Designation: ~~D6926 – 10~~ D6926 – 16

Standard Practice for Preparation of ~~Bituminous~~ Asphalt Mixture 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.)~~4 in. (101.6 mm) diameter by nominal ~~64 mm (2.5 in.)~~ 2.5 in. (63.5 mm) high cylindrical ~~bituminous paving mixture specimens by means of the original manual Marshall method and subsequent variations of the method (Test Method~~ asphalt paving mixture specimens. ~~D6927).~~ This practice is intended for use with laboratory and ~~plant produced bituminous~~ plant-produced asphalt mixtures with aggregate up to ~~25 mm (1 in.)~~ 1 in. (25.4 mm) maximum size and for recompaction of asphalt ~~pavement~~ paving mixture 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 is attached to a flat compaction foot through a ~~spring loaded~~ spring-loaded swivel and is hand operated (original standard developed by the United States Army Corps of Engineers).

1.2.2 Hammer handle restrained laterally (fixed) but not vertically, attached to a flat compaction foot through a ~~spring loaded~~ 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~~or *(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, is attached to a slanted compaction ~~foot,~~ foot on a rotating mold base, and is mechanically operated. This method must be used as a referee method.

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~~ owner or specifier 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.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

~~D2493~~D8 ~~Standard Viscosity-Temperature Chart for Asphalts~~Terminology Relating to Materials for Roads and Pavements

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

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

D6927 Test Method for Marshall Stability and Flow of Asphalt Mixtures

E1 Specification for ASTM Liquid-in-Glass Thermometers

E11 Specification for Woven Wire Test Sieve Cloth and Test Sieves

E77 Test Method for Inspection and Verification of Thermometers

E2251 Specification for Liquid-in-Glass ASTM Thermometers with Low-Hazard Precision Liquids

[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~~Asphalt Mixtures.

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[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.

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this practice, refer to Terminology D8.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lab mix lab compacted (LMLC) asphalt mixture, n*—asphalt mix samples that are prepared in the laboratory by weighing and blending each constituent then compacting the blended mixture after two hours of curing at the compaction temperature or curing time specified by the owner, using a laboratory compaction apparatus.

3.2.1.1 *Discussion—*

LMLC typically occurs during the asphalt mixture design phase.

3.2.2 *plant mix laboratory compacted (PMLC) asphalt misture, n*—asphalt mix samples that are manufactured in a production plant, sampled prior to compaction, then immediately compacted using a laboratory compaction apparatus.

3.2.2.1 *Discussion—*

PMLC specimens are often used for quality control testing. This designation is limited to specimens that have not been permitted to cool substantially, but PMLC samples may be placed in a laboratory oven to equilibrate the mix to the compaction temperature before molding.

3.2.3 *reheated plant mix lab compacted (RPMLC) asphalt mixture, n*—asphalt mix samples that are manufactured in a production plant, sampled prior to compaction, allowed to cool to room temperature, then reheated in a laboratory oven and compacted using a laboratory compaction apparatus.

3.2.3.1 *Discussion—*

RPMLCs are often used for quality acceptance and verification testing. The reheating is as brief as possible to obtain uniform temperature while avoiding artificial aging of the specimens. Asphalt mix conditioning, reheat temperature, and reheat time should be defined in the applicable specification.

4. Significance and Use

4.1 Compacted ~~bituminous~~asphalt 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~~void 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.

NOTE 2—The quality of the results produced by this practice are dependent on the competence of the personnel performing the procedure and the capability, calibration, and maintenance of the equipment used. Agencies that meet the criteria of Specification D3666 are generally considered capable of competent and objective testing, sampling, inspection, etc. Users of this practice are cautioned that compliance with Specification D3666 alone does not completely ensure reliable results. Reliable results depend on many factors; following the suggestions of Specification D3666 or some similar acceptable guideline provides a means of evaluating and controlling some of those factors.

5. Apparatus

5.1 *Specimen Mold Assembly*—Mold cylinders, base plates, and extension collars shall conform to the details shown in Fig. 1~~.~~ (Compaction Mold).

