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16. Abstract

This report describes the Texas Freeze-Thaw Pedestal Test and a preliminary test procedure to distinguish between aggregate-asphalt combinations which are susceptible to moisture damage, such as stripping, and those which are not. The test is basically a modification of the Water Susceptibility Test proposed by the Laramie Energy Technology Center. A guide to the use of this procedure to evaluate both existing and proposed mixtures is included along with the results of a small study to demonstrate the ability of the test to differentiate between known stripping and nonstripping asphalt mixtures.

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TEXAS FREEZE-THAW PEDESTAL TEST FOR EVALUATING MOISTURE SUSCEPTIBILITY FOR ASPHALT MIXTURES

by

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Freddy L. Roberts
Kang W. Lee
James N. Anagnos

Research Report Number 253-3

Moisture Effects on Asphalt Mixtures

Research Project 3-9-79-253

conducted for

Texas
State Department of Highways and Public Transportation

in cooperation with the
U. S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH
BUREAU OF ENGINEERING RESEARCH
THE UNIVERSITY OF TEXAS AT AUSTIN

February 1982

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

PREFACE

This is the third in a series of reports dealing with the findings of a research project concerned with moisture effects on asphalt mixtures. This report concerns the Texas Freeze-Thaw Pedestal Test Procedure and includes a description of the test. The objectives of the study were to evaluate the test as originally proposed by the Laramie Energy Technology Center, adapt it for use by a highway agency, and evaluate the test results to determine if the test can distinguish between stripping and nonstripping asphalt mixtures.

The work required to develop this report was provided by many people. Special appreciation is extended to Messrs. Pat Hardeman and Eugene Betts for their assistance in the testing program. In addition, the authors would like to express their appreciation to Messrs. Robert F. Kriegel, C. Weldon Chaffin, and Billy R. Neeley, all of the Texas State Department of Highways and Public Transportation, for their suggestions, encouragement, and assistance in this research effort, and to other personnel who provided the asphalt cements, their physical properties, and the various aggregates used in the testing program. Appreciation is also extended to the Center for Transportation Research staff who assisted in the preparation of the manuscript. The support of the Federal Highway Administration, Department of Transportation, is acknowledged.

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LIST OF REPORTS

Report No. 253-1, "Stripping and Moisture Damage in Asphalt Mixtures," by Robert B. McGennis, Randy B. Machemehl, and Thomas W. Kennedy, summarizes a study to determine the extent, nature, and severity of moisture related damage to asphalt mixtures used in pavements in Texas.

Report No. 253-2, "An Evaluation of the Asphaltene Settling Test," by Thomas W. Kennedy and Chee-Chong Lin, summarizes a testing program designed to evaluate the Asphaltene Settling Test, the test procedure, factors affecting the test results, and relationships between settling time and asphalt characteristics.

Report No. 253-3, "Texas Freeze-Thaw Pedestal Test for Evaluating Moisture Susceptibility for Asphalt Mixtures," by Thomas W. Kennedy, Freddy L. Roberts, Kang W. Lee, and James N. Anagnos, includes a detailed description of the Texas Freeze-Thaw Pedestal Test and describes how it can be used to distinguish between stripping and nonstripping asphalt concrete mixtures or individual aggregates.

ABSTRACT

This report describes the Texas Freeze-Thaw Pedestal Test and a preliminary test procedure to distinguish between aggregate-asphalt combinations which are susceptible to moisture damage, such as stripping, and those which are not. The test is basically a modification of the Water Susceptibility Test proposed by the Laramie Energy Technology Center. A guide to the use of this procedure to evaluate both existing and proposed mixtures is included along with the results of a small study to demonstrate the ability of the test to differentiate between known stripping and nonstripping asphalt mixtures.

KEY WORDS: stripping, water damage, Texas Freeze-Thaw Pedestal Test, asphalt, asphalt concrete mixtures, stripping aggregates, stripping mixtures

SUMMARY

The Texas Freeze-Thaw Pedestal Test was developed as a laboratory test that could be used to determine if a proposed asphalt-aggregate mixture is prone to stripping. The procedure tests the water susceptibility characteristics of the mixture by determining the number of freeze-thaw cycles a specimen can withstand before cracking. A cylindrical specimen is compacted using the proposed mixture aggregates in proportion to the job mix formula with approximately 2 percent more asphalt than is prescribed in the field mixture. The specimen consists of uniformly sized aggregate which passes the No. 20 and is retained on the No. 35 sieves. Use of uniformly sized material minimizes the effect of aggregate interlock while maximizing the effect of bond between the aggregate and the asphalt cement.

The purpose of this research was to evaluate the usefulness of the Water Susceptibility Test developed at the Laramie Energy Technology Center (LETC) to evaluate the water susceptibility of asphalt concrete paving mixtures. Comparisons between results of tests using the LETC procedure and those from the modified test provided a basis for determining the effects of modifying the length of the freeze-thaw cycle, gradations specified, and washing the ground aggregates. Using the results from these studies, the Texas procedure was prepared and is described in this report.

Using the Texas procedure, a series of tests was performed using four stripping and four nonstripping mixtures. The results demonstrated an ability to differentiate between stripping and nonstripping aggregate-asphalt mixtures.

IMPLEMENTATION STATEMENT

Tentative evaluations indicate that the Texas Freeze-Thaw Pedestal Test can be used to determine whether a mixture is prone to stripping. Therefore, it is recommended that the Districts of the Texas State Department of Highways and Public Transportation use the test procedure, on a trial basis, to evaluate mixtures selected for use in the 1982 construction season. As a result of this trial use, needed modifications and improvements can be made to improve the ability of the test to detect mixtures which are susceptible to moisture damage and to evaluate antistripping agents.

If the test is as successful in detecting stripping aggregates as preliminary laboratory results suggest, significant savings in construction and maintenance costs and improved pavement performance can be achieved.

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CHAPTER 1. INTRODUCTION

Water-induced damage of asphalt mixtures has produced serious distress, reduced performance, and increased maintenance for pavements in Texas as well as other areas in the United States. This damage occurs due to stripping of asphalt from aggregate and in some cases possibly due to softening of the asphalt matrix. In an attempt to reduce the magnitude of the problem various antistripping agents have been incorporated into asphalt mixtures. Unfortunately there has been no way to evaluate their potential effectiveness or to evaluate proposed aggregate-asphalt combinations to determine their water susceptibility.

