

Bench Test Procedures of Suspension Ball Joint for Independent Type

1. Scope

This standard specifies the bench test procedures relating to the ball joint employed in an automotive suspension of independent type (hereinafter referred to as "ball joint").

Remarks:

1. This standard does not include a suspension arm and its fastener.
2. In this standard, units and numerical values are based on SI (International System of Units), while units and numerical values given in { } are customary units system, and are given for reference.

2. Purpose

This standard aims to standardize the test procedures relating to the performance, strength and durability of the ball joints which are employed in a suspension of independent type so as to obtain generalization of quality evaluation.

3. Types of Testing

- (1) Oscillation angle test
- (2) Torque test
- (3) Rigidity test
- (4) Extrusion and drawing strength test
- (5) Ball stud static strength test
- (6) Dust cover drag strength test
- (7) Fatigue strength test

- (8) Abrasive durability test
- (9) Muddy water durability test
- (10) Dust cover ozone-deterioration test
- (11) Dust cover low temperature test
- (12) Dust cover heat resistance test

4. Common Test Conditions

- (1) Unless otherwise specified, testing shall be conducted in an atmosphere at the room temperature.
- (2) A test piece shall be mounted with proper dimensions for the installation and a sufficiently rigid means shall be taken to the extent that the purpose of testing might not be impaired.
- (3) A mounting jig shall be so shaped as not to impair the purpose of testing.

Applicable Standards: JIS K 6301-75
JIS Z 8901-74
JASO Z 213-76

JASO C 715-88

Reference Standards: JASO C 710-87

JASO F 901-70
JASO M 322-85

JASO Z 204-84
SAE J 193 SEP 79

Physical Testing Methods for Vulcanized Rubber
Dusts and Aerosols for Industrial Testing
Glossary of Terms Relating to Steering Systems
of Automobiles
Bench Test Procedures of Steering Ball Joint for
Rack and Pinion Type
Test Code of Strength and Rigidity for Steering
Column
Ball Studs and Sockets
Heat Aging and Low Temperature Tests for
Automotive Rubber Parts
Glossary of Terms to Suspension of Automobiles
Ball Stud and Socket Assembly Test Procedure

5. Ball Joint Test Method

5.1 Oscillation Angle Test

This test shall be conducted to evaluate the oscillation angle of a ball joint as follows:

(1) Test setup

As shown in Fig. 1, mount the ball joint onto a jig.

(2) Test conditions

- (a) Measuring direction: As shown in Fig. 1, measurements shall be taken in Direction A and in Direction B right-angled to Direction A from the position at which the ball stud stands vertically.

(3) Testing steps

- (a) To determine the oscillation angle, use a measuring instrument as shown in Fig. 2.

Fig. 1

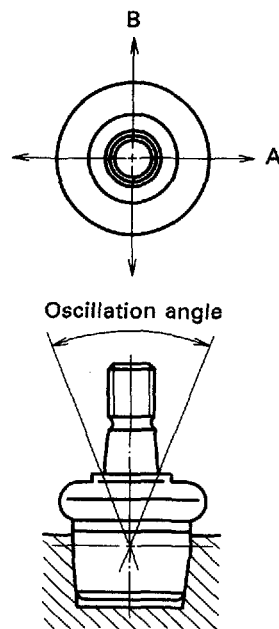
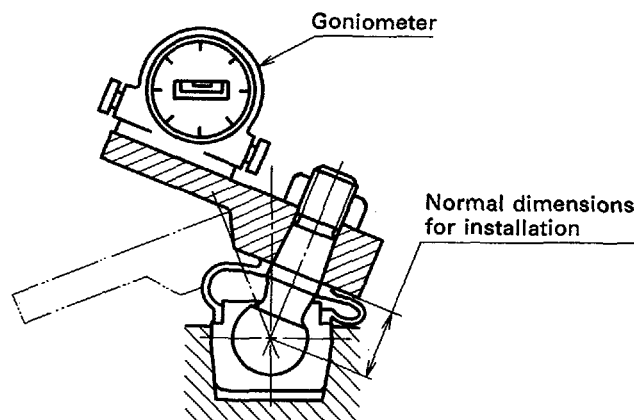


Fig. 2



As shown in **Fig. 3**, an oscillation angle is so related with an oscillation torque that the torque may rise at the end of oscillation. An angle up to the starting point of such rising torque, therefore, shall be taken tactually as the maximum oscillation angle.

(4) Measurement items and records

(See **Fig. 3**)

- (a) Oscillation angle (1):
An oscillation angle mechanically oscillatable
- (b) Maximum oscillation angle:
Maximum uniformly oscillatable angle at which the ball stud does not

interfere with any part but a stable service torque is available.

Note: (1) Oscillatable angle may be taken as the maximum oscillation angle as agreed between both parties concerned to delivery.

5.2 Torque Test

This test shall be conducted to evaluate the rotating and oscillating torques of a ball joint as follows:

(1) Test setup

As shown in **Fig. 4**, for instance, mount the ball joint onto the jig. To determine a torque, use a torque gauge or any measuring instrument that may satisfy the test conditions specified in 5.2 (2).

