The Engineering Society For Advancing Mobility Land Sea Air and Space

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Ball Stud and Socket Assembly — Test Procedures

SAE Recommended Practice
Revised February 1987

Submitted for Recognition as an American National Standard

SAE The Engineering Society For Advancing Mobility Land Sea Air and Space

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MATERIALS PRACTICE

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SAE J193

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Ø BALL STUD AND SOCKET ASSEMBLY TEST PROCEDURES

1. SCOPE: The test procedures describe a method to laboratory test suspension and steering system ball stud and/or socket assemblies for functional characteristics. This procedure is an extension of SAE J491b recommended practice on dimensional recommendations for ball studs towards a vehicle application. The tests are conducted either on ball studs individually or on complete integral assemblies representing the application.

2. OBJECTIVE: To provide a uniform method of testing ball studs and ball stud and socket assemblies to ensure that the parts will meet functional requirements of the application.

3. TEST PROCEDURES: The test procedures for suspension and steering components with few exceptions can be similar because all ball stud and socket assemblies are subject to axial, lateral and longitudinal forces, differing only in the direction and magnitude of loading depending on the application.

   The test procedures cover the following characteristics:

   5.1 Ball Stud
   5.1.1 Ball Stud Impact Strength
   5.1.2 Ball Stud Yield
   5.1.3 Ball Stud Tensile Load

   5.2 Ball Stud and Socket
   5.2.1 Ball Stud and Socket Rotating and Oscillating Torque
   5.2.2 Ball Stud and Socket Axial End Movement
   5.2.3 Ball Stud and Socket Cam-Out Strength
   5.2.4 Ball Stud and Socket Fatigue and Wear Test
   5.2.5 Ball Stud and Socket Pull-Out and Push-Out Strength
   5.2.6 Ball Stud and Socket Angularity

4. LOADING AND CYCLE LIFE: The loading used in the test procedures should be as representative as possible in magnitude and direction with loads encountered in the design application. Recommended cycle life is provided where applicable with each procedure.

To determine preliminary loading magnitude and direction, a layout design model of the complete suspension and steering system, possibly computerized, should be utilized. A paper analysis can be made solving for the component loading by assuming maximum "G" forces at the wheel/ground contact.

Using a vehicle with a similar suspension and/or steering system design, a program loading procedure can be utilized to obtain a more realistic loading assessment. With this procedure, key load carrying components are strain gaged to measure the load magnitudes, direction, frequency of load application and phasing (timing of load application). The vehicle is driven over a circuit of road input events that simulate expected usage. From this data, histograms of loading magnitude vs. cumulative load application cycles can be obtained that will establish the laboratory ultimate strength peak loads as well as a group of fatigue and wear test loads and associated cycles for a specific vehicle life.

Representative program loading procedures are described in many SAE reports (SAE Report #660102, "Simulation of Field Loading in Fatigue Testing").

5. OBJECTIVES AND TEST PROCEDURES:

5.1 Ball Stud: Tests conducted on individual ball studs.

5.1.1 Ball Stud Impact Strength:

5.1.1.1 Objective: To determine the impact strength of the ball stud.

5.1.1.2 Procedure: The test is applicable to either suspension or steering system studs. Mount the stud in a rigid fixture as shown in Fig. 1. Lock stud in fixture by torquing the retaining nut to design specifications.

Apply an impact load to exceed the expected impact load in the vehicle application.

The stud must not fail by brittle fracture. Bending deflection must be 10 deg minimum.

Increase the impact load incrementally until a separation occurs to determine the load capability. Only one impact per stud is permissible.

5.1.2 Ball Stud Yield:

5.1.2.1 Objective: To determine at what load condition the ball stud will take a permanent set without fracture.

5.1.2.2 Procedure: The test is applicable to either suspension or steering system studs.

The test fixture is shown in Fig. 2. Grind a small flat on the head of the stud for accuracy of reading, to receive the dial indicator or other measuring device.

Install the ball stud in the fixture with the mating taper hole in such a manner that a load can be applied to the stud at right angles to the stud centerline and opposite the flat ground on the stud. Lock stud in fixture by torquing the retaining nut to design specification.

