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(JRMA/JSA)

**Rubber, vulcanized or thermoplastic—
Determination of resistance to
weathering**

ICS 83.060

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Foreword

This translation has been made based on the original Japanese Industrial Standard 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 Manufactures 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 6266**:1996 is replaced with this Standard.

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Attention is drawn to the possibility that some parts of this Standard may conflict with a patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have technical properties. The relevant Minister and the Japanese Industrial Standards Committee are not responsible for identifying the patent right, application for a patent after opening to the public, utility model right or application for registration of utility model after opening to the public which have the said technical properties.

Rubber, vulcanized or thermoplastic— Determination of resistance to weathering

Introduction

This Japanese Industrial Standard has been prepared based on the second edition of **ISO 4665** published in 2006 with some modifications of the technical contents.

The portions given sidelines or dotted underlines are the matters in which the contents of the original International Standard have been modified. A list of modifications with the explanations is given in Annex JD.

Warning : 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 to establish appropriate safety and health practices.

1 Scope

This Standard specifies the natural weathering exposure test and the laboratory light source exposure test of vulcanized rubber and thermoplastic rubber (hereafter referred to as “vulcanized rubber”) in addition to the determination method of changes in colour, appearance and physical properties (resistance to weathering) resulting from exposure.

NOTE : The International Standard corresponding to this Standard is as follows.

ISO 4665:2006 *Rubber, vulcanized or thermoplastic—Resistance to weathering* (MOD)

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

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 5600-4-4 *Testing methods for paints—Part 4: Visual characteristics of film—Section 4: Colorimetry (Principles)*

NOTE : Corresponding International Standard: ISO 7724-1:1984 *Paints and varnishes—Colorimetry Part 1: Principles* (IDT)

JIS K 5600-4-5 *Testing methods for paints—Part 4: Visual characteristics of film—Section 5: Colorimetry (Measurement)*

NOTE : Corresponding International Standard: ISO 7724-2:1984 *Paints and varnishes—Colorimetry Part 2: Colour measurement* (IDT)

JIS K 5600-4-6 *Testing methods for paints—Part 4: Visual characteristics of film—Section 6: Colorimetry (Calculation of colour differences)*

NOTE : Corresponding International Standard: ISO 7724-3:1984 *Paints and varnishes—Colorimetry Part 3: Calculation of colour difference* (IDT)

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 23529:2004 *Rubber—General procedures for preparing and conditioning test pieces for physical test methods* (MOD)

JIS K 6251 *Rubber, vulcanized or thermoplastic—Determination of tensile stress-strain properties*

JIS K 6252 *Rubber, vulcanized or thermoplastic—Determination of tear strength*

JIS K 6253 *Rubber, vulcanized or thermoplastic—Determination of hardness*

JIS K 6259 *Rubber, vulcanized or thermoplastics—Determination of ozone resistance*

NOTE : Corresponding International Standard: ISO 1431-1:1989 *Rubber vulcanized or thermoplastic—Resistance to ozone cracking Part 1: Static strain test* (MOD)

JIS K 7219 *Plastics—Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors*

NOTE : Corresponding International Standard: ISO 877:1994 *Plastics—Methods of exposure to direct weathering, to weathering using glass-filtered daylight, and to intensified weathering by daylight using Fresnel mirrors* (IDT)

JIS K 7350-1 *Plastics—Methods of exposure to laboratory light sources Part 1: General guidance*

NOTE : Corresponding International Standard: ISO 4892-1:1994 *Plastics—Methods of exposure to laboratory light sources—Part 1: General guidance* (IDT)

JIS K 7350-2 *Plastics—Methods of exposure to laboratory light sources Part 2: Xenon-arc sources*

NOTE : Corresponding International Standard: ISO 4892-2:1994 *Plastics—Methods of exposure to laboratory light sources—Part 2: Xenon-arc sources* (IDT)

JIS K 7350-3 *Plastics—Methods of exposure to laboratory light sources—Part 3: Fluorescent UV lamps*

NOTE : Corresponding International Standard: ISO 4892-3:1994 *Plastics—Methods of exposure to laboratory light sources—Part 3: Fluorescent UV lamps* (IDT)

JIS K 7350-4 *Plastics—Methods of exposure to laboratory light sources—Part 4: Open-flame carbon-arc lamps*

NOTE : Corresponding International Standard: ISO 4892-4:1994 *Plastics—Methods of exposure to laboratory light sources—Part 4: Open-flame carbon-arc lamps* (IDT)

JIS K 7363 *Plastics—Instrumental determination of radiant exposure in weathering tests—General guidance and basic test method*

JIS L 0801 *General principles of testing methods for colour fastness*

JIS L 0804 *Grey scale for assessing change in colour*

NOTE : Corresponding International Standard: ISO 105-A02:1993 *Textiles—Tests for colour fastness—Part A02: Grey scale for assessing change in colour* (MOD)

JIS R 3202 *Float glass and polished plate glass*

JIS Z 2381 *General requirements for atmospheric exposure test*

JIS Z 8401 *Guide to the rounding of numbers*

JIS Z 8720 *Standard illuminants and sources for colorimetry*

JIS Z 8741 *Specular glossiness—Method of measurement*

CIE Publication No. 85 *Technical Report—Solar spectral irradiance*

3 Terms and definitions

For the purposes of this Standard, the definitions given in **JIS K 6200**, **JIS K 7219** and **JIS K 7350-1** and the following definitions apply.

