

401 PORTLAND CEMENT CONCRETE PAVEMENT

401-1 Description

High quality concrete pavement requires characteristics of durability and structural soundness in order to withstand the destructive forces of traffic, changes in moisture, temperature, and variable soil conditions. Current requirements for smoothness are very demanding. To meet these demands, it is necessary to have vigilant inspection of many operations concurrently.

It is essential that only specified materials are used and that the equipment, methods, and procedures are satisfactory in every respect. Resident Engineers (RE) and Inspectors of a concrete paving project have the responsibility of building a paving project that will render many years of service. They are also responsible for many thousands of dollars of complicated work that must be done quickly and right the first time.

The best way to direct attention to the necessary interaction required to achieve quality work is through communication. Before every paving operation, the Resident Engineer is obligated to hold two pre-paving meetings--the first with the Contractor and ADOT project personnel, and the second with his or her own personnel.

The purpose of the first meeting will be to:

1. Review the Contractor's paving plan (see subsection 401-3.01) including discussions on organization, coordination, schedule, traffic control, construction procedures, materials, equipment, and personnel.
2. Reinforce the "ground rules" necessary for an uninterrupted operation.
3. Introduce the Department's inspection team and establish the lines of communication between the Contractor's personnel and the Department.
4. Review safety procedures.

Review of the Contractor's Paving Plan

The minimum requirements for a paving plan include:

1. Paving layout drawing(s) showing the beginning, end, length, width, thickness and area of each paving pass, the areas to be hand poured, and the location of longitudinal, transverse and construction joints (check for conformance with the Project Plans for ultimate pavement width, thickness, location of joints, tapers, and breaks, as well as ensure hand pours are only called for in areas inaccessible to the paving machine);
2. Bar chart schedule showing when each pass will be poured, cure times, expected production rates, and days and hours of operations (check the realism of this schedule based on crew size, equipment production rates, temperature specifications, allowable cure times, haul rates, batching capacity, and traffic control requirements);
3. List of proposed equipment including manufacturer's operational specifications on key pieces of equipment such as the paving machine, vibrators, and finishing equipment (check to ensure the Contractor uses the correct type of equipment called out in the specifications, ensure the Contractor is operating equipment within the limits specified by the manufacturer, and that the equipment meets

- any ADOT performance specifications, as well as have an Inspector check the condition of the equipment);
4. Discussion on stockpiling and batching procedures, including storage of aggregate to prevent contamination, how aggregate moisture will be monitored, batching procedures, mixing times, and control of water so that a concrete mix is as consistent as possible while still meeting the specifications. Identify who will be the Contractor's representative authorized to make adjustments to the mix. A plan needs to be in place for handling rejected concrete (for example; not meeting the target range for slump, or temperature. Check to ensure the Contractor can produce consistent, high quality concrete to the Department's satisfactions; order trial batches if you're unsure;
 5. Specifications on proposed concrete hauling equipment and the expected haul route (check to ensure hauling equipment will not segregate or otherwise adversely affect the mix, consider traffic control requirements (flaggers, signing, etc.), legal load limits, and haul and cycle times);
 6. Staging plan showing how the paving will be accomplished while maintaining traffic through the project. This is sometimes integrated into the traffic control plans or paving layout drawings and requires careful attention on both the Contractor's part and ADOT's inspection staff so that traffic disruptions are kept to a minimum (check the project traffic control plans and construction phasing diagrams for conformance);
 7. Traffic control plan conforming to subsection 701-1 showing how the work will be safely separated from traffic including ingress and egress points as well as protection of the concrete during curing (it is important that the work and traffic are clearly separated and that entrance and exits are well delineated and do not confuse motorists);
 8. Discussion on the timing and curing methods to be used (check subsections 401-3.04 (F) & (G) for conformance);
 9. Discussion on sawing and sealing procedures including how joints will be located, what equipment will be used, when the joints will be cut, cleaned and sealed, and the manufacturer's installation requirements for the sealant (check subsections 401-3.05 & 3.06 for conformance);
 10. Detailed staking plan showing the spacing and offset subgrade control stakes and the methods used for setting the wire line and verifying its accuracy before paving (should conform to generally accepted survey and PCCP procedures.

The Department is not expecting the Contractor to produce a large, bound report. As a minimum, the Contractor needs to submit layout and staging drawings, traffic control plans, a schedule, and several pages of narration on covering stockpiling, batching, hauling, placing, finishing, curing, sawing, sealing, staking, and any other special areas of which you may want additional information. Information on equipment can be attached to the submittal. The pre-paving conference is used to review and clarify the paving plan to the extent that you understand it, and to prevent an endless cycle of re-submittals.

The Ground Rules Necessary for Uninterrupted Paving

It should be very clear to the Contractor what circumstances would lead the Department to not allow a paving operation to begin, or halting a paving operation in progress. A PCCP paving operation is a very expensive undertaking involving many pieces of equipment and increase in labor. Shutting down or suspending these operations often creates disputes between the Contractor and the Department's field personnel. One of the

objectives of the pre-paving meeting is to avoid such a circumstance. The review of the paving plan is a good start, but you need to let the Contractor know what malfunctions in the paving operation could lead to a shut down.

There is no set of rules that outline when to halt or suspend the Contractor's paving operation. Base your decision on the particular circumstances and the ability of the Contractor to quickly rectify the problem. However, it is best for the Resident Engineer and the Contractor to create a list of "red flags" that could affect the quality of PCCP and discuss the list with the paving crew and the inspection staff. The list could cover such things as out-of-spec materials, target values, changes in plan by the Contractor that conflict with his or her proposed procedure, equipment that doesn't perform, emergency vehicles, weather, safety, insufficient lighting, traffic, and changes to such operations as finishing, sawing, and previously encountered problems. It's better to have these discussions in a meeting room than in front of a \$2,000 per hour paving operation.

The importance of this pre-paving meeting with the Contractor cannot be over emphasized. The aim must be to sit down with the Contractor's crew and obligate them to explain their plan to your satisfaction. In effect, ADOT and the Contractor are building the pavement on paper. This should be the forum where you talk about problems, and expectations for the Contractor's paving operation. There should be complete agreement on methods, materials, workmanship, and equipment before concrete is placed. The Department wants no "surprises" out on the grade. Talk about the details. The meeting should be a discussion of any potential problems suspected by the Inspectors, and any solutions proposed by the Contractor.

Introducing the Department's Inspection Crew

Historically, the Department's paving inspection team has worked very closely with the Contractor's paving crews. The intensity of the work, as well as the unusual working conditions, requires teamwork by ADOT and the Contractor. The pre-paving meeting should also serve as an introduction of the key personnel on both sides. It is important to highlight the duties and responsibilities of each member, as well as establish the lines of authority on various issues. You may want to establish goals for the paving team and articulate how each member's duties will contribute to achieving these goals. It is important that each member of the team meets the other members and has an idea of their duties and expected actions.

The second meeting (with ADOT personnel) covers responsibility, assignments, and contingency plans. It is important to clearly describe the expectations, assignment, and schedule for each inspection role.

Operations that require inspection include:

- subgrade trimming and approval,
- wire line checking and grade stabbing,
- base material placement,
- batching and stockpile operations,
- paving,
- tining and curing,
- initial saw cutting,
- profilograph measurements,
- grinding,
- construction joint preparation,
- sawing and sealing, and
- core layout and coring.