In response to the above problem the Center for Transportation Research (CTR) and the Texas State Department of Highways and Public Transportation (DHT) through their cooperative research program initiated a research project to study water-induced damage to asphalt mixtures in Texas and as part of this study to evaluate various proposed test methods for ascertaining the water susceptibility of asphalt mixtures and the effectiveness of antistripping agents.

As a result of the study a test method was identified and based on preliminary tests was found capable of distinguishing between mixtures known to be susceptible and those known to be not susceptible to water damage. The proposed procedure is a modification of the Water Susceptibility Test proposed by the Laramie Energy Technology Center (LETC) and has been designated as the Texas Freeze-Thaw Pedestal Test. This report describes the test procedure and summarizes the findings of a study to evaluate its effectiveness. The results are limited and the test procedure is only preliminary; however, because of the excellent discrimination, it is felt that the test should be implemented on a trial basis. Based on the results of further laboratory and field evaluations, modifications can be made to improve the efficiency and capabilities of the test.

CHAPTER 2. TEXAS FREEZE-THAW PEDESTAL TEST

STRIPPING

Stripping is the physical separation of the asphalt cement from the aggregate produced by the loss of adhesion between the asphalt cement and aggregate which is primarily due to the action of liquid water or water vapor. The loss of adhesion between the asphalt cement and aggregate can be due to

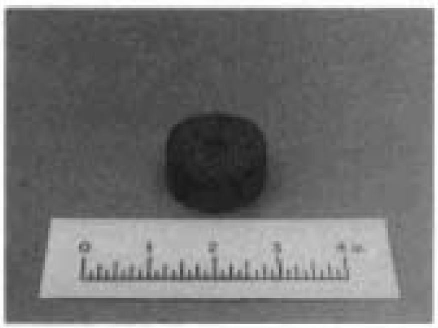
(1) interaction of the asphalt and aggregate surface,
(2) smooth aggregate surface texture, and
(3) aggregate surface coatings.

While all sizes of an aggregate may exhibit stripping, the finer aggregate is of primary concern. If stripping is confined to the larger aggregate, the damage is minimal; however, if the finer aggregate, which constitutes the basic matrix, strips, severe damage results.

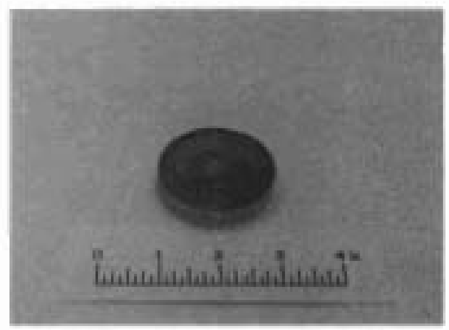
LETC WATER SUSCEPTIBILITY TEST

The Water Susceptibility Test as developed at the Laramie Energy Technology Center (LETC) is a technique for evaluating the water susceptibility of asphalt mixtures and was designed to maximize the effects of bond and to minimize the effects of the mechanical properties of the mixture (Ref 1) by using a uniform aggregate size, produced by crushing all material so that it passes the No. 20 sieve and is retained on the No. 35 sieve. In addition, a specimen preparation procedure was developed which would produce asphalt hardening similar to that achieved after five years of field exposure. The preparation procedure involved mixing the uniformly sized aggregate with an amount of asphalt equal to the asphalt content from the Marshall Mixture Design Procedure (Ref 1). The mixture is heated and mixed as prescribed in the test procedure and then cooled to room temperature. The mixture is then reheated for 20 minutes, placed in a cylindrical mold (Fig 1), and compacted at a constant load of 27.6 kN (6200 lb) for 20 minutes. Each briquet specimen (Fig 1) is cylindrical with a diameter of 41.33 mm (1.627 in.) and a height

(a) Compaction mold, base plate, and ram, from left to right.



(b) Specimen.



(c) Stress pedestal.

(d) Specimen in water.

Fig 1. Texas Freeze-Thaw Pedestal Test; special compaction equipment, specimen, stress pedestal, and prepared specimen ready for freeze-thaw cycling.

of 19.05 mm (0.750 in.). The briquet is cured for three days, placed on a stress pedestal (Fig 1), submerged in distilled water, placed in a temperature-control room, and subjected to freeze-thaw cycling, which consists of 24 hours at -12°C (10°F) followed by 24 hours at 60°C (140°F). At the end of each cycle the specimen is inspected to determine if the briquet surface has cracked. The number of freeze-thaw cycles required to induce cracking in the briquet is used as a measure of water susceptibility.

MODIFICATIONS

After evaluation, the LETC moisture susceptibility test was modified to reduce field problems and to minimize the difficulty and cost of performing these laboratory tests. These modifications include changes

(1) to allow mixtures to be evaluated as well as individual aggregates,

(2) to allow different gradations for finer aggregates,

(3) to wash or not wash the material depending on the application of test results, and

(4) to modify the length and temperature of the freeze-thaw cycles to minimize field laboratory difficulties.

Gradations

The original procedure specifes that the aggregate be crushed to produce a material passing the No. 20 sieve (0.850 mm) and retained on the No. 35 sieve (0.500 mm). This assumes that the larger aggregates are representative of the finer material, which normally is responsible for severe stripping of a mixture, that crushing does not change the stripping characteristics of the aggregate, and that the aggregate is coarser than required.

A second approach to secure material for the specimen, not a part of the original procedure, is to sieve the aggregate and collect the material which meets the specified gradation. This approach assumes that all of the material constituting the aggregate sample is the same in all respects except size and that the aggregate is not already finer than required. It is also possible that after sieving, all material is finer than the specified size. Because the method of securing material can affect test results, the LETC procedure was modified to allow materials in each of the following three categories to be used:

(1) crushed aggregate (minus No. 20 (0.850 mm) to plus No. 35 (0.500 mm)),

(2) natural screenings (minus No. 20 (0.850 mm) to plus No. 35 (0.500 mm)), and

(3) natural screenings (minus No. 40 (0.425 mm) to plus No. 80 (0.180 mm)).