Fig. 3

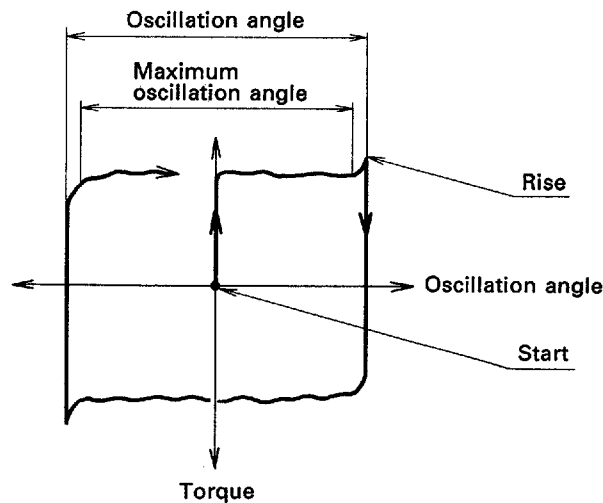
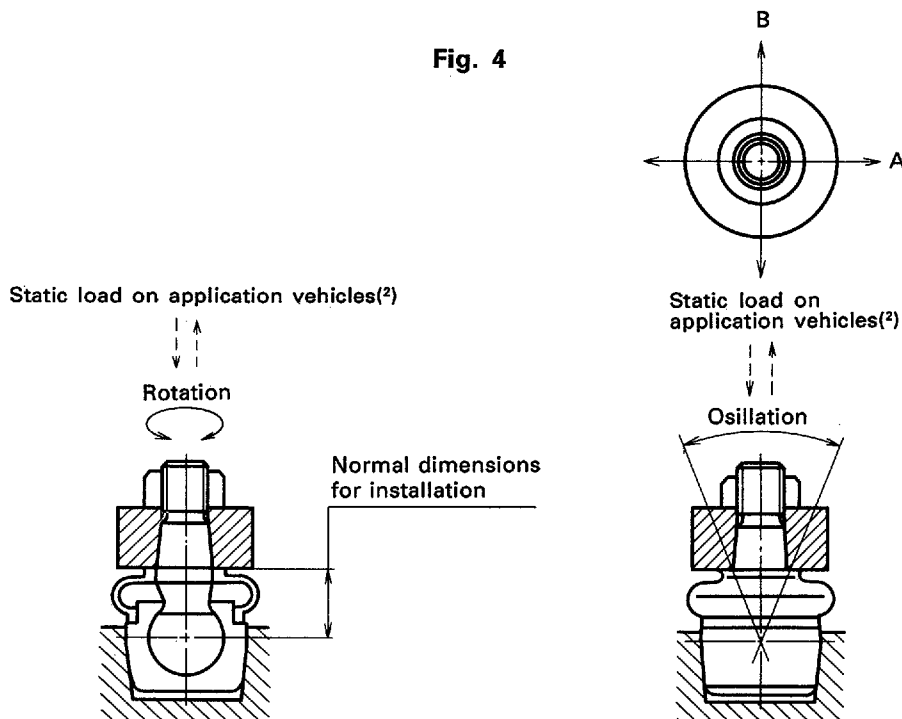


Fig. 4



(2) Test conditions

Table 1: Test Conditions

Measurement Item	Rotating torque (N · m) {kgf · m}	Oscillating torque (N · m) {kgf · m}
Measuring method	Measure the torques upon reciprocally rotating at the position where the ball stud stands vertically as shown in Fig. 4.	Measure the torque upon reciprocally oscillating in directions A and B from the position where the ball stud stands vertically as shown in Fig. 4.
Static load on application vehicles ⁽²⁾	Generally test without load, if necessary it is determined upon agreed between the parties concerned to delivery.	
Measuring range	Within $\pm 40^\circ$ or between maximum steering angles	Within $\pm 20^\circ$ or between maximum oscillation angles
Measuring rate	3 to 18°/s	
Atmospheric temperature	Generally test in an atmosphere at the room temperature, if necessary, it is conducted in an atmosphere at the low temperature (-40°C) and high temperature ($+70^\circ\text{C}$ and above).	

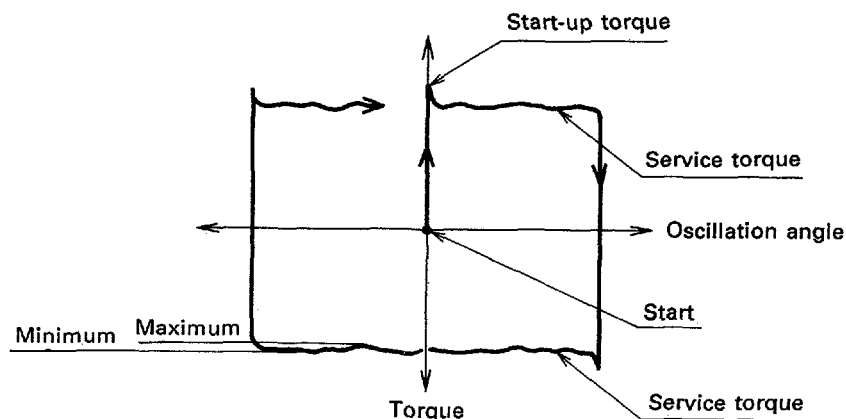
Note ⁽²⁾ Tensile or compressive load in an axial direction loaded onto a ball joint when a static load is applied on a vehicle.

(3) Testing procedures

Giving five (5) oscillations up to the maximum oscillation angle to the ball stud, as well as five (5) positive-reverse 360° reciprocal rotations before taking measurements, leaving for 24 hours as

it is, initial start-up and service torques shall be measured. Then, giving five (5) oscillations with the maximum oscillation angle and five (5) positive-reverse 360° reciprocal rotations, start-up and service torques shall be measured.

Fig. 5 Torque - Angle Curve



(4) Measurement items and records

- (a) Test conditions referred to in (2)
- (b) Torque - angle curve⁽³⁾ (see Fig. 5)
- (c) Start-up torque
- (d) Service torques
(maximum, minimum and average = $\frac{\text{max.} + \text{min.}}{2}$)⁽⁴⁾

Note : ⁽³⁾ When the torque values are directly read with a torque wrench, this item may be omitted.

⁽⁴⁾ In case of measurements by using a torque wrench, stable values are taken as average values for the representation, while the maximum and minimum values may be omitted.

