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**Rubber, vulcanized and
thermoplastic—Determination of
temperature rise and resistance to
fatigue in flexometer testing**

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Foreword

This Japanese Industrial Standard has been revised by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by The Japan Rubber Manufacturers Association (JRMA)/Japanese Standards Association (JSA) with the draft being attached, based on the provision of Article 12 Clause 1 of the Industrial Standardization Law applicable to the case of revision by the provision of Article 14. Consequently **JIS K 6265:2001** is replaced with this Standard.

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Rubber, vulcanized and thermoplastic— Determination of temperature rise and resistance to fatigue in flexometer testing

Introduction

This Japanese Industrial Standard has been prepared based on **ISO 4666-1:2010**, Edition 2, **ISO 4666-3:2016**, Edition 3, and **ISO 4666-4:2007**, Edition 1, with some modifications of the technical contents.

The vertical lines on both sides and dotted underlines indicate changes from the corresponding International Standard. A list of modifications with the explanations is given in Annex JA.

1 Scope

This Standard specifies the determination methods of the temperature rise, dynamic creep and compression set due to internal heat generation, and the fatigue life of vulcanized rubber and thermoplastic rubber using the compression flexometer.

NOTE 1 The flexometer specified in this Standard is not recommended for the tests for vulcanized rubber and thermoplastic rubber of at least 85 IRHD in international rubber hardness specified in **JIS K 6253-2** or the tests for vulcanized rubber and thermoplastic rubber of at least A85 in Type A durometer hardness specified in **JIS K 6253-3**.

NOTE 2 The International Standards corresponding to this Standard and the symbol of degree of correspondence are as follows.

ISO 4666-1:2010 *Rubber, vulcanized—Determination of temperature rise and resistance to fatigue in flexometer testing—Part 1: Basic principles*

ISO 4666-3:2016 *Rubber, vulcanized—Determination of temperature rise and resistance to fatigue in flexometer testing—Part 3: Compression flexometer (constant-strain type)*

ISO 4666-4:2007 *Rubber, vulcanized—Determination of temperature rise and resistance to fatigue in flexometer testing—Part 4: Constant-stress flexometer (overall evaluation: MOD)*

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standards and **JIS** are **IDT** (identical), **MOD** (modified), and **NEQ** (not equivalent) according to **ISO/IEC Guide 21-1**.

WARNING 1 Persons using this Standard should be familiar with normal laboratory practice. This Standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this Standard to establish appropriate safety and health practices.

WARNING 2 Certain procedures specified in this Standard might involve the use or generation of substances, or the generation of waste, that could constitute a local environmental hazard. Reference should be made to appropriate laws and regulations on safe handling and disposal after use.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. The most recent editions of the standards (including amendments) indicated below shall be applied.

JIS K 6200 *Rubber—Vocabulary*

JIS K 6250 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods*

NOTE : Corresponding International Standard: ISO 23529 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods*

JIS K 6394 *Rubber, vulcanized or thermoplastic—Determination of dynamic properties—General guidance*

NOTE : Corresponding International Standard: ISO 4664-1 *Rubber, vulcanized or thermoplastic—Determination of dynamic properties—Part 1: General guidance*

JIS Z 8401 *Guide to the rounding of numbers*

ISO 18899 *Rubber—Guide to the calibration of test equipment*

3 Terms and definitions

For the purpose of this Standard, the terms and definitions given in JIS K 6200 and JIS K 6394, and the following apply.

3.1 loading

subjection of the test piece to a predetermined stress or strain, either static or dynamic

3.2 pre-stress

constant static stress to which the test piece is subjected during the test

NOTE 1 The pre-stress is expressed in MPa.

NOTE 2 The pre-stress may be used to simulate product requirements or simply to hold the test piece in the apparatus.

NOTE 3 The term “mean load” specified in **JIS K 6394** is equivalent to “pre-stress”.

3.3 pre-strain

constant static strain to which the test piece is subjected during the test

NOTE 1 The pre-strain may be used to simulate product requirements or simply to hold the test piece in the apparatus.

