



*Standard Recommended Practice
for*

**Operational Guidelines on Test Pits
for Evaluating Pavement Performance**

AASHTO DESIGNATION: R 19-94 (1999)

INTRODUCTION

The inclusion of test pits in the materials sampling and testing activities for evaluating pavement performance has been a matter of great importance to research and in evaluating premature pavement failures. Inclusion of test pits offers the opportunity to optimize performance testing efforts and to contribute vital information on the performance-related behavior of subsurface pavement layers and subgrades.

1. SCOPE

1.1 This recommended practice identifies methods by which the condition of underlying soils can be determined. The objective of the method is to identify existing conditions that affect or influence the performance of in-service roadways. Laboratory testing of the recovered soil materials are governed by other AASHTO and ASTM Standards.

1.2 The values stated in SI units are to be regarded as the standard.

2. REFERENCED DOCUMENTS

2.1 AASHTO Standards:

- 2.1.1 M 145 Classification of Soil and Soil-Aggregate Mixtures for Highway Construction Purposes
- M 146 Terms Relating to Subgrade, Soil Aggregate, and Fill Materials
- M 147 Materials for Aggregates and Soil-Aggregate Subbase, Base and Surface Courses
- R 13 Conducting Geotechni-

- cal Subsurface Investigations
- T2 Sampling of Aggregates
- T 180 Moisture-Density Relations of Soils Using a 4.54-kg [10-lb] Rammer and a 457-mm [18-in.] Drop
- T 194 Determination of Organic Matter in Soils by Wet Combustion
- T 203 Soil Investigation and Sampling by Auger Borings
- T 233 Density of Soil In-Place by Block, Chunk, or Core Sampling
- T 251 Soil Investigation and Sampling by Hollow-Stem Auger Boring
- T 252 Measurements of Pore Pressures in Soils
- T 267 Determination of Organic Content in Soils by Loss on Ignition

2.1.2 Guide for Design of Pavement Structures

2.2 ASTM Standards:

- C 119 Definition of Terms Relating to Natural Building Stones
- C 294 Descriptive Nomenclature of Constituents of Natural Mineral Aggregates
- C 851 Standard Practice for Estimating Scratch Hardness of Coarse Aggregate Particles
- D 653 Terms and Symbols Relating to Rock and Soil Mechanics
- D 1195 Standard Test Method for Repetitive Static

Plate Load Tests and Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements

- D 1196 Standard Test Method for Nonrepetitive Static Plate Load Tests of Soils and Flexible Pavement Components, for Use in Evaluation and Design of Airport and Highway Pavements
- D 2487 Standard Test Method for Classification of Soils for Engineering Purposes
- D 2488 Standard Recommended Practice for Description of Soils (Visual-Manual Procedure)
- D 3385 Standard Test Method for the Infiltration Rate of Soils in Field Using Double Ring Infiltrometers
- D 3584 Standard Practice for Indexing Papers and Reports on Soil and Rock for Engineering Purposes
- D 4083 Standard Practice for Description of Frozen Soils (Visual-Manual Procedure)
- D 4220 Standard Practice for Preserving and Transporting Soil Samples
- D 4427 Standard Classification of Peat Samples by Laboratory Testing

3. PROCEDURES

3.1. The term "test pit" describes a hole that is cut through the surface layer of a roadway to provide access to the subsurface layers, including the base, subbase, and subgrade. Typically a test pit is 1.5 m (5 ft.) wide and 3.6 m (12 ft.) long (i.e., across the outer wheelpath, from the shoulder line to the inner edge of the highway lane), large enough for a person to conveniently enter it. It is usually done in stages, layer by layer, and at its greatest depth a test pit may extend 0.3 m (1 ft.) or more into the subbase and/or subgrade.

Since the thickness of the layers in highway pavements differs from one location to another, the depth of the test pit will vary.

To make a test pit requires a combination of equipment and hand labor. First a diamond saw is used to cut a rectangular hole through the surface layers. After the tests are made to determine the density of the base course in the wheelpath and adjacent to the wheelpath, hand labor is used to obtain a bulk sample from a portion of the test pit, and then a backhoe completes bulk removal of the base. This process is repeated layer by layer until the predetermined depth in the subgrade is reached.

