

Test code of seating comfort for automobile seats

1. Scope

This standard specifies the test methods for evaluating the general performance of automobile seats on their seating comfortability.

Remarks: In this standard, units, numerical values and equations given in { } are conventional units, shown for reference.

2. Purpose

This standard is developed for standardizing the test methods to be used for testing the seating comfortability of automobile seats and for ensuring an adequate evaluation of the seating comfortability of these seats.

3. Definitions

Definitions of principal terms used in this standard shall be pursuant to JASO Z 215 (Glossary of Terms Relating to Seats of Automobiles).

4. Test types and their applicability

4.1 Types of tests

Tests shall be classified by tpe as shown in **Table 1** according to the objectives of the tests and the characteristics of the test piece to be tested.

4.2 Test applicability

The tests shall be applied as shown in **Table 2** depending on the piece to be tested.

Table 1 Test types

Type of test	Test objective	Characteristics to examine
Load	Deflecting performance	Load-deflection curve
		Deflection
		Static spring constant
	Damping performance	Hysteresis loss coefficient
Hardness Distribution	Hardness distribution	Hardness distribution curve
Surface Hardness	Softness	Load-sinkage curve
		Sinkage
		Static spring constant
Vibration	Vibration performance	Acceleration transmissibility characteristics or displacement transmissibility characteristics
		Resonance frequency
		Resonance magnification
		Dynamic spring constant
Damping	Damping performance	Damping waveform
		Logarithmic decrement

Table 2 Test applicability

Type of test \ Type of test piece	Seat cushion	Seat back
Load	○	○
Hardness Distribution	○	○
Surface Hardness	○	○
Vibration	○	—
Damping	○	—

Remarks: ○ Test applicable

Normative references: JIS D 4607	Three dimensional manikins for use in defining automobile seating accommodations (3DM-JM50)
JIS Z 8401	Rules for rounding off of numerical values
JASO Z 009	Hip point of automobile seat
JASO Z 215	Glossary of terms relating to seats of automobiles
ISO 6549	Road vehicles – Procedure for H-point determination

5. General test conditions

5.1 Pressing plates

Pressing plates to be used in the tests shall be as follows.

5.1.1 Types of pressing plates

Pressing plates shall be of four kinds as shown in Fig. 1. They shall have sufficient strength, body rigidity and surface smoothness to meet the testing requirements.

5.1.2 Mounting the pressing plates onto the tester

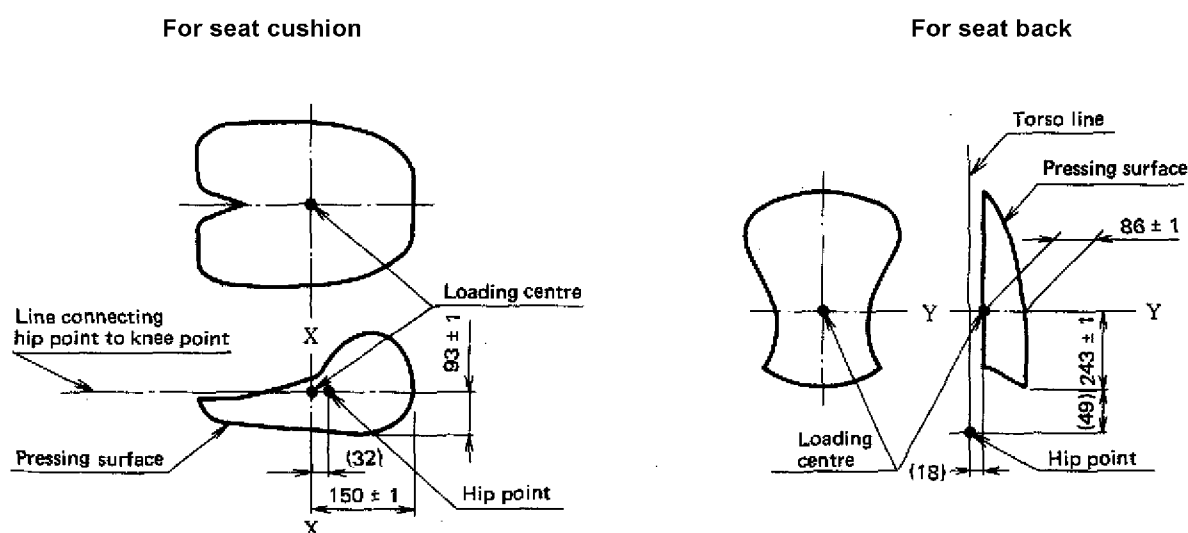
Unless otherwise specified, the mounting portion of the pressing plates shall be attached to the tester by means of the universal joints to be provided there-between except case where a column-type pressing plate is used requiring direct attachment.

5.1.3 Loading center of pressing plates

The loading center of the pressing plate shall be at the center of the universal joint.

