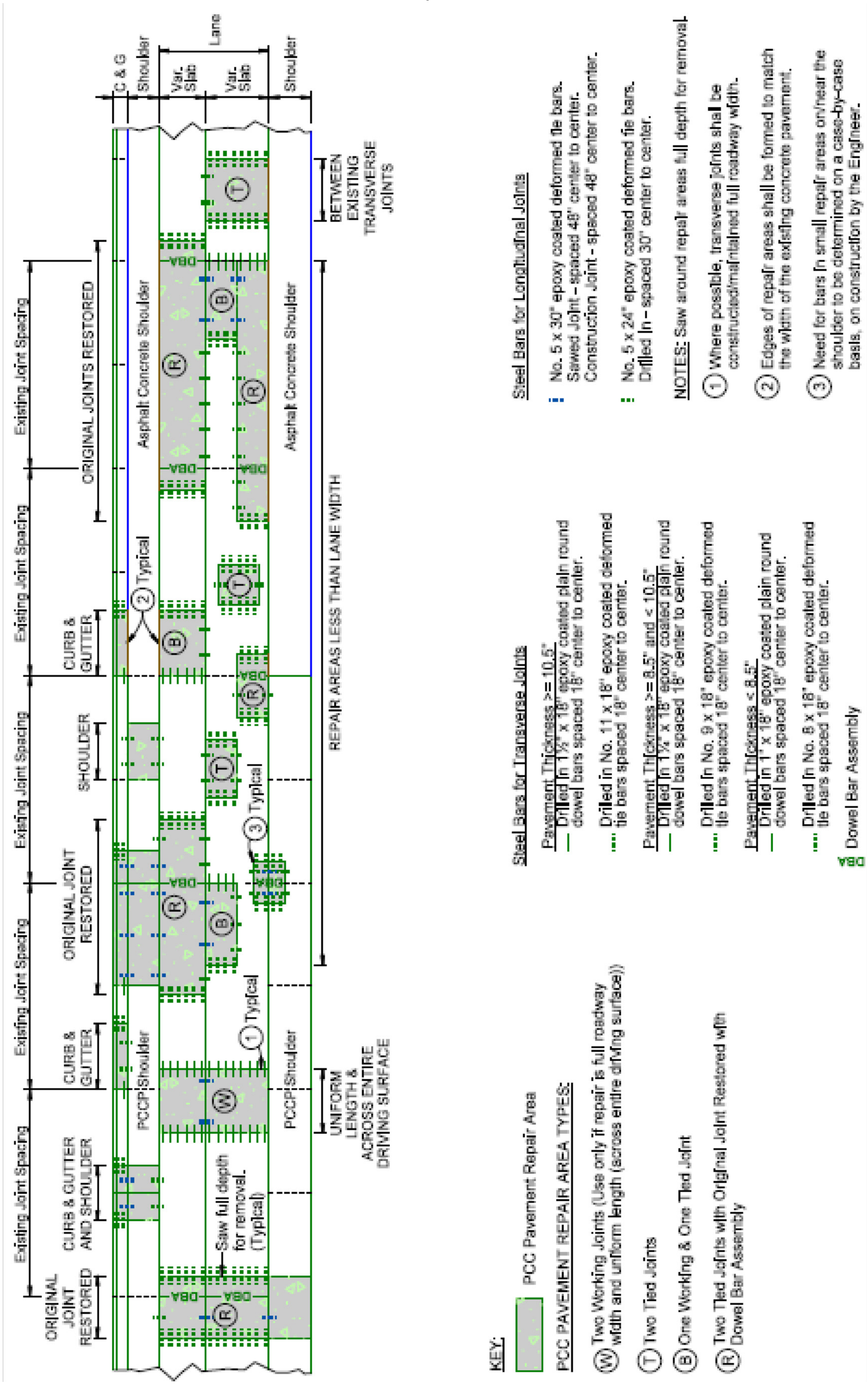
At full roadway width repairs and when specified, a working joint will be reconstructed at both ends of each pavement replacement area as shown in these plans.

Concrete placed adjacent to gravel and asphalt concrete shoulders shall be formed full depth to match the width of existing concrete pavement. Asphalt concrete shoulders adjacent to concrete pavement replacements shall be repaired with new hot-mix asphalt concrete.

At repair locations where the new working joint is not opposite the existing working joint, the Contractor shall place a ¼" preformed asphalt expansion joint material along the longitudinal joint from the existing working joint to the new working joint. The expansion joint material shall meet the requirements of AASHTO M33. Cost for this material shall be incidental to the contract unit price per square yard for Nonreinforced PCC Pavement Repair and/or Fast Track Concrete for PCC Pavement Repair.

All joints (longitudinal and transverse) through and around the repair areas will be sawed and sealed in accordance with the details shown in these plans. Refer to Saw and Seal Joints notes.

Figure 9.10 Nonreinforced PCC Pavement Repair



NONREINFORCED PCC PAVEMENT REPAIR

For existing pavement thickness greater than or equal to 8.5″ (T >= 8.5″):

New pavement thickness shall equal existing pavement thickness (T_N = T).

For existing pavement thickness less than 8.5″ (T < 8.5″):

New pavement thickness shall equal existing pavement thickness + 1″

(T_N = T+1″).

Concrete shall meet the requirements of the Standard Specifications Section 380, except as modified by the following notes:

The fine aggregate shall be screened over a one-inch square-opening screen just prior to introduction into the concrete paving mix if required by the Engineer.

The slump requirement will be limited to 3" maximum after water reducer is added and the concrete shall contain 4.5% to 7.0% entrained air. The concrete shall contain a minimum of 50% coarse aggregate by weight. Coarse aggregate shall be crushed ledge rock, Size No. 1 unless an alternative gradation is approved by the Concrete Engineer as part of the mix design submittal. The mix design shall contain at least 650 lbs of Type I or II cement or 600 lbs of Type III cement per cubic yard. The minimum 28 day compressive strength shall be 4,000 psi. The Contractor is responsible for the mix design used. The Contractor shall submit a mix design and supporting documentation for approval at least 2 weeks prior to use.

The use of a water reducer at manufacturer's recommended dosage will be required.

Concrete shall be cured with white pigmented curing compound (AASHTO M148, Type 2) applied as soon as practical at a rate of 125 square feet per gallon. Concrete shall be cured for a minimum of 48 hours before opening to traffic. The 48 hours is based upon a concrete surface temperature of 60º F or higher throughout the cure period. If the concrete temperature falls below 60º F, the cure time shall be extended or other measures shall be taken, at no additional cost to the State. In addition to the curing requirements, a strength of 4,000 psi must be attained prior to opening to traffic.

Upon placement of the concrete, repair areas shall be straight edged to ensure a smooth riding surface and shall be textured longitudinally with the pavement by finishing with a stiff broom. Repair areas shall then be checked with a 10′ foot straight edge. The permissible longitudinal and transverse surface deviation shall be 1/8″ in 10′.

Concrete shall be covered with suitable insulation blanket consisting of a layer of closed cell polystyrene foam protected by at least one layer of plastic. Insulation blanket shall have an R-value of at least 0.5, as rated by the manufacturer. Insulation blanket shall be left in place, except for joint sawing operations, until the 4000 psi is attained. Insulation blanket shall be overlapped on to the existing concrete by 4′. The initial contraction joint sawing shall be performed as soon as practical after placement to avoid random cracking.

Cost for performing the aforementioned work including sawing and removing concrete, furnishing and placing concrete, sawing and sealing joints, repairing gravel and asphalt concrete shoulders, labor, tools and equipment shall be included in the contract unit price per square yard for Nonreinforced PCC Pavement Repair.

FAST TRACK CONCRETE FOR PCC PAVEMENT REPAIR

For existing pavement thickness greater than or equal to 8.5″ (T >= 8.5″):

New pavement thickness shall equal existing pavement thickness (T_N = T).

For existing pavement thickness less than 8.5″ (T < 8.5″):

New pavement thickness shall equal existing pavement thickness + 1″

(T_N = T+1″).

Fast Track Concrete shall be used for two-lane roadway repair locations to ensure that the pavement repair area has obtained 3,800 psi within 8 hours after placement or by 7:00am the day after placement so it can be opened to traffic.

An initial cylinder shall be made and the Engineer shall calibrate a Swiss Hammer to it. All subsequent strength tests shall be by Swiss Hammer. Cylinders will be made according to Materials Manual requirements and the Swiss Hammer calibration regularly updated according to the early break cylinders.

The Engineer will test the repair areas after an initial 8 hour cure period by Swiss Hammer. If the area does not meet strength after the 8 hour cure period, the area will be tested every 2 hours until nightfall, then not again until 7:00am. No section is to be opened to traffic without the permission of the Engineer.

The fine aggregate shall be screened over a one-inch square-opening screen just prior to introduction into the concrete paving mix if required by the Engineer.

The slump requirement prior to use of a set accelerator or super-plasticizer will be limited to 2" maximum. After the addition of all admixtures the maximum slump shall be 8″ and the concrete shall contain 4.5% to 7.5% entrained air. The concrete shall contain a minimum of 50% coarse aggregate by weight. Coarse aggregate shall be crushed ledge rock, Size No. 1, unless an alternative gradation is approved by the Concrete Engineer as part of the mix design submittal. The mix design shall contain at least 700 lbs. of Type I or II cement or 650 lbs. of Type III cement per cubic yard. The minimum 28 day compressive strength shall be 4,000 psi The Contractor is responsible for the mix design used. The Contractor shall submit a mix design and supporting documentation for approval at least 2 weeks prior to use.

The use of a set accelerator and/or super-plasticizer at manufacturer's recommended dosage may be required. Both admixtures shall be added at the project site.

Fast Track Concrete shall be cured with white pigmented curing compound (AASHTO M148, Type 2) applied as soon as practical at a rate of 125 square feet per gallon. In addition, the concrete shall be immediately covered with suitable insulation blanket consisting of a layer of closed cell polystyrene foam protected by at least one layer of plastic. The insulation blanket shall have an R value of at least 0.5, as rated by the manufacturer. Insulation blanket shall be overlapped on to the existing concrete by 4′. The insulation blanket shall be left in place, except for joint sawing operations, until 3,800 psi strength is attained.

The contraction joint sawing shall be performed as soon as possible after placement of concrete to avoid random cracking. Contraction joints shall be initially sawed to the plans detailed depth and to a width of 1/8″.

The concrete repair area shall be removed, replaced, and opened to traffic in the same day during daylight hours

Once concrete is placed, if it does not achieve 3,800 psi prior to nightfall, the Contractor shall maintain traffic control and provide temporary pavement marking on centerline until the Engineer determines that the 3,800 psi has been achieved.

If the concrete does not achieve 3,800 psi by 7 a.m. the day after placement, the Contractor shall provide all proper traffic control needed (at no cost to the State) until the Engineer determines the 3,800 psi has been obtained. No additional work zones will be set up until strength requirement is met. If strength requirement has not been met by 36 hours after placement, the patches shall be removed and replaced at no cost to the State.

or

If concrete cannot be placed within the same day the Contractor shall place and compact gravel cushion and 2” asphalt concrete within the repair area prior to night fall and the roadway shall be opened to normal traffic. The Contractor shall be responsible for the additional cost for providing, placing and compacting the gravel cushion and asphalt concrete. AC required on high ADT routes

Upon placement of the concrete, repair areas shall be straight edged to ensure a smooth riding surface and shall be textured longitudinally with the pavement by finishing with a stiff broom. Repair areas shall then be checked with a 10’ foot straight edge. The permissible longitudinal and transverse surface deviation shall be 1/8” in 10’.

Cost for performing the aforementioned work including sawing and removing concrete, furnishing and placing Fast Track Concrete, sawing and sealing joints, repairing gravel and asphalt concrete shoulders, labor, tools and equipment shall be included in the contract unit price per square yard for Fast Track Concrete for PCC Pavement Repair.

CHAPTER

10

ADDITIONAL SAMPLING, DOCUMENTATION, AND INSPECTION TESTS

Some materials require certification documentation or visual inspection; other materials must be tested for inclusion on a project. Since special equipment is needed to perform the tests, samples are sent to the Central Testing Laboratory. For project test and cert requirements see DOT-14 form available from Materials & Surfacing Certification and on MS&T (Figure 10.1).

Paving materials that require Central Lab testing include:

- Liquid Membrane Curing Compound
- Silicone and Backer Rod (SD 421)
- Preformed Expansion Joint Material
- Hot Poured Joint Sealer
- Reinforcing Steel

For CCO and other over/under run situations, follow appropriate testing protocols.

Minimum Sampling and Testing Requirements (M.S.T.R., Materials Manual) for each are as follows.

Figure 10.1 Example DOT-14

Summary of Requirements for Tests and Certs — DOT - 14

Contract: 4069 — **Date Let:** 09/05/2012
PCN: 02PL (Main)
Project(s): IM 0299(61)206 (Main)

County: Roberts
Location: I 29 S from the Jct. with US12 to north of the Peever Exit

Type of Work: Nonreinforced PCC Surfacing

Contractor: PCIRoads, LLC — **Length:** 16.645 miles
Engineer: Michael Will — **Area:** Watertown Area

Material	Quantity	Unit	Reqd	Made	Requirement
380 10" Nonreinforced PCC Pavement	257,361.9	SqYd			
	71460/15000 = 5		5	6	Fresh Concrete Test for Independent Assurance - Not req'd. If less than 500 cu.yds.
			*	108	Fresh Concrete Test for Acceptance - One with cylinders & minimum of one per 2 hours of paving
			*	12	Measurements (Groove/Tining) for Acceptance - Surface Texture - 1 per 10,000 SQYD Lot.
			*	18	Pvmt Thick/Width Measurements for Acceptance - As per Standard Specifications (Coring not req'd if less than 4,000 sq yd's)
			*	16 U	Strength Test for Acceptance - 1st 250 CUYD then 1500 CUYD - Min of 1 set per day
			*	0	Surface Profile Measurements for Acceptance - Profilograph by Contr. when req'd. by Plan Note/Hi-Lo by DOT when no Plan Note
#4X6' EP CTD DEFORMED TIE BAR (Tier 2)			1	0 U	Central Lab Test per 3 Sizes for Acceptance
			1	0 U	Coater's Certificate for Certification
			1	0 U	Coating Certificate for Certification
			1	0 U	Mill Test for Certification
			1	0 U	Quality Report for Certification
			1	1	Visual Inspection for Acceptance
#5X30" EP CTD DEFORMED TIE BAR (Tier 2)			1	0 U	Central Lab Test per 3 Sizes for Acceptance
			1	0 U	Coater's Certificate for Certification
			1	0 U	Coating Certificate for Certification
			1	0 U	Mill Test for Certification
			1	0 U	Quality Report for Certification
			1	1	Visual Inspection for Acceptance
AEA (Tier 2)			1	5	Central Lab Test per Lot for Acceptance
			1	5	Cert or Approved Suppl/Prod for Certification
BACKER ROD (SILICONE) (Tier 2)			1	1	Cert or Approved Suppl/Prod for Certification
CEMENT TYPE II or V (IF CERT MILL) (Tier 2)	71460/10000 = 8		8	1 U	Central Lab Test for Acceptance - Not req'd. If less than 500 cu.yds.
			1	8	Cert or Approved Suppl/Prod for Certification
COARSE AGGREGATE (Tier 3)	71460/31500 = 3		3	9	Central Lab Test for Quality
	71460/20000 = 4		4	0	Flat & Elongated Particles for Acceptance - Not to exceed 10%.
			*	48	Moisture Content for Acceptance - One per size per 2 hours
	71460/15000 = 5		5	6	Sieve Analysis for Independent Assurance - Not req'd. If less than 500 cu.yds.
	71460/1000 = 72		72	77	Sieve Analysis for Acceptance
CURING COMPOUND (Tier 2)			1	3	Central Lab Test per Lot for Acceptance
			1	1	Cert or Approved Suppl/Prod for Certification

Texture (Tining)

Acceptance: Visual inspection and measurements documented per SD418 - one per 10,000 square yards.

Curing Materials

Liquid Membrane Curing Compound

Certification: A Certificate of Compliance is required unless the item is on the Approved Products List (Visual Inspection).

Acceptance: One sample 8 oz. plastic container per type, lot and source. Take the sample in sufficient time to allow results to get back before the compound is used.

Note Sampling of curing compound shall occur from the end of the spray nozzle. The material sampled must be properly mixed to disperse all settlement just prior to sampling. Curing compounds older than 6 months must be retested for acceptance. The compound shall be stored at temperatures above 35°F (821).

Curing Blankets (Burlap and Cotton Mat)

Acceptance: Document field inspection including yarns per inch of wrap and of filling and weight determinations (visual inspection).

Polyethylene Sheeting

Acceptance: No samples are needed, but a documented field inspection (visual inspection) is required to assure adequate thickness and durability to resist puncturing or tearing during ordinary use.

Joint Materials

Silicone Sealant and Backer Rod

Certification:

Silicone- The material must be on the approved product list (Visual Inspection).

Backer Rod - A Certificate of Compliance is required, unless the material is on the Approved Products List Form.

Acceptance:

Silicone - 1 pint sample in paint sample can per lot, per source.