5.3 Rigidity Test

This test shall be conducted to evaluate the rigidity of a ball joint as follows:

(1) Test setup

As shown in Fig. 6, for instance, mount the ball joint onto the jig.

(2) Test Conditions

- (a) Loads: With the ball stud vertically standing, apply tensile and compressive loads to the ball stud both axially and rectangularly to the axis up to the specified load value.⁽⁵⁾ The rigidity in the direction rectangular

to the axis shall be measured upon loading the static load⁽²⁾ on an application vehicles.

Note: ⁽⁵⁾ Specified applicable load value shall be determined upon agreed between the both parties concerned to delivery.

(3) Test Steps

- (a) A test piece shall be left for 24 hours or more after completion of the assembly.
- (b) After loaded up to the specified value of load in one (1) cycle, the specified loads ⁽⁵⁾ shall be applied in both tensile and compressive directions. Then the displacements of the ball stud shall be measured.

(4) Measurement items and record

- (a) Loads - displacement curves (see Fig. 7)
- (b) Specified load and displacement amount

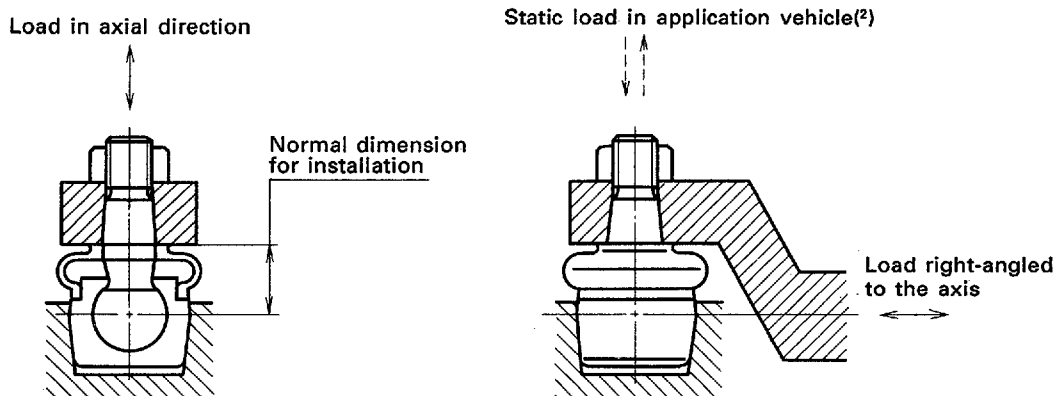
5.4 Extrusion and Drawing Strength Test

This test shall be conducted to evaluate the breaking strength of a socket body or a caulked portion of a ball joint as follows:

(1) Test setup

As shown in Fig. 8, mount the ball joint onto the jig.

Fig. 6



(2) Test conditions

- (a) Load directions: Extrusion and drawing directions
- (b) Load: 0 through breakdown (N) {kgf}

(3) Test procedures

Mounting the ball joint onto the jig, apply the load to the ball stud.

(4) Measurement items and records

- (a) Load - displacement curve (see Fig. 9)
- (b) Maximum load (for extrusion and drawing)
- (c) Condition of breakdown.

Fig. 7 Loads - Displacement Curve

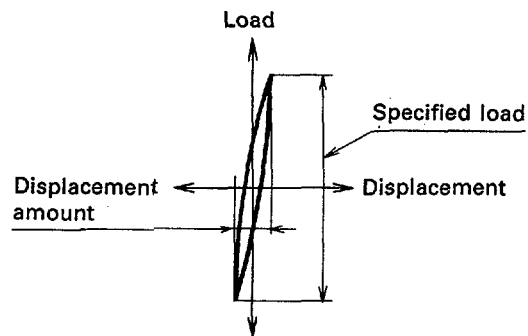


Fig. 8

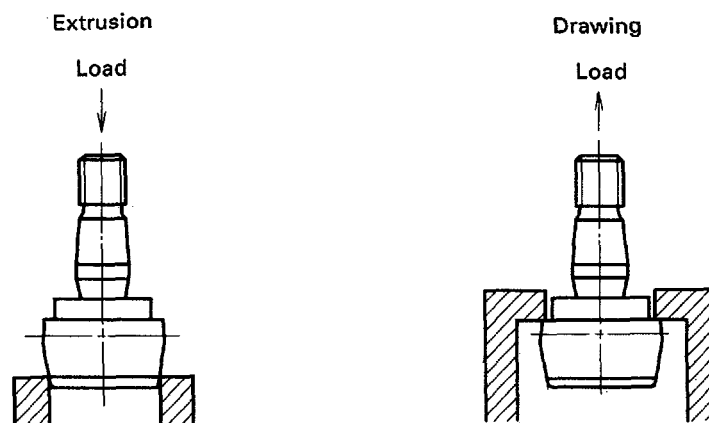
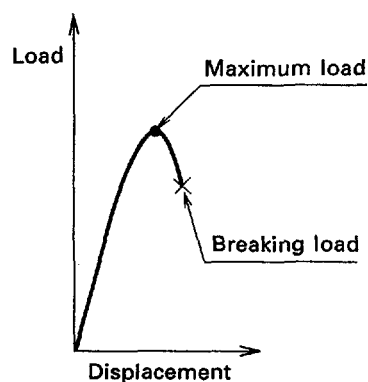


Fig. 9 Load - Displacement Curve



5.5 Static Strength Test of Ball Stud

This test shall be conducted to evaluate the strength of a ball stud of a ball joint in the direction rectangular to the axis as follows:

(1) Test setup

As shown in Fig. 10, mount the ball stud onto the jig.

(2) Test conditions

(a) Load direction: Direction rectangular to the axis of a ball stud.