3.1 resistance to weathering

the resistance to change in colour, appearance, physical properties and the like mainly caused by sunshine, rain and snow, temperature and humidity among natural environment

The resistance to change in sunshine, temperature, humidity among the resistance to weathering is called light fastness.

3.2 black panel temperature

the temperature indicated by the thermometer of black panel attached to the test piece attaching frame of weathering test equipment and the temperature representing the surface temperature of test piece

3.3 black standard temperature

the temperature indicated by the black standard thermometer attached to the test piece attaching frame of weathering test equipment and the temperature representing the surface temperature of test piece

3.4 control

a test piece exposed alongside with the test piece for the comparison after exposure

NOTE : For the control, the one having the same or resembling composition to the test piece or the one having the known response to the exposure conditions is recommended. The control can be used when the performance comparison of material is carried out or for verifying that the exposure conditions are properly carried out in the laboratory light source exposure test. The one prepared at different time can be used for comparing the dispersion between the product lots and for comparing the acceptance inspection of materials.

3.5 file test piece

a portion of material to be used for the test, stored under stable conditions and used for comparison between the state after exposure and the state before exposure (initial value)

3.6 masked area

a portion of test piece protected from light exposure by masking

It is used for comparison with test piece.

NOTE : The masked area is utilized as the initial value before the test. It may be also used for examining the effect excluding only the condition of light irradiation.

3.7 weathering reference material

reference material in accordance with Annex A whose weathering degradation properties are documented and repeatable when exposed to identical conditions

NOTE : The weathering reference material is used for assessing the performance of material and the like and is exposed simultaneously with test pieces. It may be also used as the control.

3.8 exposure stage

the intermediate and final stages in which the exposure test of test piece is carried out

It is expressed in the test time (h), radiant exposure (kJ/m^2) or spectral radiant exposure [$\text{kJ}/(\text{m}^2 \cdot \text{nm})$].

NOTE : The radiant exposure means the integrated value of radiation of specific wavelength range (for example, most representative 300 nm to 400 nm), and the spectral radiant exposure means the integrated value of radiation of narrow band centring around single wavelength (for example, 340 nm).

4 Principle

The test piece is exposed in the atmosphere of natural weathering or of laboratory light sources, and the changes in the colour, appearance and necessary physical properties of test piece are obtained. General matters of weathering test for rubber are described in Annex JA for reference.

5 Types of tests

The tests shall be classified into the six types of table 1, and selected from these to be used.

The sheltered exposure test is described in Annex JC for reference.

Table 1 Types of tests

Division of exposure method	Types
Natural weathering exposure method	Direct weathering exposure test
	Weathering using glass-filtered daylight exposure test
	Weathering by daylight using Fresnel mirrors exposure test
Laboratory light source exposure method	Open-flame carbon-arc test
	Xenon-arc test
	Fluorescent UV lamps test

6 Direct weathering exposure test

6.1 Purpose

This test is carried out for examining the resistance to weathering of vulcanized rubber under direct daylight by using the weathering exposure test equipment.

6.2 Test equipment

The test equipment shall be composed of exposure stand, test piece holding frame, test piece attaching device and the like, constructed robustly so as to suit to exposure test and in accordance with 5.2 of JIS K 7219 and 7.2.1 of JIS Z 2381. The exposure stand, test piece holding frame and test piece attaching device shall be as follows. An example is shown in figure 1.

- a) **Exposure stand** The exposure stand shall have the strength and durability to resist the storm, the load of snow fall and the maximum load when the test pieces are attached on the whole surface of exposure stand. The component materials of exposure stand shall be the inert materials such as the metallic profile of corrosion resistant stainless steel, aluminium alloy, surface-treated iron and steel, etc., the adequately anti-septic treated wood, which do not influence to the deterioration with age in the chemical properties, physical properties and performance of test pieces.

The exposure stand shall be constructed so that the surface of test piece is able to be set and maintained at the specified azimuth and angle of exposure. The equipment capable of tracking the sun by adjusting the exposure azimuth and exposure angle may be used for the better efficiency of light receiving. In such a case, the purport shall be recorded in the test report.

The distance from the ground surface of exposure stand to the lowest end part of test piece to which the exposure test is carried out shall be at least 500 mm.

- b) **Test piece holding frame and test piece attaching device** The test piece holding frame and test piece attaching device shall be constructed so as to suit to the type, shape, dimensions of test piece and the exposure test conditions, and be the inert materials without influence to the deterioration with age in the chemical properties, physical properties and performance of test piece.

The attaching mechanism of test piece shall be constructed so that the free deformation of test piece is not hindered and the possibility of the test piece drop is not present, and the attaching and detaching of test piece shall be easy and the handling shall be safe.