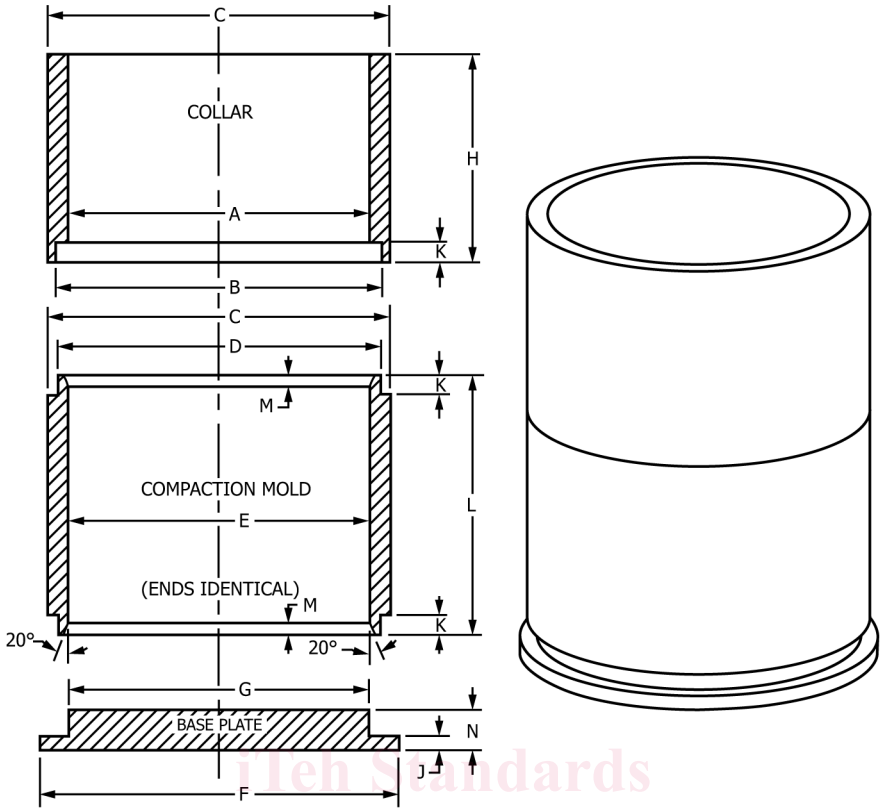
5.2 *Specimen Extractor*—The specimen extractor shall have a steel disk that will enter the mold without binding and not be less than 3.95 in. ~~(100~~(100.3 mm) in diameter and ~~½~~0.5 in. ~~(12.5~~(12.7 mm) thick. The steel disk is used for extracting compacted specimens from molds with the use of the mold collar. Any suitable extraction device such as a hydraulic jack apparatus or a lever arm device may be used, provided the specimens are not deformed during the extraction process.

5.3 *Compaction Hammers:*

5.3.1 *Compaction Hammers with a Manually Held (Type 1) or Fixed (Type 2) Handle,* either mechanically or hand operated as generally shown in ~~Fig. 2~~Figs. 2 and 3, shall have a flat, circular compaction foot with ~~spring loaded~~ spring-loaded swivel and a 10 ± 0.02 lb ~~(4.54~~(4.545 ± ~~0.01~~0.009 kg) sliding mass with a free fall of 18 ± ~~0.06 in.~~ 0.06 in. (457.2 ± 1.5 mm) (see Fig. 2 for hammer tolerances). A typical ~~mechanical~~ manual compaction hammer is shown in Fig. 2. A typical mechanical hammer is showed in Fig. 3.

NOTE 3—Manual compaction hammers should be equipped with a finger safety guard.

5.3.2 *Compaction Hammers with a Fixed Hammer Handle,* surcharge on top of handle, constantly rotating base, and mechanically operated (Type ~~3)~~3), shall have a slanted, circular tamping face and a 10 ± 0.02 lb ~~(4.54~~(4.536 ± ~~0.01~~0.009 kg) sliding weight with a free fall of 18 ± 0.06 in. (457.2 ± 1.5 ~~mm) (see~~mm). See Fig. ~~2~~4 (Hammer Bevel Detail) for hammer and



	in.	(mm)
A	4.100 to 4.150	(104.1 to 105.4)
~~B~~	~~4.295 to 3.439~~	~~(109.1 to 110.2)~~
B	4.295 to 4.339	(109.1 to 110.2)
C	4.490 to 4.560	(114.0 to 115.8)
D	4.211 to 4.320	(107.0 to 109.7)
E	3.990 to 4.005	(101.3 to 101.7)
F	4.720 to 4.780	(119.9 to 121.4)
G	3.980 to 3.990	(101.1 to 101.3)
H	2.730 to 2.770	(69.3 to 70.4)
~~J~~	~~0.235 to 0.285~~	~~(7.0 to 7.2)~~
J	0.120 to 0.285	(3.0 to 7.2)
~~K~~	~~0.235 to 0.265~~	~~(6.1 to 6.7)~~
K	0.235 to 0.295	(6.0 to 7.5)
L	3.420 to 3.460	(86.9 to 87.9)
M	0.120 to 0.190	(3.0 to 4.8)
N	0.485 to 0.585	(12.3 to 14.9)

