Designation: F3415 – 20

Standard Test Method for Triaxial Shear Strength and Cohesion of Equine Sports Surfaces[1]

This standard is issued under the fixed designation F3415; 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 adapted test method covers the determination of strength and stress-strain relationships of a cylindrical specimen of a compacted, drained cohesive natural or synthetic soil surface used in equine sports surfaces. Specimens are isotropically consolidated and sheared in compression at a constant rate of axial deformation (strain controlled).

1.2 The shear strength of an equine sports surface material describes the resistance of the material to sliding of the surface layers. Shear strength influences both slide and penetration of the hoof in the track surface. It is generally accepted that a small amount of slide on impact is desirable (**1-3**).[2] However, the surface must have sufficient shear strength to support the horse during propulsion (**1-5**). Thus, an optimal shear strength would be expected for an equestrian surface.

1.3 To determine the shear strength of an equine sports surface, a representative dirt or synthetic sample is placed into a cylindrical cell and a vertical load is applied. Shear strength is measured as per the procedures outlined in Test Method D4767 for lab-consolidated samples. This ASTM standard was adapted by Racing Surfaces Testing Laboratory for the drained condition to more accurately model the conditions of an equestrian surface.

1.4 Dirt samples are tested over a range of forming moisture contents to determine the maximum bulk density and optimal forming moisture content for a given energy input. The dirt samples are then compacted at this optimal moisture content. The maximum stress failure criteria is assumed and results are presented as the failure stress at 15 psi confining pressure versus sample forming moisture content, along with friction angle and cohesion.

1.5 Synthetic samples with good drainage are tested at a 4% forming moisture content, and over a specified range of temperatures. The temperature is controlled using a heated/refrigerated water bath with a triaxial cell cap fitted with a copper coil. Failure criteria is assumed under similar conditions for the dirt surfaces, and results are presented as the failure stress at 15 psi confining pressure versus sample temperature, along with friction angle and cohesion.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D4767 Test Method for Consolidated Undrained Triaxial Compression Test for Cohesive Soils

3. Terminology

3.1 *Definitions:*

3.1.1 *failure, n*—stress condition at failure for a test specimen.

3.1.1.1 *Discussion*—Failure for dirt is taken at 15 psi confining pressure versus sample forming moisture content, along with friction angle and cohesion. Failure for a synthetic sample is taken under similar conditions for dirt surfaces, and results are presented as the failure stress at 15 psi confining pressure versus sample temperature, along with friction angle and cohesion.

3.1.2 *shear strength, n*—resistance of the material to sliding of the surface layers.

3.1.3 *triaxial shear test, n*—method to measure the mechanical properties of deformable solids and other granular materials or powders.

[1] This test method is under the jurisdiction of ASTM Committee F08 on Sports Equipment, Playing Surfaces, and Facilities and is the direct responsibility of Subcommittee F08.28 on Equestrian Surfaces.

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[2] The boldface numbers in parentheses refer to a list of references at the end of this standard.

[3] 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.

4. Summary of Test Method

4.1 The test is done by creating a cylindrical-shaped, 70 mm-diameter, 150 mm-tall compacted sample using a rubber membrane and an aluminum shell mold. Once the compacted sample (with membrane) is removed from the mold, the sample is placed in a cylindrical Plexiglas cell which is then filled with water, placed in a tensile test machine, and subjected to a vertical compressive load until failure is reached (Fig. 1). Tests are conducted at various confining pressures, moisture contents, and temperatures depending on whether the sample is dirt or synthetic. The samples are compacted in six 25 mm (1 in.) lifts to reach the sample height of 150 mm (6 in.). Tests are performed at confining pressures of 5, 10, 15 and 20 psi and are conducted for both dirt and synthetic surface samples.

5. Significance and Use

5.1 To test the shear strength of a materials describing how the material resists sliding of surface layers. Data from these tests are used to calculate the friction angle and cohesion of a surface sample. This test can be used to help determine if a material falls within a suitable for equine sports surfaces.