NOTE 2 The term “mean strain” specified in **JIS K 6394** is equivalent to “pre-strain”.

3.4 cyclic stress amplitude

force amplitude (cyclic force) superimposed upon the pre-strain or the pre-stress

NOTE 1 The cyclic stress amplitude is expressed in MPa.

NOTE 2 The term “maximum stress amplitude” specified in **JIS K 6394** is equivalent to “cyclic stress amplitude”.

3.5 cyclic strain amplitude

displacement amplitude (cyclic displacement) superimposed upon the pre-strain or pre-stress

NOTE 1 The cyclic strain is smaller than the pre-strain.

NOTE 2 The term “maximum strain amplitude” specified in **JIS K 6394** is equivalent to “cyclic strain amplitude”.

3.6 heat generation

total heat generated in the test piece by energy absorption during the test

NOTE : “Heat generation” should be distinguished from “heat build-up”, which is sometimes used and normally associated with the temperature rise in the test piece.

3.7 temperature rise

temperature difference between that at a specific time during the test and that before the test, measured on a specific position of test piece

3.8 constant strain flexometer test

flexometer test to be carried out while the cyclic load among the compression loads is applied to a test piece so that the deflection or strain amplitude becomes constant

3.9 constant stress flexometer test

flexometer test to be carried out while the cyclic load among the compression loads is applied to a test piece so that the load or stress amplitude becomes constant

NOTE : Figure 1 shows the behaviour changes of stress and strain in the constant strain flexometer test and the constant stress flexometer test.

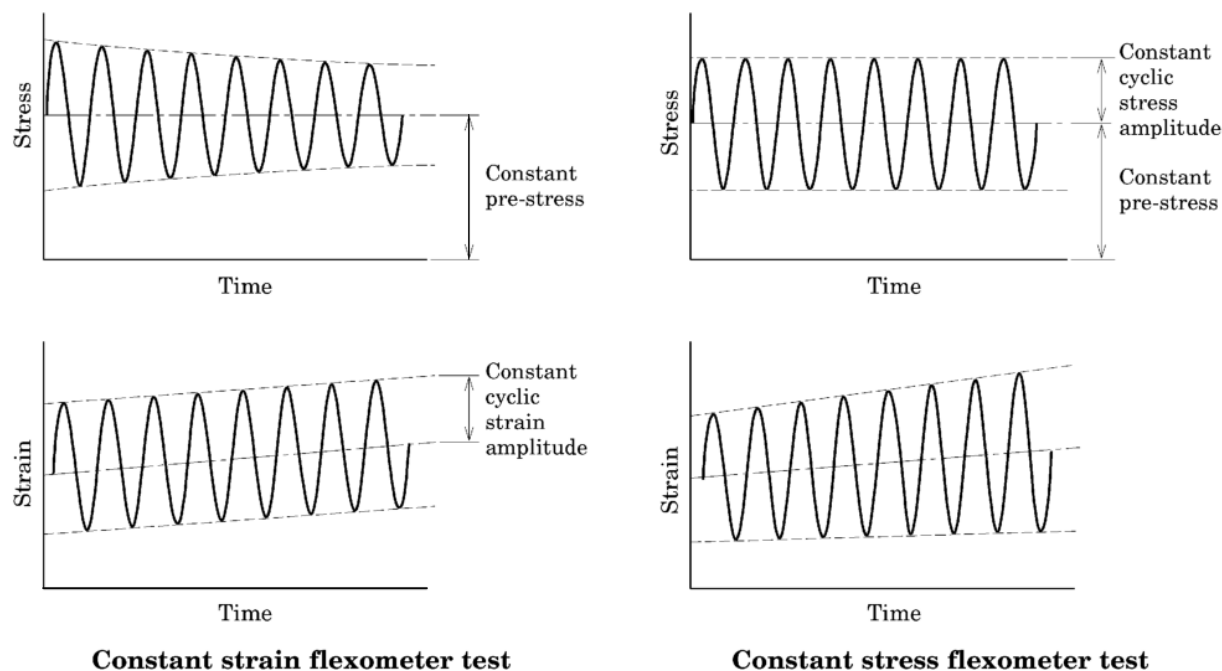


Figure 1 Behaviour changes of stress and strain

3.10 fatigue breakdown

breakdown due to the change in chemical and/or physical structure, or composition of the test piece under the simultaneous action of cyclic stress and temperature