Fig. 1 Pressing plates

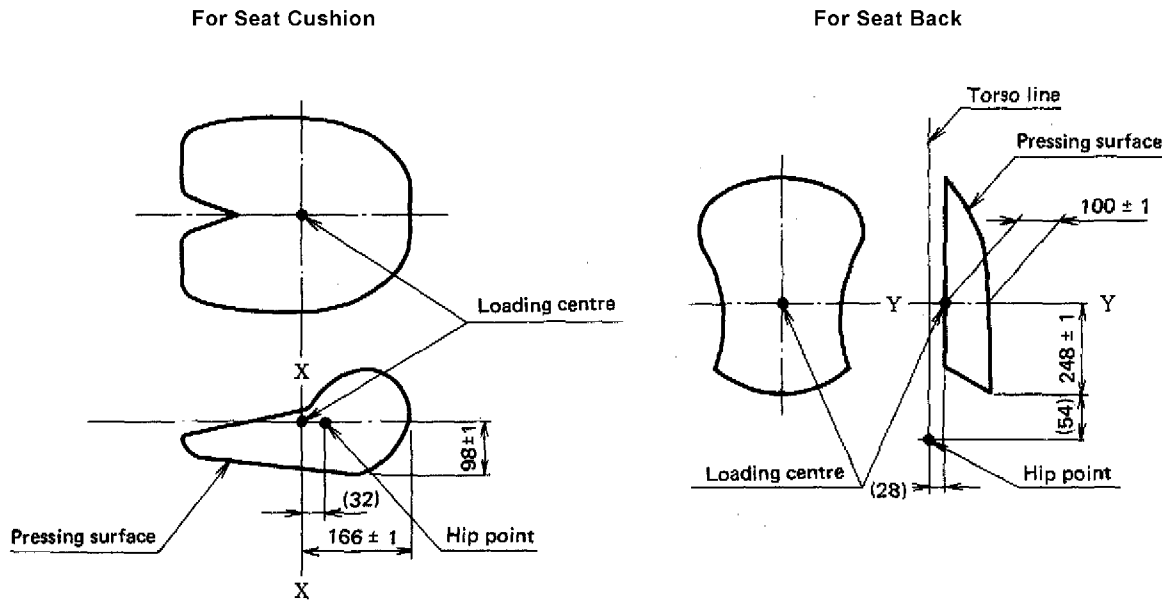
Fig. 1-1 JM type



- Remarks**
- 1: Configuration of the pressing plates shall be pursuant to Seat Pan or Back Pan specified in JIS D 4607 (Three dimensional manikins (3DM-JM50) for use in defining automobile seating accommodations)
 - 2: Center of gravity of the pressing plate shall be on the line X-X or Y-Y.
 - 3: Numerals in parenthesis shown in the Figures are for reference. They indicate the distance from the hip point or the torso line to the pressing plate.

Fig. 1-2 AM type

Unit : mm

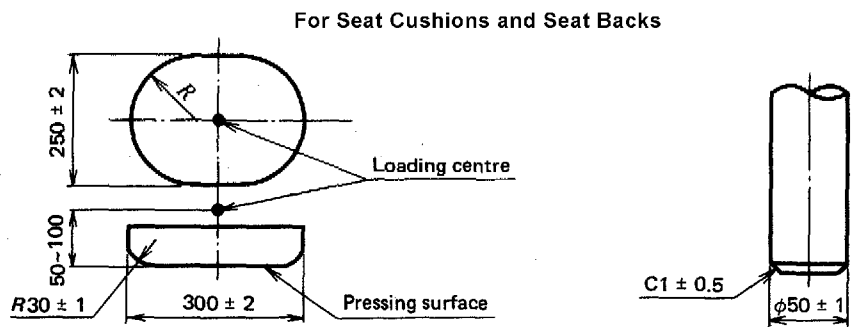


- Remarks** 1: Configuration of the pressing plates shall be pursuant to Seat Pan or Back Pan specified in JIS D 4607 (Three dimensional manikins (3DM-JM50) for use in defining automobile seating accommodations)
- 2: Center of gravity of the pressing plate shall be on the line X-X or Y-Y.
- 3: Numerals in parenthesis shown in the Figures are for reference. They indicate the distance from the hip point or the torso line to the pressing plate.

Fig. 1-3 Tekken Type

Fig. 1-4 Column Type

Unit : mm



5.2 Applicability and setting directions of pressing

plates

Applicability and setting directions of the pressing plates to be used in the tests shall be as follows.

5.2.1 Applicability of pressing plates

The pressing plates shall be applied to the tests as shown in **Table 3** depending on the type of piece to be tested and type of tests to be conducted.

Table 3 Application of pressing plates

Type of test \ Type of test piece	Seat cushion	Seat back
Load	JM-Type AM-Type "Tekken"-Type	JM-Type AM-Type "Tekken"-Type
Hardness Distribution	Column-Type	Column-Type
Surface Hardness	Column-Type	Column-Type
Vibration	JM-Type AM-Type "Tekken"-Type	—
Damping	JM-Type AM-Type "Tekken"-Type	—

5.2.2 Setting directions of pressing plates

- (1) For the JM- and AM-types, the pressing plates shall be set according to the seating methods prescribed in **JIS D 4607** and **ISO 6549**.
- (2) For the "Tekken"-type, the pressing plate shall be set with its longer side placed sideways on the seat cushion and lengthways on the seat back, as a rule.