Most aggregate mixtures consist of materials from several sources that are blended naturally or by the contractor to satisfy a grading requirement. These individual components may vary in size, shape, surface texture, and chemical composition. Thus, it is probably necessary to evaluate the mixture, although it may also be desirable to evaluate individual components. To evaluate the mixture the various components should be represented in proportion to their weight, or, probably more logically, in proportion to their surface area since stripping is a surface phenomenon. Until additional work is conducted relative to the importance of surface area, it is recommended that the components be proportioned by weight.

Washing of Aggregate

The LETC method for testing required that the aggregate mixture be washed with distilled water without surfactants several times before drying and mixing with asphalt cement. Since field aggregates are not always washed prior to mixing and since surface coatings contribute to stripping, it is desirable to provide an option to permit unwashed materials to be tested in a manner similar to the field use of the aggregate. This allows the use of test results from the laboratory in evaluating the effect of aggregate coatings in the field. Therefore, the Texas Freeze-Thaw Pedestal Test procedure allows use of either washed or unwashed aggregates.

Freeze-Thaw Cycle

The third major area of modification is the freeze-thaw cycle. The LETC test procedure required a 48-hour cycle, which involves significant expenditures of time and equipment to perform one test. Based on a study (Ref 2) to evaluate the effect of modifying the cycle time, the cycle time in the Texas procedure is 24 hours. The results of the cycle length study show that shortening the cycle from 48 to 24 hours has no significant effect on test results.

TEXAS FREEZE-THAW PEDESTAL TEST PROCEDURE

(1) Scope

(1.1) The method is used as a screening device to evaluate the moisture susceptibility of an asphalt concrete mixture by determining the freeze-thaw cycles required to crack a briquet seated on a beveled pedestal.

(2) Apparatus

(2.1) Ovens - An electric oven capable of maintaining temperatures of 150 ± 2.8^{o}C (302 ± 5^{o}F) is used to heat the asphalts and to heat or dry the aggregates. An oven capable of maintaining temperatures of 49 ± 2.8^{o}C (120 ± 5^{o}F) is used to perform the thaw cycle portion of the test procedure. A suitable environmental chamber can be used for complete freeze and thaw cycling.

(2.2) Sample Mixing Apparatus - Suitable equipment for hand mixing the aggregate and bituminous materials is required and includes round mixing pans of various sizes, bowl-shaped dishes such as porcelain evaporating dishes, stainless steel teaspoons, small masonry pointing trowels, and spatulas.

(2.3) Balance - A balance with a capacity of 5 kg or more and sensitive to at least 0.01 grams.

(2.4) Briquet Mold - A 1018 cold rolled steel molding cylinder with 41.33-mm (1.627-in.) inside diameter and 88.9-mm (3.5-in.) height, as shown in Fig 2.

(2.5) Base Plate - A 1018 cold rolled steel cylindrical molding base plate with 41.28-mm (1.625-in.) base diameter and height of at least 12.7 mm (0.5 in.) as shown in Fig 2. The nipple on the top is 6.35 mm (0.25 in.) in both diameter and height.

(2.6) Ram - A 1018 cold rolled steel ram 41.28 mm (1.625 in.) in diameter by 114.3 mm (4.5 in.) in height, as shown in Fig 2.

(2.7) Stress Pedestal - A 10^{o} beveled acrylic plastic (Lucite) pedestal 50.8 mm (2.00 in.) in diameter by 11.43 mm (0.45 in.) in height with a nipple on the top 6.35 mm (0.25 in.) in diameter by 3.56 mm (0.14 in.) in height as shown in Fig 3. If flat bottomed

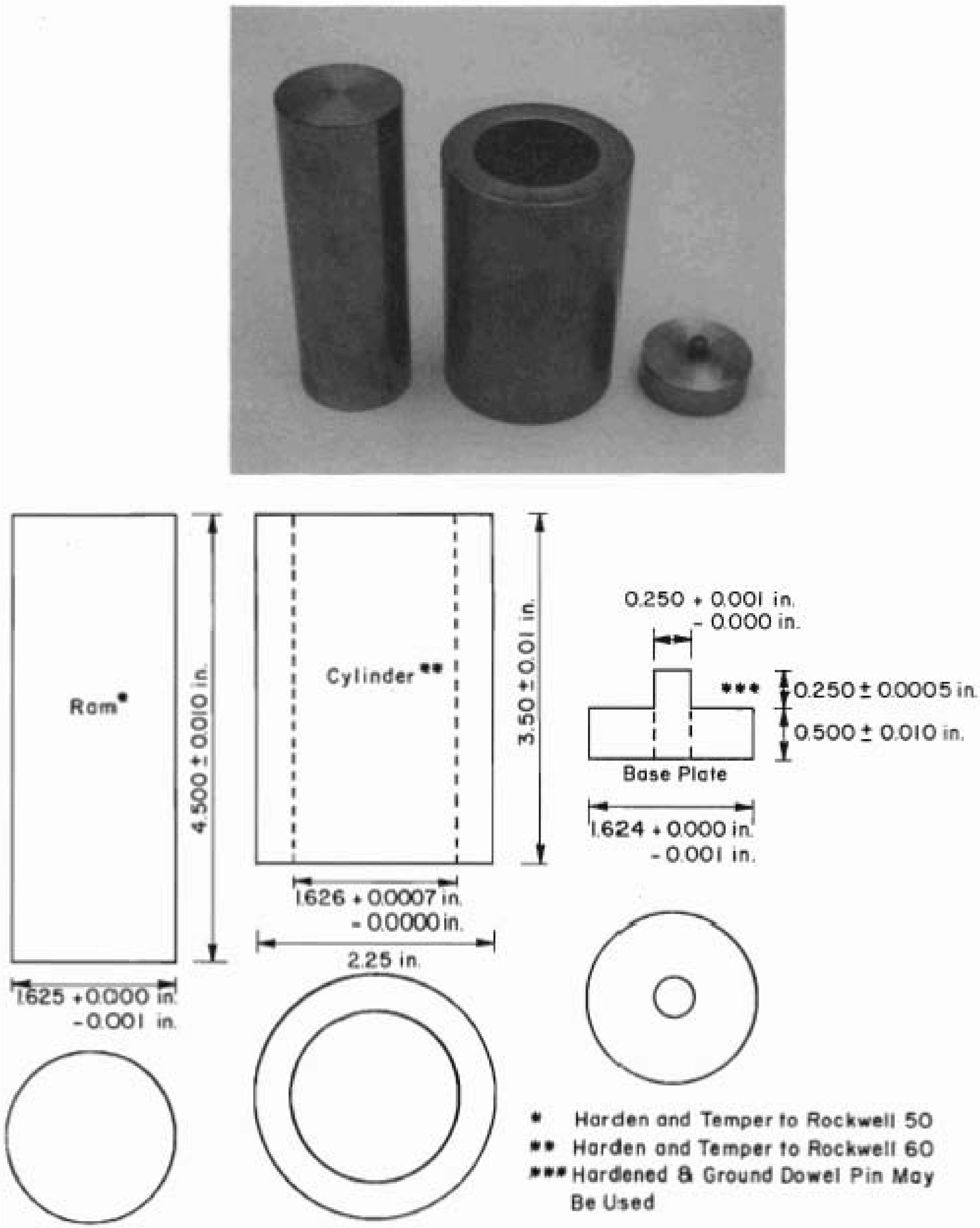
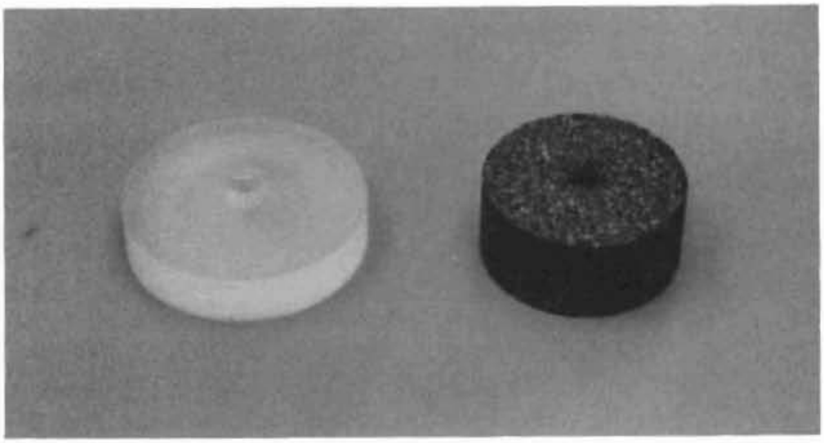


