INTERNATIONAL SLURRY SURFACING ASSOCIATION

TECHNICAL BULLETIN

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Test Methods for Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Mutilayered Fine Aggregate Cold Mixes

1. SCOPE

These methods cover three test procedures which measure the amount of compaction or displacement characteristics of multilayered, dense graded, fine aggregate cold mixes such as slurry seal or cold microasphalt bituminous surfaces under simulated rolling traffic compaction by Loaded Wheel Test, modified LWT or British Wheel Tracking machines.

These procedures are described:

A) Multilayer Load Wheel Test at ambient (ISSA TB #109)

B) British Wheel Tracking Test at 45°C

C) Lai Modified Loaded Wheel Test using variable pressure air hose at 95°F (35°C)

2. APPLICABLE DOCUMENTS AND REFERENCES

2.1 ASTM D3910 Standard Practice for Design Testing and Construction of Slurry Seal.

2.2 ISSA TB #109, "Test Methods for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion."

2.3 C. R. Benedict, "Introduction to a Loaded Wheel Test Method for the Measurement of Compaction, Stability and Rutting Resistance of Multilayered, Dense Graded, Fine Aggregate-Emulsion Cold Mixes. Proc. 2nd World Congress on Slurry Seal; Geneva, Switzerland, March 1987 (ISSA).

2.4 F. A. Jacobs, "Hot Rolled Asphalt: Effect of Binder Properties on Resistance to Deformation" TRRL Lab Report 1003, 1981.

2.5 Choyce, Lammiman and Taylor, "Resistance to Deformation of Hot Rolled Asphalt" Highway and Transportation, No. 1, Volume 31, January 1984 (J of Inst. of Hgwy. Group and HOTA - UK).

2.6 J. S. Lai, "Development of a Simplified Test Method to Predict Rutting Characteristics of Asphalt Mixes," FHWA/GaDOT project #86-8503 final report July 1986.

2.7 J. S. Lai, "Evaluation of Rutting Characteristics of Asphalt Mixes Using Loaded Wheel Tester," GaDOT project #8609, December 1986.

2.8 J. S. Lai, "Evaluation of the Effect of Gradation of Aggregate on Rutting Characteristics of Asphalt Mixes," project #FHWA/Ga 88-8706, final report August 1988.

2.9 J.S. Lai, "Use of a Loaded Wheel Testing Machine to Evaluate Rutting of Asphalt Mixes," pres. TRB, Jan, 1990.

2.10 Georgia DOT, GDT-115, "Method of Test for Determining Rutting Susceptibility using the Loaded Wheel Tester."

METHOD A-ISSA TB #109, MULTILAYER LOADED WHEEL TEST VERTICAL AND LATERAL DISPLACEMENT AT AMBIENT.

A3. APPARATUS

A3.1 Suitable mixing spoon or spatula, bowls and scales to prepare 500 gram mixes.

A3.2 24 gauge x 3" x 16" galvanized steel mounting plates and a mold to contain a specimen cast at 1/2" x 2" x 15".

A3.3 Loaded Wheel Tester as described in ISSA TB #109 consisting of a 3" diameter soft rubber wheel loaded with 125 lbs. which reciprocates through a 12" horizontal path at the rate of 44 cycles per minute.

A3.4 Gauge block .188" x .50" x 4" with .25" slot and calipers capable of measuring specimen width and depth to within .001" or .01 mm.

A4. PROCEDURE

A4.1 A 500 gram dry aggregate weight mixture is prepared using 0/#4 or other gradation aggregate and the desired quantities of fillers, water additives and asphalt emulsion. After 30 seconds of vigorous mixing, the mixture is cast into the 1/2" x 2" x 15" mold centered over the 24 gauge mounting plate and immediately struck off uniformly with a wooden dowel or "U"-shaped wooden screed using a sawing action. Care should be taken to avoid any segregation or the presence of any free liquids. It is desirable to coat the inside surfaces of the mold with a thin coating of petrolatum or a mixture of glycerine and talc as a mold release to prevent sticking.

A4.2 The casting operation should be completed within 15 seconds so that no more than 45 seconds has elapsed from starting the mix to finishing the specimen.

A4.3 As soon as the mixture is sufficiently set to prevent free flow, the mold is carefully removed without disturbing the specimen. After air curing for 24 hours, the specimen is dried to constant weight in a forced draft oven at 60°C for 18-20 hours.

A4.4 After cooling for two hours to room temperature, the specimen is measured centrally for width and net thickness using the gauge block. The net weight is obtained and recorded. The density may be obtained at this point by weighing the specimen in water, deducting the mounting plate weight.

A4.5 The specimen is then mounted in the LWT machine and subjected to 1000, 125 lb. cycles of LWT compaction. The temperature should be maintained at 22°C ± 2°C during the test.

A4.6 The specimen is then removed from the LWT machine and immediately remeasured laterally and centrally in the wheel path and the results recorded.