Silicone/Backer Rod bond in-place - after the silicone has cured, samples approximately 3 inches in length shall be cut from the in-place material to check bonding, width, depth, and shape. One sample every 1/10th mile shall be obtained.

Note Acceptance samples of silicone, backer rod or in-place tests are not required for projects that have 500 feet or less of joints to be sealed, provided the basis of acceptance is documented on a DOT-10 form.

Preformed Expansion Material

Acceptance: One sample at least 6”x36”xfull thickness is required. No sample is required for Extruded Insulation Board or for quantities less than 25 square feet; however, document the quantity used.

Hot Poured Elastic and Backer Rod

Certification: Hot Poured Elastic and Backer Rod (if used) - A certificate of compliance is required unless the item is on the Approved Products List Form.

Acceptance: Hot Poured Elastic- One container selected at random per lot, batch or date. No sample required for quantities of 200 lbs or less.

Backer Rod - When used, 2 foot length submitted with the joint material.

Keyways

Acceptance: Documented field inspection of dimension measurements (Visual Inspection).

Steel

Smooth Dowel Bars

Certification: A certified copy of the Mill Test Report for the steel and when the bars are epoxy coated, a Certificate of Compliance stating that the coating material and coating process conforms to specifications.

Support Baskets for Dowel Bars

Acceptance: Documented visual inspection.

Reinforcing Bars, Deformed Dowel Bars and Deformed Tie Bars

Heat numbers are located on metal or weather and wear resistant tags secured to the appropriate bundles of steel. The heat numbers must correspond with the shipping papers and the certified mill test reports.

Certification:

1) From Certified Fabricator, Uncoated Bars

- A record (bar list, shipping or packaging list or bill of lading) of the lengths, shapes and sizes shall be forwarded to the Engineer.

2) From Non-Certified Fabricator, Uncoated Bars and for all Epoxy Coated Bars

- A record (bar list, shipping or packing list or bill of lading) of the lengths, shapes, and sizes shall be forwarded to the Engineer.
- A certified copy of the Mill test report of chemical analysis and physical properties for each heat number or lot shall also be forwarded to the Engineer. Deliveries to the project shall be identified by heat numbers, using metal or weather and wear resistant tags wired to the bundles.

- A Certificate of Compliance stating that the epoxy coating and the coating process conform to specifications.

Note The reinforcing steel shall not be placed in the work until records or certifications have been received or tests made.

Acceptance:

Obtain one sample (two 24” lengths) per project, per source, from a randomly select size, representing not more than 3 sizes or 3 heat numbers to be tested for physical properties at the Central Laboratory.

1) From Certified Fabricator, Uncoated Bars - Using shipping record (bar list, packing list or bill of lading) to check shipment for lengths, shapes, and sizes. Visually inspect for rust scales, proper grade markings, and signs of mishandling. The inspector shall include remarks, date and sign the shipping document for the project file (Visual Inspection).

2) From Non-Certified Fabricator, Uncoated Bars and for all Epoxy Coated Bars - A visual inspection on delivery to the project to note heat numbers, size, length, shape, and condition of shipment. Inspection results shall be documented, with date and signature of the inspector on the shipping record (bar list, packing list, or bill of lading). On Epoxy Coated Bars check for voids, holes, cracks, and handling and shipping damage to epoxy coatings.

Steel Reinforcement Inspection (GPR)

Ground Penetrating Radar (GPR) is used by Central Laboratory personnel to inspect in-place tie bars on a portion of the project after the concrete has hardened. The inspection will consist of locating tie bars that are 1) missing, 2) horizontally/vertically skewed, 3) side-shifted, 4) placed too close to transverse joints, or 5) placed at improper depths (too shallow, too deep) in the pavement. A report of findings is provided to the project engineer. The information on the report should be reviewed and communicated to the Contractor, as necessary. Tie bar placement deviations result in monetary deductions, corrective actions, and/or changes in Contractor operations. Further tie bar inspection(s) may be scheduled dependent on findings.

Figure 10.2 Ground Penetrating Radar unit used for tie bar inspection.

Wire Ties and Spacers

Acceptance: Documented visual inspection for coating, if required.

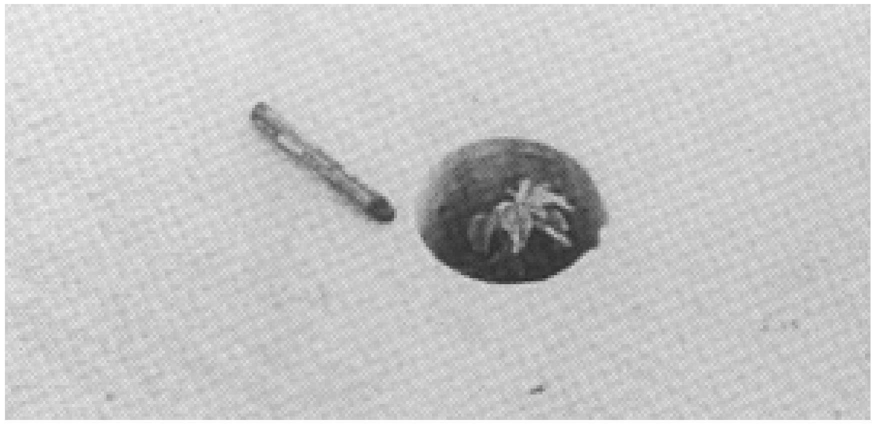
Reinforcing Wire Mesh (Misc.)

Acceptance: Documented field measurements and visual inspection.

Cores

Cores are drilled by personnel from the Materials and Surfacing Office after the concrete is cured. Cores are used to check the depth of the concrete, and may be used as a check against the compressive strength obtained from the molded cylinders. All holes left by drilling the cores must be filled with concrete.

Figure 10.3 Core hole in concrete. Size indicated by crayon beside it.



Swiss Hammer Test

The Swiss Hammer can be used to make a quick determination of the approximate compressive strength of concrete in place. It can be used to determine the compressive strength of concrete for these purposes:

- Removing forms
- Opening the pavement to traffic
- Comparative tests

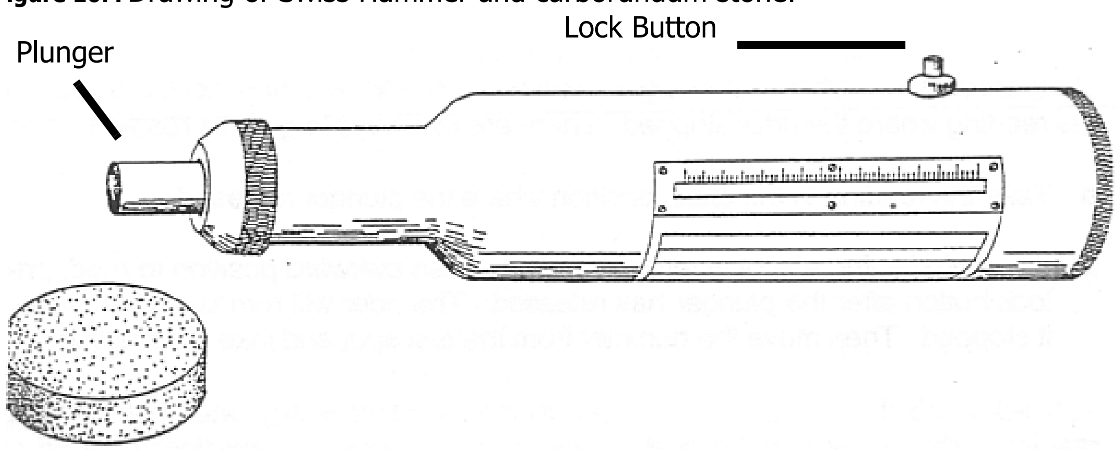
The Project Engineer will advise you which method to use to check the compressive strength. (Swiss Hammer or extra cylinders).

Equipment

All that is needed for this test is a Swiss Test Hammer and carborundum stone. Both are included in the carrying case.

When the Swiss Hammer is removed from the carrying case, it will appear as shown in the figure below. To make the plunger release, press the plunger against something solid.

Figure 10.4 Drawing of Swiss Hammer and carborundum stone.



When placing the hammer in the case, put the plunger against something solid and push it all the way in. Then press the lock button on the side On the side of the Swiss

Hammer is a scale marked 0 to 100. In the center of this scale is a small rider with a line in the center. When the hammer releases, the reading is taken where the line points. In the horizontal position, read as you see it. In the vertical upward position, subtract 500 pounds per square inch. In the vertical downward position, add 500 pounds per square inch.

Swiss hammers are calibrated by the Central testing lab. A good check in the field is to check the calibration with a cylinder. Just prior to breaking the cylinder, take the Swiss hammer reading and compare to the break number.

Procedures for Use

Refer to Materials Manual SD409

Figure 10.5 Positioning Swiss Hammer to take readings.

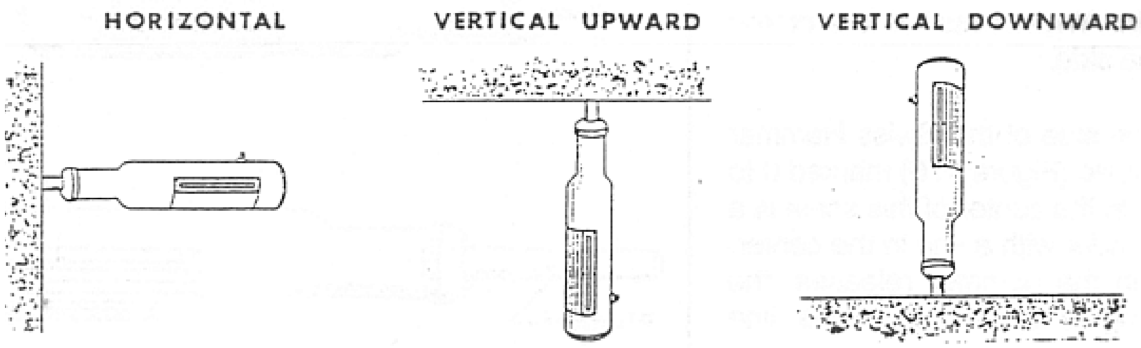
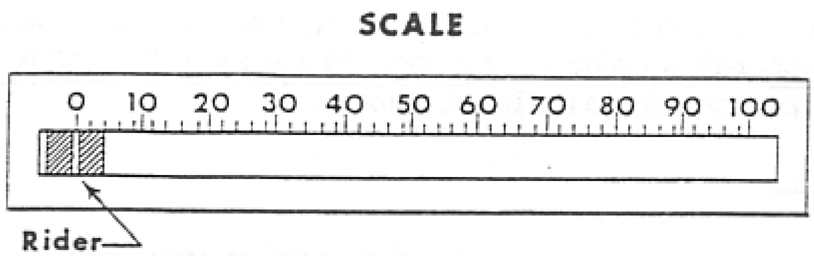


Figure 10.6 Graduated scale formed on the side of the Swiss Hammer.



APPENDIX

11

Concrete Paving Inspector's Reference and Tool List

The concrete paving inspector should consider the following list of reference materials, tools, and equipment when preparing for the job.

1. Reference Materials
    a. DOT Standard Specifications for Roads and Bridges
    b. Set of Plans for the job
    c. Any special provisions and policies in effect
    d. DOT Materials Manual
    e. Concrete Plants Manual
    f. Concrete Paving Manual

2. Tool, Equipment and DOT Forms
    a. Pickup or van
    b. Shovel
    c. Sample cans, plastic bottles, and bags
    d. DOT Forms (DOT-1, DOT-10, DOT-23, DOT-55, DOT-98, DOT-227)
    e. 2 five gallon pails
    f. 2 air meters
    g. Rubber Mallet
    h. Trowel
    i. Small scoop or shovel
    j. Slump mold with rod and platform
    k. 4 to 6 cylinder molds
    l. Swiss Test Hammer with carborndum stone
    m. Thermometer
    n. Tape Measure
    o. Yard Stick or Ruler with 1/16 inch graduations

p. 55 gallon barrel w/clean water for washing testing equipment; cleaning cloths

q. Stop watch

r. Vibrator tachometer

s. Marking Pen

t. Tube of Silicone Sealant with caulk gun

u. Knife

v. Joint Depth and Width Measuring Tool

w. Broom or brush

x. Station Numbers

y. Orange Spray paint or marking crayon

z. Grade Checker

aa. Stringline

bb. Tire tread gauge

cc. Clip board with plastic cover

dd. Scale for Unit Weight & extra batteries for scale

APPENDIX

12

Concrete Paving Inspection Check List

Prepaving Checks

1. Samples of all materials to be used on the job are taken.

2. Certificates of Compliance are on hand for materials that will be incorporated into the project.

3. DOT Forms, equipment, and tools necessary to perform minimum sampling, testing, finegrade and paving checks are on hand.

4. The project number and date are entered at the top of each days diary sheet.

5. Equipment Checks:

Presence of equipment prior to paving:

- Finegrader and paver cutting edges, paver vibrators
- Finishing straightedge present
- Carpet drag and tining machines are one site
- Curing compound is on site
- Concrete saws are on site
- Forms (if used) are checked and passed or rejected

Checks of equipment during paving:

- Finegrader cutting edge, crown & width
- Paver vibrators, strike-offs, floats, etc.
- Saws on the project are ready to saw when needed.

Checks of reinforcing steel:

- Checks of lap, tie twists, staggering, bar size, elevation of steel from base, distance between bars, and the welds for CRCP.

6. Other Prepaving Checks:

- Stringline elevation and alignment is checked

- Surface soft spots identified are repaired
- Transitions are marked for curves
- Steel inspected for correct alignment, elevation, staking with transverse joints marked
- Centerline bars are correct size and length
- The survey crew adjusted the hubs on superelevated curves
- The transition section is marked for removal of the crown
- Steel checks as per plan details (CRCP)

Daily Checks while Paving

1. Paving hubs are correctly set and the stringline is checked.
2. The stringline is tight enough to eliminate sag.
3. The crown, width, and alignment on finegrade trimming are being checked.
4. Soft spots located in the grade are being repaired.
5. Record all finegrade checks in the diary (Station & Measurements).
6. If forms are being used, alignment and elevation are checked.
7. Centerline tie-bars are checked to ensure they are the size and length called for in the plans, and they are placed in the correct position.
8. Dowel baskets are checked to ensure they are set properly and anchored with 9 stakes per basket placed on the side of the basket frame which is downstream from the paver. Spacer bars on the dowel baskets are cut and bond breaker is applied correctly.
9. Dowel basket locations are marked accurately outside of the concrete slab to assure accurate placement of transverse joints.
10. Reinforcing steel bar types correct, wire ties per lap correct, minimum stagger is correct, rebar lap correct, level elevation along surface.
11. Lime slurry sprayed on asphalt bond breaker is intact.
12. Plans checked to see if a keyway is required.
13. Plans checked for the size and tolerance for preformed joint material (if preformed joints will be used).
14. The pad line (the area the paver track runs on) is smooth and uniform; if it isn't have the Contractor level the area.
15. Proper alignment of the paver is observed as it moves off and away from the transverse construction header.
16. The finegrader and paver tracks in contact with previously poured concrete are running on rubber mats or similar material to prevent damage to the slabs.
17. Concrete is being hauled and placed correctly within the time limits; the cushion surface is being kept moist.
18. Measure the distance from the slab to the offset hub to determine if the paver is set correctly.
19. The Contractor is not allowed to add water to the concrete after it leaves the mixer.
20. Take fresh concrete samples and make cylinders per the Materials Manual.

21. Required depth checks are being taken and the results recorded.

22. Foreign materials such as cigarette butts; candy wrappers; soda cans; oil rags; bits of wood, metal, and hard concrete are not permitted on the fine grade or mat.

23. Check the pavement width, depth, and crown at least every 500 feet.

24. Air content, slump tests, and unit weight are being performed.

25. The concrete finishers are using the proper techniques (overlap 1/2 pass, etc.) when straight edging.

26. The straightedge blades are checked for straightness at least twice daily.

27. The Contractor uses a hand float if concrete is rough or porous.

28. DO NOT let the Contractor use a bucket & brush to apply water to the concrete surface. Use a fog spray to moisten the concrete surface under extreme conditions, and then only in isolated areas.

29. Have the Contractor fill any low areas in the surface with good mortar.

30. The carpet drag shall be mounted on a bridge and drawn over the surface in a longitudinal direction. The dimensions of the drag must be such that a strip of the carpet at least 2 feet wide is in contact with the pavement surface while it is operated. The drag shall be kept clean and free of encrusted mortar; if it can't be cleaned, it must be replaced.

31. Place the station numbers every 500 feet and equations as per plans.

32. The surface texture should be uniform with grooves at least 3/16 inch deep.

33. Check the cure application time and rate. Minimum of 150 sq ft/gal of cure untined surface and 125 sq ft/gal tined surface.

34. Curing blankets (if used) must be wet when laid and kept damp for at least 72 hours. Are the blankets large enough for proper coverage?

35. Verify correctness of distance of header from last transverse joint.

36. The steel is being placed in the header according to plans and chairs that are being placed under the rebar prior to paving the next day. The tie-bar size, length, and spacing are in accordance with the plans. In CRCP, additional tie bars are placed according to the plans.

