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~~Designation:D6926–04~~ Designation: D6926 – 10

Standard Practice for Preparation of Bituminous Specimens Using Marshall Apparatus[1]

This standard is issued under the fixed designation D6926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers preparation and compaction of 102 mm (4 in.) diameter by nominal 64 mm (2.5 in.) high cylindrical bituminous paving mixture specimens by means of the original manual Marshall method and subsequent variations of the method (Test Method D6927). This practice is intended for use with laboratory and plant produced bituminous mixtures with aggregate up to 25 mm (1 in.) maximum size and for recompaction of asphalt pavement samples.

1.2 There are three types of Marshall compaction apparatus in use. The following types of hammer arrangements are included in this practice:

1.2.1 Manually held hammer handle attached to a flat compaction foot through a spring loaded swivel and is hand operated (original standard developed by the Corps of Engineers).

1.2.2 Hammer handle restrained laterally (fixed) but not vertically attached to a flat compaction foot through a spring loaded swivel and is either mechanically or hand operated. There may or may not be a constant surcharge on top of the hammer handle. Mechanical hammers are available that operate at *(1)* nominal 55 blows per minute and *(2)* equal to or greater than 75 blows per minute.

1.2.3 Hammer handle restrained laterally (fixed) with constant surcharge on top of hammer, a slanted compaction foot, rotating mold base, and is mechanically operated.

1.3 Although the mass and height of mass drop for each apparatus are the same, density achieved in compacted specimens with the same number of blows will be different. It is up to the user to establish the specific required number of blows to be used for compaction of the specimen in relation to the field.

1.4 *Units*—The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.5 The text of this standard references notes and footnotes which provide explanatory material. These notes and footnotes (excluding those in tables and figures) shall not be considered as requirements of the standard.

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2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~D2171 Test Method for Viscosity of Asphalts by Vacuum Capillary Viscometer~~

D2493 Standard Viscosity-Temperature Chart for Asphalts

~~D4402 Test Method for Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer~~

D3666 Specification for Minimum Requirements for Agencies Testing and Inspecting Road and Paving Materials

D6927 Test Method for Marshall Stability and Flow of Bituminous Mixtures

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

3. Significance and Use

3.1 Compacted bituminous mixture specimens molded by this procedure are used for various physical tests such as stability, flow, indirect tensile strength, fatigue, creep, and modulus. Density and voids analysis are also conducted on specimens for mixture design and evaluation of field compaction.

NOTE 1—Uncompacted mixtures are used for determination of theoretical maximum specific gravity.

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[1] This practice is under the jurisdiction of ASTM Committee D04 on Road and Paving Materials and is the direct responsibility of Subcommittee D04.20 ~~on Mechanical Tests of Bituminous Mixes.~~ on Mechanical Tests of Bituminous Mixtures.

~~Current edition approved Aug. 1, 2004. Published August 2004. DOI: 10.1520/D6926-04.~~

Current edition approved June 15, 2010. Published September 2010. Originally approved in 2004. Last previous edition approved in 2004 as D6926–04 DOI: 10.1520/D6926-10.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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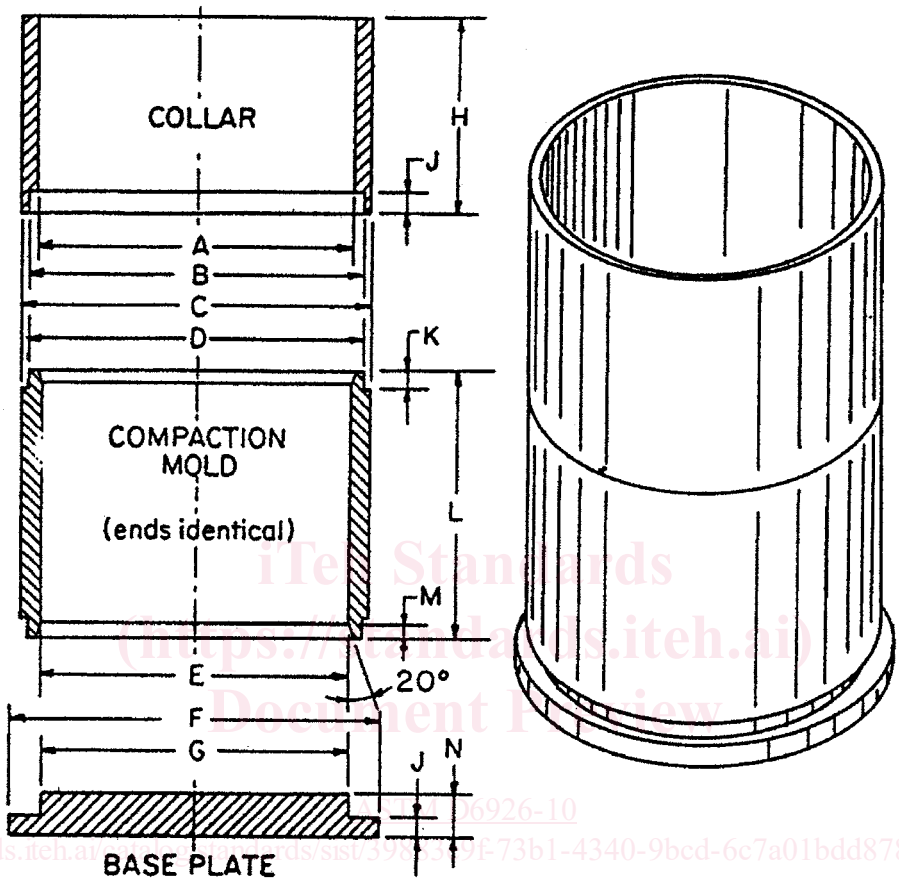
4. Apparatus

