411 Preparing the Grade for Concrete Pavement

411.1 Preparation of Foundation for Concrete Pavement

411.1.1 Base Course

Preparation of foundation for concrete paving is usually a minor item that includes reshaping of the completed base course to remove holes and ruts, correction of isolated soft spots, and minor grade adjustments. If the base course and concrete pavement are included in the same contract, preparation of foundation for concrete pavement is usually not a bid item. The exception to this is when the base course is used to carry traffic or is expected to lay over from one season to another. The reason being that, factors beyond the control of the contractor may disrupt the base course after its placement and before paving. Regardless of whether the item is bid or not, the work to be done is the same.

The base course must provide a smooth, uniform, and substantial support for the pavement. If it does not, random slab cracking between joints, tilting, or subsidence of the complete slab may occur.

The foundation for the concrete pavement is considered to extend 12 inches beyond the edge of the pavement. The base course should be trimmed and shaped to the required elevation for the full width and compacted to the required density. Unless the contract specifies special compaction, required density means the degree of compaction necessary to preclude rutting or displacing of the material under traffic as required for standard compaction of base courses under standard spec 301.3.4.2.

The base should be compacted to about 1 inch higher than plan elevation to allow the trimming machine to cut across the whole top of the base. It will be necessary to recompact disturbed base material after trimming. Excess base course material should be disposed of outside the track line in a manner as not to interfere with paving operations.

The base should be completed for a minimum of not less than 300 feet in advance of paving operations to avoid stops and starts in paving. Soft spots should be removed, replaced, and compacted before starting to pave. Ruts and ridges should be rolled out. Damaged areas resulting from hauling trucks must be corrected before being overlaid by pavement.

411.1.2 Slip-Form Method

Standard spec 211 requires the areas that support the slip-form paver to be brought to the required grade by a properly designed machine, and the area on which the pavement is to be placed to be brought to the required grade and cross section by means of a machine designed specifically for trimming foundations. The machine must use automatic sensors to trim to the required grade and cross section.

411.1.3 Form Method

The final, true cross section of the base is established after the forms have been set. This is accomplished by using a subgrade trimming machine which rides on the forms. It is equipped with cutters that trim the grade to its true cross section and with a belt conveyor that deposits excess material outside the form line. During this operation the subgrade surface is generally disturbed to the extent that rolling is required to restore it to the original state of compaction.

411.2 Testing Base Course

The base must be tested or checked by the contractor for grade and cross section immediately before placing of concrete when slip-form methods are used.

When forms are used and hauling, or other equipment is allowed on the prepared foundation, a subgrade planer must be operated ahead of the concrete being deposited or the foundation must be restored as necessary.

411.2.1 Slip-Form Method

One of the more important aspects of slip-form construction is fine grading base materials to very close grade and cross section tolerances. Tight tolerances are essential with slip-form methods because of the effect base condition has on concrete quantity, slab thickness, and ultimate pavement strength and rideability. Checking these tolerances will probably prove more difficult with slip-form than with form paving methods due to the absence of side forms that may be used for elevation reference.

The base must be checked to ensure adequate pavement thickness using stringlines, levels, a rolling template, a dry run of the slip-form paver, or other methods. The grade must be finally checked after corrections and adjustments are made and just before placing concrete on the grade. Equipment, methods, and procedures used by the contractor in testing the grade are subject to approval by the engineer.

411.2.2 Form Method

The purpose of the subgrade planer is to plane off uneven projections in the base and to act as a template to check the required depth and cross section of the pavement slab. It should be heavy
enough to accomplish this without raising the wheels off the forms. Where the grade is high and considerable material is carried ahead, or the base is disturbed excessively, corrections should be made in the grading or shaping operation in advance of the paver. It may also be an indication that form settlement is taking place. Loose material carried by the planer must be removed from the grade and not used to fill low spots. Fillets of loose material along the bottom edge of the forms should be removed and the bottom edge of the forms exposed. Frequent checks should be made to ensure the cutting edges are set for the proper depth and are tightened securely to the frame. Notes relating to such checks should be entered in the paving diary and should include date and time of check, together with the location and stationing of the check.

411.2.3 Adjusting Pavement Grades
Due to traffic, maintenance, or other causes, the profile grade of a base course constructed under a previous contract may deviate from the proposed grade. If minor adjustments need to be made in the pavement grades, the goal should be to disturb the base course as little as possible. The adjustments are limited to the extent that smooth transitions, surface drainage, foundation strength, and good riding qualities are not impaired. When adjustments are made, the rate of transition should not exceed 1 inch in 100 feet.

To establish a pavement profile that will most closely conform to the existing base, elevations should be taken well in advance of the time of construction to afford ample opportunity to select a profile that best meets the conditions.

If the base thickness is close enough to plan thickness to be acceptable, no base material should be added. Avoid cutting when it results in less than the plan thickness of base. If an extensive area of significantly deficient thickness is encountered within the pavement limits, it should be called to the attention of the engineer for determination of proper corrective procedure.

No adjustments should be made in grades established by a municipal ordinance.