The Resident Engineer and Project Supervisor have flexibility in how they assign Inspectors to each of these operations. The goal, however, is to ensure each operation is adequately inspected so that the Contractor is complying properly with the specifications. Lines of authority should be established as well as an issue escalation procedure that can be utilized by both the Inspectors and the Contractor. Scheduling and shift staggering should be discussed, as well as who will pickup cylinders on non-work days.

Paving operations run the smoothest when decisions are made at the lowest possible level and Inspectors are empowered to make those decisions. Their ability to make well-informed, timely decisions is based on their level of training and experience in PCCP. More importantly, their effectiveness as empowered decision makers depends largely on how clearly the Resident Engineer and Project Supervisor have communicated what corrective actions may be taken when the Contractor's work does not meet the specifications. Documentation and equipment requirements and issues should also be discussed

Paving Book

Maintaining a paving book is an excellent method of documentation. This not only provides a history of the project, but more importantly, it assists quality control. The following items should be periodically checked and documented to assure a quality pavement.

- Thickness
- Edge slump
- Offset distance
- Tining depth
- Vibrator frequency
- Cure application rate
- Rebar placement
- Air temperature
- Remarks as needed

Most items listed above should be measured and entered into the paving book every 50 to 100 feet (15 to 30 meters) so corrective action can be taken immediately.

401-2 Materials

Concrete

The details for batching, hauling, and mixing materials for Portland cement concrete used in concrete pavements will be discussed in Section 1006 of this manual and the applicable portions of Section 401-3.

One of the most important requirements for obtaining a smooth and durable concrete pavement is maintaining a uniform slump in the concrete mix. The optimum slump for fixed form pavement is usually about 3 to 4 inches (75 mm to 100 mm). For the slip-form method of paving, the optimum slump is usually 1 inch (25 mm). Dry batches cause high spots and surface tearing which cannot be corrected by the necessary hand finishing. Batches which have slumps appreciably higher than the optimum will result in excessive shrinkage and low spots in the pavement.

In order to obtain the necessary slump uniformity, it is essential that there be good control of aggregate grading, moisture content, proportioning of all ingredients, mixing, and frequent testing of the fresh concrete. The Inspector at the batch plant must be alert to see that the gradation and moisture content of the

aggregates, particularly the sand, does not vary without making compensating adjustments.

Subsection 1006-4.02 (C) of the Standard Specifications requires that variations of moisture in the aggregate shall not exceed 3% during any day's concrete production. In order to meet this requirement, it is essential that the sand be inspected for moisture content as it is brought from the washing plant. It may be necessary to delay mixing operations until the entire stockpile reaches a stable moisture content. If the Contractor does not maintain sufficiently large stockpiles to assure uniformity of moisture in them, the Resident Engineer may suspend mixing operations until the necessary uniformity is reached and can be maintained. Uniformity in concrete consistency cannot be maintained unless there is uniform moisture in the aggregate from batch to batch. The importance of moisture control at the plant should be discussed at the pre-paving conference. This is especially important when the concrete is furnished by an independent material supplier.

Commercial plants present problems in the control of aggregate moisture. Aggregates from several sources, as well as the lack of time these stockpiled aggregates have to reach a uniform moisture, are the major contributors to poor moisture control at commercial plants. The problems should be thoroughly discussed and solutions arrived at before the paving is started.

Continual emphasis must be made to stress the importance of not adding water to the concrete after mixing, except by the fog spraying method when conditions are particularly hot or windy. Inspectors should closely monitor concrete temperatures during hot and cold weather for compliance with the specifications. During hot weather, concrete temperatures will run at or near the specified limit. It is important for Inspectors not to allow the concrete temperature to exceed its specified limit. Hot concrete is susceptible to shrinkage cracking which directly affects durability and longevity of concrete pavement.

There are two strength requirements called out in the Standard Specifications. A compressive strength of 3000 psi (20 MPa) must be attained before traffic is allowed on the pavement (including construction traffic), and a strength requirement for acceptance based on the minimum 28-day design strength of 4000 psi (30 MPa). The strength requirement for acceptance is determined statistically by sampling and testing per subsection 1006-7, then calculating the Lower Quality Index (QL), the Percent of lot Within Limits (PWL), and the Pay Factor per subsection 401-6. The Pay Factor will determine if the concrete lot will be accepted, or rejected, or allowed to remain in place at a reduced price in accordance with Standard Specification table 401-3. Pay Factors for thickness and compressive strength are applied separately and totaled to determine a total pay factor for each lot. Any lot with a total Pay Factor less than minus \$5.00 will be rejected. Unit price adjustments for pavement smoothness, and cracked pavement slabs which require repair may also be required, but they are not included in the Total Pay Factor calculation for compressive strength and thickness. Approval to leave rejected pavement in place shall be reviewed with the District Engineer and ADOT's Materials Group, Pavement Design Section.

Unless otherwise approved by the Engineer, traffic is not allowed on the pavement before these three conditions have been met (see subsection 401-3.07):

- 7 calendar days of cure time;
- all joints have been sawed and sealed; and
- the concrete strength has reached a minimum of 3000 psi (20 MPa).

Joint Filler and Sealant

The [Approved Products List](#) has a list of accepted filler (backer rod) and sealant materials. The Material Laboratory Supervisor can find out if the Contractor's filler and sealant have been preapproved. If not, samples will have to be taken and tested prior to the use of these materials on the project.

Certificates of Compliance are required for these materials. Materials that were not preapproved must be sampled as specified in the ADOT Materials Testing Manual.

Tie Bars and Dowels

These are short pieces of steel bars that are used for the various types of joints. The type and spacing will be shown on either the Project Plans or in the Standard Drawings. These bars shall be accompanied by certificates of compliance.

When the bid schedule, or plans include "Load Transfer Dowel Assembly" then see the Special Provisions for additional requirements.

When epoxy coated dowels are used, a certificate of compliance for the coating is required. Random samples shall also be taken for checking coating thickness in accordance with subsection 1003-5. The powdered epoxy resins are preapproved material and must be the on the [Approved Products List](#) maintained by the Arizona Transportation Research Center.

Curing Compound

This may be a preapproved material and if so, all the barrels will be "green tagged" by ADOT Materials Group. Materials that were not preapproved must be sampled per lot and submitted to Central Lab for testing prior to use. Certificates of compliance shall accompany the material whether preapproved, or not.

401-3 Construction Requirements

Prior to paving, the Contractor is required to submit a paving plan, which will be reviewed and approved by the Resident Engineer. Section 401-1 of this manual establishes the guidelines for accepting a paving plan.

All mainline PCCP paving shall be done by the slip-form paving method with ramps and irregular areas done by either slip-form or fixed form methods. Crossroads may be done by fixed form methods.

The Department has allowed the fixed form methods for mainline paving on short, narrow, isolated stretches of pavement no more than 300 feet (100 meters) long. The width would depend on the type of screed used: rolling and Texas (vibratory) screeds are limited to a maximum of 18 feet (6 meters), while Bidwells are usually allowed to run up to the same width as slip-form pavers. The Contractor must still meet the smoothness specifications regardless of the equipment used.

