



Designation: F 1746 – 96

Standard Test Method for Determining In-Plane Compressive Properties of Circular Ring or Ring Segment Bridge Elements¹

This standard is issued under the fixed designation F 1746; 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 test method covers the test procedure for determining the in-plane compressive properties of circular or ring segment bridge elements of external skeletal fixators.

1.2 The values stated in SI units are to be regarded as the standard.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

E 4 Practices for Load Verification of Testing Machines²

F 1541 Terminology and Classification of External Skeletal Fixators³

F 1745 Test Method for External Fixator Connectors³

F 1747 Test Method for External Fixator Joints³

3. Terminology

3.1 *circular ring bridge element*—an external skeletal fixator component as described by Specification F 1541, which is circular, or may be assembled from several components to form a circular element; lies in a single plane; and has one center or curvature.

3.2 *ring segment bridge element*—an external skeletal fixator component as described by Specification F 1541, that consists of a single ring segment, or is assembled from several components to form a ring segment; lies in a single plane; has one center of curvature; and whose arc spans 180° or more, but less than 360°.

3.3 *test component*—a complete or assembled circular ring bridge element or ring segment bridge element prepared for testing according to 8.1 and 8.2.

4. Summary of Test Method

4.1 Complete circular ring elements (either a single component or an assembly of components to form a complete circular ring) or a ring segment ($\geq 180^\circ$ arc) are obtained for testing. In-plane compressive forces are applied quasi-statically to the circular ring or ring segment, so that the load application points are 180° apart, measured along the arc of the ring. If appropriate, load is increased until part failure occurs. A graphical plot of load versus displacement is used to determine in-plane compressive strength and stiffness.

5. Significance and Use

5.1 This test method is used to measure the compressive strength and stiffness of circular ring or ring segment bridge elements of external skeletal fixators, when loaded in the plane of the ring. The results obtained in this test method are not intended to predict the clinical efficacy or safety of the tested products. This test method is intended only to measure the uniformity of the products tested or to compare the mechanical properties of different products.

5.2 This test method may not be appropriate for all types of fixator applications. The user is cautioned to consider the appropriateness of the method in view of the materials being tested and their potential application.

6. Apparatus

6.1 *Pin and Clevis Fixture*—A U-shaped metal lug (“Clevis”) with a hole drilled across both legs of the “U” to accommodate a clearance fit steel pin. The opposite end of the Clevis is attached to the grip of the load frame. The pin diameter should be of the approximate size of the holes in the test components (if applicable); or, if a hole must be drilled for testing, the pin shall be no greater than half the width of the test component at the point of load application.

6.2 *Shims*—Metallic plane washers of varying specified thickness that will fit over the pin and between the sides of the clevis and the test component.

6.3 *Torquemeter*—An electronic or mechanical device, or both, is capable of measuring torque applied to a screw or bolt.

6.4 *Load Frame*—Machines used for testing shall conform to the requirements of Practice E 4. The loads used for the test shall be within the loading range of the test machine as defined in Practice E 4.

¹ This test method is under the jurisdiction of ASTM Committee F-4 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.21 on Osteosynthesis.

Current edition approved Oct. 10, 1996. Published February 1997.

² Annual Book of ASTM Standards, Vol 03.01.

³ Annual Book of ASTM Standards, Vol 13.01.

6.5 *X-Y Plotter*—A suitable recorder to plot a graph of load versus load frame displacement on perpendicular axes.

7. Test Specimens

7.1 All test components, including connection components, shall be representative of clinical quality products.

7.2 If one or more of the elements to be tested has been previously used, appropriately describe the nature of such prior usage.

7.3 The test component, when assembled (if applicable), shall form a full or partial ring in a single plane, with a single center of curvature.

8. Procedure

8.1 *Constructing the Test Component*—Some ring external fixation systems may fit into both the circular ring and ring segment descriptions in 8.1.1 and 8.1.2, depending on how many components are assembled. The two types are discussed separately here to be congruent with the separate descriptions given in Specification F 1541. The user must consider the appropriateness of the two test component options in view of the materials being tested, their potential application, and the manufacturer's recommendations.

8.1.1 *Circular Ring Bridge Element*—For circular ring bridge elements that are not a complete circle, the individual arcs or segments must be joined together to form a single circular ring. Join the arcs or segments using the equipment (for example, nut and bolts) recommended by the manufacturer. For screw or bolted connections, apply the tightening torque recommended by the manufacturer using a torque wrench. If a recommended torque value is not available, choose a sufficient torque, and then use it for all components.