411.3 Concrete Paving Over Existing Surfacing
Concrete pavement placed over existing asphaltic or concrete surfacing may require:
- Patching of the base.
- Wedging to achieve a smooth grade line by filling in sags with asphaltic mixture.
- An asphaltic leveling course may need to be placed to restore profile and provide a bond breaker over existing concrete pavement. This is a design consideration and if necessary, should be provided for in the contract.
- A polyethylene bond breaker may need to be placed over existing concrete pavement to avoid reflective cracking. This is a design consideration and if necessary, should be provided for in the contract.
- Defective areas and patches in the existing surfacing will need to be found and marked for repair or removal.
- The existing profile will need to be surveyed and plotted to locate low areas and sags. Wedging limits will need to be marked on the pavement.
- Cross slope and crown will have to be surveyed and plotted to determine if super-elevation and crown need to be corrected before overlay.

411.4 Setting String Lines and Forms
411.4.1 String Lines
If the slip-form method of paving is used, string lines are set to indicate alignment to the automatic sensing devices that guide the paver. The autograde used to trim the base to final elevation also uses the string line for grade as well as for alignment. To establish the string line, the survey crew will drive hubs with tacks and the contractor then will set the string line from these hubs. The inspector and the contractor should know which elevation has been set by the survey crew. An alternative to the hubs would be paving pins set on line, with elevation marked by tape.

The paving inspector is responsible for the following tasks:
- Inspect the string lines for correct elevation and line.
- Obtain the horizontal and vertical offsets from the survey crew or from the guard stake information.
- Visually check for straightness or for a smooth curve.
- Measure between the string lines for a check on pavement width.
- Check the firmness of the line supports and bracket arms, and the tautness of the strings.

Use string lines to establish a smooth grade on approaches to bridges, railroad grade crossings, or adjacent pavements. Twenty or thirty feet of the approach nearest the structure or crossing should be on the same plane as the structure to ensure a smooth riding approach. When setting string line or
forms for pavement undemeath a structure, the required vertical clearance above the pavement should be checked.

Excess base course material trimmed off by the autograder should be conveyed to the side of the roadway. If not removed at once, openings should be cut through the windrow at intervals to allow water to drain off the base.

411.4.2  Forms

Standard spec 415.3.1.6 is explicit in the requirements for steel forms. When forms become so deformed or badly worn they cannot provide and maintain specified alignment for the face and top, or the keys and locks fail to provide the necessary rigidity under the mass and forces of the finishing equipment, they should be rejected and not used until acceptably repaired or replaced.

Form depths should equal the depth of the pavement to be constructed, but the specifications allow using built-up forms where the area of any specified thickness does not exceed 2,000 square yards. According to standard spec 415.3.7 metal or wood plates providing adequate support must be used to build up the form and must be securely attached to the form.

Permission to use forms of a depth not to exceed one inch greater than pavement depth may be granted by the engineer under special circumstances.

The construction survey crew will establish line and grade for the paving operation. The survey crew will place paving pins at a predetermined offset from the edge of pavement and will mark an elevation, usually the edge of pavement, on the pins. Be sure the inspector and the contractor know which elevation is being used.

The forms must support heavy loads and withstand lateral forces imparted by the finishing equipment. It is important that the foundation is thoroughly compacted, and uniform support is provided for the full length and width of the form base. If it is necessary to trim more than 2 inches from the base or to raise it more than 2 inches to set forms, the full base should be corrected before forms are set. After the forms have been set, material under the forms must be thoroughly tamped, either with a mechanical tamper or a suitable hand tamper, under the face and back of the form. Probing with a steel pin readily discloses how effectively this has been done. Guard against excessive tamping in one spot as this has a tendency to raise the form above the true grade. After setting and tamping, the forms should be visually checked for grade and alignment and adjusted, if necessary, to provide a smooth uniform grade and proper alignment.

The foundation under forms placed before a rain should be checked for stability. Careful probing undemeath the forms will disclose whether the material is firm enough to prevent settlement under the heavy equipment. Instances of deficient pavement have been attributed to such settlement.

The inspector should be making the following checks:
- Check the top of forms for straightness on tangent or for smoothness on curves.
- Measure between form faces for a check on slab width.
- Be sure the forms are set at the correct elevation.
- Check that the forms are true and not warped, are of the correct depth for the proposed concrete slab depth, are set with the face vertical, and are heavy enough to support the paving train.
- Check that the forms are locked and pinned securely.
- Check for form settlement.

Forms should be sprayed with oil before use to prevent sticking. Forms should be set well in advance of the paving to ensure that placement of the concrete will be smooth and continuous to avoid a rough surface. Standard spec 415.3.7.1 requires forms to be set and maintained for at least 1200 square yards in advance of paving.

Any excess base between the forms should be trimmed off well in advance to avoid delay in paving. The excess base will be trimmed off by a subgrade machine riding on the forms, and the excess base course material will be conveyed to the side of the roadway. The resulting windrows should either be removed at once or openings should be cut to allow water to drain. Otherwise, the base may become waterlogged during rains as water is ponded by the windrows and will rut under construction traffic and result in thin, rough pavement.

The subgrade trimming machine must be heavy enough to stay on the rails and not be raised off the rails in areas of heavy trimming. The inspector should check to ensure that the base has been removed to the correct depth at the face of the forms. After the trimming, the base should be re-compacte...