

6-300 BASE COURSES

6-300.1 GENERAL

Roadway composition consists of several layers, each serving a different purpose. These layers, called courses, are placed on the original ground to provide strength. When a roadway section must be raised to achieve the required grade, embankment is placed on the original ground (refer to Section 6-203, Excavation and Embankment). Following is an overview of each layer, which is collectively known as the roadway "structural section":

- Original ground – The ground on which the roadway will be built.
- Borrow/Embankment – Soil that is placed on original ground to bring the roadway to the desired elevation.
- Type 1 Class B aggregate base – Aggregate base is granular soil with a variety of particle sizes, which is designed to provide strength for the roadway.
- Plantmix bituminous surface (Type 2 coarse) – A mixture of aggregate and asphalt that provides strength to support vehicle traffic loads.
- Plantmix bituminous open-graded surface – A mixture of aggregate and asphalt that provides a smooth riding surface for traffic.

Figure 6-300.1 shows a typical cross section of a roadway structural section.

Each layer of the structural section has unique costs and physical characteristics. The structural section used on a project is determined by considering variables such as cost, climate, and material availability.

Overall pavement quality, structural longevity, and riding smoothness depend on the quality and uniformity of the base course layers. Poor base course construction can affect the long term performance of the roadway.

Base courses may consist of aggregate, aggregate mixed with asphalt, or aggregate mixed with cement. Base courses are used to provide strength in the roadway and to distribute vehicle loads to a larger area on the original ground.



Figure 6-300.1. Typical Roadway Structural Section.

6-302 AGGREGATE BASE COURSES

6-302.1 GENERAL

The plans include roadway cross sections that detail where to place aggregate base. The cross sections also show the aggregate base thickness.

NDOT distinguishes aggregate bases by gradation (Type 1, 2, or 3) and by the manner in which the material is processed and placed on the roadway (Class A or B). Following are descriptions of each of these elements:

- Type 1 aggregate has a maximum size of one inch.
- Type 2 aggregate has a maximum size of $\frac{3}{4}$ inch.
- Type 3 aggregate gradation is unique to specific projects; see the project specification for details.
- Class A aggregate is mixed with water before delivery to the roadway, where it is placed and spread in a single operation.
- Class B aggregate is typically stockpiled material that is delivered to the roadway, mixed with water, and processed on the roadway before being spread and compacted.

Because Class A aggregate requires greater control in processing, placing, and spreading than Class B aggregate, Class A aggregate is typically more costly than Class B. Although the contractor is not required to mix Class B aggregate in a mixer, if the contractor elects to do so, payment is made only at the Class B aggregate price. Refer to the specifications regarding requirements for the aggregate base.

6-302.2 CLASS A AGGREGATE BASE

Class A aggregate is mechanically mixed to create a homogenous material with uniform moisture. This processing takes place at a central mixing plant before delivery to the roadway. After transport to the roadway, the contractor places and spreads the processed aggregate in a single operation using a self-propelled spreader with a screed. Figure 6-302.1 shows a Class A aggregate base spreader. If approved by the Resident Engineer, the contractor may use a motor grader if the blade is equipped with wings, the blade is locked into position, and the blade has an electronic grade-sensing device. Once placed, the contractor compacts the aggregate to the specified density and trims the aggregate to the required elevation.



Figure 6-302.1. Class A Aggregate Base Spreader.

6-302.2.1 BEFORE CONSTRUCTION

Successful aggregate processing and placement depends on a thorough understanding of the plans and specifications relating to aggregate base. In reviewing the plans and specifications, pay attention to the following areas:

- Material gradation
- Moisture content
- Mechanical mixing requirements
- Placement and spreading method
- Typical sections and profile sheets
- Compaction requirement
- Surface tolerance
- Weather limitations
- Measurement and payment

Additionally, the Resident Engineer coordinates with the contractor about the planned sequence of operations so the Resident Engineer's crew can inspect and test effectively and efficiently. Before the contractor delivers aggregate for placement, the inspector coordinates and schedules required testing with the field tester.

Before placing aggregate, the contractor finishes the subgrade. The subgrade is acceptable when compaction tests have been taken and have passed minimum requirements. To determine if the grade and surface tolerances are acceptable, the inspector confirms that the subgrade has been graded to the elevation of the Red Heads. Finally, the inspector checks the subgrade surface for defects.