8.1.2 *Ring Segment Bridge Elements*—For ring segments whose arc spans less than 180°, join individual arcs or segments together to form a ring segment that spans more than 180° but less than 360°. Join the arcs or segments using the equipment (for example, nut and bolts) recommended by the manufacturer. For screw or bolted connections, apply the tightening torque recommended by the manufacturer using a torque wrench. If a recommended torque value is not available, choose a sufficient torque, and then use it for all components.

8.2 *Preparing the Test Component*—The test component must have two holes that are positioned 180° from each other, as measured along the arc of the ring, for introduction of the load. For rings with holes provided by the manufacturer, choose two holes that are 180° apart. For rings without two properly positioned holes, drill holes through the test component. The diameter of the hole shall be less than one half of the width of the test component at the drilling location. If the test component is constructed from ring segments, the critical joint, as determined by the user, shall be 90° from the two loading holes.

8.3 *Mounting the Test Component*—Secure the two clevis fixtures to the upper and lower grips of the load frame. Insert the test component into the clevis fixture so that the loading holes are aligned with the clevis holes. Insert a clearance-fit pin through the clevis and through the test component, securing the test component to the upper and lower fixtures. As necessary, insert shims between the sides of the clevis and the test

components to ensure that the test component is centered in the clevis, and to reduce the lateral movement of the test component on the pin. The diameter of the shims must be less than the width of the test component at the loading hole location. The total lateral movement of the test component in the clevis shall be less than 0.5 mm. An example test set-up of a circular ring bridge element, constructed from two 180° ring segments bolted together, is shown in Fig. 1. An example test set-up of a single ring segment bridge element is shown in Fig. 2.

8.4 *Data Recording*—Record the load (N) and displacement (mm) measured by the testing machine on an X-Y plotter. Measure the displacement at the point of load application.

8.5 *Load Application*—Apply an increasing compressive load quasi-statically to the test component. Either load or stroke control may be utilized. Report the rate. It is recognized that no specific rate is applicable to all situations. However, in this context, interpret a quasi-static input loading rate as being sufficient to attain in approximately 30 s a load magnitude in the range of typical clinical usage, or a load sufficient to cause ring or ring segment failure, whichever is lower. If tested to failure, continue the load application until a peak load is observed on the load displacement curve, or until the load reaches a near constant value while significant irrecoverable deformation (typically 10 % of the nominal ring diameter) has occurred.

8.6 *Test Component Examination*—After the test is complete, make visual examination of the test component to determine the location and mode of failure of the test component.

9. Interpretation of Results

9.1 *In-Plane Compressive Stiffness*—Determine the in-plane compressive stiffness (N/mm) of the test component from the maximum slope of the initial portion of the load-displacement curve.

9.2 *In-Plane Compressive Yield Strength*—Determine the in-plane compressive yield strength (N) of the component from

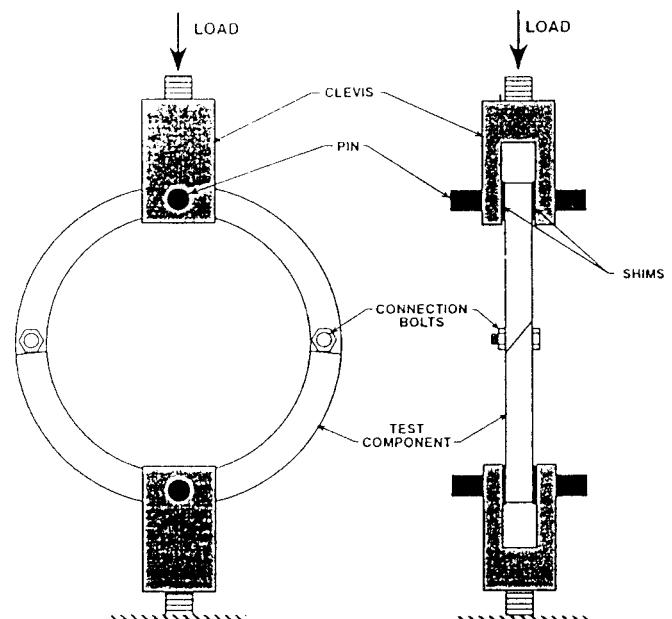


FIG. 1 Test Setup—Circular Ring Bridge Element