6. Interferences

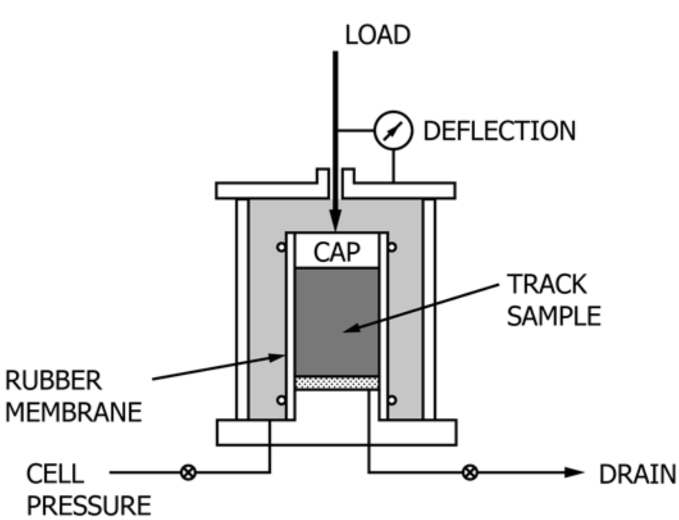
6.1 Accurate moisture content is important for consistent test results.

6.2 Similar compaction between samples are also critical for consistent results.

7. Apparatus

7.1 *Triaxial Shear Strength Apparatus*—Fig. 1 illustrates the general experimental setup once the compacted sample with rubber membrane are removed from the metal mold. Note that the heating/cooling coil is not depicted in the figure.

7.2 *Axial Loading Device*—The axial loading device shall be a screw jack driven by an electric motor through a geared transmission, a hydraulic loading device, or any other compression device with sufficient capacity and control to provide the rate of axial strain (loading) prescribed in Test Method D4767. The rate of advance of the loading device shall not deviate by more than 61 % from the selected value. Vibration due to the operation of the loading device shall be sufficiently small to not cause dimensional changes in the specimen.



NOTE 1—Copper water coil for synthetic surfaces not shown.

FIG. 1 Diagram of Triaxial Shear Strength Apparatus

7.3 *Axial Load Measuring Device*—The axial load- measuring device shall be a load ring, electronic load cell, hydraulic load cell, or any other load-measuring device capable of the accuracy prescribed in this paragraph and may be a part of the axial loading device. The axial load-measuring device shall be capable of measuring the axial load to an accuracy of within 1 % of the axial load at failure. If the load-measuring device is located inside the triaxial compression chamber, it shall be insensitive to horizontal forces and to the magnitude of the chamber pressure.

8. Test Specimen Preparation

8.1 Test sample size needed is at least 2000 g and furnace-heated to remove all moisture from sample before testing per ASTM Equine surface moisture removal spec. Any foreign matter also needs to be removed from the sample to include rubber bits greater than 1 cm in length or diameter before weighing. After cleaning, the following steps need to be completed for sample preparation: a) Cover the bottom O-ring of aluminum mold with aluminum foil and or carefully clean the mating surfaces b) transfer material to the inside of the membrane c) compact with hand (or other tamper) based on bulk density energy input d) repeat (a) and (b) until material is level with the top lip of the mold – add/remove material as needed on the top surface to ensure that it is level. There should be a total of 6 layers. If, during compaction, it becomes clear that initial amount of material per layer is too much or too little, the amount of material per layer may be adjusted.

9. Preparation of Apparatus

9.1 If the test is to be done at a specific temperature, turn on the water bath and set the water bath temperature to the desired testing temperature, typically determined as the average temperature during the summer or winter for the track specific climate region.

9.2 Turn on the tensile test machine load frame and the air compressor.

9.3 Apply vacuum grease liberally to bottom of Plexiglas sample shell and to bottom large Oring. Place onto triaxial cell base. Close all the valves on base except for the one furthest to the right and fill the cell approximately 2 in. from the top with tap water. Clean off the top of the Plexiglas shell and apply vacuum grease.

9.4 Lift the load piston of the triaxial cell cap, and confirm that it will fall under its own weight. Confirm that the large O-ring is properly sitting inside the groove the triaxial cell cap. Put the load piston into the top cap of the specimen and lower the triaxial cell cap onto the Plexiglas shell. If running a test at a temperature other than ambient, make sure to use the test cell cap fitted with a copper coil for water circulation and heat transfer. Ensure the water temperature has achieved thermal