



TECHNICAL BULLETIN

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

1.0 Scope

1.1 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 113°F (45°C)
- C) Lai Modified Loaded Wheel Test using variable pressure air hose at 95°F (35°C)

2.0 Applicable Documents and References

- 2.1 ASTM D3910 Standard Practice for Design Testing and Construction of Slurry Seal.
- 2.2 ISSA TB #109, "Test Method 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 g (1.1 lb) mixes.
- A3.2 24 gauge x 3" x 16" (0.61mm x 76.2 mm x 406.4 mm) galvanized steel mounting plates and a mold to contain a specimen cast at 1/2" x 2" x 15" (12.7 mm x 50.8 mm x 381 mm).
- A3.3 Loaded Wheel tester as described in ISSA TB #109 consisting of a 3" (76.2 mm) diameter soft rubber wheel loaded with 125 lbs. (56.7kg). Which reciprocates through a 12" (304.8 mm) horizontal path at the rate of 44 cycles per minutes.
- A3.4 Gauge block .188" x .50" x 4" (4.8 mm x 12.7 mm x 101.6 mm) with 1/4" (6.35 mm) slot and calipers capable of measuring specimen width and depth to within .001" or .01 mm.

A4. Procedure

- A4.1 A 500 g (1.1 lb.) dry aggregate weight mixture is prepared using 0/#4 (0/4.75 mm) 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" (12.7mm x 50.8 mm x 381 mm) mold centered over the 24 gauge (0.61 mm) 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 petroleum or a mixture of glycerin 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 140°F (60°C) for 18-24 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.(56.7 kg) cycles of LWT compaction. The temperature should be maintained at 71.6°F ± 3.6°F (22°C ± 2°C) during the test.
- A4.6 The specimen is then removed from the LWT machine and immediately re-measured laterally and centrally in the wheel path and the results recorded.

A5. Report

The report should include:

- A5.1. Specimen Identification, gradation range, mix formula
- A5.2. Normal thickness of the specimen mold (e.g., ½” (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 the 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 @ 113°F (45°C)

The British TRRL Wheel Tracking Test has a long experience in the predication of pavement rutting performance and in the traffic count design of bituminous pavements. The test is a traffic simulation device which measure the rate of loaded wheel penetration into compacted hot mixed asphaltic concrete. The test is normally performed in a temperature controlled chamber at (113°F) 45°C.

In the Loaded Wheel Test, the wheel moves to and fro in a rocking motion. In the Wheel Tracking Test, the table 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 TRRK Wheel Tracking Test (REF. 2.4.)

- B3.1. “The Wheel-Tracking Test assembly consists of a loaded wheel and a table on which the 12” x 12” x 1.18” (305 mm x 305 mm 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 (9.84”). A 204 mm (8.03”) diameter by 44 mm (1.73”) wide wheel with a tire of solid rubber (80 on the Dunlop hardness scale) applies a total force of 525N (118 pound-force) 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 (1.55 in²), giving a mean normal pressure of 520/550 kN/m². The test is continued until the track depth reaches 15 mm (0.60”) 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	11.2 N/mm
	(63.8 lbs./lin. in.)	(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 (113°F) 45°C and the wheel load is 63.8 lbs/in (11.2 N/mm) 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 113°F (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 un-compacted 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 rutting characteristics of 3" x 3" x 15" (76.2 mm x 76.2 mm x 381 mm) 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" (31.75 mm) 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" (76.2 mm x 76.2 mm x 381 mm) beams is shown in figures C. and includes:

- C3.1 Enlarged base plate 7" x 27" (177.8 mm x 685.8 mm)
- C3.2 4" (101.6 mm) spacer to increase the elevation of the drive assembly
- C3.3. 1-1/2" x 5" (38.1 mm x 127 mm) diameter concave aluminum wheel to replace the standard wheel
- C3.4. Sample holding device (3" (76.2 mm) angle iron frame; inside dimension of 3" x 3" x 15" (76.2 mm x 76.2 mm x 381 mm) to accommodate the specimen
- C3.5. Specimen base plate 1/2" x 3" x 15" (12.7 mm x 76.2 mm x 381 mm)
- C3.6. Linear air hose and holding bracket.
- C3.7. Profile measuring device channel with 1/4" (6.35 mm) lateral slots on 2" (50.8 mm) centers and dial depth gauge reading .001" or .01 mm
- C3.8. Controlled pressure air supply; 100 psi, \pm 2psi (689.5 kPa \pm 13.8 kPa)
- C3.9. Controlled temperature chamber; 105°F \pm 2°F (40.6°C \pm 1.1°C) When used for up to 1" (25.4 mm) thick slurry or microsurface specimens, only items 3,6,7,8 and 9 are necessary.