Before placement, determine which equipment the contractor plans to use for aggregate and water mixing, and for spreading and placement. Confirm that the equipment conforms to specifications. Discuss the thickness of each placement layer with the contractor, making sure the layer thicknesses do not to exceed the maximum stated in the specifications. Additionally, confer with the contractor and the survey crew chief to confirm that sufficient grade controls are in place. The contractor can then use the established grade controls for the automated grade control operation, such as a wire line. A wire line is a common technique in which a wire is set along the roadway shoulder. Placement equipment electronically senses the wire elevation and adjusts the grade of the aggregate base.

6-302.2.2 DURING CONSTRUCTION

After the contractor adequately prepares the subgrade and the inspector has reviewed the material processing operation, the inspector monitors the placement and spreading of the Class A aggregate. As the material arrives at the roadway, the inspector monitors the placement and spreading operation. Observe that the aggregate remains homogenous and is moist. A homogenous mix reduces the potential for defects. With the proper moisture content the contractor can efficiently achieve compaction.

As the material spreading progresses, the survey crew should periodically check that the contractor is constructing the proper grade. The inspector should continuously monitor the finished surface to verify conformance with specifications. Early monitoring of grade and surface tolerances allows time for adjustments before a substantial amount of material is placed. During the placement operation, tests and frequencies must be consistent with Table 5.1 in Section 5, Sampling and Testing, of this *Construction Manual*. Immediately following acceptance of the compacted aggregate base, the contractor is typically required to apply a prime coat to reduce moisture loss and retain compaction. See Section 6-406, Prime Coat.

The inspector must keep complete and accurate records of material quantities. Inspector reports should include information and observations relating to the equipment, operations, and materials incorporated into the work, especially anything considered uncommon. Records relating to measurement and payment must conform to the requirements of the *Documentation Manual*. When the payment method is by weight, collect and record load tickets for each truck as the load is delivered to the project.

6-302.2.3 MEASUREMENT AND PAYMENT

The specifications state the measurement and payment methods for aggregate base. Class A aggregate base is commonly measured by cubic yard or by ton. When measured by cubic yards, the cubic yards are calculated based on the cross section in the plans. When measured by tons, the aggregate is weighed after mixing but before placement. Only material that is incorporated into the work is included for payment.

Because Class A aggregate base is comparatively expensive, monitor measurements closely. When the measurement and payment method is by weight, remember to adjust the measured weight for moisture. Excessive water in the aggregate creates an artificially high weight for payment. The maximum weight for payment includes only the optimum moisture content plus one percent. Refer to the *Documentation Manual* for additional requirements.

6-302.3 CLASS B AGGREGATE BASE

Class B aggregate does not require mixing before delivery to the roadway. Class B aggregate is typically transported from the stockpile and placed directly on the roadway. To achieve the required moisture content, the contractor applies water before and during processing and spreading. A motor grader processes the aggregate on the roadway, then spreads or distributes the material. Once the material is spread, it is then compacted.

6-302.3.1 BEFORE CONSTRUCTION

Successful inspection of aggregate processing and placement depends on a thorough understanding of the plans and specifications relating to aggregate base. Class B aggregate is typically mixed on the roadway, which creates a homogenous mixture of aggregate sizes and evenly distributes moisture.

In reviewing the plans and specifications, pay attention to the following areas:

- Material gradation
- Moisture content
- Mixing requirements
- Placement and spreading method
- Typical sections and profile sheets
- Compaction requirement
- Surface tolerance
- Weather limitations
- Measurement and payment

Additionally, review the sequence of operations with the contractor so testers and inspectors can perform their tasks effectively and efficiently. Discuss the thickness of each placement layer with the contractor, making sure not to exceed the maximum stated in the specifications. Before the contractor transports the aggregate for placement, the inspector confirms that the tester is scheduled to perform the required tests.

Before placing aggregate, the contractor finishes the subgrade. The subgrade is acceptable when compaction tests have been taken and have passed minimum requirements. Finally, the inspector checks the subgrade surface to confirm that there are no defects.

Before placement, discuss equipment, methods, and sequence of operations with the contractor. An understanding of the contractor's plans allows the inspector to coordinate testing.

6-302.3.2 DURING CONSTRUCTION

After the contractor has prepared the subgrade, the inspector monitors the placement and processing of the Class B aggregate. The inspector should observe that the hauling operation does not disturb the prepared subgrade.