37. The concrete is properly vibrated after the header board and header steel gets placed.

38. The header is not removed until 12 hours have elapsed.

39. Proper alignment is attained prior to taking off from the header the following day.

40. Cold weather concrete specifications are being followed and documented if applicable.

41. Transverse and longitudinal joints are sawed at the proper time.

42. Watch for uncontrolled cracking, when sawing transverse joints.

43. Check the plans for width and depth of saw joints.

44. Any cure that is removed or damaged during the curing period (72 hours) is being reapplied correctly.

45. Observe the Contractor's personnel calibrate the profilograph and ensure the correct data is set. Contact the Concrete Engineer so they can verify the Contractor's profilograph correctly.

46. Observe the Contractor’s personnel operate the profilograph to ensure correct procedures are followed.

47. Joint widening saw cuts and joint cleaning are inspected in accordance with the Materials Manual and Policy OC-03-96, PCCP Joint Sealing Requirements.

48. Check for proper placement of backer rod and silicone sealant. Ensure tooling is performed correctly.

49. Record in the diary, any instructions given to the Contractor, weather conditions, special problems encountered, work progress, results of any checks taken, and anything else that is of importance.

50. Obtain the amount of concrete batched and wasted at the concrete plant; complete the Daily Paving Report (DOT 98 Form) and sign it.

51. Discuss any problems encountered during the day with the Contractor’s representative and the Project Engineer in sufficient time for the Contractor to initiate any needed corrections before the next day.

52. Efforts should be made to walk along the slab, sidewalk, or curb and gutter and observe the texture, tining or finishing, curing, and saw cuts. Document findings in the diary.

53. Ensure the spreader and paver are cleaned and the salvage material is removed from the grade or mat.

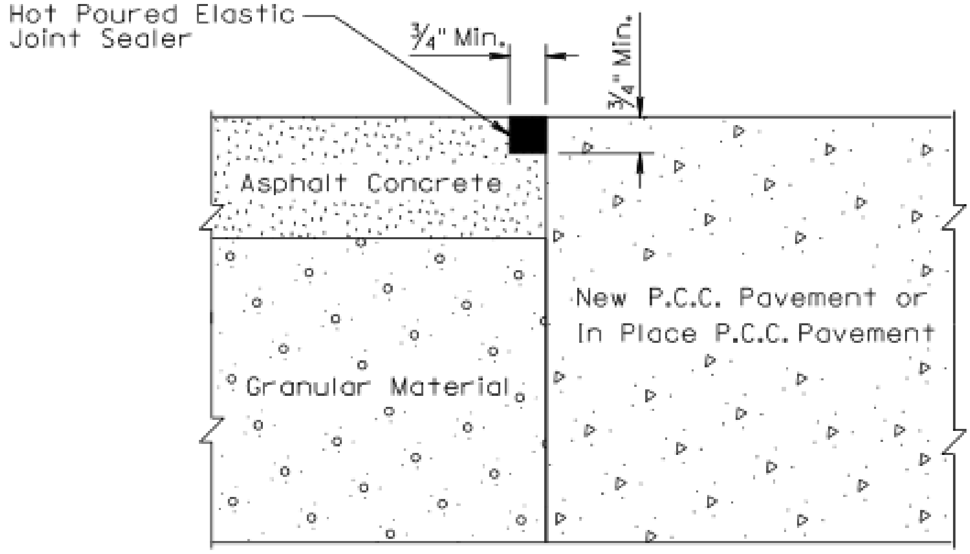
54. Thickness cores must be taken prior to opening to traffic, coordinate with Materials and Surfacing.

55. Return to item #1 on the first page of this checklist.

APPENDIX

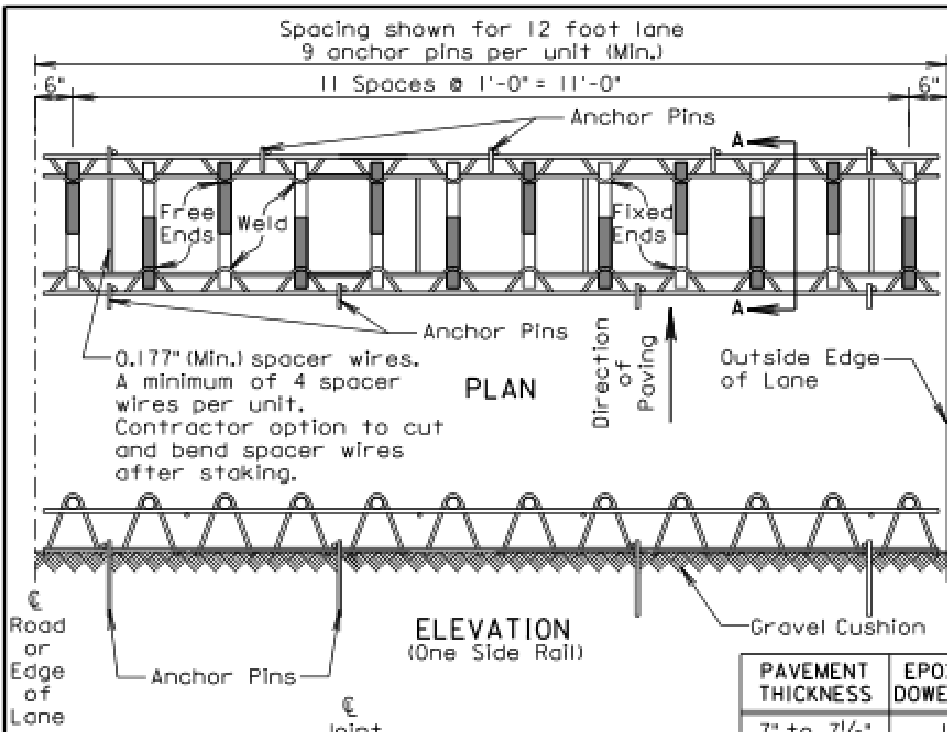
13

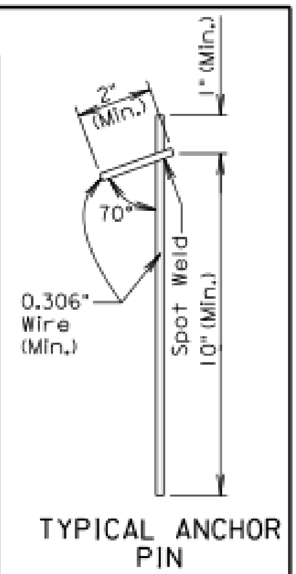
Standard Plates



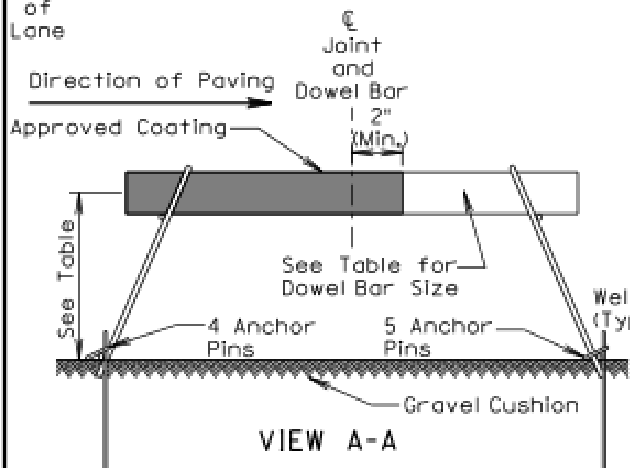
March 31, 2000

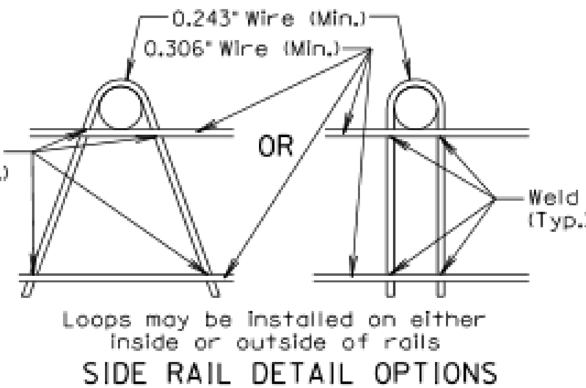
Published Date: 3rd Qtr. 2015	SDDOT	**ASPHALT CONCRETE SHOULDER JOINT ADJACENT TO PCC PAVEMENT**	PLATE NUMBER 320.15 Sheet 1 of 1





PAVEMENT THICKNESS	EPOXY COATED DOWEL BAR SIZE	HEIGHT TO CENTER
7" to 7½"	1" x 18"	3.0"
8" to 10"	1¼" x 18"	4.0"
10½" to 12"	1½" x 18"	5.0"





GENERAL NOTES:

Longitudinal joint tie bars shall be placed a minimum of 15 inches from the transverse contraction joint.

Centerline of individual dowel bars shall be parallel to top of subgrade ±1/8 inch in 18 inches and to all other dowel bars in the assembly ±1/16 inch in 18 inches.

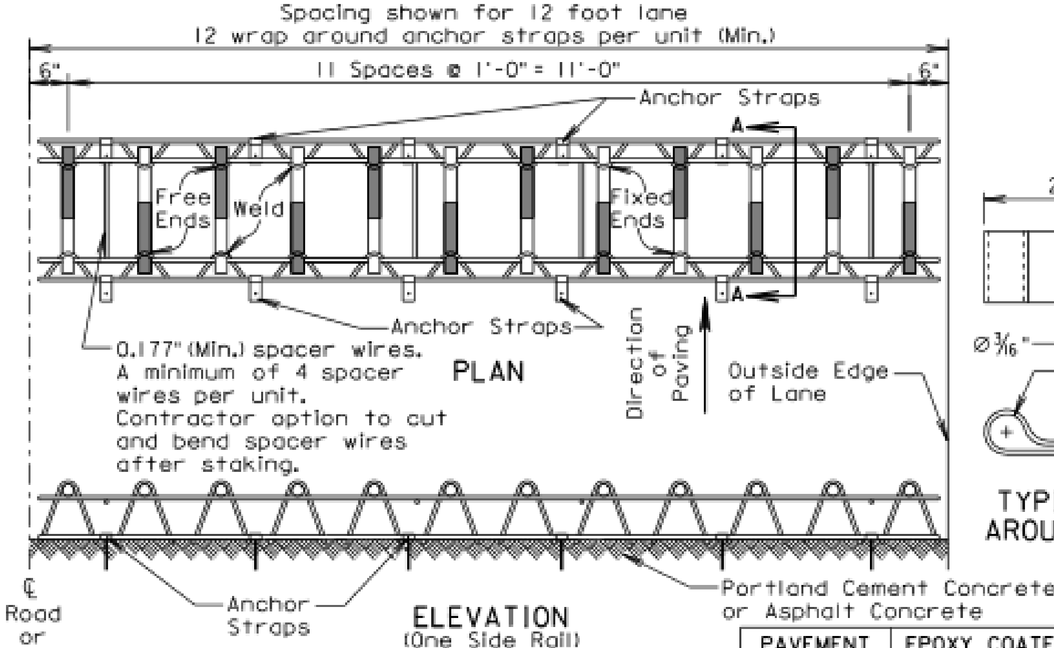
Centerline of individual dowel bars shall be parallel to the centerline of the roadway ±1/2 inch in 18 inches.

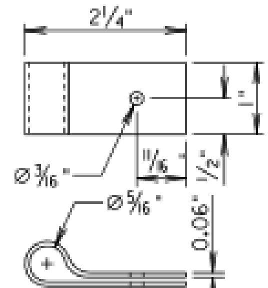
The transverse contraction joints shall be sawed perpendicular to the centerline of the roadway and the dowel bars shall be centered on the sawed joint ±1 inch.

Supporting devices as shown on this sheet, or equivalent as approved by the Engineer, shall be used to maintain proper horizontal and vertical alignment of the dowel bars.

August 30, 2013

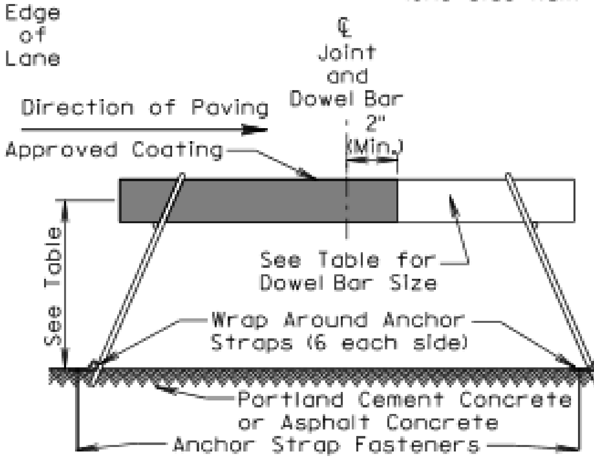
Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT DOWEL BAR ASSEMBLY FOR TRANSVERSE CONTRACTION JOINTS 12 Bar Assembly on Granular Base Material	PLATE NUMBER 380.01 Sheet 1 of 1



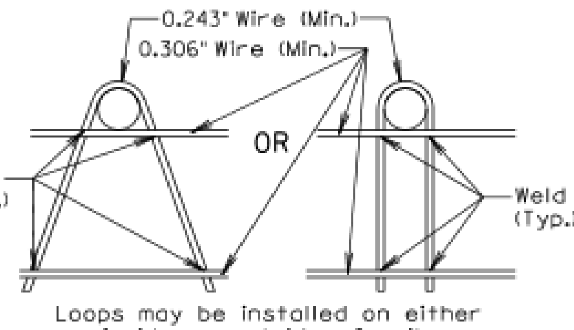


TYPICAL WRAP AROUND ANCHOR STRAP

PAVEMENT THICKNESS	EPOXY COATED DOWEL BAR SIZE	HEIGHT TO CENTER
7" to 7½"	1" x 18"	3.0"
8" to 10"	1¼" x 18"	4.0"
10½" to 12"	1½" x 18"	5.0"



VIEW A-A



Loops may be installed on either inside or outside of rails

SIDE RAIL DETAIL OPTIONS

GENERAL NOTES:

Longitudinal joint tie bars shall be placed a minimum of 15 inches from the transverse contraction joint.

Centerline of individual dowel bars shall be parallel to top of subgrade ±1/8 inch in 18 inches and to all other dowel bars in the assembly ±1/16 inch in 18 inches.

Centerline of individual dowel bars shall be parallel to the centerline of the roadway ±1/2 inch in 18 inches.

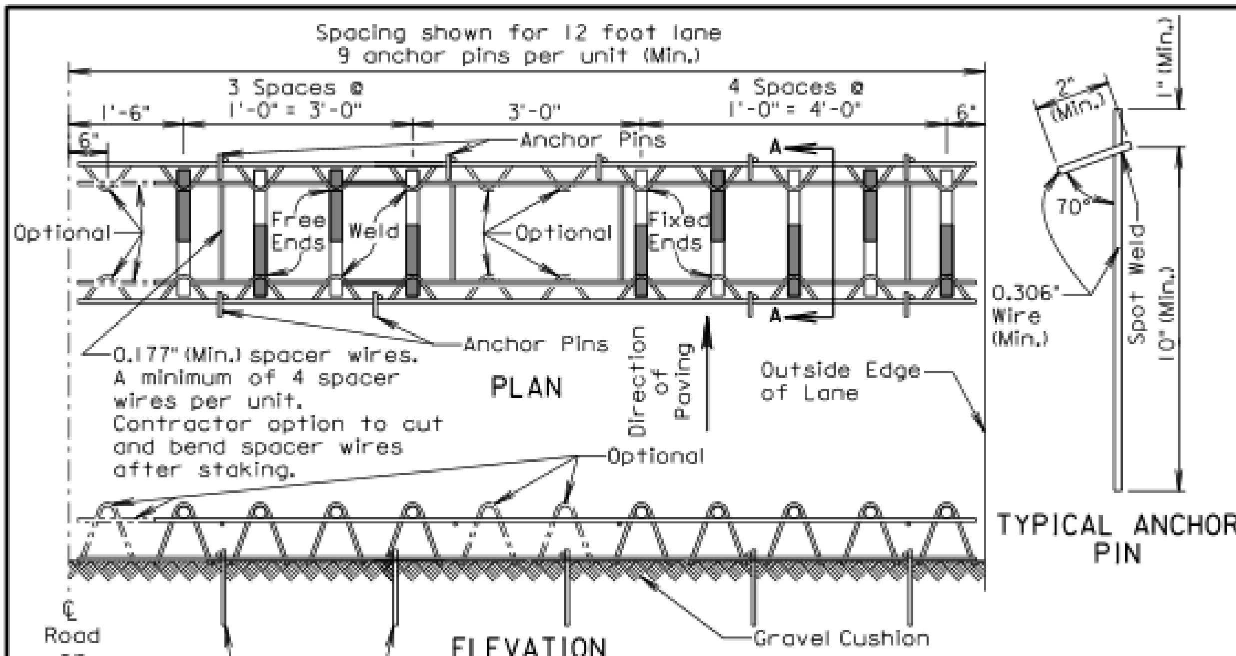
The transverse contraction joints shall be sawed perpendicular to the centerline of the roadway and the dowel bars shall be centered on the sawed joint ±1 inch.