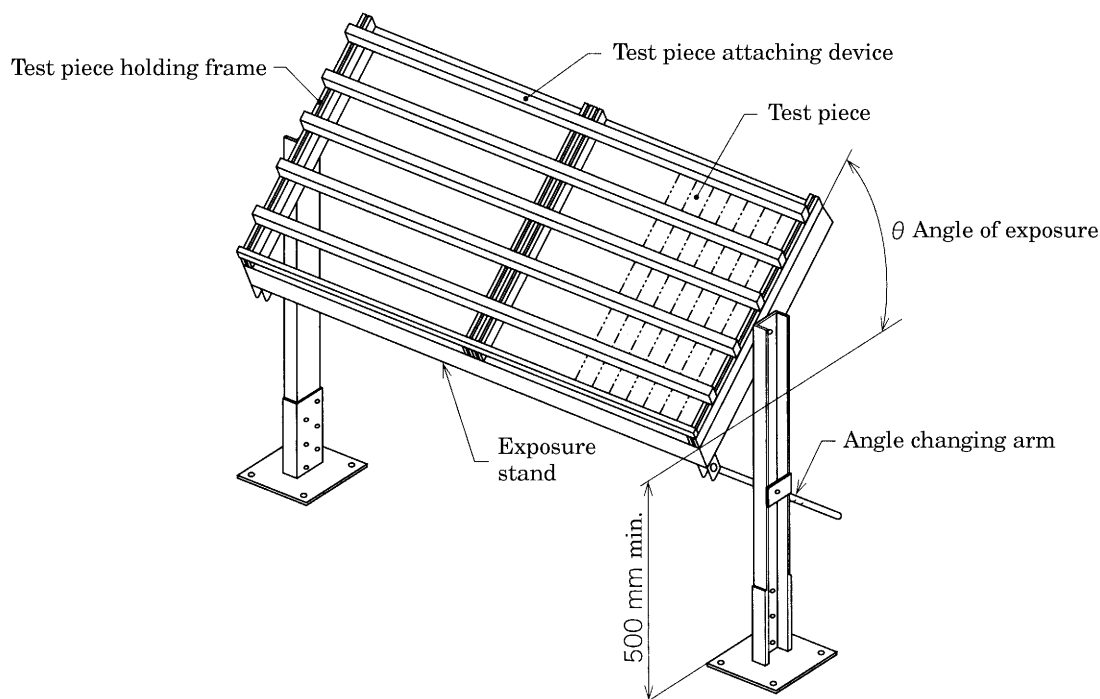


Figure 1 Example of direct weathering exposure test equipment

- c) **Irradiance radiometer** The irradiance radiometer specified in 5.5.1 of JIS K 7219.

6.3 Test piece

6.3.1 Shape and dimensions of test piece

The shape and dimensions of test piece shall be as follows.

- a) **Test piece for measuring changes in colour and appearance** The test piece for measuring changes in colour and appearance shall be the strip approximately at least 100 mm in length, approximately at least 50 mm in width, $2.0 \text{ mm} \pm 0.2 \text{ mm}$ in thickness, and the surface shall be smooth. Other dimensions than these shall be subjected to the agreement between the parties concerned with delivery.
- b) **Test piece for measuring changes in physical properties** The test piece for measuring changes in physical properties shall be used for assessing tensile property, tear strength, hardness and the like and be the shape and dimensions specified in JIS K 6251, JIS K 6252 or JIS K 6253.

The test piece of sheet, other shape or the test piece of **a)** may be used for the exposure and cut out to the specified dimensions after the exposure. In such a case, it shall be assessed by excluding the part of 20 mm from the test piece attaching device and be recorded in the test report.

6.3.2 Sampling and preparation of test piece

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

6.3.3 Number of test pieces

The number of test pieces shall be as follows.

- a) **Test piece for measuring changes in colour and appearance** Three pieces shall be prepared for every exposure stage. When the storage of test pieces is not necessary for every exposure stage, the exposure may be continued after the measurement.
- b) **Test piece for measuring changes in physical properties** The number of test pieces shall be the number specified in **JIS K 6251**, **JIS K 6252** or **JIS K 6253** for every exposure stage. The necessary total number of test pieces shall be the number of this number multiplied by the number of exposure stages.

6.3.4 Measurement of thickness and width of test piece

The measurement of thickness and width of test piece shall be in accordance with clause **10** of **JIS K 6250**.

6.4 Test methods

6.4.1 Test conditions

The test conditions shall be as follows.

- a) The storage of test piece and file test piece shall be in accordance with clause **7** of **JIS K 6250**.
- b) The test shall be carried out under the condition where the test pieces are not strained. However, when the test is carried out under the strained condition, it shall be in accordance with **JIS K 6259**.
- c) The exposure condition shall be as follows.
 - 1) The azimuth of the exposure surface of test piece shall be the equatorial plane and the angle of exposure shall be the latitude of the place of exposure or 45° in angle from the horizontal plane. The angle of elevation from the horizontal plane may be made to be the latitude of the place of exposure minus 10° in angle so as to receiving the most plenty of radiation of the sun for one year. And, as occasion demands, the angle between 10° and 90° from the horizontal plane may be allowed. The angle used shall be recorded in the test report.
 - 2) The test place shall be the field with large space being sufficiently distant from trees, buildings, etc. and the obstacle shall not be present in at least 20° in the angle of elevation. The surrounding plants shall be lower trimmed beforehand.