Subsections 401-3.04 and 1006-5 of the Standard Specifications describe the weather limitations under which PCCP may be placed. When hot, cold, or rainy weather is anticipated, the Resident and Project Supervisor should discuss the requirements with the Contractor and schedule the paving operation accordingly.

401-3.02 Pavement Base

The first requirement of an acceptable and successful concrete pavement is a well-prepared, stable, and adequately compacted base and subgrade.

Grading of the base should be a primary concern to the Contractor because the base has a significant effect on the thickness pay factor.

The base may be subgrade, aggregate base, lean concrete base, cement treated base, or bituminous treated base. Normally only a well graded, well-compacted, granular base is required; however, certain conditions may require a treated stabilized base in order to provide additional load support capacity.

Keeping the base or subgrade moist is important because a dry base will pull moisture from the fresh concrete. This causes the same shrinkage problems as does rapid surface moisture loss. Subsection 401-3.02 requires the surface to be uniformly moistened immediately prior to placing concrete when the ambient temperature is greater than 85°F (29°C).

Before any base material is placed, the entire subgrade should be proof rolled with heavy, rubber tired equipment such as a loaded water truck or dump truck. The Inspector should observe for any soft spots in the subgrade. Corrective actions should include removing any soft or wet subgrade material and replacing it with an approved aggregate base (see subsections 203-3.03(D), 305-3.01, and 304-3.01 of the Standard Specifications). Any backfilling of trenches that has been necessary in the preparation of the subgrade should also be proof-rolled and corrected before pavement is placed.

Expansive clays are potentially damaging to any pavement and especially to concrete pavement since they may cause serious pavement distortion and poor riding qualities. If any subgrade soils are encountered which are suspected of being of this type, samples should be promptly submitted to the ADOT Materials Group for tests. Corrective measures will depend on the results of tests, the extent and the location of the expansive material with respect to subgrade elevation, and other factors. If corrective measures are needed, it may become a design problem at which time the ADOT Materials Group will provide recommendations.

It has become common practice among paving Contractors to use automatic grading machines in the preparation of bases for concrete pavement principally because they facilitate finishing to very close tolerances in a minimum of time. These machines can do excellent work when they are in good mechanical condition and are properly operated.

401-3.04 Placing and Finishing

Paving trains are made up of several units of equipment having gears, hydraulic systems, fuel lines, and water systems--all of which can leak or malfunction. Leaking equipment should not be allowed to continue operating since it is harmful to the pavement.

(B) Slip-Form Method

The slip-form method of concrete paving involves spreading, consolidating, and finishing concrete pavement with a self-propelled machine on which short sections of side forms are attached. The machine operates on a previously prepared base. The surface grade is controlled by means of a tightly stretched guide wire. The equipment consists of a slip-form paving machine, texturing devices, curing machinery, and hand tools. A diagonal pipe float has been used on some slip-form paving projects for additional smoothness of surface.

The paving machine is self-propelled and equipped with:

- a crawler track assemblies which are outside the pavement section;
- a device for regulating the amount of fresh concrete fed to the primary screed (which may be an initial strike off blade or a distribution hopper);
- a system for vibration of the concrete;
- a screed system (which may be a pan, belt, auger, or other devices); and
- short lengths of side forms for each edge which hold the edge vertical for a short time and move

forward with the paver.

The function of the slip-form paver is to receive freshly mixed concrete, spread it to the required width and thickness, consolidate it by vibration, screed or float it to the proper cross section and profile, and final finish all in one operation.

Slip-form machines must be stable to prevent deviation from line and grade. The form faces must be in good condition to minimize dragging and displacement of the concrete. The slip-form must be long enough to provide support until the concrete edge can stand behind the trailing form end.

It is very important that the Resident Engineer and Inspectors become familiar with the equipment being utilized. Care must be taken to ensure that the equipment is assembled according to the manufacturer's recommendations and is operated accordingly. Key requirements to assure proper assembly and preparation include:

1. Assuring the main pan is flat from side to side. Check it with a straight edge or string line. Several adjustments may be necessary, and this is where manufacturer's recommendations and instructions are important.
2. The tamper bars should be adjusted so that they are in the lowest position, with the bottom of the tamper bar even with the bottom of the main pan.
3. Adjust vibrators up or down so that the tip of the vibrator is centered in the thickness of the concrete slab. If placing over steel mesh or dowels, it may be necessary to position the vibrators above center. The vibrators should be positioned at a maximum of 24 inches (600 mm) on center. The vibrators shall be checked to verify they operate at a minimum of 8,000 impulses per minute.
4. When adjusting the machine to line, the frame should be parallel to the string line guide.

The specification tolerances for edge alignment and edge slump should be carefully checked and adhered to at the beginning of the paving operation.

When automatically controlled slip-form paving is used, the guide wires are the grade control of the pavement surface, similar to the form edges in fixed form paving. The pavement surface cannot be any smoother than the degree of accuracy in the installation of the control wire. The setting of accurate control grades and the care in installation of the wires from these grades is of utmost importance.

The wires should be carefully checked against the survey stakes for alignment and grade. They should be firmly held in the brackets, free from kinks and bends, and they should be uniformly taut to avoid sags between supports. A final visual check and adjustment of the wire should be made immediately before paving operations are allowed to begin. The wires should also be checked occasionally throughout the paving operations because they are easily disturbed by workers.

After the wires have been checked, ADOT Inspectors and the Contractor's field staff should "stab" the grade. This involves running a string line across the grade to each wire line and then measuring the height of the string line above the grade. The measurement shall be recorded in a field book. The grade stabbing serves as final check on the wire line placement so that the correct concrete thickness is obtained.

The wire line should be clearly delineated by the Contractor by means of ribbon or tape. The line is not only a tripping hazard but can be run over by heavy equipment and other construction traffic.

Paving

The slip-forming operation should be smooth and continuous. The Department does not allow frequent stopping and starting of the paver—this directly affects the pavement smoothness. Often an insufficient number of delivery trucks or recurring problems with the batch plant are the trouble. In the past the Department has let the operation continue until the end of the shift, but after a few occurrences, the Contractor has not been allowed to start a paving shift until assurances were given to the Inspectors of a smooth continuous operation with the paver maintaining a constant speed.

Slip-form machines are equipped to receive concrete either in a hopper or on the grade immediately ahead of the paver. When the hopper method is employed, care must be taken to deposit the concrete without causing sudden shock loads or unbalancing of the paving machine.

When concrete is placed upon the grade in advance of the slip-form paver, the pattern of distribution becomes very important. Pavers that receive concrete in this manner are normally equipped with augers. The action of the strike-off device is under the control of the operator. It is important that adequate material be maintained ahead of the paver at all times. The Contractor should maintain an even distribution (or uniform head) of the concrete during placement. An even push across the width of the paver is the desired outcome. Mounding of the concrete in one area should be avoided since this tends to twist and surge the paver as it tries to push through the mound. Backing up the paver to correct grade deficiencies can usually be done but should be avoided if possible.

Non-agitating trucks are often used to deliver the concrete. Cleanliness and good repair are very important since caked concrete, bends, dents, roughness, cracks, and other imperfections can cause segregation. Insist that the load containers are kept clean and in a smooth, well repaired condition. Good coordination is needed when non-agitating trucks are used since only 45 minutes are allowed to dump the concrete once the cement is added.