C4. Procedure for Maximum 1" (25.4 mm) Thick LWT Specimens

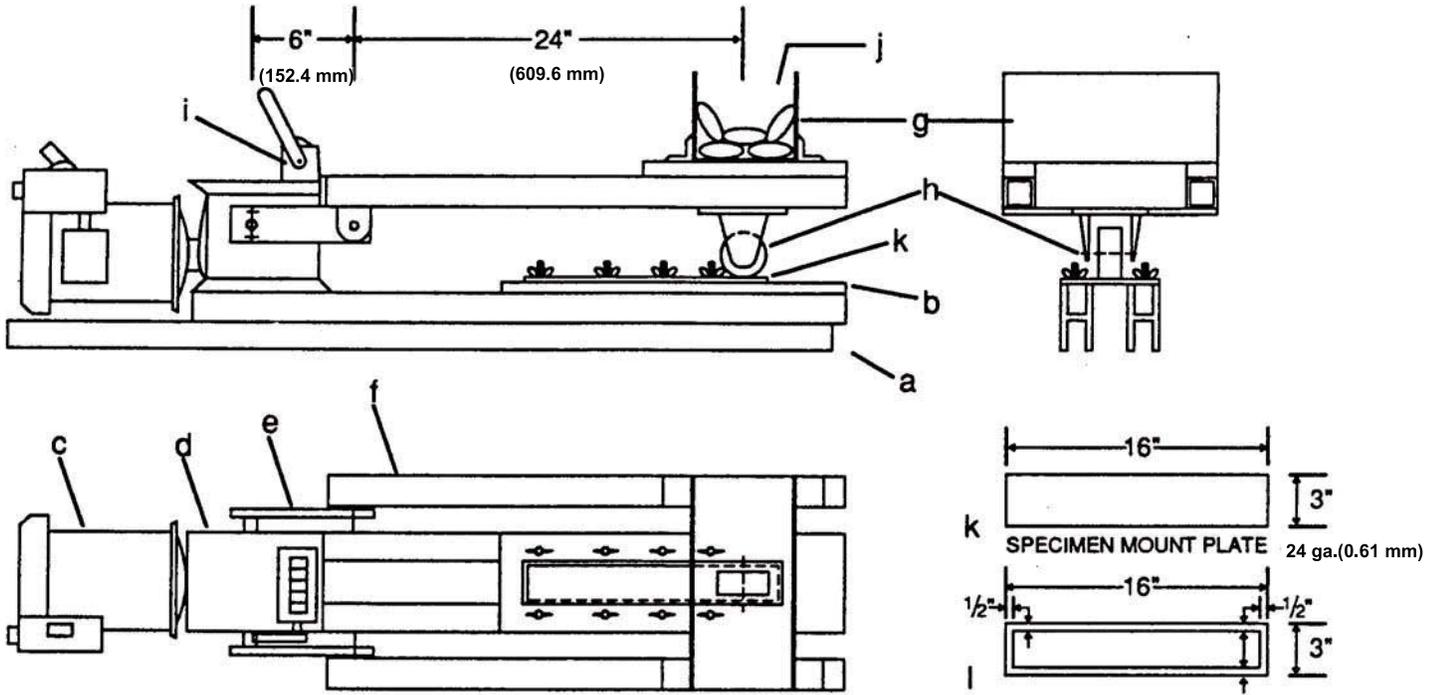
- C4.1 The specimen dimensions are of variable thicknesses x 2" (50.8 mm) x 15" (381 mm) is mounted on the LWT standard 24 gauge x 3" x 16" (0.61 mm x 76.2 mm x 406.4 mm) galvanized metal plaque are conditioned overnight for 8-10 hours in the temperature chamber at 105°F (40.6°C) along with the modified 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 (0.2") increments and recorded.
- C4.3 The linear tube assembly is clamped in place and pressurized to 100 psi \pm 2 psi (689.5 kPa \pm 13.8 kPa). The wheel is positioned and 100 lb. (45.4 kg) Load applied. After returning the revolution counter to zero, the machine is started.