NOTE : It is recommended to carry out the exposure tests in some environments for the higher reliable tests. For example, the place having the environment resembling to the conditions to be used as closely as possible, and the like.

- 3) The exposure stage shall be in accordance with any one of time, radiant exposure or spectral radiant exposure. The obtaining method of radiant exposure or spectral radiant exposure shall be in accordance with **JIS K 7363**. In the case of being in accordance with time, it shall be as follows.

3.1) One month, three months, six months or nine months

3.2) One year, one and a half years, two years, three years, four years, five years or six years

NOTE : The result of exposure stage of under one year depends on the season when the exposure is carried out. When the exposure stage is long, the influence of season is averaged, however there is the possibility that the result is different in some cases depending on the season when the exposure is started. For example, it depends on that the starting season is spring or autumn.

6.4.2 Measurement method

The measurement method shall be as follows.

- a) Prior to the exposure of test piece, measure the property values of test piece and, as occasion demands, the control.
- b) Attach the test piece and, as occasion demands, the control as they are, or the masked test piece to the test piece attaching device. When a file test piece is used, storage it at a cool and dark place for the same duration as the exposure duration of test piece.
- c) Give sufficient room around the test piece so that it is not noticeably strained.
- d) Attach a marking on the back side of test piece. Make the marking so as not to influence the test results. The layout drawing of attachment should be prepared beforehand for verification.
- e) Fix the test piece attached to the test piece attaching device and, as occasion demands, the control to the exposure stand.
- f) When an irradiance radiometer is used, attach it to the exposure stand.
- g) The test piece shall not be washed in the course of exposure. When washing is required, wash it by using clean water or soapy water (2 % non-alkaline soapy water). And, take care so as not to damage the exposure surface by rubbing the exposed surface, etc. The checking and maintenance should be periodically carried out for the re-fixing the loosened test piece, recording the condition of test piece, repairing the damage of equipment, etc.
- h) The observation shall be carried out on the following items in the course of exposure.

For each item, the data from the neighbouring meteorological station and the like may be utilized.

- 1) Radiant exposure or spectral radiant exposure
 - 2) Atmospheric temperature (average in month of the maximum in day and average in month of the minimum in day, and the maximum and minimum in month)
 - 3) Relative humidity (average in month of the maximum in day and average in month of the minimum in day, and the maximum and minimum in month)
 - 4) Other necessary information
- i) When reaching the specified exposure stage (test time, radiant exposure or spectral radiant exposure), detach the test pieces from the exposure stand.
 - j) Examine visually the change of test pieces, Next, wash the surface of test pieces by using clean water or soapy water (2 % non-alkaline soapy water), after air drying, measure the changes in colour, appearance and/or physical properties.

6.5 Assessment of test piece after exposure

The assessment of test piece after exposure shall be carried out by comparing with the test piece before exposure and be as follows. And, in **6.5.1 a) 1)**, the file test piece or masked area shall be used as the test piece before exposure.

The example of properties to be used for the assessment after exposure is described in Annex B.

6.5.1 Assessment of changes in colour and changes in appearance

The assessment of changes in colour and changes in appearance shall be as follows.

- a) **Assessment of changes in colour** For the assessment of changes in colour, either of the visual method or the colorimeter method shall be selected and be as follows.

- 1) **Visual method** Compare the difference in colour between the test piece after exposure and the file test piece or the masked area by using the grey scale for assessing change in colour specified in **JIS L 0804** and express the degree of changes in colour by the number of colour chip of grey scale which corresponds to the difference of colour. The method of comparison for the change in colour by using the grey scale for assessing change in colour may be in accordance with **JIS L 0801**.

Any one of the changes in colour or the combined kind of changes in colour in table 2 should be observed and described in the degree of changes in colour together.

Example: Example of expression “Grey scale 2-3, more yellow, duller, lighter”

Table 2 Types of changes in colour

Change in hue	Change in chrome	Change in lightness
More blue or less blue	Duller	Lighter
More green or less green	Brighter	Darker
More red or less red		
More yellow or less yellow		

The comparison of difference in colour shall be carried out under north sky daylight¹⁾ or corresponding light source for lighting of at least 600 lx so as to avoid the direct sunshine. For the light source for lighting, the daylight simulator D₆₅ specified in **JIS Z 8720** should be used. The ray of light shall be applied to the surface at approximately 45° in angle and the direction of observation shall be made to be approximately right-angled to the surface of test piece and grey scale.

Note 1) It is the north sky daylight from the time after 3 h from sunrise to the time before 3 h to sunset and the light which is not influenced by environmental colour such as surrounding buildings, interior decoration.