As the material arrives at the roadway, the inspector monitors the placement and spreading operation. The inspector periodically calculates the yield, which is the amount of material placed per station for the spread width. The inspector should make sure that the aggregate remains homogenous with a consistent moisture content. A homogenous mix reduces the potential for defects.

The contractor takes the following steps to achieve a homogenous mix:

- Spread the material in a uniform windrow on the roadway.
- Thoroughly mix the material by blading the mix from one shoulder to the center of the roadway, and back to the shoulder.
- Uniformly distribute the water to efficiently achieve compaction.

After processing, spreading, and compacting the material, the contractor finishes the aggregate base to the grade stakes placed by the survey crew. Grade stakes, typically called Red Heads, are placed to indicate the elevation of the finished aggregate base. For more information, see Section 4-304.2, Grade Stakes, of this *Construction Manual*.

Because Red Heads are placed after processing, spreading, and compaction, the inspector coordinates with the survey crew to reduce contractor delays. Early monitoring of grade and surface tolerances allows time for adjustments before placing a substantial amount of material. During the placement operation, tests and frequencies must be consistent with Table 5.1 in Section 5, Sampling and Testing, of this *Construction Manual*. Immediately following acceptance of the compacted aggregate base, the contractor is typically required to apply a prime coat to reduce moisture loss and retain compaction. See Section 6-406, Prime Coat.

The inspector must keep complete and accurate records of material quantities and qualities. Daily inspector reports should include information and observations relating to the equipment, operations, and materials incorporated into the work, especially anything considered uncommon. Records relating to measurement and payment must conform to the requirements of the *Documentation Manual*. When the method of payment is by weight, collect and record load tickets for each truck as the load is delivered to the project.

6-302.3.3 MEASUREMENT AND PAYMENT

The basis of measurement and payment of aggregate base is stated in the specifications. Coordination with the contractor regarding the details of measuring the material makes the measuring process efficient. Class B aggregate base is commonly measured by volume or by weight. When measured by volume, the volume is calculated based on the cross section in the plans. When measured by weight, the aggregate is weighed before transporting to the roadway.

When the measurement and payment method is by weight, remember to adjust the measured weight for moisture. Excessive water in the aggregate creates an artificially high weight for payment. The maximum weight for payment includes only the optimum moisture content plus one percent. Only material that is incorporated into the work is included for payment.

On projects that require small quantities of aggregate base at several locations, such as wheelchair ramps or sidewalks, measurement of aggregate quantities is modified. Weighing several small loads of aggregate is not practical. Typically, a contractor may stockpile the material on the project. Smaller amounts of the stockpiled aggregate are then transported using a loader or other small equipment. To determine the amount of material for payment, the inspector first determines the volume of aggregate placed by the contractor. The volume is then converted to weight, using the unit weight of the material obtained by the tester.

6-303 ASPHALT TREATED PERMEABLE BASE**6-303.1 GENERAL**

Water that enters a pavement's structural section can impair the strength and durability of the pavement. To allow water to drain from the structural section, base courses can be designed to provide drainage. Asphalt treated permeable base is one means of providing drainage. Asphalt treated permeable bases are often used under portland cement concrete pavements. In addition to providing strength, asphalt treated permeable bases allow water to drain away from the pavement. Removing the water reduces hydraulic erosion that may wash away fine aggregate. Asphalt treated permeable base requires an edge drainage system to collect and remove water from the structural section.

6-303.2 BEFORE CONSTRUCTION

Successful inspection of material processing and placement requires a thorough understanding of the plans and specifications relating to asphalt treated permeable base. In reviewing the plans and specifications, pay attention to the following areas:

- Material gradation
- Moisture content
- Mixing requirements
- Placement and spreading method
- Typical sections and profile sheets
- Compaction requirement
- Surface tolerance
- Weather limitations
- Measurement and payment

Asphalt treated permeable base is prepared at a batch plant that combines the aggregate, asphalt, and mineral filler. The material is then transported to the roadway, where it is placed and compacted.

Typically, one inspector monitors the batch plant and another inspector oversees the placement and compaction. For guidance on batch plant inspection, refer to Section 6-400, Surface Treatments and Pavements.

Before the contractor places material on the roadway, the contractor finishes the aggregate base. The aggregate base is acceptable when compaction tests have been taken and have passed minimum requirements. To determine if the grade and surface tolerances are acceptable, the inspector confers with the survey crew. The inspector visually checks the surface for defects. Before placing the asphalt treated permeable base, the contractor is typically required to apply a prime coat to reduce moisture loss, retain compaction, and create a moisture barrier. For more information, refer to Section 6-406, Prime Coat.

