SB202 Compressive Strength Specialist

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HMAC CERTIFIED SPECIALIST & APPLICANTS FOR CERTIFICATION: RIGHTS AND RESPONSIBILITIES

This agreement (the "Agreement") affirms that, ______________________________, the below Applicant for Certification or the current Certified Specialist (collectively, the "Specialist") seeks to meet or has successfully met the requirements for certification by the Texas Asphalt Pavement Association ("TXAPA"), a/k/a the Hot Mix Asphalt Center (HMAC) as a certified technician. In that connection, the Specialist agrees as follows:

RIGHTS AND RESPONSIBILITIES - HMAC certification includes the exclusive right to perform certified sampling, testing and reporting on Texas Department of Transportation (TxDOT) projects involving Hot Mix Asphalt (HMA) and Soils & Base (SB) in accordance with TxDOT specifications and test procedures (as may be amended by TxDOT from time to time) for the level of certification issued. Specialists are required to perform and report test results with the accuracy and precision required of a certificated HMA or SB Specialist. It is important that the Specialist fully understands the significance of performing these duties in accordance with the certification level received by the Specialist.

Each Specialist is responsible for performing their own independent sampling, testing and reporting in accordance with TxDOT specifications, test procedures and standard operating procedures. These duties must be performed in a diligent and professional manner to produce TxDOT projects of the highest possible quality.

CONTACT INFORMATION - It is the Specialist's responsibility to provide the HMAC with current contact information by logging into www.txhmac.org, Communications from the HMAC will primarily be sent electronically to the most recent contact information provided by the Specialist.

ANNUAL PROFICIENCY - Once certified, Specialists are required to complete annual proficiency testing and the reporting of results to the HMAC. The testing and reporting must be timely and independently performed by the Specialist and, where applicable, in conformance with the requirements of the Specialist's certifications. TxDOT will ship the annual proficiency samples to the Specialist's address of record. (If this address is not current, the Specialist may not timely receive a proficiency sample and his/her certification may be danger of lapsing.)

Failure to submit proficiency test results or to respond to low rating(s) by the appointed deadlines may result in a change of certification status from active to inactive. Specialists whose certifications are inactivated because their annual proficiency testing/reporting is not current or whose certifications have been revoked or inactivated are prohibited from performing the duties associated with all certifications held by that Specialist.

RECERTIFICATION - Certification(s) are valid for three (3) years from the date originally issued, after which the Specialist must be recertified by again passing the requirements for certification. Specialists may seek recertification up to one year prior to the expiration of their certificate(s).

Failure to timely obtain recertification will cause all dependent certifications held by a Specialist to be inactivated. It is the Specialist's responsibility to maintain an active certification(s). (The HMAC will not provide reminders of pending expiration dates.)

ALLEGATIONS OF MISCONDUCT - Allegations of misconduct should be submitted to the HMAC, P.O. Box 149, Buda, TX 78610 and must include the name, address and signature of the individual asserting the allegations as well as a brief description of the allegations.

If the allegations are properly submitted and appear to have merit, the HMAC Steering Committee (the "Committee") the individual asserting misfeasance and the person so accused will be asked to meet in person (but at separate dates/times) with members of the Committee. At the conclusion of the meeting(s), the Committee will issue its determination.

Misconduct generally consists of (i) neglect, (ii) abuse and/or (iii) breach of trust which are generally defined as:

1. Neglect: unintentional deviation(s) from specifications or testing procedures;

2. Abuse: careless or deliberate deviation from specifications or testing procedures; and

3. Breach of Trust: violation of the trust placed in Certified Specialists including, but not limited to, acts such as:

    a. Falsification of or deliberate omission from material records or information; or

    b. Awareness of improprieties in sampling, testing and/or production by others and the failure to timely report those improprieties to the appropriate project supervision.

The Committee may issue written reprimands (private or public) and/or revoke or inactivate a certification (if the Specialist has made a false representation or misstatement to the Committee or to the public or has engaged in misconduct) or take such other actions as the Committee, in its sole discretion, determines to be appropriate with respect to the Specialist's certification(s).

Specialists who do not achieve recertification or whose certification is revoked or inactivated by the Committee may appeal to a separate appeals committee comprised of industry members (the "Appeal Committee"). The exhaustion of this right of appeal to the Appeal Committee is a prerequisite to the exclusive remedy of administrative review by final and binding arbitration in Hays County, Texas, as administered by the American Arbitration Association by a single-member panel. Any and all other claims related in any way to this Agreement are exclusively subject to final and binding arbitration in Hays County, Texas as administered by the American Arbitration Association by a single-member panel.

In consideration for the HMAC certification/recertification process, Specialist hereby waives any and all claims of whatsoever kind or character related, directly or indirectly, to this Agreement, against the TXAPA, HMAC (including, but not limited to, the Committee and the Appeal Committee and their members), that s/he may have (including claims for attorney's fees) and further agrees to save, indemnify and hold TXAPA, the HMAC (including, but not limited to, the Committee and the Appeal Committee and their members) harmless from any claim, action or cause of action arising as a result of, or relating to this Agreement including, but not limited to, Specialist's certification, or any refusal, reprimand, revocation and/or suspension of certification or recertification of Specialist.

ACKNOWLEGED & AGREED:

SPECIALIST:

______________________________ ______________________

SIGNATURE **DATE**

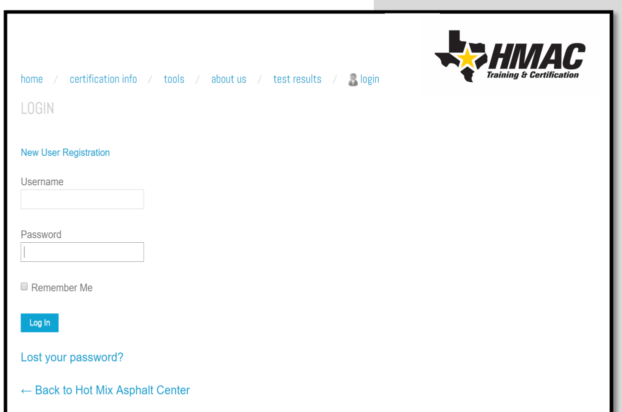
____

PRINTED NAME

WEBSITE

IT IS YOUR RESPONSIBILITY TO KEEP YOUR INFORMATION UP TO DATE

FIRST TIME LOGIN

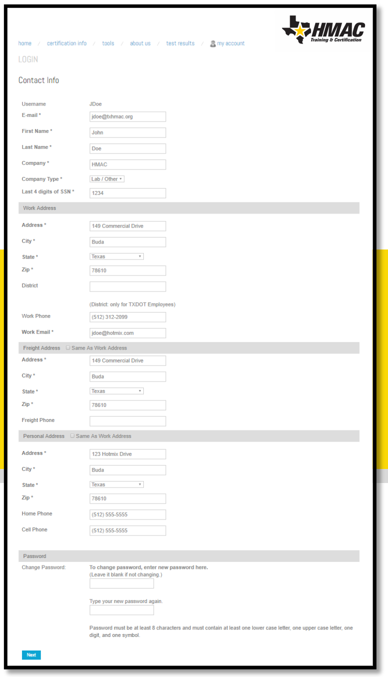


- Username: Capitalize the **FIRST LETTER OF YOUR FIRST AND LAST NAME** then spell out the rest of your last name in lower case, followed by the last 4 digits of your SSN.
- Password: The same but add a "+" at the end.

Example: **John Doe**

Username: **JDoe1234**

Password: **JDoe1234+**



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Last Name *	Doe
Company *	HMAC
Company Type *	Lab / Other
Last 4 digits of SSN *	1234
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Work Email *	jdoe@hotmix.com
Freight Address	Same As Work Address
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City *	Buda
State *	Texas
Zip *	78610
Freight Phone	
Personal Address	Same As Work Address
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City *	Buda
State *	Texas
Zip *	78610
Home Phone	(512) 555-5555
Cell Phone	(512) 555-5555
Password	
Change Password:	To change password, enter new password here. (Leave it blank if not changing.)
	Type your new password again.
	Password must be at least 8 characters and must contain at least one lower case letter, one upper case letter, one digit, and one symbol.

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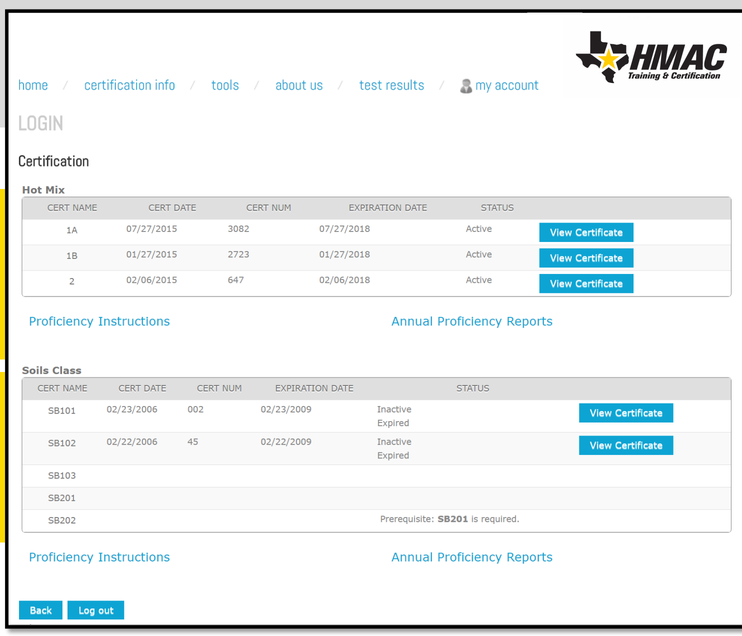
PROFICIENCY



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Certification

Hot Mix

CERT NAME	CERT DATE	CERT NUM	EXPIRATION DATE	STATUS	
1A	07/27/2015	3082	07/27/2018	Active	View Certificate
1B	01/27/2015	2723	01/27/2018	Active	View Certificate
2	02/06/2015	647	02/06/2018	Active	View Certificate

Proficiency Instructions | Annual Proficiency Reports

Soils Class

CERT NAME	CERT DATE	CERT NUM	EXPIRATION DATE	STATUS	
SB101	02/23/2006	002	02/23/2009	Inactive Expired	View Certificate
SB102	02/22/2006	45	02/22/2009	Inactive Expired	View Certificate
SB103					
SB201					
SB202				Prerequisite: **SB201** is required.	

Proficiency Instructions | Annual Proficiency Reports

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Test Procedure for

SURVEYING AND SAMPLING SOILS FOR HIGHWAYS

TxDOT Designation: Tex-100-E

Effective Date: August 1999

1. SCOPE

1.1 This method provides definitions of some basic terms and describes the procedures for surveying and sampling soils for highways. It describes the information required from the survey and the sampling methods required, and it discusses the apparatus necessary to carry out the sampling process.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

2.1 *Aggregate*—Aggregate is granular material of mineral composition such as sand, gravel, shell, slag, crushed stone or lightweight. Aggregate may be used with a cementing medium to form mortars or concrete, or alone in base courses or as a surface treatment.

2.2 *Bank Gravel*— Bank Gravel is found in natural deposits, usually intermixed with fine material, such as sand or clay, or combinations thereof; the terms “gravelly clay,” “gravelly sand,” “clayey gravel,” or “sandy gravel” indicate the varying proportions of the materials in the mixture.

2.3 *Blast Furnace Slag*—Blast furnace slag is a non-metallic by-product, developed in a blast furnace simultaneously with iron in a molten condition, essentially consisting of silicates and alumina-silicates of calcium and other bases.

2.4 *Bottom Ash*—Bottom Ash is the heavy residue from the combustion of ground or powdered coal or lignite.

2.5 *Clay*—Clay is a fine grained soil that can be made to exhibit plasticity (putty-like properties) within a range of water contents and that exhibits considerable strength when air dry.

2.6 *Clay Size*—Clay size refers to any material finer than 0.002 mm (2 µm), though not necessarily exhibiting clay characteristics.

2.7 *Coarse Aggregate*—Coarse aggregate is the portion of aggregate retained on the 2.00 mm (No. 10) sieve for Bituminous Concrete or retained on the 4.75 mm (No. 4) sieve for Portland Cement Concrete.

2.8 *Concrete*—Concrete is a composite material consisting of a binding medium within which are embedded particles or fragments of aggregate; in hydraulic cement concrete, the binder is formed from a mixture of hydraulic cement and water.

2.9 *Conglomerate*—Conglomerate is the coarse grained, clastic, sedimentary accumulation of particles, composed of rounded to sub-angular fragments larger than 2 mm (0.08 in.) in diameter, set in a fine-grained matrix of sand or silt and commonly cemented by calcium carbonate, iron oxide, silica or hardened clay.

2.10 *Crushed Face*—Crushed face is a fractured surface produced by the mechanical crushing of an aggregate. Crushed aggregate faces are identified by fresh fractures and lack of evidence of weathering.

2.11 *Crushed Gravel*—Crushed gravel is the product resulting from the mechanical crushing of gravel, with substantially all fragments having at least one face resulting from a fracture.

2.12 *Crushed Stone*—Crushed stone is the product excavated from an in-situ deposit of rock, crushed and processed for construction purposes with substantially all faces resulting from the crushing operation.

2.13 *Detrital (Weathered)*—Detrital material consists of particles that have been formed through the disintegration of other particles by erosion or weathering.

2.14 *Fine Aggregate*—Fine aggregate is the portion of the aggregate passing the 2.00 mm (No. 10) sieve for Bituminous Concrete or passing the 4.75 mm (No. 4) sieve for Portland Cement Concrete.

2.15 *Fly Ash*—Fly ash is the finely divided residue from the combustion of ground or powdered coal or lignite that is transported from the firebox through the boiler by flue gases.

2.16 *Granite*—Granite is an igneous rock consisting of quartz and alkali feldspars.

2.17 *Gravel*—Gravel consists of unconsolidated or loose detrital sediment (aggregate resulting from natural disintegration and abrasion of rock) with particle sizes passing the 76.2 mm (3 in.) sieve and retained on the 2.00 mm (No. 10) sieve.

2.18 *Lightweight Aggregate*— Lightweight aggregate consists of expanded shale, clay, or slate, and is produced by the rotary kiln method.

2.19 *Limestone Rock Asphalt*—Limestone rock asphalt is limestone impregnated with naturally occurring asphalt.

2.20 *Lithification*—Lithification is the process of hardening, induration, and compaction of sediments**,** leading to the formation of solid materials.

2.21 *Mineral Filler*—Mineral filler is a fine aggregate or manufactured material used to supply particle sizes where the mix design is deficient in gradation.

2.22 *Quarry*—A quarry is an open surface excavation of minerals or construction materials.

2.23 *Riprap*—Riprap is quarried stone especially selected, graded, and placed to prevent erosion and thereby preserve the shape of a surface, slope, or underlying structure.

2.24 *Rock*—Rock is a mass of solid, naturally occurring material from an in-situ deposit, excluding conglomerates. The formation may or may not be laminated.

2.25 *Sand*—Sand consists of fine aggregate particles that are retained on the 75 µm (No. 200) sieve, either as natural sand resulting from natural disintegration and abrasion of rock, or as manufactured sand, which is produced by the crushing of rock, gravel, slag, etc.

2.26 *Sandstone*—Sandstone is sedimentary rock consisting predominantly of weathered sand-sized particles naturally cemented together.

2.27 *Silt*—Silt is soil passing the 75 µm (No. 200) sieve that is non-plastic or very slightly plastic and that exhibits little or no strength when air dry.

2.28 *Silt Size*—Silt size is any material passing the 75 µm (No. 200) sieve that is coarser than 0.002 mm (2 µm), though not necessarily exhibiting silt characteristics.

2.29 *Slag*—Slag is a non-metallic by-product of the smelting or refining of metals and consists of calcium and alumina-silicates.

2.30 *Soil*—Soil is a superficial, unconsolidated deposit of disintegrated and decomposed rock material produced by surface weathering.

2.31 *Source*—A source is a geographical location of naturally occurring material that can be mined or quarried from the original in-situ deposit. In the case of manufactured or by-product material, it is the location of the plant at which the material is produced.

2.32 *Stone*—Stone consists of crushed**,** angular particles of rock.

2.33 *Traprock*—Traprock consists of various fine-grained, dense, dark colored igneous rocks, typically basalt or diabase; also called “trap.”

2.34 *Virgin Material*—Virgin material is material not previously used in construction.

Note 1—The Specification Committee has approved the above definitions.

3. APPARATUS

3.1 Many factors, such as the nature of the terrain, the kind of material, the depth of material below the surface, the equipment available, and the use to be made of the survey information, will affect the type and amount of equipment to be used in sampling.

3.2 Small hand tools are satisfactory for sample collection where the materials are at a shallow depth and can be easily dug. However, if the materials are very hard, power equipment may be more economical. The only feasible method of sampling strata located at a considerable depth below the surface is the use of a power drill machine with a core or auger attachment.

3.3 The following equipment should suffice for ordinary conditions:

- *Sample bags and moisture cans* for disturbed samples
- *Materials,* to maintain moisture content, and *boxes* for packing undisturbed cores
- *Power drill rig*, with core and/or auger attachments
- *Metallic tape*, 30 m (100 ft.) long
- *Post hole digger, shovel, prospector's pick, other hand tools*
- *Jackhammer and air compressor*
- *Sample splitter or quartering cloth*
- *Engineer's level and level rod*
- *Stakes*
- *Gasoline burner and pan*
- *Ruler*, 2 m (6 ft.)
- *Soil auger.*

4. SOIL SURVEY

4.1 The soil survey is an important part of the engineering survey for the design, location and construction of a highway. The investigation should furnish the following information:

- The extent and location of each type of soil or rock in the subsurface
- The condition of subsoils (moisture and density) upon which embankments will be constructed
- The design of ditches and backslopes in cut sections to prevent slides
- The location and selection of suitable material for fills, sub-grade treatment and backfill adjacent to structures
- The location of local material for base and aggregate
- The need for stabilization of sub-grade, sub-base and base materials
- The supporting values of soils as foundation materials.

5. SAMPLING

5.1 A representative sample of disturbed soil consists of a combination of the various particles in exactly the same proportion as they exist in the natural ground, roadway, or pit.

5.1.1 The proper method of obtaining a sample will depend on the place, the quantity of material, the proposed treatment, and tests to be performed in the laboratory.

5.1.2 Unless different types of materials are to be uniformly mixed in certain proportions, samples should contain only materials of like color and texture, and should not be composite of materials apparently different in character.

5.2 It is impossible to obtain a sample from the earth that is entirely undisturbed, because the removal of the surrounding soil releases the pressure from the specimen, which causes a certain amount of disturbance.

5.3 The intent of sampling, however, is to obtain a core of soil from the earth with as little disturbance as possible to the natural density, moisture content, and structural arrangement of the particles.

5.3.1 Such a soil core is satisfactory for all practical purposes and can be classified as an undisturbed sample of soil.

Test Procedure for

PREPARING SOIL AND FLEXIBLE BASE MATERIALS FOR TESTING

TxDOT Designation: Tex-101-E

Effective Date: January 2010

1. SCOPE

1.1 This method describes three procedures for preparing of soil and flexible base samples for soil constants and particle size analysis, compaction and triaxial, and sieve analysis of road-mixed material.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

2.1 *Soil Binder*—Soil binder is any material passing the 425 µm (No. 40) sieve.

2.2 *Percent Soil Binder*—Percent soil binder is equal to 100 times the ratio of the oven-dry mass of the soil binder to the oven-dry mass of the total.

3. APPARATUS

3.1 *Set of standard U.S. sieves*, meeting the requirements of Tex-907-K.

3.2 *Scale*, with a minimum capacity of 36 kg (80 lb.), with a minimum accuracy and readability of 5 g or 0.1% of the test load, whichever is greater.

3.3 *Drying oven*, maintained at 60°C (140°F).

3.4 *Crusher* (optional), which can be adjusted to produce material passing a 2.00 mm (No. 10) sieve.

3.5 *Mechanical pulverizer* (optional).

3.6 *Wedgewood mortar and pestl*e.

3.7 *Scoop.*

3.8 *Small siphon tube* (optional).

3.9 *Sample containers, metal pans, cardboard cartons.*

3.10 *Filter paper*, non-fibrous.

3.11 *Sample splitter, quartering machine, or quartering cloth.*

3.12 *Mechanical mixer* (stirring device).

3.13 *Dispenser cup.*

3.14 *Plaster of Paris molds* (optional).

Note 1—Dry the plaster of Paris molds at a temperature not to exceed 60°C (140°F) after forming, and wash and dry after each use.

4. MATERIALS

4.1 *Tap water.*

5. SAMPLE IDENTIFICATION

5.1 Give each sample an identification number on a suitable card. This card should remain with the sample throughout the processing and testing.

PART I—PREPARING SAMPLES FOR SOIL CONSTANTS AND PARTICLE SIZE ANALYSIS

6. SCOPE

6.1 If only soil constants are desired, use either “Dry Preparation (Method A)” or “Wet Preparation (Method B).” However if particle size analysis or percent soil binder is also desired, use Method A. Furthermore, use Method A when preparing a referee test.

7. PREPARING SAMPLES

7.1 *Dry Preparation (Method A)*—to be used for analysis of soil constants, particle size, or percent soil binder, or when preparing a referee test

7.1.1 Select a representative sample according to the appropriate test method (Tex-100-E or Tex-400-A) large enough to yield at least 300 g of soil binder.

7.1.2 Dry the sample in a 60°C (140°F) oven.

7.1.3 Examine the sample by visual inspection or slake small portions in water to determine if the material has any particles larger than 425 µm (No. 40).

7.1.4 If the amount of aggregate larger than 425 µm (No. 40) is easily distinguishable, remove these particles by hand and proceed to Section 7.1.27.

7.1.5 For materials containing a considerable amount of aggregate, separate the fine loose binder from the coarse particles by sieving over a 425 µm (No. 40) sieve.

7.1.6 Set the soil binder passing the sieve aside to recombine with the additional binder obtained from Sections 7.1.8 through 7.1.24.

7.1.7 If desired, slake the total material.

7.1.8 Place the material to be slaked into a pan.

7.1.9 Cover the material completely with water and soak for a minimum of 12 hours, unless Tex-102-E determines a shorter time.