(b) Load: 0 to the maximum load (N) {kgf}

(3) Test procedures

Fixing the ball stud onto the jig, apply the load to the ball stud in the direction

rectangular to the axis. Preferably the parties concerned should mutually agree upon the jig's material and hardness, as well as the tightening torque of the nut, all of which may affect the test result.

(4) Measurement items and records

(a) Load - displacement curve (see Fig. 11)

(b) Yield load

(c) Maximum load

(d) Condition of deformation/break-down.

Fig. 10

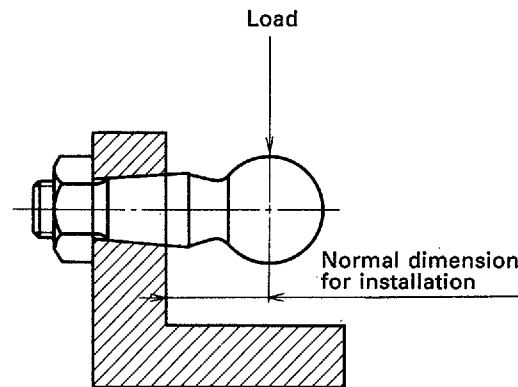
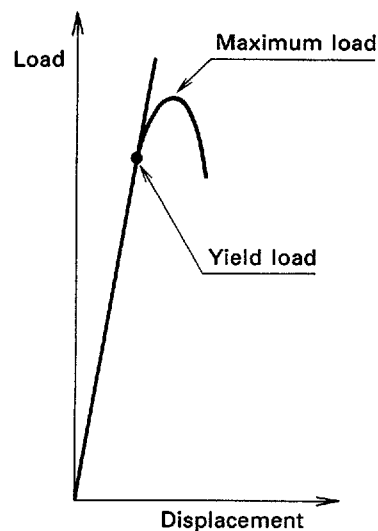


Fig. 11 Load-Displacement Curve



5.6 Dust Cover Drag Strength Test

This test shall be conducted to evaluate the drag strength of a dust cover fixed onto a socket body of a ball joint as follows:

(1) Test setup

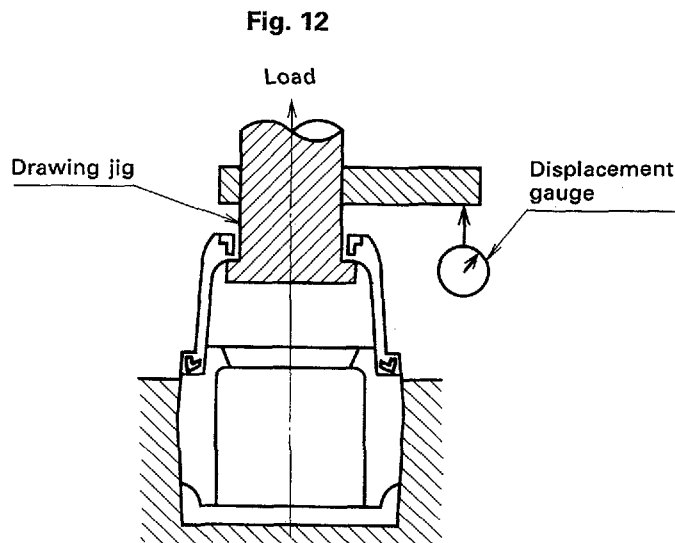
As shown in Fig. 12, mount the dust cover onto the socket body after installed the drawing jig.

(2) Test conditions

- (a) Load direction: Drawing direction of a dust cover
- (b) Load: 0 to a point at which the dust cover is pulled out of the socket body or broken. (N) {kgf}

(3) Test procedures

Fixing the socket body, apply the load to the drawing jig being installed onto the dust cover.



(4) Measurement items and records

- (a) Load - displacement curve (see Fig. 13)
- (b) Drawing or breaking load of dust cover.
- (c) State of drawing or breakdown.

5.7 Fatigue Strength Test

This test shall be conducted to evaluate the fatigue strength of a socket body and of a ball stud of a ball joint as follows:

(1) Test setup

As shown in Fig. 14, mount the ball joint onto the jig. The mounting angle, however, may be determined upon agreed between both parties concerned to delivery as required.

Fig. 13 Load - Displacement Curve

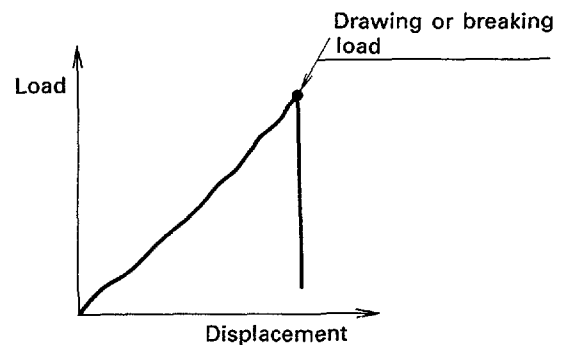
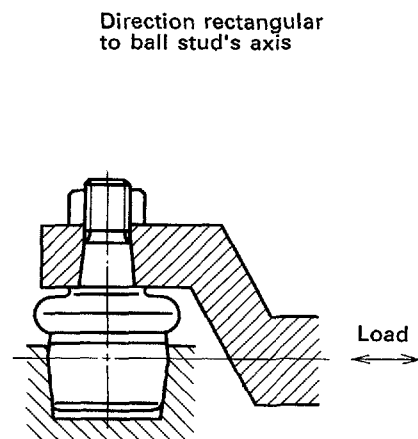
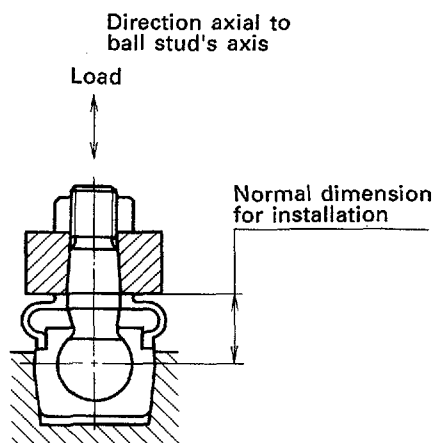


Fig. 14



(2) Test conditions

- (a) Load direction: Directions axial⁽⁶⁾ and rectangular to the axis of a ball stud.
- (b) Repeated load: A load shall be applied three (3) or more stages as agreed upon between both parties concerned to delivery.
- (c) Repetitive speed: 3 to 15 Hz
- (d) Testing frequency: Repeated cycles up to breakdown or specified number of cycles⁽⁷⁾.

