602.00 PORTLAND CEMENT CONCRETE (PCC) PAVEMENT (*SSHC Section 603)*

602.10 DESCRIPTION

Concrete pavement is a surface course composed of portland cement concrete. It may be constructed on a prepared subgrade, a stabilized fill or a granular foundation course.

The production of high quality concrete pavement requires a very close control of all phases of the work. The Project Manager and inspectors assigned to concrete pavement projects should become thoroughly familiar with the construction details outlined in *SSHC Subsection 105.13, Division 600,* and the material details given in *Sections 1002 to 1027*.

The essentials to observe in this type of pavement construction are:

1. Accurate proportioning of aggregate and cement.

2. Absolute control of the water and admixture content of the mix.

3. Prevention of segregation in the concrete.

4. Adequate amount and proper spacing of finishing equipment to handle the production of the mixer or mixers.

5. Properly trained equipment operators and finishers.

6. Proper curing.

7. Timely sawing of joints.

602.20 PCC PAVEMENT MATERIAL REQUIREMENTS

602.201 Composition of Concrete (*SSHC Section 1002)*

The plans or special provisions may offer the contractor a choice of various classes of concrete. *SSHC Section 1002* lists the classes of concrete used in Nebraska road construction. If a choice is allowed, the contractor is required to advise the Project Manager of the class of concrete to be used. This notification must be given prior to construction. The Materials and Research Division should be consulted in regard to problems of concrete composition. Table 1002.02 shows authorized mix proportions for the classes of concrete.

Material Inspection - The production of a high quality concrete requires careful control over concrete materials at the batch plant. The inspector must be prompt and accurate to insure quality concrete.

SSHC Sections 601, 602, and *603* contains requirements for concrete pavement construction. The Project Manager and inspectors must familiarize themselves with these requirements and insist that materials be tested and approved before being incorporated in the work. The frequency of sampling, testing or submitting of material samples to the Central Laboratory and the procedures to be followed are covered by the Materials & Research *Materials Sampling Guide*.

Field Testing Laboratory - *SSHC Subsection 105.03* requires the contractor to furnish a field laboratory building meeting certain specific requirements for the type required in the contract. The project manager should document compliance for the laboratory's condition in the Field Book and notify contractor of any problems.

Admixtures - *SSHC Section 1002* states that "only admixtures authorized by the contract documents will be permitted for use in portland cement concrete". Since the various materials constituting admixtures can have a profound effect on the characteristics of the hardened concrete, extreme caution is justified. (See *SSHC Section 1007* for more information on admixtures.*)*

602.202 Concrete Strength

Currently, four test cylinders are to be fabricated for each placement (generally four cylinders are required for each lot of concrete). These test cylinders are then tested at ages of 7, 10, 14, and 28 days.

@ If the 7-day cylinder tests 3500 psi (25 MPa) or above, the 10 and 14-day cylinders need not be tested and can be discarded. If the 7-day cylinder should test less than 3500 psi (25 Mpa), the 10 and 14-day cylinders must be retained and the above policy applied to the 10-day cylinder. In any case, the 28-day cylinder must be retained and tested.

@ A 5^{th} cylinder is required if the contractor wants an early break.

602.203 Concrete Sampling Locations

Concrete samples shall be collected from at least three different portions of a batch after it is discharged, whether mixed on site or central mixed. Sample location point shall be after plastic concrete has been placed on the grade, either by direct depositing from a batch truck or by use of a placer/spreader machine. On slipform paving projects, optimum sample location is between placer/spreader and slipform paver machines. Care should be taken to avoid sampling concrete that has been vibrated manually or mechanically. Samples should be taken at locations within the batch that appear to be representative.

602.204 Testing Procedures

When making test specimens, sample should consist of about 0.03 cubic meters (1 ft^3) and should be remixed a minimum amount by use of a shovel to ensure uniformity. For routine air and slump tests, smaller samples may be used.

602.205 Air Entrainment in Plastic Concrete

SSHC Table 1002.02 shows the required percent of entrained air needed in concrete paving mixes.

Newer, heavier slipform paving equipment can sometimes cause an entrained air loss greater than 1.5% due to their higher consolidation capabilities. If a contractor is consistently running near the usual minimum specified 5% entrained air content, the contractor should be advised to increase amount of air entraining agent that is supplied to the mix at the paving plant. The increased amount of entrained air added at plant should provide 6% air in the finished, consolidated concrete.

602.206 Ready Mix Concrete (See National Ready Mixed Concrete, Quality Control Manual)

Each truck load of concrete for a paving project must be identified by plant ticket.

Required Information:

- The ticket must show plant name, contractor, project number, date, quantity, class, and time batched. Complete information regarding water in materials, water added, and total allowable water need only be shown at beginning of each run, and each time thereafter when moisture content changes or plant adjustments in mixing water are made.

Any water added to the mix must be documented. Moisture tests must be made frequently to insure uniformity in concrete consistency.

602.207 Concrete Discharge Times

To insure that quality concrete is incorporated into pavement maximum discharge times have been included in *SSHC Subsection 1002.03* for both continuous agitation (agitator trucks) and non-agitated trucks (dump trucks).

These discharge times should be verified at least once during each day of normal paving. These verifications should be recorded in project field books. During hot, dry, windy weather, maximum time limitations listed in specifications are critical limits set to insure that quality concrete is being placed and incorporated into project.

The nomograph in *SSHC Figure 710.01* can be used as a guide to determine what is the current evaporation rate.

602.208 Miscellaneous Material Requirements

Concrete with a low air content shall not be incorporated into work. **Only one addition of air entraining admixture is allowed at the site.** (See *SSHC Subsection 1007.03*)

Concrete with a high air content should not be incorporated into work except under extreme circumstances. If low compressive strengths result, the concrete may be required to be removed and replaced.

The *Materials Sampling Guide* requires that the pink copy of the DR Form 22, Certificate of Compliance, or a copy of the mills own certification form be mailed to the Materials & Research Division. These are required in order for us to determine the quantity of cement which was used when additional estimates are processed.

The certificate of compliance is needed both for mills that require sampling and those that do not. When a sample is required, normal procedure has been to submit the pink copy with the sample. This is acceptable. For those mills which do not require sampling, please collect and submit the certifications on a routine basis but at a minimum of once each week.

602.30 PCC PAVEMENT EQUIPMENT (*SSHC Subsection 601.02*)

602.031 General

All equipment to be used on the project should be thoroughly inspected and measuring equipment should be carefully calibrated before the start of production. All calibration data should be recorded in plant notebooks. These notes should include a description of each piece of equipment such as make, model number, etc.

Repeated breakdown of a piece of paving equipment is sufficient reason to suspend paving operations until the machine is repaired and brought into proper operating condition or replaced. (*SSHC Subsection 105.01*)

602.032 Batching Equipment

Batching equipment should be in compliance with the National Ready Mixed Concrete Association (NRMCA) Quality Control Manual - Section 3 - Plant Certification. (See *SSHC Subsection 1002.03*)

602.303 Cement Bulk Handling Equipment

The principal concern with regard to handling cement is moisture. Contact between cement and water prior to entering the mixer must be positively prevented.

602.304 Scales

Scales shall be in compliance with National Ready Mixed Concrete Association, Quality Control Manual, Section 3, Plant Certification.

602.305 Concrete Mixers

General - Equipment for handling and mixing concrete shall conform to the requirements of *SSHC Sections 601, 603,* and *1002*.

The inspector should be familiar with the mixing drum, water meter, timing device, and AEA dispenser. Check the inside of the drums for worn pick-up or throw-over blades. The contractor is required to provide information making it possible to check the wear accurately. The blades should not be worn more than 10 percent of the original height. Check the capacity plate for size of batch and manufacturer's recommendation for speed of rotation of the mixing drum.

The mixer must be equipped with a timing device which locks the discharge lever in the closed position until the end of the full mixing time. Set the timing device for the specified mixing time after all materials are in the drum. After paving operations begin, the mixing time should be checked with the mixer operating under load. The door of the timing box shall be kept closed and locked except during repair or adjustment.

Water Measuring Devices - The water tank should be inspected and the accuracy of the gauge checked. Using a 200 L (50 gallon) drum and a platform scale furnished by the contractor, the tank should be calibrated for each gauge setting through the operating range. The measuring device shall have an accuracy of 1.0 percent of the metered volume.

Make at least two trials for each setting of the dial to insure consistency in the measuring device. Record the calibration in the inspector's notebook. Check the valves to see that no water dribbles into the mixer drum when the tank is shut off.

Admixture Dispensers - When an admixture is to be added to the mix it should be arranged to enter the drum with the mixing water. The volume graduations on the AEA dispenser should be checked by measuring the amount released at each setting and the results recorded. The amount dispensed should be accurate within 3 percent of the quantity specified for each batch.

Mixer Performance Tests - A decrease in mixing time can be made under certain conditions, including the use of interlocked automatic batching. The basis for permissible reduction of mixing time is the contractor's mixer performance test.

Specific sampling and testing procedures, equipment list and method of reporting are included under the Materials & Research *Materials Sampling Guide.*

602.306 Hauling Equipment (*SSHC Subsection 603.03)*

May be one of two different types, depending on the setup at the plant:

1. Trucks which have drums or containers (dump trucks) in which central mixed concrete is delivered to the project. (30 minute limit till discharged.)

2. Trucks which have a concrete mixer mounted on the truck bed to provide complete mixing of concrete ingredients after they have been batched or blended at the central mixing plant. (90-minute limit till discharged.)

Trucks and Mixers - Each vehicle shall have a metal plate attached and listing:

1. Designed use.

2. Concrete capacity

3. Rotation (RPMs) of the mixing drum or blades.

Mixers and agitators shall be operated within the limits of capacity and speed of rotation designed by the manufacturer of the equipment. When used as a mixer, it is important for the inspector to make sure that the equipment is not loaded beyond its capacity. Blade wear should be checked against the manufacturer’s design. Blade height should be at least 90 percent of original height. There should be no appreciable accumulation of hardened concrete. Control and measurement of water added should be clearly inspected. Revolution counters should be checked.

602.307 Subgrade Trimmer (*SSHC Subsection 302.03)*

Check the setting of the cutting blades to secure the exact subgrade crown and elevation. The subgrade trimmer, if used, should operate at least 90 m to 150 m (300 to 500 feet) ahead of the concrete placement operation. Usually, the segment that is to be paved will be trimmed at least one day prior to concrete being placed on the job.

602.308 Concrete Spreader (*SSHC Subsection 601.02)*

The spreader or mechanical strike-off must be self-propelled and equipped with:

1. A power-driven spreading device.

2. An adjustable strike-off blade capable of striking off the concrete at any required elevation within the forms. This requirement anticipates the construction of reinforced concrete pavement in two courses. The strike-off should be adjusted so that some concrete will be carried in front of the blade.

3. Vibrators, either internal or surface type, capable of consolidating the pavement to its full width and depth. These should be checked for frequency of vibration with a contractor supplied tachometer.

