



Test Procedure for Rapid Mix Design of Cement-Treated Base

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Test Procedure for

RAPID MIX DESIGN OF CEMENT-TREATED BASE

by

Stephen Sebesta
Research Scientist
Texas A&M Transportation Institute

Ross Taylor
Research Specialist III
Texas A&M Transportation Institute

and

Jinho Kim
Associate Transportation Researcher
Texas A&M Transportation Institute

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TEXAS A&M TRANSPORTATION INSTITUTE
College Station, Texas 77843-3135

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Test Procedure for

RAPID MIX DESIGN OF CEMENT-TREATED BASE



TxDOT Designation: Tex-120-E Part III

Effective Date: May 1, 2024

1. SCOPE

- 1.1 Tex-120-E consists of three parts.
 - 1.1.1 Part I determines the moisture-density curve of material treated with cement.
 - 1.1.2 Part II determines the target cement content using the unconfined compressive strength of samples molded in accordance with Tex-113-E and cured for 7 days.
 - 1.1.3 Part III develops a laboratory mixture design for cement-treated bases using the indirect tensile (IDT) strength. The IDT strength may also be used to verify the strength of materials sampled from the roadway after mixing. Test specimens are compacted to 4 in. in diameter and 2 in. in height using a Superpave gyratory compactor (SGC). The specimens are cured 72 hours and then moisture-conditioned 24 hours prior to IDT testing. When performing a mixture design, the automatic tamper (compaction) device is only required for compacting samples to 6 in. in diameter and 8 in. in height for a moisture-density curve.
 - 1.2 *This test procedure does not claim to address the safety concerns associated with its use. It is the responsibility of the user of this test procedure to establish the appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations before use.*
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2. APPARATUS

- 2.1 *Balance*, Class G2 in accordance with Tex-901-K, with a minimum capacity of 35 lb.
 - 2.2 *Zip-top bags or air- and watertight containers*, capable of preserving the molding moisture in specimens during curing.
 - 2.3 *Container*, adequate height and volume to completely submerge compacted specimens.
 - 2.4 *Mechanical mixer or mixing pans with scoops*, capable of mixing virgin and reclaimed materials with cement to produce a homogenous blend for laboratory compaction and testing.
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- 2.5 *Temperature chamber or heating oven, capable of maintaining a temperature of $104 \pm 5^{\circ}\text{F}$.*
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3. REPORTING AND DOCUMENTATION

- 3.1 Contact the Soils and Aggregates Section of the Materials and Tests Division to request a spreadsheet to calculate test results and to report and document pertinent information for this mixture design.
- 3.2 This spreadsheet includes worksheets for the following.
- 3.2.1 Gradation and weigh-up worksheets to batch samples.
- 3.2.2 Moisture-density curve.
- 3.2.3 IDT strength.
- 3.2.4 Mixture design summary including the target cement content.
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4. MATERIAL SAMPLING AND PREPARATION

- 4.1 Obtain a minimum of 1 gal of cement in a sealed container from a fresh supply of an approved source from the TxDOT Material Producer List.
- 4.1.1 Use the cement being proposed for use on the project if that source has been identified.
- 4.2 When testing stockpiled base material, sample a minimum of 200 lb of material in accordance with Tex-400-A.
- 4.3 When testing full-depth reclamation (FDR) material, sample a minimum of 200 lb of in-place roadway material to the depth shown on the plans. Use equipment to produce a gradation similar to the gradation of material reclaimed from the FDR process.
- 4.3.1 Reclaimed roadway material may include flexible base, seal coat, and reclaimed asphalt pavement (RAP).
- 4.3.2 When the reclaimed base for sampling and testing is greater than 1-3/4 in., resize the material to pass the 1-3/4-in. sieve.
- 4.3.3 When RAP is greater than 1-3/4 in., break up and resize the RAP to pass the 1-3/4-in. sieve. If necessary, heat the RAP to a maximum temperature of 140°F to help break up and resize it.
- 4.3.4 When the thickness of the asphalt pavement is greater than 2 in., separate the RAP material from the material sampled.
- 4.4 Prepare the materials sampled in accordance with Tex-101-E, Part II, "Preparing Samples for Compaction and Triaxial Tests."
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5. MOISTURE-DENSITY CURVE