Preload the stud. Set dial indicator or other measuring device to zero. Take deflection and set readings in desired increments to permanent set range.

Stud yield load is equal to load required to permanently set stud without surface cracks or failure and should be used to select stud application.

5.1.3 Ball Stud Tensile Strength:

5.1.3.1 Objective: To determine the tensile load capability of the ball stud.

5.1.3.2 Procedure: The test is applicable to either suspension or steering system studies depending on the intended application, but generally would be appropriate for a suspension ball stud where the predominant loading would be in a tensile direction.

Mount the stud in a load/deflection testing machine as shown in Fig. 3. Caution: Use care to prevent eccentric loading. A typical tensile load application rate is 5 mm/min. Record load and mode of fracture for each sample tested.

5.2 Ball Stud and Socket: Tests conducted on complete ball stud and socket assemblies.

5.2.1 Ball Stud to Socket Rotating and Oscillating Torque:

5.2.1.1 Objective: To ensure desired rotating and oscillating torque is obtained.

5.2.1.2 Procedure: The test is applicable to either suspension or steering system components. The assembly should be held in a manner to prevent addition of external clamping pressure which may affect torque readings.

5.2.1.2.1 Breakaway Torque: Assemblies should be filled with specified application lubricant when it is required.

For some designs and applications, it is necessary to store the assembly (with lubricant) for 48 h without movement prior to test to ascertain the cold flow characteristics of the materials and congelation effect of the selected lubricant and breakaway torque.

5.2.1.2.1 (Continued):

The torque is read with a torque device with gradual application of a rotating or oscillating force.

Breakaway torque values may be varied to suit the application.

5.2.1.2.2 Rotating or Oscillating Torque: Assemblies should be filled with specified application lubricant when it is required.

Rotate stud a minimum of five complete revolutions to minimize congelation and other factors prior to recording torque.

The torque is read with a torque device while the stud is being revolved or oscillated at approximately 5 rpm.

Rotating and oscillating torque values may be varied to suit the application.

5.2.2 Ball Stud to Socket Axial End Movement:

5.2.2.1 Objective: To determine end movement measurement.

5.2.2.2 Procedure: The test is applicable to either suspension or steering system components.

5.2.2.2.1 Spring Loaded Type: For axial movement, the following is commonly used. The stud should be set perpendicular to the socket. Socket should be supported on the bottom of assembly. A force is applied to the stud (less nut) and the axial movement of the stud is noted and recorded. (Fig. 4A depicts typical fixture.)

NOTE: Ensure that the top of the stud is flat at the contact point of force (grind if necessary).

5.2.2.2.2 All Other Types of Socket Assemblies: With the shank of the socket assembly clamped to prevent squeezing of socket and stud, pull upward. After the movement of the stud is noted and recorded, the operation is repeated with a force pushing downward. (Fig. 4B depicts a typical fixture for tie rod ends.)

5.2.3 Ball Stud to Socket Cam-Out Strength:

5.2.3.1 Objective: To determine retention of the ball stud in the socket at angular positions and to determine the angle of separation.

5.2.3.2 Procedure: The test is applicable to either suspension or steering system components. The ball stud and socket assemblies should be mounted in a tensile test machine with the test specimen stud held in a fixture which permits unrestricted angular travel. (Fig. 5 depicts a typical fixture.)

A tensile load is applied to the assembly parallel to the normal load direction when the test stud is in full angular travel. The test is repeated with a new sample, using a compression load. The maximum load and angle induced prior to separating the stud from the socket is recorded.

5.2.4 Ball Stud and Socket Assembly Fatigue and Heat Test:

5.2.4.1 Objective: To determine fatigue and wear characteristics of ball stud and socket assemblies.

5.2.4.2 Procedure: This test is applicable to either suspension or steering system components. Use socket assemblies which have been tested according to paragraphs 5.2.1, 5.2.2 and 5.2.6 and found acceptable. Socket assemblies should be filled with recommended lubricant when required in the application. Socket assemblies should be installed, with seals when required, in a fixture by placing the taper shank in the mating tapered hole with the retaining nut torqued to design specification. For each type to be tested, the ball stud and socket assemblies may be modified to suit the test machine providing the modifications do not affect test results. Securely clamp the link in a manner to achieve the required motions. The following are typical motions which may be used. Refer to Fig. 6 (A and B):

(1) Angular Oscillation: ±20 deg in a plan parallel to the link or 90 deg to axis of suspension control arm pivot centerline. A typical rate is 60 cpm.