602.309 Finishing Equipment

SSHC Subsection 601.02 provides for use of various types of concrete pavement finishing machines. Mainline paving is intended to be placed with a finishing machine designed for concrete paving. Approval may be given for alternate types of finishing equipment based on satisfactory field performance. Should a new machine be brought on the job and contractor's staff are not experienced with its operation, a qualified manufacturer's representative should be present until equipment is in proper adjustment and functioning as intended.

Equipment normally associated and approved for hand methods shall not be substituted for a finishing machine on mainline paving. Bridge deck finishing machines are not approved for placement of standard paving when a finishing machine is required, due to their lack of adequate consolidation equipment.

The finishing machine must be self-propelled and equipped with:

1. Two independently operating screeds constructed with end wings to prevent concrete spillage over the forms.

2. A pan-type finisher-float for each paving train.

If the screeds are the conventional reciprocating type which ride on the forms, check the end shoes for a worn surface. A poor slab surface with a valley along the form will result from worn end shoes.

A crown check of the screeds and pan-type finisher-float should be made by the contractor and in the presence of the inspector or project manager before the start of paving operation. To check the crown, raise the screed or float and stretch a 20-gauge piano wire or strong fish line across the bottom about 25 mm (1 inch) from the front face. Place a similar wire about 25 mm (1 inch) from the back face. Lower the screed or float down to the forms or to

hardwood blocks and check the distance from the wire to the screed or float surface at every 300 mm (12 inches) across the roadway. The crown elevation at centerline on the back screed and float should be set about 3 mm (1/8 inch) high to allow for subsidence and shrinkage during setting of the concrete. This 3 mm (1/8 inch) may then be worked out to a normal crown in the 1.5 m (5 feet) each side of centerline. The front screed should be set slightly higher than the back so that concrete will be available for manipulation by the back screed.

SSHC Subsection 601.02 provides that all spreading and finishing equipment in the paving train shall be equipped with scrapers or be constructed in such a manner as to keep the top of the paving form free of concrete.

602.3010 Slip Form Paving Equipment

Requirements are given in *SSHC Subsections 601.02* and *603.03*. The principal requirements is that the equipment be "capable of spreading, consolidating, striking off, shaping and float finishing the freshly placed concrete to the desired line, grade, and thickness in one continuous passage in such a manner that a minimum of finishing by hand methods will be required". This is a performance specification and the approval of the equipment depends on the end result on the current project or an earlier project. Appropriate equipment to provide internal vibration is very important. Automated electronically controlled subgrade machines are also required. The subgrade equipment must perform "in conjunction" with a taut reference line erected and maintained by the contractor.

602.3011 Saws Used on New Pavement & Unbonded PCC Overlays

SSHC Subsection 603.03, Paragraph 7 says sawing may begin when the contractor can accomplish the sawing without causing the concrete to ravel.

Sawing equipment heavier than 905 kg (2000 lb) will not be allowed on pavement with less than 18 hours age regardless of pavement thickness. Span saws with a mass of 3620 kg (8000 lb) or greater are not to be used on pavements of 175 mm or less design thickness without approval of the Project Manager and Construction Division. Span saws can be utilized on pavements greater than 175 mm (7 inches) design thickness after pavement has a minimum age of 18 hours.

The contractor shall provide sufficient sawing equipment to produce the sawing schedule required in the specifications or special provisions. Standby saws should be provided. If the sawing schedule is not maintained, uncontrolled cracking of the slab will occur.

602.3012 Miscellaneous Equipment

Master Straightedge - The contractor is required to furnish and keep in a convenient place a master straightedge, made of 150 mm (6 inches) steel channel at least 3 m (10 feet) in length for the purpose of checking the straightedges at any time during the progress of the work. A sufficient number of straightedges shall be kept in readiness so as not to delay the paving operations.

Water Supply Equipment - Check over the water supply equipment with the contractor's superintendent. Be sure that it is adequate. After the pavement is placed curing takes precedence over all other uses of water.

Forms - Forms shall be of metal and of a depth equal to the edge thickness of the pavement. Visually inspect the forms. Forms which are bent enough to produce uneven alignment or a poor riding surface should not be used until straightened. Flexible metal or wood forms should be used on curves having a radii of less than 30.0 m (100 feet). See *SSHC Subsection 603.03*.

602.3013 Accumulation of Materials in Transporting Vehicles

The contractor should periodically clean and flush all transporting equipment such as transit mixers, agitators, and wet batch trucks, to prevent accumulation of hardened concrete in compartment. This also includes central plant mixing equipment. Frequent inspection of transporting vehicles and hoppers should help assure prevention of accumulation and build-up of hardened concrete.

602.40 PCC PAVEMENT PRECONCRETING CONFERENCE (*SSHC Subsection 1002.03*)

On all projects involving PCC pavement, the Project Manager and inspectors should meet with appropriate contractor and supplier personnel to discuss concrete production and pavement placement quality issues before any materials are placed. When ready mix concrete is used, the ready mix producer should also attend.

For the various types of work, the following items should be covered:

- Approvals and required quantities of aggregate and cement, class of mix, time and rate of delivery, percent of air, slump, batch weights, volume per truck, total quantity required, preparation of delivery tickets, testing arrangements, procedures in case of load rejection (air can be increased), responsibility for setting batch weights and amount of admixtures, placing, finishing and curing arrangements, and personnel work assignments.

- Adverse (cold or hot) weather plan of action.

- Settings and condition of paving equipment, dust control, subgrade treatment, procedure for checking steel placement, utility and street return box outs, heading-up equipment, joint sawing and cleaning, joint sealing, rain damage prevention, and cold weather protection.

Only one preconcreting conference is considered necessary for thoroughly discussing the work and responsibilities and duties of all involved in the project. On small projects it may be possible to include a preconcreting conference with preconstruction conference.

602.401 PCC Daily Report of Pavement Laid (DR Form 85)

The daily inspection report on paving work is a record of the construction progress, working conditions, weather, etc. during paving and plant operations which may affect pavement quality. This report keeps the central offices advised on job status and serves as a detailed permanent record of the paving project. At the end of each day on which any pavement was placed, this report is to be completed by field inspection staff for appropriate distribution.

The Daily Pavement Laid Report must accurately reflect the type of cement used.

602.50 PCC PAVEMENT CONSTRUCTION METHODS

602.501 Subgrade General

Make sure that the grade is always drained. There should be no areas where water can pool.

602.502 Preparation of Subgrade

Compaction Requirements - The subgrade compaction requirements will be shown in the plans. When a granular foundation course is not to be constructed, the upper 150 mm (6 inches) of subgrade shall be compacted to at least 900 mm (3 feet) beyond the edge of the proposed pavement and this should be shown in the Plans. The crown and elevation of the subgrade will be established by means of trimming, as described in *SSHC Subsection 302.03*.

Subgrade Cross Sections - After completion of the Subgrade preparation items, cross-sections should be taken and recorded on a data collector.

602.503 Foundation Course

Construction Requirements - Foundation course, when required in the plans, is to be constructed according to *SSHC Section 307*.

Protection of Foundation Course - The contractor should be advised that the protection of the foundation course from rainwater is one of the most important features connected with concrete pavement. Ahead of the placing operation, holes should be opened beneath the pavement forms to drain the water off the subgrade. Trenches should also be cut through any shoulder dirt outside the form line to carry the water away. In case of rain, such precautions will protect the foundation course and earth subgrade from standing water and may prevent saturation of the material.

Behind the finisher, protection of the foundation course beneath the previously laid slab is even more critical. During rains, water running off the pavement works under the bottom edge of the slab and washes out the foundation course. Even on very slight grades the force of the water soon becomes strong enough to wash out the entire depth of the foundation course from beneath the edge of the pavement. This may be in a strip of variable width, and may amount to as much as 1 m (3 feet).

To prevent this damage to the foundation course, the contractor may push an earth windrow against the edge of the slab sometime after the curing compound has been applied. Washing away of the foundation course is not usually a problem on slab which still have the side forms in place. However, it will occur on steeper grades unless the water is diverted over the shoulder by dikes at frequent intervals.

Immediately after any rain, inspect the foundation course along the slab edges.

Cross Sections and Thickness Measurements - Cross Sections should be taken on the completed subgrade and later, on the completed foundation course.

Thickness measurements should be made at the time of testing for density.

602.504 Grades on Drives in Cities

An attempt is made to standardize grades for residential drives constructed in conjunction with urban paving projects. Standardization reduces property owner complaints about their cars dragging when using their drives. A special design will be shown on plans for commercial drives such as filling station drives. The Design Office uses a standard design detail for driveways as well as a typical automobile template to check driveway cross sections.

If field conditions necessitate a change in driveway grades, vehicle clearances should be checked using typical automobile template dimensions. This can be accomplished by using a scale model template to check plotted grades for new driveways. Keep in mind that there are exceptions to all rules and there may be cases when more clearance may be required than indicated by template. In critical locations it may be necessary to contact the Roadway Design Division for help in determining a revised driveway design.

602.505 Protection of Pavement (*SSHC Subsection 601.02)*

Wheels of finishing equipment operating on previously placed pavement shall be rubber faced. Track propelled equipment should be equipped with rubber protective pads on crawler tracks or tracks shall travel on cushions of wood or belting. The near edge of wheels or tracks shall not be closer than 75 mm (3 inches) from edge of pavement. Provisions must also be made to prevent the screed from damaging the edge of existing pavement surface.

602.506 Operating Finishing Equipment on Previously Placed Concrete in Multiple-Lane Construction *(SSHC Subsection 603.03)*

Concrete pavement finishing equipment may be permitted to travel on an adjacent lane 7 days after finishing when concrete has attained cylinder break compression strength of 25 MPa (3500 psi) or after 14 days.

602.507 Surface Cleaning

When placing a lane adjacent to completed pavement any spillage or flow of concrete slurry on the surface of existing pavement must be broomed off prior to hardening. This helps prevent the transverse groove from being filled with concrete which would reduce the effectiveness of the texture.

602.508 Material Inspections

SSHC Subsection 603.04 explains how materials for concrete pavement shall be measured. National Ready Mixed Concrete Association (NRMCA), Quality Control Manual, explains how batching shall be conducted so as to result in the mass of each material required within a tolerance of one percent for cement and two percent for aggregates. The following is a discussion of measuring and handling concrete materials as set forth in *SSHC Section 1002* and the NRMCA Quality Control Manual.