- 5.1 Determine the optimum moisture content and maximum dry density for the material prepared from Section 4 in accordance with Tex-113-E.
 - 5.1.1 Determine the moisture-density (M-D) curve for the material treated with 3 percent cement or a different percentage as deemed necessary.
 - 5.1.2 Determine a percentage for each material from Section 4. Calculate the gradation of the blend using these percentages.
 - 5.1.3 Estimate the weight of air-dry material and the moisture content.
 - 5.1.4 Weigh a trial sample.
 - 5.1.5 Weigh the amount of water in a sprinkling jar on a tared scale.
 - 5.1.6 Place the total sample in the mixing pan, mix thoroughly, and wet with the appropriate amount of mixing water by sprinkling water in increments onto the sample during mixing.
 - 5.1.6.1 Mix thoroughly, breaking up soil lumps. Do not break any aggregate particles in the sample.
 - 5.1.7 After it is thoroughly mixed, scrape all material off the mixing trowel and into the pan. Weigh the sample and pan and record the weight.
 - 5.1.8 Cover the mixture with a non-absorptive lid to prevent moisture evaporation and allow to stand for 18–24 hours.
 - 5.1.9 Prior to mixing with cement, weigh the sample (without the lid), replace evaporated water, and thoroughly mix to ensure even distribution of water throughout the sample. Scrape material off the mixing tools and into the pan.
 - 5.1.10 Place the sample in a mechanical mixer or mixing pan from Section 2.
 - 5.1.11 Add the cement uniformly and mix thoroughly to ensure even distribution of the cement throughout the sample.
 - 5.1.12 Scrape as much material as possible off the mixing paddle(s) or scoops and place the mixture into a pan.
 - 5.1.12.1 Do not allow the mixture to stand for any period of time after mixing. Start the compaction process immediately after mixing.
 - 5.1.13 Mold the trial sample in accordance with the applicable sections of Tex-113-E.
 - 5.1.14 Measure and record the trial sample weight and height.

- 5.1.15 Correct the weight from the trial sample to a height of 8.000 in. using the equation from Section 7.1. Use this weight to estimate the weights of four samples.
 - 5.1.16 Compact at moisture contents such that two are on the dry side of the curve and two are on the wet side of the curve.
 - 5.1.17 Weigh the four samples.
 - 5.1.18 Repeat Sections 5.1.5 to 5.1.12.1 to mix each sample.
 - 5.1.19 Follow the applicable sections of Tex-113-E to compact the four samples and to determine the M-D curve.
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6. MIXTURE DESIGN

- 6.1 Select a minimum of three cement contents for the mixing and compaction of IDT strength test specimens.
 - 6.2 Use the equation from Section 7.2 to calculate the moisture content for samples with different cement contents.
 - 6.3 Produce a minimum 18-lb sample for each cement content. Determine the weight of each material, water, and cement.
 - 6.3.1 Replace aggregate retained on the 7/8-in. sieve with an equivalent amount of material retained on the 5/8-in. sieve.
 - 6.3.2 Weigh the amount of water for the moisture content determined from Section 6.2.
 - 6.3.3 Place the total sample in the mixing pan, mix thoroughly, and wet with the appropriate amount of mixing water by sprinkling water in increments onto the sample during mixing.
 - 6.3.3.1 Mix thoroughly, breaking up soil lumps. Do not break any aggregate particles in the sample.
 - 6.3.4 Turn the wet material over with the mixing trowel to allow the aggregate particles to absorb water.
 - 6.3.5 After it is thoroughly mixed, scrape all material off the mixing trowel and into the pan. Weigh the sample and pan and record the weight.
 - 6.3.6 Cover the mixture with a non-absorptive lid to prevent moisture evaporation and allow to stand for 18–24 hours.
 - 6.3.7 Prior to mixing with cement, weigh the sample (without the lid), replace evaporated water, and thoroughly mix to ensure even distribution of water throughout the sample. Scrape material off the mixing tools and into the pan.
 - 6.3.8 Place the sample in the mechanical mixer or mixing pan from Section 2.
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- 6.3.9 Add the cement uniformly and mix thoroughly to ensure even distribution of the cement throughout the sample.
- 6.3.10 Scrape as much material as possible off the mixing paddle(s) or scoops and place the mixture into a pan.
- 6.3.10.1 Do not allow the mixture to stand for any period of time after mixing. Start the compaction process immediately after mixing.
- 6.3.11 Estimate a weight for the trial height sample and weigh up this amount of material.
- 6.3.12 Configure the SGC to compact to a specified height of 2 in. and compact the trial height sample using an unheated mold in accordance with Tex-241-F. Do not exceed 200 gyrations.
- 6.3.13 Measure and record the weight to the nearest 0.001 lb and the height to the nearest 0.01 in. of the compacted trial sample.
- 6.3.13.1 When the height does not meet the requirements of 2 ± 0.10 in., use the equation from Section 7.1 to calculate a corrected weight of material for a height of 2 in.
- 6.3.14 Weigh the other samples from the mixed material and compact a minimum of six specimens in accordance with Section 6.3.12.
- 6.3.15 Measure and record the weight to the nearest 0.001 lb and height to the nearest 0.01 in. for each compacted specimen.
- 6.3.16 When the height of any specimen does not meet 2 ± 0.10 in., confirm whether the weight was approximately the weight from Section 6.3.14 or corrected from the trial sample. Mix additional material and compact as many samples as needed to replace those that did not meet the height requirement.
- 6.3.17 After compaction, seal each specimen in an air- and watertight bag or container.
- 6.3.17.1 Specimens may be sealed individually or all together in zip-top bags or in suitable air- and watertight containers.
- 6.3.18 Label each specimen appropriately and proceed to Section 6.4 to cure the compacted IDT specimens.
- 6.4 ***Curing***
- 6.4.1 Cure the sealed test specimens at $104 \pm 5^{\circ}\text{F}$ for 72 ± 2 hours.
- 6.4.2 After curing, remove the test specimens from the oven and remove the specimens from the sealed containers.
- 6.5 ***Moisture Conditioning by 24-Hour Submersion***
- 6.5.1 Place each individual specimen into the container from Section 2.