Supporting devices as shown on this sheet, or equivalent as approved by the Engineer, shall be used to maintain proper horizontal and vertical alignment of the dowel bars.

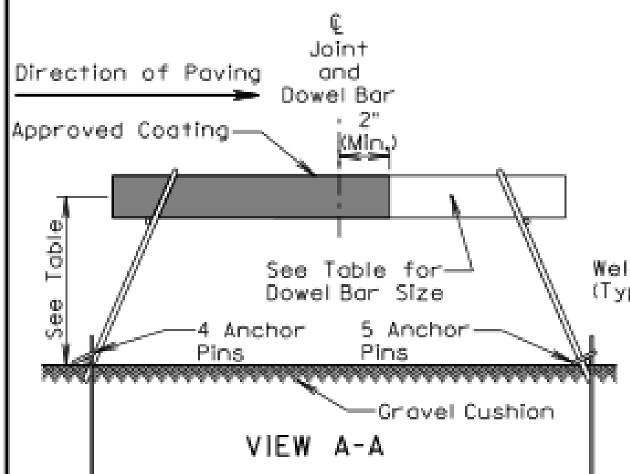
Appropriate anchor strap fasteners shall be used to prevent movement of the dowel bar assemblies during the paving operation.

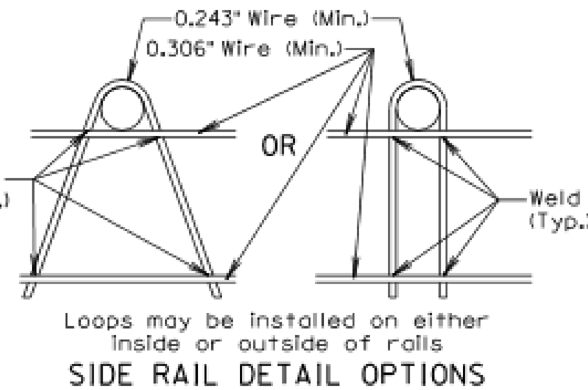
August 30, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT DOWEL BAR ASSEMBLY FOR TRANSVERSE CONTRACTION JOINTS 12 Bar Assembly on Hard Surfaced Base Material	PLATE NUMBER 380.02 Sheet 1 of 1



PAVEMENT THICKNESS	EPOXY COATED DOWEL BAR SIZE	HEIGHT TO CENTER
7" to 7½"	1" x 18"	3.0"
8" to 10"	1¼" x 18"	4.0"
10½" to 12"	1½" x 18"	5.0"





GENERAL NOTES:

Longitudinal joint tie bars shall be placed a minimum of 15 inches from the transverse contraction joint.

Centerline of individual dowel bars shall be parallel to top of subgrade ±1/8 inch in 18 inches and to all other dowel bars in the assembly ±1/16 inch in 18 inches.

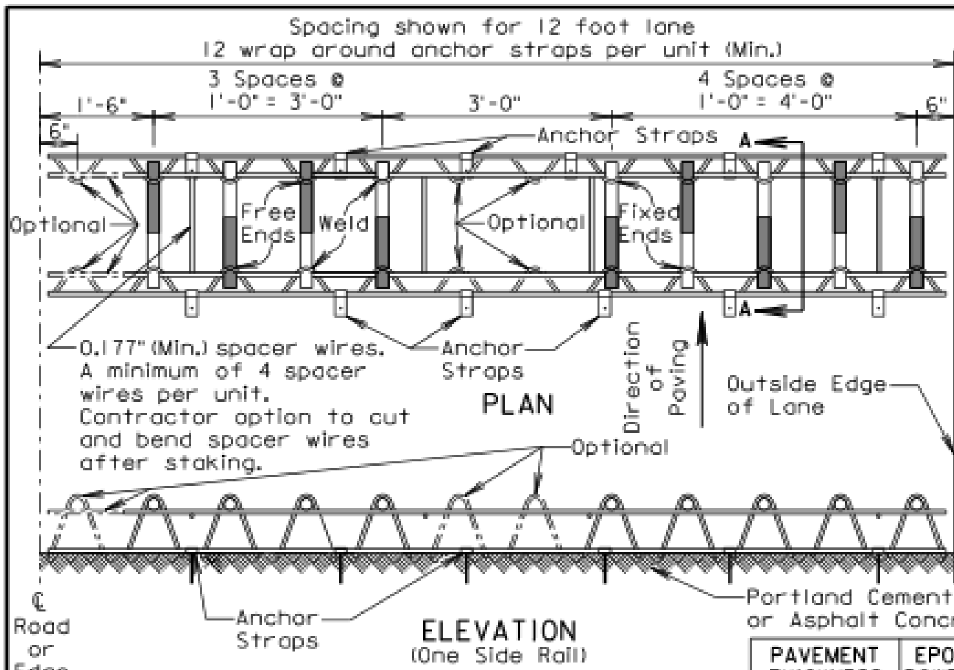
Centerline of individual dowel bars shall be parallel to the centerline of the roadway ±1/2 inch in 18 inches.

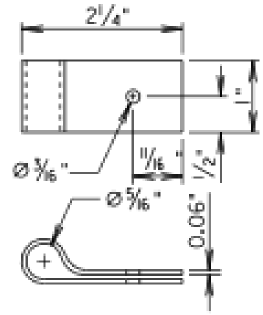
The transverse contraction joints shall be sawed perpendicular to the centerline of the roadway and the dowel bars shall be centered on the sawed joint ± 1 inch.

Supporting devices as shown on this sheet, or equivalent as approved by the Engineer, shall be used to maintain proper horizontal and vertical alignment of the dowel bars.

August 30, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT DOWEL BAR ASSEMBLY FOR TRANSVERSE CONTRACTION JOINTS 9 Bar Assembly on Granular Base Material	PLATE NUMBER 380.03 Sheet 1 of 1





TYPICAL WRAP AROUND ANCHOR STRAP

PAVEMENT THICKNESS	EPOXY COATED DOWEL BAR SIZE	HEIGHT TO CENTER
7" to 7½"	1" × 18"	3.0"
8" to 10"	1¼" × 18"	4.0"
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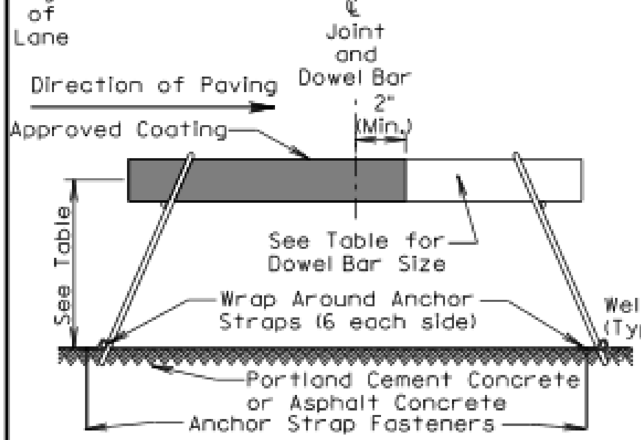

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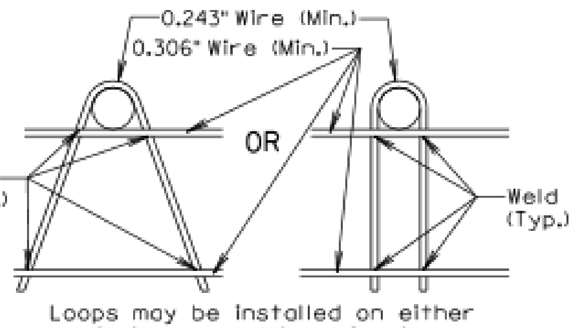


SIDE RAIL DETAIL OPTIONS

GENERAL NOTES:

Longitudinal joint tie bars shall be placed a minimum of 15 inches from the transverse contraction joint.

Centerline of individual dowel bars shall be parallel to top of subgrade ±1/8 inch in 18 inches and to all other dowel bars in the assembly ±1/16 inch in 18 inches.

Centerline of individual dowel bars shall be parallel to the centerline of the roadway ±1/2 inch in 18 inches.

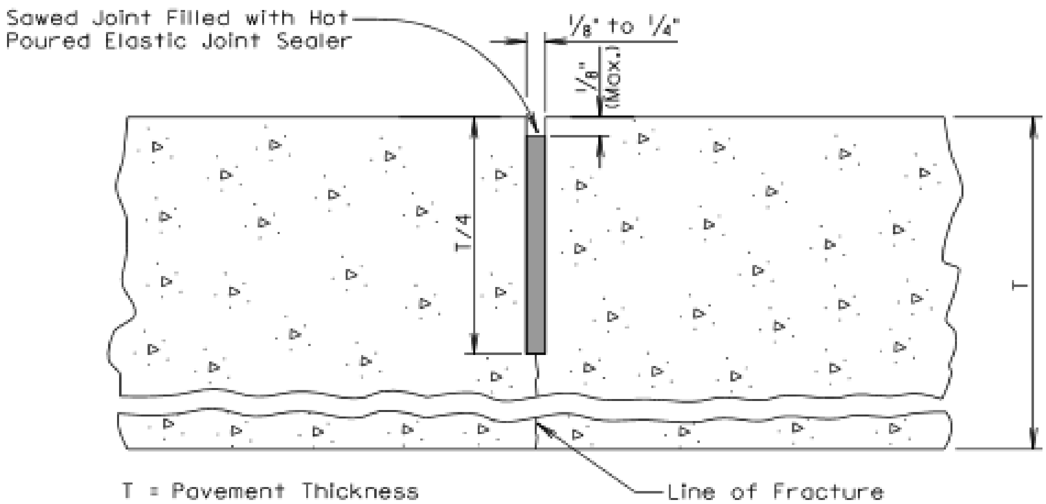
The transverse contraction joints shall be sawed perpendicular to the centerline of the roadway and the dowel bars shall be centered on the sawed joint ±1 inch.

Supporting devices as shown on this sheet, or equivalent as approved by the Engineer, shall be used to maintain proper horizontal and vertical alignment of the dowel bars.

Appropriate anchor strap fasteners shall be used to prevent movement of the dowel bar assemblies during the paving operation.

August 30, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT DOWEL BAR ASSEMBLY FOR TRANSVERSE CONTRACTION JOINTS 9 Bar Assembly on Hard Surfaced Base Material	PLATE NUMBER 380.04 Sheet 1 of 1



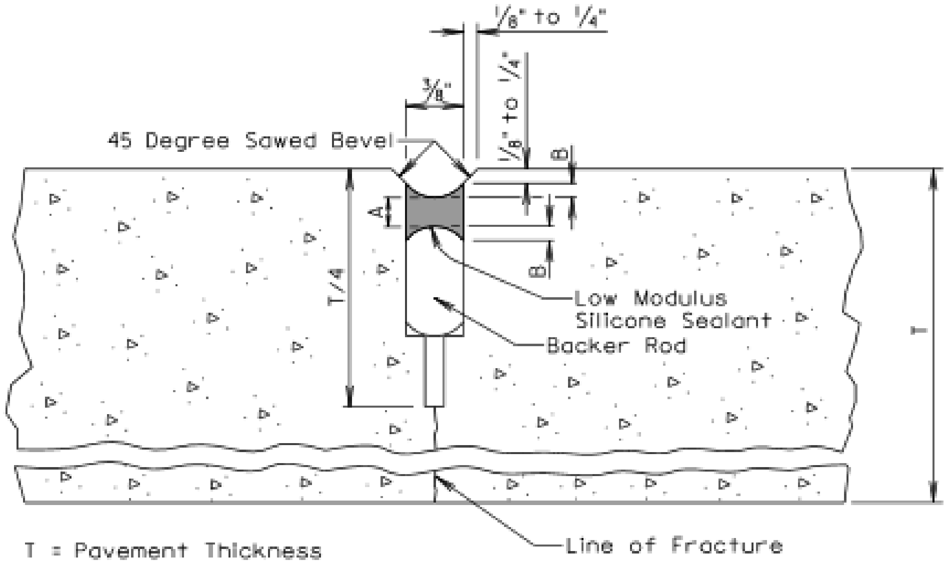
GENERAL NOTES:

If an early entrance sawcut does not develop the full transverse crack, then the saw cut to control cracking shall be a minimum of 1/4 the thickness of the pavement.

All hot poured elastic joint sealer material spilled on the surface of the concrete pavement shall be removed as soon as the material has cooled. The extent of removal of material shall be to the satisfaction of the Engineer. All costs for removal of the spilled joint sealer material shall be borne by the Contractor.

June 26, 2015

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT TRANSVERSE CONTRACTION JOINT WITH OR WITHOUT DOWEL BAR ASSEMBLY	PLATE NUMBER 380.05 Sheet 1 of 1



LOW MODULUS SILICONE SEALANT ALLOWABLE CONSTRUCTION TOLERANCES			
A (Min.) (In.)	A (Max.) (In.)	B (Min.) (In.)	B (Max.) (In.)
3/16	5/16	1/8	1/4

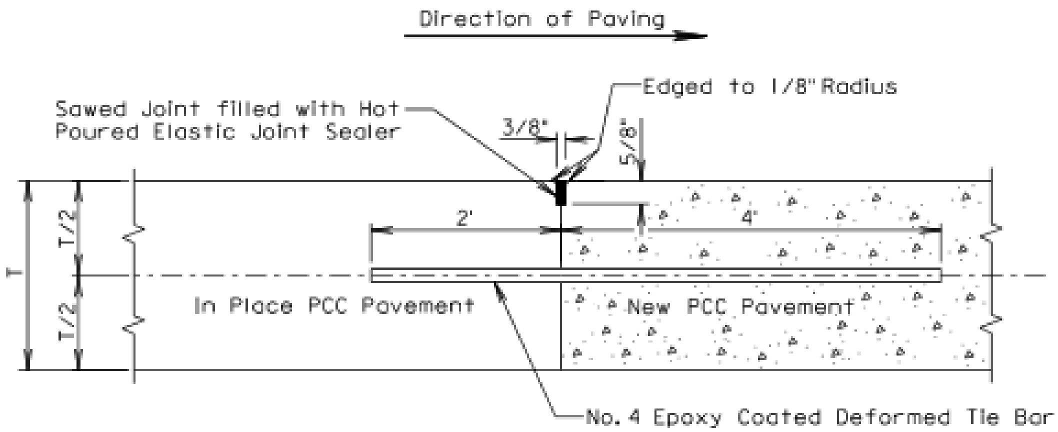
GENERAL NOTES:

The first saw cut to control cracking shall be a minimum of 1/4 the thickness of the pavement. Additional sawing for widening the saw cut to provide the width for the installation of the low modulus silicone joint sealant will be necessary.

The backer rod shall be a nonmoisture absorbing resilient material approximately 25% larger in diameter than the width of the joint to be sealed.

June 26, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT BEVELED TRANSVERSE CONTRACTION JOINT WITH OR WITHOUT DOWEL BAR ASSEMBLY	PLATE NUMBER 380.06 Sheet 1 of 1



T = Pavement Thickness

GENERAL NOTES:

No. 4 epoxy coated deformed tie bars shall be spaced 12 inches center to center and shall be a minimum of 3 inches and a maximum of 6 inches from the pavement edges.

The minimum distance between a transverse construction joint with tie bars and an adjacent transverse contraction joint shall be 5 feet.

When a transverse construction joint is made, paving will not be allowed in this area for 12 hours.

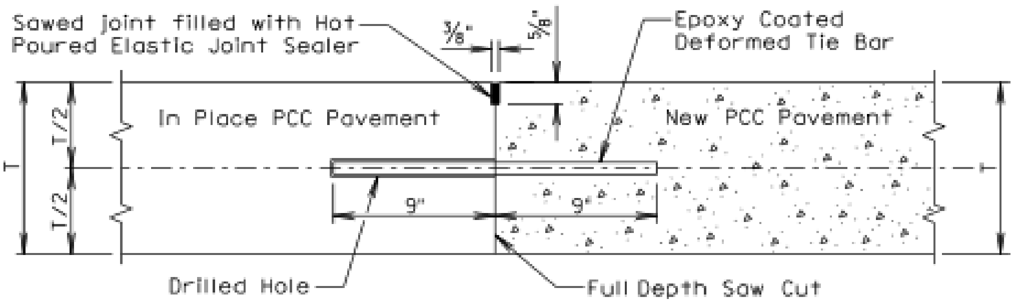
A transverse construction joint may be placed in lieu of the transverse contraction joint when shown in the plans.

The term "In Place PCC Pavement" in the above drawing indicates that the in place PCC pavement was placed on the current project.