Stockpiles - It is the contractor's responsibility to avoid harmful contamination, segregation or excessive degradation in placing or removing aggregates from the stockpile. Although the specifications do not specify the methods to be used by the contractor in stockpiling aggregates, the Project Manager should be aware of the method to be used and should

alert the contractor when chosen methods may produce unsatisfactory results. All aggregates are to be stockpiled separately. (*SSHC Section 1033)*

If a bulkhead is used in separating the individual aggregates it should be high enough to prevent intermingling of the aggregates. Aggregates which become intermixed shall not be used. Building a stockpile properly in horizontal layers tends to reduce the tendency to segregate. If the material is being dropped form a considerable height, the stacker should be equipped with a rock ladder or tremie to reduce the falling impact and prevent segregation. A brisk wind blowing through the falling aggregates will deposit the fines on the lee side of the pile while the larger particles remain on the opposite side. It is the contractor's responsibility to provide the specified gradation of the aggregate entering the mix. When crawler tractors are used on gravel stockpiles, the contractor must clean all caked dirt and mud from the track ways and from beneath the machine before running it on the pile. Crawler equipped dozers or end loaders must not be allowed to damage aggregates in the stockpiling areas.

If the aggregates are hauled to the project in railroad cars, burlap and boards used to chink cracks in these cars become mixed with the material. A grizzly with a maximum of 150 mm (6 inches) square openings should be placed on top of the aggregate bins to catch foreign material previously missed. They should be cleaned at least twice daily to prevent forcing the foreign material through the grizzly openings and into the batch.

602.509 Batching Inspections

General - The importance of proper batching inspection cannot be over-emphasized since proper proportioning of materials is one of the major steps in obtaining a satisfactory pavement. The plant inspector and his/her assistant carry out the inspection at the batching plant. The following items should be closely inspected during the progress of the work:

1. Be familiar with the physical characteristics of aggregates, design mix proportions, the method of determining batch quantities, scales operation, yield, effective water, cement factor and the procedure for adjusting proportions and yield when using air entrainment.
2. Calibration of scales and measuring devices, and the systematic and regular checking of scale settings for batches to assure proper quantities are being dispensed. (Scale settings are not to be made by the inspector since this is the contractor's responsibility.) The NRMCA, Quality Control Manual, Section 3, Plant Certification, outlines the steps required of the contractor in calibrating the scales and checking their sensitivities.
3. Sampling and testing is as indicated by the Materials & Research *Materials Sampling Guide*.
4. Water of doubtful quality must be tested and accepted prior to incorporating in the mix. The intake end of the pipe or hose used in pumping mixing water from a stream or standing body of water should be covered with wire mesh and located so that no foreign matter will enter. Hauling of mixing water should be done in clean, covered containers. Assurance of using acceptable water is the responsibility of the plant inspector for central or ready mixing and the responsibility of the slab inspector for on-the-job mixing.

5. Some scale bins do not always empty themselves after each batching cycle. The inspector should check the cement and aggregate bins for cleaning frequently at the beginning of the job. If the cement becomes packed in the corners of the scale bin, the correct mass will be shown on the scale but something less than the full mass will actually reach the batch. This condition can be corrected by rounding out such dead areas in the bin design or by means of vibrators attached to the bin sides.

6. When changing scale weights for batch correction in the aggregates, be sure that the set screws, holding the counterweights in position on the beam arms, are firmly tightened with pliers by the operators. Constant vibration around the plant tends to move these weights, causing an incorrect amount of aggregate to enter the batch.

7. If rain comes at any time while the aggregate bins are loaded, the water will collect in the material at the bottom of the bins. Two or three truckloads of each size aggregate should be taken from the bins and hauled back into the stockpiles before batching begins. When this is not done, the moisture content of the first few batches will be excessive and sloppy concrete will result at the mixer. Many contractors allow the bins to empty at the end of the day for the above reason.

8. All working parts, particularly the knife edges, should be in good condition, free from friction, readily accessible for inspection and cleaning, and protected from falling or adhering material. Dash pots should be clean, regularly inspected and filled, and free from friction. Elements of the lever system must not rub against other elements or framework of the plant. All nuts that might work loose in operation should be protected by locking devices. The scale container and closing devices should be tight against leakage and the plant should be carefully leveled and on a firm foundation.

9. At least once each shift the scale should be checked by halting the measuring cycle with a normally measured batch in the scale hopper and noting the precise scale reading. The addition of four standard 25 kg (50 lb) weights to the hopper should result in an exact indication of an additional 100 kg (200 lb) on the scale dial or beam balance. Erratic measurement due to binding scales can be detected in this manner.

10. Require that central-mixed concrete be hauled in vehicles meeting specification requirements and in a manner to avoid segregation and be delivered at the site with proper consistency and workability before the concrete starts to take its initial set. Require agitating type trucks if batch is to be held in trucks more than 30 minutes.

11. When the yield is found to vary considerably for no apparent reason, check accuracy of the scale. In addition to the methods of checking described above a quick method is to measure a loaded and tared batch truck on platform scales. Erratic measurement due to binding scales can also be detected in this manner.

602.5010 Cement Hauling Inspections

The inspector will observe the measurement of all batches and see that the beams balance after the discharge of each batch. If a springless, dial-type scale is used, the pointer must return to zero.

The inspector must also keep a complete, accurate record of all cement received, used and wasted. This record will be used to determine the cement factor being obtained and to verify the correct proportions of cement to aggregates. The record is kept in the "cement notebook" and should consist of:

A complete index
Scale calibration record
Daily cement record
Cement car record

The cement car record consists of statistical information concerning every car of cement used on the project. The railroad net mass of each car may be obtained from the freight office or from the contractor's freight bills. The remainder of the information is a record of the use of the cement on the project.

The cement used at the plant shall be checked against the cement required by the total number of batches or cubic meters mixed. These checks are to be made during the progress of the work in accordance with the procedures outlined herein. The first or initial check of cement used against the cement required should be made at or near the close of the first or second full day's paving operation, and at least before unloading the 11th carload of cement. The initial and successive cement checks should be made between carloads and with cement silo and storage or service bins completely empty.

If the initial check shows that less than 99 percent of required cement was used, the calibration and operation of all measurement and proportioning equipment, and the proportioning of aggregates and cement should be immediately and thoroughly checked. A second "empty bin" check of cement used should then be made at or near the close of the first or second full day's paving operation following and before unloading the 11th carload of cement used after the initial check.

If the initial check or succeeding checks of cement used show more than 99 percent but less than 100 percent of required cement used, a succeeding "empty bin" check shall be made at or near the close of a day's paving operations or not later than the 50th carload of cement used after the previous check, whichever involves the greater quantity of cement. The contractor can make "empty bin" cement checks at more frequent intervals if he/she so desires and our Project Managers should lend their full cooperation in making such checks.

It is realized that in the case of paving projects obtaining concrete proportioned at commercial ready-mixed plants, it is usually impossible to make accurate, "empty bin" checks of the cement used. Accordingly, it is extremely important that the project manager and the paving plant inspector make certain that the inspection of the measuring and proportioning is full time and fully adequate; that the scales measuring the aggregates and cement are accurate; and that the procedures are conducted in a careful and precise manner so as to insure the correct proportioning of aggregates and cement.

In the inspection of the cement measuring operations at either commercial ready-mixed concrete plants or proportioning plants, the Project Manager and the plant inspector should make certain that air pressure in the cement delivery and storage system is not affecting the cement scale and cement measuring operation. It has been found that in certain proportioning plants, if the service bin and the scale hopper for cement are not adequately vented, air pressure buildup in the scale hopper will cause some under measurement of the cement. This can be positively checked by introducing cement into the hopper until the scale indicates the correct amount for a batch and then hold up the operation with the scale fully loaded for a short period of time -- sufficient to void any air pressure in the cement weighing hopper. If the cement scale is functioning properly, the scale beam and dial indicator will remain stable. If air pressure is affecting the measuring operation, the cement scale beam and dial indicator will indicate a decreased mass of cement as the air pressure dissipates. It is important that this item be checked periodically on all proportioning plants using air pressure to transfer or move cement within the plant.

Checking the Interlocked Automatic Batching Controls

1. During regular batching operations, compare the dial reading at cut off with the cut off settings.

2. During a measuring cycle with the plant in automatic operation ask the operator to move the control lever from charge position to discharge position. If the discharge gates open before the weighing cycle is complete, the system is not functioning in a proper manner.

3. During the discharge cycle, before the discharge gate is closed, place or suspend 25 kg (50 lb) on the hopper. If the discharge gate can be closed and the bin gates opened automatically at the end of the discharge cycle, with the 25 kg (50 lb) mass still in place, the interlock system is not functioning properly.

4. During a normal batching cycle, ask the operator to set one bin gate for manual control, closing it early so that less than normal mass is drawn from that bin. Then ask the operator to return to operation by automatic control, with the light mass batch in the hopper. If the discharge gate opens, the controls are not functioning properly. Repeat this operation with the bin gates for each of the ingredients of the batch.

602.5011 Mixing and Hauling

Methods - Several combinations of methods for mixing and hauling of concrete for pavement construction can be used:

Since the procedures to be used by the contractor may vary, the Project Manager on each project should assign definite division of responsibility to the plant inspector and the slab inspector before paving operations are started.

Inspection - The following paragraphs include important mixing and hauling inspections:

1. Check the time on the mixer at least twice daily.

2. Check for uniformity of batch consistency. Non-uniformity may be caused by any of the following:

a. Leaky mixer valves. Indications of this condition are wet batches when mixed for periods longer than the normal interval.

b. Double pulling of water valve. Watch the mixer man for correction of this condition.

c. Moisture change in the aggregate. Loader operator may be dipping into aggregate stockpile which has not drained sufficiently.

d. Empty AEA supply container or partially clogged supply tube to mixer drum. Another indication of the failure of the AEA supply is free water on the finished slab. The plant foreman should be made responsible for delegating a reliable man to fill the AEA supply tank each day or as often as necessary. A leaking valve on the AEA dispenser will also cause trouble, producing a batch with too much slump and too high an air content.

3. Wash water in transit-mix trucks, if being used, should be completely discharged. Quality concrete work is dependent on the uniform consistency of the concrete mixture being used and will only result when good control of the water-cement ratio is maintained. Our specifications do permit the use of wash water as a portion of the mixing water when accurately measured and taken into account in determining the quantity of water to be added. However, it is very difficult, if not impossible, to accurately measure wash water remaining in the drum, and this procedure should always be discouraged.

4. Mixing is controlled either by a specified time, or number of revolutions at a specified revolutions per minute. Regardless of the method used for controlling proper mixing, it shall begin after all ingredients are in the mixer, including water. Close cooperation is required between plant and road inspectors to assure proper mixing time or number of revolution is being observed and that concrete is placed within the designated time limit.

5. Truck mixers should be checked to assure that there is no leakage from the water tank into the mixer.

6. Concrete, when it leaves the chute of a truck mixer or truck agitator, tends to segregate. Segregation can be corrected by providing a baffle at the end of the chute to cause the concrete to drop vertically.

7. A satisfactory method of extending the actual haul in transit-mix operations is to add the cement, not at the batching plant, but a point closer to the work. During the haul between the batching plant and the point at which the cement is added the mixer should not be revolving as otherwise the aggregate would be subjected to unnecessary grinding action.