Fig 2. Briquet compaction mold, ram, and base plate dimensions (Ref 1).



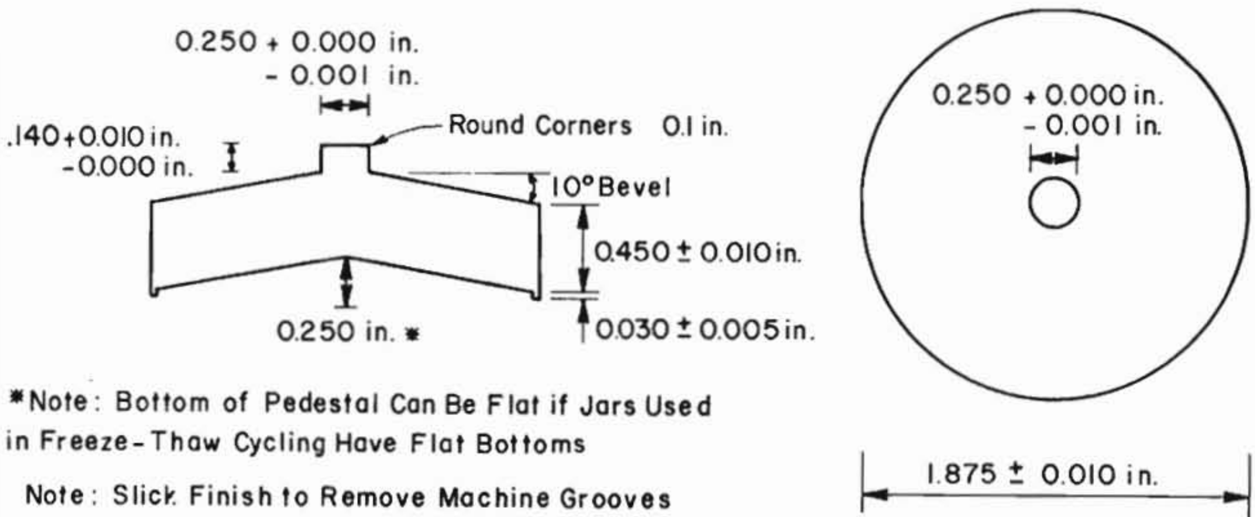


Fig 3. Stress pedestal dimensions (Ref 1).

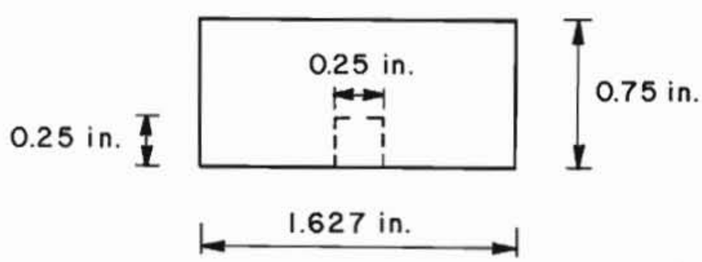


Fig 4. Briquet dimensions (Ref 1).

jars are used in the freeze-thaw cycling, the bottom of the stress pedestal can be flat.

(2.8) Molding Press - A compression testing machine capable of maintaining a constant force of 27.58 ± 0.22 kN (6200 ± 50 lb) on the specimen for 20 minutes.

(2.9) Jars - Clear polystyrene, 8 oz, straight side, wide mouth, 2-3/8-in. diameter × 3-3/8 in. high, with plastic cap (Scientific and Industrial Sales and Services, Inc., Fort Worth, Texas, catalog no. 70-400).

(2.10) Environmental Chamber or Refrigerator - The freezing cycle of the test procedure is performed in an environmental chamber or refrigerator capable of maintaining -12 ± 2.8°C (10 ± 5°F).

(2.11) Miscellaneous Apparatus - Thermometers, scoops, gloves, and tweezers.