Consolidation of concrete in slip-form paving is accomplished by spud vibrators mounted on the rear of the paver. They are spaced up to 24 inches (600 mm) apart and in such a manner that the concrete will be vibrated full depth and width. On some equipment, the lowest point of the vibrators will be near the top of the concrete (to prevent tearing). The efficiency of each spud should be observed by the Inspector, at least each hour during operation.

Vibrator failure is immediately evident by observing lack of vibration waves in the fresh concrete around the spud. The frequency can be checked with a frequency indicator. Amplitude is variable and can be adjusted to fit the speed of the paver which is directly related to the consistency of the concrete. Under no conditions should the frequency of the vibrators be lowered below the minimum allowed by the specifications.

Checking the efficiency of each spud is important. Serious consequences have resulted from malfunctioning of one spud. Experience indicates that spud motors fail frequently. Spares should be kept on the project site at all times to avoid interruptions in the paving. The Department has shut down paving operations because the failure of a single vibrator with the Contractor having no spares. Vibration of the concrete must cease at the instant that forward movement of the paver ceases.

The Project Supervisor should be alert to paving operations that may damage existing or newly placed concrete pavements. This includes:

- driving equipment over freshly placed concrete,

- placing heavy equipment on concrete too weak to carry the weight,
- dropping materials or equipment on the pavement, and
- running equipment over the pavement that gouges or scars the surface.

The last item usually involves dragging the pan of the paver over a previously placed section of pavement. Regardless of the cause, it is the Department's policy not to accept scoured, indented, or cracked pavement (see Subsection 108.07). Patching is usually not an acceptable alternative since patched pavement becomes a long-term maintenance problem.

When the Contractor's operations damage existing pavements, the procedure to be followed involves full depth removal and replacement of the damaged areas to the nearest transverse joints. See subsection 401-4.03 for help in evaluating pavement cracks. In some case entire slabs have been removed to the nearest longitudinal joint. In other cases, where the damage is near the edge, only a 1-foot (0.3 meter) strip of pavement has been removed similar to an edge slump correction and poured with the adjacent pass.

During placement, the Inspectors should be periodically checking edge slump, pavement thickness (both at the ends and in the center of the slab), straight edge tolerance, and concrete slump. All measurements shall be recorded in field books set up specifically for the paving operation.

The placement of concrete at a construction joint is particularly critical. Care must taken to ensure that only the best concrete is used at the joint.

Finishing

The primary screed is rigidly attached to the frame of the paver. It gives the top surface of the pavement its shape and preliminary finish. The finish is completed by a secondary transverse ironing screed or oscillating belt, sometimes followed by a free-floating smoothing float. Very little hand finishing is necessary if the slump of the concrete remains constant and the paving operation runs at a smooth, steady pace.

Mechanical equipment is specified for finishing because its consistency and uniformity is superior to hand finishing when all the equipment is operating properly. If handwork is needed to supplement or replace the machine work, the operation should be stopped so that replacement, repairs, or adjustments can be made, and machine finishing resumed. Hand finishing should be necessary only beyond the limits of the machine capabilities and for minor touch up. Excessive hand finishing, particularly at the edge, is grounds for ADOT Inspectors to halt any further PCCP placement after the end of that shift. The Contractor must be able to slip-form concrete without having to continuously hand finish the edge and other areas. Continuous hand finishing weakens the concrete surface.

Pipe Float

A pipe float is used with some pavers but is not required by the specifications.

The pipe float consists of an aluminum pipe 6 to 10 inches (150 mm to 250 mm) in diameter and of sufficient length to span the full width of the pavement when oriented at approximately 60 degrees to the centerline. It may be towed forward and backward over the pavement either by a self-propelled carriage running on rubber tire wheels alongside each edge of the pavement, or it may be towed by two workmen, one on each side of the pavement.

If the pipe float is the type which is towed by workmen, the towing ropes should be long enough that there is not the slightest vertical movement of the pipe--only a smooth horizontal movement. When not in use, the pipe

should rest on the bridges spanning the pavement. Resting the pipe on the fresh concrete surface creates a depression when it settles.

The function of the pipe float is to cut off small bumps and fill small depressions with grout. Because of its light weight, it cannot cut off large bumps. It is sometimes desirable to insert uniform weight (such as rebar or pipe) inside the pipe for additional weight.

If there are isolated areas of considerable size where the pavement is low (which may be evident after one or two passes of the pipe float), the Contractor must place a sufficient amount of fresh concrete into these areas, rather than to build them up with excessive thickness of mortar. It is also sometimes desirable to spray a fine mist of water on the pavement surface to prevent tearing by the float. This should be done only with the Resident Engineer's approval. The amount of water applied should never be more than that necessary for efficient functioning of the floating operation since any water applied to the surface tends to reduce the strength and scaling resistance of the surface mortar. The water applied by fog spray is intended only to compensate for rapid evaporation due to wind, high temperature, or low humidity.

The timing of the operation of pipe floating is important. It is desirable to make the first pass or two as close behind the paver as possible. Also, it is desirable to make the last pass somewhat later to accomplish the best results, but not so late as to require more than one or two light applications of mist. The use of the float should be discontinued as soon as a uniform surface has been achieved.

Edge Slump

One of the earliest and best indicators of the quality of a PCCP paving operations is the variation in edge slump. Excessive edge slump causes bumps and water to pond over the longitudinal joints; both reduce the long term durability of the pavement. The paving machine must produce an edge that is within tolerance. Continual fixing and finishing of the edge is not acceptable to the Department and is grounds for either halting paving immediately or allowing no more after the end of the shift. Inspectors must keep a record of their edge slump measurements in a field book so that areas that need to be corrected later can be easily located.

(C) Fixed Form Paving

The fixed form method involves installing steel headers or side forms at the precise line and grade for each edge of the pavement, then placing, consolidating, and finishing concrete to the reference plane established by these headers.

The equipment necessary when this technique is employed consists of a spreader, screeding/tamping finisher, machine float finisher, texturing device, and hand tools.

It is best to obtain prior approval of the forms before they are delivered to the project site. The forms should be checked for smoothness with a straight edge and with a tape measure for the correct depth. Do not allow the Contractor to "berm-up" under the forms in order to achieve the desired depth. The forms need to rest on a well-compacted, level base for stability reasons.

Fixed form methods involve self-propelled mechanical equipment—machines that move forward along the forms by themselves. A Bidwell is an example of a self-propelled paver. Fixed form manual methods involve equipment that is not self-propelled and must be handled by the finishers in order to move it along the forms. Rolling and Texas screeds are examples.

The intent of the specifications has always been that the Department prefers self-propelled paving equipment

wherever possible - it produces the best PCCP. Mainline must be done by slip-form pavers, while ramps and crossroads must be done by either slip-form or self-propelled, fixed form pavers. Manual methods should be used only as a last resort. Many Contractors continue to dispute this specification, however keep in mind that manual methods must be approved by the Resident Engineer because the Department wants these methods to be used on a very limited basis.

(F) Surface Texturing

A satisfactory skid resistance is very important. There are a number of ways that the skid resistance can be developed, but texturing the surface is the most common method.