8. The specifications provide that the truck mixer or agitator shall be capable of delivering and discharging the concrete in a thoroughly mixed and uniform condition. According to ASTM, concrete that has not been thoroughly mixed will have a slump test value that differs by more than 50 mm (2 inches) when taken at approximately the 1/4 and 3/4 discharge points.

9. *SSHC Subsection 1002.03* requires the contractor to have a procedure to issue a ticket to the driver of each load of concrete delivered to the project. In addition to the requirements shown in the specifications, the concrete ticket handling procedure shall include the following:

    a. The concrete ticket for the first load of concrete each day will indicate the number of liters of water that can be added without exceeding the maximum specified. The maximum number of liters will be indicated on subsequent tickets as changes occur.

    b. Any additional water added to the mixer, at the site of work, will be recorded in liters on the ticket by the driver. If additional mixing water is required, a minimum of 20 revolutions of the truck mixer drum at mixing speed shall be required before discharge of any concrete.

10. Truck mixers shall be randomly checked against ASTM C 94. The concrete shall be mixed for not less than 50 nor more than 100 revolutions at mixing speed. It is further required that additional mixing in excess of 100 revolutions be at agitating speed and the change from mixing to agitating speed shall be done by the truck mixer operator at an intermediate station established at a point along the route by the Project Manager. Random checks are to be made often enough to assure compliance, and in general should consist of from one to four checks daily based on the quantity of concrete produced. These random checks shall include the following:

    a. Plant inspection personnel shall check the zero setting of the revolution counter after charging of batch and the proper drum mixing speed.

    b. Placement inspection personnel shall check the number of revolutions recorded on the counter for compliance with the specifications.

    c. The random checks shall be recorded in the field notebooks.

11. The temperature controls in SSHC Section 1002 should be strictly enforced.

12. Regardless of whether concrete is mixed in site mixers, stationary mixers, or truck mixers it is the responsibility of the slab inspector to assure that it is properly mixed and meets the requirements in regard to slump, air content, uniformity, and desired workability when delivered to the subgrade. Wet and dry batches should be avoided and the slump held to within very narrow limits, normally not exceeding 12.5 mm (1/2 inch) variation.

13. The schedule of delivery of ready-mixed concrete is sometimes a problem due to the long haul and the interference of other commercial traffic. The Project Manager should check this matter carefully with the contractor's superintendent. Sufficient hauling units should be provided to assure a minimum time lag between the arrival of batches at the site of the work. In no case should this be longer than 30 minutes.

14. The two main faults with truck mixers and agitators is their inability to discharge low slump concrete and their tendency to hold back too much of the coarse aggregate until the last few cubic feet of the batch are discharged. Nothing can be done about the first of these faults, the second can be partially corrected by depositing the last increment of the batch at a point where it can be mixed into other concrete.

15. Haul time and stand-by time frequently has an adverse effect on the consistency of truck-mixed or truck-agitated concrete. The batch becomes progressively stiffer as the time increases. The rate of stiffening is affected by the characteristics of the cement and aggregates, and by temperature. The 1 1/2 hours maximum mixing and agitating time allowed in *SSHC Subsection 1002.04* shall be reduced if undue stiffening is apparent. The stiffening process may be reversed by adding extra water either at the start or at the point of delivery. In either case the end result is the same, a higher water-cement ratio and lower quality concrete. Caution should be used in employing this method of retarding stiffening, and in no case should the total amount of the water per batch exceed the total allowed by the specifications.

16. In transit-mixed concrete, the inspector should examine the batch for cement balls. These usually are the result of the method of charging the water. If sufficient water, about 40 percent, enters the drum ahead of the aggregates and cement, cement balls will not usually occur. Most of the remainder of the water should enter with the cement and aggregates and the mixer should be rotating during the charging period.

17. When discharging transit mixers at the site of the work, the rate of discharge should be regulated by the speed of rotation of the drum and not by the size of the discharge opening.

18. Truck mixers shall be examined periodically for accumulation of hardened concrete. Any truck mixers showing such accretions or excessively worn pickup and mixing blade shall not be used.

602.5012 Forms (Usually small paved areas.) *(SSHC Subsection 603.03)*

Form Setting - After the foundation course has been properly compacted, the forms may be set. If the foundation course is low along the form line, additional material shall be placed and compacted before setting the forms in place. Forms shall be tamped mechanically. Form pins shall be long enough to penetrate the earth grade below the foundation course a sufficient depth to hold the form rigidly in place. If the project is in town, or in curb sections where drainage is a factor, form elevations should be checked with an instrument after the forms are set and tamped.

Form Alignment Ahead of Paver - All forms should be inspected for alignment, elevation and adequacy of tamping immediately ahead of the paver. This should be done far enough in advance to allow for correction of high and low joints or additional tamping if necessary. A smooth form line is an important factor in the riding quality of the finished pavement and should always be checked before placing concrete between the forms. Forms should be oiled to prevent sticking to the concrete.

Check forms as necessary to verify they have not settled.

Form Removal - Forms should not be removed sooner than **12 hours** after concrete has been placed. Care is to be exercised in this operation to see that the edges of the slab are not broken or otherwise damaged. The sides of the pavement slab should be covered with the curing compound within 30 minutes after removal of the forms.

602.5013 Placing Reinforcing Steel *(SSHC Subsection 603.03)*

Steel reinforcing bars and dowel bars are required to be supported by metal chairs or units of approved design. It is the contractor's responsibility to get approval prior to construction of dowel baskets of a type not shown in the plans or described in the special provisions.

The specifications allow machine placement of the longitudinal deformed tie bars in lieu of being supported by metal chairs. The machine must be self-loading with a reasonable tie bar storage space and be capable of placing the tie bars at the spacing shown in the plans. It must be located in the paving train so as to place tie bars prior to the placement of the wire mesh on reinforced concrete pavement, or prior to the passage of the first finishing machine on non-reinforced concrete pavement.

602.5014 Tie-Bar Steel Inspection (*SSHC Subsection 603.03*)

All paving contractors should place joint tie steel according to details in the plans. The following tie-bar steel inspection procedures will be required on all portland cement concrete paving projects where centerline or lane line tie-bar steel is either manually or mechanically placed in plastic concrete:

- Manually check location and depth of tie-bar steel in the plastic concrete behind slipform paver each day.
- Using a magnetic locator (pin finder), verify location of tie-bar steel in hardened concrete every day.

To insure compliance with proper joint design parameters, use the following minimum frequencies when checking rebar location:

- Once in morning and once in afternoon for tangent roadway sections check the location.
- In at least three locations within all horizontal curve sections. These locations generally would be at the beginning transition, in the middle of the curve, and at the ending transition.
- For each inspection, at least two tie-bar steel locations within a panel should be checked.
- Checks of any area with out-of-tolerance tie-bar steel should be expanded so that extent of problem area is identified for retrofit correction. These areas should be determined on hardened concrete.

The checked areas of hardened concrete should not overlap previously checked plastic concrete areas.

Project inspector should document tie-bar steel inspection results in field book.

Minimum placement tolerances are as follows:

- Depth: D/2+25 mm, -37 mm (D/2 + 1 inch, - 1.5 inch).

- Angle: Minor variations to 1.6 radians not critical as long as at least an effective length of 300 mm (12 inches) of tie-bar steel extends across joint.

- Lateral position, number of bars shall be as shown in the plans.

- Joint deficiencies in lateral position and number should be evaluated by the Construction Division.

If previously mentioned inspection procedures discover out-of-tolerance tie-bar steel, the contractor has the following options to remedy the problem:

- Contractor may substitute a longer bar to better ensure an adequate length across joint.

- Contractor may place additional uniformly spaced bars across joint.

- Contractor may move the bar inserter uphill on the paver.

602.5015 Inlet and Utility Accesses

Inlet standards show a portion of slab, or a portion of curb and gutter unit blocked out at the time of construction which is to be filled in later when the inlets are built. Since the inlets are usually sublet by paving contractor, the question of including this insert section as a part of the inlet has been brought up frequently.

When computing the quantity of pavement, designers consider all concrete work between the curb edges of pavement.

No deduction is made for insert sections which are blocked out and then formed when the inlet is built. These insert sections are blocked out to facilitate construction of inlet. Other areas of pavement or curb and gutter may be blocked out to prevent slowdowns of the paving crew because of special shaping requirements. Insert sections and areas requiring special shaping will be paid for as part of the pavement or curb and gutter quantities.

602.5016 Box-Outs for Utility Accesses

Standard Road Plans provide for boxing out utility accesses in pavement. Clearance of the manhole ring below pavement grade shall generally be 6 mm (1/4 inch). Care must be taken during paving process to avoid disturbance of the ring. The concrete roll in front of the screed as it passes over the ring should be removed and used to pack around the ring. This should prevent movement.

Box-out for utility accesses occurring in the form line should be three-sided with the end sections at 60 degrees with form and center section parallel with form. All three sides should be about 300 mm (12 inches) from the upper edge of the ring.

The ring should be set to the required grade and concreted-in when an adjacent slab is being placed. Special procedures may be necessary when incorporating some old utility accesses into new pavement as to whether a box-out is used or not. Particular attention should be paid if bearing support of the old structure is questionable.

602.5017 Box-Outs on Slip-Form Paving

Contractors when slip-forming urban projects sometimes fill the inside area of box-outs for utility accesses and intakes with soil. This is to help keep the forms from moving and reduce the volume of concrete mix that is wasted during passage of paver over box-outs.

In some cases, the box-out is filled to a greater height than forms and soil becomes intermixed with concrete as paver passes over these areas. This results in contaminated mix being incorporated in pavement. To insure that the concrete mix will not be contaminated, the height of the fill inside box-out area should be 75 mm (3 inches) or more below top of the forms or a sheet of plywood may be placed over opening of box-out areas.

602.5018 Placing and Spreading *(SSHC Subsection 603.03)*

General - The slab inspector normally has the responsibility for inspecting the placement and spreading of the plastic concrete in such a manner as to provide a structurally sound pavement with smooth riding qualities and to see that this work and the finishing is accomplished as required by the contract documents.

The paver, truck mixer or truck agitator should distribute the concrete evenly on the subgrade without displacement of reinforcing steel or joint material. Concrete dumped in piles can cause roughness. Do not overload one side of the spreader as the extra weight on one side of the machine may cause it to displace the forms. Centerline tie bars shall be placed carefully so that the centerline splits the bar. When expansion joints are encountered, concrete should be banked around both sides of all joint material by hand prior to spreading near the joint with the machine. The slab inspector shall see that none of the dowel assemblies or joint material is displaced during the placing and vibrating of the concrete.

The quantity of concrete used should be checked by comparing the number of batches used with the number of cubic meters required. These checks should be made at shutdown, mid-shift breaks and at other points providing a distinct check on batches used and such checks should be entered in the DR Form 85 "slab report". If measurements (such as subgrade, form settlement, slab thickness, and crown measurements) indicate the possibility of thin pavement, checks on the concrete quantities used should be made more often. When the pavement is placed in two layers, concrete quantity checks are difficult to make. However, using a little forethought and exercising good judgment, a fairly accurate check can be made without "evening up".