- 2) **Colorimeter method** For the colorimeter method, use a colorimeter according to the specifications of **JIS K 5600-4-4**, **JIS K 5600-4-5** and **JIS K 5600-4-6**, measure the tristimulus values X , Y , Z or X_{10} , Y_{10} , Z_{10} of the test piece before and after exposure and calculate the colour difference (ΔE^*_{ab}) and the component of colour difference (ΔL^*_{ab} , ΔC^*_{ab} , ΔH^*_{ab}) according to the following formulae of (1) to (4).

$$\Delta E^*_{ab} = \left[(\Delta L^*_{ab})^2 + (\Delta a^*)^2 + (\Delta b^*)^2 \right]^{\frac{1}{2}} \dots\dots\dots (1)$$

$$\Delta H^*_{ab} = \left[(\Delta E^*_{ab})^2 - (\Delta L^*_{ab})^2 - (\Delta C^*_{ab})^2 \right]^{\frac{1}{2}} \dots\dots\dots (2)$$

$$\Delta C^*_{ab} = C^*_{ab,1} - C^*_{ab,0} = \left(a^{*2}_1 + b^{*2}_1 \right)^{\frac{1}{2}} - \left(a^{*2}_0 + b^{*2}_0 \right)^{\frac{1}{2}} \dots\dots\dots (3)$$

$$\Delta L^*_{ab} = L^*_{ab,1} - L^*_{ab,0} \dots\dots\dots (4)$$

where, ΔE^*_{ab} : colour difference of test piece before and after exposure

ΔL^*_{ab} : difference of lightness of test piece before and after exposure

Δa^* , Δb^* : difference of each chromaticity coordinate of test piece before and after exposure

ΔH^*_{ab} : difference of hue of test piece before and after exposure

ΔC^*_{ab} : difference of chroma of test piece before and after exposure

$C^*_{ab,0}$: chroma amount of test piece before exposure

$C^*_{ab,1}$: chroma amount of test piece after exposure

a^*_0 , b^*_0 : each chromaticity coordinate of test piece before exposure

a^*_1 , b^*_1 : each chromaticity coordinate of test piece after exposure

$L^*_{ab,0}$: lightness of test piece before exposure

$L^*_{ab,1}$: lightness of test piece after exposure

- b) **Assessment of changes in appearance** The assessment of changes in appearance should be carried out visually on the following items.

1) Gloss, blooming, bleeding and frosting

For the measurement of changes in gloss, the following method may be used.

Measure the specular gloss at 60° in angle or the specular gloss at other angle of test piece before and after exposure by using a glossmeter according to **JIS Z 8741**, calculate the gloss residual rate (γ) according to the following formula (5) and express the change in gloss.

$$\gamma = \frac{Gs_1}{Gs_0} \times 100 \dots\dots\dots (5)$$

where, γ : gloss residual rate (%)

Gs_0 : specular glossness of test piece before exposure (%)

Gs_1 : specular glossness of test piece after exposure (%)

2) Crazeing and cracking

NOTE : Cracking or crazeing in rubber test pieces exposed outdoors can result from light ageing as well as from ozone attack. A distinction is not always possible, particularly with light-coloured rubbers. Sunlight crazeing is characterized by shallow cracks and usually occurs independently of strain. Where there is doubt, it is useful to expose an unstrained test piece alongside the strained test piece for comparison.

3) Chalking

6.5.2 Assessment of changes in physical properties

The assessment of change in physical properties is calculated as the residual rate, change rate or change of tensile strength, elongation at break, tensile stress, tear strength, hardness, etc. from the test piece before and after exposure according to the following formulae (6), (7) or (8). The respective measurements shall be in accordance with **JIS K 6251**, **JIS K 6252** or **JIS K 6253**. The conditions of measurement for the test pieces before and after exposure shall be the same.

a) Residual rate

$$W_R = \frac{X_1}{X_0} \times 100 \dots\dots\dots (6)$$

where, W_R : residual rate of each property (%)

X_0 : measured value of each property of test piece before exposure

X_1 : measured value of each property of test piece after exposure

b) Change rate

$$W_c = \frac{X_1 - X_0}{X_0} \times 100 \dots\dots\dots (7)$$

where, W_c : change rate of each property (%)
 X_0 : measured value of each property of test piece before exposure
 X_1 : measured value of each property of test piece after exposure

c) Change

$$W_H = H_1 - H_0 \dots\dots\dots (8)$$

where, W_H : changes in hardness
 H_0 : hardness of test piece before exposure
 H_1 : hardness of test piece after exposure

d) Plot of the property value to exposure duration

6.5.3 Assessment of other properties

For the assessment of other properties, the dimensional change, stress relaxation, electric resistance, tension permanent set and the like should be carried out.

6.6 Expression of results

The expression of results shall be as follows.

a) **Changes in colour** For the changes in colour visually, express the results according to **6.5.1 a) 1)** for every test piece. For the changes in colour by colorimeter, express the mean value of three test pieces of the colour difference and component of colour difference calculated according to **6.5.1 a) 2)** in 1 of rounding range according to **JIS Z 8401**.

b) **Changes in appearance** For the changes in appearance, express the results according to **6.5.1 b)** for every test piece. The assessment method of qualitative changes in appearance and changes in surface property may be used. For example, there is the following method.