3.2 Purposes of the Test Pit—A test pit is useful in pavement research, pavement failure investigations, and in determining corrective action for rehabilitation.

3.2.1 Bulk Sampling—Some or all of the large quantity of material that is removed during the excavation of the layers can be saved for further testing in the laboratory. A 1.5-m by 3.6-m (5-ft. by 12-ft.) test pit will yield approximately 2.8 Mg (6200 lb.) of material.

Bulk Sampling is desirable for two reasons:

- (1) to obtain a representative sample of each layer,
- (2) to provide an adequate quantity of material for laboratory testing.

Approximately 180 kg (400 lb) of processed material will be needed from each granular layer for the comprehensive series of tests that is normally scheduled. "Processing" generally involves removal of particles larger than 19 mm ($3/4$ inch); so bulk samples having a mass of 360 kg (800 lb.) or more will be required for some base and subbase materials.

It is essential that the materials tested be *representative* of the pavement layer. Coring tends to cut through aggregate particles, thereby modifying the gradation and angularity, and generating fines, while bulk samples taken by hand in test pits avoid these problems. Coring generally involves the use of water to cool the bit, which can lead to an erroneous determination of the moisture content of the granular materials. Augering large-diameter holes (viz., 300 mm (12 in.)) to obtain bulk samples presents problems in base and subbase layers, because the auger tends to mix the materials together and blur the interfaces. Thus, it can become difficult, if not impossible, to get a representative sample of base and subbase layers using auger methods. Augering also often biases the sample toward the finer fractions.

3.2.2 In situ Properties of Materials—The current AASHTO *Guide for Design of Pavement Structures* and virtually every other pavement design methodology in use today holds as a basic assumption that all the unbound layers of the pavement structure have been compacted to a specific minimum relative dry density and that the key structural parameters implied by meeting the specified density are reliable for design purposes and will vary little during the life of the pavement. Any study of long-term pavement performance that does not test this basic assumption and its implications cannot be used to test the validity of the design procedures themselves.

Key structural parameters such as strength, stability, and resilient modulus apparently do change over time due to changes in moisture content, intrusion of fines, degradation, and so on. In some particular cases, the assumption that a satisfactory relationship exists between relative density and the key structural parameters may be invalid. In a limited number of cases, the specified density may not have been obtained during construction or may have been lost due to mechanical action of traffic or frost. Only by determining the site-specific conditions can the real relationships between the subsurface conditions and long-term performance be established.

In the current AASHTO guide, the load-carrying capacity of a specific design varies directly with resilient modulus of the subgrade. There is also a signif-

icant relationship between capacity and the modulus of subgrade reaction for rigid pavement. The guide assumes that the unbound layers are compacted to 95 percent relative dry density as determined by AASHTO T 180.

If adequate care is taken to avoid disturbing the materials in the test pit, *in situ* tests such as density and moisture content can be made. A nuclear gage can be used to obtain these data, or the sand cone test (or similar displacement tests) can be used to determine density, and a sample can be removed to determine the moisture content by drying. Variation in density and moisture content across the wheelpath can also be measured in the test pit.

It is nearly impossible to obtain good quality, accurate, *in situ* density information in an augered hole. Even a 300-mm (12-in.) diameter hole would be too small and too deep. Augering disturbs the material at the bottom of the hole, and it would not be possible to properly seat the density measuring device.

The importance of obtaining accurate information about the *in situ* moisture content of every pavement layer, including the subgrade, cannot be overemphasized. Pavement materials are subjected to a battery of sophisticated laboratory tests, including the determination of resilient modulus in the repeated-load triaxial test. Such tests must be performed on representative samples of the materials, which have been carefully compacted to the appropriate density at the proper moisture content, simulating *in situ* conditions. The resilient modulus of granular materials is very sensitive to the moisture content and density.

If the laboratory test results are to yield moduli that are correct for the field conditions, it is critical for the field moisture content and density to be correctly defined. These data will be needed to explain deflections, roughness, and other dependent variable measurements at the test sites, and the accuracy of the conclusions that will be drawn about pavement performance will be compromised if the *in situ* data are not provided or are inadequate.

3.2.3 Subsurface Observations—Test pits provide a unique opportunity to clearly view a cross section of the pavement to its full depth across the wheelpath. A permanent photographic record can be made to document visual observations.