The intent of texturing is to obtain a series of grooves that are cut into the surface and spaced far enough apart to assure a strong wall between the grooves. Grooves formed by windrows of grout raised above the concrete surface are not acceptable. They break off and wear down quickly. The groove depth specified is necessary to allow for wear without losing the groove.

When testing the groove depth, the plane of reference is the undisturbed surface. The timing of the grooving operation is most important. If the concrete is too wet, the grooves will flow together. If it is too dry, the grooving will dig out material that will be ragged and weak. Either extreme will result in less groove depth than is needed.

It sometimes improves grooving if the tines of the grooving tool are set at a 10 to 15 degree angle vertical to the pavement surface. This arrangement will allow greater pressure without tearing the surface.

Texturing is usually done by using a burlap drag followed by longitudinal texturing using steel tines. Tine size and spacing is very important in obtaining an effective, long wearing texture. Texturing equipment should be carefully inspected prior to use to assure that it conforms to the specifications.

It is important that the steel tines are correctly spaced. The tining on the finished concrete surface must meet the required tolerances in Subsection 401-3.04(F) of the Standard Specifications.

The Contractor should be aiming for the mid-range specified for tining depth. If the Contractor is continually tining too lightly or too heavily, the operation should be adjusted so that the mid-range tining depth can be achieved.

The burlap drag and the tine texture device are required to be supported on separate bridges.

It is necessary to have tools for hand texturing available for use in areas inaccessible to equipment or when equipment breaks down.

AR-ACFC Overlay

Many PCCP pavements now receive a 3/4" lift of rubberized ACFC on top. The rubberized ACFC absorbs traffic noise, thus making it quieter for adjacent residential neighborhoods. In addition the ride is quieter and smoother for the driver.

The requirements for tining as described above are not necessary should the plans specify rubberized ACFC. If traffic is required to temporarily use the new PCCP, prior to placement of the rubberized ACFC, tining is required.

Some sort of texturing on the PCCP is required so the rubberized ACFC adheres to the pavement. This is developed by dragging a mat of Astroturf, extending the full width of the new pavement, behind the paving operation. Placing weight in the form of 2 x 4's on top of the Astroturf mat assists in developing the required texture.

Prior to placing the rubberized ACFC, the PCCP needs to be thoroughly cleaned, removing any curing compound; otherwise the rubberized ACFC may not bond to the PCCP.

(G) Curing

Curing the concrete is as important to achieving strong, durable concrete as any of the other phases of concrete construction. Whatever method of curing is used, the purpose is to seal off the surface to retain moisture that is needed for hydration and to reduce drying stress. Loss of moisture, particularly at the surface, will result in weak concrete that will be subject to shrinkage cracking with reduced durability.

The specifications provide for only the membrane method of curing Portland cement concrete pavement. This method consists of spraying the entire surface of the freshly placed concrete pavement, including the edges, with a liquid membrane curing compound. The cured surface should still be moist when the coating is applied. This application of compound must be sprayed by equipment capable of applying a smooth, even textured coat. Care must be taken to see that all exposed surfaces and edges receive an application of the curing compound applied at the rate specified. Application at the specified rate should be insisted on because a continuous seal is vital to the eventual "toughness" of the pavement surface.

The rate of application of curing compound should be checked several times daily by calculating the area of pavement to be covered versus the amount of cure used. This amount should then be compared to the required application and noted in a diary or paving book for future reference.

To ensure a uniform content of white pigment in the curing material, it is necessary that the curing compound be applied in an agitated condition. It must be either freshly or continuously agitated, because the pigment has a higher specific gravity than the emulsifier and tends to settle.

If the curing membrane is being applied during wind, shielding (a burlap drape) should be provided to prevent loss and avoid bare spots on the surface. If the application of curing membrane should be delayed for any reason, water in the form of a mist should be applied until the curing membrane can be applied. It is important that the concrete retains all the moisture it needs for the chemical reaction of hydration and to avoid shrinkage cracks.

Note that whenever the ambient air temperature is above 85°F (30°C), the Contractor will continually fog mist the concrete surface until the initial saw cutting is completed. Even if the Contractor wants to double the amount of curing compound sprayed, there are no exceptions.

401-3.05 Joints

The performance of concrete pavement depends to a large extent upon satisfactory performance of the joints. Most concrete pavement failures can be attributed to failures at the joint, as opposed to inadequate structural capacity. Pavement distresses that may result for joint failure include faulting, pumping, spalling, corner breaks (D-cracking), blow-ups, and mid-panel cracking. Both research and field experience has confirmed that adequate load transfer and proper concrete consolidation contribute significantly to joint performance.

Stresses in concrete pavements come from two principal sources; the force applied by vehicles, and the

volume changes that take place during curing and temperature changes. When the top of the pavement shrinks more rapidly than the bottom, stresses are set up in the slab, which tend to warp the edges upward. This tendency to warp results in severe stresses since the pavement is actually lifted off of the subgrade a slight distance at all four edges. Studies indicate that the critical loading in a pavement slab is highest in the corners due to the accumulation of edge stresses.

Joints control cracking and expansion of concrete slabs, which allow the concrete to release the build up of internal stresses. There are basically four types of joints:

1. Weakened Plane.
2. Expansion.
3. Construction.
4. Edge seal.

The characteristics of each type of Portland cement concrete pavement (PCCP) joint is described in Exhibit 401-3.05-1. See Standard Drawing C-07.01 for further details.

Transverse expansion joints are located at pavement junctions with bridge approach slabs and at other locations shown on the plans. The plan detail for expansion joints shows a reservoir for joint filler. It is important that the joint is correctly made so that a good seal will result.

Load transfer dowel bars are sometimes specified for transverse weakened plane joints so that loads will be transferred between slabs after a crack has formed. It is important that these dowels are lightly coated with heavy waterproof grease approved by the Resident Engineer, which will allow the dowels to slide after they are cast into the pavement. This is necessary in achieving a truly weakened plane joint that will control random cracking. Thick coatings of grease should be avoided since they may result in large voids in the concrete around the dowels.

When load transfer dowel basket assemblies are specified, a predetermined alignment system is necessary to assure accurate layout of the basket assemblies and to assure centering of the initial saw cut over the dowels. Experience has shown that a nail on each side of the pavement slab highlighted with paint works well. The references should be set back far enough to avoid their loss under concrete slobbers and curing compound application (recommend 6 to 12 inch [150 mm to 300 mm] offset). Consolidation around the dowel basket assemblies is critical. Check for proper consolidation with a straight edge on the concrete surface over the dowels approximately one half to one hour after concrete placement. Any depressions under the straight edge would indicate that good consolidation is not being achieved during placement.

