
7 Subgrade Construction

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CHAPTER SEVEN:

SUBGRADE CONSTRUCTION

Subgrade is that portion of the earth roadbed which after having been constructed to reasonably close conformance with the lines, grades, and cross-sections indicated on the plans, receives the base or surface material. In a fill section, the subgrade is the top of the embankment or the fill. In a cut section the subgrade is the bottom of the cut (Figure 7-1). The subgrade supports the subbase and/or the pavement section. To ensure a stable, long-lasting, and maintenance free roadway, the subgrade is required to be constructed using certain proven procedures that provide satisfactory results.

After the rough grading is completed, the fine grade stakes are set and the final processing of the subgrade may begin. The rough grade is the top grade of the embankment as built using the information provided on the grade sheets. The grade is normally within 2 in. at this point. The finish grading operation consists of trimming the excess material down to the final grade. Filling any low spots with thin lifts of materials tends to slide these lifts around if not properly worked into the underlying materials.

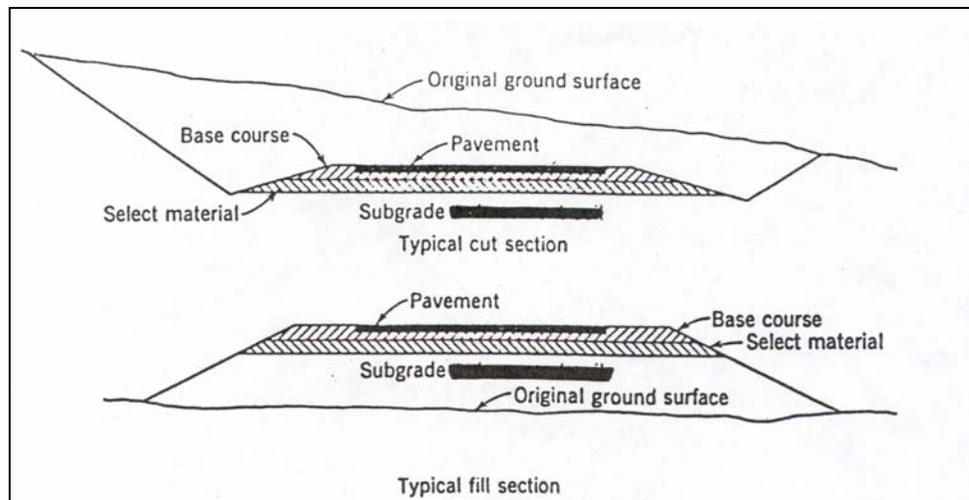


Figure 7-1. Typical Roadway Cross Sections

The subgrade is constructed uniformly transversely across the width of the pavement including 2 ft outside the edge of shoulders or curbs, unless indicated otherwise on the plans, by one of the following methods.

- 1) Chemical modification in accordance with Section **215**
- 2) Aggregate No. 53 in accordance with Section **301**
- 3) Geogrid in accordance with Section **214** placed under aggregate No. 53 in accordance with Section **301**
- 4) Soil compaction to 100 % of maximum dry density

Longitudinally, the treatment may vary depending on the method of construction

CONSTRUCTION REQUIREMENTS

Soils containing greater than 3 % by dry weight calcium, magnesium carbonate, or organic material, or with a maximum dry density of less than 100 lb/ft³, or with liquid limit of greater than 50, are not allowed within the specified thickness of the subgrade. Density is determined in accordance with **AASHTO T 99** and loss of ignition is determined in accordance with **AASHTO T 267**. Liquid limit is determined in accordance with **AASHTO T 89**.

Coal within the specified thickness of the subgrade is excavated, if directed, and disposed of in accordance with Section **202.05**. Coal or coal blossoms that are allowed to remain are mixed thoroughly with subgrade soils and compacted in accordance with Section **207.04**.

During subgrade preparation, adequate drainage is required to be provided at all times to prevent water from standing on the subgrade.

The final goal is to have a subgrade that meets the cross section and finish grade requirements as well as satisfying the density and proof rolling Specification prior to placing the initial subbase material. Even though the proof rolling is the last operation to be conducted, most of the potential soft spots are required to be detected and treated before the final grading is completed.