Provided, number of cycles with a minimum load shall be 10^6 or more.

Note: ⁽⁶⁾ Necessity of a test with loads to be applied axially shall be determined as agreed upon between both parties concerned to delivery.

⁽⁷⁾ The specified number of cycles shall be determined as agreed upon between both parties concerned to delivery.

(3) Test procedures

Fixing the ball joint onto the jig, apply repeated loads to the ball stud.

(4) Measurement items and records

- (a) Test conditions specified in (2) above.
- (b) Load - repetitive cycle curve (see Fig. 15)
- (c) Broken portion and breaking behavior
- (d) Any other possible abnormality

5.8 Abrasive Durability Test

This test shall be conducted to evaluate the abrasion durability of a ball joint as follows:

(1) Test setup

As shown in Fig. 16, mount the ball joint onto the jig.

Fig. 15 Load - Repetitive Cycle Curve

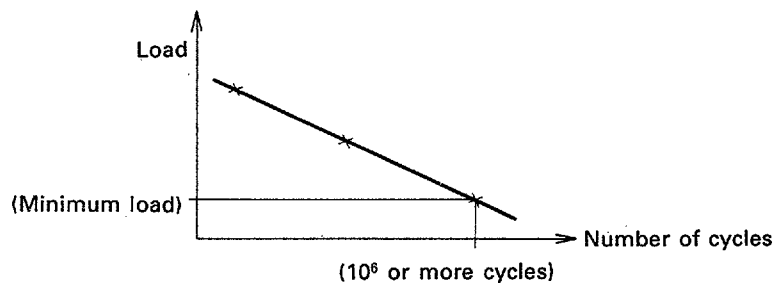
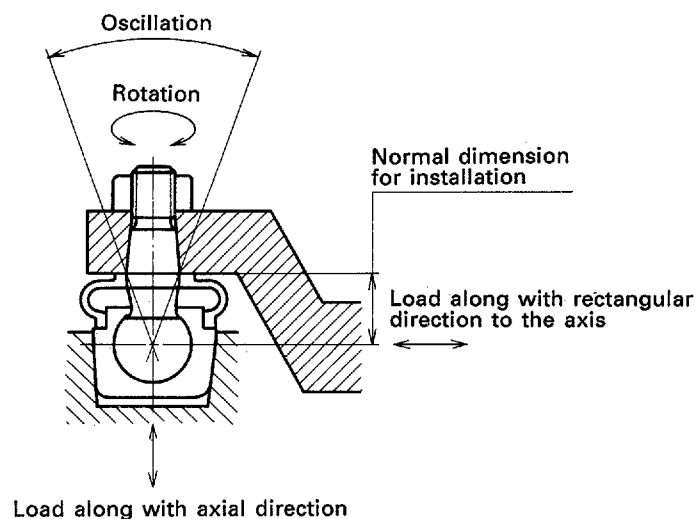


Fig. 16



(2) Test conditions

- (a) Oscillation angle: $\pm 20^\circ$ or 80% and above of the vehicle's designed maximum oscillation angle (bump-rebound)
- (b) Oscillation repeating rate⁽⁸⁾: 1 to 3 Hz
- (c) Rotation angle: $\pm 40^\circ$ or 80% and above of the vehicle's maximum steering angle
- (d) Rotation repeating rate⁽⁸⁾: 0.3 to 1 Hz
- (e) Load along with rectangular direction to the axis: To be agreed upon between both parties concerned to delivery.
- (f) Load along with axial direction: To be agreed upon between both parties concerned to delivery.
- (g) Load repeating rate⁽⁸⁾: 0.1 to 1 Hz
- (h) Test cycles: 10^6 and above in oscillation cycles
- (i) Atmospheric temperature: According to Table 1 in 5.2 (2) above.

Note: ⁽⁸⁾ The applicable combination of the test conditions shall be determined upon agreed upon between both parties concerned to delivery.

(3) Test procedures

- (a) Carry out testing under a certain fixed combination selected from the test conditions referred to in (2) above.
- (b) Since the ball joint may generate heat depending on the test condition applied, it should be necessary to

consider to provide an appropriate cooling method (e.g. air cooling, etc.) or sufficient time for cooling off between tests.