(3) Test Specimens

(3.1) Selection of Asphalt Content for Specimens - Determine the optimum asphalt content for the paving mixture for which the individual aggregate or mixture is a part by performing Test Method Tex-204-F (Ref 4). The asphalt content for a trial mixture specimen is recommended to be the optimum from Tex-204-F plus 2.0 percent. If some of the aggregate is not coated well, if the mixture appears wet, or if the mixture appears dry, adjust the asphalt content until satisfactory coating is achieved. For tests of individual aggregates, the first trial specimen can be prepared at the design asphalt content for the mixture in which the aggregate is to be used. Based on the results, subsequent specimens should be prepared at one percent increments above or below this initial trial value. The objective is to coat the particles with approximately the same asphalt film thickness as in mixture design method Tex-204-F. As a general guide there should be very little asphalt left on the mixing bowl after the material is removed for compaction.

(3.2) Preparation of Aggregates - The aggregates should be crushed and wet-screened without surfactants to obtain material between the interval of 0.500 to 0.850 mm (passing the No. 20 and retained on the No. 35 sieves). The material is to be rinsed several times with distilled water, dried to a constant weight at 150 ± 2.8°C (302 ± 5°F), and cooled at room temperature.

Note: If a field mixture of several aggregate components is to be evaluated, the pedestal specimen must have components that represent each of the aggregate sources and sizes. In addition, when crushing aggregates to meet specified gradations, special care must be exercised if the materials are of different geology. All materials should be combined into the specimen mixture in the same proportions as in the field mixture. The standard method of preparing aggregates involves wet screening the material retained between the No. 20 and No. 35 sieves. However, if the predominance of the material is either larger than the No. 20 or smaller than the No. 35 or it is desired to test the material unwashed, a modified procedure can be performed. Since some aggregates also contain surface coatings, the tests can also be conducted without washing the aggregates prior to specimen preparation. If individual components of the aggregate mixture are to be evaluated, the material can also be tested without crushing, if the proper size of the aggregate is available. Finer crushed or noncrushed components can be tested, if necessary, by sieving to the interval between the No. 40 and No. 80 sieves.

(3.3) Preparation of Mixtures - Weigh out about 60 g of aggregate for each test specimen 19.05 ± 0.127 mm (0.75 ± 0.005 in.) in height. Multiple specimens may be prepared at the same time. Heat the dry aggregate and the asphalt cement at 150 ± 2.8°C (302 ± 5°F) for one hour. After both materials are hot, pour the required asphalt cement into the preweighed aggregate. Mix the aggregate and asphalt as thoroughly and rapidly as possible. Reheat the mixture at 150 ± 2.8°C (302 ± 5°F) for one hour; stir the mixture; heat the mixture for an additional hour at 150 ± 2.8°C (302 ± 5°F). Stir the mixture and divide into small dishes each containing about 60 g if multiple specimens are to be fabricated; heat the mixture in each dish for an additional one-half hour; remove from the oven, and cool for over 30 minutes before compaction begins. Discard all of the unused mixture that is not compacted into specimens during the same day it is prepared.

(3.4) Trial Mixture to Secure Proper Height of Specimens - Test briquets are to be 41.33 mm (1.627 in.) in diameter and 19.05 ± 0.127 mm (0.75 ± 0.005 in.) high. Each specimen has a mounting hole in the bottom, 6.35 mm (0.25 in.) in both diameter and height (see Fig 4). Trial pedestal briquets are to be prepared to determine the quantity of material that is required to meet height restrictions. Because of the required accuracy on the height of the specimens, an initial trial mixture is to be prepared for each test material. Once the weight of mixture required to obtain the sample height of 19.05 ± 0.127 mm (0.75 ± 0.005 in.) is determined, the record testing can be completed. To determine the weight of mixtures required to obtain the sample height, the following procedure is recommended. Prepare sufficient material for 3 to 5 briquets according to Section 3.3. Compact the first specimen using 55 g of asphalt mixture according to Section 3.5, and measure the height of the specimen. If the specimen lies outside the tolerable height interval of from 18.923 to 19.177 mm (0.745 to 0.755 in.), adjust the weight of the specimen according to the following proportioning scheme and prepare a second specimen:

$$W_2 = W_1 \left(\frac{19.05}{h_1} \right)$$

where

W_2 = weight of mixture required to secure a 19.050-mm pedestal specimen, g ,

W_1 = weight of mixture in first specimen, g , and

h_1 = height of first specimen, mm .

Compact the second specimen according to Section 3.5 and measure the height. If the height is within tolerances, prepare a third specimen using the weight of the second specimen, W_2 , according to Section 3.5 and use these two specimens for record testing. Discard all remaining material. If the height of the second specimen lies outside the height interval, prepare a third specimen by proportioning in the same way as for the second specimen, compact according to Section 3.5, and measure the height for compliance. Usually three specimens are sufficient to determine the volume of mixture required to produce a height within the tolerable range. Prepare at least two specimens and test using the procedure described in Section 4 and use the average as the test result for the individual material or mixture. If the number of cycles to failure of the two specimens varies by more than 4, prepare and test additional specimens until consistent test values are secured.

(3.5) Compaction of Specimens - Remove the dish containing 50 to 60 g of the asphalt mixture, which has been heated at 150 ± 2.8°C (302 ± 5°F) for 20 minutes. Place the assembled cylinder mold and base plate on the balance; quickly transfer the amount of the asphalt mixture required to produce a 19.05 ± 0.127-mm (0.75 ± 0.005-in.)-high compacted briquet into the cylinder mold; insert the molding ram; and compact by applying a constant load of 27.58 ± 0.22 kN (6200 ± 50 lb) for 20 minutes. Less than two minutes should elapse between the time that the mixture is removed from the oven and the time that the load of 27.58 ± 0.22 kN (6200 ± 50 lb) is reached. Extract briquet from mold and allow to cool. Measure height of briquet. Cure the briquet on a flat surface at 24 ± 2.8°C (75 ± 5°F) for three days before freeze-thaw cycling.

(4) Freeze-Thaw Test Procedures

(4.1) Water Immersion - Place the briquet on the stress pedestal with a gentle twisting motion. Place the stress pedestal with briquet in a jar and add distilled water until it is about one-half inch over the briquet. Seal the jar.