Batch volume underruns may be due to any of the following reasons and should be investigated immediately:

1. High subgrade
2. Form settlement
3. Low crown
4. Excess mass from aggregate scale operator
5. Wrong scale setting or slipping of counter weight at aggregate scale

Slab thickness and crown checks should be performed a minimum of three times each day. The slab thickness check shall be made by placing a thin piece of plywood or other suitable material of approximately 200 x 200 mm (8" x 8") size at existing subgrade or foundation course level at three points along the transverse section, such as at the two one-quarter points and at centerline. After the finishing machine has passed over the selected location the thickness of the slab shall be measured at the three predetermined points. Crown checks shall be made directly back of finishing machine by the use of a taut line over blocks placed on the edge of the slab. The blocks should be of the same thickness as the height of the crown. The line should be drawn taut and lowered to the blocks and then moved back and forth in a sawing action. If the crown is correct, the taut line will leave a mark of approximately 0.5 to 1 m (18 to 36 inches) in length at the center of the slab. Generally, the contractor makes similar checks and these checks can be made in conjunction with his/her checking. All checks are to be made a matter of record in a field notebook.

602.5019 Slip-Form Construction *(SSHC Subsection 603.03)*

The pavement may be constructed by means of slip-form equipment conforming to the requirements of the *Standard Specifications*. Conventional methods of construction shall be used on irregular or variable width sections which are not adaptable to slip-form construction.

Any provisions of the specifications requiring the use of equipment riding on forms will not be applicable when slip-form construction is used.

The adequacy of the finished pavement constructed by the slip-form method is highly dependent upon a sequence of correct methods, equipment and inspection procedures. In order that the essential events occur in their proper order, the inspectors shall carry out their assignments with diligence. The paver is equipped with side forms to support the concrete laterally for a sufficient length of time during placement to produce pavement of the required cross section.

Smooth pavement begins with a uniformly stable subgrade and foundation course which have been constructed, trimmed and maintained at true line and grade during the time prior to the passage of the slip-form paver. These courses shall be constructed to conform to the typical cross sections shown on the plans and of sufficient width to include the trackways for the subgrade machine or machines and the slip-form paver.

Vigilant inspection is required of all construction operations to insure that they are in accordance with the requirements of the specifications. Various factors essential to production of sound, smooth and durable slip-form pavement are listed below:

1. Use of aggregates meeting specified requirements for quality and gradation.
2. Accurate determination of batch proportions with adjustments for determined moisture content of aggregate.
3. Use of minimum quantity of mixing water required to produce a plastic, workable concrete mix of uniform consistency and specified slump.
4. Introduction of air into mix within the prescribed limits.
5. Thorough mixing for required length of time.

6. Proper placing and consolidation of the concrete.

7. Correct placement of steel reinforcement and dowel joint assemblies.

8. Strict compliance with required curing methods.

9. Timely sawing of transverse contraction joints.

10. Restriction of loads on pavement until it has gained the required strength.

Control of line and grade for both the subgrade and foundation course work is accomplished by using a reference line set from the offset hub line. It is supported and tensioned to prevent any measurable sag or transverse movement. The machines have sensors which use the reference line for alignment and automatic grade control. The use of these automatic controls is analogous to the form line in the conventional method. The maintenance of the cross-section of the subgrade or foundation course to the plan elevation, controls the thickness of the finished pavement. Once the subgrade or foundation course has been completed to plan requirements of line, grade and density, it is extremely important that it be protected, particularly the tracking path area, until the passage of the slip-form paver.

The concrete is delivered to the paver in any conventional manner. When possible, keep concrete trucks off the subgrade. The fresh concrete is deposited on the subgrade, by uniform distribution of batches, just ahead of the paver. The uniform distribution of the batches is very important in slip-form paving. For the purpose of metering the correct amount of concrete for the full paving width to the main screed, pavers of this type are normally equipped with an initial strike-off blade provided with power travel fore and aft independent of the forward travel of the paver. Some pavers are equipped with augers which effectively meter the fresh concrete to the main screed. The forward speed of the paver shall be adjusted to the average progress of the concrete production and delivery in order that operations shall be as continuous and uninterrupted as possible.

Because of physical limitations as to the mass of the machine and of the relatively large screed area, the importance of using concrete of proper consistency and uniform distribution is extremely critical. Large piles of concrete or dry batches will cause the paver to "float" or lift above the true grade and result in a high area or bump. Wet batches cause low spots and edge slump and irregularity.

The concrete, for the full paving width, shall be effectively consolidated by internal vibration with transverse vibrating units of a series of longitudinal vibrating units. The paver extrusion plate or screed shall extrude the concrete under load, properly shaping and compacting the concrete into a dense, stable mass to assure that the concrete remains stable, with a minimum amount of slumping after the passage of the paver. Some pavers may have more than one device for the screeding operation.

When the pavement is being constructed by slip-form method, all reinforcing steel shall be placed in accordance with *SSHC Subsection 603.03*, Paragraph 4. In some instances two slip-form pavers may be required in tandem in order to comply with the requirements.

The finishing and curing shall be in accordance with *SSHC Subsection 603.03*, Paragraphs 5 and 6. The requirements for surface texturing and curing may be accomplished by accessories mounted on the self-propelled float finisher.

602.5020 Surface Finishing

General - The traveling public judges your pavement job by its riding qualities. Careful inspection of the finishing operation will assure a surface which will receive public approval.

The intention of the specifications is that manipulation of the concrete during finishing should be held to a minimum. Overworking tends to bring water to the top. This is detrimental to the wearing surface and to the strength of the concrete. Hand finishing, unless allowed by the special provisions, can be used only in cases of emergency on normal width pavement or on narrow or variable width sections where mechanical methods are impractical.

Machine Finishing (*SSHC Subsection 601.02)* - The minimum requirement of mechanical finishing equipment prescribed by the specifications is:

1. Self-propelled concrete spreader
2. Self-propelled finishing machine equipped with a pan-type finisher-float

On high production pavement projects [over 45 m (150 feet)] of pavement per hour or when more than one concrete mixer is used), an additional finishing-machine without the pan-type finisher-float is recommended. The goal of this paving train is to adjust the forward speed of the final finishing machine (equipped with the pan-type finisher-float) to the concrete production, so as to provide an uninterrupted strike-off operation. The combination float-finisher is designed for a one-pass operation. Concrete should be accurately metered to this machine. The spreader of the auxiliary finisher (if required) should leave enough concrete for a uniform roll of approximately 100 mm (4 inches) for the front screed. This screed in-turn should be tilted enough to allow 50 to 75 mm (2 to 3 inches) roll for the rear screed. The pavement surface is then trimmed to the desired grade and crown by the rear screed. The pan float will normally be set almost flat longitudinally with the roadway and should just make contact with the pavement surface.

Transitions - Some pavements are designed with a tangent crown, which shall be removed gradually for superelevated curves. The distance in which the crown is to be removed will be shown on the standard or special plans. This will require adjustments on both the spreader and the finish machine or machines. The operation of this equipment should be synchronized so that the same amount of crown is being removed, or replaced, by each machine at any given point in the transition.

The transverse finishers in use usually have a single adjustment point at one end of the screeds and pan float which permits running the crown in and out on superelevated curve transitions.

The distance in which the crown is removed is not critical and may be increased or decreased over the distance given on the standard plan, if the Project Manager determines a change is beneficial. The crown is removed in the transition distance in equal increments. The number of increments to be used should be divided into the transition distance to obtain the length between each crown change. Set a stake in the shoulder along the form line at

each of these points, where it will be visible to the machine operators. The pavement foreman should delegate experienced personnel to "crank out" the crown on the screeds and float.

Straightedging *(SSHC Subsection 603.03)* - After completion of the mechanical finishing and while the concrete is still plastic, laitance and surplus water shall be removed and the surface shall be made true and smooth with approved 3 m (10 foot) straightedges supplemented by such floating as is necessary to eliminate all depressions and irregularities. Straightedges shall be set parallel to centerline and shall be lapped 1/2 their length in each successive position. High areas shall be removed and depressions shall be filled with fresh concrete and consolidated by floating with approved hand floats. Straightedge testing shall be continued as necessary until all irregularities have been found to be satisfactorily corrected. Straightedges should be checked against the master straightedge at least twice daily. When using slip form construction, straightedging will generally only be required at the beginning and ending of the daily placement. (Also see *SSHC Section 602*.)

At longitudinal contraction joints along old pavement or companion lanes, care must be taken to prevent the newly finished surface overhanging the top of the adjacent slab. This can be accomplished by the flat finishers "dragging off" the excess concrete with a straightedge pulled longitudinally along the joint after the initial subsidence of the fresh concrete. This "pushing up" of the fresh concrete against the previously laid slab is especially noticeable when the crown elevation of the fresh concrete is higher than that of the lane already in place. (This also channels water into the joint and shall be avoided.) If this is not corrected, it will be very annoying to traffic when changing lanes and may even become a traffic hazard. Edgers must not depress this joint. Competent workmen shall be detailed to the finishing and edging of this part of the work.

Drag Finish - The surface of the pavement shall be given a final finish by means of a wet burlap, carpet or canvas drawn in the longitudinal direction. The drag should be of sufficient width so that the entire slab can be textured in one operation. It is required to be supported from a mandrel which is often attached to the rear of the belting machine or the self-propelled float finisher when slip forming.

Expansion joints, if any, should be edged at this time taking care to remove all concrete from the top of the joint leaving a full 25 mm (1 inch) wide opening. Workmen should be cautioned not to bear down on edgers as this will depress the concrete and leave a rough joint. Edger marks at the joints and the edge of the slab should be removed with a small piece of wet burlap, leaving the surface with a uniform texture and appearance. Straightedge all joints after edging.

602.5021 Use of Water in Finishing Concrete

SSHC Subsection 603.03 does not allow concrete finishers to apply water to surface of pavement to aid in finishing of concrete except limited amounts with an orchard sprayer. Any additional water added to surface of fresh concrete increases water/cement ratio of mortar and adversely affects air content. This results in a less durable matrix and concrete surface is more prone to early scaling and general surface deterioration.

Chemical finishing aids and evaporation retarders may be approved by the Project Manager.

Should a voided surface occur during finishing and finishers experience difficulty in closing an open pavement surface, fresh mix or mortar should be obtained from in front of paving train and added to surface to facilitate finishing and produce a tight, closed pavement surface.

602.5022 Tining *(SSHC Subsection 603.03)*

The plans indicate those pavements that shall receive tining.

Tining impressions are made in plastic concrete while grooves are made once concrete has hardened.

@ The Department has changed tining requirements. Mainline pavement will now be longitudinally tined instead of transversely tined. Transverse tining shall be done with a rake, not a bull float. Ramps and other irregular areas that cannot be properly tined longitudinally shall be transverse tined.

