Chapter 5 - Base Courses

2-501 Subgrade

2-501A General

The subgrade is the part of the roadbed on which the pavement and shoulder structures are constructed. The pavement and paved shoulder structures include subbase, base and surface courses. The surface of the subgrade is the same grade as the bottom surface of the subbase.

Subgrade is covered in Article 2.09 of the Standard Specifications. The name of the pay item is “Formation of Subgrade.” Formation of the subgrade involves shaping and compacting the existing embankments and excavations to the grade and cross slope shown on the plan cross sections and then protecting the finished subgrade from damage and maintaining subgrade drainage. Additional excavation and fill may be required during subgrade formation to achieve the correct density or stability or to bring the subgrade to the correct line, grade and cross section.

The subgrade item may involve additional types of work. If the contract has no item for clearing and grubbing and no items for grading, the work of clearing waterways, ditches, drainage structures, and culverts is performed under the subgrade item. Clearing and grubbing work is covered in Chapter Three, “Excavation and Embankment.” In addition, scarifying existing stone or gravel roads, if needed, is covered under the subgrade item.

2-501B Construction Method

Prior to forming the subgrade, grade stakes should be set by the survey party or contractor. The Inspector must ensure that the contractor sets the stakes needed to construct the subgrade to the required lines, grades, and cross section. Stakes must be set at least every 50 ft. (15 m). The Inspector checks grades transferred to the contractor's stakes and makes necessary minor adjustments to true up the lines. A hand (Locke) level can be used.

The Chief Inspector must inspect the subgrade thoroughly and be assured that it is in the proper condition to receive the subbase, base and surface courses. The subgrade must be free of intermittent hard or soft spots and must be uniformly compacted to the density called for in the Standard Specifications. Volume 2, Chapter Three, “Excavation and Embankment,” covers the sampling and testing procedures. Irregularities eventually show up in the surface. The surface cannot be properly compacted if it rests upon a yielding subgrade, and the correct thickness of subbase cannot be installed unless the subgrade is shaped and compacted to the designed cross section.

2-501C Payment

Payment for the formation of subgrade is by square yards (meters). The limits of the pay area run along the edges of pavement or, if paved shoulders are constructed, along the outside edges of the shoulders. If additional excavation or fill is needed for density or stability, the payment is governed by the rules for excavation and embankment items. There is no additional direct payment for excavation or fill needed to achieve the correct line, grade, and cross section.
2-502 Subbase

2-502A General

Subbase is placed on the floors of cuts or on embankments. The material consists of a clean soil-aggregate mixture of bank or crushed gravel, crusher-run stone, reclaimed miscellaneous aggregate, or a combination of these materials. Subbase is covered in Article 2.12 of the Standard Specifications.

The top surface of the subbase supports the pavement, shoulders, and related appurtenances. Additionally, subbase allows water to drain from beneath the pavement and intercepts the upward flow of water. Because of its drainage characteristics, subbase helps prevent the formation of ice beneath the pavement and, consequently, helps prevent frost heave and related problems.

The Inspector completes a Base & Bituminous Concrete Inspection Report, Form CON-136, each day that subbase material is used. Figure 2-5.1 shows a CON-136.

2-502B Construction Method

Before any subbase is placed, the underlying material is graded and compacted to the required cross section to drain water that may reach the subbase—either from the top or arising by seepage from the underlying material. Unstable, yielding foundation material should be removed and replaced with satisfactory embankment material or additional subbase, as directed by the Engineer. Care should be taken to match the characteristics of the additional material to those of the material in place to avoid creating a trap for water. After embankment grading is complete, the Inspector should spot check the cross sections of the top surface before subbase material is placed and the final cross sections after subbase grading is complete. The Inspector should contact District Survey, if needed.

If the required subbase thickness is not more than 8 in. (200 mm) after compaction, the subbase can be placed in one course. If the total compacted thickness is 8 in. (200 mm) or more, the subbase is placed in courses not greater than 6 in. (150 mm) each after compaction. The subbase is compacted such that the dry density is 95 percent of the dry density of the material determined by AASHTO T-180, Method D. Volume 2, Chapter Three, “Excavation and Embankment,” covers the general procedures for density sampling and testing. The “Schedule of Minimum Requirements for Sampling Materials for Test,” published by the Division of Material Testing, includes information about sampling for subbase tests.

Because subbase may be placed intermittently and in varying thicknesses on different sections of the road, the Inspector must check its end points and points of change in depth to make sure that water will not be trapped. For example, where the mainline and a ramp or local road comes together, a constant depth is not always attainable because of different requirements or designer preferences. Figure 2-5.2 shows an example of underdrain placement that prevents trapping water where two different road sections meet.