- 0 – none
- 1 – barely perceptible
- 2 – moderate
- 3 – substantial

When the gloss residual rate is obtained, express the mean value of test results of three test pieces in 1 of rounding range according to **JIS Z 8401**. The assessment of cracking shall be in accordance with **JIS K 6259**.

c) **Changes in physical properties** For the changes in physical properties, express the result according to **6.5.2** in 1 of rounding range according to **JIS Z 8401**.

d) **Changes in other physical properties** For the changes in other physical properties, express the results according to **6.5.3** for every test piece.

6.7 Record

The following information shall be recorded in the test report.

- a) The number of standard applied
- b) Details of sample
 - 1) Details, history, etc. of sample
 - 2) Details, vulcanization conditions, etc. of compound
 - 3) Preparation method for test piece
 - 4) Details when any weathering reference material is used
- c) Details of test
 - 1) Name of standard of method used for determination of changes in physical properties
 - 2) Types of exposure method and test equipment
 - 3) Position and details of place of exposure
 - 4) Procedures used for determination of exposure stage (radiant exposure, spectral radiant exposure or time)
 - 5) Type when file test piece or masked area is used as test piece before exposure
 - 6) Whether test pieces are strained or not. If so, the degree of it.
 - 7) Property of backing or supporting device
 - 8) Conditions of storage of file test pieces
 - 9) Method used for determining radiant exposure or spectral radiant exposure
 - 10) Details of washing (if relevant)
 - 11) Other test methods different from specifications of this Standard
- d) Test results
 - 1) Exposure stage
 - 2) Climatic data (radiant exposure or spectral radiant exposure, atmospheric temperature, relative humidity, other necessary matters)
 - 3) Changes in colour
 - 4) Changes in appearance (if measured)
 - 5) Degradation grade of cracking in the case where test pieces are strained
 - 6) Individual value of each physical property value (before exposure)
 - 7) Test results of each physical property value after each exposure stage
 - 8) Residual rate, change rate and change of each physical property value and the unit of each measurement value
- e) Date of the test
- f) Other necessary information

7 Weathering using glass-filtered daylight exposure test

7.1 Purpose

This test is carried out to examine the lightfastness of vulcanized rubber under the daylight transmitted through glass by using the weathering exposure test equipment.

7.2 Test equipment

The exposure test equipment is composed of the exposure stand for test and the box which is framed by an adequate glass cover such as the plate glass for building, wind shield glass, window glass for automobile and of which the bottom is open. The sample holding frame to which the sample is attached directly or by using the appropriate sample holder shall be set in parallel to the glass cover surface of box. The exposure test equipment should be capable of adjusting in relation to the height of the sun (that is, the angle of elevation of the sun) or azimuth.

For the space between the glass cover and the sample holding frame, the sufficient interval is required so as to ventilate adequately. For example, the interval of at least 75 mm is required. For minimizing the shadow due to the frame of glass cover, the area to be used for the exposure below glass shall be limited to the range reduced by the area determined by the distance between the glass cover and the sample.

The exposure stand, test piece holding frame, test piece attaching device and irradiance radiometer shall be in accordance with 6.2. However, the upper surface of exposure stand shall be constructed so that the test box covered with glass is attached. An example is shown in figure 2.

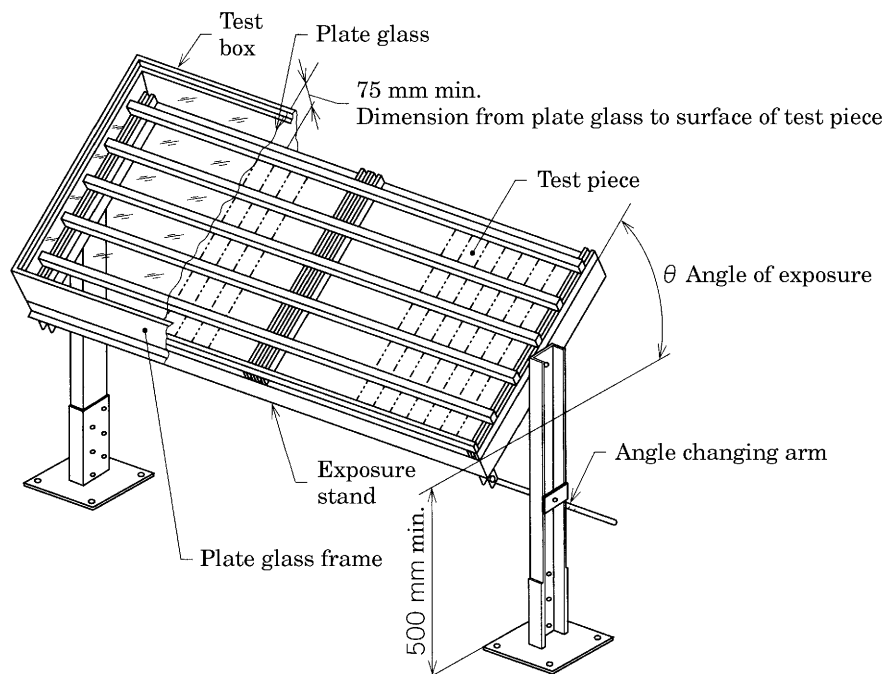


Figure 2 Example of weathering using glass-filtered daylight exposure test equipment

- a) The structural type of test box shall be in accordance with any one of the following types.
- 1) **Natural air flow type** Constructed so that rain water does not affect, the external flows freely and portion of the side surface and the bottom of test box are open for reducing the temperature rise in test box.
 - 2) **Forced air flow type** Constructed so that the ventilation mechanism is provided for controlling the temperature in test box²⁾.
 - 3) **Sealed type** Constructed so that the whole surface of test box is closed to prohibit free flow of external air.