7.1.10 Place the empty 425 µm (No. 40) sieve into a clean pan and pour the liquid from the wet sample through it.

7.1.11 Transfer the wet sample to the sieve in increments not exceeding 450 g.

7.1.12 Pour water over the sieve until the water level is about 12.5 mm (0.5 in.) above the sample on the sieve.

7.1.13 Alternately agitate the sieve up and down and stir the sample by hand.

7.1.14 If the material retained on the sieve contains lumps that have not disintegrated, crumple any that can be broken down between thumb and fingers and wash through the sieve.

7.1.15 After all the soil binder appears to have passed through the sieve, hold the sieve above the pan and wash the retained aggregates clean by pouring a small amount of water over it and letting the water drain into the pan.

7.1.16 Transfer the retained aggregate from the sieve to a clean pan.

7.1.17 Repeat the procedure in Sections 7.1.10 through 7.1.16 until all of the soaked sample has been washed.

7.1.18 Dry the retained aggregate portion of the sample in a 60°C (140°F) oven.

7.1.19 Re-screen over the 425 µm (No. 40) sieve and add the binder passing the sieve to the soil binder obtained in Section 7.1.6.

7.1.20 Weigh the mass of the aggregate and retain for use in Tex-110-E, Part I.

7.1.21 Place the pan containing the soil binder and wash water aside, where it will not be disturbed, until all the soil has settled to the bottom of the pan and the water above the soil is clear.

7.1.22 Decant the water off the soil.

7.1.23 Dry the remaining soil in a 60°C (140°F) oven.

7.1.24 In cases where the materials fail to settle overnight, evaporate the water by placing the sample in a 60°C (140°F) oven until it is dry, or siphon the water on to a plaster of Paris mold lined with filter paper.

7.1.25 When the water has disappeared, place the filter paper with adhering soil in a pan and dry in the oven.

7.1.26 Sweep the dry soil from the filter paper with a stiff brush into the pan of fines.

7.1.27 Break down the dried soil binder with a mortar and pestle or use a suitable mechanical pulverizer with an opening set from 635 to 889 μm (0.025 to 0.035 in.)

7.1.28 If a pulverizer is used, any material still aggregated in lumps larger than 425 μm (No. 40) should be broken down with a mortar and pestle.

7.1.29 Combine all of the soil binder obtained and weigh the mass to the nearest 5 g.

7.1.30 Mix thoroughly to produce a uniform sample of all of the particles.

7.1.31 Add the masses obtained in Sections 7.1.20 and 7.1.29, and record the sum as the Total Dry Mass of the sample.

7.2 *Wet Preparation (Method B)*—to be used for the analysis of soil constants only

7.2.1 Select a representative sample according to Tex-100-E or Tex-400-A.

7.2.2 Make the sample large enough to yield at least 300 g of soil binder.

7.2.3 Place the sample in a clean pan.

7.2.4 Cover the sample completely with clear water.

7.2.5 Soak soils with moderate to high Plasticity Indices (PI) for a minimum of 12 hours, unless Tex-102-E determines a shorter time.

7.2.6 Soak flexible base and low PI materials for a minimum of two hours.

7.2.7 Sieve the wet sample into a clean pan in increments of approximately 450 g over a 2.00 mm (No. 10) sieve to remove large aggregate particles.

7.2.8 Wash the aggregate retained on the sieve with a small amount of water.

7.2.9 Discard the portion of material retained on the sieve.

7.2.10 For soils and base materials with low PI, go to Section 7.2.14.

7.2.11 For soils with moderate to high PI, place the wet material passing the 2.00 mm (No. 10) sieve into the dispersion cup of a mechanical malt mixer.

7.2.12 Do not fill the cup more than half-full.

7.2.13 Mix the material for three to five minutes or until the soil binder is separated.

7.2.14 Pour the material through a 425 µm (No. 40) sieve into a plaster of Paris bowl lined with filter paper.

7.2.15 Vigorously agitate the sieve up and down over the bowl while occasionally stirring the sample by hand to allow as much material as possible to pass the 425 µm (No. 40) sieve.

7.2.16 If the material retained on the sieve contains lumps that have not disintegrated, return to the dispersion cup, and remix and wash through the sieve.

7.2.17 Sieve until at least 95% of the soil binder appears to have passed through the sieve.

7.2.18 Reduce the water content of the material in the plaster of Paris bowl to below the liquid limit.

7.2.19 When the sample can be divided into pie-like wedges, and each wedge can be easily removed, it can be used for testing of soil constants.

7.2.20 If the soil constants are not to be determined immediately, place the material into an airtight container to prevent moisture loss.

8. CALCULATION

8.1 Use the following to calculate the percent soil binder:

$$Percent\ Soil\ Binder = 100(W_1/W_T)$$

Where:
W_1 = dry mass of soil binder
W_T = dry mass of total sample.

9. REPORT

9.1 Report the percent soil binder to the nearest whole percent.

PART II—PREPARING SAMPLES FOR COMPACTION AND TRIAXIAL TESTS

10. SCOPE

10.1 Use this part to prepare samples for the compaction and triaxial tests. This procedure applies to all materials, except stabilized material, in the roadway or stockpile condition.

11. PREPARING SAMPLES

11.1 Select approximately a 90 kg (200 lb.) representative sample according to Tex-100-E or Tex-400-A.

11.2 Check specifications for maximum aggregate size.

11.3 Spread sample on a clean floor to air dry or use a forced draft of warm air not to exceed 140°F (60°C) for soils and 230°F (110°C) for flexible base material.

11.4 Dry soils in accordance with Section 11.4.1 and flexible base in accordance with Section 11.4.2.

11.4.1 Reduce the water content of soil samples to slightly below the estimated optimum moisture content.

11.4.2 Dry flexible base materials to constant weight. Constant weight will be considered achieved when the weight loss is less than 0.1% of the sample weight in four hours of drying.

11.5 Process soils in accordance with Section 11.5.1 and flexible base in accordance with Section 11.5.2.

11.5.1 Process moist clay and other soils (which form hard lumps when dried or contain aggregates) so that it will pass a 6.3 mm (1/4 in.) wire-mesh.

11.5.2 Separate flexible base by dry sieving into the following sizes:

- 1 3/4 in. (44.5 mm)
- 1 1/4 in. (31.7 mm)
- 7/8 in. (22.2 mm)
- 5/8 in. (16 mm)
- 3/8 in. (9.5 mm)
- No. 4 (4.75 mm)
- No. 40 (0.425 mm).

Note 2—Do not overload the screens. The material passing the No. 4 and retained on the No. 40 sieve may need to be shaken separately and in several small batches to avoid overloading the screen.

11.5.3 When material contains aggregate retained on the 44.5 mm (1-3/4 in.) sieve, add the material passing the 1-3/4 in. (44.5 mm) sieve and retained on the 1-1/4 in. (31.7 mm) sieve for recombining individual specimens.

Note 3—Do not use particles larger than 1-3/4 in. (44.5 mm) in the compacted specimens.

11.6 When aggregate between 1- 3/4 in. (44.5 mm) and 1-1/4 in. (31.7 mm) is needed, crush particles larger than 1-3/4 in. (44.5 mm) or obtain additional material from the project.

Note 4—Do not crush the material if it is an uncrushed gravel.

11.7 Mix each size to make moisture as uniform as possible.

11.8 Weigh each size of material to the nearest 0.1 lb (5 g).

11.9 Calculate the cumulative percentages retained on each sieve size as shown under Section 12.

11.10 These values are to be used in recombining the sample for compaction specimens.

12. CALCULATION

12.1 Calculate the cumulative percentages retained on each sieve.

$$Percent\ Retained = 100(Mass\ Retained / Total\ Mass\ of\ Sample)$$

PART III—SIEVE ANALYSIS OF ROAD-MIX STABILIZED MATERIAL

13. SCOPE

13.1 This procedure applies to chemically stabilized materials sampled from the roadway during construction. These materials may be tested in the roadway condition for adequate pulverization, using sieves required by the governing Department Standard Specifications.

14. PROCEDURE

14.1 Select a representative sample from the roadway according to Tex-100-E.

14.2 Reduce the sample, using a sample splitter or other approved method, to a minimum of 4.5 kg (10 lb.)

14.3 Remove all non-slakable aggregates retained on the specified sieves.

14.4 Weigh the sample to the nearest 5 g and record as the Total Mass under Section 15.

14.5 Use the specified sieves to separate the sample into different size fractions.

14.6 Use either a sieve shaker or the hand method in the sieving operation.

14.7 Sieve the sample with a lateral and vertical motion of the sieves, accompanied by a jarring action to keep the material moving over the surface of the sieve.

14.8 Continue the sieving operation until no more than one percent of the test sample, by mass, passes through any sieve after one minute of continuous shaking.

14.9 Weigh the material passing each of the required sieves and record its mass to the nearest 5 g.

15. CALCULATION

15.1 Use the following to determine percent material passing each sieve.

$$Percent\ Passing = 100(Mass\ Passing\ a\ Sieve / Total\ Mass\ of\ Sample)$$

16. REPORT

16.1 Report test results to the nearest whole percent.

17. ARCHIVED VERSIONS

17.1 Archived versions are available.

Test Procedure for

LABORATORY COMPACTION CHARACTERISTICS AND MOISTURE-DENSITY RELATIONSHIP OF BASE MATERIALS

TxDOT Designation: Tex-113-E

Effective Date: June 2011

1 SCOPE

1.1 This method determines the relationship between water content and the dry unit mass (density) of base materials. Base materials are compacted in a 6-in. diameter × 8-in. tall mold with a 10-lb. rammer. The test is performed on prepared materials passing the 1-3/4 in. (45 mm) sieve. Follow Tex-114-E to determine moisture-density relationships of untreated subgrade and embankment soils.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard..

1.3 Instructional videos are available using the following links.

- Definitions
- Apparatus
- Procedure

2 DEFINITIONS

2.1 *Maximum Dry Density (D_A)*—Maximum dry density is the maximum value obtained from the compaction curve using the specified compactive effort.

2.2 *Optimum Water Content (W_{OPT})*—Optimum water content is the water content at which the soil can be compacted to the maximum dry density.

2.3 *Compactive Effort (C.E.)*—Compactive effort is the total energy, expressed as foot-pounds per cubic inch (kilo-Newton-meters per cubic meter), used to compact the specimen.

2.3.1 Calculate compactive effort as follows:

$$C.E. = \frac{Ht. of\ Drop (m\ or\ ft) \bullet Wt. of\ Hammer (kN\ or\ lb) \bullet \#\ Drops \bullet \#\ Layers}{Volume of\ Mold (m^3\ or\ in.^3)}$$

2.3.2 This procedure requires 15 ft-lb per drop (13.26 ft-lb /in.^{3}).

Note 1—In the metric system, the units for weight and mass are not the same. In order to convert the mass of the hammer to the metric "weight," you must multiply the mass by the force of gravity, g, which in the metric system is 9.8 m/sec^2. The resulting unit is a Newton. Divide that number by 1,000 to get kilo-Newtons (kN).

3 APPARATUS

3.1 *Automatic tamper (compaction) device,* with base plate to hold 6-in. (152.4 mm) inside diameter (I.D.) molds, equipped with a 10 ± 0.02 lb. (4.54 ± 0.01 kg) rammer and adjustable height of fall.

3.1.1 Striking face of the rammer should conform to a 43 ± 2° segment of a 2.9 ± 0.1 in. (74 ± 2.5 mm) radius circle.

3.1.2 Bolt the base plate of the tamper to a rigid foundation, such as a concrete block, with a mass of not less than 200 lb. (91 kg). Use an alternate foundation support, such as a rigid stand or table, only if the D_A produced is within 2% of that produced by an automatic tamper bolted to a concrete floor.

3.2 *Rigid metal compaction mold*, with a 6 in., +1/16, or -1/64 in. (152.4 mm, +1.59 or -0.40 mm) I.D. and 8.5 ± 1/16 in. (215.9 ± 1.6 mm) height, with removable collar.

3.3 *Metal stand*, with a set of standard spacer blocks 1, 4, 6, and 11 in. (25.4, 101.6, 152.4, and 279.4 mm) accurate to 0.025 mm (0.001 in.), and a micrometer dial assembly with 2 in. (50 mm) travel for determining height of specimens.

3.4 *Balance*, Class G2 in accordance with Tex-901-K, with a minimum capacity of 35 lb. (16 kg).

3.5 *Extra base plate*, secured on a rigid, level stand to hold the mold.

3.6 *Hydraulic press*, to extrude compacted specimens from mold.

3.7 *Drying oven*, maintained at 230 ± 9°F (110 ± 5°C).

3.8 *Metal pans with lids*, wide and shallow for mixing and drying materials.

3.9 *Non-absorptive bowls with lids.*

3.10 *Set of standard U.S. sieves*, meeting the requirements of Tex-907-K, in the following sizes:

- 1-3/4 in. (44.5 mm)
- 1-1/4 in. (31.7 mm)
- 7/8 in. (22.2 mm)
- 5/8 in. (16 mm)
- 3/8 in. (9.5 mm)

- No. 4 (4.75 mm)
- No. 40 (0.425 mm).

3.11 *Sprinkling jar and wash bottle.*

3.12 *Clean, circular, porous stones,* slightly less than 6 in. (152.4 mm) in diameter and 2 in. (51 mm) high.

3.13 *Non-porous paper discs*, 6-in. (150 mm) diameter, Gilson MSA-121 or equivalent.

3.14 *Supply of small tools,* including a level, putty knife, spatula, horsehair bristle brush, plastic mallet, open-ended wrenches (7/16 in. and 9/16 in.), crescent wrenches (12 in. and 16 in.), Allen wrenches (1/8 in., 3/16 in., and 9/64 in.), and feeler gauges.

3.15 *Soil Compactor Analyzer (SCA) approved by TxDOT,* with sensor rod assembly, control box, computer, and compaction device analysis system software capable of turning the automatic tamper off once the required compactive energy has been delivered to the layer being compacted.

3.15.1 Sensor rod assembly consists of sensing rod, magnetostrictive linear displacement transducer, frame (powder coated), circular magnet, magnet mount, cable, and miscellaneous mounting hardware.

3.15.2 Control box consists of enclosure, power supply, data acquisition card, miscellaneous electronics, and emergency stop.

3.15.3 Computer with system software, TxDOT SCA V8.1.10, maintained by the Construction Division, Materials and Pavements Section.

3.15.4 *SCA Reference Guide*.

3.16 *Slide finishing hammer*, meeting the dimensions in Figure 1. The drop weight will be 10 ± 0.02 lb. (4.55 ± 0.01 kg), and drop height will be 18 in. along a vertical, fixed shaft. The finishing tool will have a smooth, flat surface. Weight of entire slide finishing hammer will be 23.4 ± 0.1 lb.

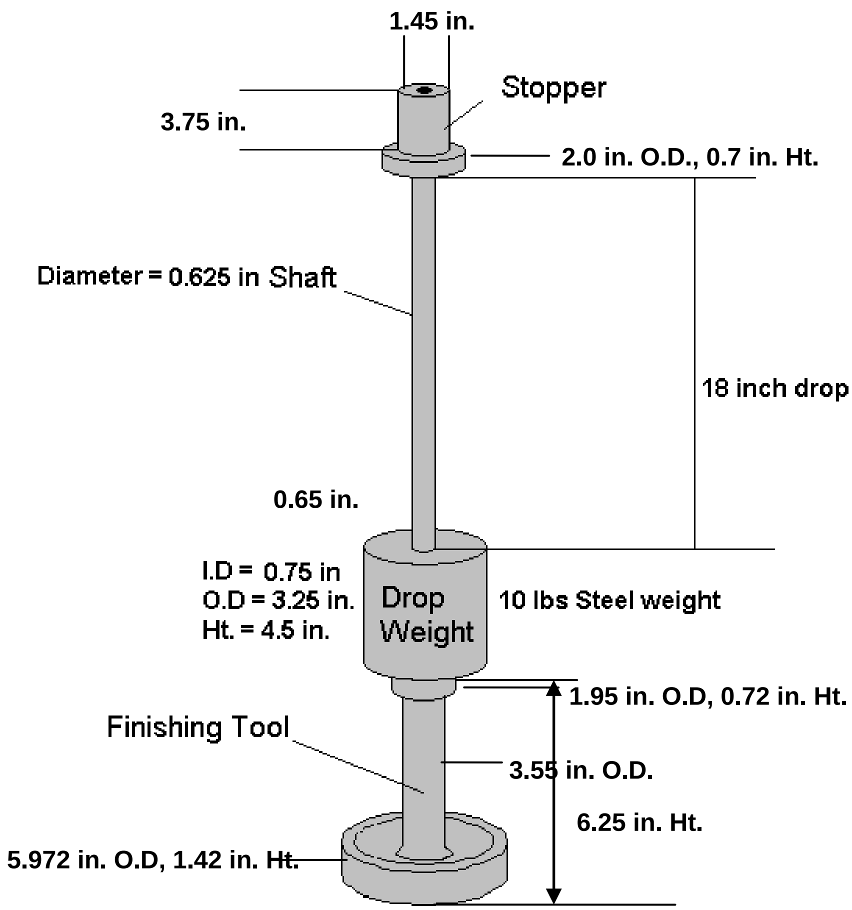

Figure 1—Slide Finishing Hammer

4 CALIBRATING EQUIPMENT

4.1 Calibrate and maintain all equipment required by this procedure in accordance with Tex-198-E.

4.2 Perform the following additional activities to properly maintain the automatic tamper:

4.2.1 Wipe the guide rods and disc with a wet rag after each use.

4.2.2 Wipe the guide rods and disc with alcohol weekly to ensure that no oil or residue begins to build up on them.

4.2.3 Lubricate the guide disc prior to compaction with a graphite pencil. The rods will become lubricated by picking up a bit of the graphite from the edge of the disc during compaction.

4.2.4 Check the guide bushing located on top of the compactor weekly. There should be very little play between the shaft and the guide bushing. The acceptable clearance between the shaft and the guide bushing is 0.007–0.013 in. Replace the guide bushing if the clearance is outside these limits.

4.2.5 Check the guide rod brackets weekly. There should be very little to no play between the rods and the brackets. If the play is excessive, replace the brackets.

4.2.6 Check the spacing between the guide disc and rods weekly by pushing the shaft/disc towards two of the guide rods and measuring for a total clearance of 0.016 in. with feeler gauges. If the total clearance exceeds 0.016 in., adjust the spacing until it meets the tolerance.

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5 MATERIAL SAMPLING AND PREPARATION

5.1 Obtain a representative sample in accordance with Tex-400-A.

5.2 Check specifications for maximum aggregate size.

5.3 Spread sample on a clean floor to air dry or use a forced draft of warm air not to exceed 230°F (110°C) and dry to constant weight. Constant weight will be considered achieved when the weight loss is less than 0.1% of the sample weight in four hours of drying.

5.4 Separate flexible base by dry sieving into the following sizes.

- 1-3/4 in. (44.5 mm)
- 1-1/4 in. (31.7 mm)
- 7/8 in. (22.2 mm)
- 5/8 in. (16 mm)
- 3/8 in. (9.5 mm)
- No. 4 (4.75 mm)
- No. 40 (0.425 mm)

Note 2—Do not overload the screens. The material passing the No. 4 and retained on the No. 40 sieve may need to be shaken separately and in several small batches to avoid overloading the screen.

5.5 When material contains aggregate retained on the 1-3/4 in. (44.5 mm) sieve, add the material passing the 1-3/4 in. (44.5 mm) sieve and retained on the 1-1/4 in. (31.7 mm) sieve for recombining individual specimens.

Note 3—Do not use particles larger than 1-3/4 in. (44.5 mm) in the compacted specimens.

5.5.1 When aggregate between 1-3/4 in. (44.5 mm) and 1-1/4 in. (31.7 mm) is needed, crush particles larger than 1-3/4 in. (44.5 mm) or obtain additional material from the project.

Note 4—Do not crush the material if it is an uncrushed gravel.

5.6 Weigh each size of material to the nearest 0.1 lb. (5 g).

5.7 Calculate the cumulative percentages retained on each sieve:

$$Percent\ Retained = 100(\ Mass\ Retained / Total\ \ Mass\ of\ \ Sample\ )$$

Note 5—These values are to be used in recombining the sample for compaction specimens.

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6 PROCEDURE

6.1 Estimate the mass of air-dry material that will fill the mold when wetted and compacted.

6.2 Using this estimated mass and the percentages of the various sizes of particles obtained in the preparation of the sample, compute the cumulative masses for each size to be combined to mold a specimen.

$$Cumulative Weight\ Retained = \left(\frac{Cumulative Percent\ Retained}{100} \right) \times Estimated\ Mass\ of\ \ Material$$

EXAMPLE: Estimated Mass of Material = 18.250 lb.

Sieve Size (in.)	Cumulative Percent Retained (%)	Cumulative Weight Retained (lb.)
1-3/4	0.0	$\left(\frac{0.0}{100} \right) \times 18.25 = 0.000$
1-1/4	2.6	$\left(\frac{2.6}{100} \right) \times 18.25 = 0.475$
7/8	10.6	$\left(\frac{10.6}{100} \right) \times 18.25 = 1.935$
5/8	20.6	$\left(\frac{20.6}{100} \right) \times 18.25 = 3.760$
3/8	35.7	$\left(\frac{35.7}{100} \right) \times 18.25 = 6.515$
No. 4	52.8	$\left(\frac{52.8}{100} \right) \times 18.25 = 9.636$
No. 40	82.1	$\left(\frac{82.1}{100} \right) \times 18.25 = 14.983$
(-)No. 40	100.0	$\left(\frac{100.0}{100} \right) \times 18.25 = 18.250$

6.3 Weigh a trial sample as calculated in Section 6.2.

6.3.1 Estimate the percent moisture at optimum and calculate the weight of water to add based on the mass of the air-dried material.

$$Weight\ of\ Water = \left(\frac{Estimated\ Moisture\ at\ Optimum}{100}\right) \times Estimated\ Mass\ of\ Material$$

EXAMPLE:

Estimated Mass of Material = 18.250 lb., Estimated Moisture at Optimum = 5.2 %

$$Weight\ of\ Water = \left(\frac{5.2}{100}\right) \times 18.250 = 0.949\,lb$$

6.3.2 Weigh the water calculated in Section 6.3.1 in a tared sprinkling jar.

6.3.3 Mold the trial sample in accordance with Sections 6.7–6.32.

6.4 Using the height and mass of the trial sample, calculate the corrected mass of material required to mold samples with a height of 8 ± 0.250 in. (203.2 ± 6.4 mm):

Corrected mass = (8.000 in.) × (trial mass/trial height)

6.5 Weigh four samples for the moisture-density curve using the corrected mass of material calculated in Section 6.4 and the percentages of the various sizes of particles obtained in the preparation of the sample.

