

## Chapter 300

### Bases - 19

**This chapter is not part of the Project's specifications, but is a guide for project personnel in interpreting CDOT specifications, understanding ASTM, AASHTO, and Colorado Procedures (CPs) for testing, and for completing CDOT forms.**

The design and construction of a pavement structure may include one or more base courses. A base course is a layer of material below the wearing surface of a pavement. Bases may be constructed of gravels, mixtures of soil and aggregate, mixtures of asphalt and aggregate, mixtures of cement and aggregate or soil, or other innovative materials. Bases may be made of unbound materials, such as gravel, or bound materials, such as lime treated subgrade.

Base courses under concrete pavements provide a drainage layer, reduce pumping, provide protection against frost damage, and provide support for the heavy equipment used for placing concrete pavements. There is some increase in structural capacity when a base is placed under a concrete pavement, but it is typically not a significant amount.

Base courses under flexible pavements provide a significant increase in structural capacity. Pavement design of flexible pavement depends on the wheel loads being distributed over a greater area as the depth of the pavement structure increases. There are the added benefits of improved drainage and protection against frost damage.

#### **ITEM 206 STRUCTURE BACKFILL**

#### **ITEM 304 AGGREGATE BASE COURSE**

Compaction of unbound bases is important for the stability of the pavement it supports. The maximum dry density is established in the laboratory before construction. During construction measurements of the base dry density are compared to the maximum dry density. The requirements for compaction of aggregate base course (ABC) are shown in Subsection 304.06 of the Standard Specifications for Road and Bridge Construction. Structure Backfill has similar requirements as shown in Subsection 206.03.

Two methods to determine maximum dry density of soils are AASHTO T 99 and AASHTO T 180. AASHTO T 99 is similar to ASTM D 698 and is commonly referred to as the Proctor Test, as it was first proposed by R. R. Proctor in 1933. AASHTO T 99 uses a 5.5 lb. rammer dropped from 12 in. When a 4 in. mold is used, three layers are compacted with 25 blows on each layer. When a 6 in. mold is used, three layers are compacted with 56 blows on each layer. AASHTO T 99 results in a compactive effort of 12,400 ft-lbf/ft<sup>3</sup>. AASHTO T 180 is similar to ASTM D 1557 and is commonly referred to as the Modified Proctor Test. AASHTO T 180 uses a 10 lb. rammer dropped from 18 in. When a 4 in. mold is used, five layers are compacted with 25 blows on each layer. When a 6 in. mold is used, five layers are compacted with 56 blows on each layer. This results in a compactive effort of 56,000 ft-lbf/ft<sup>3</sup>. Comparing compactive efforts, AASHTO T 180 produces four and a half times the compactive effort than a sample receives compacted according to AASHTO T 99.

AASHTO T 99 is the appropriate standard for compaction of cohesive soils, particularly if there is the potential for swelling when saturated. AASHTO T 180 is appropriate for granular soils, such as aggregate base course and Structure Backfill, Class 1.

There are four methods of determining moisture-density relationships by AASHTO T 180:

- Method A uses a 4 in. mold and the fraction of the soil passing a No. 4 sieve. AASHTO states that this is applicable to soil mixtures that have 40% or less retained on a No. 4 sieve.
- Method B uses a 6 in. mold and the fraction of the soil passing a No. 4 sieve. AASHTO states that this is applicable to soil mixtures that have 40% or less retained on a No. 4 sieve.
- Method C uses a 4 in. mold and the fraction of the soil passing a 3/4 in. sieve. AASHTO states that this is applicable to soil mixtures that have 30% or less retained on a 3/4 in. sieve.
- Method D uses a 6 in. mold and the fraction of the soil passing a 3/4 in. sieve. AASHTO states that this is applicable to soil mixtures that have 30% or less retained on a 3/4 in. sieve.

The gradation requirements for Class 1 Structure Backfill and ABC are shown in Subsections 703.08 and 703.03 respectively. A review of the gradation requirements shows that many granular materials will meet the gradation requirements and exceed the limits of application stated in AASHTO T 180.

Colorado has developed a rock correction formula in Colorado Procedure 23 (CP 23) when AASHTO T 180 is used:

$$\text{MDD} = (P_f \times D_f + P_c \times 0.95 D_c) / 100$$

The standard practice within the Department follows:

- 110 lbs. of granular material are sampled and sent to the laboratory before construction begins. This would typically require two standard sample bags.
- The material is separated into two fractions, material retained on a No. 4 sieve and material passing a No. 4 sieve.
- The specific gravity and absorption of the material retained on a No. 4 sieve is determined according to AASHTO T 85 Specific Gravity and Absorption of Coarse Aggregate.
- The maximum dry density and optimum moisture of the material passing a No. 4 sieve is determined according to AASHTO T 180, Method A.
- For bases with crushed concrete or reclaimed asphalt pavement (RAP), an accurate specific gravity determination is difficult to make. For these materials T 180, Method D is used.
- Method D may be used if more than 30% of the material is retained on the No. 4 sieve, but has 30% or less of the material retained on the 3/4 inch sieve. When Method D is used, use the above procedure but substitute the 3/4 inch sieve for the No. 4 sieve.

During construction the control of compaction follows according to the plans, specifications, and the Frequency Guide Schedule for Minimum Materials Sampling, Testing and Inspection. Each field test must include a separation of the sample into the two fractions, material retained on a No. 4 sieve and material passing a No. 4 sieve. Percent relative compaction is determined according to CP 25. CP 23 is used to correct the maximum dry density and optimum moisture for soil-rock mixtures with more than 5% material retained on a No. 4 sieve.

**ITEM 308 PORTLAND CEMENT & FLY ASH**

Sources of portland cement and/or fly ash are listed on the Department’s Approved Product List. To verify a specific cementitious material that may be considered for a project check if the supplier / manufacturer of the cement or fly ash is on the Approved Products List at the web site address of:

<https://www.codot.gov/business/apl>

If a manufacturer wants to add a cement or fly ash source use the same web site and follow the instructions within Notice to Manufacturers: <https://www.codot.gov/business/apl/manufacturers.html> and also follow all references within CP 11:

**CDOT Materials Forms - Applicable for Bases**

<https://www.codot.gov/library/forms/form-numbers-broken-down>

**Materials Forms, Instructions & Examples Chapter**

**NOTE: The example forms are still in development, as they are completed they will be entered into the chapter. Use the relevant example forms from the Electronic version of the 2018 FMM.**

Form	Title	Page
157	Field Report for Sample Identification or Materials Documentation.....	
6	Field Tests of Base Aggregate, Fillers, Paving and Miscellaneous Aggregates.....	
38	Aggregate Test Report - [ <i>computer output</i> ].....	
194	Structure Backfill Density Report.....	
564	Soils and Aggregate Sieve Analysis When Splitting On the No. 4 Sieve .....	
565	Sieve Analysis For Aggregate Not Split On the No. 4 Sieve .....	
633	Sample Tag (Sacks) .....	
1126	Stabilometer Record of Item 304 Aggregate Base Course .....	
1296	Granular Materials Moisture – Density Report - [ <i>computer output</i> ].....	

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