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A5. REPORT

The report should include:

A5.1. Specimen Identification, gradation range, mix formula

A5.2. Nominal thickness of the specimen mold (e.g., 13 mm)

A5.3. Specimen net weight

A5.4. Number of LWT compaction cycles, wheel loading weight

A5.5. Temperature at compaction

A5.6. Percent vertical displacement (Rut depth as a percent of the original net thickness)

A5.7. Percent lateral displacement (Percent increase of original width)

A5.8. Optional: Specific gravity, uncompacted and calculated compacted specific gravity (increased by the percent compaction) from the above standard procedure

Note 1: Variations of aggregate gradation, specimen thickness, confinement and test temperature should also be noted.

Note 2: When a series of specimens, containing a wide range of emulsion contents is tested, an optimum emulsion content for rutting resistance may be determined at the minimum vertical and lateral displacements.

Note 3: It has been found that unconfined vertical displacements under conditions of this test which substantially exceed 10% are not satisfactory for uncompacted multilayer applications.

METHOD B-MODIFIED BRITISH WHEEL TRACKING TEST @ 45°C

The British TRRL Wheel Tracking Test has a long experience in the prediction of pavement rutting performance and in the traffic count design of bituminous pavements. The test is a traffic simulating device which measures the rate of loaded wheel penetration into a compacted hot mixed asphaltic concrete. The test is normally performed in a temperature controlled chamber at 45°C (115°F).

In the Loaded Wheel Test, the wheel moves to and fro in a rocking motion. In the Wheel Tracking Test, the work moves to and fro while the wheel remains stationary and there is no rocking motion.

Good Wheel Tracking Rate correlations have been found with Marshall Stability, Marshall Flow and Marshall Quotient, Ring and Ball Softening Points, as well as field rutting performance (Ref. 2.4., 2.5.).

B3. DESCRIPTION OF THE BRITISH TRRL WHEEL TRACKING TEST (REF. 2.4.)

B3.1. "The Wheel-Tracking Test assembly consists of a loaded wheel and a table on which the 305 x 305 x 30 mm asphalt slab is rigidly restrained on its four sides. A motor and a reciprocating device gives the table a to and fro motion of 42 passes a minute with a distance of travel of 250 mm. A 204 mm diameter by 44 mm wide wheel with a tire of solid rubber (80 on the Dunlop hardness scale) applies a total force of 525N and indents a straight track in the specimen, the depth of track being recorded at the mid-point of its length. The contact area between the wheel and specimen is about 1000 mm², giving a mean normal pressure of 520/550 kN/m². The test is continued until the track depth reaches 15 mm or for 45 minutes, whichever is the shorter time. From the deformation/time curve, the asymptotic rate of increase in track depth is determined and expressed in mm/hr."

B3.2. Comparison of the British TRRL and US Modified Wheel Tracking Machines:

	TRRL	US
Cycles per Minute	42.0	43.8
Stroke Length	250 mm (9.84")	254 mm (10")
Tire Diameter	204 mm (8.03")	203.2 mm (8")
Tire Width	47 mm (1.85")	50.8 mm (2")
Wheel Load	525N (118 lbs)	567.6N (127.6 lbs)
Unit Contact Weight	11.2 N/mm (63.8 lbs/lin. in.)	11.2 N/mm (63.8 lbs/lin. in.)

B4. USE AND PROCEDURE MODIFICATIONS

The WTT machine is used in the case of uncompacted slurry mixes in the same way as the previous LWT method "A" except that the test temperature is 45°C (115°F) and the wheel load is 63.8 lbs/in of tire width (roughly one half the LWT loading).

Specimen sizes and confinement may be varied as well as cycles run and temperature. All conditions of the test should be included in the report. It is recommended that the test should run for 1 hour or 2520 cycles.

For pre-compacted specimens, the standard running time is 45 minutes at 45°C at 42 cycles per minute or a total of 1890 cycles. With the US modification, the equivalent running time of 1890 cycles is 43' 9". The rate of displacement is projected to the rate per hour or mm/1000 cycles.

For uncompacted specimens, the standard running time is 60 minutes at 42 cycles or 2520 cycles. With US modification, the equivalent running time is 57' 32" for 2520 cycles.

B5. REPORT

The report should include all items as in section A5.0. The report should include, in addition to the percent vertical displacement measured centrally, the mm/hour of displacement.

Note: It has been found that vertical displacements of uncompacted slurry or microsurface specimens which are substantially greater than 10%, lateral displacements of greater than 5% or compacted specific gravity of greater than 2.10 (corrected to ASG 2.65) are not satisfactory for multilayer application.

METHOD C-LAI/GA. DOT MODIFIED LOADED WHEEL TEST USING A VARIABLY PRESSURED AIR HOSE @ 105°F (40.6°C)

This modification of the LWT machine has been used to test the rutting characteristics of 3" x 3" x 15" confined, compacted hot mixed asphalt concrete fatigue beams. The standard ISSA TB #109 LWT is modified to accommodate the larger specimens. Tracking is accomplished by a loaded metal wheel longitudinally compressing a 1.25" OD pressurized air hose into the specimen at 105°F (40.6°C).