6.6 Determine the moisture content of each specimen.

6.6.1 Estimate the optimum moisture content and calculate the water content of the first specimen at 2 percentage points below this estimate.

6.6.2 Calculate the water content of the other three specimens, increasing each in increments of one percentage point.

6.6.3 Calculate the weight of water to add to each specimen based on the mass of the air-dried material.

6.6.4 Weigh each of these water contents in a tared sprinkling jar.

6.7 Place the total sample in the mixing pan, mix thoroughly, and wet with all of the mixing water by sprinkling water in increments onto the sample during mixing.

6.7.1 Mix thoroughly, breaking up soil lumps. Do not break any aggregate particles in the sample.

6.7.2 Turn the wet material over with the mixing trowel to allow the aggregate particles to absorb water.

6.8 After it is thoroughly mixed, scrape all material off the mixing trowel into the pan. Weigh the sample and pan, and record the weight.

6.9 Cover the mixture with a non-absorptive lid to prevent moisture evaporation and allow to stand for 18–24 hours.

Note 6—Allow the trial sample to stand for a minimum of 2 hours before compaction.

6.10 Prior to compaction, weigh the sample (without the lid), replace evaporated water, and thoroughly mix to ensure even distribution of water throughout the sample. Scrape material off mixing tools and into pan.

6.11 Cover and allow the samples to stand 1–2 hours before molding.

Note 7—For the trial sample, this step can be eliminated.

6.12 Weigh the compaction mold and record on Form Tx113,4, “Moisture-Density Relations of Base Material and Sand or Subgrade and Embankment Soils.”

6.13 Place one non-porous paper disc in the bottom of the mold.

6.14 Separate the sample using a 7/8 in. (22.6 mm) sieve.

6.14.1 Distribute the material retained on the 7/8 in. (22.6 mm) sieve equally, based on size, shape, and number of particles, into four separate non-absorptive bowls.

6.14.2 Cover each bowl to prevent loss of moisture.

6.14.3 Using the horsehair bristle brush, brush the material stuck to the 7/8 in. (22.6 mm) sieve back into the pan containing the material passing the 7/8 in. (22.6 mm) sieve.

6.14.4 Divide the material passing the 7/8 in. sieve into four equal, homogeneous portions.

6.15 Estimate the mass needed for one 2-in. (51-mm) layer of compacted material (approximately one-quarter of the total material for the specimen). Weigh one of the portions of material retained on the 7/8 in. sieve with one of the portions of material passing the 7/8 in. sieve, adjusting the amount of material as needed to attain the estimated weight for one layer.

6.16 Construct the layer.

6.16.1 Cover the bottom of the mold with approximately 1/4 in. of material passing the 7/8 in. sieve and level with a spatula.

6.16.2 Hand place all of the aggregate particles retained on the 7/8 in. (22.6 mm) sieve that are contained in one of the non-absorptive containers, minimizing contact with the edges of the mold.

6.16.3 Place aggregates in their most stable position. Aggregates may be placed on top of each other in order to make them all fit, but they must also fill the entire diameter of the mold.

6.16.4 Use a scoop held slightly above the top of the mold to pour the remaining weighed portion of material passing the 7/8 in. (22.6 mm) sieve into the mold.

6.16.5 Use a spatula to move the material passing the 7/8 in. sieve around to fill voids between the aggregate particles retained on the 7/8 in. sieve. Do not rearrange the aggregate particles retained on the 7/8 in. sieve.

6.16.6 Completely cover the aggregate particles retained on the 7/8 in. sieve with material passing the 7/8 in. sieve.

6.16.7 Use a spatula to spade around the inside perimeter of the mold to allow some of the material passing the 7/8 in. sieve to fill cavities around the edge.

6.16.8 Level the surface with the spatula. Do not push this layer down by hand or other means than those described above.

6.17 Lower the hammer and allow it to rest on the surface of the uncompacted lift.

6.18 Prepare the SCA for data collection in accordance with the SCA Reference Guide. Use the option that allows the SCA to shut the automatic tamper off when the required compactive energy is attained.

6.19 Use the SCA to start the compactor. Compact the layer by dropping the 10-lb. (4.55-kg) rammer from a height of 18 ± 1/2 in. (457 ± 12.7 mm) until the SCA indicates the total energy delivered to the lift equals 750 ± 15.0 ft-lb. The number of blows needed to achieve 750 ft-lb must be a minimum of 50 and a maximum of 60. If the number of blows is outside this range, discard the sample and adjust the compactor so that the specified energy is attained within the allowable number of blows.

Note 8—The SCA will turn the compactor off when the correct energy has been delivered to the lift.

6.20 Remove material sticking to the ram face after completing compaction of each lift.

6.21 Use the sample mass and compacted thickness of the first layer (measured by the SCA) to adjust the mass of the subsequent lifts.

6.22 Weigh one of the portions of material retained on the 7/8 in. sieve with one of the portions of material passing the 7/8 in. sieve. Adjust the amount of material to attain the mass for one layer determined in Section 6.21.

6.23 Use a spatula to scarify the surface of the lift just compacted. Do not dislodge aggregates from the previously compacted lift.

6.24 Repeat Sections 6.16.2–6.23 for each of the remaining lifts. Use all material to mold the sample. The surface of the fourth lift should be as free as possible from large aggregates.

Note 9—Use a flexible collar to extend the height of the mold collar on the fourth lift to prevent loss of material, if needed.

6.25 After the fourth layer has been compacted, fasten the mold containing the material on top of the extra base plate.

6.25.1 Ensure that the mold sits level on the base plate.

6.25.2 Use a spatula or other suitable hand tool to dislodge material from the side of the mold that extends above the compacted surface. Press this material into the surface.

6.26 Use a small level to check the levelness of the specimen's surface.

6.26.1 If needed, level the surface by placing the slide hammer on top of the specimen's surface and tap the bottom edge of the slide hammer with the plastic mallet. Repeat until the top of the specimen is level.

Note 10—Do not trim the compacted material with a straight edge. The compacted material should not completely fill the mold after compaction.

6.26.2 After the surface is level, apply ten blows to the top of the specimen with the slide hammer.

Note 11—Ensure that the shaft of the slide hammer is maintained perpendicular to the specimen surface when dropping the 10 lb. weight.

6.26.3 Repeat Sections 6.26.1–6.26.2 a second time.

6.26.4 Use a small level to check the levelness of the specimen's surface and tap the edge of the slide hammer if needed to level the sample one final time.

6.27 Remove the mold from the base plate.

6.28 Weigh the specimen in the mold to the nearest 0.001 lb. (0.5 g) and measure the sample height with the micrometer dial assembly to the nearest 0.001 in. (0.03 mm). The height of the finished specimen should be 8 ± 0.250 in. (203.2 ± 6.4 mm).

6.29 Record data on Form Tx113,4.

6.30 Turn the specimen over and carefully center it over a porous stone. Place a non-porous paper disc between the stone and the specimen to prevent moisture from traveling from the specimen into the porous stone.

6.31 Place in the hydraulic press and extrude the specimen from the mold.

6.32 If unconfined compressive strengths are desired, proceed to Section 6.33; otherwise proceed to Section 6.34.

6.33 Immediately after extruding the specimen from the mold, enclose the specimen in a triaxial cell, with top and bottom porous stones in place, and allow it to remain undisturbed at room temperature until the entire set of test specimens has been molded.

6.33.1 After the entire test set has been molded, break the specimens at 0 psi lateral pressure in accordance with Tex-117-E, Section 5.19 when using an automated load frame or Section 5.20 when using a screw jack press.

6.33.2 Remove the triaxial cell from each specimen just before testing.

6.33.3 Place a drying pan under the sample to catch the material as it breaks.

6.33.4 Plot the test results in accordance with Section 8.2 to establish the effect of moisture content and density on strength characteristics of the material.

6.34 Record the weight of a flat drying pan. Remove the porous stones and place the specimen in the flat drying pan.

6.35 Break up the specimen and place the identification tag with the loose material in the tared drying pan.

6.36 Weigh the tared pan and wet sample to the nearest 0.001 lb. (0.5 g) and record on Form Tx113,4.

6.37 Place the drying pan with wet material in an oven at a temperature of 230°F (110°C) until a constant mass is reached.

6.38 Weigh the tared pan and oven-dried material to the nearest 0.001 lb. (0.5 g) and record on Form Tx113,4.

Note 12—Do not reuse material from compacted sample(s) for preparation of other compaction specimens.

6.39 Repeat Sections 6.6–6.38 for each sample.

7 CALCULATIONS

7.1 Use Form Tx113,4 to calculate and record the following:

7.1.1 Calculate the wet density of the compacted specimens, lb./ft.^{3} (kg/m^3):

$$D_{WET} = (W_T - W_M) / V_M$$

Where:
W_T = mass of the mold and the compacted sample, lb. (kg)
W_M = mass of the mold, lb. (kg)
V_M = volume of the mold, ft.^{3} (m^3).

7.1.2 Calculate the percent water content:

$$WC = 100[(W_W - W_D) / W_D]$$

Where:
W_W = wet mass of the sample, lb. (kg)
W_D = oven dried mass of the molded sample, lb. (kg).

7.1.3 Calculate the dry density of the compacted specimens:

$$D_{DRY} = 100 \bullet D_{WET} \,/\, (100 + WC)$$

Where:
WC = water content of the compacted specimen, % (includes hygroscopic moisture).

7.1.4 Calculate the zero air voids density:

$$D_{ZAV} = (Specific\,Gravity \bullet 62.5)/\{1 + [Specific\,Gravity \bullet (\%WC/100)]\}$$

Where the specific gravity is unknown, use a value of 2.65 as an average value.

7.2 Use the electronic worksheets contained in Form Tx117, “Triaxial Compression Tests,” to record and calculate unconfined compressive strength results.

8 GRAPHS

8.1 Construct the M/D curve.

8.1.1 Plot the dry density versus the percent of molding moisture on Form Tx113,4 for each compacted specimen, as shown in Figure 2.

8.1.2 To obtain a well-defined compaction curve, provide at least two water content percentages on both sides of optimum.

8.1.3 The R-square value for the fit of the data to the curve must be greater than or equal to 0.9500. If it is not, mold additional samples to improve the fit of the data to the curve and to achieve a minimum R-square value of 0.9500.

8.1.4 Use the zero air void line as an aid in drawing the moisture-density curve. For materials containing more than 10% fines, the wet leg of the moisture-density curve generally parallels with the zero air void curve. Theoretically, the moisture-density curve cannot plot to the right of the zero air void curve. If it does, there is an error in specific gravity, in measurement, in calculation, in sample preparation, or in plotting.

8.2 If strength behavior is required, plot unconfined compressive strength versus the percent of molding moisture on Form Tx113,4 for each compacted specimen, as shown in Figure 3.

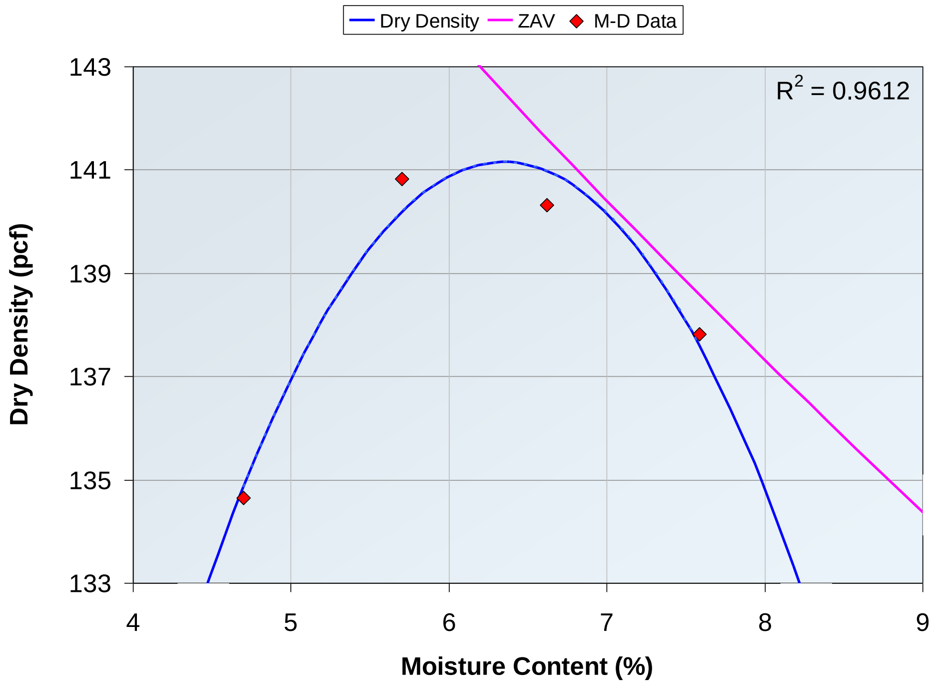

Figure 2—Example of Moisture-Density Curve

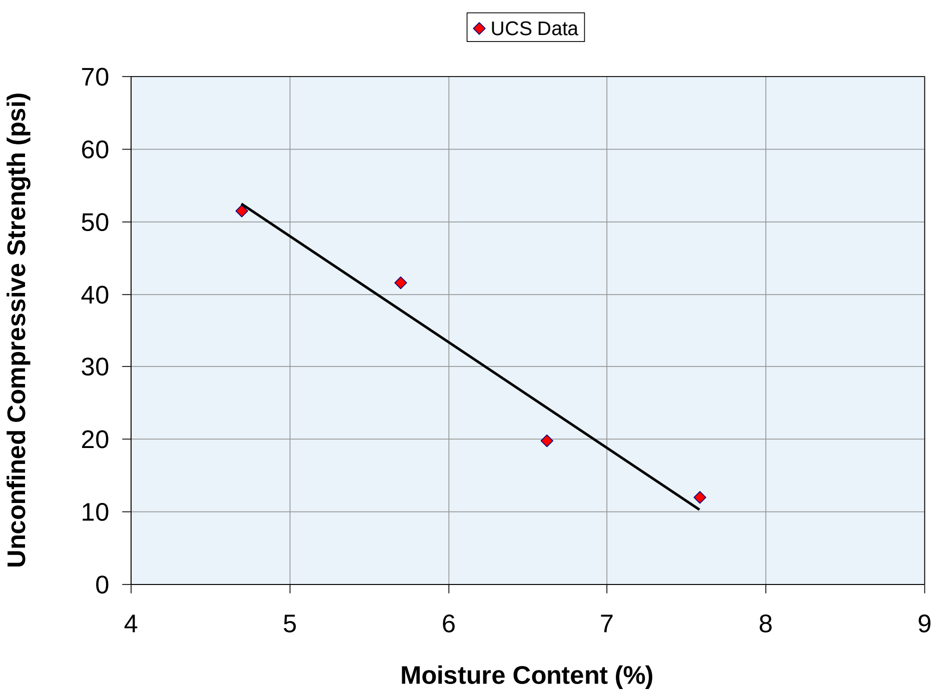

Figure 3—Example of Unconfined Compressive Strength versus Percent Molding Moisture

9 GENERAL NOTES

9.1 When determining the M/D curve for lime treated subgrade and base materials, determine the percent lime needed to achieve a pH of 12.4 in accordance with Tex-121-E, Part III.

9.2 For wetted stabilized materials taken from the roadway, see appropriate test method for preparation procedure for specification compliance, density, and/or strength:

- Cement Stabilization: Tex-120-E
- Lime Stabilization: Tex-121-E
- Lime-Fly Ash Stabilization: Tex-127-E

9.3 *Materials Difficult to Compact:*

9.3.1 Materials that are difficult to compact are an exception and require special attachments to the compaction apparatus.

- *Rammer*, 10 lb. ± 0.02 (4.54 ± 0.01 kg), with twin striking face.
- *Neoprene pad*, 0.5 in. (12.7 mm) thick, Type A Shore durometer 65 ± 3. The 6-in. (152.4-mm) diameter neoprene pad should just slide into the mold on top of the sand layer and will divert some of the impact to vibrations.

9.3.2 Compact the material in eight 1-in. (25.4-mm) layers using the neoprene pad and 100 ram blows of the 10-lb. (4.55-kg) rammer for each layer.

9.3.3 Use the rammer with a twin striking face when the material—wetted to slightly below optimum water content, mixed thoroughly, and molded in two 2-in. (51 mm) lifts—is sheared or torn by the ram in excess of 1 in. (25.4 mm) on the last blow.

10 REPORTING TEST RESULTS

10.1 Record test data on Form Tx113,4 and Form Tx117.

10.2 Record the following SCA data on Form Tx113,4 for each lift compacted for each molded specimen:

- total energy,
- average drop height,
- average energy per blow, and
- number of blows per lift.

10.3 Report all test data recorded in Sections 6, 7, and 8.

10.4 Report maximum dry density (D_A) to the nearest 0.1 lb./ft.^{3} (kg/m^3).

10.5 Report optimum moisture content (W_{OPT}) to the nearest 0.1%.

11 ARCHIVED VERSIONS

11.1 Archived versions are available.

Tex-113-E, Moisture-Density Worksheet

	Lbs. Additive 0.000					
A	Total % Water 0.0					
B	lbs. Material 0.000					
C	lbs. Water Added (A x B) / 100 0.000					
D	Wet Mass Specimen & Mold 0.000					
E	Tare Mass of Mold, Base & Collar 0.000					
F	Wet Mass of Specimen (D – E) 0.000					
G	Height of Specimen 0.000					
H	Volume of Mold Linear mm/in 0.0000					
I	Volume of Specimen (G x H) 0.0000					
J	Wet Density of Specimen (F / I) 0.0					
K	Wet Mass Pan & Specimen 0.000					
L	Dry Mass Pan & Specimen 0.000					
M	Tare Mass of Pan 0.000					
N	Dry Mass of Material (L – M) 0.000					
O	Mass of Water (K – L) 0.000					
P	% Water Content on Total (O / N)100 0.0					
	Dry Density (100 x J) / (100 + P) 0.0					
	Maximum Dry Density 0.0					
	Optimum Moisture % 0.0					

Test Procedure for

TRIAXIAL COMPRESSION FOR DISTURBED SOILS AND BASE MATERIALS

TxDOT Designation: Tex-117-E

Effective Date: January 2010

1. SCOPE

1.1 This method determines the shearing resistance, water absorption, and expansion of soils and/or soil-aggregate mixtures.

1.2 Use Part I when triaxial classification is required. Use Part II for flexible base materials and low to non-plastic soils.

1.3 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. DEFINITIONS

2.1 *Triaxial Test*—measures stresses in three mutually perpendicular directions.

2.2 *Axial Load*—the sum of the applied load and the dead load (including the weight of the top porous stone, metal block and bell housing) applied along the vertical axis of the test specimen.

2.3 *Lateral Pressure (Minor Principal Stress)*—the pressure supplied by air in the triaxial cell, applied in a radial or horizontal direction.

2.4 *Axial (Major Principal Stress)*—the axial load divided by the average area of the cylindrical specimen.

2.5 *Strain*—the vertical deformation of the specimen divided by the original height, often expressed as a percentage.

2.6 *Mohr's Diagram*—a graphical construction of combined principal stresses in static equilibrium.

2.7 *Mohr's Failure Cycle*—a stress circle constructed from major and minor principal stresses of the specimen at failure.

2.8 *Mohr's Failure Envelope*—the common tangent to a series of failure circles constructed from different pairs of principal stresses required to fail the material. The envelope is generally curved, with its curvature depending on the factors related to the characteristics of the material.

3. APPARATUS

3.1 *Apparatus* used in Tex-101-E, Tex-113-E, and Tex-114-E.

3.2 *Triaxial cells for base material*, lightweight stainless steel cylinders with 6.75 in. (171.5 mm) inside diameter (ID) and 12 in. (304.8 mm) height, fitted with standard air valve and tubular rubber membrane.

3.3 *Triaxial cells for subgrade*, lightweight stainless steel cylinders with 4.5 in. (114.3 mm) ID and 9 in. (228.6 mm) height, fitted with standard air valve and tubular rubber membrane.

3.4 *Aspirator or other vacuum pump*.

3.5 *Air compressor.*

3.6 *Automated load frame or screw jack press.*

3.7 *Pressure regulator, gauges, and valves,* to produce lateral pressure in curing and testing.

3.8 *Equipment to measure deformation of specimen*, accurate to 0.001 in. (0.025 mm).

3.9 *Proving ring* (for use with screw jack press).

3.10 *Load cell,* 10K (for use with automated load frame).

3.11 *Circumference measuring device*, accurate to 0.05 in. (1.0 mm).

3.12 *Lead weights*, for surcharge loads.

3.13 *Curing pans*, at least 2 in. (51 mm) deep, with porous plates.

3.14 *Filter paper,* medium flow porosity, such as VWR No. 413.

3.15 *Non-porous paper discs,* 6 in. (150 mm) diameter, Gilson MSA-121 or equivalent.

4. TEST RECORD FORMS

4.1 Record test data on:

- Form Tx113,4, “Moisture-Density Relations of Base Material & Sand or Subgrade & Embankment Soils” and “Moisture-Density Mold Information Sheet,”
- Form 1964, “Triaxial Compression Test Capillary Wetting Data,” and
- Form 1062, “'Triaxial Test Data Sheet” (use with screw jack press) or Form Tx117, “Triaxial Compression Tests” (use with automated compression machine).

PART I—STANDARD TRIAXIAL COMPRESSION TEST

5. PROCEDURE

5.1 Prepare all materials in accordance with Tex-101-E, Part II.

5.2 Determine optimum water content and maximum dry density of the material in accordance with Tex-113-E for base material and Tex-114-E for subgrade, embankment, and backfill.

5.3 Mold seven specimens at optimum moisture and maximum dry density in accordance with Tex-113-E for base and sub-base materials; mold six specimens at optimum moisture and maximum dry density in accordance with Tex-114-E for subgrade, embankment, and backfill materials.