(4) Measurement items and records

- (a) Test conditions as specified in (2) above.
- (b) Initial and post-test torques as specified in 5.2.
- (c) Initial and post-test rigidity as specified in 5.3.
- (d) After completion of the test, disassemble and check the ball seat and the ball stud for possible abrasion. And make certain that the grease has been properly sealed.
- (e) Any other possible abnormality

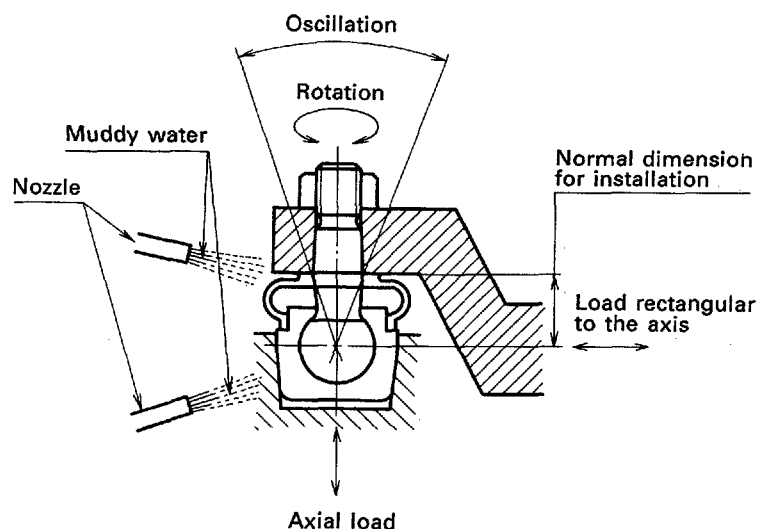
5.9 Muddy Water Durability Test

This test shall be conducted to evaluate the sealing property of a ball joint as follows:

(1) Test setup

As shown in Fig. 17, mount the ball joint onto the jig with the mounting direction along with the condition in the application vehicle. The dimensions and shape of the jig and roughness of sealing faces shall be similar to those of the application vehicle. The sealed and caulked portions of the dust cover of the ball joint shall be so arranged that muddy water is splashed over such portions.

Fig. 17



(2) Test conditions

- (a) Oscillation angle: Same as 5.8 (2) (a)
- (b) Oscillation repeating rate⁽⁹⁾: Same as 5.8 (2) (b)
- (c) Turning angle: Same as 5.8 (2) (c)
- (d) Turning repeating rate⁽⁹⁾: Same as 5.8 (2) (d)
- (e) Load along with rectangular direction to the axis: Normally, no load⁽¹⁰⁾
- (f) Load along with axial direction: Normally, no load⁽¹⁰⁾
- (g) Load repeating rate⁽⁹⁾: Same as 5.8 (2) (g)
- (h) Muddy water: 50 grams of the testing Dust Type 8 as specified in JIS Z 8901 (Dusts and Aerosols for Industrial Testing) mixed with one (1) litre of water.
- (i) Rate of water to be poured⁽⁹⁾: 0.5 to 3 litres per minute.
- (j) Water pouring cycle⁽⁹⁾: Pour water every 30 minutes through 1 hour. A drying time shall be three times of the pouring time. And both shall make up one cycle.
- (k) Number of testing cycles: The both parties concerned to delivery shall agree upon the number of testing cycle including the water pouring cycles.
- (1) Test specimen: The both parties

concerned to delivery shall agree upon whether a new article or an ozone-deteriorated article is to be evaluated.

Note ⁽⁹⁾ The applicable combination of the test conditions shall be determined upon agreed between both parties concerned to delivery.

⁽¹⁰⁾ A ball joint of such construction of which the sealing properties may be affected from a load (where a pre-load is partially held by caulking or the like) shall be loaded under the same conditions as those specified in 5.8 (2) (e) and 5.8 (2) (f).

(3) Test steps

Same as 5.8 (3).

(4) Measurement items and records

- (a) Test conditions referred to in (2)
- (b) Examination for water immersion
- (c) Examination for abnormal condition of sealed grease
- (d) Abrasive condition on sealed parts

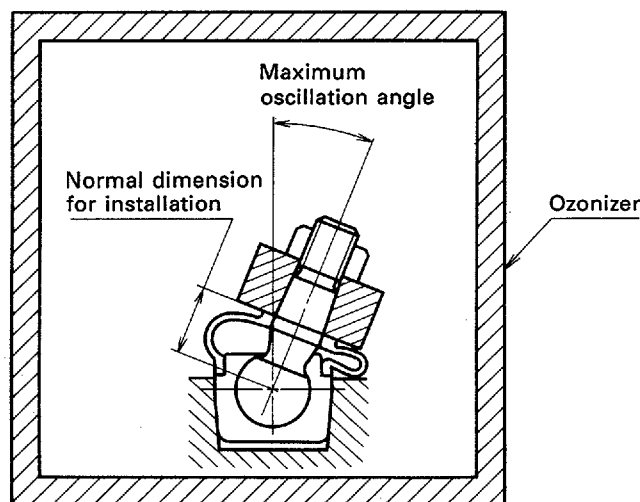
5.10 Ozone - Deterioration Test of Dust Cover

This test shall be conducted to evaluate the ozone - deterioration of a dust cover on a ball joint as follows:

(1) Test setup

For reference, see 16.3.2 in Ozonizer JIS K 6301 (Physical Testing Methods for Vulcanized Rubber).

Fig. 18



(2) Test conditions

- (a) Ozone concentration: 50 to 100 pphm
- (b) Atmospheric temperature: $40 \pm 2^\circ\text{C}$
- (c) Exposure time: 72 hours

(3) Test procedures

- (a) As shown in Fig. 18, fix the dust cover onto the jig, giving the maximum oscillation angle of the ball joint and leave in the ozonizer.
- (b) Carry out the test under a certain condition within the range of the test conditions specified in (2).

(4) Measurement items and records

- (a) Test conditions specified in (2)
- (b) Deterioration behaviour as specified in 16.4.6 of JIS K6301.
- (c) Any other possible abnormality

5.11 Low Temperature Test of Dust Cover

This test shall be conducted to evaluate the low temperature resistance of a dust cover of a ball joint as follows:

(1) Test setup

Environmental tank

(2) Test conditions

- (a) Exposure temperature: $-40 \pm 2^\circ\text{C}$
- (b) Exposure time: 5 hours and above

(3) Test procedures

- (a) As shown in Fig. 19, fix the dust cover onto the jig and let the ball stud vertically stand up.