(4.2) Freeze-Thaw Cycling - Place the jar in a temperature controlled room or refrigerator at -12 ± 2.8°C (10 ± 5°F) for 12 hours. Remove the jar from the freezer and submerge it in warm water for about 45 minutes. The warm water is to be at room temperature, approximately 24 ± 5.6°C (75 ± 10°F). Place the jar in a 49 ± 2.8°C (120 ± 5°F) oven for 12 hours.

(4.3) Visual Observation - At the end of each complete cycle, carefully examine the briquet surface for appearance of cracks. If no crack is visible, subject the specimen to an additional freeze-thaw cycle and examine again for cracks. Repeat this cycling until a surface crack appears.

(5) Report

(5.1) Report the number of freeze-thaw cycles required to crack the briquet. The value reported is to be an average of all tests results and be reported in whole cycles.

CHAPTER 3. APPLICATION AND USE OF TEXAS FREEZE-THAW PEDESTAL TEST

The purpose of the Texas Freeze-Thaw Pedestal Test is to evaluate the moisture susceptibility of an aggregate-asphalt mixture, with or without an antistripping agent, prior to use of the mixture in a pavement. In so doing, serious stripping and moisture related failures can be averted with a corresponding saving in maintenance and reconstruction costs and in user costs associated with poor pavement performance and maintenance activities.

This evaluation can occur in a number of forms, such as the

(1) evaluating proposed field mixtures;
(2) evaluating the various components of the aggregate mixture;
(3) determining the amount of moisture susceptible aggregate which is allowable;
(4) evaluating new aggregate sources; and
(5) evaluating the effectiveness of proposed remedial measures, such as
    (a) washing aggregate,
    (b) crushing aggregate,
    (c) using commercial liquid antistripping agents, and
    (d) using lime.

Since the basic use of the results from this test procedure is to analyze the water susceptibility of asphalt mixtures, tests should be on mixtures with components in the proportions of the job mix formula. If test results indicate that the mixture strips or is a borderline stripper, then tests can be performed on the individual components of the mixture to determine which aggregate is causing the problem. Since the severity of stripping is determined largely by the extent to which the fine aggregate strips, these tests should concentrate on the fine aggregate. Once the stripping aggregate or aggregates are located, the engineer can either replace those aggregates with nonstripping aggregates of the same size range or prescribe smaller amounts of those stripping aggregates to produce a mixture that does not strip.

Replacement of stripping aggregates with nonstripping aggregates is the option with the highest probability of success, but replacement is not always possible. The engineer may also evaluate the effect of washing dirty aggregates, or simply crushing an aggregate to enhance its resistance to stripping.

The engineer may also investigate the effect of using antistripping agents to improve the adhesion characteristics of the asphalt and aggregate with respect to stripping and moisture damage. However, the engineer should not assume that using an antistrip agent will always solve the problem; rather, specimens containing the selected antistrip agent, asphalt, and aggregate should be prepared and tested to determine if the antistrip agent improves test results. Test results reported in Ref 5 indicate that many antistrip agents may be ineffective with some aggregates and asphalts while with other combinations the agent may be quite satisfactory.

The effect of any particular treatment can be evaluated using the Texas Freeze-Thaw Pedestal Test procedure. Specimens should be prepared using the desired treatment and then tested and results should be compared to those from the standard test procedure to evaluate the effectiveness of each treatment.

CHAPTER 4. APPLICATION OF FREEZE-THAW PEDESTAL TEST TO EVALUATE MATERIALS

The general purpose of the Texas Freeze-Thaw Pedestal Test is to evaluate the susceptibility of an aggregate mixture to stripping before placing it in the field. If this test can provide an indication of such a potential problem, serious stripping failures can be averted along with potential saving in repair and construction costs.

The objective of this portion of the study was to determine if the Texas Freeze-Thaw Pedestal Test could be used to differentiate between aggregate-asphalt mixtures known to strip and those which do not strip.

MATERIALS

Mixtures from eight projects, one each from Districts 5, 9, 11, 13, 14, and 19 and two from District 12, are used in this evaluation. Of these eight projects, four have previously experienced stripping problems and four have not. The stripping mixtures are from the Waco, Lufkin, Houston (Harris County), and Yoakum districts. The major portion of these stripping mixtures is siliceous river gravel or sand. Each stripping mixture and its components are shown in Table 1. The nonstripping mixes are from the Lubbock, Houston (Galveston County), Austin, and Atlanta districts. The major portions of these nonstripping materials are crushed limestone, caliche, or slag. The composition of each mixture by aggregate type and percentage is shown in Table 2.

The asphalt cements selected for the testing program are the same as those used for the construction of corresponding pavements. The asphalt properties, as determined by the Texas DHT, are summarized in Table 3.

TABLE 1. LOCATION AND DESCRIPTION OF STRIPPING AGGREGATES

District	Aggregate Type	Producer and/or Source	Aggregate Proportion, %
9 - Waco	Coarse gravel	Waco Sand & Gravel Co. (Bosqueville pit)	65.0
	Washed sand	Waco Sand & Gravel Co. (Bosqueville pit)	21.0
	Field sand	Pendeley River Sand, Inc. (Pendeley pit)	14.0
11 - Lufkin	Crushed limestone	Gifford-Hill	27.0
	Pea gravel	Crocket Sand & Gravel Co.	15.0
	Coarse sand	Midway Material Co.	15.0
	Local fine sand	Dickerson pit	43.0
12 - Houston (Harris County)	Gravel screenings	Lone Star, Eagle Lake	63.3
	Crushed limestone	Texas Crushed Stone Co.	10.3
	Local field sand	(Harris County)	26.4
13 - Yoakum	Lone Star coarse agg.	Lone Star, Eagle Lake	43.0
	Lone Star Gem sand	Lone Star, Eagle Lake	12.2
	Styles coarse sand	Styles	13.3
	Tanner Walker sand	Tanner Walker	31.5

TABLE 2. LOCATION AND DESCRIPTION OF NONSTRIPPING AGGREGATES

District	Aggregate Type	Producer and/or Source	Aggregate Proportion, %
5 - Lubbock	Crushed caliche	Long pit, Lubbock	100.0
12 - Houston (Galveston County)	Crushed limestone	Texas Crushed Stone Co. (Georgetown)	55.0
	Limestone screenings	Texas Crushed Stone Co. (Georgetown)	20.0
	Field sand	Flora pit (Alvin)	25.0
14 - Austin	Crushed limestone	Southwest Materials Co.	39.0
	Crushed limestone	Southwest Materials Co.	22.0
	Limestone screenings	Texas Crushed Stone Co.	22.0
	Local sand	Centex Materials (Sheppard pit)	17.0
19 - Atlanta	Coarse slag	Gifford-Hill	60.0
	Slag screenings	Gifford-Hill	15.0
	Local sand	Panola County	12.0
	Wilson red sand	Shelby County	13.0