- 6.5.2 Fill the container to approximately ½ to 1 in. above the top of the specimens with tap water in a manner that does not disturb and contact the specimens.
- 6.5.3 Soak each specimen in the container for 24 hours ± 15 minutes.
- 6.5.4 Remove each specimen from the container and use an absorptive cloth or paper towel to remove free water on the surface of the specimen.
- 6.6 ***IDT Strength Testing***
- 6.6.1 Measure and record the IDT strength of the moisture-conditioned specimens following Sections 4.5 to 4.11 of Tex-226-F using the appropriate loading strips for 4-in.-diameter test specimens.
- 6.6.2 When the test results do not meet specifications, modify the mixture design as deemed necessary.
- 6.6.2.1 When adjusting the percentage of cement, proceed to Section 6.2. A new M-D curve is not required.
- 6.6.2.2 When adjusting the percentages of reclaimed base, RAP, or flexible base, or choosing to add additional material of flexible base, proceed to Section 5. A new M-D curve is required.
- 6.6.3 Proceed to Section 8 when the test results meet specifications.

7. CALCULATIONS

- 7.1 Use the following equation to calculate the corrected weight of material for a compacted specimen when the height is less or more than the target height:

$$\text{Corrected Weight} = \text{Target Height} \times \left(\frac{\text{Trial Weight}}{\text{Trial Height}} \right)$$

Where:

Target Height = 2.0 in. for an IDT sample or 8.000 in. for an M-D curve sample.

Trial Weight = weight of trial sample, lb.

Trial Height = height of trial sample, in.

- 7.2 Use the following equation to calculate the moisture content of the sample when using cement contents that are different from the M-D curve from Section 5:

$$MC = OMC + [0.25 \times (C_1 - C_0)]$$

Where:

MC = moisture content of the sample.

OMC = optimum moisture content, % from the M-D curve.

C_1 = new cement content, %.

C_0 = cement content, % from the M-D curve.

0.25 = adjustment factor for % cement difference.

8. TEST REPORT

8.1 Report the type of cement.

8.1.1 This procedure was developed using Portland Type I/II cement.

8.2 Report the following information to the nearest 0.1:

- Design cement content,
- Gradation of aggregate blend,
- Maximum dry density, and
- Optimum moisture content.

8.3 Report the following information to the nearest whole number:

- Average IDT strength for moisture-conditioned test specimens,
- Percent of stockpile material when applicable,
- Percent of roadway salvage material when applicable, and
- Percent of RAP when applicable.