(2) Angular Rotation: ±40 deg measured about the ball stud shank centerline. A typical rate is 32 cpm.

(3) Load: Alternating designated horizontal tension and compression load for steering applications. Suspension ball stud and socket tests will also require vertical tension or compression loads. A typical rate is 60 cpm.

Load application angle may be varied to suit the application. The socket assemblies are then tested to required angles, frequencies, and load applications concurrently and completed in two phases. When actual use dictates, other application loads, angles, and frequencies may be substituted.

5.2.4.2.1 Phase I Test - Peak Load: To correlate the cycle life with the maximum operating load to which the assembly will be subjected in its actual application.

The cycle life varies for each type of application and environment; therefore, a program loading procedure for the specific application is required to establish load and cycle life required for this test.

In the absence of complete program loading data, and to provide a basis for standardized testing of the assembly, 7500 cycles is a reasonable cycle life for this test.

5.2.4.2.2 Phase II Test - Endurance Load: To correlate the cycle life of the assembly for the average load to which the assembly will be subjected in its application and environment, with life in actual use, and to establish the load which provides for extended fatigue and heat life.

The load and cycle life varies for each type of application and environment; therefore, a program loading procedure for the specific application is recommended to establish load and cycle life required for this test.

In the absence of complete program loading data and to provide a basis for standardized testing of the assembly, 250 000 cycles is reasonable life for this test.

During the Phase I and Phase II tests, artificial cooling may be used where deemed necessary to prevent heat build-up which would not be experienced in the application.

If the application of the ball stud and socket assembly includes environmental contamination, contaminants should be provided to correlate with these conditions in the test. This procedure will determine seal durability and effectiveness.

Typical test environments commonly used are:

(1) Ozone atmosphere

(2) Saline and dust 4.0 L of water, 50% saturated solution of common salt at 21-24°C, and 0.15 kg. of SAE air cleaner test dust fine grade.

(3) Steam

Conditions to be examined at completion of test to determine adequacy for the application:

The rotating and oscillating torque condition (see paragraph 5.2.1).

The end movement (see paragraph 5.2.2).

The ball stud should be examined for any surface cracks, determined by a dye check or approved equivalent.

5.2.4.2.2 (Continued):

The ball stud should be examined for any local yielding, determined by a dimension check.

The internal components should be examined for damage.

5.2.5 Ball Stud and Socket Pull-Out and Push-Out Strength:

5.2.5.1 Objective: To determine the tension or compression loads which will separate the ball stud from the socket.

5.2.5.2 Procedure: This test is applicable to either suspension or steering system components. Assemble the ball stud and socket assembly in a load/deflection testing machine so that the load applied to the stud is perpendicular to the ball joint mounting surface.

Measure and record the stud tensile load required to separate the stud from the socket assembly. A typical load application rate is 5 mm/min. Repeat the test with another sample using a compressive load.

The acceptance criteria for stud pull or push-out should be established from the calculated or measured loads based on the application.

5.2.6 Ball Stud and Socket Angularity:

5.2.6.1 Objective: To determine if the socket throat is capable of providing the required stud angularity.

5.2.6.2 Procedure: This test is applicable to either suspension or steering system components. Assemble the ball stud and socket assembly into a rigid fixture simulating the assembly into a suspension arm or steering linkage.

Measure and record stud travel angularity both along the socket throat major axis and across the minor axis.

The acceptance criteria is based on the angularity requirements in the specific application adjusted to take into account the effect of dimensional variations and suspension/linkage compliance.