- C4.4 After 1000 cycles, the apparatus is stopped, disassembled and re-measured 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

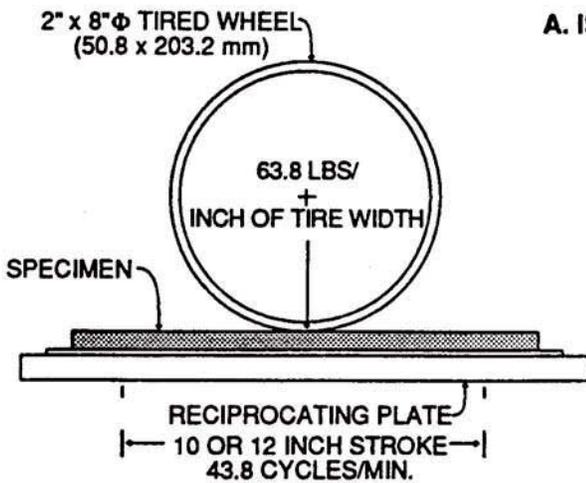
- C5.1 Specimen identification, gradation range, mix formula.
- C5.2 Nominal thickness of the specimen mold (e.g., 1/2" (12.7 mm)) and compaction state (The WTT compacted specimens may be used) and whether the specimen was confined or unconfined.
- C5.3 Specimen net weight.
- C5.4 Number of cycles run, 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 \pm 2" (50.8 mm) 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 essential parallel. The best results at 1000, 100-lb. (45.4 kg) Cycles at 100 psi (689.5 kPa) hose pressure and 95°F (35°C) 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 (40.6°C) and adopted as the standard temperature.

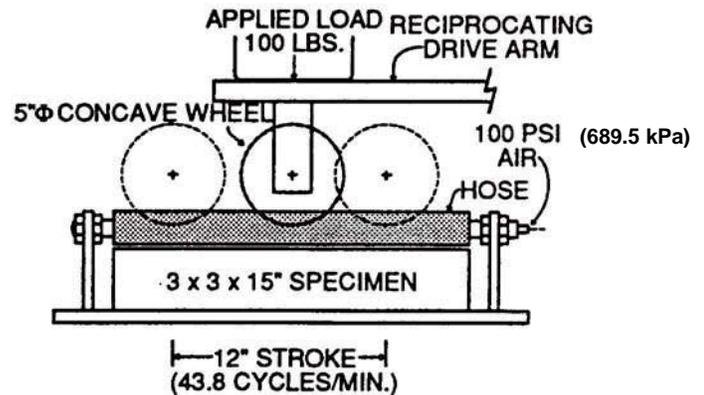


A. ISSA TB #109 LWT.

SPECIMEN MOUNT PLATE
24 ga.(0.61 mm)
SPECIMEN MOLDS - 6 REQUIRED
1/8", 3/16", 1/4", 5/16", 3/8", 1/2" THICK
3.18, 4.76, 6.35, 7.94, 9.53, 12.7 mm Thick