3.11 fatigue life

period of time or number of cycles from the start of specific amplitude application and specific frequency cyclic stress (load) to the test piece up to the detection of fatigue breakdown

4 Outline of test

4.1 General

The flexometer testing is used for the prediction regarding the durability of rubbers in finished articles subject to dynamic flexing in service, such as tyres, bearings, supports and V-belts. However, owing to the wide variations in service conditions, no simple correlation between the test results and the service performance can be assumed.

4.2 Types of tests

Tests are of two types as given below.

- a) Constant strain flexometer test
- b) Constant stress flexometer test

5 Constant strain flexometer test

5.1 Test apparatus

5.1.1 General

The test apparatus shall consist of the upper and lower anvils to apply the static and dynamic loads, micrometer mechanism to measure the change in height of test piece, thermostatic chamber, temperature measuring device, and the like. Figure 2 shows the operation principle of test apparatus, and Figure 3 shows an example of test apparatus.

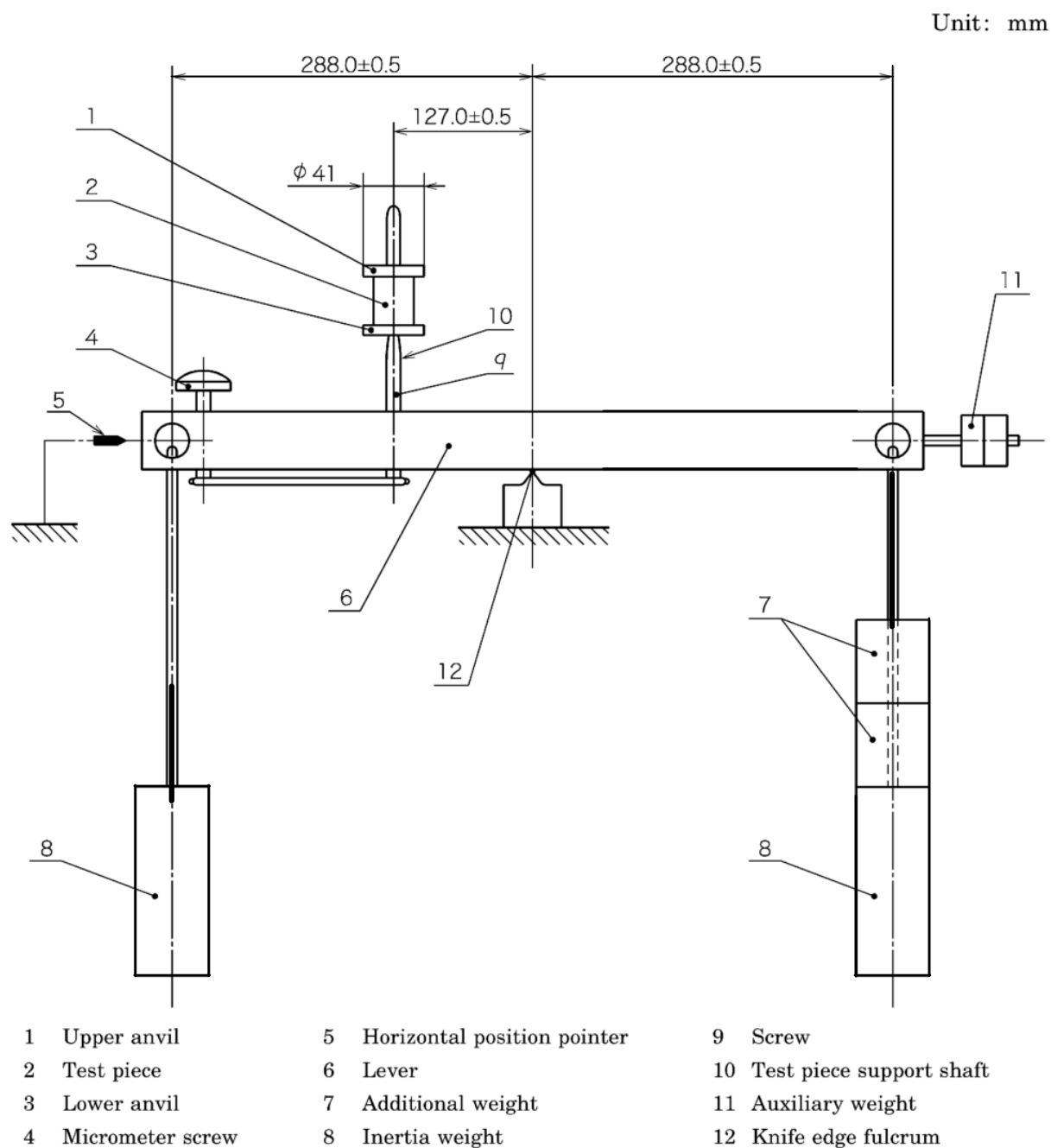


Figure 2 Operation principle for constant strain flexometer

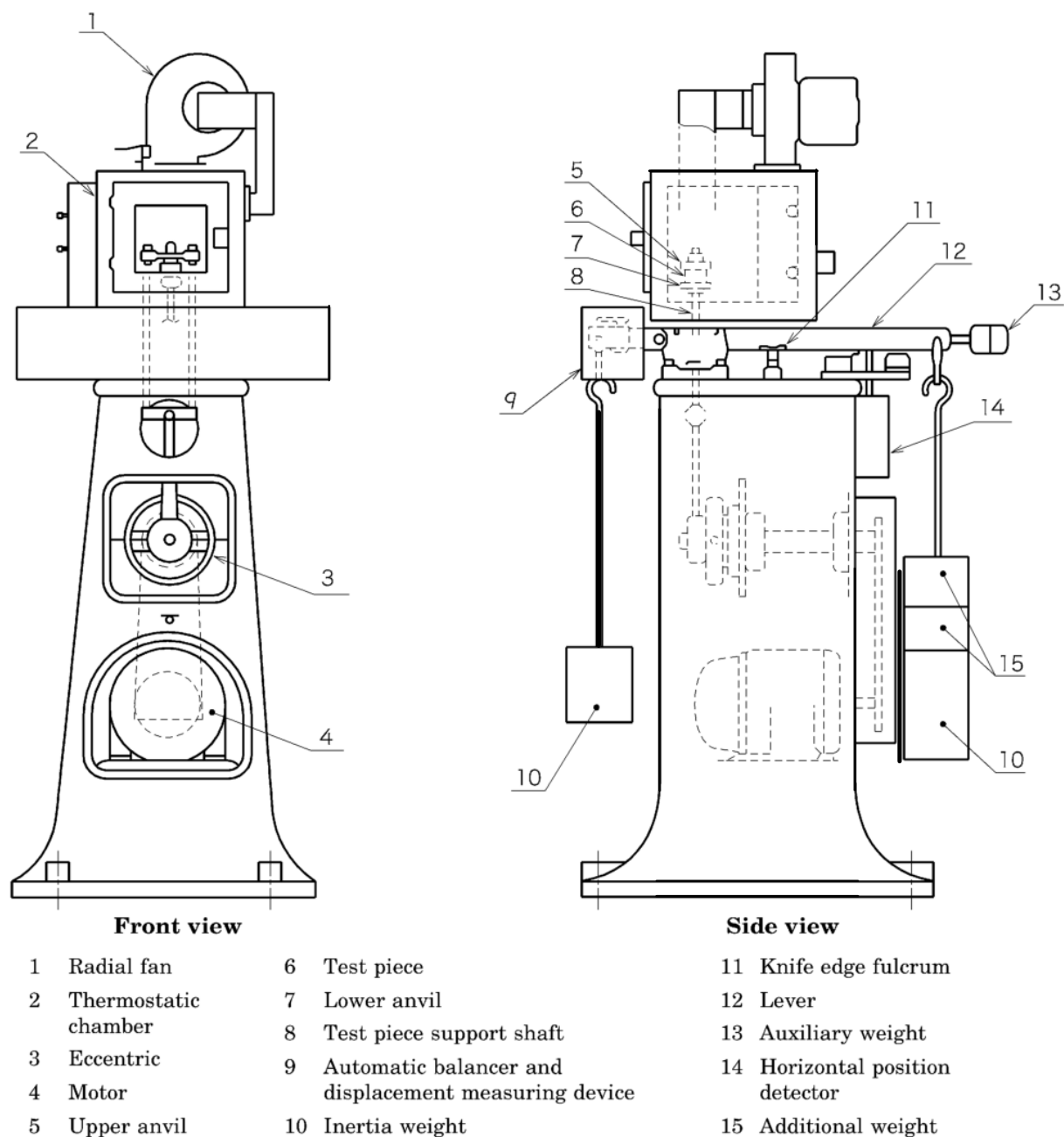