June 26, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT MID PANEL TRANSVERSE CONSTRUCTION JOINT	PLATE NUMBER 380.07
			Sheet 1 of 1

DETAIL A
TRANSVERSE CONSTRUCTION JOINT WITH TIE BARS



T = In Place PCC Pavement and New PCC Pavement Thickness

GENERAL NOTES:

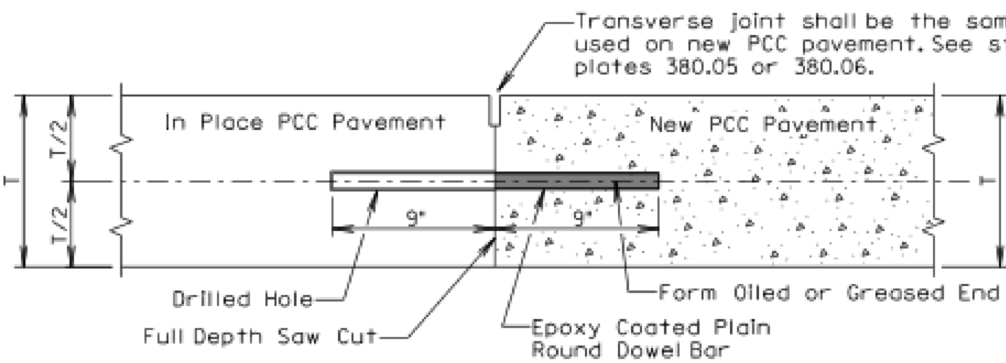
The term "In Place PCC Pavement" in the above drawing indicates that the in place PCC pavement was placed on a previous project.

See sheet 2 of 2 of this standard plate to determine if Detail A shall be used.

The tie bars shall be embedded a minimum depth of 9 inches into the in place PCC pavement and anchored with an epoxy resin adhesive.

No. 9 epoxy coated deformed tie bars shall be used in 10 inch thickness and less PCC Pavement and No. 11 epoxy coated deformed tie bars shall be used in 10.5 inch thickness and greater PCC Pavement. The tie bar spacing shall be 18 inches center to center and shall be a minimum of 3 inches and a maximum of 9 inches from the pavement edges.

DETAIL B
TRANSVERSE CONSTRUCTION JOINT WITH DOWEL BARS



T = In Place PCC Pavement and New PCC Pavement Thickness

GENERAL NOTES:

The term "In Place PCC Pavement" in the above drawing indicates that the in place PCC pavement was placed on a previous project or current project.

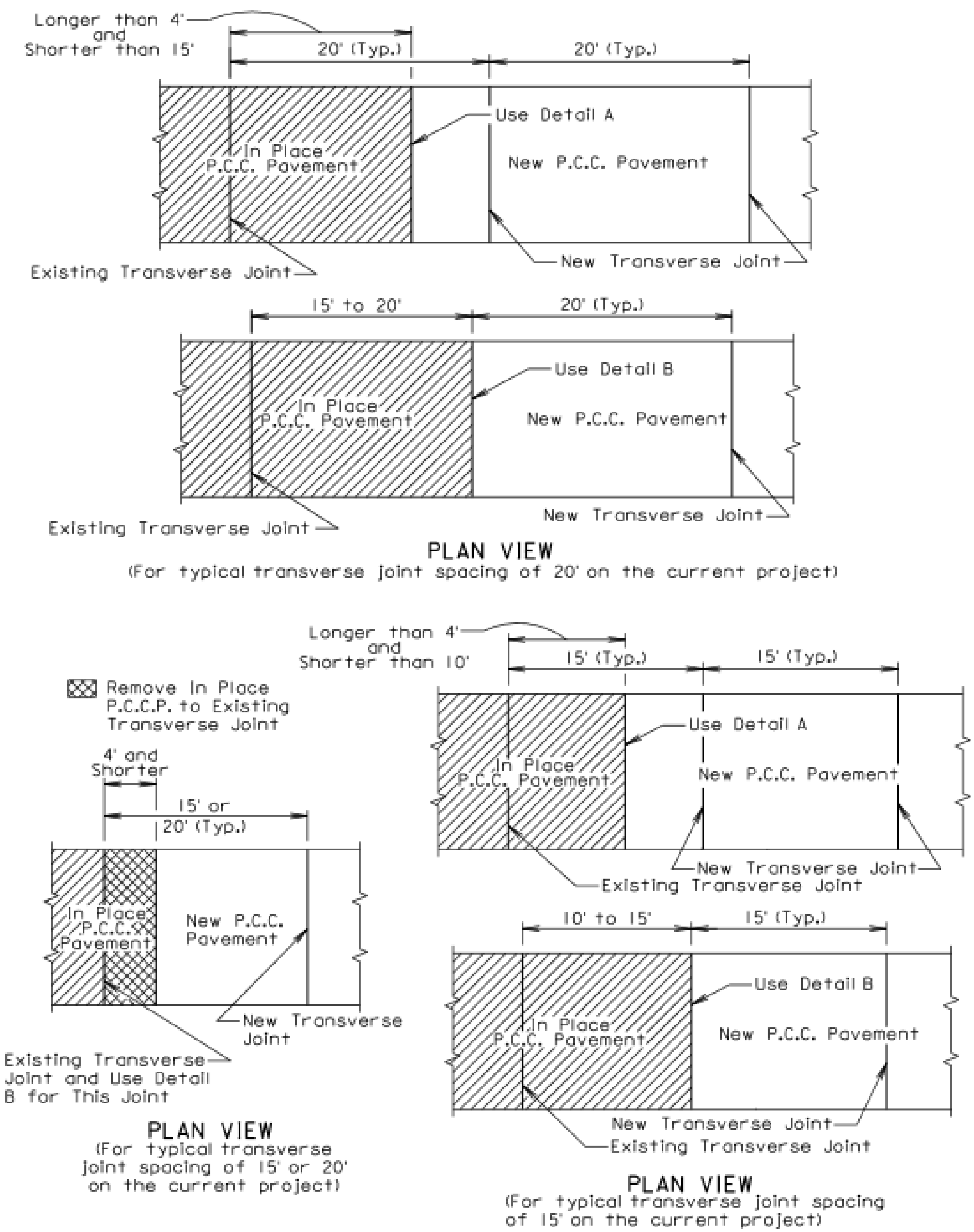
See sheet 2 of 2 of this standard plate to determine if Detail B shall be used.

The plain round dowel bars shall be embedded a minimum depth of 9 inches into the in place PCC pavement and anchored with an epoxy resin adhesive.

The epoxy coated plain round dowel bar size, number, and spacing shall be the same as detailed on the corresponding dowel bar assembly standard plate (380.01, 380.02, 380.03, or 380.04). The epoxy coated plain round dowel bars shall be a minimum of 3 inches and a maximum of 6 inches from the pavement edges.

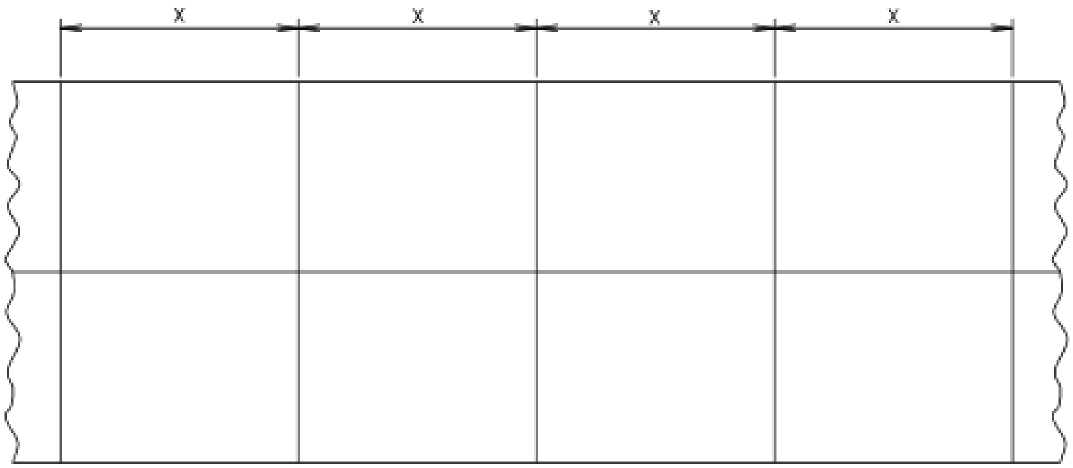
September 6, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT TRANSVERSE CONSTRUCTION JOINTS WITH TIE BARS OR DOWEL BARS	PLATE NUMBER 380.08 Sheet 1 of 2



September 6, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT TRANSVERSE CONSTRUCTION JOINTS WITH TIE BARS OR DOWEL BARS	PLATE NUMBER 380.08 Sheet 2 of 2



PCCP Thickness	Transverse Contraction Joint Spacing (X)
8" to 9.5"	15'
10" and Thicker	20'

August 31, 2013

Published Date: 3rd Qtr. 2015

SDDOT

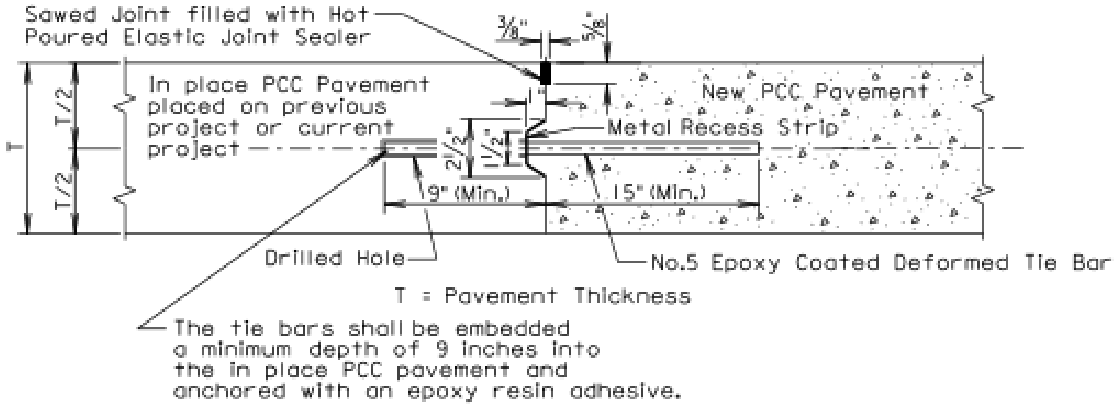
PCC PAVEMENT TYPICAL CONTRACTION JOINT SPACING

PLATE NUMBER 380.09

Sheet 1 of 1

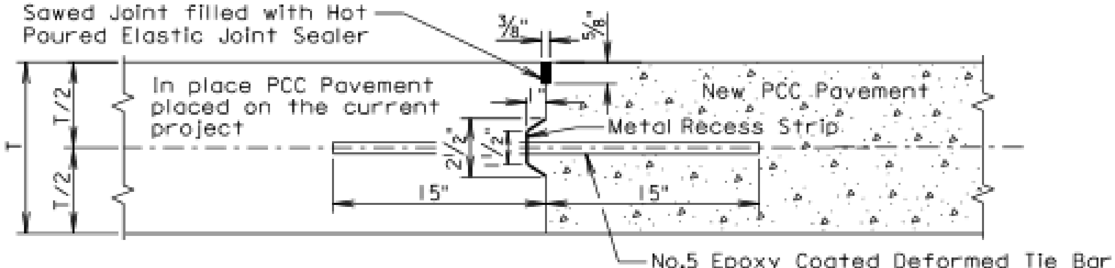
LONGITUDINAL CONSTRUCTION JOINT WITH TIE BARS

(DRILLED IN BARS)



LONGITUDINAL CONSTRUCTION JOINT WITH TIE BARS

(INSERTED OR FORMED IN BARS)



GENERAL NOTES (For the details above):

The epoxy coated deformed tie bars shall be spaced in accordance with the following tables:

Tie Bar Spacing 48" Maximum	
Transverse Contraction Joint Spacing	Number of Tie Bars
6.5' to 10'	2
10.5' to 14'	3
14.5' to 18'	4
18.5' to 22'	5

Tie Bar Spacing 30" Maximum	
Transverse Contraction Joint Spacing	Number of Tie Bars
5' to 7'	2
7.5' to 9.5'	3
10' to 12'	4
12.5' to 14.5'	5
15' to 17'	6
17.5' to 19.5'	7
20' to 22'	8

The tie bars shall be placed a minimum of 15 inches from transverse contraction joints.

The required number of tie bars as shown in the table shall be uniformly spaced within each panel. The uniformly spaced tie bars shall be spaced a maximum of 48 inches center to center for a female keyway and shall be spaced a maximum of 30 inches center to center for a vertical face and male keyway. The maximum tie bar spacing shall apply to tie bars within each panel.

The keyway illustrated in the above details depict a female keyway.

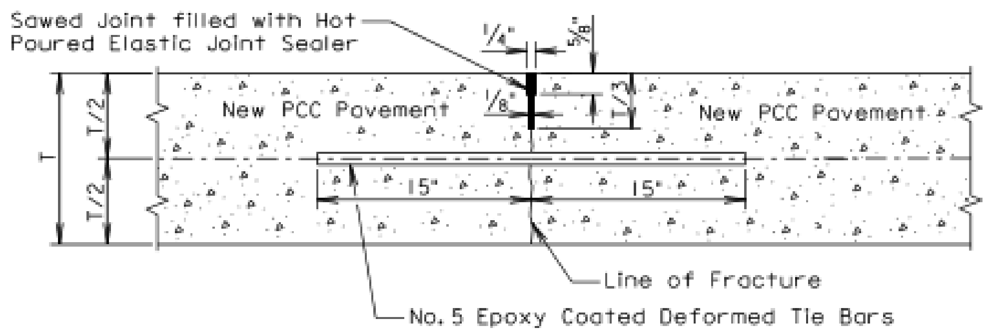
The keyway is optional and is not required. When concrete pavement is formed and a keyway is provided, a metal recess strip shall be used. When concrete pavement is slip formed, a metal recess strip is not required.

August 31, 2013

Published Date: 3rd Qtr. 2015	**SDDOT**	**PCC PAVEMENT LONGITUDINAL JOINTS WITH TIE BARS**	PLATE NUMBER 380.10 Sheet 1 of 2

SAWED LONGITUDINAL JOINT WITH TIE BARS

(POURED MONOLITHICALLY)



T = Pavement Thickness

GENERAL NOTES (For the detail above):

The epoxy coated deformed tie bars shall be spaced in accordance with the following table:

Tie Bar Spacing 48" Maximum	
Transverse Contraction Joint Spacing	Number of Tie Bars
6.5' to 10'	2
10.5' to 14'	3
14.5' to 18'	4
18.5' to 22'	5

The tie bars shall be placed a minimum of 15 inches from the transverse contraction joints.

The required number of tie bars as shown in the table shall be uniformly spaced within each panel with a maximum space of 48 inches center to center. The maximum tie bar spacing shall apply to tie bars within each panel.

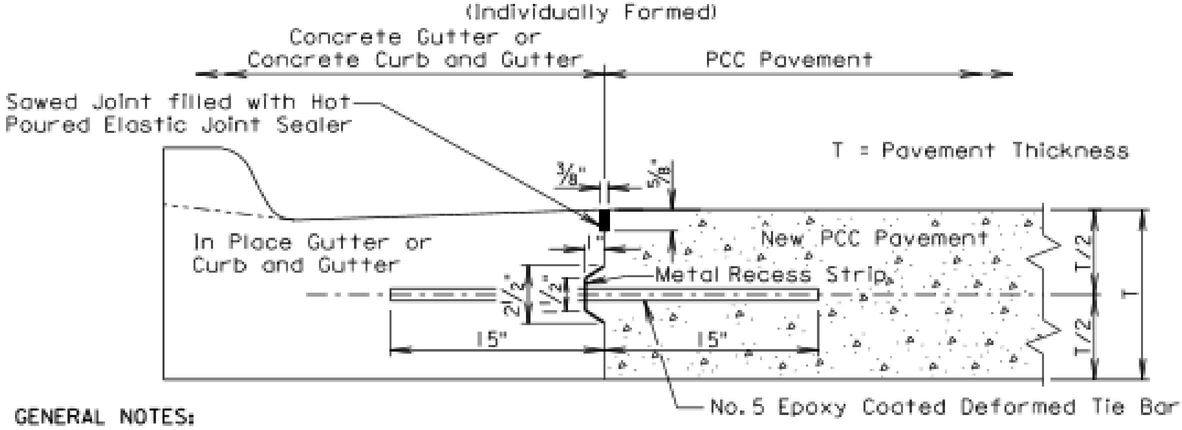
The first saw cut to control cracking shall be a minimum of 1/3 the thickness of the pavement. Additional sawing for widening the saw cut to provide the width for the installation of the hot poured elastic joint sealer is necessary.

August 31, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT LONGITUDINAL JOINTS WITH TIE BARS	PLATE NUMBER 380.10
			Sheet 2 of 2

LONGITUDINAL CONSTRUCTION JOINT WITH TIE BARS

(Individually Formed)



GENERAL NOTES:

No. 5 epoxy coated deformed tie bars shall be spaced 48 inches center to center. The keyway shown above is a female keyway.