An approved mix design is required. The approved mix design provides the basis for the contractor to submit a proposed job mix formula to the Resident Engineer. The Resident Engineer then establishes a job mix formula for production and delivery to the project. The job mix formula provides a range of values and is used to monitor the materials being produced for incorporation into the work, such as gradation, temperature, and bitumen ratio. The contractor must request and the Resident Engineer must approve any modifications to the job mix formula. If approved, a new job mix formula would be established by the Resident Engineer. Refer to Section 6-401.2.2, Job Mix Formula.

Coordinate with the contractor to confirm that sufficient equipment and labor are available for spreading, compacting, and trimming before starting batch plant operations. Before the contractor begins paving, confirm the placement width of each spread. The contractor should minimize construction joints both longitudinally and transversely to build a stronger base.

Requirements for placing the asphalt treated permeable base are the same as other plantmix bituminous pavements. Refer to Section 6-400, Surface Treatments and Pavements.

6-303.3 DURING CONSTRUCTION

Before placing asphalt treated permeable base, the contractor constructs a test section. The test section will use the same equipment and procedures that will be used for the roadway. Observe and document rolling patterns for each roller. After a rolling pattern produces the required results, the contractor uses the same rolling pattern for subsequent placement of asphalt treated permeable base.

The thickness of the compacted base is important to the strength of the completed section. During placement, allow for consolidation of the base caused by rolling. If the grade of the material placed exceeds the planned grade by more than 5/8-inch, the contractor must take corrective action. If the grade of the material placed is below the planned grade by more than 5/8-inch, the contractor may be required to remove and replace the material. The contractor may be required to modify the spreading operation if it produces a grade that requires an excessive amount of trimming.

The specifications require the contractor to place asphalt treated permeable base in one lift, and, although it has no density specification, it is compacted in accordance with the rolling pattern established by the test section, and to the Resident Engineer's satisfaction. The inspector should pay attention to construction joints at the end of each day, making sure they are smooth and thoroughly compacted. Be aware that bumps or depressions at these joints invariably show up in the finished surface.

Because surface irregularities transfer to the finished surface, an inspector uses a 12-foot straightedge to identify variations in the surface of the asphalt treated permeable base. The contractor must use methods approved by the Resident Engineer to correct areas that are not smooth or are otherwise defective. Construction traffic entering or exiting the placement operation may contaminate the material being placed, not allowing the permeable base to drain as designed. Construction traffic may also cause surface irregularities. The inspector should monitor and confirm that the contractor minimizes construction traffic and takes corrective action to address contamination or surface irregularities.

Improper spreading, poor grade control, changes in rolling patterns, or types and weights of rollers may affect the finished surface of asphalt treated permeable base. Whenever equipment or procedures differ from those used for the test section, the contractor may need to construct a new test section at the Resident Engineer's request.

The inspector must keep complete and accurate records of material quantities. Daily inspector reports should include information and observations relating to the equipment, operations, and materials incorporated into the work, especially anything considered uncommon. Records relating to measurement and payment must conform to the requirements of the *Documentation Manual*. When the payment method is by weight, collect and record load tickets for each truck as the load is delivered to the project.

6-303.4 MEASUREMENT AND PAYMENT

Measurement and payment are described in the specifications and the *Documentation Manual*. Measurement and payment are usually by the ton, so accurate weighing of the material is required. Do not use material on the roadway that has not been properly weighed. Also, be sure to record the quantity on the proper forms.

6-304 PORTLAND CEMENT TREATED BASE

6-304.1 GENERAL

Cement treated bases are used under both plantmix bituminous pavements and portland cement concrete pavements. With cement treated bases, the structural section thickness is less than that required for untreated aggregate bases. The addition of cement to the aggregate increases the structural strength.

6-304.2 BEFORE CONSTRUCTION

Successful inspection of cement treated base processing and placement requires a thorough understanding of the plans and specifications. In reviewing the plans and specifications, pay attention to the following:

- Material gradation
- Moisture content
- Mechanical mixing requirements
- Placement and spreading method
- Typical sections and profile sheets
- Compaction requirement
- Surface tolerance
- Weather limitations
- Measurement and payment

Additionally, the inspector should coordinate the sequence of operations with the contractor so testers and inspectors can perform their tasks effectively and efficiently.

