

# Chapter 4 Bases

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## 4-02 Gravel Base

### GEN 4-02.1 General Instructions

Gravel Base is typically used in the construction of the roadway section and provides support for the pavement. For the pavement to provide a long life, it is important the gravel base be placed uniformly and compacted properly.

### SS 4-02.2 Construction Requirements

When gravel base is specified in the contract, the Contractor may request, in writing, that gravel borrow be used in lieu of gravel base. When gravel borrow is substituted for gravel base, the top 0.10 feet of gravel borrow shall be replaced with 0.10 feet of crushed surfacing top course (CSTC). Testing and sampling frequencies will be as required for the material actually placed. The CSTC and gravel borrow used in lieu of the gravel base is measured and paid for as gravel base and not as CSTC or gravel borrow. The inspector should note on the item quantity ticket that the CSTC or gravel borrow is being used in lieu of gravel base. The as-built plans will identify sections where gravel borrow and CSTC were substituted for gravel base.

## 4-04 Ballast and Crushed Surfacing

### GEN 4-04.1 General Instructions

Ballast and crushed surfacing is used in the construction of the roadway section and provides support for the pavement. Ballast may be naturally occurring or manufactured, crushed surfacing is a manufactured material. Careful inspection during the manufacturing process is required to verify that the material meets the contract specifications. This is important so the material will have the properties needed to provide support to the pavement and drain water from beneath it. For the pavement to provide a long life, it is important that ballast or crushed surfacing be placed uniformly to the line, grade, and cross section specified in the plans and compacted properly.

### Staking

Red and yellow tops for surfacing materials shall be set accurate to + or -0.01 ft. The finish of the compacted materials shall conform to the grade established by the blue tops as closely as is practicable and in general, should not deviate from the established grade in excess of the following:

Ballast and Base Course	+ or -0.05 ft.
Top Course for Bituminous Surface Treatment	+ or -0.03 ft.
Top Course for Asphalt Concrete	+ or -0.02 ft.
Surfacing Under Treated Base Course	+ or -0.03 ft.
Treatment Base Under Portland Cement Concrete Pavement	+0.00 to -0.02 ft.

Conformance should be checked by use of rod and levels from blue tops and/or by string-line or straight edge methods as determined appropriate by the Project Engineer. The above schedule refers to conformance both longitudinally and transversely to the traveled way. The outer shoulder line finished grades shall not exceed double the deviations outlined for the traveled way.

In the event that additional blue tops are not set for setting grade of surfacing courses, the grade of the surfacing shall be referenced to the earthwork subgrade blue tops and adequate controls shall be used to ensure the placement of the required thickness of surfacing and a final surface meeting the requirements outlined above.

See the [Highway Surveying Manual](#) M 22-97 for additional instruction concerning staking.

### Inspection of Course Thickness

Tabulated below are the permissible deviations in measured thickness for specified depths of surfacing. While these are the maximum deviations that can be allowed, the Project Engineer may impose tighter requirements for conforming to the plan dimensions where there is a reason to do so.

Material	Specified Depth	Max. Allowable Deviation at Any One Point	Average Depth Deviation for Entire Project
Untreated Surfacing	0 - 0.25'	-0.05'	-0.025'
	0.26 - 0.50'	-0.06'	-0.03'
	0.51 - 0.75'	-0.07'	-0.035'
	0.76 - 1.0'	-0.08'	-0.04'
	Over 1.0'	-8%	-4%

### GEN 4-04.2 Inspector's Checklist

Inspection duties include but are not limited to:

1. Watch for segregation of material on roadway. Make sure each course of surfacing is properly prepared and meets density specifications before allowing the next course to be placed.
2. When applying water to a surfacing course, see that it is distributed evenly over the entire course. Avoid over-watering which may cause soft spots in subgrade.
3. Make frequent checks of yield to see that the specified quantity of material is placed.
4. See that surfacing courses are completed and compacted true to profile and section. See that humps and sags in the profile are removed.
5. See that surfacing is maintained properly. Should irregularities develop in any surfacing the Contractor shall repair the defects prior to placement of the next course.
6. Make depth checks to ensure conformance with the roadway section.
7. Make daily moisture checks on material paid for by the ton when excess moisture is present.
8. Make sure that adequate survey hubs are used in order to verify that the grade will be smooth and uniform.