Good correlations between Lai Modified LWT laboratory rutting and field rutting potential have been found. Other comparisons with Creep and Repeated Load Triaxial Tests have been made and found to be less reliable as a predictor of rutting potential (Ref. 2.6., 2.7., 2.8.).

C3. APPARATUS - MODIFIED LWT

The Lai Compaction Hose Modified LWT is for testing 3" x 3" x 15" beams is shown in figures ___ and includes:

C3.1. Enlarged base plate 7" x 27"

C3.2. 4" spacer to increase the elevation of the drive assembly

C3.3. 1-1/2" x 5" diameter concave aluminum wheel to replace the standard wheel

C3.4. Sample holding device (3" angle iron frame; inside dimension of 3" x 3" x 15" accommodate the specimen

C3.5. Specimen base plate 1/2" x 3" x 15"

C3.6. Linear air hose and holding bracket.

C3.7. Profile measuring device channel with 1/4" lateral slots on 2" centers and dial depth gauge reading .001" or .01 mm

C3.8. Controlled pressure air supply; 100 psi, ± 2 psi

C3.9. Controlled temperature chamber; 105°F ± 2°F

When used for up to 1" thick slurry or microsurface specimens, only items 3, 6, 7, 8 and 9 are necessary.

C4. PROCEDURE FOR MAXIMUM 1" THICK LWT SPECIMENS

C4.1 The specimen dimensions are of variable thicknesses x 2" x 15" is mounted on the LWT standard 24 gauge x 3" x 16" galvanized metal placque are conditioned overnight for 8-10 hours in the temperature chamber at 105°F along with the modified machine and accessories.

C4.2 The specimen is clamped centrally under the wheel path of the LWT and depth measured centrally across the entire specimen width at 5 mm increments and recorded.

C4.3 The linear tube assembly is clamped in place and pressurized to 100 psi ± 2 psi. The wheel is positioned and 100 lb. load applied. After returning the revolution counter to zero, the machine is started.

C4.4 After 1000 cycles, the apparatus is stopped, disassembled and remeasured as above (C4.2.) and recorded.

C4.5 Different numbers of cycles, other wheel loads, hose pressures and temperatures may be used and should be indicated in the report.

C5 REPORT

C5.1 Specimen identification, gradation range, mix formula.

C5.2 Nominal thickness of the specimen mold (e.g., 1/2") and compaction state (The WTT compacted specimens may be used) and whether the specimen was confined or unconfined.

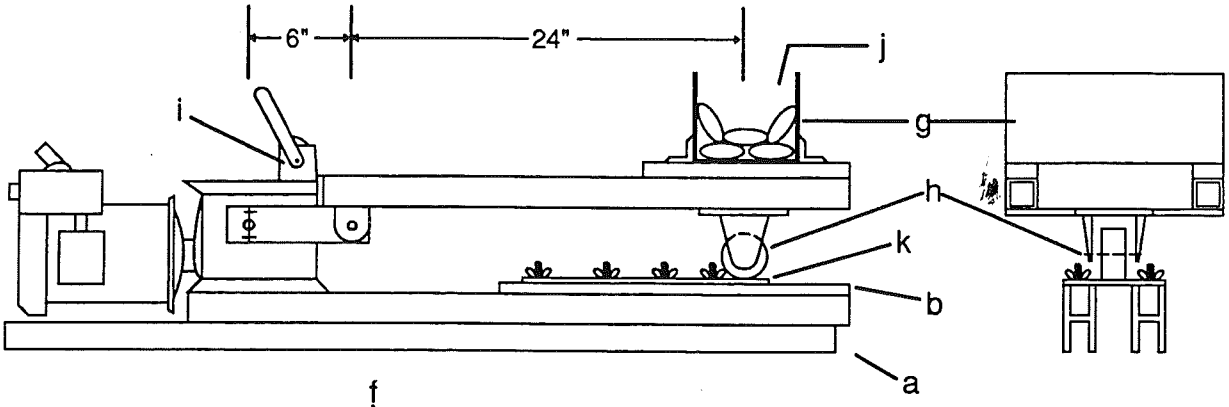
C5.3 Specimen net weight.

C5.4 Number of cycles run, wheel loading weight and linear hose pressure.

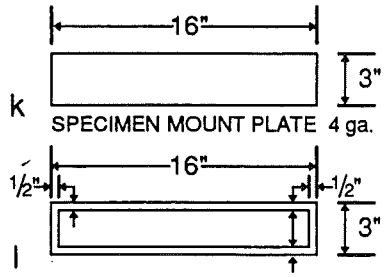
C5.5 Temperature of test.