FINE GRADING

Fine grade is required to be provided for the final trimming and checking of the cross section and grade. Stakes are usually set at 50 ft intervals near each edge of the subgrade with a grade mark established at some known distance above the actual finish subgrade elevation. A stringline is stretched across the grade marks on two adjoining stakes and the subgrade

elevation is checked by measuring down the known offset distance from the stringline to the dirt grade. The appropriate corrections for a crown in the typical cross section are used in calculating the correct offset distance. The tolerance for finishing the earth subgrade is 1/2 in. from the true grade. Any low areas in the grade requiring less than 3 in. additional fill material are scarified prior to placing the fill material so the thin layer of fill is tied into the previous layer when compacted.

Fine Grading (Figure 7-2) the subgrade for aggregate or asphalt base courses is usually conducted with a motorgrader and checked with a stringline, but may be conducted with an automatic grading machine controlled from a stringline. The automatic grading machine is required to be used for preparing the subgrade for concrete base and pavement. When underdrains are specified, special care is required to be taken to ensure that there is no damage to the drains and that the aggregate backfill does not become contaminated with soil.



Figure 7-2. Fine Grading

DENSITY TESTING

Where the density and moisture control option is used, compaction of the embankment areas is required to be in accordance with Section **203.23**. The minimum number of tests required is outlined in the Frequency Manual. For mainline and shoulders, one test for each 1500 ft for each lift is required. For widening trenches ≤ 5 ft, one test each 1500 ft is required. Any failing tests require additional work on the subgrade in that area to obtain the required density. Soil compaction at the optimum moisture content requires the least amount of compactive effort to obtain 100 % maximum dry density. Therefore, drying excess moisture or adding water to a dry subgrade may be necessary to obtain this required density.

PROOFROLLING

Even though the subgrade has been previously accepted, the condition of the subgrade at the time paving material is placed is required to be in accordance with Section **105.03** and Section **207.04**. Prior to placing the base course on the subgrade, proofrolling in accordance with Section **203.26** is completed. Undue distortion of the subgrade is avoided. If limits of the work make mechanical preparation of the subgrade impractical, appropriate hand methods may be used. Two complete coverages with the proofroller are required to verify the condition of the subgrade. All roller marks, irregularities, or failures are required to be corrected. Any depressions in the subgrade that hold water are required to be eliminated.

Preparing the subgrade well ahead of the paving operation helps insure a more uniform subgrade with fewer paving delays.

CHEMICAL MODIFICATION OF SOILS

Chemical modification of soils consists of uniformly mixing dry Portland cement, fly ash, lime, or a combination of the materials with soil to aid in achieving the workability of soils having an excessive moisture content.

The Contractor is responsible for all tests required to determine the optimum chemical modifier content for modification of the soils. The modifier selection, laboratory testing, and mix design are conducted by an approved geotechnical consultant in accordance with the Department's Design Procedures for Soil Modification or Stabilization. The test results, recommendations, and type A certifications are submitted to the PE/PS and Office of Geotechnical Engineering for approval at least 5 days prior to use. The quantity of chemical modifier may be adjusted for different soil types. However, the source or type of chemical modifier may not be changed during the progress of the work without approval, and any change in source requires a new mix design.

Chemical soil modification is conducted when the soil has a minimum temperature of 45° F, 4 in. below the surface, and with the air temperature rising. The modifier is not allowed to be mixed with frozen soils.

The soil is scarified to a planned depth prior to placement of the chemical modifier when type A-6 or A-7 soils are used or encountered. The modifier is uniformly distributed by a cyclone, screw-type, or pressure manifold distributor. Spreading of the modifier is limited to an amount which may be placed into the soil within the same work day and during acceptable wind conditions.

The chemical modifier, soil, and possibly water are thoroughly mixed by rotary speed mixers until a homogenous layer of the required thickness has been obtained. Compaction of the mixture begins as soon as possible, but is required to be started within:

- 1) For cement modified soils, mixing is required to be completed within 30 min of cement placement, and compaction completed within 3 h after mixing.
- 2) Fly ash modified soils are required to be compacted within 4 h
- 3) Lime modified soils are required to be compacted within 24 h

The compaction effort is required to be in accordance with recommendations provided in the mix design and the maximum dry density is determined in accordance with Section **203.23**. The moisture content of the mixture is required to be between optimum moisture and optimum plus 2 %.