@ Mainline pavement tined surface longitudinally is the primary goal to reduce noise levels.

@ Proper timing is critical. Longitudinal or transverse tining of the surface too early may result in grooves filling up with mortar or surface tearing. Tining too late results in a reduced groove depth.

To obtain a uniform transversely grooved pavement inspector should check the following items:

- Texture machine operating properly and all control devices functioning correctly.
- Pad line maintained in smooth and stable condition.
- @ Tining rake carrier rails set to pavement crown, so uniform down pressure on tines maintained as comb sweeps down across the slab.
- Four springs attached to carrier frame and to broom channel with a tension adjusting chain are identical and adjusted to obtain proper groove depth.
- Tines of comb parallel. A bent tine, which narrows spacing at tips, undercuts adjoining groove.
- No build up of dry mortar near tips of tines. A build up of mortar widens groove at surface and may cause tearing or displacement of larger aggregate particles.
- Steel tines not worn and comb in good condition, to ensure sufficient groove depth.

@ Should an unsatisfactory tined surface result for any reason, stop the paving operation and do not allow resumption until the problem is corrected.

Tine Determination

Depth of the grooves may be determined by using a standard commercial tire tread depth gauge, but normally a visual inspection without measurements is adequate.

Guidelines for Tining Concrete Pavement

@ 1. Tine mainline pavement longitudinally.

2. Ramps and small irregular areas can be transverse tined with a tining rake.

3. Tine all concrete pavements where posted speed limit will be 40 mph or greater. When a mainline is tined, include tining in intersections, acceleration lanes, deceleration lanes, left-turn lanes and ramps.

4. Do not tine concrete shoulders.

5. On pavement built without curb, stop tining 6 inches (150 mm) from edge of pavement (for edge of pavement painted line.)

6. On pavement built with curb, stop tining 2 feet (600 mm) from back of curb.

602.5023 Pavement Depression

A pavement depression prevents proper drainage of slab during periods of rain and may cause maintenance problems during the winter. This may be due to one or more of the following reasons:

- Screed not set correctly
- Poor workmanship by finishers in manipulating straightedge
- Improper tension between ends of trailing forms
- Improper adjustment of edges attached to trailing forms

@ Check this deficiency by placing a 10 ft (3 m) straightedge or 4 ft (1.2 m) carpenters level transversely on pavement surface and noting trueness of surface with bottom of straightedge.

602.5024 Pavement Station Stamping

@ Station location of all PCC pavement shall be stamped in plastic concrete at every station (100 ft/100 m) by the NDR inspector.

Permanent Station Numbers - Each station number shall be marked permanently in the surface of the concrete slab by the use of metal dies furnished by the department. The numbers should be stamped neatly in the concrete just before it takes its initial set. They @ should be placed about 6 inches (150 mm) in from the right-hand edge of the slab so that they can be read from the right roadway shoulder.

On interstate concrete pavement, station numbers should be stamped on the outside edge of both roadways (sides: away from the median). These numbers will also be 150 mm (6 inches) in from the slab edge and facing so that they can be read from the outside asphalt shoulder. Placement of station numbers on all ramps, loops, "S" roads, etc., should be made in conformity with the first paragraph of this section.

On concrete slabs having integral curbs, the location of station numbers will vary between projects according to desires of parties most likely to use them in the future. The city engineer and/or District Engineer should be consulted on this matter prior to construction.

602.5025 Integral Curb Placement

Integral curb may be placed simultaneously with the pavement placement, directly behind the pavement finishing operation, or at some later date. When placed directly behind the finishing operation, the specifications require placement within 30 minutes from the time of placement of the pavement and that the curb be placed on a roughened surface. Both of these requirements are important to insure an adequate bond to the slab. If the integral curb is to be placed at a later date, reinforcing steel, as indicated in the plans, shall be placed during the construction of the slab.

Two important items to note during the inspection of constructing curb is proper consolidation of the concrete and configuration of the finished curb. Proper consolidation will eliminate voids on the backside. Should voids be present they are to be filled with a mortar, immediately if slip-form methods are being used or in the case of forms immediately upon removal of the forms. Configuration should be checked for conformance with dimensions shown in the plans. If hand methods are being used a "mule" type float of the proper configuration should be used in the construction of the curb.

602.5026 Protection and Curing

The slab inspector in charge of curing should study the requirements for the method proposed for use by the contractor. If the method of cure involves the use of "blanket-type" coverings, these should be inspected and sampled, if necessary, prior to pavement production. Impervious coating material proposed for use must be tested before use. Although its application rate will not be less than 0.3 L/m² (1.5 gal/22 yd^2) for tine/surfaces and 0.2 L/m² (1.0 gal/22 yd^2) for all other finishes, the rate of application may be increased depending on the moisture retention qualities of the impervious coating.

One method of curing is the use of "wet burlap and impervious coatings". When this method is used, the initial curing with wet burlap is very important as it prevents evaporation of the mixing water at the time when hydration is most rapid. The wet burlap should be applied as soon as the fingertips can be gently touched to the concrete without becoming sticky. If hair checking develops during hot weather, the wet burlap should be applied immediately behind the finishing operations. Hair checks are much more objectionable than burlap marks. If the burlap is applied with care, and with the seams up, burlap marks will be held to a minimum. Water for curing takes priority over all other pavement operations. Impervious coatings are then applied after the first 20 hours of initial curing. The testing laboratory will test each lot of impervious materials received and will designate the quantity per square yard to be applied. A daily record of the liters used and the amount applied per square meter shall be kept in the slab inspector's notebook. It will be the inspector's duty to see that the coating materials are applied uniformly and in an amount at least equal to the

amount designated by the laboratory. The vertical edges of the slab shall be coated with the same quantity per square meter as the surface. Keep the material from coating any joint areas to which joint-sealing filler is to be applied.

When curing with burlap, at times keeping the burlap in place and continuously in a dampened condition is an endless task. However, since proper curing is essential to good quality in the concrete, the curing requirements for the particular work should be reviewed and discussed with the contractor. It is the responsibility of the Project Manager to ensure that the contractor carries out the curing requirements as specified.

Prior to start of paving operations the inspector should be assured that the contractor has sufficient material on hand, such as burlap, polyethylene sheeting or other approved material, to properly protect the pavement surface in case of rain. Sudden showers which might occur during paving operations or immediately after finishing operations require the exposed surface of the fresh concrete to be covered to prevent washing cement from the surface. Mixing and placing of concrete should cease immediately in the event of rain.

When hot dry and windy conditions prevail, the application or placement of curing material becomes extremely important.

602.5027 Joints *(SSHC Subsection 603.03)*

Joints are sawed in PCC pavements to eliminate random cracking and to provide areas for pavement to expand and contract. These control joints are then cleaned and sealed with various types of sealants to keep out water and incompressibles such as soil, sand, and gravel.

Transverse Construction Joints - The header board used to form the construction joint at the end of the day's run should be cut from 50 mm (2 inch) material and approximately 37.5 mm (1 ½ inch) shorter than the width of the pavement. Holes bored in the board to receive the load transfer dowels should be at least 6 mm (1/4 inch) larger in diameter than the dowel bars.

When due to breakdowns, construction joints are necessary during the day, and work is resumed after a short delay, great care must be used in removing the header board from the green concrete. Any pressure or lift on the dowel bars will break the bond with concrete and cause the joint to spall at some future date.

Generally, header boards should be set 3 mm (1/8 inch) below normal crown at centerline. Observe the straightedging of the header joint the next morning and adjust the setting of the next header board, accordingly. When paving down steep grades (4 to 6 percent), set the header board 6 mm (1/4 inch) below crown elevation. When paving up steep grades, set the board exactly to crown elevation. Boards should be set at right angles to the pavement grade with dowel bars parallel to the subgrade.

Concrete pavement failures on the "morning" side of transverse construction joints have sometimes been noted. This is normally caused by unconsolidated concrete. Machine vibration should be observed at this point and if not considered adequate, hand vibrations for a few feet out from the header should be required.

Dowel bars on all joints shall be greased as shown in the plans.

Transverse Expansion Joints - The joint materials should be set at right angles to the pavement grade with dowel bars parallel to the subgrade and to the centerline of the

pavement. Tilted or skewed dowels will "blow up" the joint at some future date when the pavement expands. The joint material must touch the subgrade throughout its entire length and there should be no gaps between the mastic sections. Concrete plugs form in such gaps and defeat the purpose of the joint. Make certain that the expansion tubes are not driven on past the stop lugs or the joint will fail to function. The 25 mm (1 inch) temporary filler between the ends of the expansion material and the side form should be removed before placing the hot-poured joint material. If the temporary filler is composed of unyielding material, it should be removed the day after the pavement is poured to prevent spalling the corners of the concrete slab when the pavement expands.

The strike bar on the spreader and the screeds of the finishing machine should be raised slightly when making their trip over the joint. Machines pushing a heavy roll of concrete tend to tilt the mastic, and shovelers should be employed to transfer such rolls across the joint. The inspector shall check all joints for position behind the finishing machine by inserting a thin wood stake about 0.8 m (30 inches) long in the concrete alongside and in contact with the joint material. If the stake contacts the joint material all the way to the subgrade and appears to be plumb, the joint will function properly. Tilted joints should be dug out and reset.

Contraction Joints - The specifications provide that plane of weakness joints shall be sawed. Great care and attention should be given to the planning of sawing joints. Sawing at the wrong time or sawing along side of a crack already formed can be the cause of extensive maintenance work. The cutting of transverse-control joints to relieve early shrinkage stresses may be necessary depending on the type of slab, the atmosphere conditions and the amount of shrinkage inherent in the concrete. No exact time can be given as to when sawing of transverse-control joints should start, and it will be necessary to prepare a sawing sequence for each project.

The plans should be carefully checked to determine the location and depth of sawing required. Usually the specified depth of cut is different for transverse and longitudinal joints. The depth of cut should be checked as soon as possible so that the contractor may seal the joints.

On Reinforced Concrete Pavement, with transverse contraction joints at 14.17 m (46.5 ft), it probably won't be necessary to cut control joints except in very hot weather periods. It is recommended that on the first day of concrete paving, sawing of the transverse joints begin as soon as possible without excessive raveling or tearing. The time at which this sawing should start may vary from 6 hours on warm days to 20 hours in cold, cloudy weather. Sawing of these joints should continue progressively at the plan spacing until concrete is encountered that is so green that it cannot be sawed without tearing. Some slight raveling of the concrete must be expected. If a sharp edge joint is being obtained, it is quite likely that the concrete may have hardened sufficiently to result in uncontrolled cracking. This would indicate that sawing should be earlier or control joints should be made.

The first joint following the previous day's construction joint should always be sawed as a control joint. The older concrete will place sufficient stress on the newly placed concrete to produce an uncontrolled crack near the header if a plane of weakness is not provided at this point.