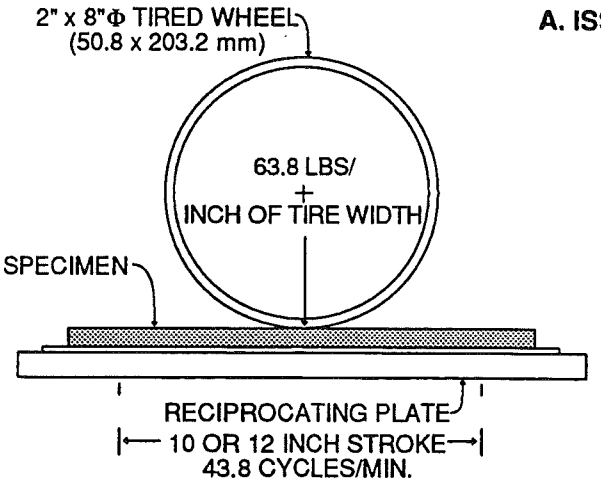
C5.6 Rut depth may be reported as centrally measured or as the average of 3 central measurements taken at the midpoint and ± 2" from the midpoint.

Note: Not enough work has yet been reported (2/89) to categorize the Hose Modified LWT test results. In the initial studies with compacted fatigue beams, the results of 4 different mixes were each different in rate of vertical displacement (permanent deformation) but were essentially parallel. The best results at 1000, 100-lb cycles at 100 psi hose pressure and 95°F were found at .032" (.82 mm) track depth (2.6.). In later studies (2.7., 2.8.) .042" (1.1 mm) was lowest with typical values for about .080" (2.1 mm) and the highest values were .130" (3.3 mm). More recent work has been reported using 105°F and adopted as the standard temperature.

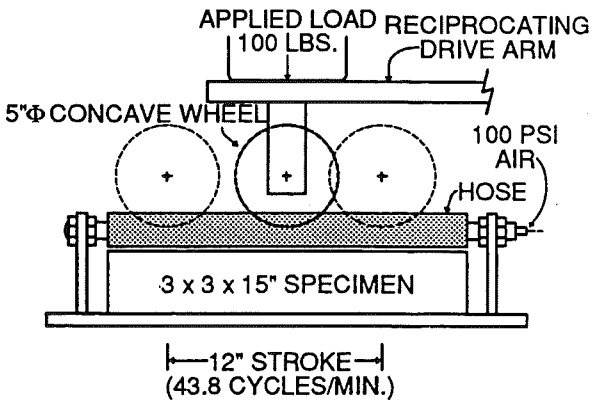


A. ISSA TB #109 LWT.

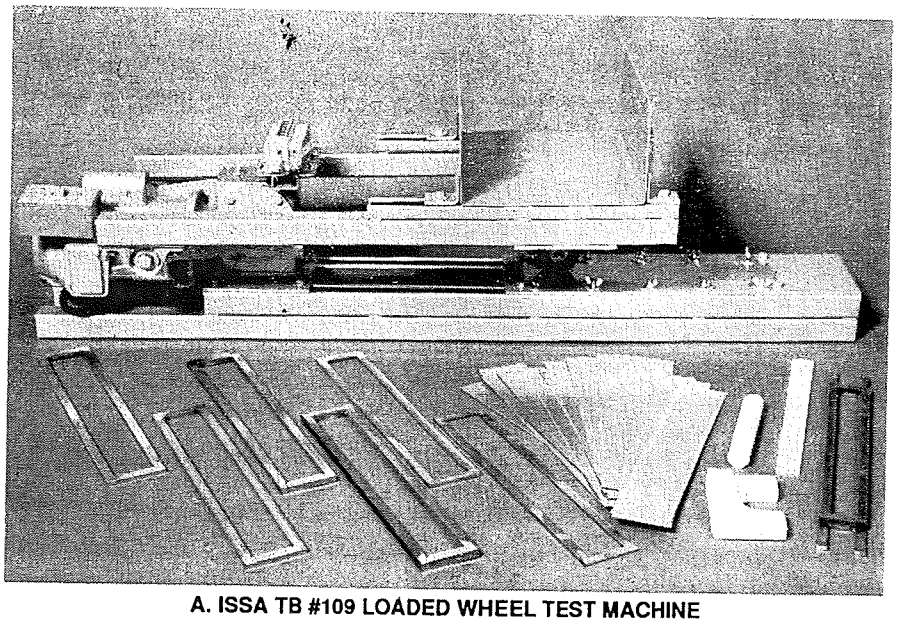




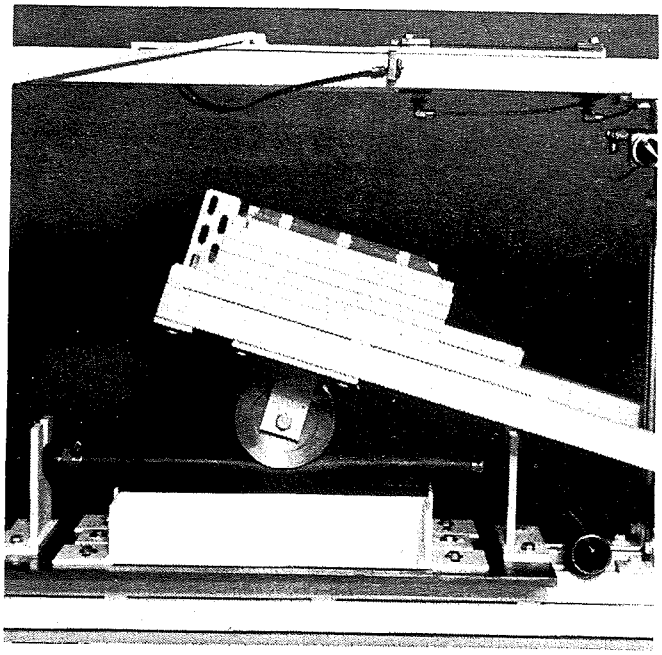
B. U.S. MODIFIED WHEEL TRACKING TEST (115°F, 45°C)