5.3 Points of load application and loading directions

Locations of the loading points and loading directions shall be determined as specified below with the test piece placed at its standard mounting position. (Refer to **Fig. 2**) Hip-point, Knee-point, Torso Line, point B and the reference lines herein referred to in **Fig. 2** are the points and lines of standard design. If these standard points or lines are not known, they shall be determined by actual measurement.

5.3.1. Location of loading points

Location of points of loading onto the test piece shall be as follows depending on the type of pressing plates.

(1) Seat cushion

- (a) For the JM- and AM-types, the point on the seating center line of the seat cushion, 32 mm shifted toward the knee point from the hip point specified in **JASO Z 009** (Hip point of automobile seat).
- (b) For the "Tekken"- and Column-types, the point on the seating center line of the seat cushion, 130 mm forward-shifted horizontally from point B shown in **Fig. 2**.

(2) Seat back

- (a) For the JM-type, the point on the seating center line of the seat back, 292 mm upward-shifted in parallel with the torso line, from the hip point specified in **JASO Z 009**.
- (b) For the AM-type, the point on the seating center line of the seat back, 302 mm upward-shifted in parallel with the torso line, from the hip point specified in **JASO Z 009**.
- (c) For the "Tekken"- and Column-types, the point on the seating center line of the seat back, 170 mm upward-shifted from point B in parallel with the reference line shown in **Fig. 3** or in parallel with the torso line specified in **JIS D 4607** as shown in **Fig. 2**.

Fig. 2 Positions and directions of the load

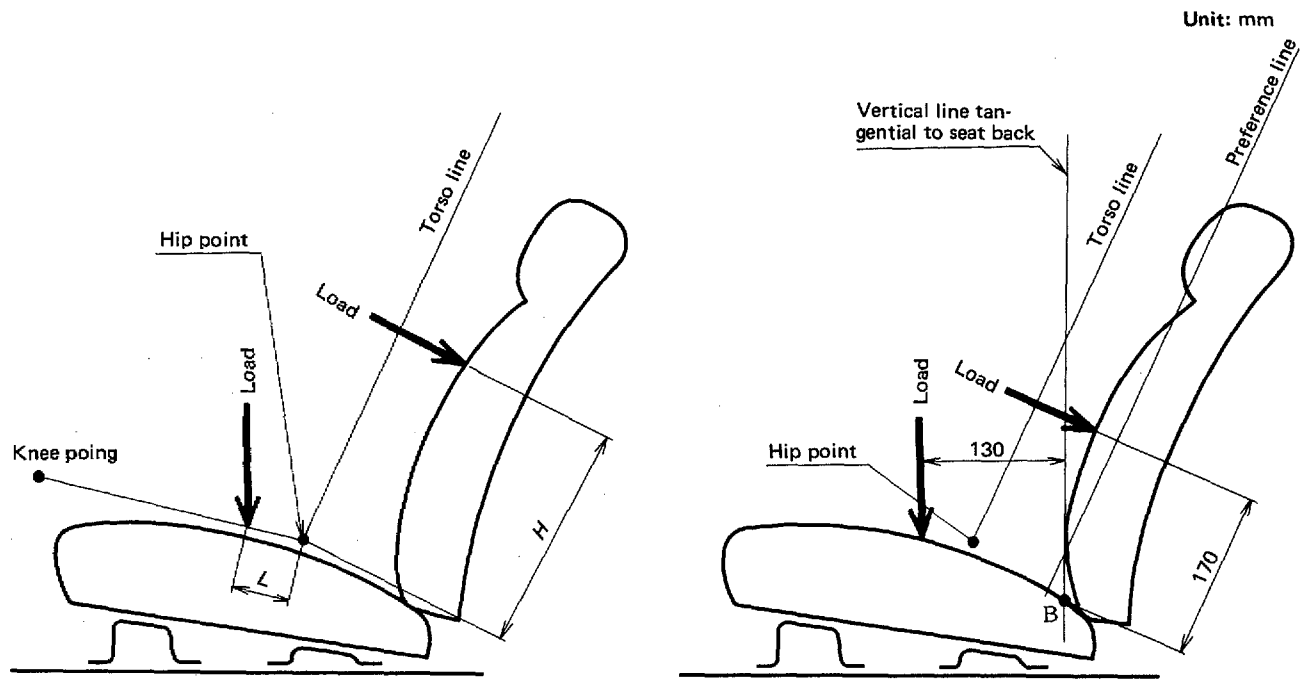
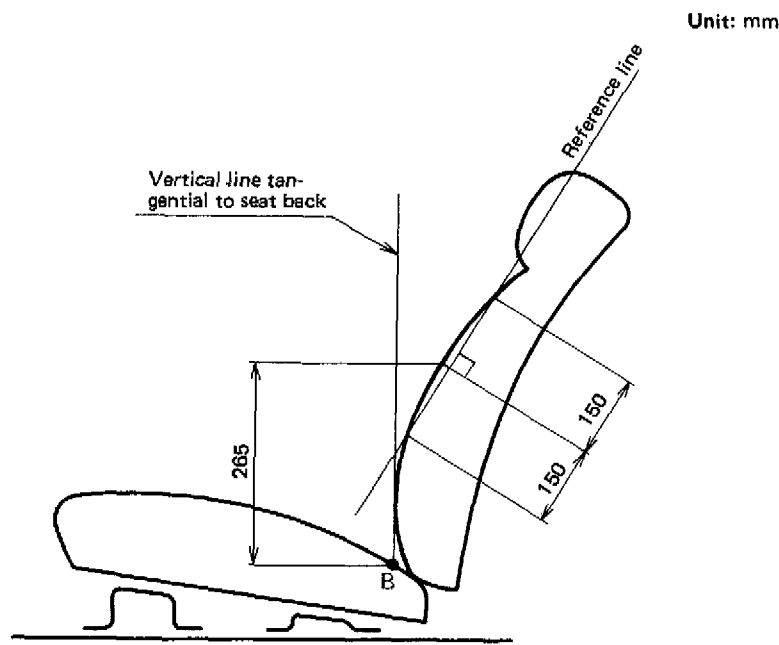