5.3.1 These specimens should be 6 in. (152.4 mm) in diameter ± 0.0625 in. (1.6 mm) and 8 in. (203.2 mm) in height ± 0. 250 in. (6.4 mm) or 4 in. (101.6 mm) in diameter ± 0.0156 in. (0.4 mm) and 6 in. (152.4 mm) in height ± 0.0026 in. (0.07 mm) using a straight edge to strike off the top and bottom.

5.3.2 These specimens should be wetted, mixed, molded, and finished as nearly identical as possible.

5.4 Record the weight of the compacted specimens on Form Tx113,4, “Moisture-Density Relations of Base Material & Sand or Subgrade & Embankment Soils” and “Moisture-Density Mold Information Sheet.”

5.5 Extrude the specimens from the molds and identify each test specimen by laboratory number and specimen number.

5.6 Immediately after extruding the specimens from the molds, enclose the specimens in triaxial cells, with porous stones on top and bottom and a non-porous paper disc between the top of the specimen and the top porous stone to prevent moisture from traveling from the specimen into the porous stone. Allow all the specimens to remain undisturbed at room temperature until the entire set of test specimens has been molded.

5.7 After all specimens in the set have been molded, remove the triaxial cells, leaving the top and bottom porous stones in place. Dry the specimens according to the type of material described below.

5.7.1 *For Flexible Base Materials and Select Granular Soils with Little or No Tendency to Shrink:*

5.7.1.1 Place specimens in the oven and remove one third of the molding moisture content at a temperature of 140°F (60°C). Record the weight after drying.

5.7.1.2 Allow the specimens to return to room temperature.

5.7.2 *For Very Plastic Clay Sub-Grade Soils that Crack Badly if Subjected to Large Volume Changes during Shrinkage:*

5.7.2.1 Air dry these soils at room temperature, inspecting specimens frequently by looking at the sides of the specimens and raising the top porous stones to examine the extent of cracking at the top edges of the specimens.

5.7.2.2 When these cracks have formed to a depth of approximately 1/4 in. (6.4 mm), replace the triaxial cell and prepare the specimens for capillary wetting.

5.7.3 *For Moderately Active Soils that Might Crack Badly if Placed in an Air Dryer for the Full Curing Time:*

5.7.3.1 Dry at 140°F (60°C) and check frequently for the appearance of shrinkage cracks.

5.7.3.2 If cracks appear, examine the extent of cracking as described above and allow some air-drying at room temperature during the cooling period before enclosing specimens in cells.

5.8 Prepare the specimens for capillary wetting.

5.8.1 Do not change the porous stones or remove them until the specimens have been tested.

5.8.2 Weigh each specimen and its accompanying stones and record the mass.

5.8.3 Cut a piece of filter paper to approximately 12 × 20 in. (300 × 508 mm), fold into 5 × 20 in. (127 × 508 mm), and make several slits perpendicular to the folded edge with scissors. These cuts will prevent any restriction by the paper.

5.8.4 Unfold the filter paper and wrap it around the specimen and stones so the cuts are parallel with the length of the specimen, allowing the bottom of the paper to be near the bottom of the bottom porous stone, and fasten with a piece of tape.

5.8.5 Replace cell by applying a partial vacuum to the cell, deflating the rubber membrane, then place the cell over the specimen and release the vacuum.

5.9 Transfer the specimens to a temperature controlled environment and place them into the rectangular pans provided for capillary wetting. Adjust the water level on the lower porous stones to approximately 0.5 in. (12.5 mm) below the bottom of the specimens. Add water later to the pans, as necessary, to maintain this level. (See Figure 1.)

5.10 Connect each cell to an air manifold and open the valve to apply a constant lateral pressure of 1 psi (6.9 kPa). Maintain this constant pressure throughout the period of absorption.

5.11 Place a suitable vertical surcharge load (which will depend upon the proposed use or location of the material in the roadway) on the top porous stone. (See Table 1.) When determining the mass for the surcharge, include the mass of the top porous stone as part of the surcharge mass.

5.12 Subject all flexible base materials and soils with plasticity index of 15 or less to capillary absorption for 10 days. Use a period of days equal to the plasticity index of the material for sub-grade soils with PI above 15. Keep the specimens at 77 ± 9°F (25 ± 5°C) during the period of capillary absorption.

5.13 Disconnect the air hose from the cell and remove the surcharge weight. Use a vacuum and deflate the rubber membrane to aid in removing the cell from specimens and discard filter paper. If any appreciable material clings to paper, carefully press it back into the available holes along the side of the specimen.

5.14 Weigh the specimens and record as total mass after capillary absorption. Note that the wet mass of the stones is obtained after the specimens are tested. Record on Form 1964.

5.15 Measure the circumference of each specimen by means of the metal measuring tape. Measure the height of the specimen including the stones, and enter on the data sheet as height in/out capillarity. Record the height of each stone.

5.16 Ready the specimen to be tested by replacing the triaxial cell to eliminate any moisture loss from the specimen and then releasing the vacuum. When a specimen is designated to be tested at zero lateral pressure, remove the cell just before testing. It is important to keep the correct identification on the specimens at all times because weights, measurements, test values, and calculations are determined for each individual specimen.

5.17 Test the specimens in compression while they are being subjected to their assigned lateral pressure. The usual lateral pressures used for a series of tests are 0 psi (0 kPa), 3 psi (20.7 kPa), 5 psi (34.5 kPa), 10 psi (69.0 kPa), 15 psi (103.5 kPa), and 20 psi (138.0 kPa). In cases where the load or stress is high, 175–180 psi (1207–1241 kPa), for the specimen tested at 15 psi (103.5 kPa) lateral pressure, use 7 psi (48.3 kPa) instead of 20 psi (138.0 kPa) for the last specimen.

5.18 Operate the automated load frame (or screw jack press) at a rate of 2.0 ± 0.3% strain per minute.

5.19 *Automated Load Frame:*

5.19.1 Lower the load frame bottom platen to allow for adequate room to place the specimen in the load frame. Ensure that load frame platform is clean of debris that may cause the specimen to sit irregularly.

Note 1—Follow the instruction manual furnished with the load frame and data acquisition software for specifics on the operation of the load frame. This is essential, due to the fact that various load frame models and brands are in standard use by the Department.

5.19.2 Carefully transfer the specimen with porous stones and triaxial cell in place to the bottom platen of the load frame. For specimens broken at 0 psi lateral pressure, a pan may be placed beneath the specimen to catch any small fragments that may fall off the specimen during testing.

5.19.3 Place the end cap, with ball bearing, onto the top porous stone.

5.19.4 Raise the crossbar or lower the bottom platen to a height that allows for movement of the specimen without causing damage to or disturbing the specimen.

5.19.5 Shift the end cap and porous stone laterally to bring the ball bearing directly over the vertical axis of the specimen. Adjust the specimen in the load frame such that the ball bearing is centered with the load cell button and the axial load will be applied along the vertical axis of the specimen.

5.19.6 Tare the load cell, using the data acquisition software.

5.19.7 Raise the bottom platen so that the load cell is in contact with the ball bearing. The ball bearing should be seated in the button of the load cell.

5.19.8 Apply a vertical load of approximately 1/2–1 psi (15–30 lb.)

5.19.9 Connect the air line, with electronic pressure sensor, to the triaxial cell and apply the designated lateral pressure, as defined in Section 5.17, to the specimen. Allow the pressure to stabilize prior to proceeding. (The lateral pressure applied by the air will tend to change the initial load cell reading.)

5.19.10 Once the lateral pressure has stabilized, zero the deformation gauge, begin testing the specimen in compression, and start data acquisition.

5.19.11 Initiate the software and load frame testing sequence.

5.19.12 Manually or via the testing software, record the initial load cell reading when data acquisition begins.

5.19.13 Record load and specimen deformation in 0.02 in. (0.5 mm) increments.

5.19.14 Follow the data acquisition software instructions to monitor test progress.

5.19.15 Continue readings until failure has occurred as defined in Section 5.22.

5.20 *Screw Jack Press (See Figure 2):*

5.20.1 Lower the load frame platen far enough to have room to place the specimen, loading blocks, and deformation measuring equipment in the press.

5.20.2 Center the specimen with upper and lower loading blocks in place in the load frame. Determine if the deformation gauge will compress or extend during testing and set the dial stem accordingly. Set the dial of the strain gauge to read zero.

5.20.3 Next, set the bell housing, if used, over the deformation gauge and adjust so that it does not touch the gauge or its mounting.

5.20.4 Shift the bell housing laterally to bring the ball directly over the vertical axis of the specimen in order to apply the compressive force along the vertical axis of the test specimen.

5.20.5 Raise the platen by means of the motor, align, and seat the ball on the bell housing into the socket in the proving ring.

5.20.6 Apply just enough pressure to obtain a perceptible reading on the proving ring gauge (not to exceed 5 lb.)

5.20.7 Read the deformation gauge and record as deformation under dead load.

5.20.8 Connect the air line to the triaxial cell and apply the designated lateral pressure, as defined in Section 5.17, to the specimen. Allow the pressure to stabilize prior to proceeding.

Note 2—In testing specimens with aggregates, the slipping and shearing of aggregates will cause temporary decreases in proving ring readings.

5.20.9 The lateral pressure applied by the air will tend to change the initial proving ring and deformation gauge readings. Start the motor momentarily to compress the specimen until the deformation gauge reads the same as the reading obtained in Section 5.20.7.

5.20.10 Record the proving ring reading.

5.20.11 Turn the motor on and read the proving ring dial in 0.02 in. (0.5mm) increments.

5.20.12 Continue the test until failure has occurred as defined in Section 5.22.

5.21 Continue reading until 0.60 in. (15.2 mm) of deformation is reached or failure has occurred. After 0.60 in. (15.2 mm) of deformation the cross sectional area of the specimen has increased so that the subsequent small increase in load readings is little more than the increase in tension of the membrane acting as lateral pressure.

5.22 Failure is reached when the proving ring dial or load cell readings remain constant or decrease with increased deformation.

5.23 The above procedure also applies to an unconfined specimen, except that no air or axial cell is used. For materials that contain a large amount of aggregate, test two specimens at zero lateral pressure. Use average of test results unless large rocks appear to have created point bearing; in this case use highest value.

5.24 Remove the cell and stones from the specimen over a flat, tared drying pan. Use a spatula to clean the material from the inside of cell and stones. Break up the specimen taking care to lose none of the material and place the identification tag in the tray.

5.25 Dry material to constant mass at a temperature of 230°F (110°C) and determine the dry mass. Determine and record the moisture content of the entire specimen after breaking, in accordance with Tex-103-E.

5.26 Clean the damp stones and then dry at 140°F (60°C) to constant mass.

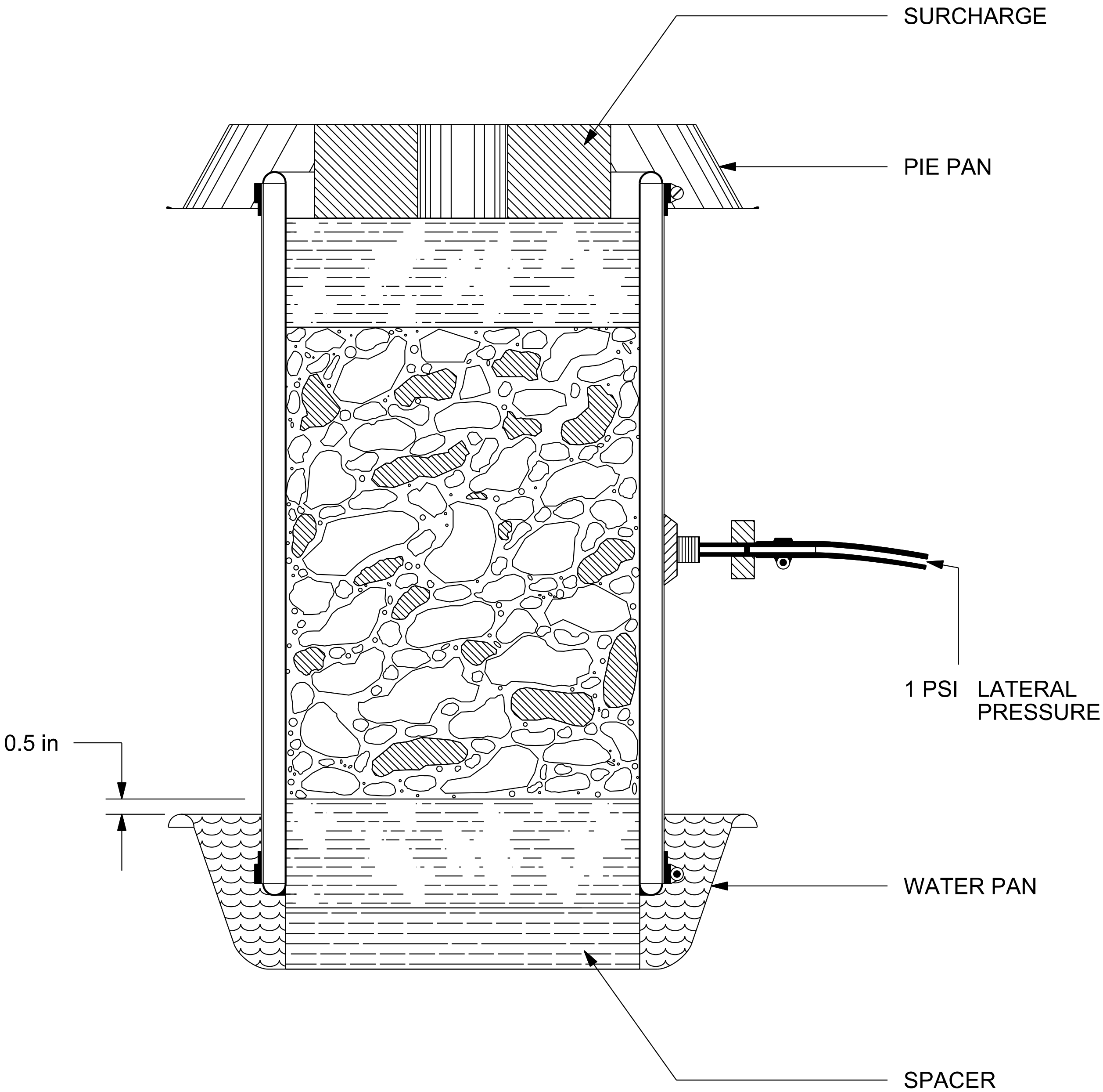

Figure 1—Schematic Arrangement for Capillary Wetting

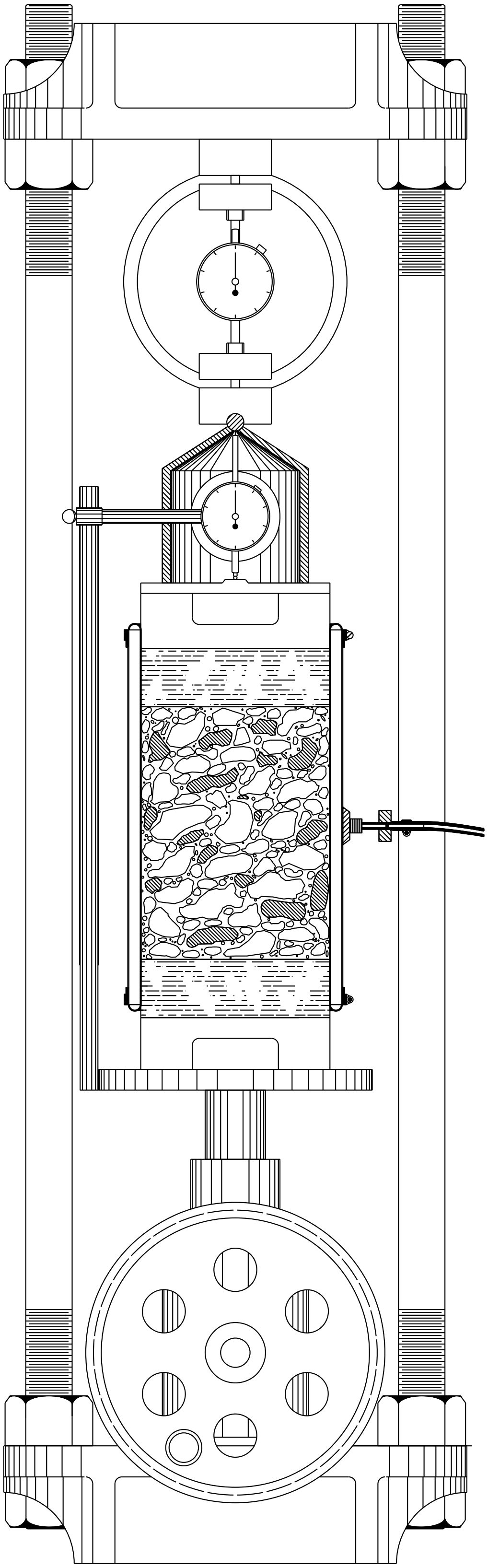

Figure 2—Assembly for Screw Jack Press

Table 1—Vertical Surcharge Load

Mold Diameter	Flexible Base	Sub-grade Soil
6 in. (152 mm)	14.1 lb. (6.4 kg)	28.3 lb. (12.8 kg)
4 in. (102 mm)	N/A	12.6 lb. (5.7 kg)

6. CALCULATIONS

6.1 Use the electronic worksheets contained in Form Tx113,4 and Form 1062 (use with screw jack press) or Form Tx117 (use with automated compression machine) to calculate and record the following:

6.2 Calculate dry density (D_D) in lb./ft.^{3} (pcf):

$$D_D = W_D / V$$

Where:
V = volume of compacted specimen, ft.^{3} (m^3)
W_D = dry mass of specimen, lb. (kg).

6.3 Calculate the percent molding moisture (M_M):

$$M_M = [100(W_W - W_D) / W_D]$$

Where:
W_W = wet mass of specimen, lb. (kg)

6.4 Calculate the percent of volumetric swell (V_S):

$$V_S = 100(V_A - V) / V$$

Where:
V_A = volume of specimen after capillary absorption, ft.^{3} (m^3).

6.5 Calculate the percent moisture in the specimen after capillarity (M_C):

$$M_C = 100(W_A - W_B - W_D) / W$$

Where:
W_A = wet mass of specimen and stones after absorption, lb. (kg)
W_B = wet mass of stones, lb. (kg)
W_D = correct oven-dry mass of specimen, lb. (kg).

6.6 Calculate the percent moisture in the specimen before capillarity (M_B):

$$M_B = 100(W_C - W_S - W_D)/W_D$$

Where:

W_S = dry mass of stones, lb. (kg)

W_C = mass of specimen and stones before capillarity, lb. (kg).

6.7 Calculate the corrected vertical unit stress in psi (kPa). A correction is necessary because the area of the cross-section increases as the specimen is reduced in height. Assume that the specimen deforms at constant volume.

$$S = 100(d/h) = \text{percent strain}$$

Where:

d = total vertical deformation at a given instant, in. (mm), by deformation gauge

h = the height of the specimen, in. (mm), measured after specimen is removed from capillarity.

6.8 Calculate the corrected vertical unit stress (p):

$$p = 9.81\,[P(1 - S/100)/A], \text{in kPa} \quad or \quad p = P[(1 - S/100)/A], \text{in psi}$$

Where:

A = the end area of the cylindrical specimen at the beginning of test, in.^{2} (mm^2)

P = the total vertical load on the specimen at any given deformation expressed in lb. (g). It is the sum of the applied load measured by the proving ring plus the dead mass of the upper stone, loading block, and dial housing.

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7. GRAPHS AND DIAGRAMS

7.1 Use the electronic worksheets contained in Form Tx113,4 and Form 1062 (use with screw jack press) or Form Tx117 (use with automated compression machine) to plot the following.

7.2 Plot the moisture-density curve shown in Tex-113-E, Figure 1.

7.3 Plot the stress-strain diagram as shown in Figure 3, when requested.

7.4 Construct the Mohr's Diagram of stress upon coordinate axes in which ordinates represent shear stress and abscissas represent normal stress, both expressed as psi (kPa) to the same scale. (See Figure 4.)

- L = Minor principal stress which is the constant lateral pressure applied to the specimen during an individual test.
- V = The major principal stress which is the ultimate compressive strength or the highest value of p determined at the given lateral pressure.

7.5 Show each individual test by one stress circle.

- Plot L and V on the base line of normal stress.
- Locate the center of each circle a distance of (V + L)/2 from the origin and construct a semi-circle with its radius equal to (V - L)/2 intersecting the base line at V and L.
- Repeat these steps for each specimen tested at different lateral pressures to provide enough stress circles to define the failure envelope on the Mohr's diagram.

7.6 Draw the failure envelope tangent to all of the stress circles. Since it is practically impossible to avoid compacting an occasional specimen that is not identical with the other specimens in the same set, disregard any stress circle that is obviously out of line when drawing the tangent line.