SSHC Subsection 603.03, Paragraph 7 should be thoroughly reviewed and understood by both the inspector and contractor. Transverse joints near cracks developing before sawing should be skipped, the crack routed and filled with joint material. Sawing shall be

discontinued when a crack develops ahead of the saw. If a joint is sawed where a crack exists or develops during sawing, the sawed joint or portion considered to not be the working joint shall be cleaned and epoxied.

In the multilane pavement, for the companion lanes, those joints that are open and working should be sawed as control joints. Volume change stresses from the initial lane are transmitted through the tie bars and edge friction to the second lane. A matching plane of weakness must be sawed in the second lane to prevent formation of an uncontrolled crack.

Uncontrolled cracks in the initial lane must be matched with a control joint in the companion lane. In laying out joints, blocks of concrete should always be 3 m (10 feet) or more in length.

Instances have been noted where the depth of the sawed joint through the curb section was insufficient on concrete pavement construction requiring integral curb. The depth through the curb section is variable and is to be sawed as shown on the plans. This should be brought to the attention of the contractor and your assigned inspector.

Longitudinal Joints - The time for sawing the longitudinal center joint is not critical. The concrete shall have hardened sufficiently to permit the sawing of a sharp-edged, clean cut joint.

Sealing Joints

As concrete cures, moisture moves to the surface. Therefore, concrete should be cured seven days or more before sealants are applied. Insure that sealant manufacturer's procedures are followed. Check for moisture in the joint before the sealant is applied.

Hot Poured Sealants

All joints required to be sealed shall be filled immediately after they have been cleaned and dried, and checked for proper depth. A hot poured joint sealer must be applied with the use of a pressure-type applicator equipped with a nozzle which will fit into the sawed groove. How full the joint is to be filled should be discussed with the District Construction Engineer. However, placement of joint sealer should be done in a neat, workmanlike manner striving to eliminate any smearing of sealer on the pavement.

The Project Manager should obtain the manufacturers recommendations for temperature control of the joint sealer, and frequent measurements of the actual temperatures should be made to insure compliance with those recommendations.

If curing compound is applied on a slab with open joints the contractor should lay a rope or belt along the length of the joint to exclude the cure from the opening. If curing compound has been permitted to enter a joint, the contractor should be required to resaw the joint.

All joints to be sealed shall be cleaned with a jet of compressed air, flushed out with water under high pressure and diked before pouring the joint sealing filler.

We have experienced some problems in the past regarding hot pour joint sealer and white pigmented curing compound. The problem stems from the fact that the manufacturer is supplying his/her distributor, or the contractor, with a certificate of compliance staring that the material meets Nebraska Department of Roads' specifications as well as the applicable

ASTM and AASHTO specifications. In one instance, the certification also stated the material to be pretested. However, this has since been corrected by the manufacturer.

We want to emphasize that if hot pour joint sealer is from tested and approved stock, this material can then be used upon delivery to the project. The lot number will appear on the NDR Approved Products List for approved stock. The Materials and Research Division should be notified as to the lot numbers and quantity delivered. If the lot number is not on the NDR Approved Products List, then the joint sealer must be tested and approved before it is used. We do not accept joint sealer by certificate of compliance or by a Project Manager's certification, unless this is the rubber modified asphalt compound consisting of an asphalt cement containing a minimum of 22 percent of new or reclaimed, synthetic or natural rubber. This material is accepted by a certificate of compliance furnished by the supplier per the Special Provisions.

The foregoing instructions concerning tested and approved stock also applies to cold poured joint sealer, preformed joint filler, and pressure relief joint filler.

White Pigmented Curing Compound

White pigmented curing compound that is approved for use is shown on the Approved Products List. The Materials and Research Division should be advised as to the quantity and lot numbers involved. Reports will then be issued to the project. Curing compound not from tested stock must be sampled and tested prior to being used. We do not accept curing compounds by certificate of compliance or Project Manager's certification.

Preformed Polychloroprene Elastomeric Type *(SSHC Section 1016)*

The construction procedures in *SSHC Subsection 603.03*, Paragraph 7 are quite detailed and close adherence to these instructions is important to insure the proper performance of the seals. Important points to emphasize in this type of construction follow:

1. Installation should result in less than 5 percent elongation of the performed seal.
2. Sawed joint dimensions should be of correct size - neither too large nor too small.
3. Sawed joints should be inspected closely for cleanliness at the time of installation.
4. Spalls should be repaired as indicated in the specifications.
5. Certification as indicated in Specification Subsection 1016 should be in the Project Manager's files before installation.
6. Excessive adhesive has been known to accumulate on the top of the seal, preventing proper expansion of the seal.
7. Hot dry weather can produce a condition of premature set to the adhesive and this can be the cause of seal popping.
8. The seals be placed at the specified depth. If placed too high, attrition will take its toll.

Silicone Sealants (*SSHC Section 1014)*

Silicone sealants shall meet requirements in *SSHC Section 1014* and shall be installed in accordance with the manufacturer's recommended procedures.

Mastic Sealants *(SSHC Section 1014)*

Mastic sealants are considered as temporary sealants and their composition is not tested. The contractor must submit a letter from the manufacturer certifying materials comply with AASHTO M 213 requirements for nonextruding and resilient bituminous, filter type, preformed joint filler or AASHTO M 33 for bituminous type (asphalt type) preformed joint filler.

Cleaning Joints

The Project Manager must ensure adequate inspection of joint cleaning operations prior to sealing. *SSHC Subsection 603.03* discusses proper method of cleaning joints.

In order for the joint sealant materials to adhere properly to joint edge, joint edges need to be properly cleaned. All recemented sawing residue from the initial saw cut operation must be removed immediately after cut is made. If these joint faces are not properly cleaned, sealer will prematurely fail. This will start deterioration of pavement and will eventually result in spalled or faulted pavement due to water intrusion into joint.

The sandblast wand should have a means to positively guide the nozzle along actual joint line. This is to insure that sandblast passage does not miss any of the joint face. This can be seen when sandblast nozzle passage shows as a wavy line on the pavement surface.

Air compressors shall have suitable traps to remove moisture and oil.

Sealing Sawed Joints

The plans identify the joint sealant material to be used. All joints are to be sealed before any traffic, including construction traffic, is permitted on the pavement.

Joint Filling *(SSHC Subsection 603.03)*

Due to pavement crown, hot poured asphaltic or any flowable joint material may flow out of the joint leaving an opening below the pavement surface which allows entrance of sand and dirt into the joint opening. This will cause spalling of joint edges when pavement expands. To insure a properly filled joint across the entire pavement width, the contractor is required to tape the joint opening at pavement edge. This helps to prevent sealant from flowing out of the joint opening. A ball of mud plastered on the pavement edge is not to be allowed in lieu of required tape.

All joint sealant materials should be placed so that the top edge is approximately 6 mm below pavement's surface. See paving details or manufacturer's instructions for exact elevation. Excessive filling of transverse and longitudinal joints can result in excessive sealant material being forced out of the joint and soiling the pavement surface. Excess sealant material should be removed from pavement surface prior to project acceptance.

Sealing Equipment

Hot poured asphaltic joint material may be overheated in hot pour kettles. An overheated sealant has lost its elasticity and will prematurely fail. Thermometers on hot pour kettles need to be checked and replaced if necessary. Calibrated thermometers are available from Quality Assurance Manager to use in checking contractor's thermometers.

Backer Rod

Backer rod is approved on a brand name basis. Approved backer rods are shown in the NDR Approved Products List.

Doweled Support Assemblies *(SSHC Subsection 603.03)*

To insure that a doweled contraction joint will function as designed, it is critical that assembly be properly installed. Dowel bars provide load transfer across the joint without prohibiting the opening and closing of the joint during pavement temperature changes.

Dowel Tolerances

To permit pavement slabs to move longitudinally on the subgrade during expansion and contraction, dowels must be parallel to both centerline and surface of pavement. The plans show the dowel placement tolerances. Dowel assemblies should not be permitted to remain in place if wire supports cannot hold dowels in correct alignment. Position of outside dowel bar to edge of pavement slab shall be within plus or minus 25 mm (1 inch).

Dowel Assembly Placement

When placing assemblies on subgrade, contractors use bottom support wires of assembly as a guide for bar alignment. This is not objectionable provided bars are fabricated at proper angle to wire supports. Assemblies should be inspected for proper fabrication when delivered to project.

Contractors shall not be permitted to block up or support the assemblies on bricks to obtain proper height of dowel bars. When paving project has two different slab thicknesses requiring load transfer devices, the contractor shall furnish correct height basket dowel assemblies specifically fabricated to position bars at mid-depth in slab for each slab thickness.

Temporary wire fasteners, which hold some assemblies together for shipping, are to be cut if they extend across a joint. Check for movement of assemblies during passage of slipform paver. If properly set, the side forms of the paver should not come in contact with the ends of wire bar supports. Check to insure vibrators on paver or finishing equipment are set to proper height so vibrators do not touch steel during passage over assemblies.

Workers who position steel and vibrate concrete must not step on joint assemblies. Assemblies must be firmly anchored to subgrade or subbase with a minimum of eight stakes per 3.6 m (12 feet) width to resist horizontal and vertical movement during concrete placement and subsequent finishing operations.

Marking Joint Locations

Prior to paving, dowel midpoint must be marked on the subgrade or granular foundation course so an accurate saw cut location can be made on cured pavement. A narrow band of paint can be applied to the subgrade at midpoint of dowels in same direction as proposed saw cut. This band of paint must be kept as narrow as possible to minimize chance of error in correctly locating saw cut. An alternate method would be to place a dowel basket staking pin on either side of pad line.

Dowel midpoint markings should then be transferred to PCC concrete surface. This may be accomplished with a string line marking plastic concrete or by use of a chalk line after concrete has hardened. This should insure that the transverse joint will be sawn over the center of the dowel bar basket assembly. Do not permit the saw operator to eyeball joint sawing from one edge of the slab to the other.

Blanking Bands

The plans may indicate a blanking band be used to blank out the transverse texture over the center of the dowel assemblies. Care needs to be taken to ensure that the blanking band is correctly located over the center of the dowel assemblies. Using a blanking band will ensure a smooth, nontextured pavement surface at the midpoint on the dowel assembly.

Longitudinal Joint Design

The standard plans show joint layout details. The joint layout designs for paving plans have specific requirements for certain type joints which consider traffic movements during and after construction and the effect of the joint type on these traffic movements.

Joints should be constructed as shown in the plans, unless the Standard Road Plans allow for alternates. Any requests by the contractor for joint substitution shall be submitted to the Construction Division for review.

Curing of Keyed and Doweled Joints

The vertical sides of pavement in areas where joints are constructed~~,~~ *can be cured with* the use of a liquid curing compound is an acceptable method of curing this portion of the slab.

Generally, little or no bond is obtained or expected between vertical faces of adjacent concrete. Deformation on tie bars provide adequate lateral support.

Tie bars should not be sprayed with curing compound. They must be protected from the spray. If a curing compound is sprayed on steel, this film should be removed before placing adjacent concrete.