If the subbase does not extend the full width of the roadway by design, the Inspector must provide means to drain the subbase by installing sections of base through material that may be impervious to water, to the outer face of the slope, and bring the situation to the attention of the Project Engineer. The Inspector must make sure that a section of subbase is not terminated at a grade point but carried at least 25 ft. (8 m) out of a cut section onto the adjacent fill section.

In addition to serving as a drainage layer, the subbase itself has little or no detrimental frost action, such as frost heaving or frost boils during a thaw. Both of these conditions are dependent on the subbase being “clean,” that is, having very little silt or clay or excessive fines. Bank-run material, such as natural gravel, must be closely watched to ensure compliance with the gradation requirements. Most gravel banks contain stratified courses of fine and coarse aggregate material. Blending the material to comply with the gradation requirements is the responsibility of the contractor. Unsatisfactory material must be removed and replaced with acceptable material.
Figure 2-5.1 Base & Bituminous Concrete Inspection Report, Form CON-136

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<tr>
<th>Item No.</th>
<th>Description</th>
<th>Quantity</th>
<th>Unit</th>
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<th>UTons Received</th>
<th>UTons Used</th>
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Paving Work Force and Equipment

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Inspector's Signature:

Reviewed by:

- Chief Inspector
- Project Engineer

Inspector's Hours of Work:

- Start: 
- End: 

Contractor's Hours of Work:

- Start: 
- End: 

Day of Week: 

Date: 

Location: 

Project No.: 

Site Used: Y N

Paving Contractor:

STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION
BASE & BITUMINOUS CONCRETE INSPECTION REPORT

Air: 

Surface:

Width Measurements

Depth Measurements

Mix Temperatures

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Base & Bituminous Concrete Inspection Report, Form CON-136
Figure 2-5.1 Base & Bituminous Concrete Inspection Report, Form CON-136 (continued)

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*Waste: Show computations if over 10 t (10 tons). If material is used elsewhere on project document purpose, reason and item number material was paid under.

Sketch and Theoretical Computations:

Checked by ________________________
Required underdrains must be installed before or during subbase placement. The underdrains help dry wet spots and prevent the subbase from being contaminated by churning and mixing with wet material underneath it. If the subbase is contaminated with the soil below, it must be removed and replaced with clean material.

The top of the subbase often develops an impervious skin in a thin surface, 1 to 2 in. (25 to 50 mm) thick. The affected areas typically are large and have concentrations of fine soil. The skin is caused by the wringing action of vehicle wheels, aided by the puddling action of surface water. Because the skin prevents downward drainage into the subbase, it should be removed and replaced before paving.
2-502C Payment

Subbase is paid for by the cubic yard (meter). It is measured horizontally after final grading and compaction. The thickness is measured every 500 ft. (150 m) along lanes. For total thickness less than 24 in. (600 mm), the tolerances are –1 and +¾ in. (–25 mm and +19 mm). If thickness is deficient, additional measurements are made to determine the extent of the thin area, and the contractor must make corrections without additional pay.

2-503 Base Courses

A base course consists of a layer or layers of material placed between the top of the subbase and the surface course of a pavement to provide economical, homogeneous and stable support. Base courses are subjected to severe loading, and thus the materials must be durable enough to support and transmit these loads to the underlying roadway components.

Before any base course is placed, the subbase must be constructed according to the current Standard Specifications. As mentioned previously, the riding surface of the completed pavement is affected by irregularities in either subbase or the surface of the base course; therefore it is necessary for the Inspector to ensure that the contractor is conscientious in carrying out this phase of the work. The contractor is responsible for draining and protecting the subbase. No base material should be placed on a soft, loose, or frozen subbase.

Each day a base material is incorporated in the job, a Base & Bituminous Concrete Inspection Report, Form CON-136, is completed by the Chief Inspector. Figure 2-5.1 is an example CON-136.

Base courses include:

- Rolled Granular Base
- Processed Aggregate Base
- Bituminous Concrete Class 4
- Concrete Base

Sampling and testing requirements differ for the different types of base courses. The requirements are in the “Schedule of Minimum Requirements for Sampling Materials for Test,” published by the Division of Materials Testing.

2-504 Rolled Granular Base

2-504A General

Granular base consists of one or more courses constructed on a prepared subbase. The material is a mixture of bank or crushed gravel or reclaimed miscellaneous aggregate and approved binder material. Rolled granular base is covered in Article 3.02 of the Standard Specifications.

2-504B Construction Method

The material is spread on the subbase to produce the specified depth after compaction. Bases less than 6 in. (150 mm) deep compacted may be constructed in one course; bases over 6 in. (150 mm) must be constructed in two courses of equal depth. A mechanical spreader is not required. The material may be spread directly from trucks. However, the trucks must be equipped to discharge the gravel fairly uniformly at the desired rate. The material must not be dumped
in piles on the subbase

If additional binder is needed, it is incorporated with the material in place by scarifying, harrowing, brooming, or another approved method. The material is shaped, wetted and compacted with a roller not less than 10 tons (9 metric tons) or an equivalent vibratory roller. Segregated areas are removed and replaced. Compacting and wetting are continued until all voids are filled; then the section is left to dry. The material must be recompacted and wetted on succeeding days as directed by the Engineer. If needed, a second course is placed after the first is compacted and bound. The construction method is the same as for the first course.