Fig. 3 How to determine point B and reference line



5.3.2 Loading directions

Directions for loading the test piece shall be as follows.

- (a) The seat cushion is vertical.
- (b) The seat back is perpendicular to the torso line shown in **Fig. 2**. The reference line shown in **Fig. 3** may be used in place of the torso line.

5.4 Preliminary pressing

As the preliminary pressing, the load specified in Table 4 shall be applied, at least two times, to the loading point specified in 5.3.1. This preliminary pressing, however, may be omitted when a load equivalent to this preliminary pressing load has already been applied prior to this test.

Table 4 Loads for preliminary pressing

Unit: N {kgf}

Type of the test piece Type of pressing plate	Seat cushion	Seat back
JM-Type	700 {71}	400 {41}
AM-Type	850 {87}	500 {51}
"Tekken"-Type	700 {71}	300 {31}

5.5 Indication of characteristic values

The number of digits to indicate characteristic values shall be as shown in Table 5.

Table 5 Number of digits of numerals to indicate characteristic values

Characteristic	Unit	Number of digits to indicate
Deflection	mm	Integer only
Static spring constant	N/mm {kgf/mm}	Down to one place of decimal {Down to two places of decimal}
Coefficient of Hysteresis Loss	%	Integer only
Sinkage	mm	Integer only
Resonance frequency	Hz	Down to one place of decimal
Resonance Magnification	—	Down to one place of decimal
Dynamic spring constant	N/mm {kgf/mm}	Down to one place of decimal {Down to two places of decimal}
Logarithmic decrement	—	Down to two places of decimal

Remarks: Rounding off of the numerals shall be made in accordance with JIS Z 8401.

6. Test methods

6.1 Load test

6.1.1 Mounting the test piece onto the tester

The test piece shall be mounted onto the tester so that the loading direction prescribed in 5.3.2 can become vertical.

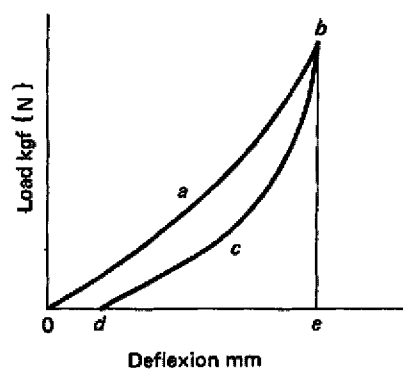
6.1.2 Relative location of pressing plate and test piece

The test piece shall be placed so that the vertical line from the loading center of the pressing plate can be in alignment with the loading direction at the loading point on the test piece specified in 5.3.1 and most of the pressing surfaces of the pressing plate can become mostly parallel with the surfaces of the test piece prior to applying any load.

6.1.3 Initial load, loading/unloading speeds, and maximum load

Apply the initial load of 5N {0.5 kgf} onto the test piece, and then with the load center of the pressing plate set as the starting point, apply the load onto the test piece and release the load at the speeds of 150~300 mm/min. Develop the load-deflection curve as shown in **Fig. 4**. Record the loading and unloading speeds at that time. The maximum load to be applied during the loading shall be equal to the preliminary load shown in Table 4. The break time for switchover from loading to unloading shall be no longer than 2 seconds.

Fig. 4 Load-deflection curve



6.1.4 Results

Obtain the following values from the load-deflection curve as shown in **Fig. 4**, examining the deflection and damping performance.

- (1) Deflections shall be the values corresponding to the values at the time the loads shown in **Table 6** are applied.

Table 6 Loads for deflection measurement

Unit: N {kgf}		
Type of test piece Type of pressing plate	Seat cushion	Seat back
JM-Type	500 {51}	250 {26}
AM-Type	600 {61}	300 {31}
"Tekken"-Type	450 {46}	150 {15}

- (2) The static spring constant shall be the value of the tangent of the tangential line to the loading-side curve at the time the load shown in **Table 6** is applied.