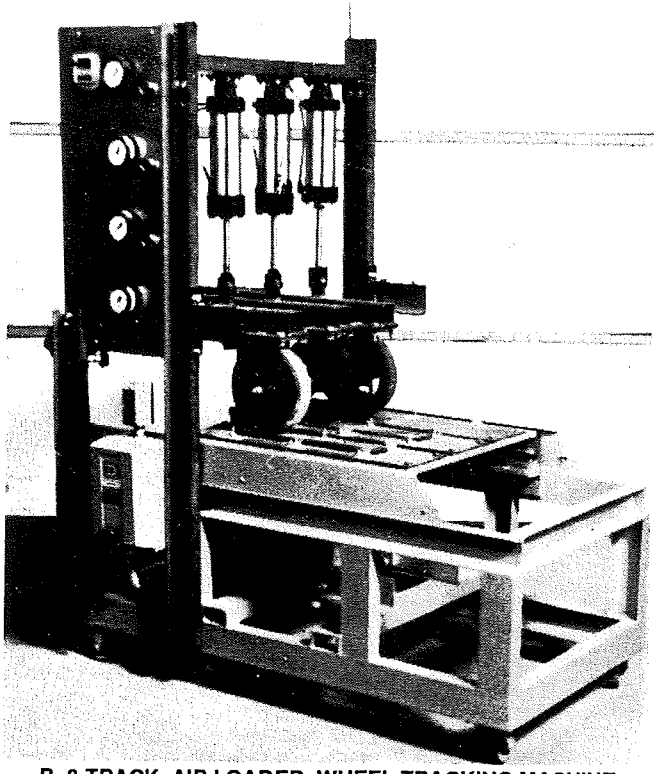
C. GEORGIA DOT MODIFIED LOADED WHEEL TEST (105°F-40.6°C)



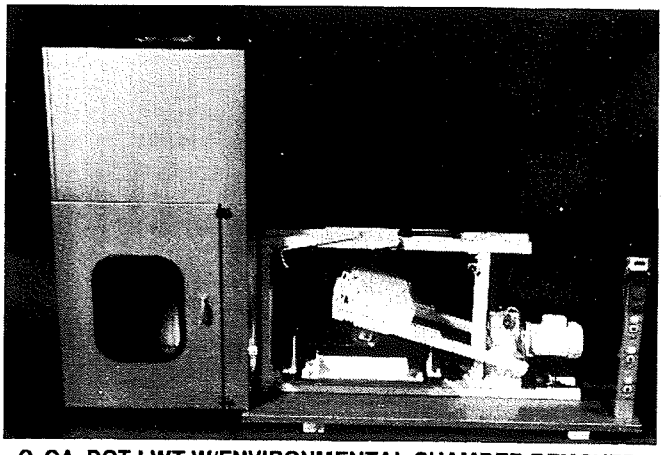
A. ISSA TB #109 LOADED WHEEL TEST MACHINE



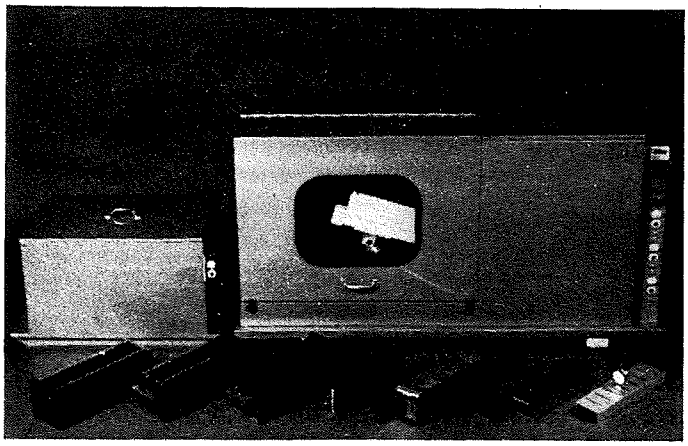
C. GA. DOT HOSE MODIFIED LWT



B. 3-TRACK, AIR LOADED, WHEEL TRACKING MACHINE



C. GA. DOT LWT W/ENVIRONMENTAL CHAMBER REMOVED



C. GA. DOT LWT, CONDITIONING BOX, MOLDS & TEMPLATE

INTERNATIONAL SLURRY SURFACING ASSOCIATION

TECHNICAL BULLETIN

1200 19TH STREET, N.W., SUITE 300, WASHINGTON, D.C. 20036-2401

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Test Method for Measurement of Excess Asphalt in Bituminous Mixtures by Use of a Loaded Wheel Tester and Sand Adhesion

1. SCOPE

1.1 The loaded wheel test is intended to compact fine aggregate bituminous mixtures such as slurry seal by means of a loaded, rubber tired reciprocating wheel. The test may be used for design purposes to establish maximum limits of asphalt content and enable the mix designer to avoid severe asphalt flushing under heavy traffic loads.