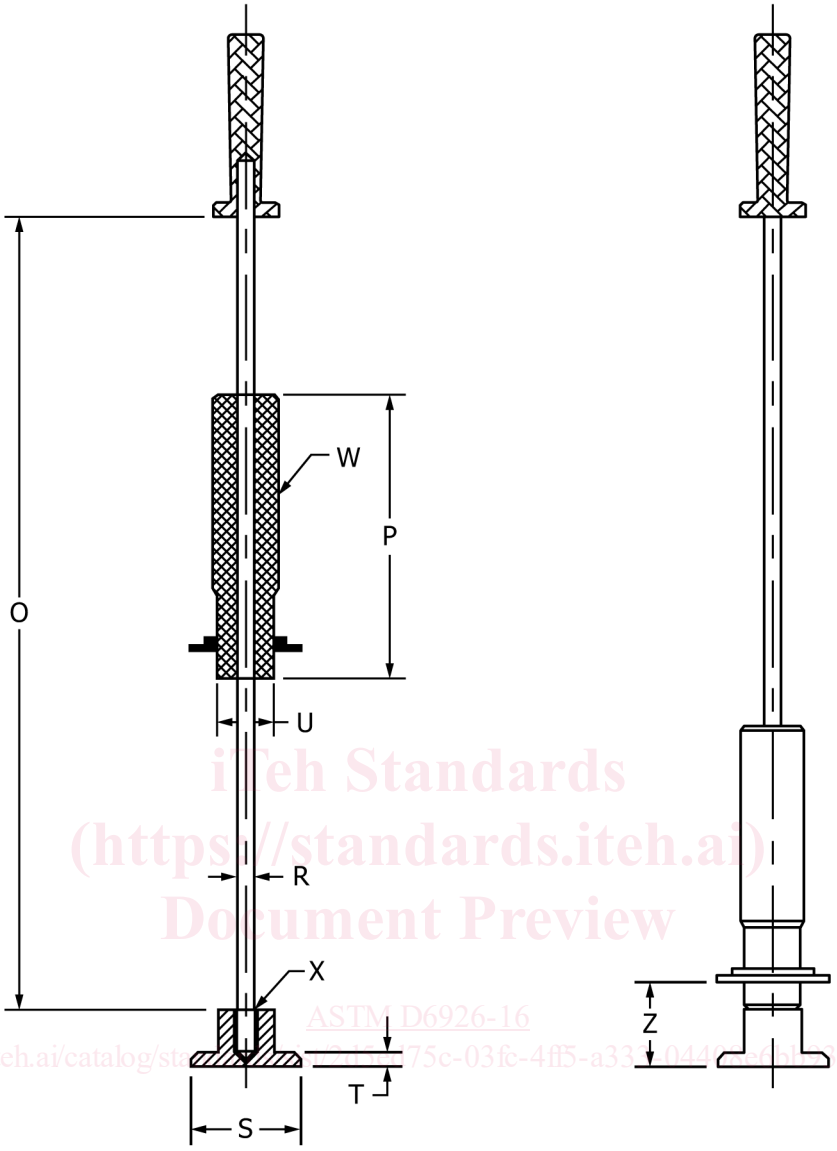
FIG. 1 Compaction Mold

tamping face bevel angle and tolerances, ~~respectively).~~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 4—~~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.~~may affect the density of the samples.

5.4 *Compaction Pedestal*—The compaction pedestal shall consist of a ~~nominal 8~~ 7.5 in. by ~~8~~8.0 in. ~~(203.2~~(191.0 mm by 203.2 mm) wooden post approximately 18 in. ~~(457~~(457.2 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~~ 48 lb ~~lb/ft~~/ft^3 ~~(670~~ (674.2 to ~~770~~770.5 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.

5.5 *Specimen ~~Mold-Holder—~~Mold Holder*—With ~~single hammer~~ 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.



		in.	(mm)
O – P	Drop Distance	17.94 to 18.06	(455.7 to 458.7)
Q	Guide Bushing	. . .	. . .
R	Guide Rod Nominal Diameter	0.625	(15.9)
S	Face Diameter Hardened Impact Resistant	3.860 to 3.960	(98.0 to 100.6)
T	Foot Thickness	0.450 to 0.550	(11.4 to 14.0)
U	Weight Face Diameter	1.960 to 2.040	(49.8 to 51.8)
X	Spring	. . .	. . .
Z	Finger Guard	2.95 to 4.50	(75.0 to 114.3)
		lb.	(kg)
W	Weight Mass	9.98 to 10.02	(4.527 to 4.545)

FIG. 2 Manual Compaction Hammer

5.6 *Ovens, Heating Pots or Hot Plates*—Circulating air ovens or thermostatically controlled heating ~~pot~~pots and hot plates shall be provided for heating aggregates, ~~bituminous~~asphalt material, specimen molds, compaction hammers, and other equipment to within ~~5°F (3°C)~~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.

5.7 *Mixing Apparatus*—Mechanical mixing is ~~recommended.~~ recommended, but also can be mixed manually. 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.