- (3) For obtaining the coefficient of hysteresis loss, first measure the loaded area and the hysteresis loss area, and subsequently obtain it from the following formula.

$$\alpha = \frac{\text{Area } Oabcd}{\text{Area } Oabe}$$

where, α : coefficient of hysteresis loss (%)

6.2 Hardness distribution test

Hardness distribution test shall be conducted as follows.

6.2.1 Mounting the test piece onto tester

The test piece shall be mounted on the tester so that the loading direction prescribed in **5.3.2** can become vertical.

6.2.2 Relative location of pressing plate and test piece

As shown in **Fig. 5**, the points where the load is to be applied shall be set, in sequence, 50 mm apart with the reference points specified in **5.3.1**. They will be set on the longitudinal and lateral lines for the seat cushion, and on the longitudinal and vertical lines for the seat back, passing through these reference points and running crosswise with each other at right angles on the planes vertical to the loading directions. The loading centers on the pressing plates shall come in alignment with the loading directions set at the loading points. Measurements shall be taken for all the loading points where ever possible.

6.2.3 Initial load, loading speed, and loads when deflections are measured

Apply the initial load of 5N {0.5 kgf} onto the test piece, and, with the loading center identified at that time on the pressing plates set as the starting point, further apply the load onto the seat cushion and onto the seat back at a speed not exceeding 1000 mm/min. The load to be applied shall be not less than 200N {20 kgf} for the seat cushion and not less than 100N {10 kgf} for the seat back. Measure the deflections when the load of 100N is applied to the seat back. The loading speed at the respective loading points shall be the same. Loading speed at that time shall be recorded.

6.2.4. Results

Develop the hardness distribution curves as shown in **Fig. 6** from the deflections identified at the respective loading points, examining the hardness distribution.

Fig. 5 Location of loading points

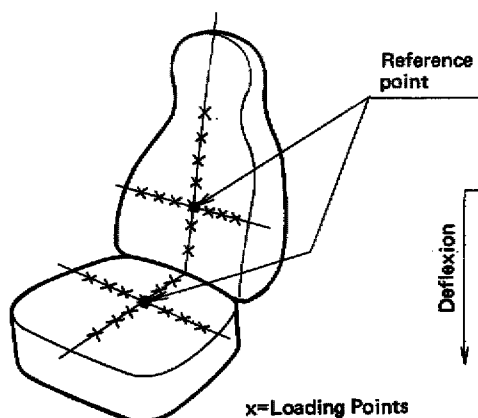
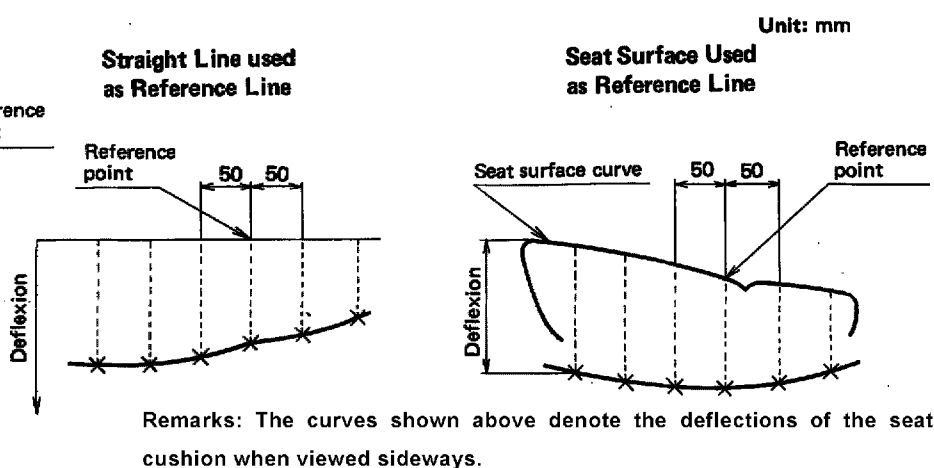


Fig. 6 Hardness distribution curves (examples)



6.3 Surface hardness test

A surface hardness test shall be conducted as follows.

6.3.1 Mounting the test piece onto the tester

The test piece shall be mounted on the tester so that the loading direction prescribed in 5.3.2 can become vertical.

6.3.2 Relative location of pressing plate and test piece

The test piece shall be positioned so that the vertical line from the loading center of the pressing plate comes in alignment with the loading direction at the loading point specified in 5.3.1.

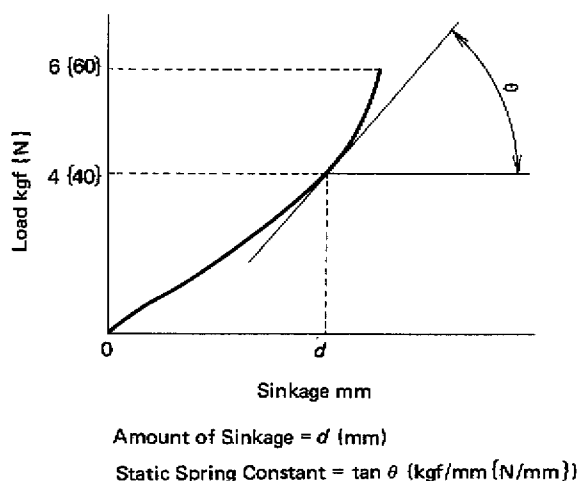
6.3.3 Initial load and loading speed

Apply the initial load of 5N {0.5 kgf} onto the test piece, and, with the loading center identified at that time on the pressing plate set as the starting point, apply a load up to 60N {6 kgf} at the loading speed of 150~300 mm/min. The load-sinkage curve shall be developed as shown in Fig. 7. Record the loading speed at that time.

