



Standard Test Method for Load Controlled Cyclic Triaxial Strength of Soil¹

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1. Scope

1.1 This test method covers the determination of the cyclic strength (sometimes called the liquefaction potential) of saturated soils in either undisturbed or reconstituted states by the load-controlled cyclic triaxial technique.

1.2 The cyclic strength of a soil is evaluated relative to a number of factors, including: the development of axial strain, magnitude of applied cyclic stress, number of cycles of stress application, development of excess pore-water pressure, and state of effective stress. A comprehensive review of factors affecting cyclic triaxial test results is contained in the literature (1).²

1.3 Cyclic triaxial strength tests are conducted under undrained conditions to simulate essentially undrained field conditions during earthquake or other cyclic loading.

1.4 Cyclic triaxial strength tests are destructive. Failure may be defined on the basis of the number of stress cycles required to reach a limiting strain or 100 % pore pressure ratio. See Section 3 for Terminology.

1.5 This test method is generally applicable for testing cohesionless free draining soils of relatively high permeability. When testing well-graded materials, silts, or clays, it should be recognized that pore-water pressures monitored at the specimen ends do not in general represent pore-water pressure values throughout the specimen. However, this test method may be followed when testing most soil types if care is taken to ensure that problem soils receive special consideration when tested and when test results are evaluated.

1.6 There are certain limitations inherent in using cyclic triaxial tests to simulate the stress and strain conditions of a soil element in the field during an earthquake.

1.6.1 Nonuniform stress conditions within the test specimen are imposed by the specimen end platens. This can cause a redistribution of void ratio within the specimen during the test.

1.6.2 A 90° change in the direction of the major principal stress occurs during the two halves of the loading cycle on isotropically consolidated specimens.

1.6.3 The maximum cyclic shear stress that can be applied to the specimen is controlled by the stress conditions at the end of consolidation and the pore-water pressures generated during testing. For an isotropically consolidated contractive (volume decreasing) specimen tested in cyclic compression, the maximum cyclic shear stress that can be applied to the specimen is equal to one-half of the initial total axial pressure. Since cohesionless soils are not capable of taking tension, cyclic shear stresses greater than this value tend to lift the top platen from the soil specimen. Also, as the pore-water pressure increases during tests performed on isotropically consolidated specimens, the effective confining pressure is reduced, contributing to the tendency of the specimen to neck during the extension portion of the load cycle, invalidating test results beyond that point.

1.6.4 While it is advised that the best possible undisturbed specimens be obtained for cyclic strength testing, it is sometimes necessary to reconstitute soil specimens. It has been shown that different methods of reconstituting specimens to the same density may result in significantly different cyclic strengths. Also, undisturbed specimens will almost always be stronger than reconstituted specimens.

1.6.5 The interaction between the specimen, membrane, and confining fluid has an influence on cyclic behavior. Membrane compliance effects cannot be readily accounted for in the test procedure or in interpretation of test results. Changes in pore-water pressure can cause changes in membrane penetration in specimens of cohesionless soils. These changes can significantly influence the test results.

1.6.6 The mean total confining pressure is asymmetric during the compression and extension stress application when the chamber pressure is constant. This is totally different from the symmetric stress in the simple shear case of the level ground liquefaction.

1.7 The values stated in both inch-pound and SI units are to be regarded separately as the standard. The values given in parentheses are for information only.

¹ This test method is under the jurisdiction of ASTM Committee D18 on Soil and Rock and is the direct responsibility of Subcommittee D18.09 on Dynamic Properties of Soils.

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² The **boldface** numbers in parentheses refer to a list of references at the end of the text.