Before placing cement treated base, the aggregate base is finished. The aggregate base is acceptable when compaction tests have been taken and have passed minimum requirements. To determine if the grade and surface tolerances are acceptable, confer with the survey crew. Finally, visually inspect the subgrade surface for defects.

Two methods of mixing cement treated base are plantmix or roadmix. NDOT only specifies mixing cement treated base using the plantmix method.

The plantmix method of mixing utilizes a central mixing plant to combine the aggregate, portland cement, and water. The material is then transported to the roadway, where it is placed and spread. Once in place, the cement treated base is compacted, sealed, and cured. Typically, one inspector monitors the mixing of the material at the plant, and another inspector oversees the placement operation.

The specifications allow using various types of mixing equipment. Any type is acceptable if it produces a satisfactory product. The most common type of mixer is the pugmill, which consists of revolving blades or paddles on a shaft. Depending on the capacity, the pugmill may have more than one shaft. The mixer is loaded, or charged, at one end and discharged at the other. Batch weights or volumes control the quantity of material in the mixer when material is prepared a batch at a time. For continuous mixing, adjustable vertical gates control the material proportions. Introducing water into the mixture and maintaining uniform moisture in the mixture is critical. Use positive controls to maintain uniformity.

Mixing equipment has paddles, studs, or flights located inside the revolving drum. As the drum rotates, the paddles or flights create a mixing action. The specifications do not state the number or arrangement of the paddles. However, the specifications require complete mixing and prohibit collection of unmixed materials in the mixer. Areas in the mixer that collect unmixed materials are called "dead areas" in the specifications.

Adding water in the mixing operation is important to the quality of the cement treated base. The best time to add water is several seconds after mixing the dry materials; this creates a more homogenous mix of aggregate and cement.

The specifications tightly control the contractor's preparation of cement treated base material, and the inspector must thoroughly understand these specifications. Review Section 304 of the specifications before inspecting mixing operations.

6-304.3 DURING CONSTRUCTION

Before placing material on the roadway, the contractor finishes the aggregate base. The aggregate base is acceptable when compaction tests have been taken and have passed minimum requirements. To determine if the grade and surface tolerances are acceptable, confer with the survey crew. Finally, visually inspect the surface for defects.

Coordinate with the contractor to confirm that sufficient equipment and labor are available for spreading, compacting, and trimming before the contractor spreads the material. The contractor determines the method and amount of spread, but closely cooperating and checking the spread will lead to a more efficient operation. Additionally, confirm the placement width of each spread before starting operations. For improved quality in the base, the contractor minimizes construction joints both longitudinally and transversely.

Because time is an important factor in cement treated base construction, discuss the timing of the various activities with the contractor. Three hours is the maximum time allowed between adding water to the mixture and final compaction and trimming. After three hours, the mixture begins to harden and can be damaged. The specifications may include additional time limitations.

Because the contractor must maintain the appropriate water content throughout the mixing and placement process, the contractor typically does the following:

- Keeps the exposed subgrade moist
- Covers the material during transport
- Maintains the moisture of the compacted mixture until application of the curing seal or a subsequent layer of material

The specifications require a certain amount of cement be added to aggregate. To determine the actual cement content, take a sample after mixing and before compaction. If the material is mixed at a central mixing plant, test the cement content at the plant after mixing. Take sufficient samples to monitor uniform distribution of cement in the mixture.

Closely monitor the contractor's spreading operation. The specifications tightly control the spreading of cement treated base. During the spreading of the mixture on the subgrade or base, confirm that the depth of placement and the surface conform to tolerances stated in the specifications. Continuously monitor the screed settings because they determine the cross section of the completed roadway.

The thickness of the compacted cement treated base is important to the strength of the completed section. During placement, make allowances for consolidation of the base caused by rolling. If the grade of the material placed exceeds the planned grade by more than 5/8-inch, the contractor must take corrective action. The contractor's spreading operation may need to be modified if it needs an unusual amount of trimming. Excessive trimming is costly to the contractor and results in wasted material.

If the thickness of the cement treated base is greater than six inches, the specifications require the contractor to place it in more than one lift, each lift being approximately equal thickness. If placed in multiple lifts, each layer must be kept moist after meeting compaction requirements. Pay attention to construction joints, making sure they are smooth and thoroughly compacted. Be aware that bumps or depressions at these joints invariably show up in the finished surface.