4.1 *Specimen Mold Assembly*—Mold cylinders, base plates, and extension collars shall conform to the details shown in Fig. 1.

4.2 *Specimen Extractor*—The specimen extractor shall have a steel disk that will enter the mold without binding and not be less than ~~100 mm (3.95 in.)~~3.95 in. (100 mm) in diameter and ~~12.5 mm (½ in.)~~½ in. (12.5 mm) thick. The steel disk is used for extracting compacted specimens from molds with the use of the mold collar. Any suitable extraction device such as a hydraulic



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	~~mm~~ in.	~~in.~~ (mm)
~~A~~	~~104.1 to 105.4~~	~~4.100 to 4.150~~
A	4.100 to 4.150	(104.1 to 105.4)
~~B~~	~~109.1 to 110.2~~	~~4.295 to 3.439~~
B	4.295 to 3.439	(109.1 to 110.2)
~~C~~	~~114.0 to 115.8~~	~~4.490 to 4.560~~
C	4.490 to 4.560	(114.0 to 115.8)
~~D~~	~~107.0 to 109.7~~	~~4.211 to 4.320~~
D	4.211 to 4.320	(107.0 to 109.7)
~~E~~	~~101.3 to 101.7~~	~~3.990 to 4.005~~
E	3.990 to 4.005	(101.3 to 101.7)
~~F~~	~~119.9 to 121.4~~	~~4.720 to 4.780~~
F	4.720 to 4.780	(119.9 to 121.4)
~~G~~	~~101.1 to 101.3~~	~~3.980 to 3.990~~
G	3.980 to 3.990	(101.1 to 101.3)
~~H~~	~~69.3 to 70.4~~	~~2.730 to 2.770~~
H	2.730 to 2.770	(69.3 to 70.4)
~~J~~	~~7.0 to 7.2~~	~~0.235 to 0.285~~
J	0.235 to 0.285	(7.0 to 7.2)
~~K~~	~~6.1 to 6.7~~	~~0.235 to 0.265~~
K	0.235 to 0.265	(6.1 to 6.7)
~~L~~	~~86.9 to 87.9~~	~~3.420 to 3.460~~
L	3.420 to 3.460	(86.9 to 87.9)
~~M~~	~~3.0 to 4.8~~	~~0.120 to 0.190~~
M	0.120 to 0.190	(3.0 to 4.8)
~~N~~	~~12.3 to 14.9~~	~~0.485 to 0.585~~
N	0.485 to 0.585	(12.3 to 14.9)

FIG. 1 Compaction Mold

jack apparatus or a lever arm device may be used, provided the specimens are not deformed during the extraction process.

4.3 *Compaction Hammers*:

4.3.1 *Compaction Hammers with a Manually Held (Type 1) or Fixed (Type 2) Handle*, either mechanically or hand operated as generally shown in Fig. 2~~, shall have a flat, circular compaction foot with spring loaded swivel and a 4.54 ± 0.01 kg (10 ± 0.02 lb) sliding mass with a free fall of 457.2 ± 1.5 mm (18 ± 0.06 in.) (see~~ , shall have a flat, circular compaction foot with spring loaded swivel and a 10 ± 0.02 lb (4.54 ± 0.01 kg) sliding mass with a free fall of 18 ± 0.06 in. (457.2 ± 1.5 mm) (see Fig. 2 for hammer tolerances). A typical mechanical hammer is shown in Fig. 3.

NOTE 2—Manual compaction hammers should be equipped with a finger safety guard.