1.2. Various accessory measurements may also be made during this test to study compaction rates and plastic deformation of mono and multiple layered bituminous mixture specimens. Refer to ISSA TB #147," Test Method for Measurement of Stability and Resistance to Compaction, Vertical and Lateral Displacement of Multilayered Fine Aggregate Cold Mixes."

2. APPARATUS AND MATERIALS

2.1 Loaded Wheel Testing machine as shown in Figures 1 and 2 consisting of the following main components:

a. Frame of adjustable steel channel
b. Mounting plate for specimens
c. 1/3 HP, 1750 RPM flanged motor
d. 40:1 horizontal double output shaft gear reducer
e. Drive cranks, 6-inch radius
f. Driven connecting arms of adjustable, steel channel
g. Weight box, centrally adjustable over the wheel
h. Bassick caster frame #3YY6-2 with wheel #WR6203 with 3" diameter x 1" soft (60-70 durometer) rubber tire mounted at a horizontal distance of 24" between drive and caster axles. (Other wheels may be used.)
i. Resetable revolution counter
j. 5-25 pound bags of #7 or #8 lead shot
k. Specimen mounting plates, 24 ga.(.024"-.60mm) galvanized steel x 3" x 16", deburred.
l. Specimen molds, variously .125, .188, .250, .313, .375 and .500 inches thick (3.2, 4.8, 8.0, 9.5, 12.7mm), x 3" x 16" outside and 2" x 15" inside dimensions
m. 1" dia. x 6" long wood strike-off dowel or "U"-shaped screed.
n. Steel sand frame, .188" x 2.5" x 15" outside and 1.5" x 14" inside dimensions, completely line one side with 1/2" x 1/2" adhesive-backed foam rubber insulation and hold down clamps.
o. Flat, platform scale, 250 pound capacity, sensitive to one pound.

2.2 Sample Preparation Apparatus:

Balance of 2000 grams or more capacity and sensitive to .1 gram, constant temperature over (140°F), 600 to 1000 ml. mixing bowl or beaker, 1" mixing spatula or spoon specimen mounting plates (2.1.k) and strike-off dowel or "V"-shaped screed, specimen molds (2.1.1), cone consistency apparatus (ISSA TB #106).

2.3 Sand Adhesion Apparatus and Materials:

Fine Ottawa Sand -30, +100 mesh (ASTM Designation C-109 - graded standard), hot plate or oven for heating sand (180°F), 1000-5000 ml. metal bowl, household vacuum cleaner, thermometer for measuring sand temperature, steel sand frame with foam rubber strips (2.1 n).

2.4 Optional compaction and distortion measuring apparatus such as suitable profilograph and calipers shown in Figure 2.

3. TEST SPECIMENS

3.1 Slurry Seal mixtures are prepared with formulations selected for test using project materials.

3.2 Mold thickness is selected that will result in a specimen of desired thickness for testing, e.g., 25% thicker than the coarsest particle thickness.

3.3 25 to 35% more material than required to fill the mold is mixed. (Normally, 300 grams of aggregate fills the 1/4" mold.)

3.4 Trial mixes are made to determine the consistency characteristics of the selected formulation. (See ISSA TB #106). Notation of the exact percentage formulation to be used is made listing the quantity of aggregate, filler, water, emulsion and the consistency obtained; e.g., 100-2-10-18-3 cm.

3.5 The materials are carefully weighed into the mixing container. Mixing should proceed rapidly and thoroughly so that the specimen is cast 30 seconds after the addition of the emulsion.

3.6 The selected mold is centered over a previously weighed specimen mounting plate and uniformly over-filled with the mixture. Using a horizontal sawing motion with the strike-off bar held in a vertical position, the specimen is struck off level with the specimen frame. When the specimen has set sufficiently to prevent displacement, the mold is removed. The specimen is dried for a minimum of 12 hours to constant weight in a 140° oven. The specimen is removed from the oven and cooled to room temperature.

4. ADJUSTMENT AND WEIGHT OF THE LOADED WHEEL TESTER

4.1 The connecting arm bearings and caster assembly are adjusted and secured so that the projected horizontal distance between the crank and wheel axles is 24 inches. The wheel assembly must be aligned so the wheel runs true and parallel with the frame.