### SS 4-04.3 Construction Requirements

#### SS 4-04.3(2) Subgrade

Subgrade for ballast or crushed surfacing is prepared in accordance with the appropriate specifications. Any soft or spongy areas shall be removed or stabilized before the ballast or surfacing material is placed over it.

#### SS 4-04.3(3) Mixing

The *Standard Specifications* require the material to be mixed by the Central Plant Mix Method, the Road Mix Method, or a combination of the two methods. On some projects, the Central Plant Mix Method is the required method.

#### SS 4-04.3(4) Placing and Spreading

Ballast and crushed surfacing materials shall be hauled and placed on the roadway with the equipment and in accordance with the *Standard Specifications*.

It is imperative that the Inspector watch for segregation of materials during all stages of hauling and placement. The design of the roadway section is based on all materials meeting all requirements of the specifications, including gradation requirements. If crushed surfacing materials are deposited on the roadway in a segregated condition, the only corrective measure available is processing of the material on the roadway, using motor graders or other mixing equipment. Excessive processing of material on the roadway is a poor substitute for placement of material in the proper condition in the first place. Therefore, it is very important that every effort be made to ensure correct handling of the materials at all stages of surfacing operations.

Various types of equipment have been developed in order to facilitate placing the required amount of material with a minimum of segregation to the correct cross-section. When the material is mixed with water in a central plant before placing on the roadway with a spreading machine, it can be compacted and shaped to the proper grade and cross-section with a minimum of handling and shaping on the roadway. Some equipment operates from grade control wires to ensure the material is placed at the proper elevation and transverse slope. If this type of operation is proposed to be used by the Contractor, the Inspector should become familiar with the operation and intricacies of the equipment.

Before each course of surfacing is placed, the Inspector should verify that the underlying course is uniformly graded and compacted properly. The Inspector should also see that each course is finished to a true, smooth profile with no humps or hollows. A good way to locate irregularities in the roadway profile or crown is by careful visual inspection. Viewing the grade from a prone position or using stringlines between hubs may be helpful. In this way, additional material can be spot-placed to eliminate low and irregular areas, and the material graded and compacted to a true, smooth surface.

It is important the Contractor place the courses of surfacing material in such a manner as to minimize any deleterious effect on the quality of the material already placed. One of the best ways to minimize damage to the previously placed materials is to reduce the amount of hauling equipment traveling over each course. The placement of the surfacing should begin at the extreme end of the haul and proceed toward the point of loading. In this way, the least amount of hauling over completed courses will be required.

### SS 4-04.3(5) Shaping and Compaction

Prior to placing any surfacing material, the Project Engineer submits representative samples of each surfacing material to be used on the project to the Regional Materials Engineer sufficiently in advance of the time of its intended use to permit completion of the compaction control test. For each surfacing material, the Project Engineer will receive a Maximum Density Curve worksheet from either the Regional Materials Laboratory or State Materials Laboratory. This worksheet shows the standard density for all gradations of the tested material as related to the percent passing the U.S. No. 4 sieve.

Each layer of surfacing material placed, including gravel base, is to be compacted with approved compaction equipment and checked for compliance with density specifications before the next layer of material is placed. When individual layers are placed to a depth of less than 1 inch, testing of two layers at one time is permissible. Field in-place density tests are performed in accordance with the test procedures and testing frequencies outlined in [Chapter 9](#). A minimum of 95 percent of the standard density as determined by the compaction control test for granular materials is typically required before the next layer of material is placed.

During processing and compaction, the moisture content of the material should be maintained at the optimum water content. The optimum water content is determined by the State Materials Laboratory and is listed on the Maximum Density Curve worksheet. Frequent light applications of water rather than periodic heavy applications are preferable as light applications tend to avoid saturation of the surfacing material below the surface. Some projects, typically ones with a large quantity of crushed surfacing, will require the water be added to the surfacing by the central mix plant method. With this method, the amount of water added can be closely controlled and mixed thoroughly with the aggregate. This will result in a material that is uniform both in gradation and water content which will be easier to compact.