4.3.2 *Compaction Hammers with a Fixed Hammer Handle*~~, surcharge on top of handle, constantly rotating base, and mechanically operated (Type 3) as generally shown in Fig. 4 shall have a slanted, circular tamping face and a 4.54 ± 0.01 kg (10 ± 0.02 lb) sliding weight with a free fall of 457.2 ± 1.5 mm (18 ± 0.06 in.) (see~~ , surcharge on top of handle, constantly rotating base, and mechanically operated (Type 3) shall have a slanted, circular tamping face and a 10 ± 0.02 lb (4.54 ± 0.01 kg) sliding weight with a free fall of 18 ± 0.06 in. (457.2 ± 1.5 mm) (see Fig. 2 ~~and Fig. 4~~ for hammer and tamping face bevel angle and tolerances, respectively). A rotating mechanism is incorporated in the base. The base rotation rate and hammer blow rate shall be 18 to 30 rpm and 64 ± 4 blows per minute, respectively.

NOTE 3—Type 3 Marshall hammer apparatus are available in versions with more than one hammer. Multiple hammer operation will affect specimen density and is not recommended. Best comparative results will be obtained by compacting all specimens with the same hammer and with no other hammers operating.

4.4 *Compaction Pedestal*~~—The compaction pedestal shall consist of a nominal 203.2 by 203.2 mm (8 by 8 in.) wooden post approximately 457 mm (18 in.) long capped with a steel plate approximately 304.8 by 304.8 mm (12 by 12 in.) and 25.4 mm (1 in.) thick. The wooden post shall be oak, yellow pine, or other wood having an average dry density of 670 to 770 kg/m~~—The compaction pedestal shall consist of a nominal 8 by 8 in. (203.2 by 203.2 mm) wooden post approximately 18 in. (457 mm) long capped with a steel plate approximately 12 by 12 in. (304.8 by 304.8 mm) and 1 in. (25.4 mm) thick. The wooden post shall be oak, yellow pine, or other wood having an average dry density of 42 to 48 lb/ft^3 ~~(42 to 48 lb/ft (670 to 770 kg/m^3~~). The wooden post shall be secured by bolts through four angle brackets to a solid concrete slab. The steel cap shall be firmly fastened to the post. The pedestal assembly shall be installed so that the post is plumb and the cap is level.

4.5 *Specimen Mold-Holder*—With single hammer compactors, the holder shall be mounted on the compaction pedestal so as to center the compaction mold over the center of the post. Specimen mold-holders of multi-hammer compactors are not necessarily centered. The holders shall hold the compaction mold, collar, and base plate securely in position during compaction of the specimen.

4.6 *Ovens, Heating Pots or Hot Plates*—Circulating air ovens or thermostatically controlled heating pot and hot plates shall be provided for heating aggregates, bituminous material, specimen molds, compaction hammers, and other equipment to within ~~3°C (5°F)~~5°F (3°C) of the required mixing and compaction temperatures. Suitable shields, baffle plates, or sand baths shall be used on the surfaces of the hot plates to minimize localized overheating.

4.7 *Mixing Apparatus*—Mechanical mixing is recommended. Any type of mechanical mixer may be used provided the mix can be maintained at the required temperature and mixing will produce a well-coated, homogeneous mixture of the required amount in the allowable time, and further provided that essentially all of the batch can be recovered. A metal pan or bowl of sufficient capacity for hand mixing may also be used.

4.8 *Miscellaneous Equipment*:

4.8.1 *Containers for Heating Aggregates*, flat-bottom metal pans, or other suitable containers.

4.8.2 *Covered Containers for Heating Bituminous Material*, either gill-type tins, beakers, pouring pots, or saucepans may be used.

4.8.3 *Mixing Tools*, shall consist of a steel trowel (Mason's pointing trowel with point rounded), spoon or spatula, for spading and hand mixing.

4.8.4 ~~*Calibrated Thermometers*, for determining temperatures of aggregates, bitumen, and bituminous mixtures. Armored-glass or dial-type thermometers with metal stems are recommended. A range from 10 to 200°C (50 to 400°F) with sensitivity of 3°C (5°F) is required.~~ Thermometer(s)—temperature measuring device(s) readable to 2°F (1°C) for checking mixing and compacting temperatures.

4.8.5 ~~*Balance*, readable to at least 0.1 g for batching mixtures.~~ Calibrated Thermometers, for determining temperatures of aggregates, bitumen, and bituminous mixtures. Armored-glass or dial-type thermometers with metal stems are recommended. A range from 50 to 400°F (10 to 200°C) with sensitivity of 3°C (5°F) is required.

NOTE 4—Standardization practices specified in Specification D3666 are recommended for the thermometer used in this test method. Dial thermometer may exhibit inaccuracies due to frequently use or mishandling. It is recommended that the standardization of dial thermometers be conducted more frequently by a comparison to a reference thermometric device of equal or greater readability at a temperature within the range of intended use.

4.8.6 *Balance*, readable to at least 0.1 g (0.004 oz (avoir)) for batching mixtures.

4.8.7 *Gloves*, for handling hot equipment.

~~4.8.7~~

4.8.8 *Marking Crayons*, for identifying specimens.

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