4.2 The weight box is centered and secured directly over the wheel axle.

4.3 The wheel is placed on a platform scale so that the connecting arms are parallel with the frame. The lead weights are added to the weight box until the desired weight is obtained.

5. MOUNTING THE SPECIMEN

5.1 The specimen is then placed on the mounting plate firmly against the locating pins and clamped in position with the clamp washers and wing nuts provided.

6. PROCEDURE

6.1 Temperature is maintained at 77°F±2° or as otherwise specified or noted.

6.2 The wheel is inspected and thoroughly cleaned with evaporative solvent and water. The wheel is then placed on the specimen and the weight box is loaded to the desired weight (see note).

6.3 The counter is returned to zero and compaction is started with the electrical switch. The cycles per minute should be 44 at the stated drive ratios. (Caution: Care should be taken to guard the machine against personal contact with the moving parts. Careless, unguarded operation can result in serious injury.)

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6.4 At some point during the compaction, an audible tackiness and visible shine may be noted. At this point, sufficient water to prevent adhesion of the specimen to the wheel must be added from the wash bottle. (With certain aggregates, it may become necessary to liberally flush the wheel path with water to prevent abraded fines from impacting the specimen.) Notation of the revolutions required to reach the tack point is made.

6.5 After 1000 cycles, or as otherwise specified, the machine is stopped, unloaded, and the specimen washed of loose particles and dried at 140°F to constant weight.

6.6 The dried weight of the specimen is noted and the specimen is mounted on the mounting plate in its original position. The sand frame is centered over the specimen and with the foam rubber against the specimen and secured to prevent loss of sand. 300 grams of hot sand (180°F) is uniformly spread in the sand mold. The wheel is immediately loaded on the specimen and 100 cycles is completed.* (see Note 6.6.).

6.7 All loose sand is removed with the vacuum cleaner and the specimen is removed and weighed. The increase in weight due to sand adhesion is noted.

7. REPORT

7.1 The tack point is reported as ___ cycles of ___ pound load at ___ °F.

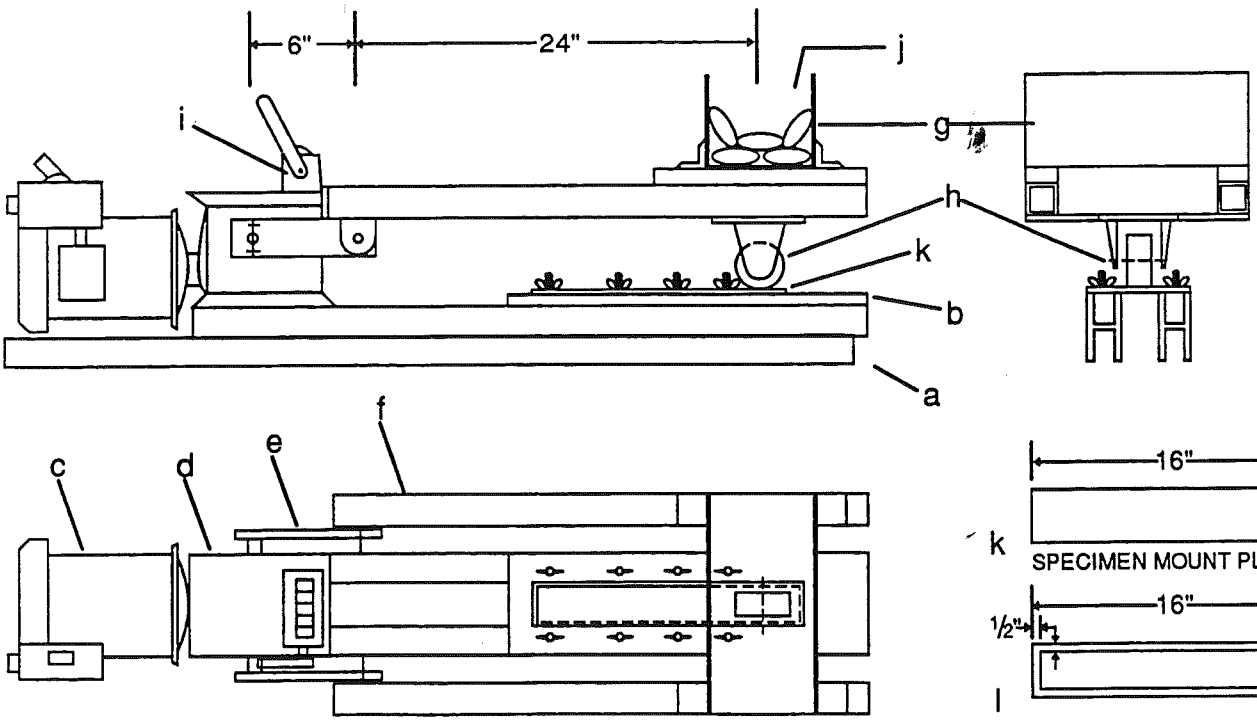
7.2 Sand adhesion is reported as ___ grams adhered after ___ cycles of ___ pound load @ ___ °F.