Joint Type	Description	Direction	Reinforcing	Remarks
<p>Weakened Plane, or Contraction (most common)</p> <p>TWP = transverse weakened plane joint</p> <p>LWP = longitudinal weakened plane joint</p>	<p>Serves to control random cracking in concrete slabs; a saw cut of 1/3 of the slab depth is made in a predetermined pattern, both transversely and longitudinally. The saw cut weakens the concrete at the joint and, thus, any cracking in the slab occurs at the joint and under the saw cut; longitudinal (LWP) joints promote cracking caused by warping stresses in the slab.</p>	<p>transverse and longitudinal</p>	<p><i>transverse:</i> none, except on interstate projects where load transfer dowels are used in TWP type joints.</p> <p><i>longitudinal:</i> tie bars are used in LWP type joints</p>	
<p>Expansion</p> <p>E = Doweled transverse expansion joint</p> <p>H = non-doweled longitudinal expansion joint</p> <p>K = non-doweled; constructed around the perimeter of a misc. structure</p>	<p>Preformed Expansion Joint Material allows for thermal expansion and contraction of PCC pavements near fixed objects such as bridge approaches, box culverts, and where ramps meet cross roads.</p>	<p>transverse and longitudinal</p>	<p><i>transverse:</i> E type joints have load transfer dowel.</p> <p><i>longitudinal:</i> K & H type joints do not have dowels.</p>	<p>A sufficient gap must be left to allow the joint to both close and open.</p>
<p>Construction</p> <p>TC = transverse construction joint</p> <p>LC = longitudinal construction joint</p>	<p>Used to join a new Portland cement concrete (PCC) pavement to an existing PCC pavement.</p>	<p>transverse and longitudinal</p>	<p><i>transverse:</i> TC type joints use epoxy coated smooth dowels</p> <p><i>longitudinal:</i> LC type joints use epoxy coated smooth dowels</p>	<p>Joints are saw cut and sealed like a weakened plane joint. However, the saw cut is 1-1/4" (32 mm) rather than 1/3 the slab depth</p>
<p>Edge Seal</p> <p>S = AC / PCCP edge joint</p>	<p>Used to join edge of Portland cement concrete pavement (PCCP) to edge of Asphaltic concrete (AC) pavement.</p>	<p>transverse And longitudinal</p>	<p><i>none</i></p>	<p>Saw cut or rout joint in AC and seal with rubber sealant.</p>

Table 401-3.05-1. Joint Types

The dowel basket detail should be checked to make sure the dowels are held firmly at proper grade and alignment during concrete placement. No dowels should deviate more than 1/4 inch (6 mm) from being parallel with the surface or edge of pavement. Significant deviations in dowel alignment may restrict the movement of the pavement at the transverse joints. This movement is needed to prevent cracking that can result from temperature changes in the slabs, as well as subgrade movements and long term shrinkage.

Some of the important points to keep in mind relating to joints are:

1. Transverse construction joints are placed at the end of a run or whenever operations will be interrupted for more than one hour.
2. When adjoining lanes are placed separately, the TWP joints must match.
3. All construction and weakened plane joints shall be sawed.
4. When two or more lanes are placed concurrently, the tie bars in the longitudinal joint are placed automatically by the paving machine. The bar placing operation should be checked to be sure that the equipment is working properly. Tie bars for longitudinal construction joints are to be placed by acceptable mechanical methods while the concrete is still plastic or other approved process after the concrete has hardened. In addition, the Inspector should perform random measurements of how deep each tie bar is placed in the fresh concrete. Consistently placing the bars at the incorrect depth is grounds for halting any further concrete placement.
5. Smooth epoxy coated dowels are used for longitudinal construction joints to provide load transfer and to allow for some joint movement. The epoxy helps prevent corrosion of the dowel should the joint sealant fail.

Joint details should be thoroughly discussed prior to start of work, preferably as part of the pre-paving meeting. The items to review should include the following:

1. the Contractor's responsibility for timely and proper sawing of joints (since saw blades are round, it is necessary for the center of the blade to be over the edge of pavement or the last point to be sawed, otherwise, the proper depth of cut will not be obtained; on fixed form pavements, the Contractor may have to remove the forms in order to achieve the proper depth cut at the edge);
2. the sawing plan to ensure that the Contractor keeps a spare saw of the proper type on site at all times when initial sawing is to be performed (see subsection 401-3.06);
3. spacing of construction joints;
4. how joints will be made around openings and other appurtenances in the pavement;
5. tolerances of sawed joint locations versus the center of dowel baskets when load transfer dowels are used;
6. proper matching of transverse weakened plane joints with adjacent lanes (this will require some thought when dealing with transverse construction joint);
7. the importance of having joints of correct width and depth along with having clean joints before sealing;

8. test results on the sealant with concern for the age of the material. If it has a limited shelf life, test results and certifications of sealant should be required prior to beginning paving operations; the backer rod material should be compatible with the sealant manufacturer's recommendations; backer rod is required to be expanded closed cell polyethylene foam; backer rod materials that hold excessive amount of moisture such as paper products are not desirable; they may reduce the effectiveness of the sealant;
9. stress keeping the top of the sealant 1/4 inch (6 mm) below the surface; and
10. any additional requirements of the Special Provisions, Plans, and Standard Drawings (C-07.01, 07.02, 07.03, and 07.04).

401-3.06 Joint Construction

Pavement joints provide a means to allow for expansion and contraction and to control cracking. If constructed without joints, a concrete pavement will crack in a random pattern wherever the stresses get too great for the concrete strength.

The dimensions of the saw cut should conform to the project plans or Standard Drawings C-07.01, 07.03, and 07.04. The minimum depth is important for directing any crack that will develop below the saw cut.

It is required that sawing be done before random cracking develops, but not so soon that tearing or raveling of the concrete occurs. It is the Contractor's responsibility to determine the time to saw. Different aggregates, weather conditions, and other factors can require changes in sawing procedures; what was workable on one project may not be best for the next. The proper time will have to be found by the trial and error method. Sawing should be avoided when the slab is under tension because uncontrolled cracking can develop. Concrete is in tension when it rapidly cools - such as in the early morning. The amount of tension will depend on temperature differences so experimentation will determine if there is a problem. Early morning is a good time to examine the pavement to see if there are any uncontrolled cracks. The Contractor should be discouraged from attempting to perform the sawing by a predetermined schedule because changing temperatures, humidity, and wind speed may alter the optimum time for sawing. If a crack should open up at a joint where sawing is being performed, the sawing at the joint should be stopped. Otherwise, there could be two cracks causing spalling of the concrete between the cracks.

Sawing is usually performed with a circular diamond blade saw. The specifications require the Contractor to keep an additional saw on the project site in case any of the saws in use breakdown. Exceptions have been made if the Contractor or concrete sawing Subcontractor has a saw at their yard, which is less than 20 minutes from a project site and it is not dedicated to another project. The specifications also require that the additional saw to be a span saw. This type of saw spans the entire width of the slab and cuts the slab much more quickly than a circular saw. If the Contractor has not had chronic problems with random cracking before or during the initial saw cuts then exceptions have been made to not require the Contractor's standby saw to be a span saw.

If the Contractor falls behind in his or her sawing, it may be necessary to increase the joint spacing (up to 60 feet [18 meter]) to control early cracking. Intermediate joints can be cut later, once early cracking has been controlled. The Project Supervisor or Resident Engineer should be alerted to this condition.

Joint Sealant

The purpose of a joint sealant is to deter the entry of water and incompressible material (such as small stones and pebbles) into the joint and the pavement structure. Minimizing the amount of water that enters the pavement structure will reduce moisture-related distresses such as pumping and faulting. Incompressibles, if allowed to enter the joint, will prevent it from closing normally during slab expansion. This will lead to joint spalling and blow-ups.

Sawed joints should be cleaned and filled with joint sealant as soon as possible while they are still relatively clean and to help promote curing. It is recommended that any required grinding be completed prior to joint sealing. However, Contractors have been allowed to seal before grinding with the understanding that any ground joints will be cleaned and resealed.