6.3.4 Results

Obtain the amount of the sinkage and static spring constant, from the load-sinkage curve as shown in Fig. 7, at the time when the load of 40N {4 kgf} is applied, examining the softness. The static spring constant shall be the value of the tangent of the angle between the tangent line to the curve and the axis of abscissa at the time a load of 40N {4 kgf} is applied.

Fig. 7 Load-sinkage curve



6.4 Vibration test

A vibration test shall be conducted as follows.

6.4.1 Mounting the test piece onto the tester

The test piece shall firmly be fixed onto the tester so that the loading direction prescribed in 5.3.2 can become vertical.

6.4.2 Relative location of the pressing plate and test piece

The test piece shall be positioned so that the vertical line from the loading center of the pressing plate comes in alignment with the loading direction at the loading point specified in 5.3.1.

6.4.3 Mass of pressing plate

The mass of the pressing plate shall be equivalent to the load at the time deflection is measured as indicated in Table 6.

6.4.4 Total amplitude and frequency

Total vertical amplitude of the shaking table shall be selected from among 2, 5, 10, 15 and 20 mm. The exciting frequency shall be within a range of 1 Hz to a frequency to exceed the resonance frequency by 2 Hz or more. The shaking wave shall be sine wave.

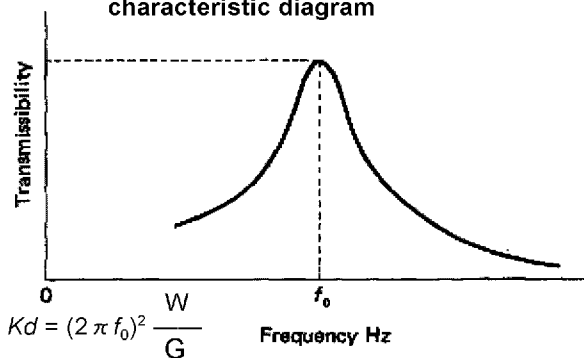
6.4.5 Acceleration and absolute displacement measuring positions

Measuring positions of acceleration and absolute displacement shall be as close to the loading center of the pressing plate as possible.

6.4.6 Results

Develop, from the measurements obtained, the acceleration transmissibility characteristics diagram or the displacement transmissibility characteristics diagram, as shown in **Fig. 8**, on the relationship between transmissibility⁽¹⁾ and frequency. Obtain, from these respective diagrams, the resonance frequency⁽²⁾ and the resonance magnification⁽³⁾, calculating, from the following formula, the dynamic spring constant for examining the vibration performance.

Fig. 8 Acceleration transmissibility characteristic diagram or displacement transmissibility characteristic diagram



where, Kd : Dynamic spring constant (N/mm) {kgf/mm}
 f_0 : Resonance frequency (Hz)
 W : Load (N) {kgf}
 G : Acceleration of gravity (9800 mm/s²)

Note ⁽¹⁾: In the case of acceleration transmissibility, it denotes the ratio between the acceleration found on the pressing plate and the acceleration found on the shaking table. Whereas, in the case of displacement transmissibility, it denotes the ratio between the absolute displacement found on the pressing plate and the total vertical amplitude of the shaking table.

⁽²⁾: The frequency to read at the time the transmissibility shows its maximum value.

⁽³⁾: The maximum value of the transmissibility.

6.5 Damping test

A damping test shall be conducted as follows.

6.5.1 Mounting the test piece onto the tester

The test piece shall be firmly fixed to the tester so that the loading direction prescribed in 5.3.2 can become vertical.

6.5.2 Relative location of the pressing plate and test piece

The test piece shall be positioned so that the vertical line from the loading center of the pressing plate comes in alignment with the loading direction at the loading point specified in 5.3.1.

6.5.3 Mass of the pressing plate

The mass of the pressing plate shall be equivalent to the load for the preliminary pressing indicated in **Table 4**.

6.5.4 Drop height and damping wave measuring position

Raise the pressing plate to any point arbitrarily chosen within a distance up to 20 mm high vertically measured from the loading center of the test piece, and have it dropped freely. Record the damping waveform of the point as close to the loading center of the pressing plate as possible as shown in **Fig. 9**.