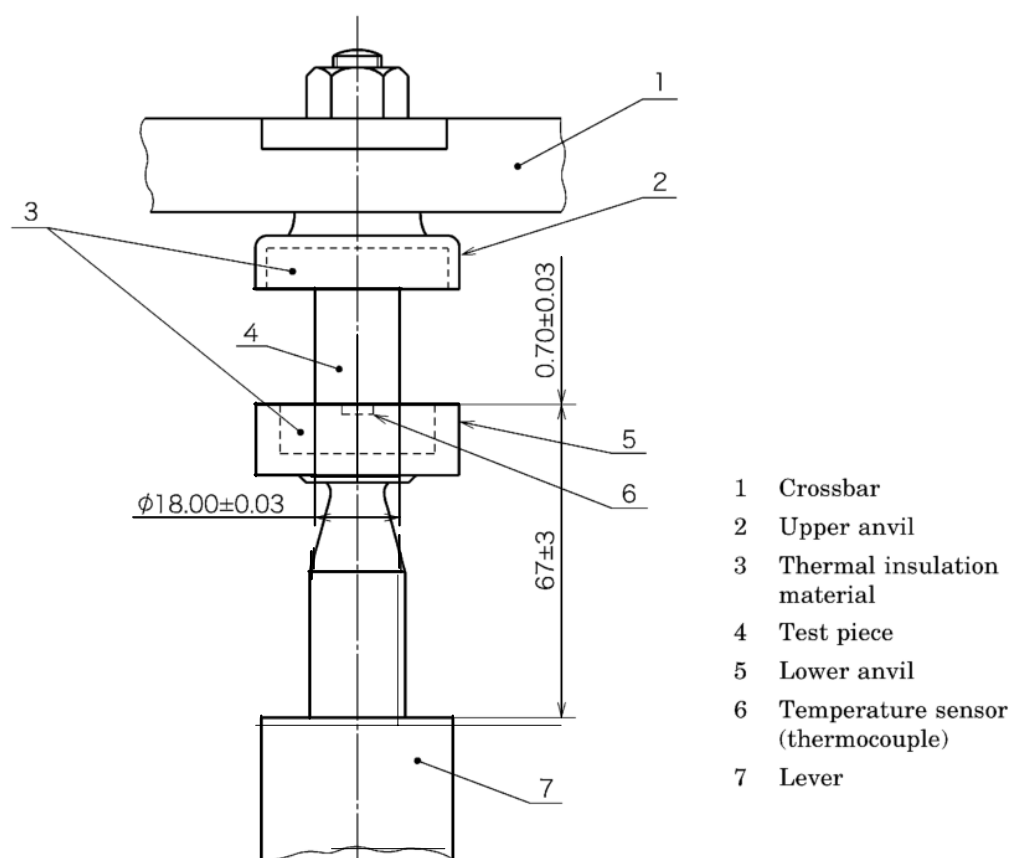
Figure 3 Example of constant strain flexometer

5.1.2 Test piece support

The test piece support shall consist of a pair of anvils (upper and lower). The lower anvil is connected to the lever, and transmits a static compression load to the test piece. The upper anvil is connected to the eccentric, and adds dynamic compressive deformation to the test piece. The upper and lower anvils shall be made of a thermal insulating material of not more than $0.28 \text{ W}/(\text{m} \cdot \text{K})$ or $0.24 \text{ kcal}/(\text{h} \cdot \text{m}^\circ\text{C})$ in thermal conductivity.