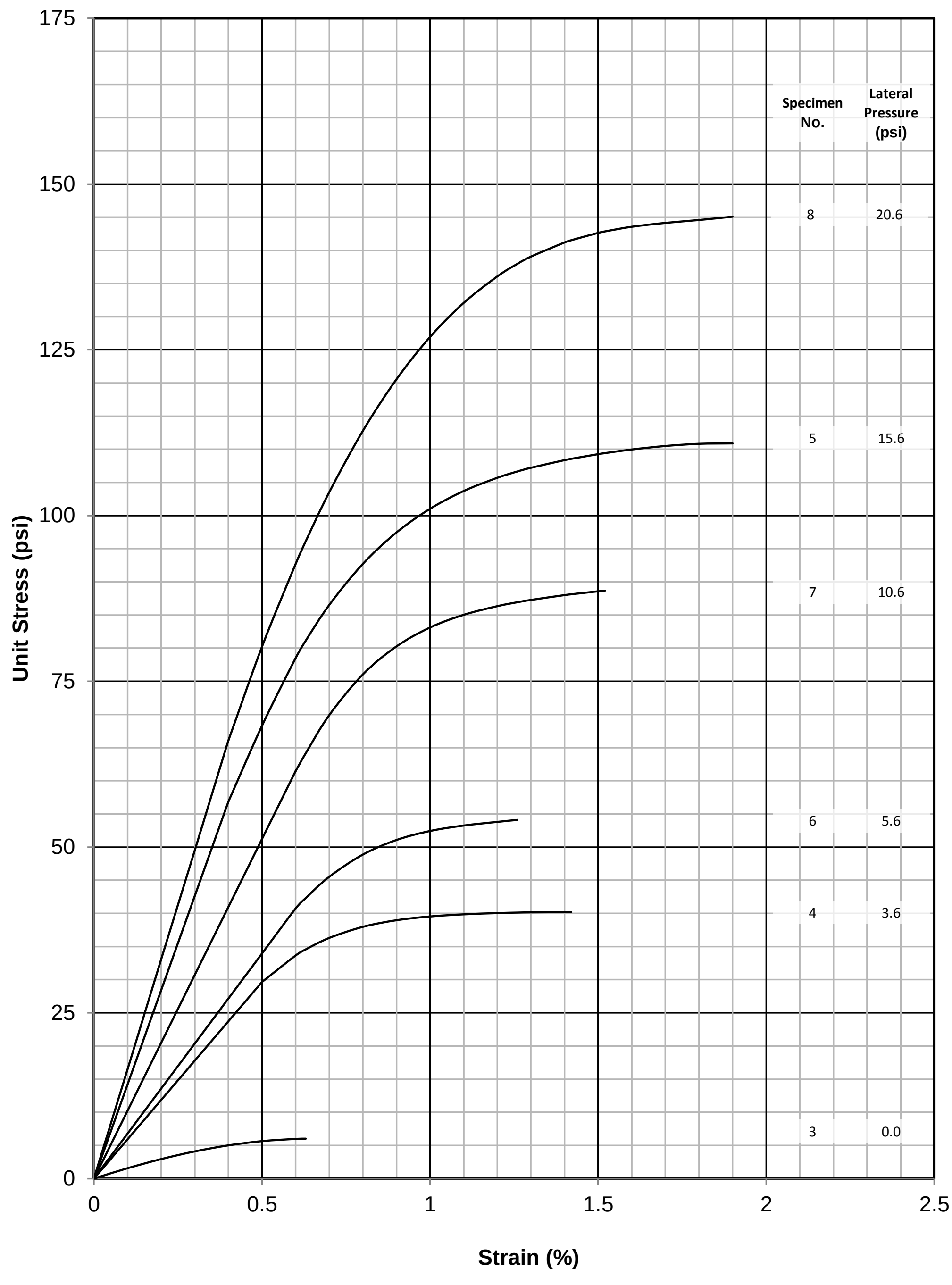

Figure 3—Stress-Strain Diagram

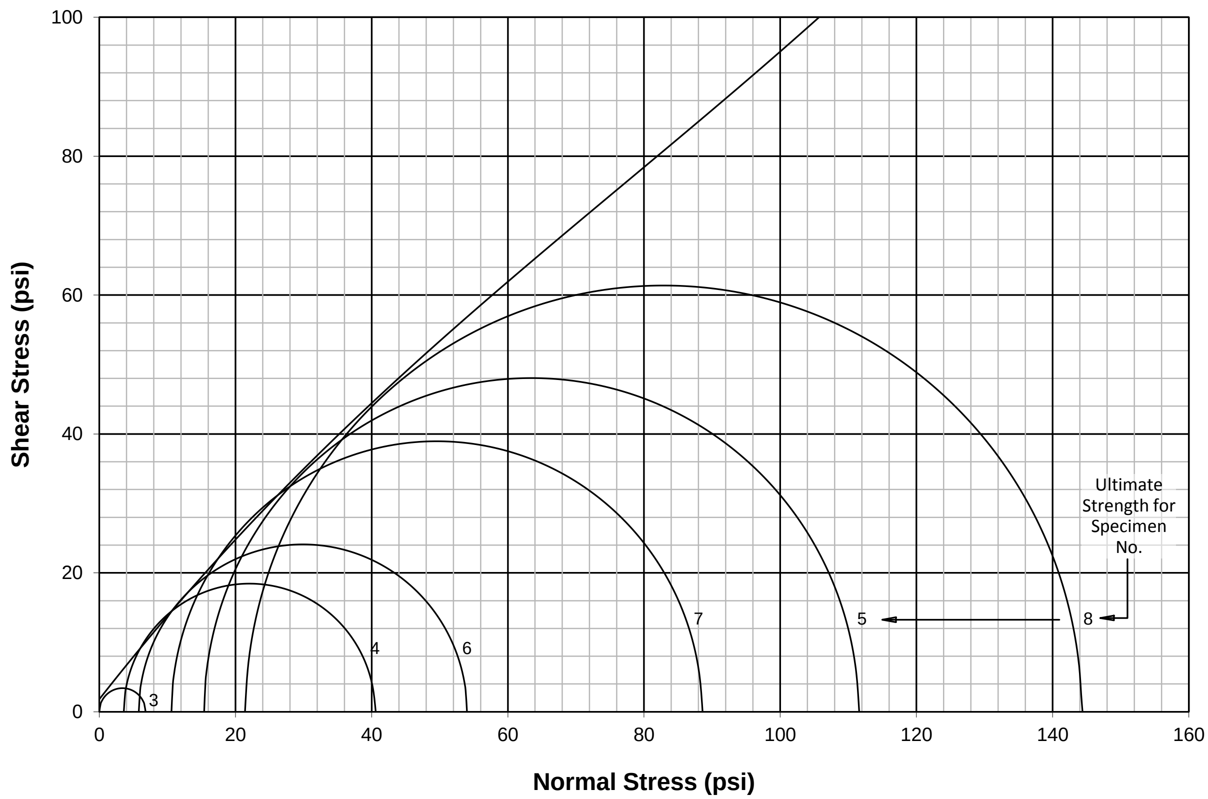

Figure 4—Mohr's Diagram

8. CLASSIFICATION OF MATERIAL

8.1 Use Form Tx117 to classify the material to the nearest one-tenth of a class.

8.2 When the envelope of failure falls between class limits, select the critical point or weakest condition on the failure envelope.

8.3 Measure the vertical distance down from a boundary line to the point to obtain the exact classification (3.7) as shown in Figure 5.

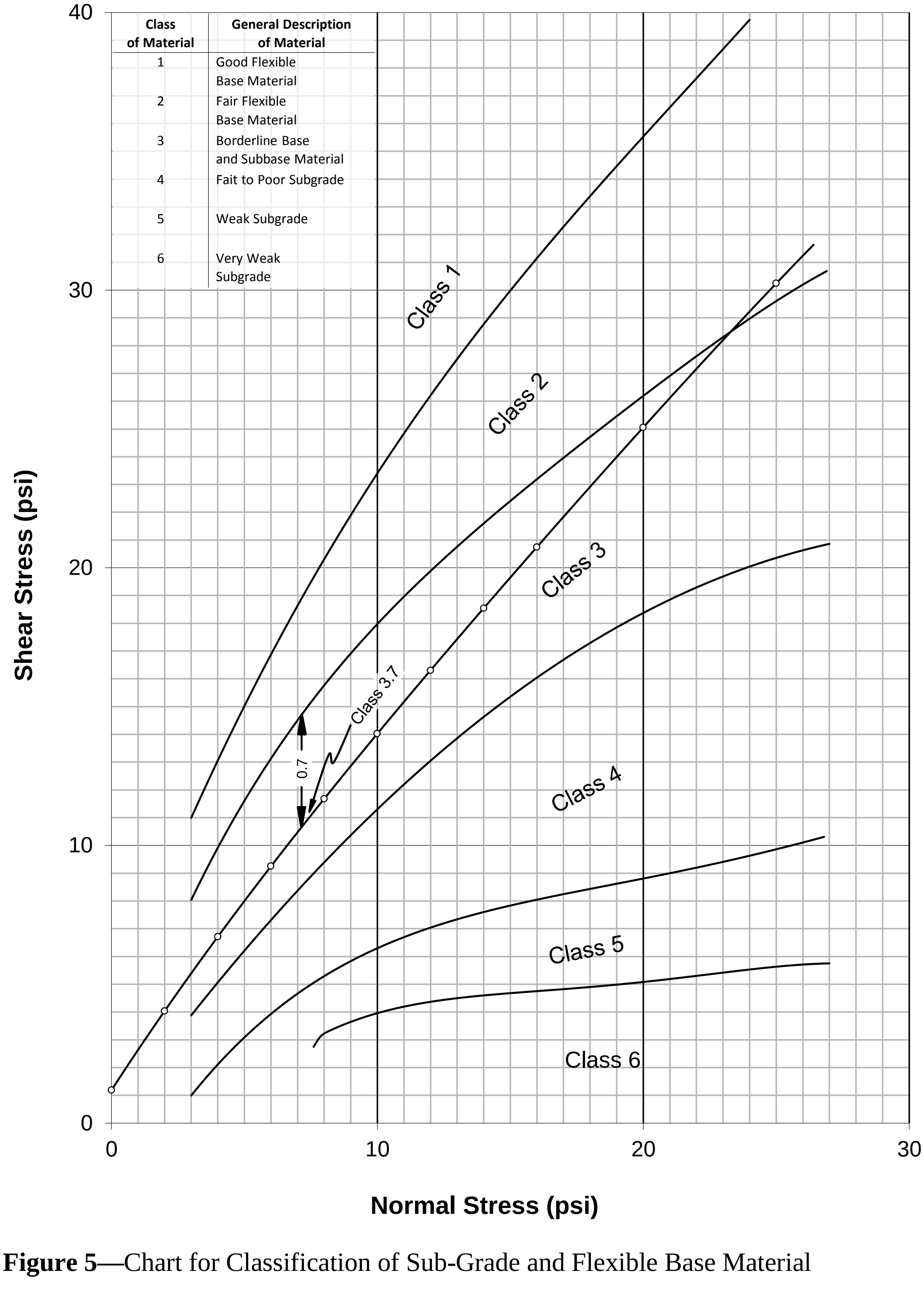

Figure 5—Chart for Classification of Sub-Grade and Flexible Base Material

9. TEST REPORT

9.1 Report the soil constants, grading, and wet ball mill value for the base material. Summarize test results on Form Tx117.

PART II—ACCELERATED METHOD FOR TRIAXIAL COMPRESSION OF SOILS

10. SCOPE

10.1 This accelerated procedure is based on a correlation with Part I, performed on a large number of different types of materials. Generally, use the accelerated test to control the quality of base materials with low absorption in group (d) during stockpiling. In such cases, roadway samples will not be considered representative.

11. PROCEDURE

11.1 Group the materials into one of the following five general types of materials:

- A—Fine granular materials with plasticity index less than 5.
- B—Very low swelling soils with plasticity index of 5 through 11.
- C—Swelling sub-grade soils with plasticity index of 12 or more.
- D—Flexible base with or without recycled materials.
- E—Combination soil types.

11.2 Prepare all materials in accordance with Tex-101-E, Part II.

11.3 Determine optimum moisture content and maximum dry density of the material in accordance with Tex-113-E for base material and Tex-114-E for subgrade, embankment, and backfill.

11.4 Molded specimens should be 6 in. (152.4 mm) in diameter ± 0.0625 in. (1.6 mm) and 8 in. (203.2 mm) in height ± 0.250 in. (6.4 mm) or 4 in. (101.6 mm) in diameter ± 0.0156 in. (0.4 mm) and 6 in. (152.4 mm) in height ± 0.0026 in. (0.07 mm) using a straight edge to strike off the top and bottom.

11.5 Record data on Form Tx113,4.

11.6 Follow the correct procedure for the specimen soil type, as shown below

11.6.1 *Group A—Fine Granular Materials with Plasticity Index Less Than 5:*

11.6.1.1 Mold six specimens 6 in. (152.4 mm) in diameter and 8 in. (203.2 mm) in height at the optimum moisture and density in accordance with Tex-113-E.

11.6.1.2 Cover the specimen (with stones in place) with a triaxial cell immediately after removing from mold and allow to set for 24 ± 1 hr. undisturbed at room temperature.

Note 3—Do not dry or subject specimens to capillary absorption.

11.6.1.3 Test the specimens at the usual lateral pressures.

11.6.1.4 Calculate unit stress, plot diagrams, and classify material.

11.6.2 *Group B—Very Low Swelling Soils with Plasticity Index of 5 through 11:*

11.6.2.1 Compact a set of six identical specimens at the optimum moisture and density condition in accordance with Tex-113-E.

11.6.2.2 Use filter paper, lead surcharge weight, and air pressure for lateral support and subject the specimens to capillary absorption overnight as described in Part I, Sections 5.8–5.12.

11.6.2.3 The next morning, remove filter paper and test the specimens at the usual lateral pressure shown above. Calculate unit stress, plot diagrams, and classify material.

11.6.3 *Group C – Swelling Sub-Grade Soils, Plasticity Index of 12 or More:*

11.6.3.1 Obtain the plasticity index and hygroscopic moisture of these soils in advance of molding specimens.

11.6.3.2 Calculate the Percent Molding Moisture:

Percent Molding Moisture = (1.4 × optimum moisture) – 2.2

11.6.3.3 Obtain the desired molding density from the following expression:

Molded Dry Density = Optimum dry density (from Section 11.2) / [1 + (% volumetric swell / 100)]

11.6.3.4 To determine the percent volumetric swell to be expected, use average condition in chart shown in Figure 6. It is important to modify the percent volumetric swell by multiplying by percent soil binder divided by 100 to obtain the percent volumetric swell to be expected.

11.6.3.5 Use the moisture content (Section 11.6.3.2), adjusted if necessary, and adjust the blows per layer to obtain the desired density (Section 11.6.3.3). Where this moisture content is too great to permit the desired density, reduce the molding water slightly (usually about 1%) and continue molding. Mold six specimens, in accordance with Tex-114-E, at the water content established for the desired density. The specimens, being in capillarity overnight, will pick up the moisture that was left out.

11.6.3.6 When the six specimens have been molded, put them to capillary absorption (as in Part I) overnight. Test at the usual lateral pressures and classify.

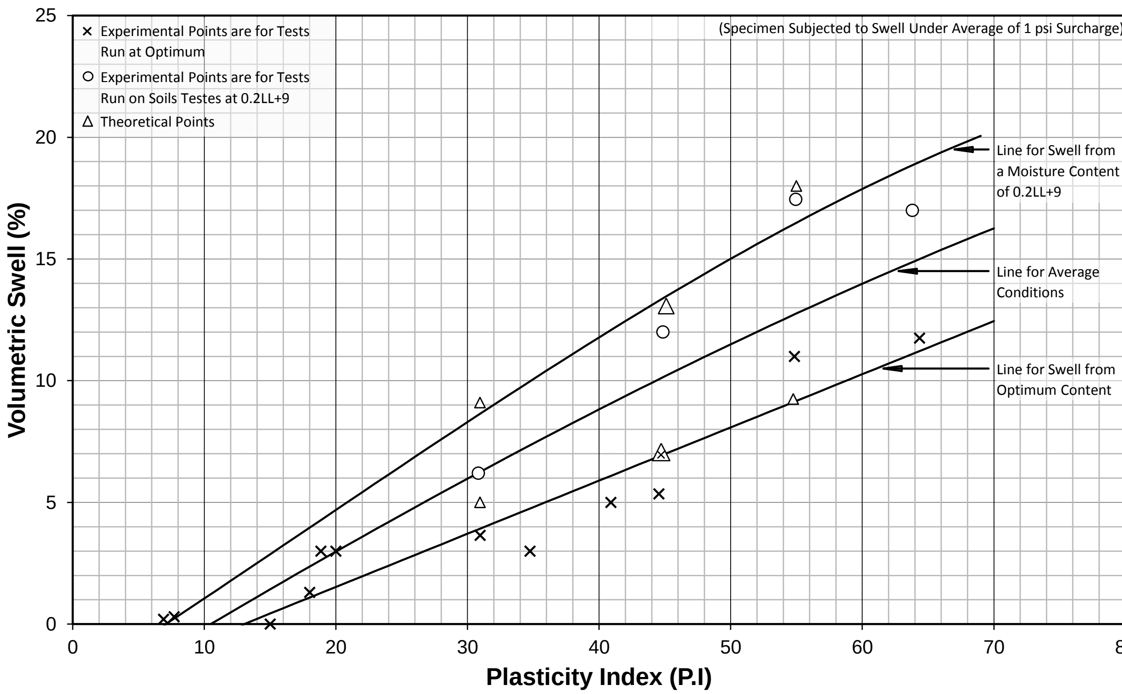

Figure 6—Interrelationship of PI and Volume Change

11.6.4 *Group D – Flexible Base With or Without Recycled Materials:*

11.6.4.1 Mold specimens at optimum moisture and maximum dry density in accordance with Tex-113-E.

11.6.4.2 All specimens should be wetted, mixed, molded, and finished as nearly identical as possible.

11.6.4.3 Identify each test specimen by laboratory number and specimen number.

11.6.4.4 Immediately after extruding the specimens from the molds, enclose the specimens in triaxial cells, with porous stones on top and bottom and non-porous paper discs between the specimen and porous stones to prevent moisture from traveling from the specimen into the porous stone.

11.6.4.5 Allow specimens to set 24 ± 1 hr. undisturbed at room temperature.

Note 4—Do not air dry or subject specimens to capillary absorption.

11.6.4.6 Test specimens in compression in accordance with Section 5.19 when using an automated load frame or Section 5.20 when using a screw jack press. Test three specimens at 0 lateral confinement, three specimens at 3 psi (20.6 kPa) lateral confinement and three specimens at 15 psi (103.4 kPa) lateral confinement.

11.6.4.7 Continue reading until 0.60 in. (15.2 mm) of deformation is reached or failure has occurred. After 0.60 in. (15.2 mm) of deformation the cross sectional area of the specimen has increased so that the subsequent small increase in load readings is little more than the increase in tension of the membrane acting as lateral pressure.

11.6.4.7.1 Failure is achieved when the proving ring dial or load cell readings remain constant or decrease with increased deformation.

11.6.4.7.2 The above procedure also applies to an unconfined specimen, except that no air or triaxial cell is used. For materials that contain a large amount of aggregate, test two specimens at zero lateral pressure. Use average of test results unless large rocks appear to have created point bearing; in this case use highest value.

11.6.4.8 Remove the cell and stones from the specimen over a flat, tared drying pan. Use a spatula to clean the material from the inside of cell and stones. Break up the specimen taking care to lose none of the material and place the identification tag in the tray.

11.6.4.9 Dry material to constant mass at a temperature of 230°F (110°C) and determine the dry mass. Determine and record the moisture content of the entire specimen after breaking, in accordance with Tex-103-E.

11.6.4.10 Clean the damp stones and then dry at 140°F (60°C) to constant mass.

11.6.4.11 Calculate and record dry density (D_D) in lb./ft.^{3} (pcf) on Form Tx113,4 for each specimen:

$$D_D = W_D / V$$

Where:

V = volume of compacted specimen, ft.^{3} (m^3)

W_D = dry mass of specimen, lb. (kg).

11.6.4.12 Calculate and record the percent molding moisture (M_M) on Form Tx113,4 for each specimen:

$$M_M = [100(W_W - W_D) / W_D]$$

Where:

W_W = wet mass of specimen, lb. (kg).

11.6.4.13 The percent molding moisture of the individual specimens calculated in Section 11.6.4.12 must be within 0.3 percentage points of the optimum moisture content determined by Tex-113-E and the dry density of the individual test specimens calculated in Section 11.13 must be within 1.0 pcf (16.0 kg/m^3) of the maximum dry density determined by Tex-113-E. Specimens not meeting these tolerances may be used in Section 11.6.4.14 only if their strength is within 10 psi of the other test specimens broken at the same lateral confinement.

11.6.4.14 Average and record the strengths for each state of confinement on Form Tx117. A minimum of two samples per lateral confinement must be used to determine the average strength.

11.6.5 *Group E – Combination Soil Types:*

11.6.5.1 This group includes all materials with enough soil binder to separate the aggregate particles or overfill the voids of the compacted specimen. For example, if the material is a clayey gravel with high plasticity:

- Treat the material as a swelling soil.
- Allow the material to soak a minimum of 12 hours as in the case of aggregate materials.

11.6.5.2 Note that the total swelling is figured only for that part passing the No. 40 (425 μm) sieve. Other combinations must be recognized and tested in the proper group.

11.6.5.3 Mold six specimens at optimum moisture and maximum dry density in accordance with Tex-114-E for subgrade, embankment, and backfill materials.

11.6.5.4 Subject all specimens to overnight capillarity, test, and classify.

11.6.5.5 When testing aggregate materials under Part II where classification is required:

11.6.5.5.1 Test two specimens at 0 psi (0 kPa).

11.6.5.5.2 Test the others at 3 psi (20.7 kPa), 5 psi (34.5 kPa), 10 psi (69.0 kPa), and 15 psi (103.4 kPa).

11.6.5.5.3 Average the result of the zero lateral pressure tests as one value.

11.6.5.5.4 Classify fine grain soils using lateral pressures of 0 psi (0 kPa), 3 psi (20.7 kPa), 5 psi (34.5 kPa), 10 psi (69.0 kPa), 15 psi (103.4 kPa).

12. REPORTING TEST RESULTS

12.1 The reports and forms are the same as given in Part I of this procedure.

13. GENERAL NOTES

13.1 Wetted stabilized materials taken from the roadway during construction should be screened over a 1/4 in. (6.3 mm) sieve at the field moisture content without drying.

13.1.1 Each of these two sizes is mixed for uniformity and weighed.

13.1.2 Specimens are then weighed and recombined to produce multiple identical specimens with the received gradation.

13.1.3 Moisture can be adjusted in each specimen by adding water to the material or removing from the material by a fan, as needed.

13.1.4 See the appropriate test method (listed below) for testing wetted stabilized materials taken form the roadway during construction:

- Tex-120-E, "Soil-Cement Testing"
- Tex-121-E, "Soil-Lime Testing"
- Tex-127-E, "Lime Fly-Ash Compressive Strength Test Methods"

13.2 In any event, the stabilized material should not be completely air-dried.

13.3 When molding a set of preliminary specimens for testing lime stabilized sub-grades and base materials, refer to Tex-121-E, Figure 1, for the recommended amounts of lime to use.