Construction traffic is not allowed on the treated soils within 72 h of compaction.

When selected by the Contractor, subgrade construction may be done by excavation and replacement with No. 53 aggregate in accordance with Section **301**.

When specified in the plans, subgrade construction may be constructed with geogrid and No. 53 aggregate in accordance with Sections **214** and **301**.

SUBGRADE TREATMENTS

The subgrade treatment type is required to be as specified on the contract plans.

Within each of the following subgrade treatment types, the Contractor may choose from the listed options for each type.

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| Type I | 16 in. chemical soil modification, 12 in. of the subgrade excavated and replaced with No. 53 aggregate, or by 24 in. of soil compacted to density and moisture requirements. |
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Type IA	16 in chemical soil modification or 12 in. of the subgrade excavated and replaced with No. 53 aggregate.
Type II	8 in. chemical soil modification, 6 in. of the subgrade excavated and replaced with No. 53 aggregate, or 12 in. of soil compacted to density and moisture requirements.
Type IIA	8 in. chemical soil modification or 6 in. of the subgrade excavated and replaced with No. 53 aggregate.
Type III	6 in. of soil compacted to the density and moisture requirements, or 6 in. of subgrade excavated and replaced with No. 53 aggregate.
Type IIIA	6 in. of subgrade excavated and replaced with No. 53 aggregate.
Type IV	9 in. of the subgrade excavated and replaced with No. 53 aggregate on geogrid.

MOISTURE CONTROL

The moisture content is required to be controlled during the special subgrade treatment operations. Fine grain or clay type soils are placed at a moisture content within -2 and +1 percentage points of the optimum. Silts, silty loams, or loessial type soils are required to be within -3 percent of the optimum. Soils composed primarily of sand or sand and gravel may normally be compacted to the specified density at a moisture content several percentage points below optimum. Careful monitoring and control of the moisture content and density of the soil during the special subgrade treatment process is essential for attaining a uniformly dense and stable subgrade.

EXCEPTIONS

Undercutting may not be necessary if the lower lifts of the subgrade treatment area meet the required moisture and density requirements and only the upper 6 in. is treated. In sections where shale, shale and soft rock mixtures, or soft rock are encountered, these materials are undercut 12 in. below the subgrade elevation and replaced with No. 53 or No. 73 aggregate in accordance with Section **301**. All irregularities and holes are graded to provide positive drainage. Where necessary, finishing to subgrade elevation is accomplished using No. 11 or No. 12 aggregate.

DRAINAGE

Providing surface drainage for the undercut areas is usually not possible. The size of the undercut areas is limited, and the undercutting schedule regulated so that an area is not left open when rain is likely. Water ponding in the undercut area would likely worsen the excess moisture problems that the undercut was designed to alleviate. The final moisture and density testing, and proofrolling are conducted on the top 8 in. of the completed subgrade near the beginning of the paving operation.

MEASUREMENT AND PAYMENT

Subgrade treatment is measured in both cut and fill areas by the square yard. The cost of subgrade treatments including testing, sampling, aggregates, modifiers, geogrid materials, water, or the excavation required for the methods selected by the Contractor is included in the cost of the pay item for subgrade treatment. The under cutting of rock, where encountered, is measured in accordance with Section **203.27(b)**. No direct payment is made for subgrade treatment on the bottom 6 in. below the undercut or the top 6 in. in those cut sections where undercutting is not necessary. Where conditions exist below the specified subgrade compaction depth that prevent achieving the specified compaction, payment for correcting such conditions is based on the directed method of treatment. The accepted quantity of chemically modified soils is paid for by the square yard, complete in place.

SUMMARY

Proper subgrade construction and treatment is one more step toward the completion of a good roadway. The specified moisture and density requirements are required when the subgrade is covered by any subsequent courses. Through careful schedule planning and construction, the Contractor may attain these results in the most economical way possible while providing a good, stable, subgrade.