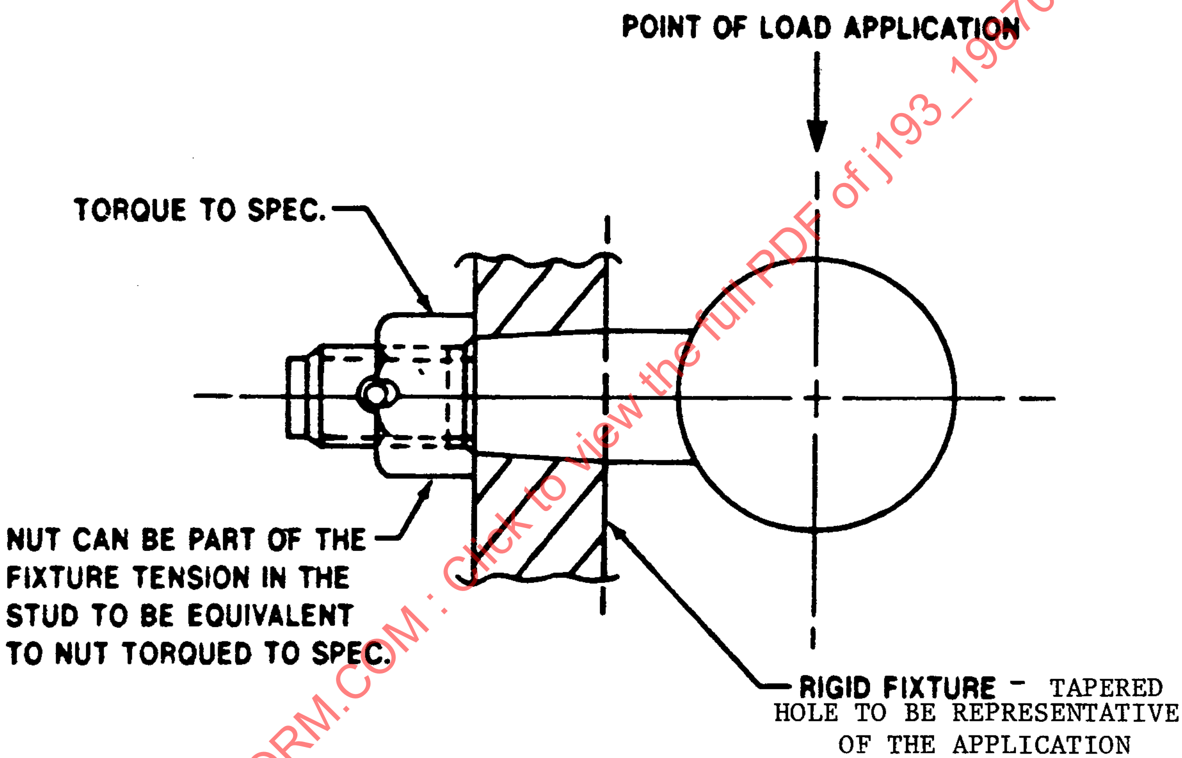

FIG. 1 - IMPACT TEST

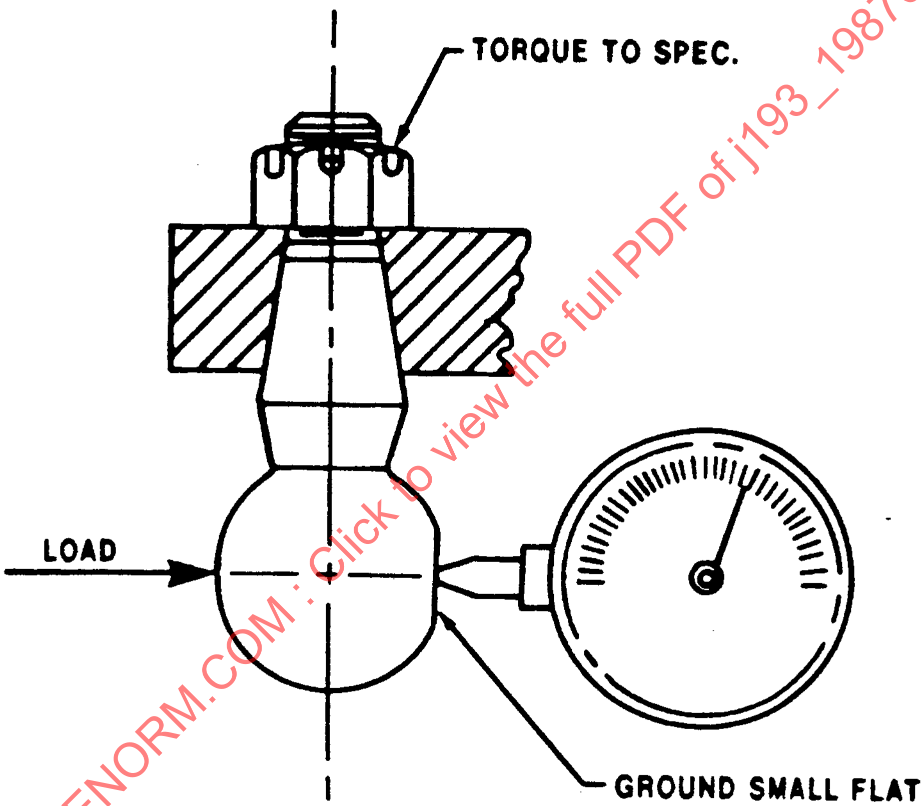