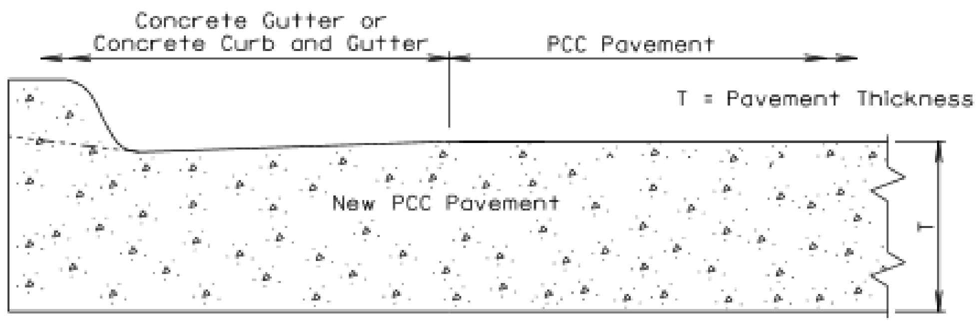
The tie bars shall be placed a minimum of 15 inches from existing transverse contraction joints.

The keyway is optional and is not required. When concrete pavement is formed and a keyway is provided, a metal recess strip shall be used. When concrete pavement is slip formed, a metal recess strip is not required.

The transverse contraction joints in the concrete gutter or concrete curb and gutter shall be placed at each mainline PCC pavement transverse contraction joint. The transverse contraction joints in the concrete gutter or the concrete curb and gutter shall be 1½ inches deep if formed in fresh concrete using a suitable grooving tool. If a saw is used to cut the transverse contraction joints, then the depth of the joint shall be at least ¼ the thickness of the concrete gutter or concrete curb and gutter.

The term "In Place Gutter or Curb and Gutter" in the above drawing indicates that the in place concrete gutter and concrete curb and gutter was placed on the current project.

POURED MONOLITHICALLY



GENERAL NOTES:

The mainline curb and gutter may be placed monolithically with the PCC pavement if the mainline lane width is less than or equal to 12 feet. If this method of construction is used, the tie bars and the sawed joint between the curb and gutter and the PCC pavement shall be eliminated.

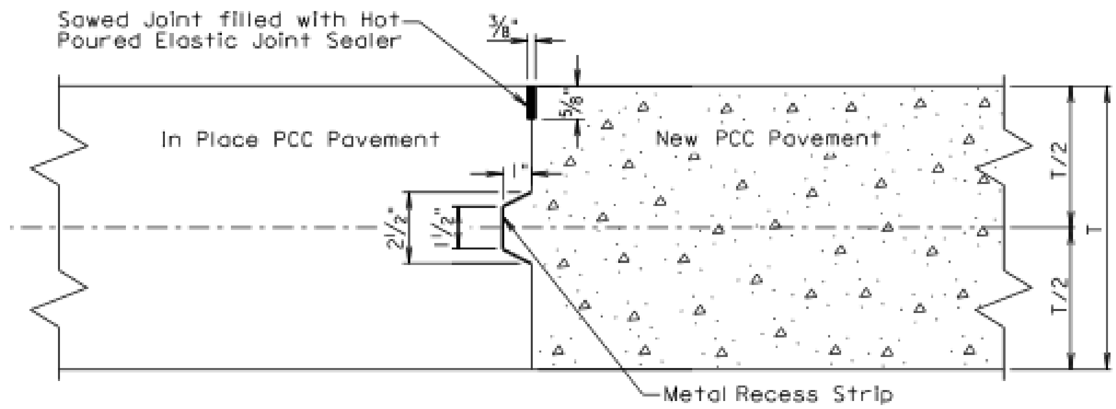
The gutter or curb and gutter shall be sawed transversely at each mainline transverse contraction joint. The transverse contraction joints in the gutter or curb and gutter shall be sawed and sealed same as the transverse contraction joints in the PCC pavement.

The slope of the gutter shall be the slope designated for the type of gutter or curb and gutter to be constructed. The bottom slope of the gutter or curb and gutter shall be constructed at the same slope as the mainline concrete pavement.

June 26, 2013

Published Date: 3rd Qtr. 2015	SDDOT	PCC PAVEMENT LONGITUDINAL CONSTRUCTION JOINTS WITH CONCRETE GUTTER OR CONCRETE CURB AND GUTTER	PLATE NUMBER 380.11 — Sheet 1 of 1

LONGITUDINAL CONSTRUCTION JOINT WITHOUT TIE BARS



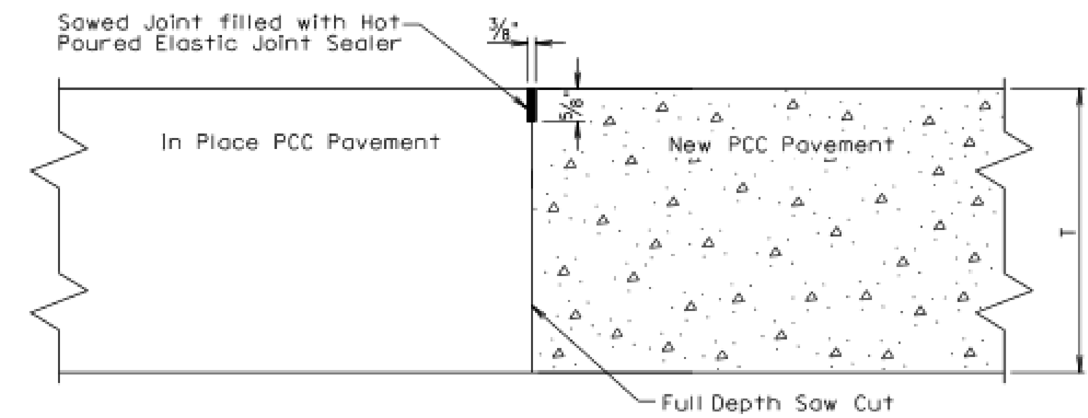
T = Pavement Thickness

GENERAL NOTES:

When concrete pavement is formed and a keyway is provided, a metal recess strip shall be used. When concrete pavement is slip formed, a metal recess strip is not required.

The term "In Place PCC Pavement" in the above drawing indicates that the in place PCC pavement was placed on the current project.

LONGITUDINAL CONSTRUCTION JOINT WITHOUT TIE BARS



T = Pavement Thickness

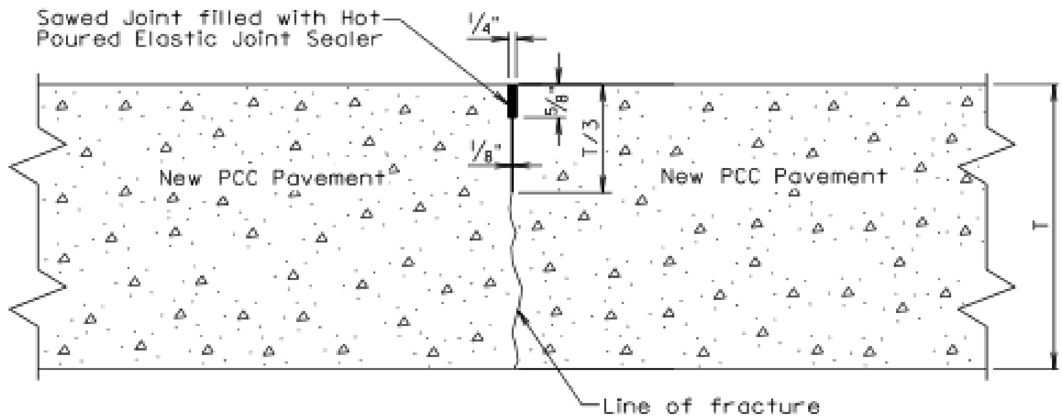
GENERAL NOTE:

The term "In Place PCC Pavement" in the above drawing indicates that the in place PCC pavement was placed on a previous project.

September 14, 2001

Published Date: 3rd Qtr. 2015	**SDDOT**	**PCC PAVEMENT LONGITUDINAL JOINTS WITHOUT TIE BARS**	**PLATE NUMBER** 380.12 / Sheet 1 of 2

SAWED LONGITUDINAL JOINT WITHOUT TIE BARS



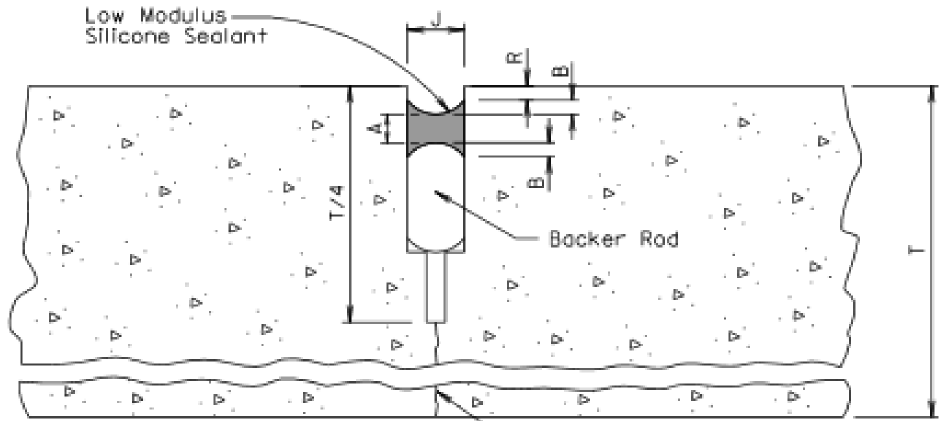
T = Pavement Thickness

GENERAL NOTE:

The first saw cut to control cracking shall be a minimum of 1/3 the thickness of the pavement. Additional sawing for widening the saw cut to provide the width for the installation of the hot poured elastic joint sealer will be necessary.

September 14, 2001

Published Date: 3rd Qtr. 2015	SDDOT	**PCC PAVEMENT LONGITUDINAL JOINTS WITHOUT TIE BARS**	PLATE NUMBER 380.12 Sheet 2 of 2



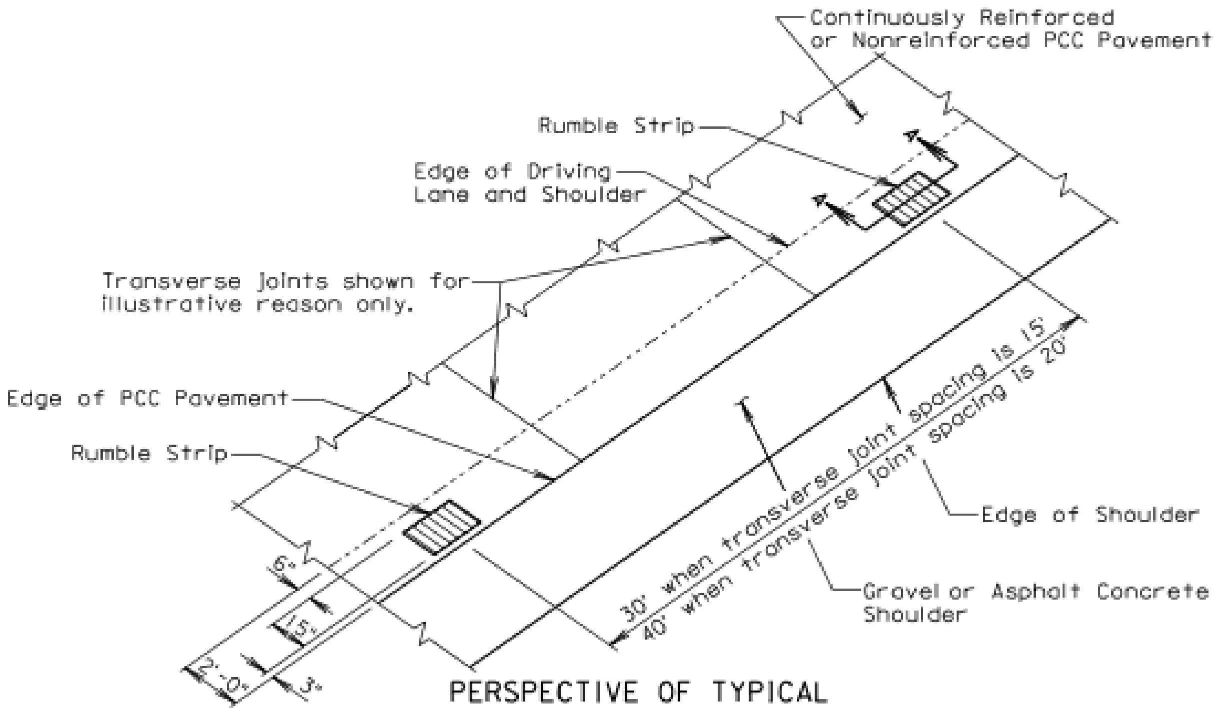
LOW MODULUS SILICONE SEALANT ALLOWABLE CONSTRUCTION TOLERANCES				
J = 3/8"				
A (Min.) (In)	A (Max.) (In)	B (Min.) (In)	B (Max.) (In)	R (In)
3/16	5/16	1/8	1/4	1/4
J = 1/2"				
A (Min.) (In)	A (Max.) (In)	B (Min.) (In)	B (Max.) (In)	R (In)
3/16	3/8	1/8	1/4	1/4
J = 5/8"				
A (Min.) (In)	A (Max.) (In)	B (Min.) (In)	B (Max.) (In)	R (In)
1/4	7/16	1/8	5/16	1/4
J = 3/4"				
A (Min.) (In)	A (Max.) (In)	B (Min.) (In)	B (Max.) (In)	R (In)
5/16	1/2	3/16	3/8	5/16
J = 1"				
A (Min.) (In)	A (Max.) (In)	B (Min.) (In)	B (Max.) (In)	R (In)
3/8	5/8	3/16	1/2	5/16

GENERAL NOTE:

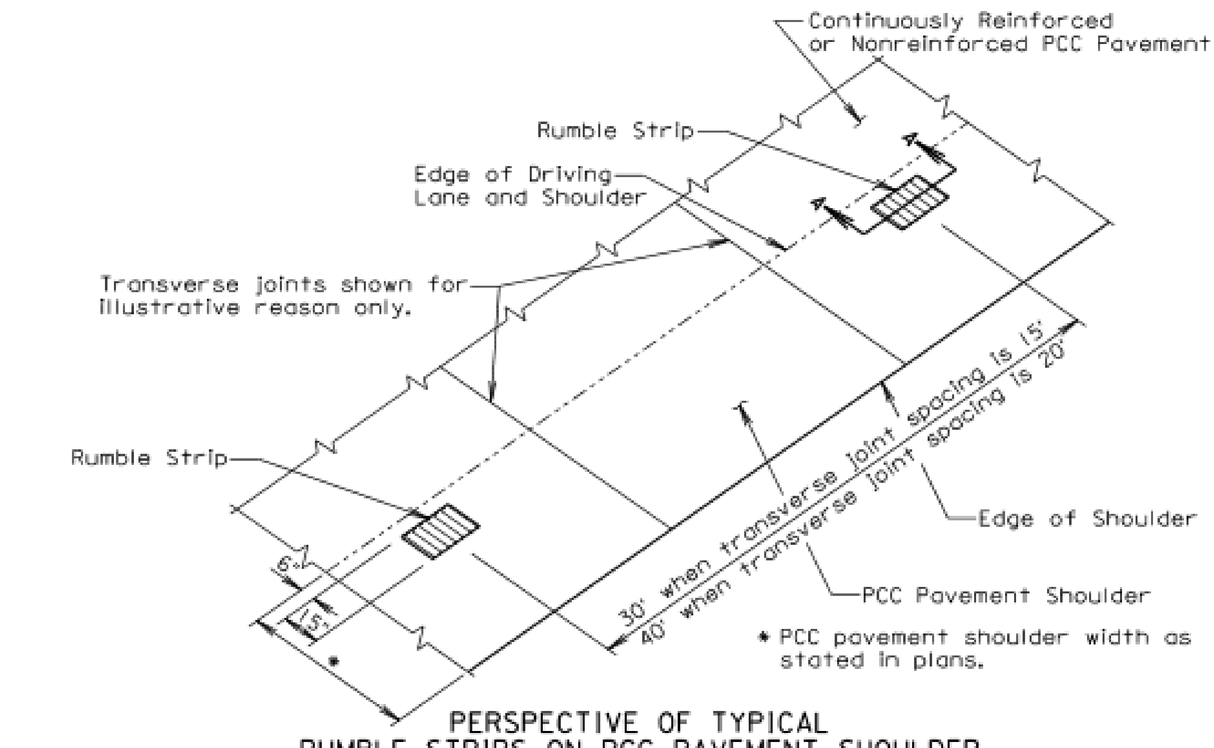
The backer rod shall be a nonmoisture absorbing resilient material approximately 25% larger in diameter than the width of the joint to be sealed.