602.5028 Prevention of Rain Damage to Plastic Concrete

SSHC Sections 603 and *1002* require contractors to produce a quality product and have materials for proper protection of edges and surface of concrete available near work site. Contractor must protect pavement from damage due to rain. Failure to properly protect concrete may constitute cause for removal and replacement of defective pavement.

At the preconstruction conference, it is important to emphasize that protective coverings and temporary forms must be available and that protection of fresh pavement from rain damage is the contractor's responsibility. The contractor should be advised to follow the weather forecasts closely to prevent being caught unprepared in case of rain. Plastic film is preferred for surface and edge protection, since burlap alone in a heavy rain is insufficient to prevent access of water and subsequent pavement surface erosion.

The District Engineer and the Construction Division should be notified when pavements are damaged by rain so an evaluation of the damage can be made. Acceptance or rejection of damaged portions of pavement will be based on the extent of damage incurred as determined by the Project Manager. Repair of damaged edges and surface may be considered, but extensively damaged pavement may require removal and replacement.

602.5029 Repair of Deficient Pavement

Pavements damaged by rain and deficiencies caused by poor workmanship may be repaired or restored to an acceptable condition without complete removal and replacement of damaged areas.

Rain damage varies considerably depending on rainfall intensity, duration, and protective measures taken by contractor. Covering and side forms placed by the contractor afford sufficient protection to unhardened concrete in some cases. In other cases, surface and edges may erode to such a degree that removal and replacement of slab is the only solution.

Guidelines follow for corrective measures that may be taken or used to restore damaged pavement to an acceptable condition. This instruction is not intended to cover the whole spectrum of correcting deficiencies that may occur on a paving project during construction. Other proposed procedures or methods suggested by the contractor may be considered.

Recommended Repair Method *(SSHC Subsection 108.05)*

A. Rain Damage and Excessive Edge Slump

1. On plastic concrete:

- Pavement surfaces which have slight surface damage due to placement of protective covering or sandy appearance may be retextured provided concrete is still plastic and in workable condition.

- Pavement surface which has texture removed and coarse aggregate exposed may be reworked by adding fresh concrete (same mix as pavement) to surface, rescreeding, texturing, and curing. Areas reworked must also meet specified smoothness requirements.

- Eroded edges may be repaired by setting side forms and replacing eroded concrete with fresh mix.

- Excessive edge slump may be corrected by setting side forms of proper height along slumped edge and refinishing to the correct elevation.

2. After concrete has cured and hardened:

   - Pavement surfaces that have lost transverse groove texture without affecting surface profile shall have transverse or longitudinal grooves reestablished.

   - Pavement surfaces which have been severely eroded require reprofiling by diamond grinding equipment and subsequent reestablishment of transverse grooving.

   - Minor edge erosion and edge slump with a key and doweled joint and adjacent slab need to be butted to existing pavement. Establish a new edge, not to exceed 75 mm (3 inch) in from previous edge, by sawing to the top of the tie bar, remove concrete and replace when new adjacent pavement is poured. If necessary to go more than 75 mm (3 inch) from edge of pavement to correct eroded or slumped edge, the edge shall be repaired by using pavement patching methods prior to pouring adjacent slab.

   - Excessive edge slump may be repaired by using pavement patching methods.

   - Edges or panels that have been severely eroded may require all or a section of lane to be removed or replaced. If determined that a section of lane more than 600 mm (2 ft) in width should be removed, then entire lane or panel shall be removed and replaced with new concrete. Areas less than 600 mm (2 ft) in width shall require full depth repair with holes drilled and tie bars installed to anchor new concrete to remaining concrete.

   - For areas with extreme severely eroded surface and edges, contractor should be required to place a bonded PCC overlay.

B. Vehicle Traffic on Plastic Concrete

Remove and replace sections where rutting is severe.

Minor wheel track rutting may be repaired by using pavement patching methods.

C. Shrinkage Cracks

Remove and replace affected areas with new pavement in severe cases.

Minor cracks may be filled with pressure injected epoxy or repaired using pavement patching methods.

D. Rough Pavement Sections

Surface variations which exceed specification smoothness requirements require correction by the contractor. Surface correction shall be accomplished with approved diamond grinding equipment. Use of milling machines, Roto Mill, Galion Scarifier, or other impact devices shall not be permitted.

Reestablishing transverse grooving of corrected areas is not required but longitudinal grooves must be established. Equipment for regrooving shall be specifically designed for grooving concrete with a cutting head fitted with diamond blades. Use of hand held equipment is not permitted.

E. Limitations

Necessary corrective measures on hardened concrete shall only be made after concrete attains age and strength requirements in *SSHC Section 603*.

All required corrective measures shall be completed prior to coring for pavement thickness measurements.

Approval of the Construction Division is required before placing a bonded PCC overlay.

602.5030 Mud Ball Repair

Occasionally mud balls appear in the surface on new concrete pavements. These usually are due to clay balls from a quarry or mud thrown into dump trucks from portable batch plant located at a wet site.

Correction of any discovered mud balls in pavement surface shall be as follows:

- Any thin concrete skin around perimeter of mud ball should be removed so that nearly vertical void walls remain.
- Each void shall be cleaned by a high pressure washer, followed by air blasting to dry void.
- Voids shall be filled with an approved grout. This material shall be used according to manufacturer's recommendations.
- Surface of filled voids shall be given the same texture as surrounding pavement.
- Void shall be given proper cure time recommended by manufacturer prior to opening roadway to normal traffic.

If a severe problem with mud balls is suspected and the suspicions have been document, then formal acceptance by Project Manager should be delayed until the following spring. This will allow the winter freeze-thaw cycles and snowplowing activities to expose additional mud balls located adjacent to pavement surface. These newly discovered mud ball areas will then also require corrective measures as stated above. The Project Manager may also elect to have the contractor use a high pressure sprayer (1200 psi) to locate mud balls and allow the project to be finalized immediately after any repairs are made.

602.5031 Cold Weather Paving and Plant Operations

Cold Weather Pavement Protection

During cold weather, *SSHC Subsections 601.01, 603.03* and *1002.02* requires that newly placed paving be protected against freezing temperatures. This protection is necessary to allow the hydration process of the curing concrete to continue in cold weather. Adequate protection of concrete allows for paving to be placed later in the cold seasons.

Materials that may produce acceptable insulation include:

- 3 layers of Burlene.
- 1 layer of Fast Track Blankets.
- 1 layer of 12 mm (1/2 inch) extruded polystyrene, must be weighted down.
- 2 layers of 6 mm (1/4 inch) air celled polyethylene.
- 1 layer of 12 mm (1/2 inch) air celled polyethylene.

Do not advise contractor regarding cold weather protection.

When cold weather protection is required, the contractor will not be reimbursed for whatever protection is used.

Cold Weather Plant Operation

SSHC Subsection 603.03 states that concrete mixing and placement may be started when air temperature is at least 5°C (40° F) and rising. In the late fall season before the subgrade begins to freeze and soil temperatures are still relatively warm, it is permissible to allow paving plant operations to begin below 5°C (40° F) providing a warming weather forecast is predicted. Paving plant operations basically self regulate during these conditions.

The intent is to maximize the remaining good paving weather still available in the fall. This provision is not intended to make a paving day out of one that is not but to allow for as much concrete pavement placement as possible during good weather.

After the subgrade begins to freeze, the above provisions should be halted and the Specifications strictly enforced.

602.60 PCC PAVEMENT METHOD OF MEASUREMENT

602.601 Smoothness Tests (Profilograph)

1. See *SSHC Section 602* for profilograph procedures.

2. When the contract Special Provisions require the smoothness of the concrete pavement to be tested by measurement with the profilograph, it is necessary and a requirement of the Provision that the thickness cores be taken after to any surface correction (grinding) by the contractor.

3. Since the thickness cores are taken by personnel from the Materials and Research Division (Lincoln), it is necessary they be kept posted as far in advance as possible when the coring must be done. It is generally preferable to do the coring prior to opening the pavement (segments in some cases) to traffic. Accordingly, prior planning is necessary and shall be accomplished by the Project Manager. Contact Rhonda DeButts at 479-4760 or Dave Hall at 479-4837 in the Materials & Research Quality Assurance Section.

602.602 Requirements for Thickness

SSHC Subsection 603.05 indicates the thickness requirements and includes a table of payments to be made for concrete of less than plan thickness. The table is based on the premise that a pay deduction should be proportioned to the reductions in service resulting from thin pavement. Thus the reductions in payment are quite severe.

602.603 Material Quantities

Concrete pavement is measured for payment in square meters in place and accepted, minus deductions. The reinforcing steel and dowel bars required by the Plans and Special Provisions will be considered subsidiary to the other pay items in concrete pavement construction.

SSHC Subsection 603.04 states that the quantity of concrete pavement will be measured by the square meter. This is interpreted by the Construction Division to mean that when the plans, stakes, etc., order a nominal width of pavement and the Project Manager determines that this nominal width requirement is met or exceeded, the nominal width will be used to compute the quantity for the concrete pavement item, i.e., the contractor should not be permitted to increase his/her compensation by purposely or inadvertently constructing the pavement to a width greater than the nominal width.

Base course, foundation course, and subgrade preparation are not measured quantities. They are established quantities that are based on the paved area.

602.604 Concrete Driveways

SSHC Subsection 609.04 states that concrete driveways will be measured by the square meter. This is interpreted by the Construction Division to mean that when the Project Survey Crew stakes the driveway for certain dimensions these are the dimensions that will be used to compute the area for payments.

602.605 Records and Reports

Daily Report of Concrete Pavement Laid (DR Form 85) should be prepared daily. The cylinder data for the day covered by the report should be written at the bottom of the form. Reports should be delivered to the plant inspector as early as possible so he/she may complete his/her records for the day reported.

When reporting multilane pavement, or when paving one lane on 2-lane pavement always report the lane being paved. Identification of the lane on multilane pavement should be positive - such as: 12' lane, 12'-24' Rt. of centerline. Lack of this information may result in confusion and delay in preparing the pattern of cores for the core drill. Sketches of irregular areas should be shown on the reverse side of the slab report DR Form 85, or prints of intersections and other unusual layouts may be ordered from the Lincoln Office for the purpose of logging daily pour information and should be turned in with the slab report which substantially completes the area involved. Sketches need not be elaborate but should clearly identify the area placed with any necessary dimensions. A diary record is also required.

Section corners falling within the area of the concrete pavement may be perpetuated by a registered land surveyor who will take a core as described in *CM Section 1300.03*, "Perpetuating Section Corner Markers". In many instances it may be possible to set the section corner while the concrete is plastic and cores need not be taken. If cores are needed to set the section corners, a list of the corners to be so perpetuated should be submitted to the Materials and Research Division as early as possible prior to the time that the pavement is to be cored. This list should include the station location and distance right or left of centerline of each section corner to be cored.