6.5.5 Result

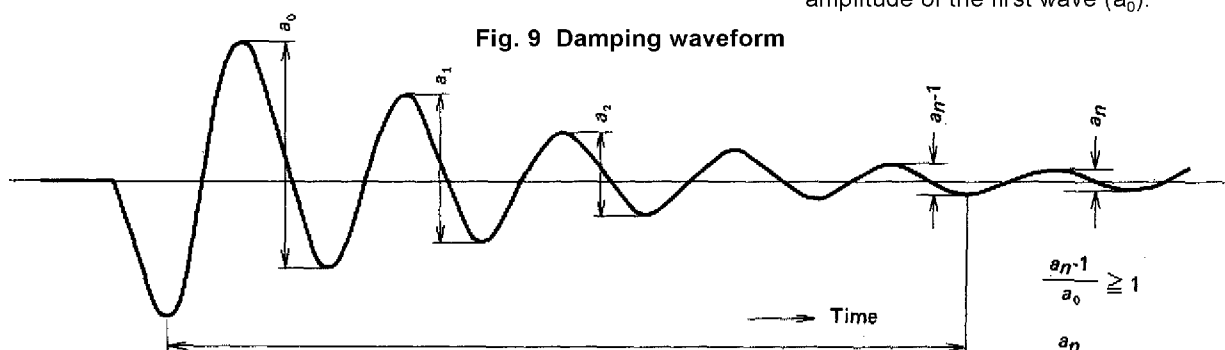
Using the damping waveform diagram as shown in **Fig. 9**, obtain the logarithmic decrement from the following formula for examining the damping performance.

$$\lambda = \log_e \frac{1}{n} \left[\frac{a_0}{a_1} + \frac{a_1}{a_2} \dots + \frac{a_{n-1}}{a_n} \right]$$

where, λ : Logarithmic decrement

a : Amplitude

n : Number of waves which have been read. The waves shall be read until the amplitude of the last wave becomes smaller than 10% of the amplitude of the first wave (a_0).



Remarks: The waveform shown above denotes the damping waveform caused by the acceleration.

Explanatory Notes for JASO B407-87 Test code of seating comfort for automobile seats

1. Applicability of this standard

This standard is to be applied to the methods for evaluating the general performance of automobile seats for seating comfort. Seating comfort herein referred to is represented by the extent of deflection of the seat cushion and seat back to sustained both in static and in dynamic conditions when occupied by an average adult. By ascertaining the extent of such deflection, the seat comfortability and resultant vehicle ride quality can be evaluated.

This standard is applicable to generally used tests.

4. Test types and applicability

4.1 Test types

This standard specifies the testing methods to be used. Five types of testing methods are established, but all are not necessarily required, and the sequence of testing is not specified.

Selection of the test or tests to be conducted and the sequence of testing when two or more tests are to be conducted can be determined by the parties involved, i.e., the product manufacturer and the product receiver.

5. General testing conditions

5.1 Pressing plate

(1) Four types of pressing plates are specified. Of these four, the JM, AM and "Tekken"-types are used for testing load, vibration and damping. The JM-type is equivalent to the JSAE-3DM, and the AM-type is equivalent to the SAE-3DM. The "Tekken"-type was developed by the Railway Technical Research Institute of the Japan National Railway Corporation.

(2) The JM- and AM-type pressing plates determine the loading center so that their inclination at the time of loading is the same as when the 3DM is seated.

5.2 Points of loading and loading directions

(1) The loading point for seat cushions on the "Tekken"-type pressing plate is the point 130 mm forward-shifted from point B after consideration is given to the following requirements:

(a) Seats affixed with a seat back require a clearance of at least 125 mm between the pressing plate and the seat back to avoid interference.

(b) For the 3DM, the distance from the "H" point to the back of the buttocks is 118 mm for the JM50 and 134 mm for the AM50.

(c) For a human body, the distance from the sciatic tuber to the back of the buttocks is 130-149 mm.

(2) For the seat back, the loading point set on the "Tekken"-type pressing plate is the point 170 mm upward-shifted from point "B" for the following reasons.

For a human body, the distance from the sciatic tuber to the 3rd-4th lumbers (where the seat back is supported) is 230-250 mm (or approx. 240 mm on average). The amount of deflection of the seat cushion (the distance from the loading point on the seat cushion to the line running on point "B" when measured parallel to the reference line) is approx. 70 mm on average. The amount of upward-shifting of the loading point, 170 mm, is obtained by deducting the 70 mm from the 240 mm.

(3) The loading directions are set based on the following requirements:

(a) The load exerted onto the surface of the seat cushion, when seated, works vertically and the direction of loading by the pressing plate should also be set vertically.

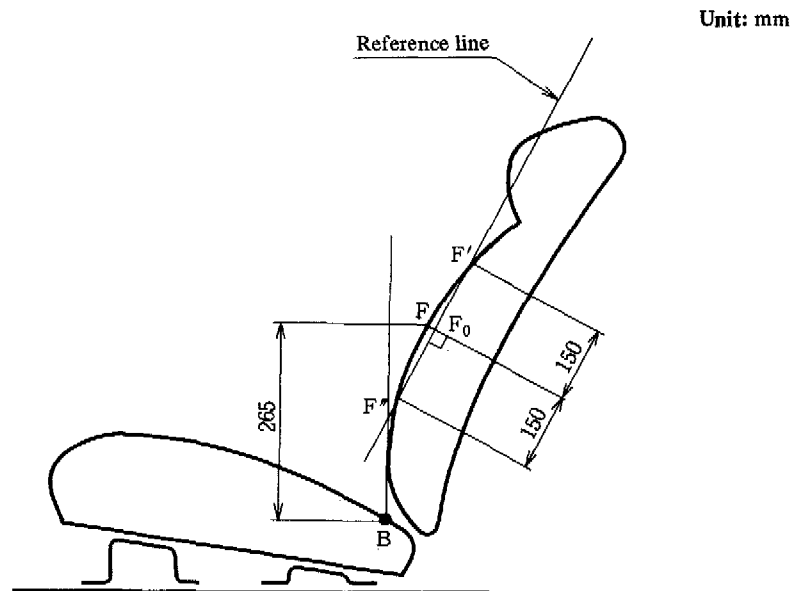
(b) The load exerted rearward on the seat back, when seated, is considered to work around point "H" and the direction of loading from the pressing plate should be set vertical to the torso line.