Careful attention should be given to the manufacturer's recommended installation procedures. Joint preparation and sealant installation are very important to the successful performance of the joint. It is, therefore, strongly recommended that the Inspector pay particular attention to both the construction of the joint and installation of the sealant material.

Key inspection items include:

- regularly check joint depth while joints are being cut;
- ensure sandblasting of the joints to help promote bonding of the sealant;
- ensure cleanliness of the joint and removal of all loose material while joints are being cleaned, and check the joints again just before the backer rod and sealant are applied;
- closely monitor the installation of the sealant to ensure conformance with every aspect of the manufacturer's recommendation (sealant properties, application rate, correct equipment, etc.);
- randomly remove small sections of sealant after it has hardened to check for the required thickness (the Contractor must reseal areas where you have removed joint material).

Hydraulic jetting of the joints is required in areas where fugitive dust is a recognized air pollution hazard. The common practice is to hydraulic jet one day, then air jet the joint the following day just prior to sealing.

401-4 Pavement Evaluation and Remedial Measures

401-4.02 Pavement Smoothness

Arizona Test Method 801 and 401-4.02 of the Standard Specifications outline the procedures for measuring and evaluating the surface profile of the pavement and for correcting any deficiencies by the removal of high areas or bumps in the surface through grinding with a multiple diamond blade machine.

The surface profile of all sections of pavement placed shall be tested with the profilograph furnished by the Department and by other means required by the specifications as soon as possible. Straight edging should be done while the pavement is being placed so that any deficiencies can be repaired immediately. Straight edging can be accomplished from the back of the paving machine and along the edge of the pavement. It is not necessary to straight edge every square yard (square meter) of pavement. However, much of the straight edging should be done when the Contractor first begins the daily paving operation and then random straight edging should be done thereafter at a rate acceptable to the Project Supervisor.

The Department has allowed the use of the Contractor's profilograph to measure pavement smoothness as long as Arizona Test Method 801 is strictly followed and the work is witnessed by an ADOT Inspector. The Inspector

should check the calibration of the Contractor's profilograph for conformance with current Department policy. The Inspector may want to verify the accuracy of the profilograph by running a test section and correlating the results with one of the Department's profilographs. Currently, the trend in the Department is to favor the use of the automated profilographs since their readings tend to be less subjective and open to interpretation than the manual instruments.

All PCCP shall be measured for smoothness with a profilograph. The results should be reported to the Contractor within 48 hours of placement, when possible. The intent is to get feedback on the smoothness of the pavement to the Contractor's paving operation as quickly as possible. This allows the Contractor time to fine tune the paving operation before many thousands of square yards (square meters) of pavement have been placed. Locating areas of the pavement that are to be ground can be simplified if the operator of the profilograph will mark areas for grinding on the pavement and on the profilogram when he or she makes the initial profilograph test. It will also be helpful if stationing is well marked prior to profiling the pavement by using paint or on stakes alongside the pavement.

Bumps required to be ground to meet specification requirements can be located approximately by correlating the profilogram with the stationing. A straight edge should be used to define the exact location and limits of the bump. The bump cutter or grinder is then set for the proper depth of cut and operated over the bump, moving parallel with the centerline. The machine is moved repeatedly over the bump making parallel cuts until the entire area and depth of the bump has been removed. A straight edge should be used repeatedly during the operation to check the depth of cut and the uniformity of the profile. After the cutting operation has been completed, the profilograph should be used again to determine if tolerances have been met. If not, the grinding should be repeated until the tolerances have been met. The profilograph should be run again over the corrected sections as a documentation record.

401-4.03 Pavement Cracks

Large concrete slabs have a tendency to crack. This is a natural process as the concrete shrinks. Tensile stresses build up in the concrete, and cracking is the means by which the concrete releases those stresses. We cannot stop cracking, but we can control it. Jointed slabs cause the cracking to occur at the joints where the concrete thickness has been reduced by sawing. Sometimes, however, the concrete cracks away from the joint. This random cracking may be due to many causes such as lack of a uniform water/cement ratio between batches, segregation, improper curing, or not sawing joints early enough. Regardless of the cause, the procedures outlined in Subsection 401-4.03 of the Standard Specifications must be followed to ensure long lasting, low maintenance pavements.

On or just before the 28th day after the concrete has been placed, the Inspector will perform a crack survey of the PCCP showing the location, orientation, and length of each visible crack on a diagram. A copy of this diagram must be given to the Contractor. In turn, the Contractor will submit to the Department a crack repair plan which needs to be reviewed and approved by the field office. Crack repair procedures must begin seven days after the pavement crack survey, so an expeditious submittal and review process will be needed.

The crack repair procedure depends upon the orientation and location of the crack. In general, transverse cracks are repaired by the routing and sealing method, except when the transverse joints contain load transfer dowels. Then the crack is epoxy injected and the joint is cut deeper. Longitudinal cracks that do not fall within the wheel path (this area is wider than the wheel path for the profilograph) can also be routed and sealed. However, longitudinal cracks that do fall within the wheel path are not repaired; instead the entire slab is removed. Slabs with multiple cracks should always be rejected in accordance with subsection 401-4.03(C), even when each crack would be acceptable if evaluated individually. The goal is to have the largest slab possible by

keeping cracks and joints to a minimum. The crack repair requirements are summarized in Table 401-4.03-1 and Exhibit 401-4.03-1.

Before the pavement is opened to traffic under either a final or partial acceptance of the project, the Inspectors shall perform another crack survey as described previously. The cost of any repairs is shared equally between the Contractor and the Department.

It's important for Inspectors to note that the amount of crack repair in lieu of slab replacement should be kept down to the absolute minimum required by the specifications. When there is doubt about whether the Inspector should allow the Contractor to repair a crack, err on the side of removing the cracked concrete from joint to joint. The Department refrains from buying cracked or patched PCCP wherever possible, since both present long-term maintenance problems.

Crack Type (Exhibit 4-1)	Crack Repair Methods	
	PCCP Joints With Load Transfer Dowels	PCCP Joints Without Load Transfer Dowels
1	a.	a.
2	d.	d.
3-a	f. and g.	a. and b.
3-b	g.	a
4	g.	a. and c.
5	f. and g.	a. and b.
6	e.	e.
7	d.	d.

Crack Type (See Exhibit 401-4.03-2 for an illustration of crack types):

1. Longitudinal crack more than 54 inches (1.4 meter), or less than 12 inches (0.3 meter) from a longitudinal joint.
2. Longitudinal crack inside the wheel path. The wheel path is the surface area between 12 inches and 54 inches of a longitudinal joint.
3. Transverse crack that is approximately parallel and within 5 feet (1.5 meter) of a transverse contraction (weakened plane) joint.
 - a. Transverse contraction joint has not cracked.
 - b. Transverse contraction joint is cracked.
4. Transverse crack more than 5 feet (1.5 meter) away from a transverse contraction (weakened plane) joint.
5. Transverse crack crossing or terminating in a transverse contraction (weakened plane) joint.
6. Diagonal crack (intersecting the transverse and longitudinal joints within 1/3 the width and length of the slab).
7. Multiple cracks separating the slab into three or more parts.