2-504C Payment

The pay units for rolled granular base are cubic yards (cubic meters). Horizontal measurements are taken after the material is spread and compacted. The limits are as shown on the plans or ordered by the Engineer. Thickness measurements are taken along lanes at intervals of 500 ft. (150 m) or less. The thickness tolerance is ±¾ in. (±19 mm). Additional measurements are taken to determine the extent of deficient areas. Areas outside the tolerances are corrected at the expense of the contractor.

2-505 Processed Aggregate Base

2-505A General

The material for processed aggregate base is a mixture of coarse and fine aggregate. The coarse aggregate consists of gravel, broken stone, or reclaimed miscellaneous aggregate, at the contractor's option. However, only one type of coarse aggregate can be used on a project unless specifically permitted by the Engineer. The fine aggregate is natural sand, stone sand, screenings, or any combination. Processed aggregate base is covered in Article 3.04 of the Standard Specifications.

2-505B Construction Method

The base is spread and then compacted and bound. Prepared subbase must be maintained true to line and grade for a minimum of 200 ft. (60 m) in advance of the spreading operation. Aggregate courses must not be placed more than 500 ft. (150 m) ahead of the compaction and binding operation.

Only approved spreaders or stone boxes are used. Power graders cannot be used unless approved by the Engineer. Rollers must be able to deliver a ground pressure of 300 lbs./in. (52.5 N/mm) of contact width and must have a mass of at least 10 tons (9 100 kg). Vibratory units must have a mass of not less than 4 tons (3 650 kg). The water used for binding is applied from an approved device.

The thickness of the first course cannot be more than 4 in. (100 mm) after compaction. The compacting and binding operation starts at the outside edge, overlapping the shoulder by 6 in. (150 mm), and progresses toward and parallel to the centerline. It covers the entire surface, each pass overlapping the preceding by a uniform amount. On superelevations, the operation progresses from the low edge to the high edge. There must be at least four complete passes of the compaction and binding equipment. The operation continues until the voids in the surface are reduced to provide a firm and uniform surface, to the satisfaction of the Engineer. The top course is spread, compacted and bound in the same manner as the bottom course, such that the combined thickness is as planned.
2-505C Payment

The payment units for processed aggregate base are tons. Payment is not made for material placed more than 3 in. (75 mm) outside the planned horizontal limits. Measurements for thickness are made along lanes at intervals of at least 500 ft. (150 m). The thickness tolerances are −¾ in. (−19 mm) and +½ in. (+13 mm). The Engineer may waive some measurements if:

- other thickness measurements taken nearby are within acceptable limits
- the contractor is using proper controls
- the serviceability of the completed construction is not impaired

Additional measurements may be taken to determine the limits of deficient areas. There is no payment for material placed over the +½ in. (+13 mm) limit. Thicknesses less than the −¾ in. (−19 mm) limit are corrected at the contractor's expense.

All aggregate must be weighed on scales in accordance with Department specifications. Scales are inspected by Weights and Measures, Division of Consumer Protection.

The District Office may allow the contractor to stockpile the aggregate prior to placement. If stockpiling is approved, a method of measurement for the item must be agreed in advance. The following methods are acceptable:

- A method to re-weigh the stockpiled material to establish the tonnage placed.
- A method to compute the pay quantity in place. If approved by the Office of Construction, the District can sample the aggregate, request a Proctor density test to determine the in-place density, and arrive at a factor for computing the in-place tonnage.
- Another suitable method recommended by the District and approved by the Office of Construction.

2-506 Bituminous Concrete Class 4

This material consists of a graded mixture of course and fine aggregates to which mineral filler is added if necessary, combined with asphalt cement in accordance with an approved job mix formula. Article 4.06 of the Standard Specifications and Chapter 2-6, "Bituminous Pavements," cover Class 4 bituminous concrete, along with other types of bituminous concrete. Automatic grade controls should be used when placing Class 4.

2-507 Concrete Base

The base consists of portland cement concrete and may be reinforced. Construction is the same as for concrete pavements, except there usually are no joints. Concrete base is covered in Article 3.03 of the Standard Specifications. Article 4.01 of the Standard Specifications and Volume 2 Chapter Seven covers concrete pavements.

Joints are constructed around objects that project through the base and between the base and curbs, concrete gutters, etc., if ordered by the Engineer. If there are no transverse joints, make a bulkhead at the end of a day's run. The bulkhead should be made of steel or 2 in. (50 mm) plank. It is perpendicular to the surface and at right angles to the centerline. The concrete is finished to it.