February 14, 2011

Published Date: 3rd Qtr. 2015	SDDOT	RESEAL PCC PAVEMENT JOINT (SILICONE)	PLATE NUMBER 380.13 / Sheet 1 of 1



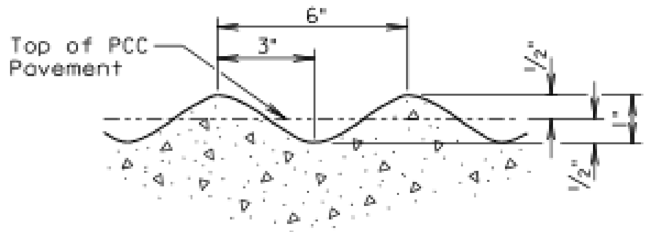
PERSPECTIVE OF TYPICAL
RUMBLE STRIPS ON PCC PAVEMENT SHOULDER
ADJACENT TO GRAVEL OR ASPHALT CONCRETE SHOULDER



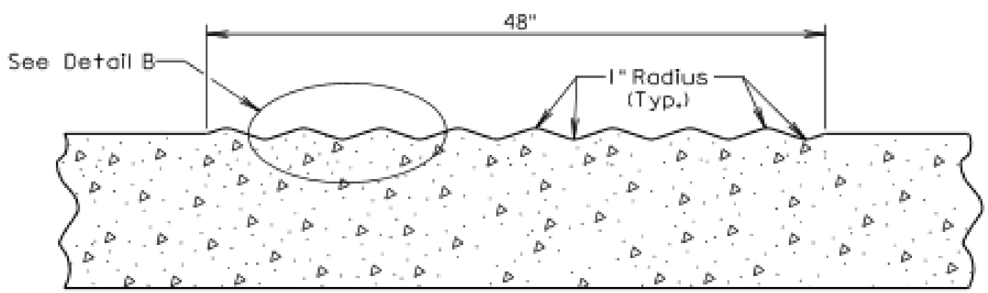
PERSPECTIVE OF TYPICAL
RUMBLE STRIPS ON PCC PAVEMENT SHOULDER

August 31, 2013

Published Date: 3rd Qtr. 2015	SDDOT	RUMBLE STRIP ON PCC PAVEMENT SHOULDER	PLATE NUMBER 380.15 Sheet 1 of 2



DETAIL B



SECTION A-A

GENERAL NOTES:

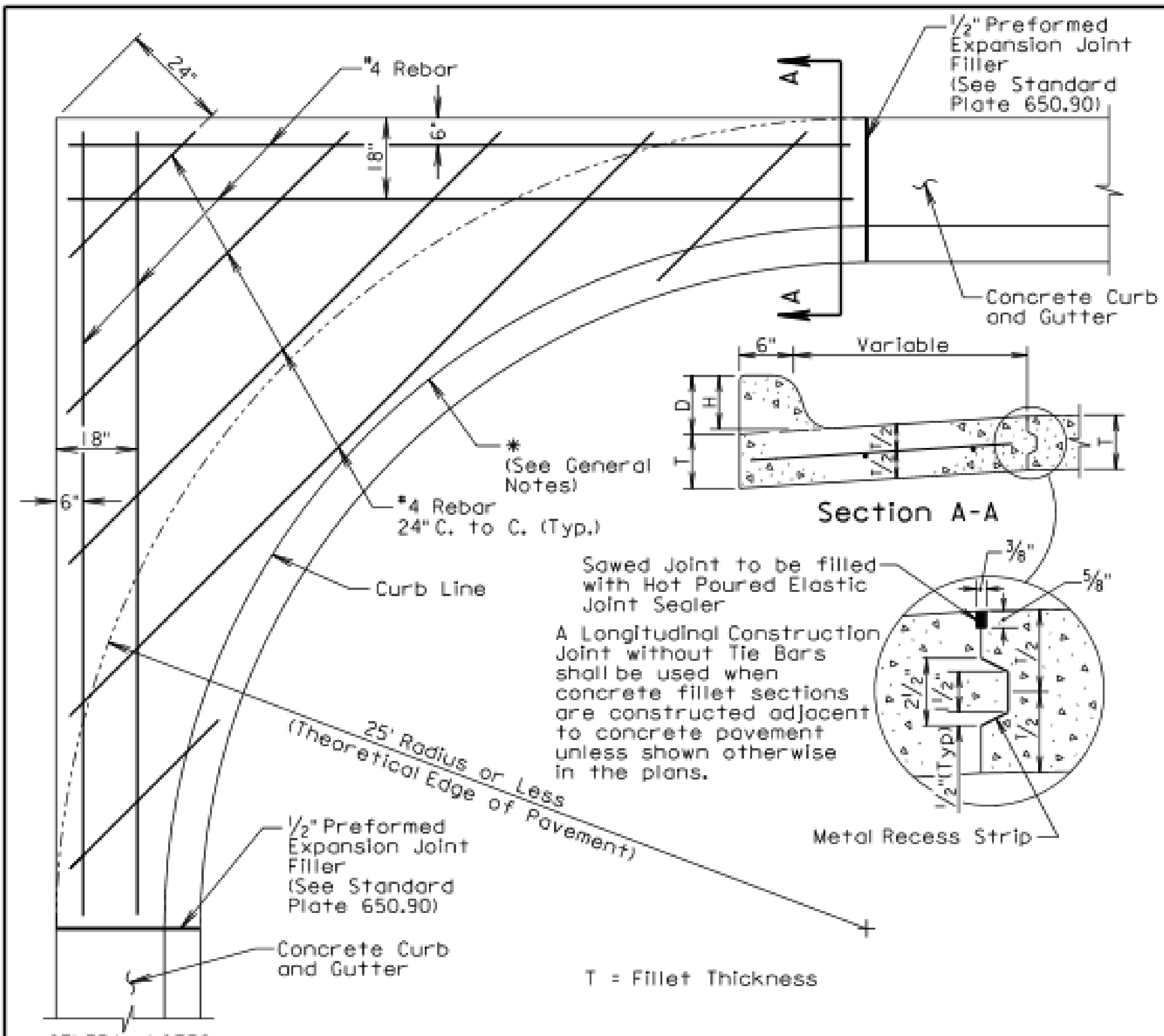
The rumble strips shall be evenly spaced and shall not coincide with any transverse contraction joints.

The rumble strips shall NOT be placed along areas adjacent to entrance ramps, exit ramps, and gore areas.

Payment for constructing the PCC Pavement Rumble Strips shall be incidental to the contract unit price per square yard for the corresponding PCC Pavement bid item.

August 31, 2013

Published Date: 3rd Qtr. 2015	SDDOT	RUMBLE STRIP ON PCC PAVEMENT SHOULDER	PLATE NUMBER 380.15 Sheet 2 of 2



GENERAL NOTES:

* If a curb ramp is constructed adjacent to a PCC fillet section, the curb will need to be modified. Refer to the corresponding curb ramp standard plate or other special details in the plans for modification of the PCC fillet section.

Dimensions D, H, and T shall conform to those shown on the appropriate curb and gutter standard plate.

All rebar shall be in conformance with Sections 480 and 1010 of the Specifications. All rebar shall have a minimum of 3" clear cover.

Class M6 Concrete shall be used in construction of the fillets.

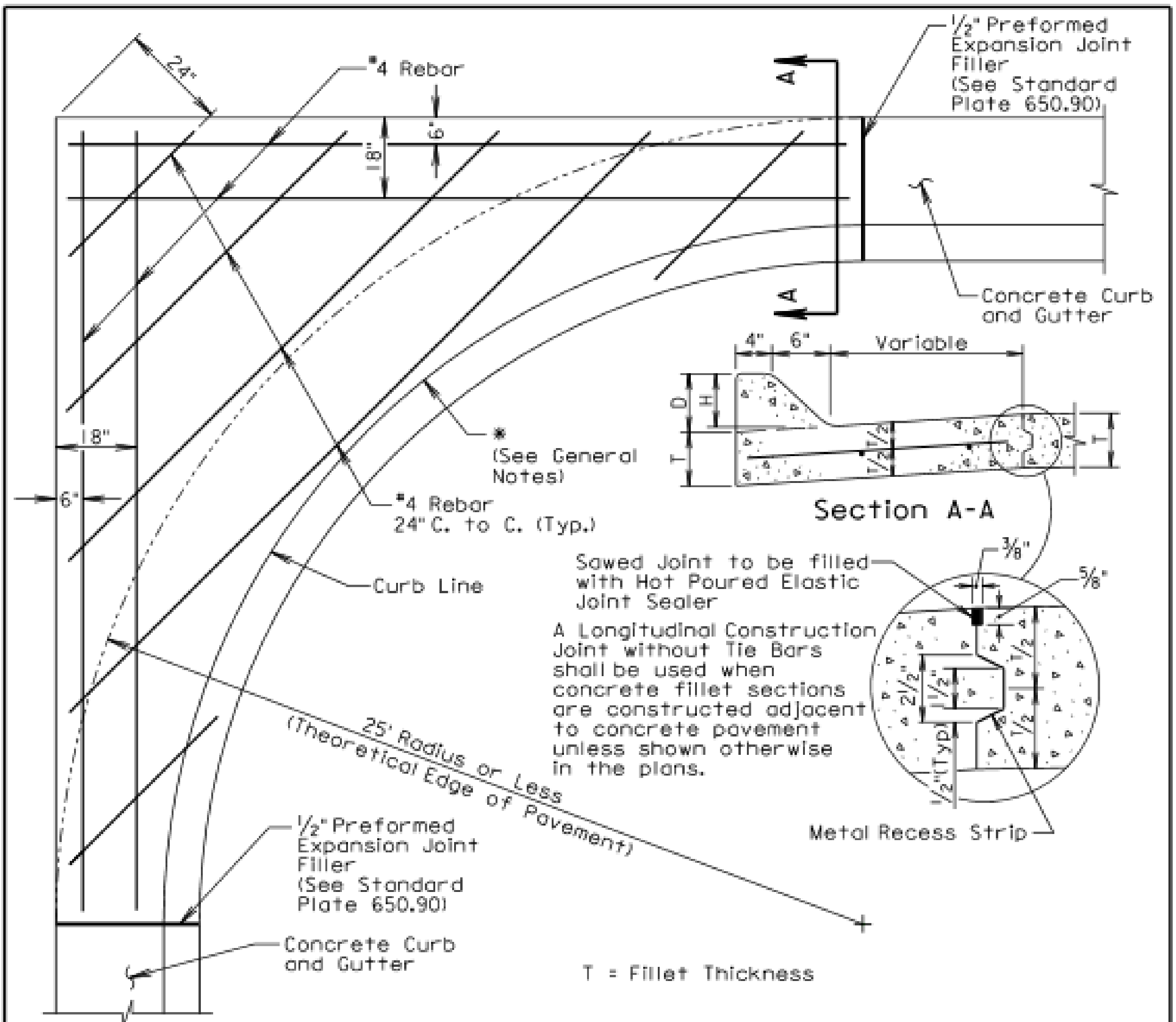
The concrete curb shall be monolithic with the concrete fillet. No separate payment for this curb will be made as the curb is considered a part of the fillet.

Joints shall be constructed at 10' intervals except when fillets are constructed adjacent to PCC Pavement. If there is adjacent PCC Pavement the joints shall be extended from edge of pavement through the fillet section as directed by the Engineer.

The cost for all materials, labor, and incidentals necessary to construct the PCC fillet section with curb and gutter shall be incidental to the contract unit price per square yard for the corresponding PCC fillet section bid item.

June 26, 2015

Published Date: 3rd Qtr. 2015	SDDOT	PCC FILLET SECTION WITH TYPE B CURB AND GUTTER	PLATE NUMBER 380.16 Sheet 1 of 1



GENERAL NOTES:

* If a curb ramp is constructed adjacent to a PCC fillet section, the curb will need to be modified. Refer to the corresponding curb ramp standard plate or other special details in the plans for modification of the PCC fillet section.

Dimensions D, H, and T shall conform to those shown on the appropriate curb and gutter standard plate.

All rebar shall be in conformance with Sections 480 and 1010 of the Specifications. All rebar shall have a minimum of 3" clear cover.

Class M6 Concrete shall be used in construction of the fillets.

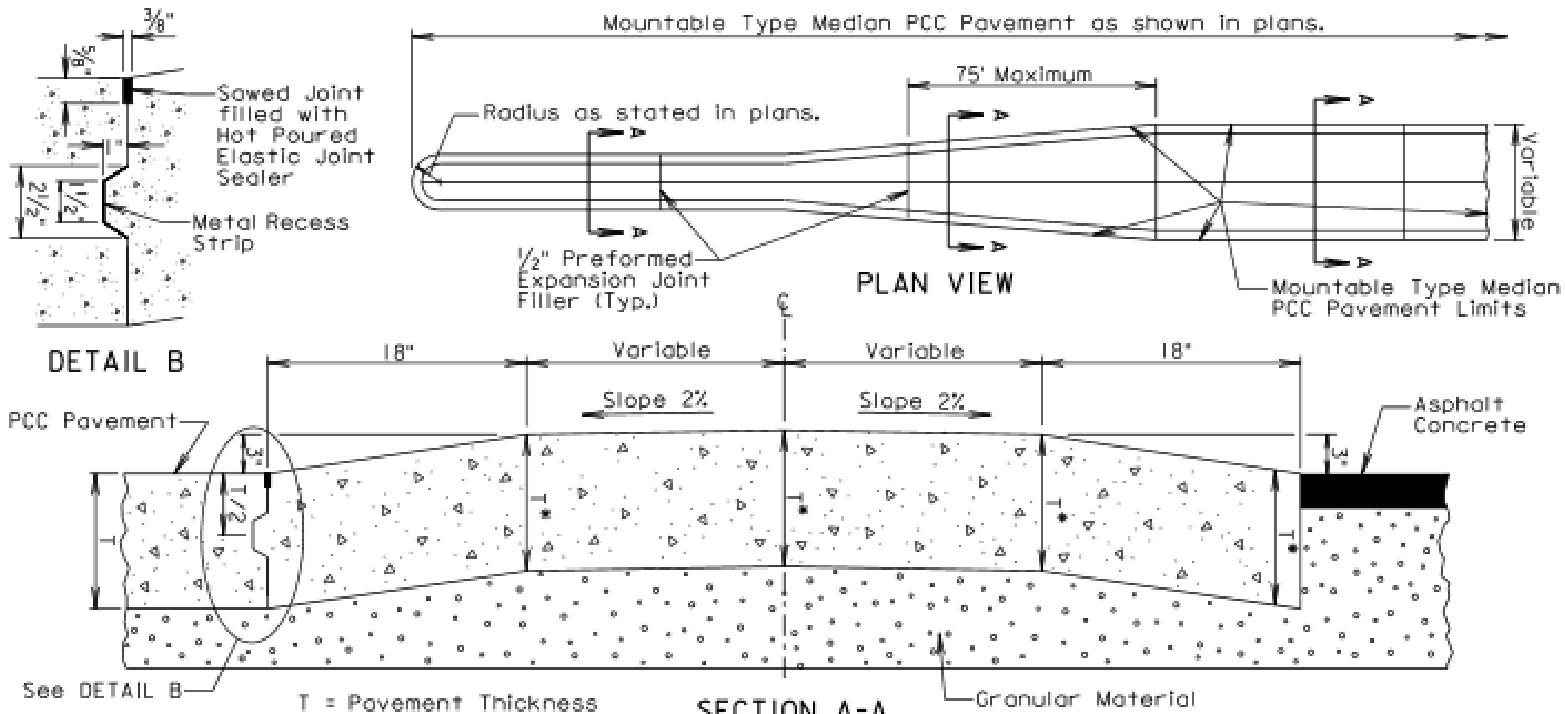
The concrete curb shall be monolithic with the concrete fillet. No separate payment for this curb will be made as the curb is considered a part of the fillet.

Joints shall be constructed at 10' intervals except when fillets are constructed adjacent to PCC Pavement. If there is adjacent PCC Pavement the joints shall be extended from edge of pavement through the fillet section as directed by the Engineer.

The cost for all materials, labor, and incidentals necessary to construct the PCC fillet section with curb and gutter shall be incidental to the contract unit price per square yard for the corresponding PCC fillet section bid item.

June 26, 2015

Published Date: 3rd Qtr. 2015	SDDOT	PCC FILLET SECTION WITH TYPE F CURB AND GUTTER	PLATE NUMBER 380.17 / Sheet 1 of 1



GENERAL NOTES:

This standard plate may also be used for mountable concrete island construction.

* T shall be 8" when mountable type median PCC pavement is placed adjacent to asphalt concrete pavement.

Excavation necessary for construction of the mountable type median PCC pavement and excavation for granular material will be measured and paid for as "Unclassified Excavation".

If PCC pavement is placed adjacent to mountable type PCC pavement, the keyway is optional and is not required. When adjacent PCC pavement is formed and a keyway is provided, a metal recess strip shall be used (See DETAIL B). When adjacent PCC pavement is slip formed, a metal recess strip is not required.

Concrete for mountable type median PCC pavement shall comply with the requirements of the Specifications for Class M6 Concrete. One-half inch expansion joint filler shall be placed transversely in the median PCC pavement at a maximum spacing of 75'. A minimum of one expansion joint shall be placed in areas less than 75' long. Transverse joints shall be sawed to coincide with or at the same spacing of adjacent mainline PCC pavement. Where median PCC pavement is 15' and wider, a longitudinal joint shall be sawed along the centerline of the median PCC pavement. Where median pavement is adjacent to mainline asphalt concrete pavement, transverse joints shall be sawn to create square sections not exceeding 15' or as approved by the Engineer. All joints shall be sawed to a depth of 1/3 the thickness of the median PCC pavement.