Repair methods:

- a. Rout and seal crack.
- b. Epoxy uncracked portion of transverse contraction joint.
- c. Resaw and reseal the transverse contraction joints on each side of the crack.
- d. Remove and replace the entire slab.
- e. Remove and replace smaller portion of slab.
- f. Deepen uncracked transverse contraction joints on each side of the crack to ½ inch (13 mm) above the load transfer dowel and seal joint.
- g. Repair transverse crack by epoxy-injection method.

Notes:

- Slabs with multiple cracks (type 7) should always be rejected even when each crack would be acceptable if evaluated individually.
- Cracks at angles less than 45 degrees to the direction of travel and longer than 3 feet (1 meter) are considered to be longitudinal cracks.

Table 401-4.03-1. Crack Repair

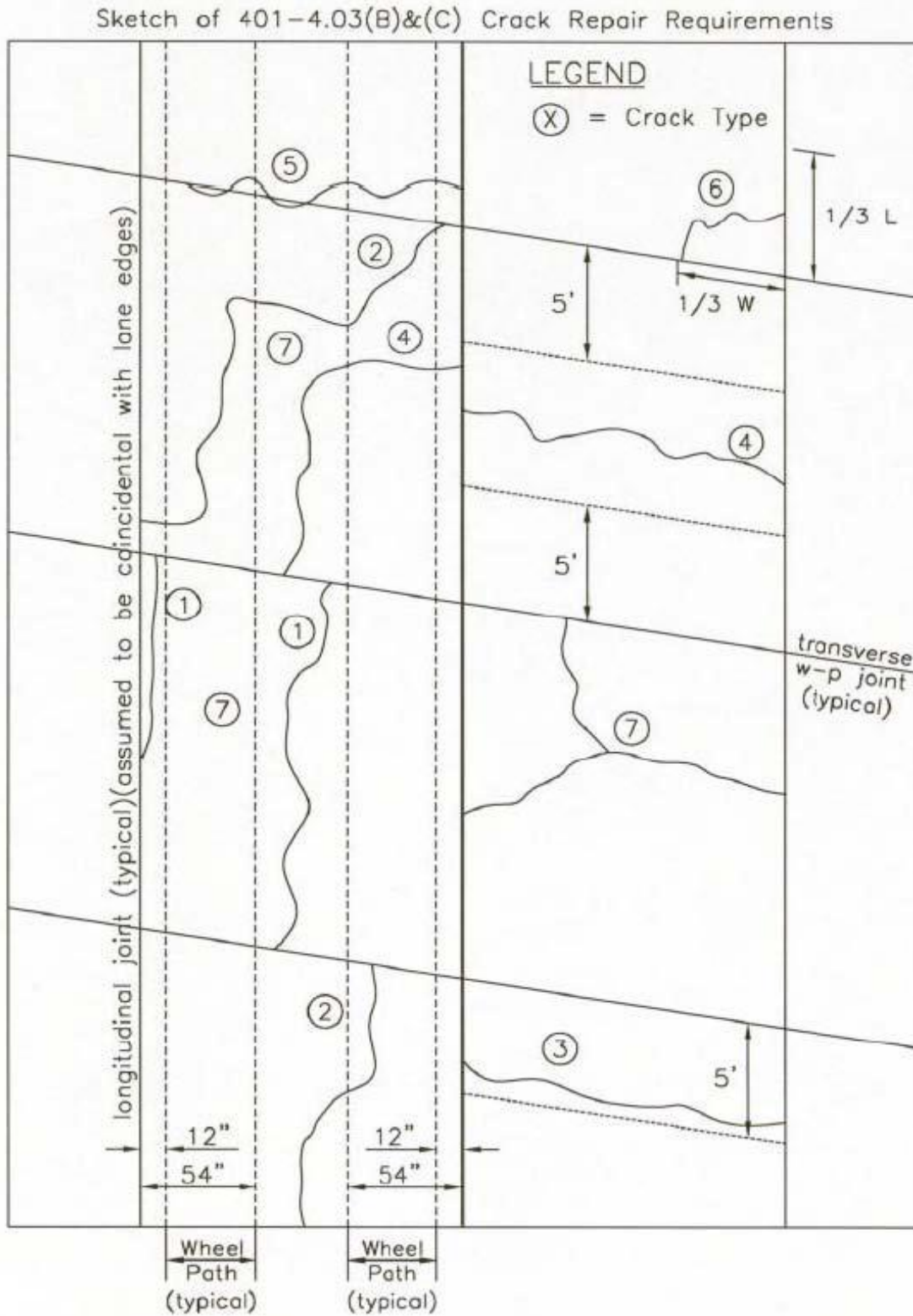


Exhibit 401-4.03-1. Crack Repair Diagram

401-4.04 Pavement Thickness

Pavement thickness is evaluated for acceptance by lot. Lot limits are identical to those specified in subsection 1006-7.03 for compressive strength acceptance of class P concrete. The contractor must obtain ten cores per lot at random locations determined by the engineer. The inspector must observe the coring operation, and immediately take custody of the cores. The inspector must be familiar with requirements of AASHTO T 24 to insure the contractor removes the cores properly. All cores obtained for thickness acceptance shall be clearly identified as to lot and location, then sent to the Regional or Central Lab for measurement by appropriate measuring device according to AASHTO T148. Cores should be returned to the project and retained for inspection by interested parties until final acceptance of the project. Cores taken in areas requiring grinding must be re-cored to determine lot thickness. Additional acceptance cores are required if any core indicates a deficiency in thickness of 0.60 inches (15 mm) or more. The additional cores must be obtained at intervals not exceeding 10 feet (3 meter) in each direction from the deficient core, until one core is obtained in each direction which is not deficient by 0.60 inches (15 mm) or more. The pavement between these cores shall be rejected. Any thickness checks made in the field are approximate and are for informational purposes only. The Inspector or Project Supervisor shall prepare a log showing precise lot, location, and thickness of all cores. From this log, the determination can be made as to the need for and location of additional cores. These cores shall be taken and their locations and measurements entered in the log. Copies of the log shall be supplied to the Contractor and to ADOT Materials Group.

The contractor should be notified in writing when pavement is rejected in accordance with Section 1006 or 401 of the Standard Specifications. The rejected pavement must be removed and replaced, unless the contractor submits a written proposal to accept the pavement at a reduced price. The contractor's proposal must be received within 10 days of the rejection notice. The Resident Engineer and the ADOT Materials Group, Pavement Design Section shall evaluate the acceptability of the contractor's proposal for rejected sections of the pavement and shall determine the proportion of the unit bid price to be paid the Contractor. The State Materials Engineer or the Materials Pavement Designer shall be consulted before any action is taken with respect to the acceptance of any section of the pavement without pay.

401-6 Basis of Payment

PCCP is paid for by the square yard (square meter) but adjustments are made to the unit price for:

- thickness,
- compressive strength,
- cracking, and
- smoothness.

These adjustments can become complicated, and Project Supervisors should use a computer-generated spreadsheet to track these adjustments for each section of pavement. Because the unit price adjustments to PCCP is so complicated, it is very important that the Project Supervisor document to the fullest extent possible the justifications for the price adjustments. Profilograph measurements, marked up drawings, computerized spread sheets, core measurements, and test reports should be part of the documentation kept with the Project Supervisor's diaries that support the pay adjustments.