Because surface irregularities transfer to the finished surface, the inspector uses a 12-foot straightedge to identify variations in the surface of the cement treated base. The contractor must use methods approved by the Resident Engineer to correct areas that are not smooth or are otherwise defective.

Once the surface is finished and compacted, the contractor maintains the moisture content of the cement treated base until the curing seal is applied. The contractor is typically required to apply the curing seal within 24 hours of final rolling to maintain the moisture content until fully cured. A curing seal is typically an asphalt product, such as MC-250. The contractor should protect the seal from construction operations. Traffic is not allowed on the cement treated base for 72 hours after applying the curing seal.

The inspector must keep complete and accurate records of material quantities. Daily inspector reports should include information and observations relating to the equipment, operations, and materials incorporated into the work, especially anything considered uncommon. Records relating to measurement and payment must conform to the requirements of the *Documentation Manual*. When the method of payment is by weight, collect and record load tickets for each truck as the load is delivered to the project.

6-304.4 MEASUREMENT AND PAYMENT

Measurement and payment are described in the specifications and the *Documentation Manual*. Measurement and payment are usually by the weight, so material must be accurately weighed. Do not use material on the roadway that has not been properly weighed. Also, be sure to record the quantity on the proper forms.

6-305 ROADBED MODIFICATION

6-305.1 GENERAL

Roadbed modification rehabilitates an existing bituminous roadway. To rehabilitate the roadway, the existing surface is pulverized or milled depending on the depth of the existing material. Sometimes a portion of the existing base material is pulverized along with the bituminous surface. If the depth of the existing material is greater than the depth to be pulverized, the contractor will typically use a coldmilling machine to avoid disturbing the remaining material. The pulverized or milled material is mixed with cement and water, spread, and compacted. This construction method is typically used on roadways with a weak structural section or with a non-uniform structural section.

6-305.2 BEFORE CONSTRUCTION

The plans will specify the depth and width of the existing roadway to be pulverized. Throughout a project, the depth of pulverization may change. Review the plans to identify changes in the specified depth.

Because roadbed modification projects rehabilitate existing roadways, traffic is maintained during construction. Review the plans and specifications to determine the following:

- Maximum delay times for traffic
- Compatibility with contractor operations
- Provisions for appropriate work zones
- Hours of operation
- Other limitations to construction operations
- Access to abutting properties
- Weather limitations
- Typical sections

Confirm that the contractor's equipment to be used on the project is capable of producing the specified product. For example:

- The pulverizing equipment must have the ability to pulverize to the specified depth. If the specified depth goes beyond the existing bituminous surface and into the base, the pulverizing equipment must be capable of pulverizing only to the specified depth and not disturb the underlying base. If the existing bituminous surface section is deeper than the specified depth for roadbed modification, the contractor typically uses a coldmilling machine instead of a pulverizer.
- The cement-spreading machine must be capable of regulating the amount of cement added to the pulverized material.
- The mechanical mixing machine must have sufficient capacity to produce a homogenous mixture and must be able to control the quantity of water added during mixing. The mixing machine must not have excessive water leaks.
- Compaction equipment should be the type and size described in the specifications.

Because existing traffic is typically maintained throughout a roadbed modification project, efficiency in performing all operations is important. As the roadbed modification operation progresses, the paving operation should be staged to begin as soon as the cement treated roadway is cured. Before starting the roadbed modification activities, a plantmix bituminous surface mix design should be approved. Additionally, all equipment and materials needed for the bituminous surface paving operation should be on site and staged. The specifications state the time limitations related to curing and traffic.

6-305.3 DURING CONSTRUCTION

To pulverize the existing roadway, the contractor can use a variety of equipment. The contractor is required, however, to meet specified gradation requirements. The tester checks the material gradation at specified frequencies to determine if the material is acceptable. Review the specifications for gradation requirements.

After pulverizing a portion of the roadway, the contractor grades and compacts the pulverized material to within one inch of the adjacent travel lane surface. The excess material is moved to the shoulder of the roadway. Traffic is only allowed on the pulverized and compacted untreated base for limited amounts of time.