All costs for labor, materials, and incidentals necessary for construction of the mountable type median PCC pavement shall be incidental to the contract unit price per square yard for "Mountable Type Median PCC Pavement".

Granular material shall be paid for at the contract unit price for the respective granular material bid item.

June 26, 2015

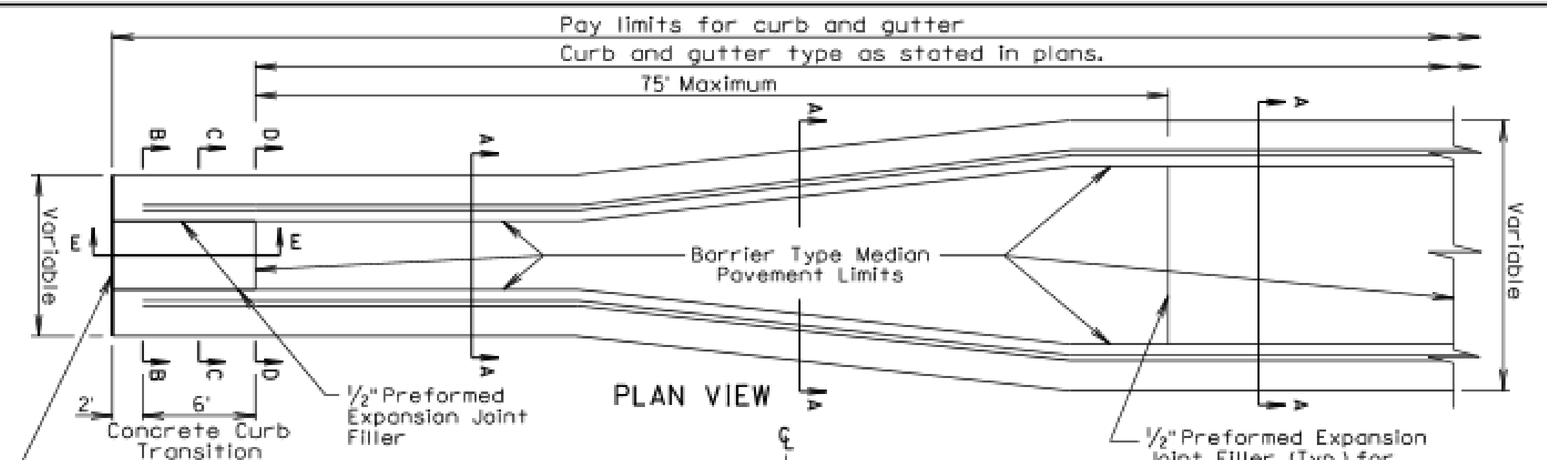
Published Date: 3rd Qtr. 2015

SDDOT

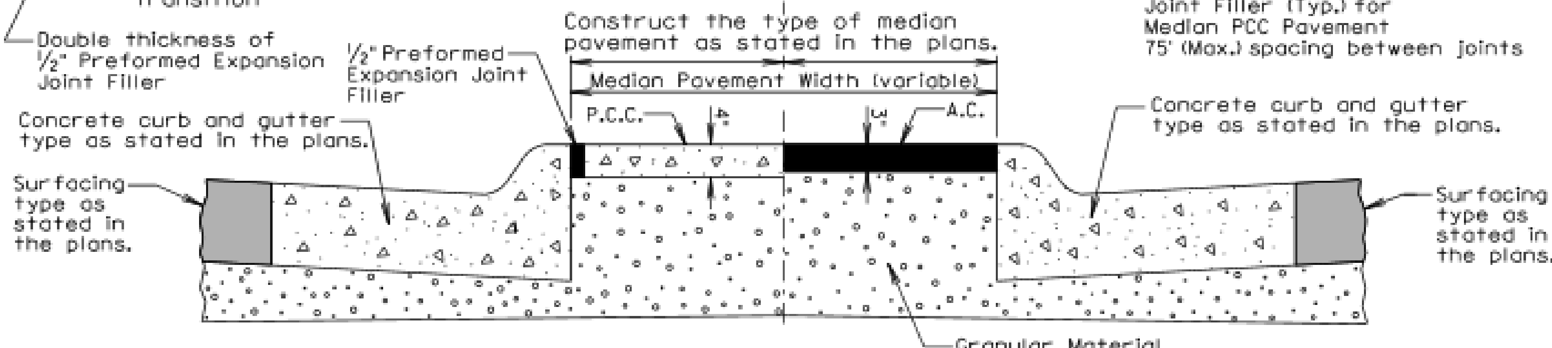
MOUNTABLE TYPE MEDIAN PCC PAVEMENT

PLATE NUMBER 380.21

Sheet 1 of 1



PLAN VIEW



SECTION A-A

GENERAL NOTES:

Necessary excavation for construction of barrier type PCC and asphalt concrete median pavements and excavation for granular material will be measured and paid for as "Unclassified Excavation".

Concrete for barrier type median PCC pavement shall comply with the requirements of the Specifications for Class M6 Concrete. One-half inch expansion joint filler shall be placed transversely in the median PCC pavement at a maximum spacing of 75'. Where median PCC pavement is wider than 8', a longitudinal joint shall be sawed or grooved along the centerline of the median PCC pavement. Where the median PCC pavement is 4' or narrower and at width transitions, contraction joints shall be sawed or grooved at spacings as approved by the Engineer. All other contraction joints shall be sawed in square sections. All joints shall be sawed or grooved to a depth of 1/3 the thickness of the median PCC pavement.

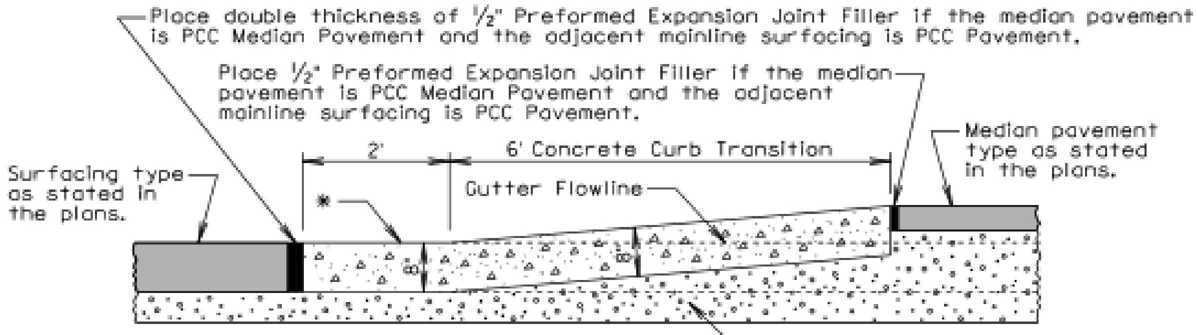
All costs for labor, materials, and incidentals necessary for construction of the barrier type median pavement shall be incidental to the contract unit price per square yard for "Barrier Type Median PCC Pavement" or "Barrier Type Median Asphalt Concrete Pavement".

All costs for labor, materials, and incidentals necessary for construction of the 6' concrete curb transition (See Sections B-B, C-C, and D-D) and the adjacent 8" thick concrete (See Section E-E) shall be incidental to the contract unit price per foot for the corresponding curb and gutter bid item.

Granular material shall be paid for at the contract unit price for the respective granular material bid item.

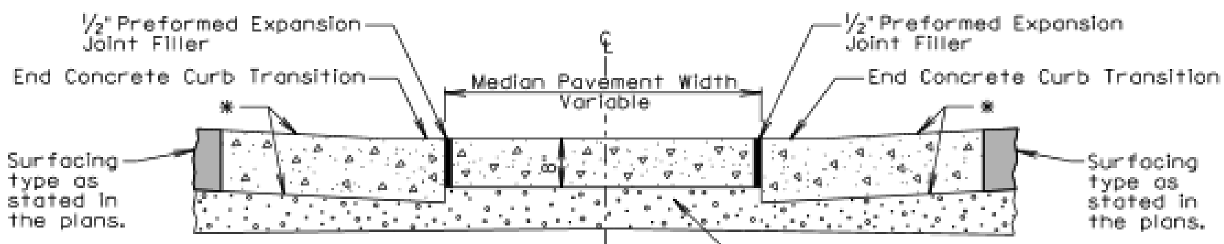
June 26, 2015

Published Date: 3rd Qtr. 2015	**SDDOT**	**BARRIER TYPE MEDIAN PAVEMENT**	*PLATE NUMBER* 380.22 / *Sheet 1 of 2*

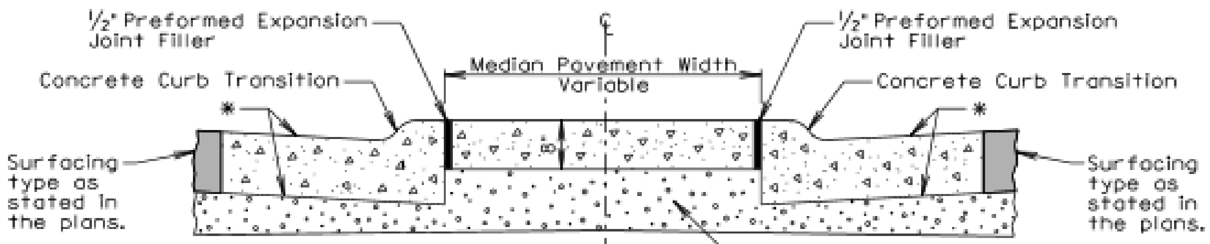


SECTION E-E

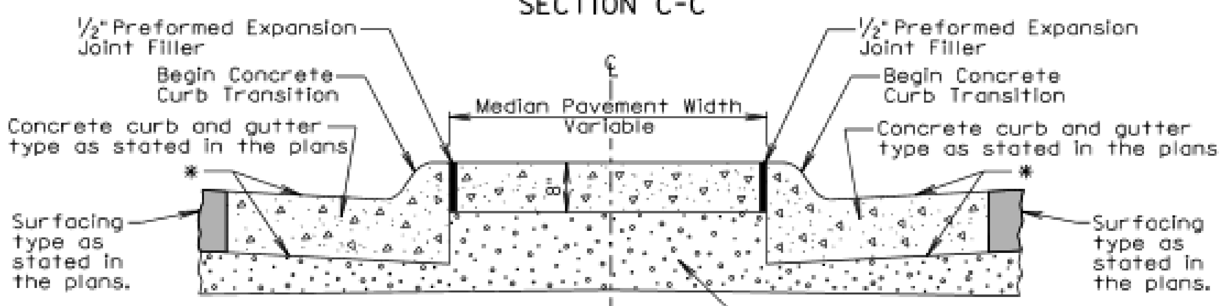
* The slope shall be as shown on the standard plate for the corresponding curb and gutter type, on the typical sections, or on the cross sections. The slope shall be modified when necessary at locations that would hold or pond water as determined by the Engineer.



SECTION B-B



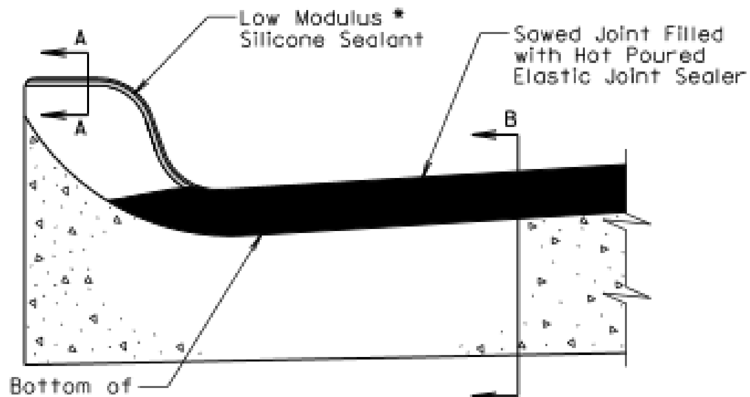
SECTION C-C



SECTION D-D

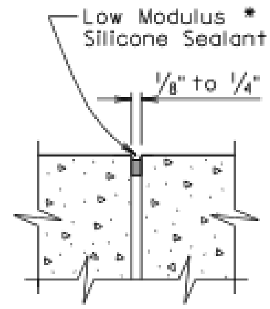
June 26, 2015

Published Date: 3rd Qtr. 2015	SDDOT	**BARRIER TYPE MEDIAN PAVEMENT**	PLATE NUMBER 380.22 Sheet 2 of 2

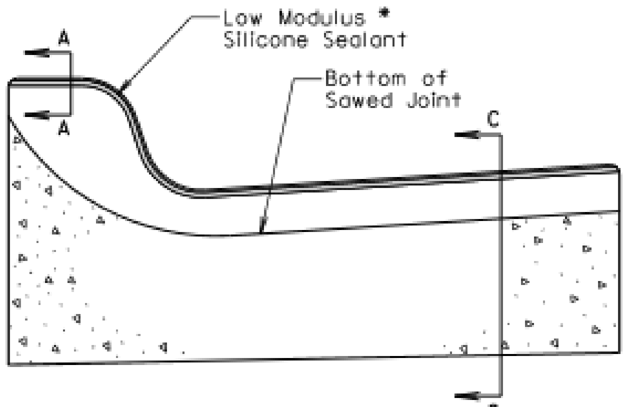


SECTIONAL VIEW

(Curb and Gutter Placed Monolithic with Adjacent Mainline PCC Pavement)

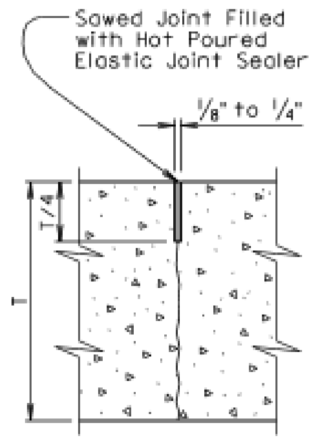


SECTION A-A

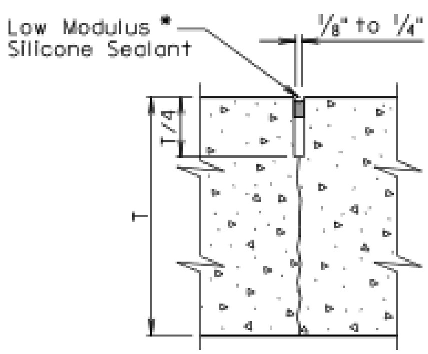


SECTIONAL VIEW

(Curb and Gutter not Placed Monolithic with Adjacent Mainline PCC Pavement or Mainline Surfacing is not PCC Pavement)



SECTION B-B



SECTION C-C

* The silicone sealant shall be placed such that it completely seals the joint and is bonded to the sides of the clean joint as approved by the Engineer.

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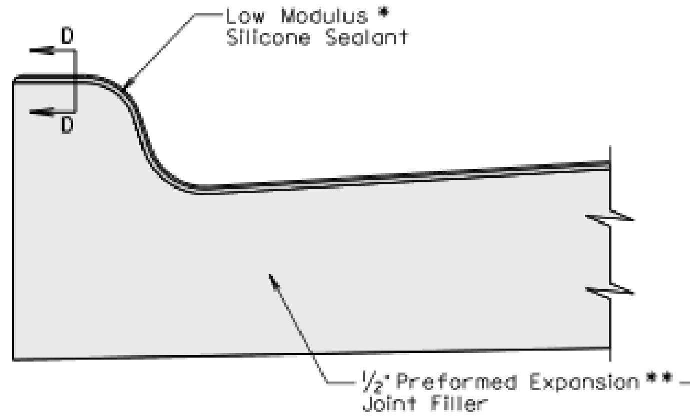
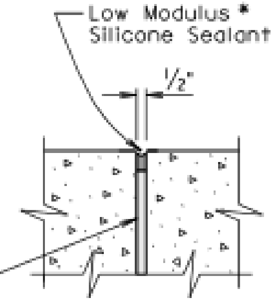


SECTIONAL VIEW
(Curb and Gutter at ½" Preformed Expansion Joint Filler Location)



SECTION D-D

* The silicone sealant shall be placed such that it completely seals the joint and is bonded to the sides of the clean joint as approved by the Engineer.

GENERAL NOTES:

For illustrative reason, only the type B curb and gutter is shown.

** A ½" preformed expansion joint filler shall be placed transversely in the curb and gutter at the following locations:

1. At each junction between the radius return of curb and gutter and curb and gutter which is parallel to the project centerline.
2. At each junction between new curb and gutter and existing curb and gutter.

Transverse contraction joints shall be constructed at 10' intervals in the concrete curb and gutter except when the concrete curb and gutter is constructed adjacent to mainline PCC pavement. When concrete curb and gutter is constructed adjacent to mainline PCC pavement, a transverse contraction joint shall be constructed in the concrete curb and gutter at each mainline PCC pavement transverse contraction joint location.

When concrete curb and gutter is not placed monolithically with the mainline PCC pavement or when the adjacent mainline surfacing is not PCC concrete, the transverse contraction joints in the concrete curb and gutter shall be 1½ inches deep if formed in the fresh concrete using a suitable grooving tool. If a saw is used to cut the contraction joints, then the depth of the joint shall be at least ¼ the thickness of the concrete and the joint shall be sealed in accordance with the details shown above.

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