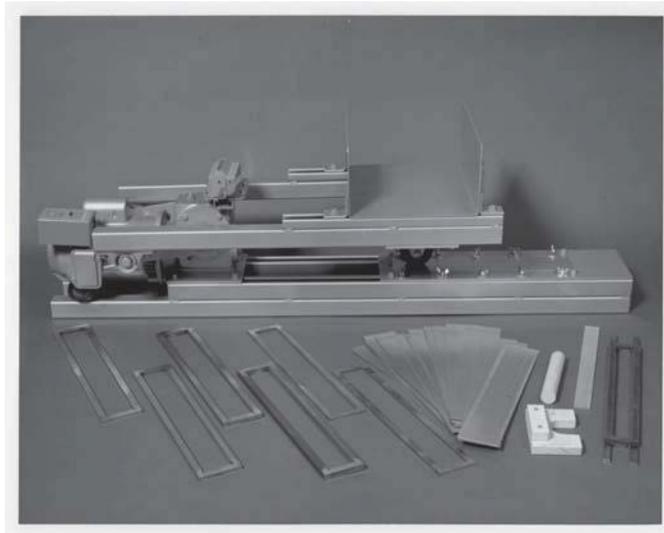


**B. U.S. MODIFIED WHEEL TRACKING TEST
(115°F, 45°C)**

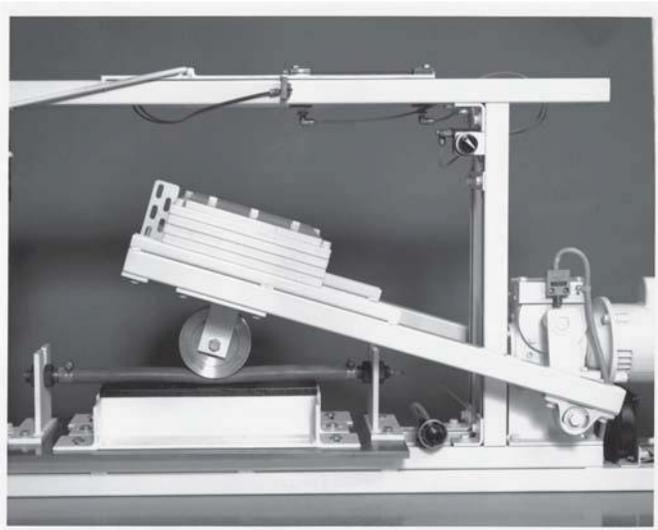


**C. GEORGIA DOT MODIFIED LOADED WHEEL TEST
(105°F-40.6°C)**

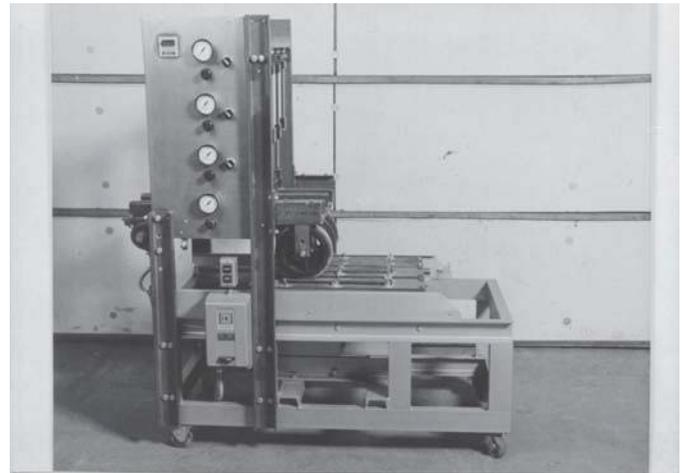
Additional Conversions								
U.S. Units	63.8 lbs./lin. in.	100 lbs.	1"	3"	5"	10"	12"	15"
Metric Units	11.2 N/mm	45.4 kg	25.4 mm	76.2 mm	127 mm	254 mm	304.8 mm	381 mm



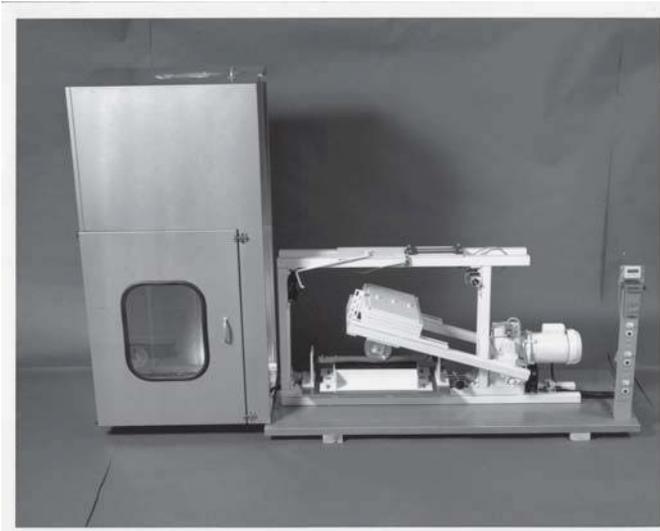
A. ISSA TB#109 LOADED WHEEL TEST MACHINE



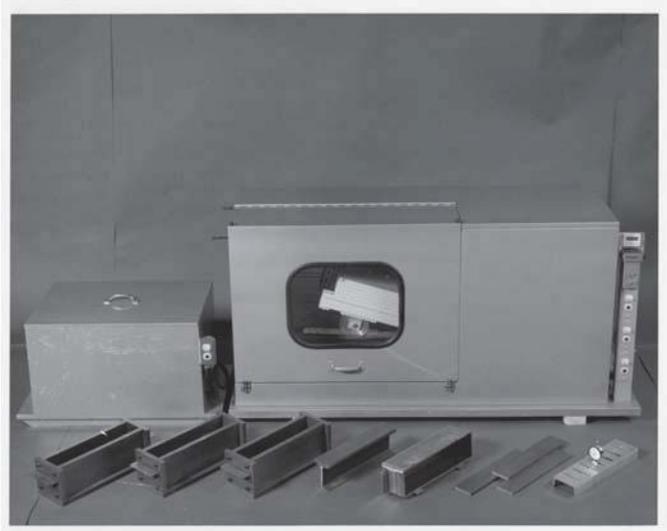
C. GA. DOT HOSE MODIFIED LWT



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



C. GA. DOT LWT W/ENVIRONMENTAL CHAMBER REMOVED



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