14. ARCHIVED VERSIONS

14.1 Archived versions are available.

Tex-113-E, Moisture-Density Worksheet

	Lbs. Additive 0.000					
A	Total % Water 0.0					
B	lbs. Material 0.000					
C	lbs. Water Added (A x B) / 100 0.000					
D	Wet Mass Specimen & Mold 0.000					
E	Tare Mass of Mold, Base & Collar 0.000					
F	Wet Mass of Specimen (D – E) 0.000					
G	Height of Specimen 0.000					
H	Volume of Mold Linear mm/in 0.0000					
I	Volume of Specimen (G x H) 0.0000					
J	Wet Density of Specimen (F / I) 0.0					
K	Wet Mass Pan & Specimen 0.000					
L	Dry Mass Pan & Specimen 0.000					
M	Tare Mass of Pan 0.000					
N	Dry Mass of Material (L – M) 0.000					
O	Mass of Water (K – L) 0.000					
P	% Water Content on Total (O / N)100 0.0					
	Dry Density (100 x J) / (100 + P) 0.0					
	Maximum Dry Density 0.0					
	Optimum Moisture % 0.0					

Calculate Correct Weights for Molded Samples that are out of Height Tolerance

A =	Molded Sample Weight	18.500 lbs.
B =	Molded Sample Height	8.350”
C =	% Moisture	7.50%
D =	% Additive	4.0%
E =	(% Moisture / 100) + 1	1.075
F =	(% Additive / 100) + 1	1.040
G =	Desired Height	8.000

H =	(Step 1) Adjust total sample weight to desired height	(A / B) x G	
I =	(Step 2) Calculate dry weight of Aggregate & Additive	H / E	
J =	(Step 3) Calculate lbs. of Water	H - I	
K =	(Step 4) Calculate lbs. of Aggregate	I / F	
L =	(Step 5) Calculate lbs. of Additive	I - K	
	(Step 6) Confirm % Moisture	(J / I) x 100	
	(Step 7) Confirm % Additive	(L / K) x 100	
	(Step 8) Confirm Total Weight	K + J + L = H	

Calculate Correct Weights for Molded Samples that are out of Height Tolerance

A =	Molded Sample Weight	
B =	Molded Sample Height	
C =	% Moisture	
D =	% Additive	
E =	(% Moisture / 100) + 1	
F =	(% Additive / 100) + 1	
G =	Desired Height	

H =	(Step 1) Adjust total sample weight to desired height	(A / B) x G	
I =	(Step 2) Calculate dry weight of Aggregate & Additive	H / E	
J =	(Step 3) Calculate lbs. of Water	H - I	
K =	(Step 4) Calculate lbs. of Aggregate	I / F	
L =	(Step 5) Calculate lbs. of Additive	I - K	
	(Step 6) Confirm % Moisture	(J / I) x 100	
	(Step 7) Confirm % Additive	(L / K) x 100	
	(Step 8) Confirm Total Weight	K + J + L = H	

Test Procedure for

SOIL-CEMENT TESTING

TxDOT Designation: Tex-120-E

Effective Date: April 2013

1. SCOPE

1.1 This method consists of two parts.

1.1.1 Part I determines the unconfined compressive strength of compacted soil-cement specimens after seven days curing (10 lb. hammer, 18-inch drop, 50 blows/layer using 6 × 8 in. mold).

1.1.2 Part II applies to cement treated materials sampled from the roadway during construction.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

2.1 As outlined in test methods:

- Tex-101-E
- Tex-113-E
- Tex-117-E.

2.2 *Compression testing machine*, with capacity of 267 kN (60,000 lb.), meeting the requirements of ASTM D 1633.

2.3 *Triaxial screw jack press* (Tex-117-E), used when anticipated strengths are not in excess of 2758 kPa (400 psi).

3. MATERIALS

3.1 *Hydraulic (portland) cement.*

3.2 *Tap water.*

4. PREPARING SAMPLE

4.1 Select approximately 90 kg (200 lb.) of material treat with cement in accordance with Tex-101-E, Part II.

PART I—COMPRESSIVE STRENGTH TEST METHODS (LABORATORY MIXED)

5. PROCEDURE

5.1 Determine the optimum moisture content and maximum density for a soil-cement mixture containing 6% cement in accordance with Tex-113-E. The amount of cement added is a percentage based on the dry mass of the soil.

5.2 Recombine the sizes prepared in accordance with Tex-101-E, Part II, to make three individual samples and add the optimum moisture content, from Tex-113-E, to each sample. Mix thoroughly.

5.2.1 Cover the mixture to prevent loss of moisture by evaporation. Allow the wetted samples to stand for at least 12 hours before compaction. When the plasticity index (PI) is less than 12, the standing time may be reduced to not less than three hours. Split or referee samples should stand the full term.

5.2.2 Prior to compaction, replace any evaporated water and thoroughly mix each specimen.

5.2.3 Add cement uniformly and mix thoroughly.

5.3 Compact the specimen in four layers using Tex-113-E compactive effort.

5.3.1 Alter the percent molding water slightly as the percent cement is increased or decreased. Do this in order to mold nearer optimum moisture without running a new M/D curve for each percentage of cement.

Note 1—A new M/D curve for each percentage of cement may be performed, if desired.

5.3.2 Use the following equation to vary the molding water:

% molding water = % optimum moisture from M/D curve + 0.25 (% cement increase)

Where:

% cement increase = difference in cement content between curve and other cement contents.

5.4 Using the moisture contents outlined above, mold three specimens for each cement content using 4, 8, and 10% cement to complete the full set.

5.4.1 After the top surface of each specimen has been leveled and the specimen measured, carefully center over porous stone and remove specimen from mold by means of small press.

5.4.2 Place a card on each specimen showing the laboratory identification number and the percent of cement.

Note 2—In calculating the actual dry density of laboratory mix soil-cement specimens, the dry mass of material is the total mass of oven dry soil in the specimen plus the mass of cement. The amount of moisture should be the mass of hygroscopic moisture in the soil plus the amount of water added based on the dry mass of the soil plus cement. Determine moisture and density of road-mixed and wetted materials and soil-cement cores from the oven dry masses.

5.5 Store test specimens the same day as molded, with top and bottom porous stones, in the damp room for seven days. Do not subject specimen to capillary wetting or a surcharge. Do not use a triaxial cell. Place a pan on top of the top porous stone to protect the specimen from dripping water.

5.6 Remove test specimens from the damp room and use a cloth to remove any free water on the surface of the specimens.

5.7 Test specimens in compression at 0 kPa (0 psi) lateral confinement in accordance with Tex-117-E, Section 5.19 when using an automated load frame, or Section 5.20 when using a screw jack press.

6. TEST REPORT

6.1 Report molding moisture to the nearest 0.1%.

6.2 Report dry density to the nearest 1 kg/m^3 (0.1 pcf).

6.3 Report unconfined compressive strength to the nearest whole kPa (psi) for each cement content tested.

6.4 Report recommended cement content to the nearest 0.5%.

Note 3—Store cement in airtight container or use fresh supply.

Note 4—When comparing laboratory strengths with roadway strength, use the H/D correction factors in Tex-118-E, Table 1 on both laboratory and roadway specimens.

PART II—COMPACTION TESTING OF ROAD MIXED MATERIAL

7. PROCEDURE

7.1 Obtain samples for moisture/density curve just prior to the start of compaction operations on the roadway.

7.2 Screen cement stabilized materials taken from the roadway during construction over a 6.3 mm (1/4 in.) sieve at field moisture content, without drying.

7.2.1 Mix each of these two sizes, plus 6.3 mm (1/4 in.) and minus 6.3 mm (1/4 in.), for uniformity and weigh.

7.2.2 Cover each size fraction to maintain field moisture.

7.3 Recombine and mold one specimen at the field moisture condition and estimated mass to produce specimen compacted using Tex-113-E compactive effort. Molding should be accomplished using the same equipment and compactive effort as in Part I.

7.3.1 Adjust mass, if necessary, and weigh out not less than two additional specimens at the field moisture content for compaction. Molding moisture can be adjusted in each specimen by adding or removing moisture uniformly as needed.

7.3.2 Compact cement stabilized material in the laboratory in approximately the same timeframe as on the road. Compaction sample of cement-stabilized material from the road mix should not be prepared by oven drying.

Note 5—To determine moisture-density relationship of fine-grained materials with less than 20% retained on the 6.3 mm (1/4 in.) sieve and 100% passing the 9.5 mm (3/8 in.) sieve, the engineer may elect to use a mold with approximate dimensions of 101.6 mm (4.0 in.) in diameter by 152.4 mm (6.0 in.) in height. The number of blows must be calculated when changing mold size to maintain a compactive effort of 1100 kN-m /m^3 (13.26 ft-lb/$in.^3$)

Note 6—The contractor should be provided an initial optimum moisture based on preliminary laboratory tests.

7.4 Store test specimens the same day as molded, with top and bottom porous stones, in the damp room for seven days. Do not subject specimen to capillary wetting or a surcharge. Do not use a triaxial cell. Place a pan on top of the top porous stone to protect the specimen from dripping water.

7.5 Remove test specimens from the damp room and use a cloth to remove any free water on the surface of the specimens.

7.6 Test specimens in compression at 0 kPa (0 psi) lateral confinement in accordance with Tex-117-E, Section 5.19 when using an automated load frame, or Section 5.20 when using a screw jack press.

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8. TEST REPORT

8.1 Report density to the nearest 1 k/m^3 (0.1 pcf).

8.2 Report moisture content to the nearest 0.1 %.

8.3 Report unconfined compressive strength to the nearest whole kPa (psi).

9. ARCHIVED VERSIONS

9.1 Archived versions are available.

Calculate Correct Weights for Molded Samples that are out of Height Tolerance

A =	Molded Sample Weight	18.500 lbs.
B =	Molded Sample Height	8.350”
C =	% Moisture	7.50%
D =	% Additive	4.0%
E =	(% Moisture / 100) + 1	1.075
F =	(% Additive / 100) + 1	1.040
G =	Desired Height	8.000

H =	(Step 1) Adjust total sample weight to desired height	(A / B) x G	
I =	(Step 2) Calculate dry weight of Aggregate & Additive	H / E	
J =	(Step 3) Calculate lbs. of Water	H - I	
K =	(Step 4) Calculate lbs. of Aggregate	I / F	
L =	(Step 5) Calculate lbs. of Additive	I - K	
	(Step 6) Confirm % Moisture	(J / I) x 100	
	(Step 7) Confirm % Additive	(L / K) x 100	
	(Step 8) Confirm Total Weight	K + J + L = H	

Test Procedure for

SOIL-LIME TESTING

TxDOT Designation: Tex-121-E

Effective Date: August 2002

1. SCOPE

1.1 This method consists of three parts.

1.1.1 Part I determines the unconfined compressive strength as an index of the effectiveness of hydrated lime treatment in improving structural properties in flexible base and subgrade materials (10 lb. hammer, 18-inch drop, 50 blows/layer using 6 x 8 in. mold).

1.1.2 Part II applies to lime treated materials sampled from the roadway during construction.

1.1.3 Part III determines the minimum percent lime needed for a soil-lime mixture to attain a pH of 12.4. Cation exchange occurs at this pH, resulting in modification of the soil particle structure to achieve improved workability and decrease swell and plasticity.

1.2 The values given in parentheses (if provided) are not standard and may not be exact mathematical conversions. Use each system of units separately. Combining values from the two systems may result in nonconformance with the standard.

2. APPARATUS

2.1 Apparatus outlined in Test Methods:

- Tex-101-E
- Tex-113-E
- Tex-117-E.

2.2 *Compression testing machine*, with capacity of 267 kN (60,000 lb.), meeting the requirements of ASTM D 1633.

2.3 *Triaxial screw jack press*, if anticipated strengths do not exceed 2758 kPa (400 psi.)

3. MATERIALS

3.1 *Hydrated lime*.

3.2 *Tap Water*.

4. PREPARING SAMPLE

4.1 Select approximately 91 kg (200 lb.) of material and prepare in accordance with Tex-101-E, Part II.

PART I—COMPRESSIVE STRENGTH TEST METHODS (LABORATORY MIXED)

5. PROCEDURE

5.1 Determine the optimum water content and maximum dry density for the soil-lime mixture using Tex-113-E.

5.2 Determine the amount of lime needed based on the dry mass of the soil.

Note 1—Store lime in an airtight container or use a fresh supply.

5.3 Recombine the sizes prepared according to Tex-101-E, Part II to make three individual samples and add the optimum moisture content. Mix thoroughly and cover the mixture to prevent loss of moisture by evaporation.

5.3.1 Allow the wetted samples to stand for at least 12 hours before compaction.

5.3.2 A standing time of at least 12 hours is required for materials with a PI greater than or equal to12. When the PI is less than 12, the standing time may be reduced to not less than three hours. Split or referee samples should stand the full term.

5.3.3 Prior to compaction, replace any evaporated water and thoroughly mix each specimen.

5.3.4 Add the desired amount of lime uniformly to a specimen and mix thoroughly.

5.4 Following Tex-113-E, compact three specimens, 152.4 mm (6 in.) in diameter, and 203.2 mm (8 in.) in height, at the optimum moisture content found in Section 5.1. You may use a 101.6 mm (4 in.) diameter mold 152.4 mm (6 in.) high when the material meets the requirements of Note 2.

Note 2—To determine moisture-density relationship of fine-grained materials with less than 20 % retained on the 6.3 mm (1/4 in.) sieve and 100 % passing the 9.5 mm (3/8 in.) sieve, the engineer may elect to use a mold with approximate dimensions of 101.6 mm (4.0 in.) in diameter by 152.4 mm (6.0 in.) in height. Calculate the number of blows when changing mold size to maintain a compactive effort of 1100 kN-m /m^3 (13.26 ft.-lb./$in.^3$).

5.4.1 Lime-treated subgrade soil specimens should be compacted as nearly identical as possible and three specimens cured and tested for unconfined compression.

5.4.2 If the material to be improved by lime treatment is a flexible base material, the unconfined compression test is used to evaluate the strength. Compact three identical specimens for each percentage of hydrated lime, cure, and test for unconfined compression.

5.5 Cover specimens with top and bottom porous stones and place in triaxial cells immediately after extrusion from molds.

5.5.1 Store specimens at room temperature for seven days of moist curing at room temperature on the countertop.

5.6 After curing, remove cells and place the specimens in an air dryer oven at a temperature not to exceed 60°C (140°F) for about six hours or until 1/3 to 1/2 of the molding moisture has been removed. All lime-treated soils are dried as given above even though a considerable amount of cracking may occur. Allow the specimens to cool to room temperature before continuing the test.

5.7 Weigh, measure, and enclose the specimens in triaxial cells, and subject them to capillarity for ten days. Use a constant lateral pressure of 6.9 kPa (1 psi), and a surcharge pressure of 3.4 kPa (1/2 psi) for base to 6.9 kPa (1 psi) for subgrade depending upon the use of the material being tested. (A wet room is not required for this curing.)

5.8 Test the specimens for unconfined compression without a cell. A compression testing machine of adequate range and sensitivity may be used.

6. CALCULATIONS AND GRAPHS

6.1 Calculate, plot and interpret test data for the unconfined compression test. Lime stabilized clay soils are not recommended for top course of base, regardless of strength.

7. TEST REPORT

7.1 Strength value, reported to the nearest whole kPa (psi) for each lime content tested

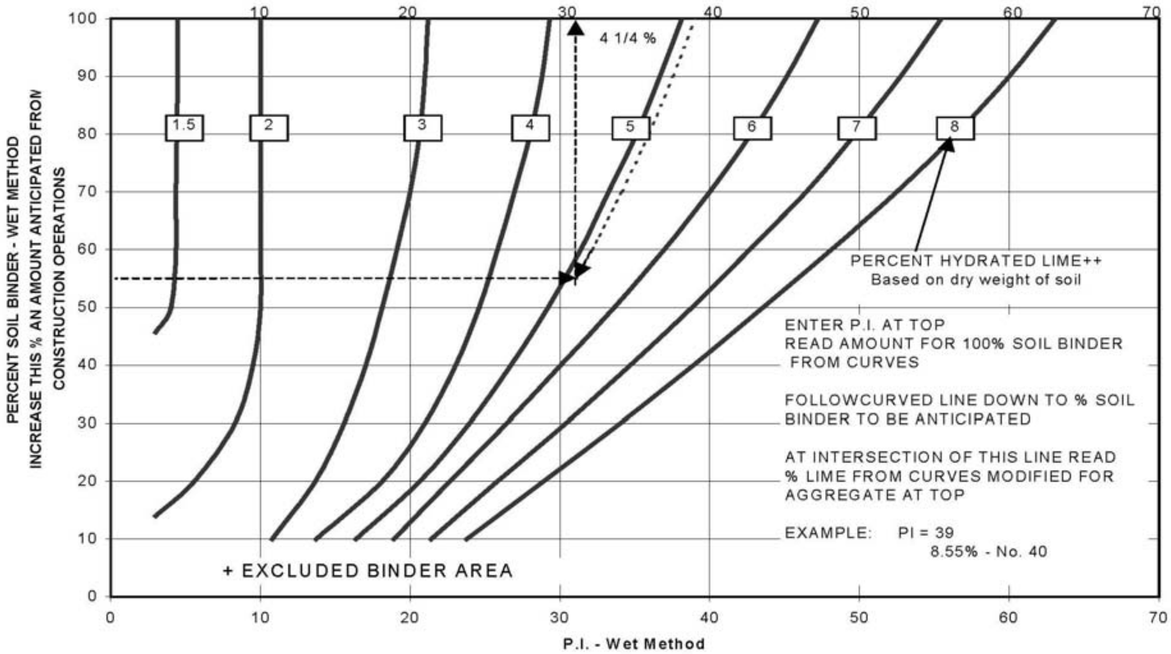
7.2 Density, reported to the nearest 1 kg/m^3 (0.1 pcf)

7.3 Optimum moisture content, reported to the nearest 0.1%

7.4 Recommended lime content, reported to the nearest 0.5%

Note 3—This test determines the quality of soils treated with lime to be used for subbase or base protected with a wearing surface. Flexible base materials and granular soils can usually be stabilized with about 3% lime. A larger amount of lime may be required to improve the strength of a very plastic clay subgrade. Unconfined compressive strength of 1035 kPa (150 psi) is satisfactory for final course of base construction and it is desirable that materials for such courses contain a minimum of 50 percent plus 425 µm (No. 40) before treatment.

The amounts of lime from Figure 1 are recommended amounts for stabilization of sub-grade soils and base materials. These percentages of lime should be substantiated by these methods to insure adequate strengths. Unconfined compressive strengths of at least 345 kPa (50 psi) are suggested as adequate for subbase soils treated with lime. It is possible for short-term tests of soil-lime mixes, using smaller percentages of lime, to give misleading results due to field variations in materials, mixing, lower densities, and so forth.



\+ Exclude use of chart for materials with less than 10% minus 425um (No. 40) and cohesionless materials (PI less than 3).

++ Percent of relatively pure lime usually 90% or more of Ca and/or Mg hydroxides and 855 or more of which pass the 75um (No 200) sieve. Percentages shown are for stabilizing subgrades and base courses where lasting effects are desired. Satisfactory temporary results are sometimes obtained by the use of as little as ½ of above percentages. References to cementing strength is implied when such terms as "Lasting Effects" and "Temporary Results" are used.

Figure 1—Recommended Amounts of Lime for Stabilization of Subgrades and Bases

PART II—COMPACTION TESTING OF ROAD MIXED MATERIAL

8. PROCEDURE

8.1 Obtain samples for the moisture/density curve just prior to the start of compaction operations on the roadway.

8.1.1 If the material on the roadway is reworked and re-compacted for any reason, it will be necessary to obtain samples just prior to re-compaction of the reworked material for a new curve representing the reworked material.

8.2 Screen lime stabilized materials taken from the roadway during construction for density and/or strength testing over a 6.3 mm (1/4 in.) sieve at field moisture content, without drying.

8.2.1 Mix each size for uniformity and record the weight.

8.2.2 Cover each size material, plus 6.3 mm (1/4 in.) and minus 6.3 mm (1/4 in.) to maintain field moisture.

8.2.3 Recombine one representative specimen and mold at the field moisture condition.

8.2.4 Adjust mass, if necessary, and weigh out specimens for compaction and strength testing, if desired.

8.2.5 Molding moisture can be adjusted in each specimen by adding or removing moisture in the total specimen uniformly as needed.

8.2.6 Lime stabilized material should be sampled, prepared and molded during the same day compaction operations begin on the project.

8.2.7 Molding should be accomplished using the same equipment and compactive effort as in Part I.

Note 4—Compaction sample of lime-stabilized material from the road mix should not be prepared by oven drying.

Note 5—The contractor should be provided an initial optimum moisture based on preliminary tests.

9. TEST REPORT

9.1 Density, reported to the nearest 1 kg/m^3 (0.1 pcf)

9.2 Optimum water content, reported to the nearest to 0.1%

PART III—DETERMINING STABILIZATION ABILITY OF LIME BY SOIL pH

10. APPARATUS

10.1 Same as for Tex-128-E.

11. MATERIALS

11.1 Same as for Tex-128-E.

12. PREPARING SAMPLE

12.1 Use the same sample preparation as described in Tex-128-E.

13. PROCEDURE

13.1 Heat sample and approximately 1400 mL (47.5 fl. oz.) of distilled water to 45–60°C (112–140°F) in separate containers.

13.2 Weigh to the nearest 0.01 g a series of 30 g samples of soil and place in separate containers.

13.3 Weigh to the nearest 0.01 a series of quantities of lime equivalent to 0, 2, 4, 6, 8, and 10% of the total dry soil sample.

13.4 Add one of the lime percentages to each of the soil samples, add 150 mL (5 fl. oz.) of distilled water to each combination, and stir vigorously.

13.5 Stir the samples every 15 minutes for 1 hour to disperse the soil and make sure all soluble material is in solution.

13.6 At the end of an hour, record the temperature of the mixture and adjust the pH meter to that temperature.

13.7 Standardize the meter (buffer solution of pH 7.0) according to the manufacturer's recommendations. (If the meter allows multiple standardizations, standardize the meter to buffer solutions of pH 7.0 and 10.0).

13.8 Clean electrode with distilled water.

Note 6—If there are scratches on the glass bulb of electrode, replace with new electrode.

13.9 Check the pH of each sample as described in Tex-128-E, Sections 5.7–5.9 and record.

13.10 Plot the pH of the samples versus the percent lime (pH on the y-axis, percent lime on the x-axis.) (See Figure 2.)

13.10.1 If the pH readings are 12.4 or higher, the lowest percentage of lime that gives a pH of 12.4 is the percent required to stabilize the soil.

13.10.2 If the pH readings do not go beyond pH of 12.3 and two percentages give this reading, the lowest percentage of lime to give a pH of 12.3 is the percent required to stabilize the soil.