(4) Point "B" and the reference line shown in Fig. 3 are determined as follows. (refer to Explanatory Fig. 1)

(a) **Point "B"** Draw a vertical line tangent to the surface of the seat back down from a point on the seating center line of the seat. Next, find the intersection of this tangent line and the surface of the seat cushion. This is point "B".

(b) **Reference line** Find the point on the surface of the seat back which is on the seating center line of the seat, 265 mm* above point "B" vertically. Define this point as point F. Next, find two other points, F' and F'', on the surface of the seat back so that the respective distance, F_0-F' and F_0-F'' , is 150 mm as shown in the figure. The line passing through these two points, F' and F'', is defined as the reference line.

Explanatory Fig. 1 How to get point B and reference line



Note: *265mm per SAE. Point "F" is the center of loading onto the seat back.

5.3 Preliminary loading

Preliminary pressing is applied so as to secure a satisfactory pre-test deflection settling-in of the test piece.

6. Test methods

6.1 Load test

(1) Loading and unloading speeds are specified to 150-300 mm/min according to the following requirements identified through a series of experiments made with several different kinds of seats.

(a) No significant difference can be found, between seats, in the amount of deflections if the loading speed remains within the range of loading acceleration of 150-300 mm/min.

(b) No significant difference can be found, between seats, in the static spring constant if the loading speed remains within the range of loading acceleration of 50-600 mm/min.

(c) No significant difference can be found, between seats, in the coefficient of hysteresis loss if the loading speed remains within the range of loading acceleration of 150-600 mm/min.

(2) For ascertaining the static spring constant, the tangent of the tangential line to the load-deflection curve is measured. Another possible method is to measure the tangent of the line passing through two points on the load-deflection curve – one located on one side of the load measuring point. To minimize measurement error, the adoption of the tangent of the tangential line to the load-deflection curve is considered preferable.

(3) While minimal initial load is preferred, 5N is adopted as the reasonable value of the initial load to be applied. This value has been justified by experiments on several different kinds of seats

(4) Deflection and static spring constants can be measured both on the loading and the unloading side of the load-deflection curve. Measurements are usually made on the loading side of that curve. We adopt this method in this standard.

6.2 Hardness distribution test

(1) In this standard, the load measuring points are set 50 mm apart. If arranged too wide apart, the measuring points will decrease in number, resulting in less accuracy in the test results. If arranged too close, measurement takes too much time without much increase in accuracy. Practical testing recommend an interval of 560 mm, which is the same as the diameter of the pressing plate.

6.3 Surface hardness test

(1) This physical evaluates the extent of the softness of the seat surfaces which have customarily been evaluated by hand touching. The newly adopted test method is based on the results of our experiments which tell us that the rating of the subjective evaluation made by hand touching can be well appreciated by a physical testing in which a load of approx. 4N is applied to the test surfaces by a column-type pressing plate.

6.4 Vibration test

(1) Total shaking amplitude can be selected from 2, 5, 10, 15 and 20 mm, as required. For seats with considerable transmissibility, the amplitude of the pressing plate can become excessively high. To avoid such an occurrence, an optional amplitude is acceptable. It must be noted, however, that resonance frequency changes in proportion to changes in the amplitude, larger amplitude relates to smaller resonance frequency.

(2) Exciting frequency is limited from 1 Hz to a point exceeding the resonance frequency by 2 Hz or more. This is because, when the exciting frequency stays at 1 Hz or below, the transmissibility remains very close to 1 (where, the resonance frequency of the seat is 2-4 Hz), and, when the exciting frequency disagrees as much as 2 Hz with the resonance frequency, the exciting vibration is insulated.

6.5 Damping test

(1) The height from which the pressing plate is dropped onto the seat surface should be as close to the seat surface as possible. Determination of the most appropriate height is rather difficult. As long as the drop height stays within a range of 20 mm from the seat surface, there will be no negative effect on the test results. The drop height may, therefore be set to any point up to 20 mm from the seat surface.

(2) The characteristics to be ascertained in the damping test are the damping waveform and the logarithmic decrement only. The damping time is not adopted in this test. This is because damping time is not usually examined in this kind of test, and if examined, there is too much variance in the measurements obtained. We have judged that the damping performance of the seat can be sufficiently ascertained only by examining both the damping waveform and the logarithmic decrement.