If the special provisions require that the surfacing courses be trimmed with an automatically controlled trimming machine, the top of each course of different surfacing courses shall be trimmed to grade and cross-section. The cutting of the surfacing by the trimming machine is controlled by wire lines setup along each side of the roadway. It is therefore important that frequent checks of the wire be made both at the initial setup of the wire and during the trimming operation. This is necessary to verify that the wire has not been disturbed and that the grade will be trimmed correctly. The Project Engineer should be aware that the trimming machines now in use only trim the top surface and do not move material longitudinally from high spots to low areas. The Project Engineer shall see that the materials are placed in reasonably correct amounts and slightly higher than the finished elevations. After completion of the trimming and compaction of the surfacing the finished grade should be checked. Most of the existing trimming machines do a good job of trimming if they are cutting a nominal amount and they tend to chatter and leave an unacceptable washboard surface when operating over a surface that is at or below the finished grade elevation or very hard. On some projects subsequent operations such as concrete paving will also require wire lines and the Contractor will typically use the same wire for both operations. The wires for these cases will need to be set far enough out to allow for the operation of the paving equipment. An alternative to requiring trimming machines for some projects is to use motor graders with automatic controls.

## Maintenance of Surfacing

Upon completion of the surfacing courses, the Contractor is required to maintain and water the surface if any traffic is allowed to travel upon the roadway. When traffic is heavy, considerable damage can result if maintenance is not performed daily. It is much better to perform frequent light maintenance on a surfacing course than to wait until considerable rutting, potholing and segregation occur in which event heavy processing and blading will be required. Testing for density in the top surfacing course shall be deferred until just prior to commencing paving operations.

The specifications provide that WSDOT may perform routine maintenance of a traveled roadway only in the event of a suspension of work for an extended period, as in the case of a shutdown for the winter.

### SS 4-04.3(6) Keystone

Keystone may be used as needed to provide a tight surface for ballast, gravel base, crushed surfacing base course, or any other surfacing. If the Contractor's operation are such that a considerable amount of coarse rock accumulates on the surface of the completed course that will not compact tightly, keystone may be constructed in accordance with the requirements specified in *Standard Specifications* Section 4-04.3(6). If the Contract includes crushed surfacing top course, the Project Engineer may order the construction of keystone and include the quantity in the measurement and payment of crushed surfacing top course. If the Contract does not include the item crushed surfacing top course, approval for adding the item to the Contract is required before it may be used. Keystone placed for the convenience of the Contractor, with approval of the Project Engineer, is paid for at the lower unit Contract price for either the base material being keyed or the crushed surfacing top course.

The Specifications require that when keystone is necessary that it be placed at the end of each day on the course prepared that day. This requirement is especially important when traffic is being carried through the project to protect the course just completed and also to maintain a satisfactory roadway for the traffic. In areas where the pavement is subject to freeze thaw conditions, the use of crushed surfacing top course may not be appropriate if the crushed surfacing top course is frost susceptible. The Regional Materials Engineer should be contacted prior to using crushed surfacing top course in freeze thaw locations.

### SS 4-04.4 Measurement

The *Standard Specifications* require that surfacing materials be weighed and paid for by the ton or measured by the cubic yard in the hauling vehicle at the point of receiving the material.

For surfacing materials paid for by the ton, water in excess of the maximum permissible amounts, as specified in *Standard Specifications* Section 3-01.5, will be deducted from the weight of material to be paid for on a daily basis. The deduction will be determined by the following formula:

Based on dry weight:

$$D = \frac{T(M - A)}{100 + M}$$

Where:

- D = daily tonnage deduction for excess moisture
- T = total daily tonnage over the scales
- M = percent of moisture
- A = allowable moisture

#### Measurement by the Ton

Refer to Section 10-2.2 for instructions for measuring materials by the ton.

The following is a list of the scaleman's duties:

1. Check scale for zero at least twice during a day.
2. Tare each truck at least twice a day and enter on tare sheet.
3. Check the scales often and enter in diary.
4. Fill in appropriate spaces on each ticket.

#### Measurement by the Cubic Yard

Refer to Section 10-2.3A for instructions for measuring materials by volume, truck measure.