TABLE 3. PROPERTIES OF ASPHALT CEMENT AS DETERMINED BY TEXAS DHT

	Yoakum	Houston (Harris County)	Lufkin	Waco	Lubbock	Atlanta	Austin	Houston (Galveston County)
Asphalt Type	AC-20	AC-10	AC-20	AC-20	AC-10	AC-20	AC-10	AC-10
Producer	Exxon	Exxon	-	Vickers	Cosden Oil	Texaco	Exxon	Exxon
Water, percent	Nil	-	-	-	Nil	-	-	-
Viscosity at 135°C (275°F), Stokes	3.3	-	-	-	2.5	-	-	-
Viscosity at 60°C (140°F), Stokes	2,093	-	-	-	912	1,926	1,052	-
Solubility in CCl_4, percent	99.7	-	-	-	99.7	-	-	-
Flash Point, C.O.C., °C (°F)	>315 >(600)	-	-	-	>315 >(600)	>315 >(600)	-	-
Ductility at 25°C (77°F), 100 g, 5 sec	56	-	-	-	86	90	100	-
Specific Gravity at 25°C (77°F)	1.020	1.026	1.020*	1.003	1.026	1.030	1.022	1.026
Tests on Residues from Thin Film Oven Tests								
Viscosity at 60°C (140°F), Stokes	3,574	-	-	-	2,172	-	-	-
Ductility at 25°C (77°F), 5 cm/min, cm	>141	-	-	-	>141	-	-	-
Spot Test	Neg	-	-	-	Neg	-	-	-

\- Means Unknown * Assumed

DETECTION OF STRIPPING AGGREGATE MIXTURES

The four stripping and four nonstripping mixtures and each constituent are described in Tables 1 and 2. Each of these materials was combined in the same proportion as used in the field and tested to determine the number of cycles required to cause failure. The test results are summarized in Table 4 and Fig 5. The four stripping mixtures failed in less than 10 cycles while the four nonstripping materials did not fail even after 25 cycles of freezing and thawing. This suggests that somewhere in the range from 10 to 20 cycles to cracking may be the borderline between stripping and nonstripping mixtures. Thus, it appears that the Texas Freeze-Thaw Pedestal Test offers great potential for use in detecting those asphalt concrete mixtures that are potential strippers in the field.

EVALUATION OF INDIVIDUAL AGGREGATES

Once a mixture is identified as a potential stripping mix, it becomes desirable to determine which one of the individual aggregates contributes to the stripping. Tests were run on each of the individual components of the four stripping asphalt mixtures to determine which are prone to strip.

The test results for each of the individual aggregates are included in Table 5. The screenings and sands varied in the number of cycles to cracking from one for the Lone Star gravel screenings to more than 25 for the Dickerson fine sand. All of the crushed limestone products exhibit excellent resistance to stripping. However, no pattern is obvious for the sandy materials. Further study is recommended to determine if there are physical or mineralogical characteristics of these sands that can help explain the differences in test results.

Based on the test results shown in Table 5, the following individual aggregates are the ones that contributed most to the stripping of the four asphalt concrete mixtures:

District 9	- Waco	- Coarse sand (65.0)
		- Washed sand (21.0)
District 11	- Lufkin	- Pea gravel (15.0)
		- Midway coarse sand (15.0)

TABLE 4. PREDICTION OF WATER DAMAGE ON ASPHALT CONCRETE USING FREEZE-THAW PEDESTAL TEST

Stripping or Nonstripping	District	Number of Cycles to Cracking
Stripping	9 - Waco	9
	11 - Lufkin	9
	12 - Houston (Harris County)	2
	13 - Yoakum	5
Nonstripping	5 - Lubbock	>25
	12 - Houston (Galveston County)	>25
	14 - Austin	>25
	19 - Atlanta	>25