13.10.3 If the highest pH reading is a pH of 12.3 and only the highest percentage of lime used gives a pH of 12.3, additional testing is required using higher percentages of lime.

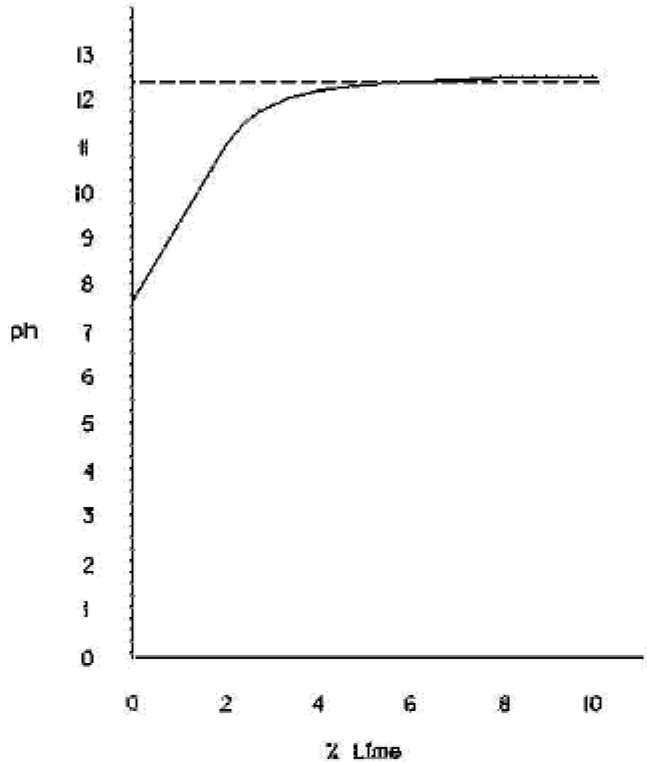


Figure 2—pH Versus Percent Lime

14. REPORT

14.1 Report the recommended percent lime to the nearest 0.1%.

15. ARCHIVED VERSIONS

15.1 Archived versions are available.

Calculate Correct Weights for Molded Samples that are out of Height Tolerance

A =	Molded Sample Weight	18.500 lbs.
B =	Molded Sample Height	8.350”
C =	% Moisture	7.50%
D =	% Additive	4.0%
E =	(% Moisture / 100) + 1	1.075
F =	(% Additive / 100) + 1	1.040
G =	Desired Height	8.000

H =	(Step 1) Adjust total sample weight to desired height	(A / B) x G	
I =	(Step 2) Calculate dry weight of Aggregate & Additive	H / E	
J =	(Step 3) Calculate lbs. of Water	H - I	
K =	(Step 4) Calculate lbs. of Aggregate	I / F	
L =	(Step 5) Calculate lbs. of Additive	I - K	
	(Step 6) Confirm % Moisture	(J / I) x 100	
	(Step 7) Confirm % Additive	(L / K) x 100	
	(Step 8) Confirm Total Weight	K + J + L = H	

Item 247
Flexible Base

1. DESCRIPTION

Construct a foundation course composed of flexible base.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. The Engineer may sample and test project materials at any time before compaction throughout the duration of the project to assure specification compliance. Use Tex-100-E material definitions.

2.1. **Aggregate**. Furnish aggregate of the type and grade shown on the plans and meeting the requirements of Table 1. Each source must meet Table 1 requirements for liquid limit, plasticity index, and wet ball mill for the grade specified. Do not use additives, such as but not limited to lime, cement, or fly ash to modify aggregates to meet the requirements of Table 1 unless shown on the plans.

Table 1
Material Requirements

Property	Test Method	Grade 1–2	Grade 3	Grade 4[2]	Grade 5
Sampling	Tex-400-A				
Master gradation sieve size (cumulative % retained)	Tex-110-E				
2-1/2"		0	0	As shown on the plans	0
1-3/4"		0–10	0–10		0–5
7/8"		10–35	–		10–35
3/8"		30–65	–		35–65
#4		45–75	45–75		45–75
#40		65–90	50–85		70–90
Liquid Limit, % Max	Tex-104-E	40	40	As shown on the plans	35
Plasticity Index, Max[1]	Tex-106-E	10	12	As shown on the plans	10
Plasticity index, Min[1]		As shown on the plans	As shown on the plans	As shown on the plans	As shown on the plans
Wet ball mill, % Max	Tex-116-E	40	–	As shown on the plans	40
Wet ball mill, % Max increase passing the #40 sieve		20	–	As shown on the plans	20
Min compressive strength, psi	Tex-117-E			As shown on the plans	
lateral pressure 0 psi		35	–		–
lateral pressure 3 psi		–	–		90
lateral pressure 15 psi		175	–		175

1. Determine plastic index in accordance with Tex-107-E (linear shrinkage) when liquid limit is unattainable as defined in Tex-104-E.
2. Grade 4 may be further designated as Grade 4A, Grade 4B, etc.

2.1.1. **Material Tolerances**. The Engineer may accept material if no more than 1 of the 5 most recent gradation tests has an individual sieve outside the specified limits of the gradation.

When target grading is required by the plans, no single failing test may exceed the master grading by more than 5 percentage points on sieves No. 4 and larger or 3 percentage points on sieves smaller than No. 4.

The Engineer may accept material if no more than 1 of the 5 most recent plasticity index tests is outside the specified limit. No single failing test may exceed the allowable limit by more than 2 points.

2.1.2. **Material Types**. Do not use fillers or binders unless approved. Furnish the type specified on the plans in accordance with the following:

2.1.2.1. **Type A**. Crushed stone produced and graded from oversize quarried aggregate that originates from a single, naturally occurring source. Do not use gravel or multiple sources.

2.1.2.2. **Type B**. Crushed or uncrushed gravel. Blending of 2 or more sources is allowed.

2.1.2.3. **Type C**. Crushed gravel with a minimum of 60% of the particles retained on a No. 4 sieve with 2 or more crushed faces as determined by Tex-460-A, Part I. Blending of 2 or more sources is allowed.

2.1.2.4. **Type D**. Type A material or crushed concrete. Crushed concrete containing gravel will be considered Type D material. Crushed concrete must meet the requirements in Section 247.2.1.3.2., "Recycled Material (Including Crushed Concrete) Requirements," and be managed in a way to provide for uniform quality. The Engineer may require separate dedicated stockpiles in order to verify compliance.

2.1.2.5. **Type E**. Caliche, iron ore or as otherwise shown on the plans.

2.1.3. **Recycled Material**. Reclaimed asphalt pavement (RAP) and other recycled materials may be used when shown on the plans. Request approval to blend 2 or more sources of recycled materials.

2.1.3.1. **Limits on Percentage**. Do not exceed 20% RAP by weight, when RAP is allowed, unless otherwise shown on the plans. The percentage limitations for other recycled materials will be as shown on the plans.

2.1.3.2. **Recycled Material (Including Crushed Concrete) Requirements**.

2.1.3.2.1. **Contractor-Furnished Recycled Materials**. Provide recycled materials, other than RAP, that have a maximum sulfate content of 3,000 ppm when tested in accordance with Tex-145-E. When the Contractor furnishes the recycled materials, including crushed concrete, the final product will be subject to the requirements of Table 1 for the grade specified. Certify compliance with DMS-11000, "Evaluating and Using Nonhazardous Recyclable Materials Guidelines," for Contractor furnished recycled materials. In addition, recycled materials must be free from reinforcing steel and other objectionable material and have at most 1.5% deleterious material when tested in accordance with Tex-413-A. For RAP, do not exceed a maximum percent loss from decantation of 5.0% when tested in accordance with Tex-406-A. Test RAP without removing the asphalt.

2.1.3.2.2. **Department-Furnished Required Recycled Materials**. When the Department furnishes and requires the use of recycled materials, unless otherwise shown on the plans:

- Department-required recycled material will not be subject to the requirements in Table 1,
- Contractor-furnished materials are subject to the requirements in Table 1 and this Item,
- the final product, blended, will be subject to the requirements in Table 1, and
- for final product, unblended (100% Department-furnished required recycled material), the liquid limit, plasticity index, wet ball mill, and compressive strength is waived.

Crush Department-furnished RAP so that 100% passes the 2 in. sieve. The Contractor is responsible for uniformly blending to meet the percentage required.

2.1.3.2.3. **Department-Furnished and Allowed Recycled Materials**. When the Department furnishes and allows the use of recycled materials or allows the Contractor to furnish recycled materials, the final blended product is subject to the requirements of Table 1 and the plans.

2.1.3.3. **Recycled Material Sources**. Department-owned recycled material is available to the Contractor only when shown on the plans. Return unused Department-owned recycled materials to the Department stockpile location designated by the Engineer unless otherwise shown on the plans.

The use of Contractor-owned recycled materials is allowed when shown on the plans. Contractor-owned surplus recycled materials remain the property of the Contractor. Remove Contractor-owned recycled materials from the project and dispose of them in accordance with federal, state, and local regulations before project acceptance. Do not intermingle Contractor-owned recycled material with Department-owned recycled material unless approved.

2.2. **Water**. Furnish water free of industrial wastes and other objectionable matter.

2.3. **Material Sources**. Expose the vertical faces of all strata of material proposed for use when non-commercial sources are used. Secure and process the material by successive vertical cuts extending through all exposed strata, when directed.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work.

3.1. Provide rollers in accordance with Item 210, “Rolling.” Provide proof rollers in accordance with Item 216, “Proof Rolling,” when required.

3.2. When ride quality measurement is required, provide a high speed or lightweight inertial profiler certified at the Texas A&M Transportation Institute. Provide equipment certification documentation. Display a current decal on the equipment indicating the certification expiration date.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

Stockpile base material temporarily at an approved location before delivery to the roadway. Build stockpiles in layers no greater than 2 ft. thick. Stockpiles must have a total height between 10 and 16 ft. unless otherwise approved. After construction and acceptance of the stockpile, loading from the stockpile for delivery is allowed. Load by making successive vertical cuts through the entire depth of the stockpile.

Do not add or remove material from temporary stockpiles that require sampling and testing before delivery unless otherwise approved. Charges for additional sampling and testing required as a result of adding or removing material will be deducted from the Contractor’s estimates.

Haul approved flexible base in clean trucks. Deliver the required quantity to each 100-ft. station or designated stockpile site as shown on the plans. Prepare stockpile sites as directed. When delivery is to the 100-ft. station, manipulate in accordance with the applicable Items.

4.1. **Preparation of Subgrade or Existing Base**. Remove or scarify existing asphalt concrete pavement in accordance with Item 105, “Removing Treated and Untreated Base and Asphalt Pavement,” when shown on the plans or as directed. Shape the subgrade or existing base to conform to the typical sections shown on the plans or as directed.

When new base is required to be mixed with existing base, deliver, place, and spread the new flexible base in the required amount per station. Manipulate and thoroughly mix the new base with existing material to provide a uniform mixture to the specified depth before shaping.

Proof roll the roadbed in accordance with Item 216, “Proof Rolling,” before pulverizing or scarifying when shown on the plans or directed. Correct soft spots as directed.

4.2. **Placing**. Spread and shape flexible base into a uniform layer with an approved spreader the same day as delivered unless otherwise approved. Construct layers to the thickness shown on the plans. Maintain the shape of the course. Control dust by sprinkling, as directed. Correct or replace segregated areas as directed, at no additional expense to the Department.

Place successive base courses and finish courses using the same construction methods required for the first course.

4.3. **Compaction**. Compact using density control unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. When necessary, sprinkle the material in accordance with Item 204, “Sprinkling.”

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least 1/2 the width of the roller unit. Begin rolling at the low side and progress toward the high side on superelevated curves. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish requirements before the next course is placed or the project is accepted. Continue work until specification requirements are met. Perform the work at no additional expense to the Department.

Before final acceptance, the Engineer will select the locations of tests and measure the flexible base depth in accordance with Tex-140-E. Correct areas deficient by more than 1/2 in. in thickness by scarifying, adding material as required, reshaping, recompacting, and refinishing at the Contractor’s expense.

4.3.1. **Ordinary Compaction**. Roll with approved compaction equipment as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing approved material as required, reshaping, and recompacting.

4.3.2. **Density Control**. Compact to at least 100% of the maximum dry density determined by Tex-113-E, unless otherwise shown on the plans. Maintain moisture during compaction within ±2 percentage points of the optimum moisture content as determined by Tex-113-E. Measure the moisture content of the material in accordance with Tex-115-E or Tex-103-E during compaction daily and report the results the same day to the Engineer, unless otherwise shown on the plans or directed. Do not achieve density by drying the material after compaction.

The Engineer will determine roadway density and moisture content of completed sections in accordance with Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

4.4. **Finishing**. After completing compaction, clip, skin, or tight-blade the surface with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of it at an approved location. Seal the clipped surface immediately by rolling with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades as shown on the plans or as directed.

Correct grade deviations greater than 1/4 in. in 16 feet measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Correct by loosening and adding, or removing material. Reshape and re-compact in accordance with Section 247.4.3., “Compaction.”

4.5. **Curing**. Cure the finished section until the moisture content is at least 2 percentage points below optimum or as directed before applying the next successive course or prime coat.

4.6. **Ride Quality**. This section applies to the final travel lanes that receive a 1 or 2 course surface treatment for the final surface, unless otherwise shown on the plans. Measure ride quality of the base course after placement of the prime coat and before placement of the surface treatment, unless otherwise approved. Use a certified profiler operator from the Department's MPL. When requested, furnish the Engineer documentation for the person certified to operate the profiler.

Provide all profile measurements to the Engineer in electronic data files within 3 days after placement of the prime coat using the format specified in Tex-1001-S. The Engineer will use Department software to evaluate longitudinal profiles to determine areas requiring corrective action. Correct 0.1-mi.sections having an average international roughness index (IRI) value greater than 100.0 in. per mile to an IRI value of 100.0 in. per mile or less for each wheel path, unless otherwise shown on the plans.

Re-profile and correct sections that fail to maintain ride quality until placement of the next course, as directed. Correct re-profiled sections until specification requirements are met, as approved. Perform this work at no additional expense to the Department.

5. MEASUREMENT

Flexible base will be measured as follows:

- **Flexible Base (Complete In Place)**. The ton, square yard, or any cubic yard method.
- **Flexible Base (Roadway Delivery)**. The ton or any cubic yard method.
- **Flexible Base (Stockpile Delivery)**. The ton, cubic yard in vehicle, or cubic yard in stockpile.

Measurement by the cubic yard in final position and square yard is a plans quantity measurement. The quantity to be paid for is the quantity shown in the proposal unless modified by Article 9.2., "Plans Quantity Measurement." Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment as follows.

5.1. **Cubic Yard in Vehicle**. By the cubic yard in vehicles of uniform capacity at the point of delivery.

5.2. **Cubic Yard in Stockpile**. By the cubic yard in the final stockpile position by the method of average end areas.

5.3. **Cubic Yard in Final Position**. By the cubic yard in the completed and accepted final position. The volume of base course is computed in place by the method of average end areas between the original subgrade or existing base surfaces and the lines, grades, and slopes of the accepted base course as shown on the plans.

5.4. **Square Yard**. By the square yard of surface area in the completed and accepted final position. The surface area of the base course is based on the width of flexible base as shown on the plans.

5.5. **Ton**. By the ton of dry weight in vehicles as delivered. The dry weight is determined by deducting the weight of the moisture in the material at the time of weighing from the gross weight of the material. The Engineer will determine the moisture content in the material in accordance with Tex-103-E from samples taken at the time of weighing.

When material is measured in trucks, the weight of the material will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for the types of work shown below. No additional payment will be made for thickness or width exceeding that shown on the typical section or provided on the plans for cubic yard in the final position or square yard measurement.

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item unless otherwise shown on the plans. When proof rolling is shown on the plans or directed, it will be paid for in accordance with Item 216, “Proof Rolling.”

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade will be at the Contractor’s expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade will be paid in accordance with pertinent Items or Article 4.4., “Changes in the Work.”

6.1. **Flexible Base (Complete In Place)**. Payment will be made for the type and grade specified. For cubic yard measurement, “In Vehicle,” “In Stockpile,” or “In Final Position” will be specified. For square yard measurement, a depth will be specified. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, spreading, blading, mixing, shaping, placing, compacting, reworking, finishing, correcting locations where thickness is deficient, curing, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

6.2. **Flexible Base (Roadway Delivery)**. Payment will be made for the type and grade specified. For cubic yard measurement, “In Vehicle,” “In Stockpile,” or “In Final Position” will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing materials, temporary stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

6.3. **Flexible Base (Stockpile Delivery)**. Payment will be made for the type and grade specified. For cubic yard measurement, “In Vehicle” or “In Stockpile” will be specified. The unit price bid will not include processing at the roadway. This price is full compensation for furnishing and disposing of materials, preparing the stockpile area, temporary or permanent stockpiling, assistance provided in stockpile sampling and operations to level stockpiles for measurement, loading, hauling, delivery of materials to the stockpile, furnishing scales and labor for weighing and measuring, and equipment, labor, tools, and incidentals.

Item 260
Lime Treatment (Road-Mixed)

1. DESCRIPTION

Mix and compact lime, water, and subgrade or base (with or without asphaltic concrete pavement) in the roadway.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of the proposed material sources and of changes to material sources. Obtain verification from the Engineer that the specification requirements are met before using the sources. The Engineer may sample and test project materials at any time before compaction. Use Tex-100-E for material definitions.

2.1. **Lime**. Furnish lime that meets the requirements of DMS-6350 “Lime and Lime Slurry,” and DMS-6330, “Pre-Qualification of Lime Sources.” Use hydrated lime, commercial lime slurry, quicklime, or carbide lime slurry as shown on the plans. Do not use quicklime when sulfates are present in quantities greater than 3,000 ppm. When furnishing quicklime, provide it in bulk.

2.2. **Subgrade**. The Engineer will determine the sulfate content of the existing subgrade in accordance with Tex-145-E and organic content in accordance with Tex-148-E before lime treatment begins. Suspend operations when material to be treated has a sulfate content greater than 7,000 ppm or an organic content greater than 1.0% and proceed as directed.

2.3. **Flexible Base**. Unless otherwise shown on the plans, furnish base material that meets the requirements of Item 247, “Flexible Base,” for the type and grade shown on the plans, before the addition of lime.

2.4. **Water**. Furnish water free of industrial wastes and other objectionable material.

2.5. **Asphalt**. When asphalt or emulsion is permitted for curing purposes, furnish materials that meet the requirements of Item 300, “Asphalts, Oils, and Emulsions,” as shown on the plans or as directed.

2.6. **Mix Design**. The Engineer will determine the target lime content and optimum moisture content in accordance with Tex-121-E or prior experience with the project materials. The Contractor may propose a mix design developed in accordance with Tex-121-E. The Engineer will use Tex-121-E to verify the Contractor’s proposed mix design before acceptance. Reimburse the Department for subsequent mix designs or partial designs necessitated by changes in the material or requests by the Contractor. Limit the amount of recycled asphalt pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, “Rolling.” Provide proof rollers in accordance with Item 216, “Proof Rolling,” when required.

3.1. **Storage Facility**. Store quicklime and dry hydrated lime in closed, weatherproof containers.

3.2. **Slurry Equipment**. Use slurry tanks equipped with agitation devices to slurry hydrated lime or quicklime on the project or other approved location. The Engineer may approve other slurrying methods.

3.3. Provide a pump for agitating the slurry when the distributor truck is not equipped with an agitator. Equip the distributor truck with a sampling device in accordance with Tex-600-J, Part I, when using commercial lime slurry or carbide lime slurry.

3.4. **Hydrated Lime Distribution Equipment**. Provide equipment to spread lime evenly across the area to be treated. Provide equipment with a rotary vane feeder to spread lime, when shown on the plans.

3.5. **Pulverization Equipment**. Provide pulverization equipment that:

- cuts and pulverizes material uniformly to the proper depth with cutters that plane to a uniform surface over the entire width of the cut,
- provides a visible indication of the depth of cut at all times, and
- uniformly mixes the materials.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas, and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or as directed.

4.1. **Preparation of Subgrade or Existing Base for Treatment**. Before treating, remove existing asphalt pavement in accordance with Item 105, “Removing Treated and Untreated Base and Asphalt Pavement,” when shown on the plans or as directed. Shape existing material in accordance with applicable bid items to conform to typical sections shown on the plans and as directed.

Unless otherwise approved, proof roll the roadbed in accordance with Item 216, “Proof Rolling,” before pulverizing or scarifying existing material. Correct soft spots as directed.

When material is imported from a borrow source, notify the Engineer of the location of the borrow source well in advance to allow time for testing and approval to avoid delay to the project. Stockpile as directed. The Engineer will test the borrow source and determine the sulfate and organic contents. When the borrow source has a sulfate content greater than 3,000 ppm or an organic content greater than 1.0%, proceed as directed.

When new base material is required to be mixed with existing base, deliver, place, and spread the new material in the required amount per station. Manipulate and thoroughly mix new base with existing material to provide a uniform mixture to the specified depth before shaping.

4.2. **Pulverization**. Pulverize or scarify existing material after shaping so that 100% passes a 2-1/2 in. sieve. If the material cannot be uniformly processed to the required depth in a single pass, excavate and windrow the material to expose a secondary grade to achieve processing to plan depth.

4.3. **Application of Lime**. Uniformly apply lime using dry or slurry placement as shown on the plans or as directed. Add lime at the percentage determined in Section 260.2.6., “Mix Design.” Apply lime only on an area where mixing can be completed during the same working day.

Start lime application only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend application when the Engineer determines that weather conditions are unsuitable.

Minimize dust and scattering of lime by wind. Do not apply lime when wind conditions, in the opinion of the Engineer, cause blowing lime to become dangerous to traffic or objectionable to adjacent property owners. When pebble grade quicklime is placed dry, mix the material and lime thoroughly at the time of lime application. Use of quicklime can be dangerous. Inform users of the recommended precautions for handling and storage.

4.3.1. **Dry Placement**. Before applying lime, bring the prepared roadway to approximately 2 percentage points above optimum moisture content. When necessary, sprinkle in accordance with Item 204, "Sprinkling." Distribute the required quantity of hydrated lime or pebble grade quicklime with approved equipment. Only hydrated lime may be distributed by bag. Do not use a motor grader to spread hydrated lime.