In order to prevent the lateral dislocation, a dent of diameter $18.00 \text{ mm} \pm 0.03 \text{ mm}$ and depth $0.70 \text{ mm} \pm 0.03 \text{ mm}$ is necessary for the upper and lower anvils at each centre of the contact surfaces with the test piece. Figure 4 shows an example of upper and lower anvils.

Unit: mm

**Figure 4 Example of upper and lower anvils****5.1.3 Lever**

A lever is a balance beam capable of being fixed in a horizontal position by means of a steel pin. In order to reduce the natural frequency of the lever, suspend the inertia weights of 24 kg in mass as shown in Figure 2 at the positions $288.0 \text{ mm} \pm 0.5 \text{ mm}$ from the knife edge fulcrum¹⁾. Also, attach the lower anvil at the position $127.0 \text{ mm} \pm 0.5 \text{ mm}$ from the knife edge fulcrum of the lever.

The lever shall be equipped with the fine-adjustable auxiliary weight to keep the lever horizontal (see Figure 2).

Note ¹⁾ The inertia system equivalent thereto may be used as far as the lever is balanced.

5.1.4 Static loader

The static loader gives a static compression load to the test piece via the lever by adding an additional weight to the inertia weight opposite the test piece.

5.1.5 Displacement measuring device

The displacement measuring device shall have micrometer mechanism which is incorporated in the lever and adjusts the height of the lower anvil from the lever, and shall be able to measure the change in height of test piece, in conjunction with the mechanism for keeping the lever horizontal by reading the horizontal position. The displacement

measuring device shall be able to measure the change in height of test piece with an accuracy of 0.1 mm during the test.

NOTE : Some displacement measuring devices are capable of automatically controlling by detecting the deviation from the horizontal position by a sensor such as a differential transformer and keeping the lever horizontal, and recording a travel distance of the micrometer automatically.

5.1.6 Eccentric

The eccentric is linked with the upper anvil via a guide bearing. The eccentric shall be capable of setting a stroke within a range of 4.45 mm to 6.35 mm, and capable of applying a dynamic compressive deformation to the test piece at $30.0 \text{ Hz} \pm 0.2 \text{ Hz}$.

5.1.7 Thermostatic chamber

Figure 5 shows an example of thermostatic chamber. Internal dimensions of thermostatic chamber shall be 100 mm to 220 mm in width, 130 mm to 250 mm in depth, and about 230 mm in height. The bottom surface of thermostatic chamber shall be positioned at $25 \text{ mm} \pm 2 \text{ mm}$ above the lever.

The thermostatic chamber shall control the temperature $\pm 1 \text{ }^{\circ}\text{C}$ in the range of $40 \text{ }^{\circ}\text{C}$ to $100 \text{ }^{\circ}\text{C}$ as specified in **11.2.2** of **JIS K 6250**. For the measurement of the thermostatic chamber temperature, use a temperature sensor of the same type as that for the test piece and perform measurement at 6 mm to 9 mm from the end of anvil and at a height midway between the upper and the lower anvils. A length of at least 100 mm of the temperature sensor shall be inserted into the thermostatic chamber.

Circulate the air in the thermostatic chamber, as an example, by providing an air inlet of 60 mm in diameter and an air outlet of $45 \text{ mm} \times 45 \text{ mm}$, and rotating a radial fan of 75 mm in diameter at 25 Hz to 28 Hz.

A grid shelf (see Figure 5) for placing the test piece during conditioning, is preferably provided at a position of $10 \text{ mm} \pm 2 \text{ mm}$ from the bottom surface of the thermostatic chamber.

NOTE : Another thermostatic chamber may be used for conditioning of test pieces.