FIG. 2

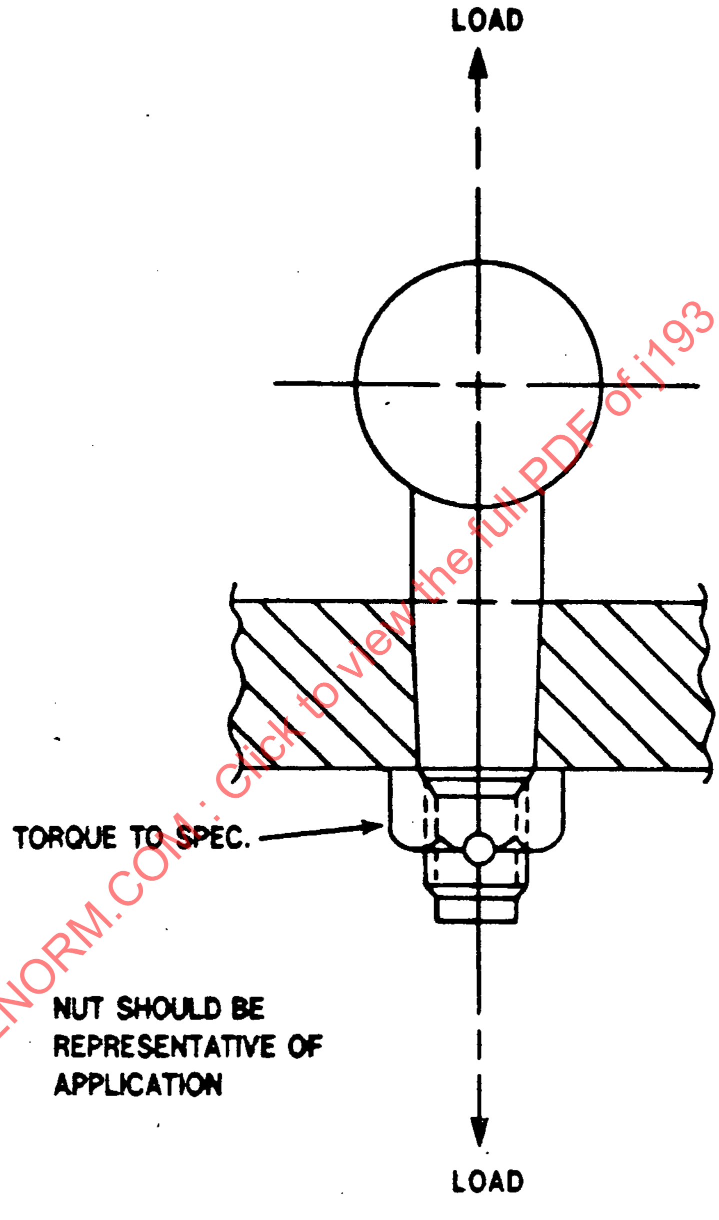

FIG. 3 - TENSILE TEST

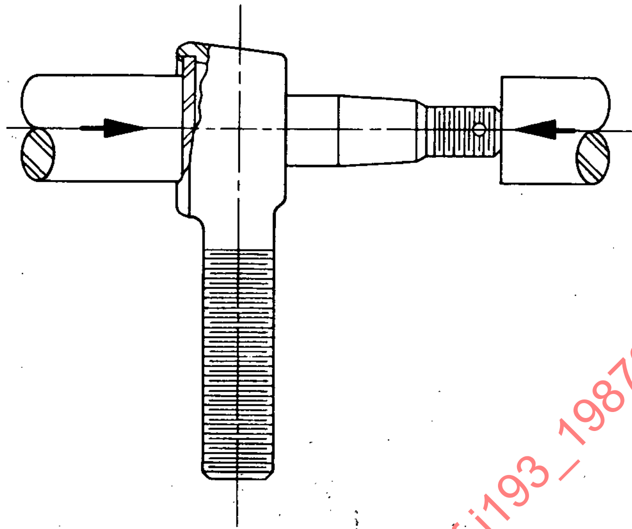