4.3.2. **Slurry Placement**. Provide slurry free of objectionable materials, at or above the minimum dry solids content, and with a uniform consistency that will allow ease of handling and uniform application. Deliver commercial lime slurry or carbide lime slurry to the jobsite, or use hydrated lime or quicklime to prepare lime slurry at the jobsite or other approved location, as specified. When dry quicklime is applied as slurry, use 80% of the amount shown on the plans.

Distribute slurry uniformly by making successive passes over a measured section of roadway until the specified lime content is reached. Uniformly spread the residue from quicklime slurry over the length of the roadway being processed, unless otherwise directed.

4.4. **Mixing**. Begin mixing within 6 hr. of application of lime. Hydrated lime exposed to the open air for 6 hr. or more between application and mixing, or that experiences excessive loss due to washing or blowing, will not be accepted for payment.

Thoroughly mix the material and lime using approved equipment. When treating subgrade, bring the moisture content above the optimum moisture content to insure adequate chemical reaction of the lime and subgrade materials. Allow the mixture to mellow for 1 to 4 days, as directed. When pebble grade quicklime is used, allow the mixture to mellow for 2 to 4 days, as directed. Sprinkle the treated materials during the mixing and mellowing operation, as directed, to achieve adequate hydration and proper moisture content. When the material to be treated has a sulfate content greater than 3,000 ppm but less than or equal to 7,000 ppm, mellow for a minimum of 7 days. Maintain in a continuously moist condition by sprinkling in accordance with Item 204, "Sprinkling." After mellowing, resume mixing until a homogeneous, friable mixture is obtained. After mixing, the Engineer may sample the mixture at roadway moisture and test in accordance with Tex-101-E, Part III, to determine compliance with the gradation requirements in Table 1.

Table 1
Gradation Requirements (Minimum % Passing)

Sieve Size	Base	Subgrade
1-3/4"	100	100
3/4"	85	85
#4	–	60

4.5. **Compaction**. Compact the mixture using density control, unless otherwise shown on the plans. Multiple lifts are permitted when shown on the plans or approved. Bring each layer to the moisture content directed. Sprinkle the treated material in accordance with Item 204, "Sprinkling" or aerate the treated material to adjust the moisture content during compaction so that it is no more than 1.0 percentage points below optimum and 2.0 percentage points above optimum as determined by Tex-121-E. Measure the moisture content of the material in accordance with Tex-115-E or Tex-103-E during compaction daily and report the results the same day, unless otherwise shown on the plans or directed.

Begin rolling longitudinally at the sides and proceed toward the center, overlapping on successive trips by at least 1/2 the width of the roller unit. On superelevated curves, begin rolling at the low side and progress toward the high side. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph as directed.

Before final acceptance, the Engineer will select the locations of tests in each unit and measure the treated depth in accordance with Tex-140-E. Correct areas deficient by more than 1/2 in. in thickness or more than 1/2% in target lime content by adding lime as required, reshaping, recompacting, and refinishing at the Contractor's expense.

Rework, recompact, and refinish material that fails to meet or that loses required moisture, density, stability, or finish before the next course is placed or the project is accepted. Continue work until specification requirements are met. Rework in accordance with Section 260.4.6., “Reworking a Section.” Perform the work at no additional expense to the Department.

4.5.1. **Ordinary Compaction**. Roll with approved compaction equipment, as directed. Correct irregularities, depressions, and weak spots immediately by scarifying the areas affected, adding or removing treated material as required, reshaping, and recompacting.

4.5.2. **Density Control**. The Engineer will determine roadway density and moisture content of completed sections in accordance with Tex-115-E. The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

4.5.2.1. **Subgrade**. Compact to at least 95% of the maximum density determined in accordance with Tex-121-E, unless otherwise shown on the plans.

4.5.2.2. **Base**. Compact the bottom course to at least 95% of the maximum density determined in accordance with Tex-121-E, unless otherwise shown on the plans. Compact subsequent courses treated under this Item to at least 98% of the maximum density determined in accordance with Tex-121-E, unless otherwise shown on the plans.

4.6. **Reworking a Section**. When a section is reworked within 72 hr. after completion of compaction, rework the section to provide the required density. When a section is reworked more than 72 hr. after completion of compaction, add additional lime at 25% of the percentage determined in Section 260.2.6., “Mix Design.” Reworking includes loosening, adding material or removing unacceptable material if necessary, mixing as directed, compacting, and finishing. When density control is specified, determine a new maximum density of the reworked material in accordance with Tex-121-E, and compact to at least 95% of this density.

4.7. **Finishing**. Immediately after completing compaction of the final course, clip, skin, or tight-blade the surface of the lime-treated material with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. Remove loosened material and dispose of at an approved location. Roll the clipped surface immediately with a pneumatic tire roller until a smooth surface is attained. Add small amounts of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades shown on the plans or as directed.

Finish grade of constructed subgrade to within 0.1 ft. in the cross-section and 0.1 ft. in 16 ft. measured longitudinally.

Correct grade deviations of constructed base greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape, and roll with a pneumatic-tire roller. Correct as directed if material is more than 1/4 in. low. Do not surface patch. The 72-hr. time limit required for completion of placement, compaction, and finishing does not apply to finishing required just before applying the surface course.

4.8. **Curing**. Cure for the minimum number of days shown in Table 2 by sprinkling in accordance with Item 204, “Sprinkling,” or by applying an asphalt material at a rate of 0.05 to 0.20 gal. per square yard as directed. Maintain moisture during curing. Upon completion of curing, maintain the moisture content in accordance with Section 132.3.5., “Maintenance of Moisture and Reworking,” for subgrade and Section 247.4.5., “Curing” for bases before placing subsequent courses. Do not allow equipment on the finished course during curing except as required for sprinkling, unless otherwise approved. Apply seals or additional courses within 14 calendar days of final compaction.

Table 2
Minimum Curing Requirements before Placing Subsequent Courses[1]

Untreated Material	Curing (Days)
PI ≤ 35	2
PI > 35	5

1. Subject to the approval of the Engineer. Proof rolling may be required as an indicator of adequate curing.

5. MEASUREMENT

5.1. **Lime**. When lime is furnished in trucks, the weight of lime will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at a location approved by the Engineer. Scales must conform to the requirements of Item 520, "Weighing and Measuring Equipment."

When lime is furnished in bags, indicate the manufacturer's certified weight. Bags varying more than 5% from that weight may be rejected. The average weight of bags in any shipment, as determined by weighing 10 bags taken at random, must be at least the manufacturer's certified weight.

5.1.1. **Hydrated Lime**.

5.1.1.1. **Dry**. Lime will be measured by the ton (dry weight).

5.1.1.2. **Slurry**. Lime slurry will be measured by the ton (dry weight) of the hydrated lime used to prepare the slurry at the jobsite.

5.1.2. **Commercial Lime Slurry**. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

5.1.3. **Quicklime**.

5.1.3.1. **Dry**. Lime will be measured by the ton (dry weight) of the quicklime.

5.1.3.2. **Slurry**. Lime slurry will be measured by the ton (dry weight) of the quicklime used to prepare the slurry multiplied by a conversion factor of 1.28 to give the quantity of equivalent hydrated lime, which will be the basis of payment.

5.1.4. **Carbide Lime Slurry**. Lime slurry will be measured by the ton (dry weight) as calculated from the minimum percent dry solids content of the slurry, multiplied by the weight of the slurry in tons delivered.

5.2. **Lime Treatment**. Lime treatment will be measured by the square yard of surface area. The dimensions for determining the surface area are established by the widths shown on the plans and the lengths measured at placement.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid in accordance with Section 260.6.1., "Lime," and Section 260.6.2., "Lime Treatment."

Furnishing and delivering new base will be paid for in accordance with Section 247.6.2., "Flexible Base (Roadway Delivery)." Mixing, spreading, blading, shaping, compacting, and finishing new or existing base material will be paid for in accordance with Section 260.6.2., "Lime Treatment." Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with Item 216, "Proof Rolling."

Where subgrade is constructed under this Contract, correction of soft spots in the subgrade or existing base will be at the Contractor's expense. Where subgrade is not constructed under this Contract, correction of soft spots in the subgrade or existing base will be paid for in accordance with pertinent Items or Article 4.4., "Changes in the Work."

Where subgrade to be treated under this Contract has sulfates greater than 7,000 ppm, work will be paid for in accordance with Article 4.4., "Changes in the Work."

Asphalt used solely for curing will not be paid for directly but will be subsidiary to this Item. Asphalt placed for curing and priming will be paid for under Item 310, "Prime Coat."

6.1. **Lime**. Lime will be paid for at the unit price bid for "Lime" of one of the following types:

- Hydrated Lime (Dry),
- Hydrated Lime (Slurry),
- Commercial Lime Slurry,
- Quicklime (Dry),
- Quicklime (Slurry), or
- Carbide Lime Slurry.

This price is full compensation for materials, delivery, equipment, labor, tools, and incidentals.

Lime used for reworking a section in accordance with Section 260.4.6., "Reworking a Section," will not be paid for directly but will be subsidiary to this Item.

6.2. **Lime Treatment**. Lime treatment will be paid for at the unit price bid for "Lime Treatment (Existing Material)," "Lime Treatment (New Base)," or "Lime Treatment (Mixing Existing Material and New Base)," for the depth specified. No payment will be made for thickness or width exceeding that shown on the plans. This price is full compensation for shaping existing material, loosening, mixing, pulverizing, spreading, applying lime, compacting, finishing, curing, curing materials, blading, shaping and maintaining shape, replacing mixture, disposing of loosened materials, processing, hauling, preparing secondary subgrade, water, equipment, labor, tools, and incidentals.

Item 276
Cement Treatment (Plant-Mixed)

1. DESCRIPTION

Construct a base course composed of flexible base, hydraulic cement, and water, mixed in an approved plant.

2. MATERIALS

Furnish uncontaminated materials of uniform quality that meet the requirements of the plans and specifications. Notify the Engineer of proposed sources of materials and of changes in material sources. The Engineer will verify that the specification requirements are met before the sources can be used. The Engineer may sample and test project materials at any time before compaction. Use Tex-100-E for material definitions.

2.1. **Cement**. Furnish hydraulic cement that meets the requirements of DMS-4600, "Hydraulic Cement," and the Department's *Hydraulic Cement Quality Monitoring Program* (HCQMP). Sources not on the HCQMP will require testing and approval before use.

2.2. **Flexible Base**. Furnish base material that meets the requirements of Item 247, "Flexible Base," for the type and grade shown on the plans, before the addition of cement.

2.3. **Water**. Furnish water that is free of industrial waste and other objectionable material.

2.4. **Asphalt**. Furnish asphalt or emulsion that meets the requirements of Item 300, "Asphalts, Oils, and Emulsions," when permitted for curing purposes as shown on the plans or as directed.

2.5. **Mix Design**. Using the materials proposed for the project, the Engineer will determine the target cement content and optimum moisture content necessary to produce a stabilized mixture meeting the strength requirements shown in Table 1 for the class specified on the plans. The mix will be designed in accordance with Tex-120-E. The Contractor may propose a mix design developed in accordance with Tex-120-E. The Engineer will use Tex-120-E to verify the Contractor's proposed mix design before acceptance. The Engineer may use project materials sampled from the plant or the quarry, and sampled by the Engineer or the Contractor, as determined by the Engineer. Limit the amount of asphalt concrete pavement to no more than 50% of the mix unless otherwise shown on the plans or directed.

Table 1
Strength Requirements

Class	7-Day Unconfined Compressive Strength, Min psi
L	500
M	300
N	As shown on the plans

3. EQUIPMENT

Provide machinery, tools, and equipment necessary for proper execution of the work. Provide rollers in accordance with Item 210, "Rolling." Provide proof rollers in accordance with Item 216, "Proof Rolling," when required.

3.1. **Cement Storage Facility**. Store cement in closed, weatherproof containers.

3.2. **Mixing Plant**. Provide a stationary pugmill, weigh-batch, or continuous mixing plant as approved. Equip plants with automatic proportioning and metering devices that produce a uniform mixture of base material, cement, and water in the specified proportions.

3.3. **Spreader Equipment**. Provide equipment that will spread the cement-treated mixture in a uniform layer in 1 pass when shown on the plans. Equip spreaders with electronic grade controls when shown on the plans.

4. CONSTRUCTION

Construct each layer uniformly, free of loose or segregated areas and with the required density and moisture content. Provide a smooth surface that conforms to the typical sections, lines, and grades shown on the plans or established by the Engineer. Start placement operations only when the air temperature is at least 35°F and rising or is at least 40°F. The temperature will be taken in the shade and away from artificial heat. Suspend operations when the Engineer determines that weather conditions are unsuitable.

4.1. **Mixing**. Thoroughly mix materials in the proportions designated on the mix design, in a mixing plant that meets the requirements of Section 276.3.2., “Mixing Plant.” Mix at optimum moisture content, unless otherwise directed, until a homogeneous mixture is obtained. Do not add water to the mixture after mixing is completed unless directed. The Engineer may sample the mixture to verify strength in accordance with Tex-120-E and adjust cement content to achieve the target strength for work going forward.

4.2. **Placing**. Place the cement-treated base on a subgrade or base prepared in accordance with details shown on the plans. Bring the prepared roadway to the moisture content directed. Haul cement-treated base to the roadway in clean trucks and begin placement immediately. Place cement-treated base only on an area where compacting and finishing can be completed during the same working day. Spread and shape in a uniform layer with an approved spreader. Construct individual layers to the thickness shown on the plans. Maintain the shape of the course by blading. Correct or replace segregated areas as directed, at no additional expense to the Department.

Construct vertical joints between new cement-treated base and cement-treated base that has been in place 4 hr. or longer. The vertical face may be created by using a header or by cutting back the face to approximately vertical. Place successive base courses using the same methods as the first course. Offset construction joints by at least 6 in.

4.3. **Compaction**. Compact each layer immediately after placing. Complete compaction within 2 hr. after plant-mixing water with dry material. Complete compaction of the final lift within 5 hr. after adding water to the treated base used in the first lift when multiple lifts are permitted.

Moisture content in the mixture at the plant may be adjusted so that during compaction it is within 2.0 percentage points of optimum as determined by Tex-120-E. Measure the moisture content of the material in accordance with Tex-115-E or Tex-103-E during compaction daily and report the results the same, unless otherwise shown on the plans or directed. Maintain uniform moisture content by sprinkling the treated material in accordance with Item 204, “Sprinkling.”

Begin rolling longitudinally at the sides and proceed towards the center, overlapping on successive trips by at least 1/2 the width of the roller unit. Begin rolling at the low side and progress toward the high side on superelevated curves. Offset alternate trips of the roller. Operate rollers at a speed between 2 and 6 mph, as directed.

Achieve at least 95% of maximum density determined in accordance with Tex-120-E when compaction is complete. The Engineer will determine roadway density and moisture content in accordance with Tex-115-E. Remove material that does not meet density requirements. Remove areas that lose required stability, compaction, or finish. Replace with cement-treated mixture, compact, and test in accordance with density control methods.

The Engineer may accept the section if no more than 1 of the 5 most recent density tests is below the specified density and the failing test is no more than 3 pcf below the specified density.

4.4. **Finishing**. Clip, skin, or tight blade the surface of the cement-treated material with a maintainer or subgrade trimmer to a depth of approximately 1/4 in. immediately after completing compaction. Remove loosened material and dispose of at an approved location. Roll the clipped surface immediately with a pneumatic tire roller until a smooth surface is attained. Add small increments of water as needed during rolling. Shape and maintain the course and surface in conformity with the typical sections, lines, and grades shown on the plans or as directed.

Trim grade deviations greater than 1/4 in. in 16 ft. measured longitudinally or greater than 1/4 in. over the entire width of the cross-section in areas where surfacing is to be placed. Remove excess material, reshape, and then roll with a pneumatic tire roller. Correct as directed if material is more than 1/4 in. low. Do not surface patch.

4.5. **Microcracking**. Maintain moisture content of the finished cement-treated base for a period of 24 to 48 hr. when shown on the plans. Roll the finished course with a vibratory roller to induce microcracking during this time, but not sooner than 24 hrs. The vibratory roller must be in accordance with Item 210, “Rolling,” with a static weight equal to or more than 12 tons and the vibratory drum must be not less than 20 in. wide. The roller must travel at a speed of 2 mph, vibrating at maximum amplitude, and make 2 to 4 passes with 100% coverage exclusive of the outside 1 ft. of the surface crown, unless otherwise directed by the Engineer. Additional passes may be required to achieve the desired crack pattern as directed. Notify the Engineer 24 hr. before the microcracking begins.

4.6. **Curing**. Cure for at least 3 days by sprinkling in accordance with Item 204, “Sprinkling,” or by applying an asphalt material at the rate of 0.05 to 0.20 gal. per square yard, as shown on the plans or directed. When a section is microcracked, cure section for an additional 2 days after microcracking. Maintain the moisture content during curing at no lower than 2 percentage points below optimum. Continue curing until placing another course.

5. MEASUREMENT

Cement-treated base will be measured by the ton, cubic yard, or square yard as a composite mixture of cement, flexible base, and recycled materials.

Measurement by the cubic yard in final position and square yard is a plans quantity measurement. The quantity to be paid for is the quantity shown in the proposal unless modified by Article 9.2., “Plans Quantity Measurement.” Additional measurements or calculations will be made if adjustments of quantities are required.

Measurement is further defined for payment as follows:

5.1. **Cubic Yard in Vehicles**. Cement-treated base will be measured by the cubic yard in vehicles as delivered on the road.

5.2. **Cubic Yard in Final Position**. Cement-treated base will be measured by the cubic yard in its completed and accepted final position. The volume of each course will be computed in-place between the original subgrade surfaces and the lines, grades, and slopes of the accepted base course as shown on the plans, and calculated by the method of average end areas.

5.3. **Square Yard**. Cement-treated base will be measured by the square yard of surface area. The dimensions for determining the surface area are established by the dimensions shown on the plans.

5.4. **Ton**. Cement-treated base will be measured by the ton (dry weight) in vehicles as delivered on the road. The dry weight is determined by deducting the weight of the moisture in the material at the time of weighing from the gross weight of the material. The Engineer will determine the moisture content in the material in accordance with Tex-103-E from samples taken at the time of weighing.

When material is measured in trucks, the weight of the material will be determined on certified scales, or the Contractor must provide a set of standard platform truck scales at an approved location. Scales must conform to the requirements of Item 520, “Weighing and Measuring Equipment.”

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under “Measurement” will be paid for at the unit price bid for “Cement Treatment (Plant-Mix)” of the class (strength), flexible base type, grade, and thickness (for square yard measurement) specified. For cubic yard measurement, “In Vehicle” or “In Final Position” will be specified. This price is full compensation for furnishing and disposing of materials (including cement and base); storing, mixing, hauling, placing, sprinkling, compacting, microcracking, finishing, curing, and maintaining and reworking treated base; and equipment, labor, tools, and incidentals.

Sprinkling and rolling, except proof rolling, will not be paid for directly but will be subsidiary to this Item, unless otherwise shown on the plans. When proof rolling is shown on the plans or directed by the Engineer, it will be paid for in accordance with Item 216, “Proof Rolling.”

Where subgrade or base courses are constructed under this Contract, correction of soft spots will be at the Contractor’s expense. Where subgrade or base is not constructed under this Contract, correction of soft spots will be paid for in accordance with pertinent Items and Article 4.4., “Changes in the Work.”

Asphalt used solely for curing will not be paid for directly but will be subsidiary to this Item. Asphalt placed for curing and priming will be paid for under Item 310, “Prime Coat.”

Removal and disposal of existing asphalt concrete pavement will be paid for in accordance with pertinent Items or Article 4.4., “Changes in the Work.”

6.1. **Thickness Measurement for Cubic Yard In Final Position and Square Yard Payment Adjustment**. Before final acceptance, the Engineer will select the locations of tests within each unit and measure the treated base depths in accordance with Tex-140-E.

6.1.1. **Units for Payment Adjustment**.

6.1.1.1. **Roadways and Shoulders**. Units for applying a payment adjustment for thickness to roadways and shoulders are defined as 1,000 ft. of treated base in each placement width. The last unit in each placement width will be 1,000 ft. plus the fractional part of 1,000 ft. remaining. Placement width is the width between longitudinal construction joints. For widening, the placement width is the average width placed of the widened section that is deficient in thickness.

6.1.1.2. **Ramps and Other Areas**. Units are defined as 2,000 sq. yd. or fraction thereof for establishing an adjusted unit price for ramps, intersections, irregular sections, crossovers, entrances, partially completed units, transitions to ramps, and other areas designated by the Engineer.

6.1.2. **Price Adjustments of Deficient Areas**.

6.1.2.1. **Thickness Deficiency ≤ 1.0 in.** Table 2 will govern the price adjustment for each unit with deficient areas ≤ 1.0 in.

Table 2
Measurements and Price Adjustment for Each Unit

<table>
<tr><th>Thickness Deficiency</th><th>Additional Measurements</th><th colspan="2">Average Thickness Deficiency of 3 Measurements</th><th>Price Adjustment</th></tr>
<tr><td>≤ 0.5 in.</td><td>None</td><td colspan="2">N/A</td><td>Full Payment</td></tr>
<tr><td rowspan="4">> 0.5 in.</td><td rowspan="4">2</td><td colspan="2">≤ 0.5 in.</td><td>Full Payment</td></tr>
<tr><td>> 0.5 in.</td><td>≤ 0.8 in.</td><td>75% Payment</td></tr>
<tr><td>> 0.8 in.</td><td>≤ 1.0 in.</td><td>50% Payment</td></tr>
<tr><td colspan="2">> 1.0 in.</td><td>In accordance with Section 276.6.1.2.2., “Thickness Deficiency ≥ 1.0 in.”</td></tr>
</table>

6.1.2.2. **Thickness Deficiency ≥ 1.0 in.** Remove and replace areas of treated base found deficient in thickness by more than 1.0 in., unless otherwise approved. Take exploratory measurements at 50-ft. intervals parallel to the centerline in each direction from the deficient measurement until a measurement is not deficient by more than 1.0 in. The minimum limit of non-pay will be 100 ft.

6.2. **Excess Thickness and Width**. For cubic yard in final position and square yard measurement, no additional payment will be made for thickness or width exceeding that shown on the plans.