NOTES:

6.2 In time, solvents may saturate the rubber tire and give false tack point and sand adhesion values. A fine disc sander mounted onto a 1/4" or 3/8" drill is recommended to clean the rubber tire.

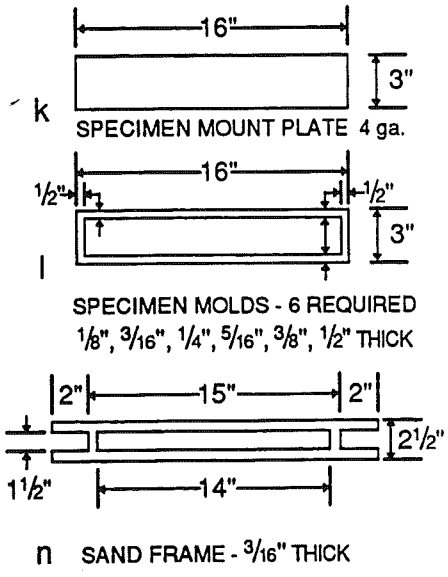
6.6 It is convenient to use 200 grams, preweighed and preheated in a suitable container (e.g., 200 ml beaker). The 200 grams of hot sand is uniformly spread in the sand frame and covered immediately with a preheated metal strip (1/8" x 1 3/8" x 14 7/8"). The compaction wheel then rides on the metal strip. Better reproducibility and less mess is experienced by this method.

6.7 When the metal strip is used, vacuum is unnecessary. The specimen assembly may be removed as a unit, disassembled over a waste container and gently tapped to remove the unadhered sand.



2.1 LOADED WHEEL TESTER

FIGURE 1



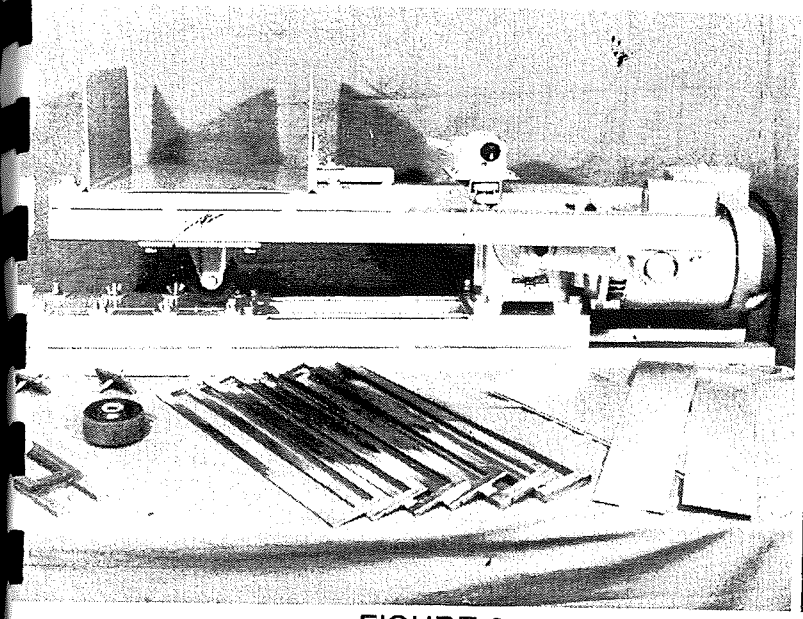


FIGURE 2

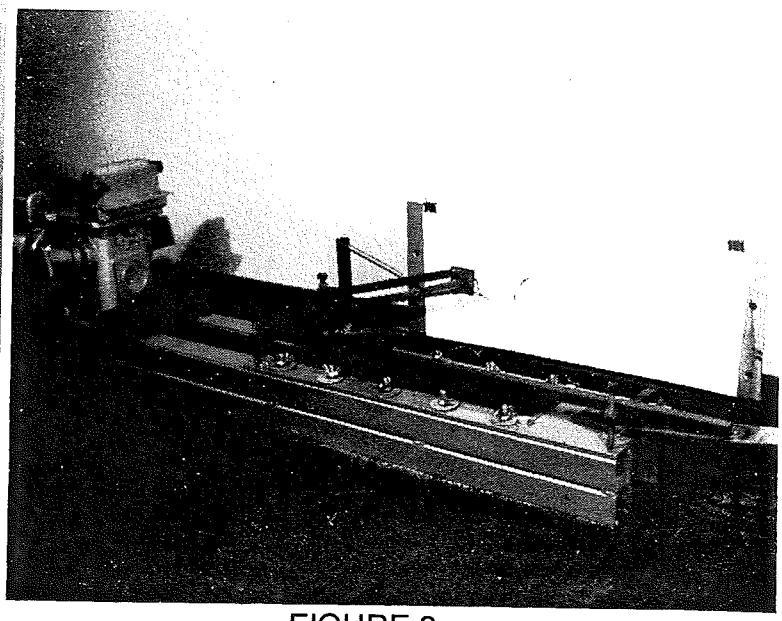


FIGURE 3