The pulverized material is used to determine the maximum density. After the density is determined, the spread rate for portland cement is calculated. Typically, cement is added at the rate of two percent by weight to the pulverized material. Because cement is measured and paid by the ton, the contractor must weigh the cement before spreading. Use the weight of the cement in the spreader to calculate a theoretical spread rate. The cement is spread on the re-compacted material. The cement and the material are mixed while water is added in the mixer. The contractor uses a motor grader to grade the cement treated mixture to conform with the planned cross slope and existing adjacent travel lanes. During the mixing and grading, the inspector observes the operation to confirm that the material is homogenous and that there are no defective areas. The inspector also checks that the uncompacted depth will yield the required compacted depth. After grading, the contractor compacts the material to the specified compaction rate.

While checking the depth of the roadbed modified base or during a compaction test, a hole is dug in the material. When the hole is exposed, the inspector or tester can check the uniformity of cement distribution by spraying a phenolphthalein solution on the vertical face of the hole. The solution changes color when it contacts cement. The intensity of the color varies depending on the amount of cement in the base material. Because the chemical characteristics of the phenolphthalein change with time, solutions that have aged may not give accurate indications.

After the surface is finished, the contractor maintains the moisture content of the treated base until the curing seal is applied. The curing seal is applied within 24 hours of final rolling to maintain the moisture content until fully cured. Most contractors place the curing seal near the end of each production day. A curing seal is typically an asphalt product, such as MC-250. If the cured cement treated base must carry public traffic, spread sand over the curing seal. Make sure the sand blotter meets gradation specifications, as large aggregate particles can damage vehicle windshields and small particles can create excessive dust. Verify that the contractor installs dust hazard signs throughout the work zone. Do not allow traffic on the roadbed modified surface until after the curing seal and sand blotter are applied.

Specifications limit the amount of time that roadbed modification can progress before paving must start, and maximum distances that are allowed between the two operations. The inspector should review these requirements and monitor the progress of both operations.

The inspector must keep complete and accurate records of material quantities. Daily inspector reports should include information and observations relating to the equipment, operations, and materials incorporated into the work, especially anything considered uncommon. Records relating to measurement and payment must conform to the requirements of the *Documentation Manual*.

6-305.4 MEASUREMENT AND PAYMENT

Measurement and payment are in accordance with the specifications and the *Documentation Manual*.

6-307 SHOULDERING MATERIAL

6-307.1 GENERAL

Shouldering material is a graded material placed and compacted against the edge of the plantmix bituminous surface or portland cement concrete pavement. Shouldering material aids roadway drainage by diverting water away from the structural section. The material is part of the finished roadway slope, which also acts as a recovery area for vehicles..

6-307.2 BEFORE CONSTRUCTION

Review the plans and specifications to determine the type of shoulder material specified for the project. When the surface of an existing roadway is ground or milled, the specifications may allow ground or milled material as shouldering material. To ensure meeting gradation requirements, samples of the milled material are tested before placing milled material as shouldering material.

Plans and specifications state the requirements that the contractor must meet regarding the placement of shouldering material. Before placing the shouldering material, the contractor must clear and grub the shoulder a minimum of 10 feet from the edge of the existing pavement. The contractor must dispose of trash, vegetation, and non-organic material as described in Subsection 107.14 of the specifications.

6-307.3 DURING CONSTRUCTION

Placement of shouldering material must not alter existing drainage channels. Shouldering material is placed in accordance with the specifications before paving. The contractor must place the material in a windrow along the roadway shoulder. Traffic safety hazards can be reduced by making windrow heights four inches or less. Avoid placing additional shouldering material after open-graded paving because this can damage the open-graded pavement surface. However, in unique situations and to shape the shoulder properly, the contractor may place additional shouldering material after open-graded paving if necessary.

After paving is completed, the contractor moistens, spreads, and compacts the shouldering material. The roadway cross section shown in the plans typically describes the shape of the roadway shoulder. The plans also specify the location and quantity of shouldering material to be placed.

6-307.4 MEASUREMENT AND PAYMENT

Measurement and payment are in accordance with the specifications and the *Documentation Manual*.

Shouldering material that consists of millings or grindings typically come from NDOT roadways. Millings are not typically paid for. Except for millings or grindings, measurement and payment for shouldering material are by the ton. Accurate weighing of the material is required. The specifications require the contractor provide certified scales to weigh material. Occasionally, a contractor will request using an average weight per truckload instead of weighing each load. This method can lead to inaccurate estimates of material quantities. Since specified shouldering quantities can be monitored only with accurate weights, deny contractor requests to use a method of measurement other than weighing.

Water added before weighing will be deducted from the weight of shouldering material weighed for payment. Perform moisture tests on stockpiled material to adjust weights as required by the specifications.