

STANDARD SPECIFICATION FOR QUALITY MANAGEMENT OF EARTHWORK AND PAVEMENT FOUNDATION LAYERS USING MODULUS

AASHTO Designation M XXX

1. SCOPE

This specification covers the quality management of compacted materials using modulus for the construction of embankments and pavement foundation layers including subgrade, subbase, and base.

2. REFERENCED DOCUMENTS

AASHTO Standards:

- M 57 Materials for Embankments and Subgrades
- M 147 Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses
- T 2 Sampling of Aggregates
- T 11 Materials Finer Than 75- μ m (No. 200) Sieve in Mineral Aggregates by Washing
- T 27 Sieve Analysis of Fine and Coarse Aggregates
- T 99 Moisture-Density Relation Soils Using 2.5-kg (5.5-lb) Rammer and 305-mm (12-in) Drop
- T 180 Moisture-Density Relation Soils Using 4.54-kg (10-lb) Rammer and 457-mm (18-in) Drop
- T 217 Determination of Moisture in Soils by Means of Calcium Carbide Gas Pressure Tester
- T 265 Laboratory Determination of Moisture Content of Soils
- T 310 In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods

3. DEFINITIONS

3.1. Lift: Lift is a thickness of material within a layer that is placed for compaction.

3.2. Layer: Layer is the total thickness of each material and may be comprised of one or more lifts.

3.3. Optimum Moisture Content: Optimum moisture content is determined by AASHTO T 99 (standard method) or AASHTO T 180 (modified method).

3.4. Maximum Dry Density: Maximum dry density is determined by AASHTO T 99 or AASHTO T 180.

4. MATERIALS¹

4.1. Materials shall comply with Table 4.1. The Contractor shall correct noncompliant material. The corrected material shall be tested for compliance.

Table 4.1 Material Specifications

Material	Specification
Embankment	AASHTO M 57
Subgrade	AASHTO M 57
Subbase	AASHTO M 147
Base	AASHTO M 147

¹ State agency may replace the AASHTO specifications and test methods with their own specifications and methods.

- 4.2. The Contractor shall implement a process control program in accordance with random sampling procedures in AASHTO T 2.
- 4.3. A change in material source without permission of the Engineer is prohibited.
- 4.4. The Contractor shall assume full responsibility for the production of acceptable materials.

5. PLACING AND COMPACTING MATERIALS

- 5.1. Each lift of material shall comply with Section 4.
- 5.2. Before an overlying lift of material is placed, the underlying material shall have been compacted such that the overlying lift can be properly compacted.
- 5.3. Limit lift thickness by the capability of the equipment to uniformly blend and compact the entire lift.
- 5.4. The material shall be uniformly blended and comply with gradation requirements.
- 5.5. Water shall be added or removed in order to achieve proper compaction.
- 5.6. Place material in uniform lifts, parallel to the profile grade, and over the full width of the roadway.
- 5.7. Each lift shall be properly compacted before placing the overlying lift.
- 5.8. The surface of each lift shall be maintained until the overlying lift is placed.

6. CONTRACTOR QUALITY CONTROL

6.1 The Contractor shall develop and deploy a written Quality Control Program that addresses all elements affecting the quality of the compacted materials including but not limited to the following:

- Uniformity as defined in Section 6.2
- Moisture content as defined in Section 6.3
- Minimum density as defined in Section 6.4
- The Quality Control Program shall define the actions that shall be taken by the Contractor when construction is not in compliance with the quality elements included in the Quality Control Program.

A Quality Control Program verification test section may be required by the Engineer for equipment verification, compaction process verification, and Quality Control Program demonstration prior to project construction.

6.2. Uniformity²

- 6.2.1. Material gradation shall be determined before compaction by AASHTO T 27 and AASHTO T 11 or other methods specified by the Engineer.
- 6.2.2. Material gradation shall comply with Table 6.1. The Contractor shall correct noncompliant material. The corrected material shall be tested for compliance.