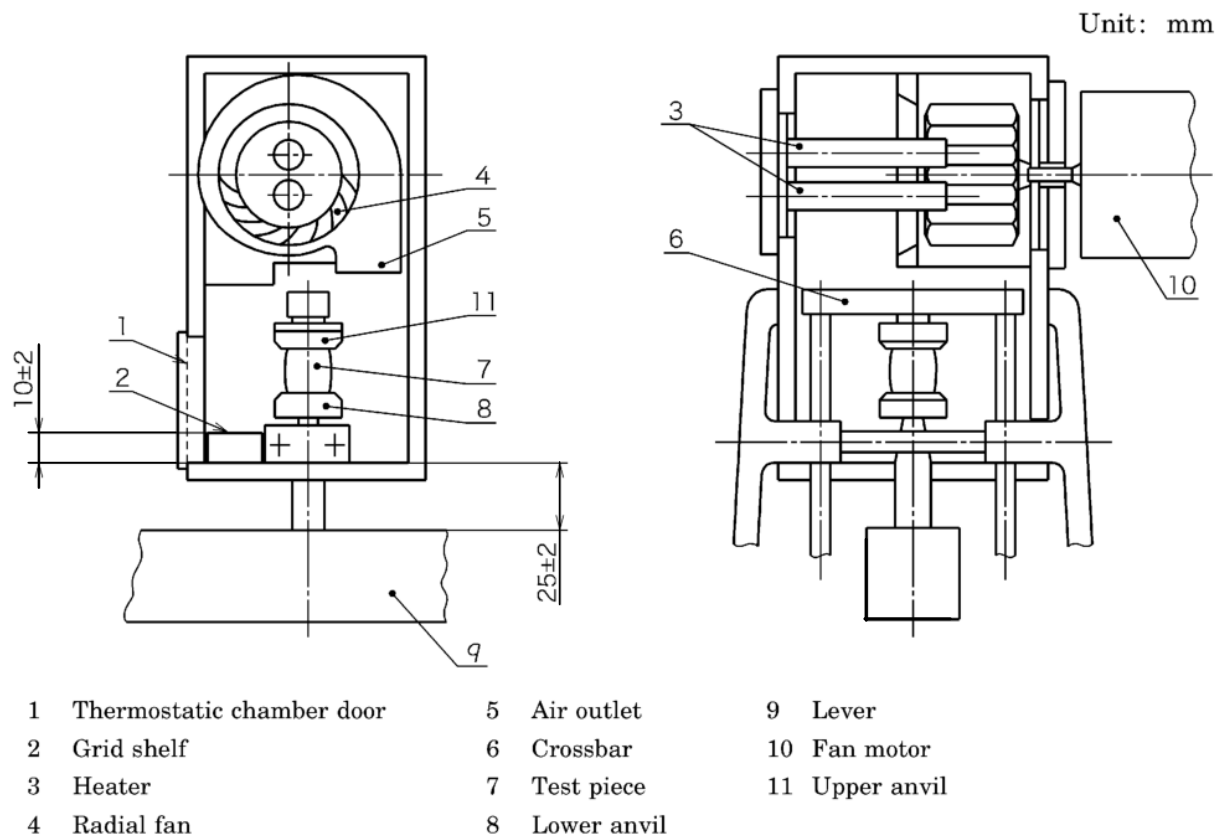


Figure 5 Example of thermostatic chamber

5.1.8 Test piece temperature measuring device

Operate the test piece temperature measuring device by attaching a temperature sensor to the centre of lower anvil. The temperature detection part of sensor shall come in contact with a test piece.

The detecting precision shall be $\pm 0.5\text{ }^{\circ}\text{C}$. An automatic recorder is preferably used.

5.2 Calibration of test apparatus

The calibration of test apparatus shall be in accordance with Annex C.

5.3 Test pieces

5.3.1 Shape and dimensions of test pieces

Test pieces shall be cylindrical with $17.80\text{ mm} \pm 0.15\text{ mm}$ in diameter and $25.00\text{ mm} \pm 0.25\text{ mm}$ in height.

5.3.2 Sampling/preparation of test pieces

The sampling/preparation of test pieces shall be in accordance with clause 8 of **JIS K 6250**.

5.3.3 Number of test pieces

Two or more test pieces shall be prepared.