Note ²⁾ Pay attention that there is a possibility of accumulation of atmospheric pollutants in the test box with forced air flow.

- b) The glass to be used shall be the float plate glass specified in **JIS R 3202** and the plate glass, which is flat, free from defect and approximately at least 90 % in spectral transmittance in the range at 370 nm to 830 nm of wavelength and not exceeding 1 % in spectral transmittance of not exceeding 310 nm of wavelength, is recommended. The thickness of plate shall usually be 2 mm to 3 mm, however it may be altered depending on the climatic condition in the district such as wind pressure, snow fall, hail fall. However, in such a case, the thickness shall be recorded in the test report.

The using duration of glass shall usually be for two years.

- c) The glass is put in the test box by using elastic sealant or gasket so that the test piece is not influenced by rain, snow and water leakage. For the glass, other type of plate glass or plastics material for window may be used in accordance with the agreement between the parties concerned with delivery.
- d) The distance between the upper surface of test piece and the lower surface of glass in test box shall be at least 75 mm.

NOTE : When comparing weathering using glass-filtered daylight exposure with the direct weathering exposure, the different result is generated in many cases by the difference of spectral distribution of daylight and the difference between the temperature in glass-filtered daylight exposure test box and the temperature of atmospheric air.

7.3 Test piece

The test piece shall be in accordance with **6.3**.

7.4 Test methods

7.4.1 Test conditions

The test conditions shall be in accordance with **6.4.1**.

7.4.2 Operation method

The operation method shall be as follows.

- a) Prior to the exposure of test piece, measure the characteristic values of test piece and, as occasion demands, the control.

- b) Attach the test piece and, as occasion demands, the control as it is or the masked test piece to the test piece attaching device. When a file test piece is used, store it at a cool and dark place for the same duration as the exposure duration of test piece.
- c) Give sufficient room around the test piece so that it is not noticeably strained.
- d) Attach a marking on the back side of test piece. Make the marking so as not to influence the test results. It is recommended to prepare the layout drawing for attachment beforehand for verification.
- e) Fix the test piece attached to the test piece attaching device and, as occasion demands, the control to the exposure stand.
- f) When an irradiance radiometer is used, attach it to the exposure stand.
- g) The test piece shall not be washed in the course of the exposure. When washing is required, wash it by using clean water or soapy water (2 % non-alkaline soapy water). And, take care so as not to damage the exposure surface by rubbing the exposed surface, etc. The checking and maintenance should be periodically carried out for the re-fixing the loosened test piece, recording the condition of test piece, repairing the damage of equipment, etc.
- h) The meteorological observation shall be carried out on the following items in the course of exposure.
 - 1) Radiant exposure or spectral radiant exposure
 - 2) Temperature of the air in glass-filtered test box or outdoor temperature (average in month of the maximum in day, average in month of the minimum in day, and the maximum and the minimum in month).

For each item, the data from the neighbouring meteorological station and the like may be utilized.
 - 3) Relative humidity in glass-filtered test box or the relative humidity of outdoor air (average in month of the maximum in day, average in month of the minimum in day, and the maximum and the minimum in month).
 - 4) Other necessary information
- i) Detach the test pieces from the exposure stand at the time of reaching the specified exposure stage (test time, radiant exposure or spectral radiant exposure).
- j) Examine visually the change of test piece. Next, wash the surface of test piece by using clean water or soapy water (2 % non-alkaline soapy water), and after air drying, measure the changes in colour, appearance and/or physical properties.
- k) Wash the glass periodically. After the stormy weather in which dirt, sand, etc. easily stick, wash them quickly. The back side of glass should be periodically washed for removing the stuck dust, the emitted matter from the test pieces, etc.

7.5 Assessment of test pieces after exposure

The assessment of test pieces after exposure shall be in accordance with 6.5.

7.6 Expression of results

The expression of results shall be in accordance with **6.6**.

7.7 Record

The record shall be in accordance with **6.7**.

8 Weathering by daylight using Fresnel mirrors

8.1 Purpose

This test is carried out for examining the resistance to weathering of vulcanized rubber by using the weathering by daylight using Fresnel mirrors exposure test equipment.

This test is the exposure test method to examine the resistance to weathering of vulcanized rubber by the collected daylight so that the test piece is attached at the position where the daylight is collected by using the Fresnel mirrors by tracking the optical axis of daylight vertically.