- (b) Upon leaving in the environmental tank under the conditions specified in (2), as shown in Fig. 20, rapidly apply six (6) or more strokes with the maximum oscillation angle of the ball joint as well as six (6) or more strokes with the vehicle's designed maximum steering angle or the rotation angle of $\pm 40^\circ$ in the tank in principle.

(4) Measurement items and records

- (a) Test conditions specified in (2)
- (b) Examination for cracks
- (c) Any other possible abnormality

5.12 Heat Resistance Test of Dust Cover

This test shall be conducted to evaluate the heat resistance of a dust cover on a ball joint as follows:

(1) Test setup

Environmental tank

(2) Test conditions

- (a) Exposure temperature: 70°C and above
- (b) Exposure time: 70 hours or more

(3) Test procedures

- (a) As shown in Fig. 19, mount the dust cover onto the jig and let the ball stud vertically stand up.
- (b) Upon leaving in the environmental tank under the conditions specified

Fig. 19

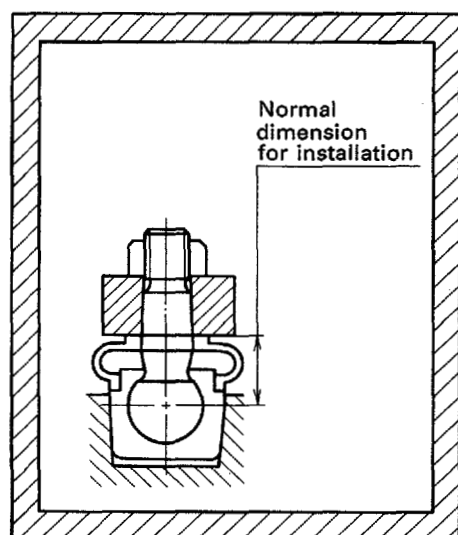
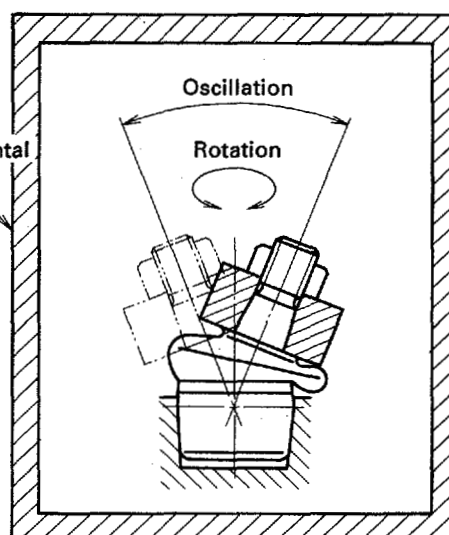


Fig. 20



in (2) above, expose the ball joint for three hours or longer at the room temperature. Thereafter, as shown in Fig. 20, rapidly apply six (6) or more strokes with the maximum oscillation angle of the ball joint as well as six (6) or more strokes with the vehicle's designed maximum steer-

ing angle or the rotation angle of $\pm 40^\circ$.

(4) Measurement items and records

- (a) Test conditions specified in (2).
- (b) Examination for cracks
- (c) Examination for grease leakage from the caulked and sealed portions
- (d) Any other possible abnormality

**Explanatory Note
on
JASO C 615-89 Bench Test Procedures of Suspension Ball Joint for
Independent Type**

The following descriptions will be given for supplemental explanation. (The numbers of items are the same with those in the Text).

3. Types of Testing

Explanatory Table 1. is given, comparing this standard with **JASO C 715-88** and **SAE J 193 SEP 79** in relation to the testing methods.

5. Ball Joint Test Method

5.1 Oscillation Angle Test

(3) Test procedures

- (a) The way of taking the oscillation angle was taken as the same method with that specified in **Fig. 2 of 6.1 (3)** (a) in **JASO C 715**.

5.2 Torque Test

(1) Test setup

A torque may be measured by using either a measuring device or a torque wrench, any of which is available. The latter is commonly applied allowing easy measurements regardless sizes of test pieces. However since the measurement error is liable to find in this method, it is preferably recommended to use an appropriate measuring device if a detailed record is required. When a friction torque of a spherical surface of a ball stud is taken as the torque of a ball joint excluding a torque generated in a dust cover, a determination shall be agreed upon between both parties concerned to delivery.

Explanatory Table 1. A comparison of JASO C 615-89 with JASO C 715-88 and SAE J 193 SEP 79 in Terms of Testing Methods

JASO C 615-89	JASO C 715-88	SAE J 193 SEP 79
Oscillation angle test	Oscillation angle test	—
Torque test	Torque test	Rotating and oscillating test of ball stud
Rigidity test	Rigidity test	Axial direction movement test of ball stud
Extrusion and drawing strength test	Extrusion and drawing strength test	Cam out strength test of ball stud
Ball stud static strength test	Ball stud static strength test	Ball stud yield load test
Dust cover drag strength test	—	—
Fatigue strength test	Fatigue strength test	—
Abrasive durability test	Service temperature abrasive durability test	Ball stud assembly fatigue and wear test
Muddy water durability test	Muddy water durability test	(Durability test with a solution mixture of brine and dust)
Dust cover ozone-deterioration test	Dust cover ozone-deterioration test	(Durability test in an ozone atmosphere)
Dust cover low temperature test	Dust cover low temperature test	—
Dust cover heat resistance test	Dust cover heat resistance test	(Durability test with steam)

Remark: The test conditions parenthesized have not been described concretely.

As types of static loads on application vehicles, a compressive load as shown in **Explanatory Fig. 1** and a tensile load as shown in **Explanatory Fig. 2** are involved.

Explanatory Fig. 3 shows an example of a measuring device for determination of rotating and oscillating torques by applying a load onto an axial direction of a ball stud of a ball joint.