FIG. 4A

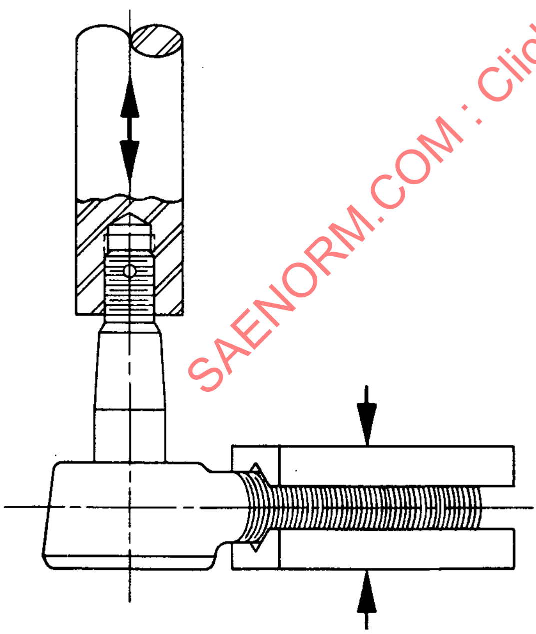

FIG. 4B

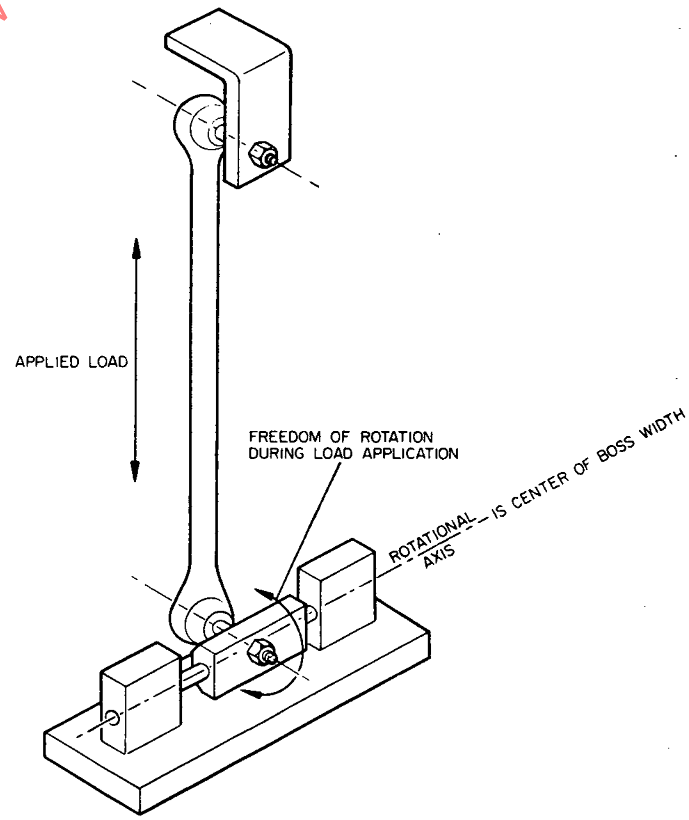

FIG. 5