Table 6.1 Material Control Requirements

Material	Percent Difference from Target Gradation			
	Sieve 1 in. (25.0 mm)	Sieve No. 4 (4.75 mm)	Sieve No. 40 (425 µm)	Sieve No. 200 (75 µm)
Embankment	10%	10%	10%	10%
Subgrade	10%	10%	10%	10%
Subbase	5%	8%	5%	3%
Base	5%	8%	5%	3%

² State agency may replace the test methods and values with their own test methods and values.

6.3. Moisture Content³

- 6.3.1. Moisture content shall be determined before compaction by AASHTO T 217 or other method specified by the Engineer.
- 6.3.2. Moisture content samples shall be taken randomly before compaction, in accordance with random sampling procedures contained in AASHTO T 2.
- 6.3.3. Moisture content, before and during compaction, shall comply with Table 6.2.
- 6.3.4. The Contractor shall correct noncompliant material. The corrected material shall be tested for compliance.

Table 6.2 Moisture Content Requirements

Optimum Moisture Content (OMC)	Moisture Content	
	Minimum	Maximum
<10%	OMC-2%	OMC + 1%
≥10%	0.8 OMC	1.1 OMC

6.4. Minimum Density

- 6.4.1. Density shall be determined by AASHTO T 99 or AASHTO T 180.
- 6.4.2. Density samples shall be taken randomly in accordance with random sampling procedures contained in AASHTO T 2.
- 6.4.3. The full thickness of each lift shall be compacted and comply with Table 6.3.
- 6.4.4. The Contractor shall correct noncompliant material. The corrected material shall be tested for compliance.
- 6.4.5. The density requirements can be waived by the Engineer, if compaction is accomplished by instrumented rollers using continuous compaction control as defined in the Contractor's Quality Control Process.

Table 6.3 Relative Density Requirements for Compaction

Material	Minimum Required Relative Density
Embankment	95% of Maximum Dry Density
Subgrade	100% of Maximum Dry Density
Subbase	100% of Maximum Dry Density
Base	100% of Maximum Dry Density

7. ENGINEER QUALITY ACCEPTANCE

- 7.1. Acceptance of the compacted lift is based on the modulus determined using AASHTO T E1E⁴ or other method specified by the Engineer.
- 7.2. Moisture content of the material at the time of modulus testing shall be measured by AASHTO T 217 or AASHTO T 310 or other method specified by the Engineer.

³ Moisture content at the time of compaction is extremely critical to the successful implementation of a modulus-based specification. SHAs may consider tightening these requirements.

⁴ Light Weight Deflectometer

- 7.3. Modulus tests shall occur in a timely manner and before the moisture content of the compacted lift decreases by more than 2% of the moisture content measured at the time of compaction described in Section 6.3.
- 7.4. The Contractor shall correct noncompliant material. The corrected material shall be tested for compliance.
- 7.5. The minimum frequency modulus and moisture tests is shown in Table 7.1⁵. This frequency can be reduced as justified by the use of continuous compaction control as defined in the Contractor's Quality Control Program.

Table 7.1 Minimum Frequency of Modulus and Moisture Tests

Material	Maximum Lot Size	No. of Sublots	No. of Tests per Sublot
Embankment	4000 yd ² (3400 m ²)	2	5
Subgrade	3000 yd ² (2500 m ²)	2	5
Subbase	2400 yd ² (2000 m ²)	2	5
Base	2000 yd ² (1700 m ²)	2	5

- 7.6. Modulus tests shall be evaluated for acceptance on a lot basis using the method of percentage within limits (PWL) unless altered by the Engineer.
- 7.7. The lower tolerance limit for modulus shall be 0.8 times the target modulus specified in AASHTO T E1E unless altered by the Engineer. The Contractor shall target production quality to achieve 90 PWL or higher unless altered by the Engineer.
- 7.8. The lot shall be acceptable if the PWL of the lot equals or exceeds 50 unless altered by the Engineer.

⁵ State agency may replace these values with their own values.