(3) Test procedures

To eliminate an uneven effect of grease after assembling, the ball joint shall be run-in before measuring. In addition, the ball joint shall be left as it is for at least 24 hours so as to eliminate effects of running-in of plastic parts as well as to make sure of solidification effects of the lubricant. SAE takes 48 hours for the pur-

poses. The initial measurement shall be made mainly for the evaluation of a sticking torque and the post-operation measurement mainly for the evaluation of a service torque.

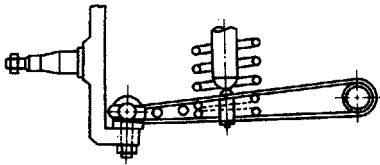
Furthermore if measurements for both an oscillating and a rotating torque are taken with a same test specimen, at least 24 hours interval shall be given between both measurements according to the test procedure as indicated in the Text.

5.3 Rigidity Test

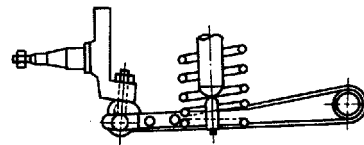
(3) Test procedures

- (a) In order to stabilize the running-in of plastic parts, the ball joint shall be used for the test specimen which has been left as it is for at least 24 hours

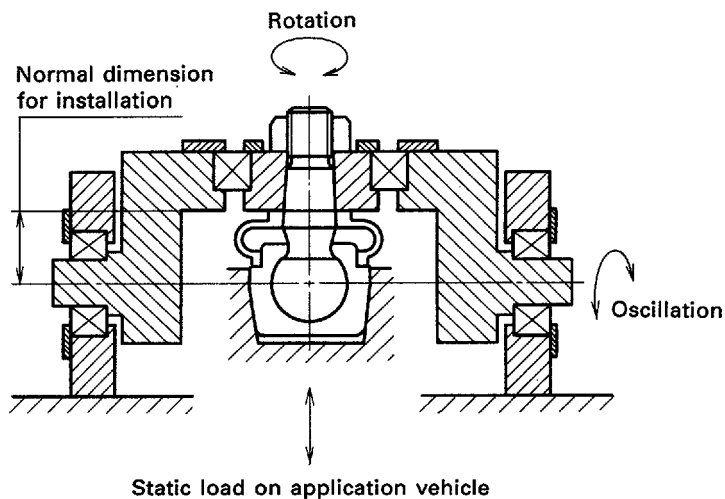
Explanatory Fig. 1



Explanatory Fig. 2



Explanatory Fig. 3



after assembling. SAE takes 48 hours for this purpose. The time left for the stabilization may be omitted for such a ball joint constructed of metallic materials which is free from a secular change.

5.4 Extrusion and Drawing Strength Test

(4) Measurement items and records

- (a) Load - displacement curve: Various different features are represented according to constructions of ball joints. Peculiarities appeared in a process lead to the maximum load shall be preferably analyzed, if necessary, in comparison with the ball joint's working conditions. (See Explanatory Fig. 4)

5.5 Static Strength Test of Ball Stud

(4) Measurement items and records

- (a) Load - displacement curve: Various different features are represented according to materials of ball studs, conditions for heat treatment and so forth. Peculiarities appeared in a process lead to the maximum load shall be preferably analyzed, if necessary, in comparison with the ball joint's working conditions.

5.7 Fatigue Strength Test

(1) Test setup

In the case of loads along with the direction rectangular to the ball stud's axis, the jig on the other end of the ball stud shall have the same materials with

the same hardness as those of the application vehicle. It is preferable to simultaneously replace along with the ball joint.

On the other hand, in the case of loads along with the axial direction of the ball stud, the jig on the other end to which the socket is mounted shall have the same constraint condition as those of the application vehicle for the opening or caulked portion of the socket.

(2) Test conditions

(c) Repeating rate

Since an exothermic behavior will be arisen under high frequency in this test, the rate in the order of 3 to 15 Hz was taken.

5.9 Muddy Water Durability Test

(1) Test setup

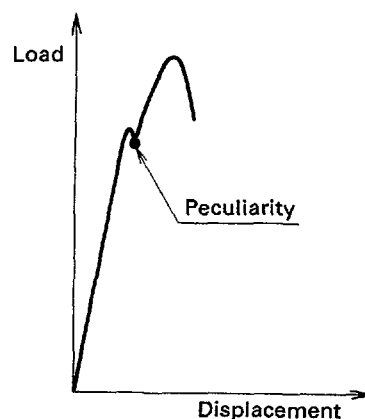
The mounting condition and direction of the ball joint shall be determined in such manner similar to the application vehicle upon considering conditions such as drip, etc. when muddy water is splashed.

(2) Test conditions

The test conditions have been defined upon referring to the requirements specified in 6.8 (2) of JASO C 715.

However, in SAE J 193, a condition of continuously spraying muddy water of 0.15 kg mixed in 50% saturated salt water of four (4) litres is specified. Accordingly, necessity of addition of salinity shall be determined upon agreed between both parties concerned to delivery.

Explanatory Fig. 4 Example of Load - Displacement Curve



5.11 Low Temperature Test of Dust Cover

(3) Test procedures

- (b) The minimum number of stroke shall be taken as six (6), and a further requirement for number of stroke shall be determined upon agreed between both parties concerned to delivery.

5.12 Heat Resistance Test of Dust Cover

(3) Test procedures

- (b) The minimum number of stroke shall be taken as six (6) cycles, and a further requirement for number of stroke shall be determined upon agreed between both parties concerned to delivery.

In the event of any doubt, the original standards in Japanese should be referred.

 : SECOND PHASED STANDARD
(The standard where customary units and converted values are given in brackets after values of SI units.)

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