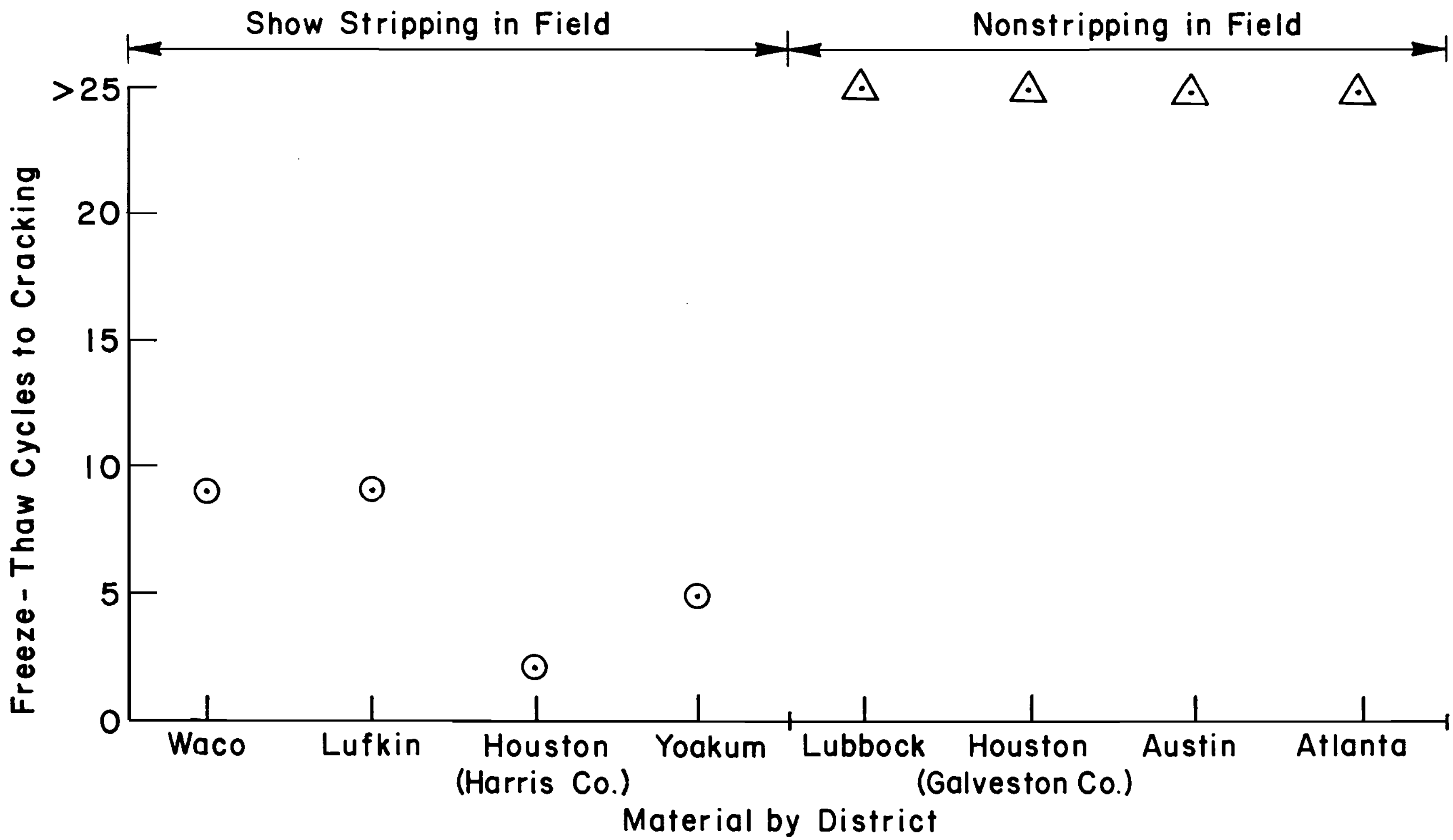


Fig 5. Differentiation between mixtures that experience stripping in the field and those that do not using Freeze-Thaw Pedestal Test results.

TABLE 5. FREEZE-THAW PEDESTAL TEST RESULTS FOR SPECIMENS COMPACTED FROM INDIVIDUAL AGGREGATES AT THE SAME TIME BY THE SAME OPERATOR

District	Individual Aggregate and Design Mixture	No. of Cycles to Cracking						Coefficient of Variation, %	Mixture Proportion, %
		Specimen No.							
		1	2	3	Range	Mean	Standard Deviation		
9	Waco Washed Sand	5	7	6	2	6	1.00	16.7	21.0
	Pendeley Field Sand	14	14	14	0	14	0.00	0.0	14.0
	Design Mixture	8	9	9	1	9	0.58	6.7	100.0
11	Crushed Limestone	>25	>25	>25	*	>25	*	*	27.0
	Pea Gravel	8	8	8	0	8	0.00	0.0	15.0
	Midway Coarse Sand	5	5	4	1	5	0.58	12.4	15.0
	Dickerson Fine Sand	>25	>25	>25	*	>25	*	*	43.0
	Design Mixture	9	9	9	0	9	0.00	0.0	100.0
12 (Harris County)	Lone Star Gravel Screenings	1	2	1	1	1	0.58	43.3	63.3
	Texas Crushed Stone Crushed Limestone	>25	>25	>25	*	>25	*	*	10.3
	Harris County Field Sand	8	8	8	0	8	0.00	0.0	26.4
	Design Mixture	2	2	3	1	2	0.58	24.7	100.0
13	Lone Star Coarse Agg.	3	3	4	1	3	0.58	17.3	43.0
	Lone Star Gem Sand	3	2	3	1	3	0.58	21.6	12.2
	Styles Coarse Sand	4	3	2	2	3	1.00	33.3	13.3
	Tanner Walker Sand	12	12	12	0	12	0.00	0.0	31.5
	Design Mixture	5	5	5	0	5	0.00	0.0	100.0

* Unable to calculate

District 12 - Houston
(Harris County) - Lone Star gravel screenings (63.3)
- Harris County local field sand (26.4)

District 13 - Yoakum - Lone Star coarse aggregate (43.0)
- Lone Star Gem sand (12.2)
- Styles coarse sand (13.3)

The number in parentheses is the proportion of each aggregate expressed as a percent of total aggregate in the mixture.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

Results from this study show that the Texas Freeze-Thaw Pedestal Test possibly can detect asphalt mixtures that exhibit stripping tendencies in the field. It is possible to conduct the test with a minimum amount of special equipment and with existing staff in the District laboratories. Because of the potential offered by this test, the following recommendations are offered:

(1) That both the District and D-9 laboratories begin to use the Texas Freeze-Thaw Pedestal Test to evaluate selected field mixtures for those Districts that have experienced moderate to severe stripping problems.

(2) That, during the initial trial period, samples of aggregate, asphalt, and antistrip materials tested by the Districts be sent to the CTR laboratories for comparison tests and evaluation.

(3) That, in the event a stripping mixture is detected, the proposed antistrip additive be tested using the Texas Freeze-Thaw Pedestal Test to evaluate its effectiveness in improving the adhesion between each asphalt cement and aggregate in the mixture. Other tests such as the boiling test and the wet-dry indirect tensile test using the Lottman's moisture conditioning procedures could also be used to evaluate the effectiveness of selected antistrip additives.

(4) That samples of materials from pavements that have experienced stripping in the field be secured and tested by both the District and D-9 and that a determination be made as to whether results from this test can be used to detect the stripping mixtures. If results of any such testing are sent to the CTR, a master compilation of test results will be prepared for validation of the accuracy of the test to detect stripping-prone mixtures.

If results from District testing indicate that the test is useful in detecting stripping mixtures and aggregate, then additional refinement of the test procedure is in order. The objective of this refinement is to simplify the test procedure and to minimize the time and equipment requirements of the current procedure but still retain the ability to differentiate between stripping and nonstripping mixtures. The effect of aggregate size should be evaluated further and a definite attempt should be made to shorten the cycle time and to develop a cycle which lends itself to a normal work day, such as

15 hours for freezing followed by a 9-hour heating cycle. An additional factor that should be considered is a change of the heating cycle temperature to 60°C (140°F) to use ovens already set up for other standard tests.

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