It is best that the weathering using glass-filtered daylight exposure test is carried out at the place of dry and fine weather such as at least 3 500 h in annual sunshine duration and not exceeding 30 % in annual average relative humidity in the daytime. For the minimum condition for carrying out this test, the rate of direct solar radiation³⁾ at the vertical surface to the sun to the global solar radiation⁴⁾ shall be 0.8.

Notes ³⁾ Irradiance of the sun directly entering from the sun (W/m^2)

⁴⁾ All irradiance of the sun entering from the sun (W/m^2)

The radiant light of ultraviolet ray is scattered to the sky in the district of lots of the scattered light of the radiation from the sun such as the district of higher relative humidity and the district of lots of floating dust, therefore the concentration efficiency of ultraviolet ray to the radiation position of test piece is greatly reduced and the magnifying factor of intensifying is greatly reduced.

8.2 Test equipment

The test equipment shall be in accordance with **JIS K 7219** or **JIS Z 2381**.

8.3 Test piece

The test piece shall be in accordance with **6.3**.

8.4 Test methods

8.4.1 Test conditions

The test conditions shall be as follows.

- a) The storage of test piece and file test piece shall be in accordance with clause **7** of **JIS K 6250**.
- b) The test shall be carried out under the condition where the test pieces are not noticeably strained. However, when the test is carried out under the strained condition, it shall be in accordance with **JIS K 6259**.

- c) The exposure stage shall be in accordance with either radiant exposure or spectral radiant exposure.

8.4.2 Operation method

The operation method shall be as follows.

- a) Attach the test piece to the test piece attaching plane so as not to move or fall off even if the test equipment rotates.
- b) Measure the surface temperature of test piece of appropriate intervals ⁵⁾.
- c) Measure the radiant exposure of the reflected light radiated to test piece. The obtaining method for radiant exposure or spectral radiant exposure shall be in accordance with **JIS K 7363**.
- d) Control the surface of Fresnel mirrors so as to be always clean.
- e) The surface temperature of test piece should be controlled so as not to be heated at the temperature or higher where materials and products are thermally degraded.
- f) Determine the presence of water spraying and spraying conditions according to the purpose of exposure test.
- g) Maintain and control the test equipment so as to always track the optical axis of daylight vertically.

Note ⁵⁾ An appropriate method such as the use of black panel thermometer is preferable.

8.5 Assessment of test piece after exposure

The assessment of test piece after exposure shall be in accordance with **6.5**.

8.6 Expression of results

The expression of results shall be in accordance with **6.6**.

8.7 Record

The record shall be in accordance with **6.7**.

9 Open-flame carbon-arc test

9.1 Purpose

This test is carried out to test the resistance to weathering of vulcanized rubber by using the open-flame carbon-arc lamp type resistance to weathering test equipment.

9.2 Test equipment

The test equipment shall be in accordance with clause **5** of **JIS K 7350-1** and clause **4** of **JIS K 7350-4**. The laboratory light sources (emission part) shall be as follows.

NOTE : The details of test equipment should refer to **JIS B 7753**.

9.2.1 Laboratory light sources (emission part)

The laboratory light sources shall be the open-flame carbon-arc lamp and filter and these shall be as follows.

- a) The open-flame carbon-arc lamps shall be composed of the arc formed between carbon rod electrodes in open air and shall have the spectral distribution of which the peak is in the wavelength range of approximately 380 nm.
- b) The radiation which reaches the test piece shall be made to pass through a filter. Usually, eight filters are attached to the filter frames provided around the light source. The spectral distributions of radiation passed through the typical three filters (Type I, Type II and Type III) shall be in accordance with table 3 to table 5.

Table 3 Typical irradiance distribution after passing through Type I filter

Wavelength range of spectral distribution λ (nm)	Rate of irradiance %		Rate of irradiance according to table 4 of CIE Publication No. 85 %
	Minimum value	Maximum value	
$\lambda < 290$	—	4.9	—
$290 \leq \lambda \leq 320$	2.3	6.7	5.4
$320 < \lambda \leq 360$	16.4	24.3	38.2
$360 < \lambda \leq 400$	68.1	80.1	56.4
250 to 400	100	100	100

NOTE : Type I is historically the oldest, and has been specified in many standards. The radiant energy of this filter, approximates to the spectral distribution of the daylight on the surface of the earth described in **CIE Publication No. 85** and it emphasizes the energy of ultraviolet range. It transmits the radiation of comparatively short wavelength which is not present in the daylight reaching the surface of the earth, therefore there is the possibility that the degradation reaction which does not occur in natural weathering may be produced.

Table 4 Typical irradiance distribution after passing through Type II filter

Wavelength range of spectral distribution λ (nm)	Rate of irradiance %	Rate of irradiance according to table 4 of CIE Publication No. 85 %
$\lambda < 290$	0.05	—
$290 \leq \lambda \leq 320$	2.9	5.4
$320 < \lambda \leq 360$	20.5	38.2
$360 < \lambda \leq 400$	76.6	56.4
290 to 400	100	100

NOTE : Type II filter is the filter of which the radiant energy approximates to the spectral distribution of the daylight on the surface of the earth described in **CIE Publication No. 85**. It is also called a daylight filter.