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Metallic materials—Bend test

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Contents

	Page
Introduction.....	1
1 Scope	1
2 Normative reference	1
3 Terms and definitions	1
4 Principle of testing	1
5 Shape of test pieces and sampling and preparation of test pieces	1
5.1 General	1
5.2 Test piece No. 1	2
5.3 Test piece No. 2	2
5.4 Test piece No. 3	3
5.5 Finish of edges	3
5.6 Test pieces from forgings, castings and semi-finished products	4
6 Testing method	4
6.1 Press bending method	4
6.2 Winding	6
6.3 V-block method	7
6.4 Test temperature	7
6.5 Bending angle and bending inside radius	7
7 Interpretation of results	7
8 Test report	8
Annex A (informative) Determination of the bend angle from the measurement of the displacement of the former	9
Annex JA (informative) Comparison table between JIS and corresponding International Standard	11

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 Iron and Steel Federation (JISF)/ 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Consequently **JIS Z 2248** : 1996 is revised and replaced with this Standard and **JIS Z 2204** : 1996 is withdrawn and replaced with this Standard.

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Metallic materials—Bend test

Introduction This Japanese Industrial Standard has been prepared based on the second edition of **ISO 7438** published in 2005 with some modifications of the technical contents.

Annex A (informative) of **ISO 7438** is shown in Annex A as a reference. 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 JA.

1 Scope This Standard specifies the method of bend test for metallic materials.

NOTE : The International Standard corresponding to this Standard and the symbol which denotes the degree of correspondence are as follows.

ISO 7438:2005 *Metallic materials—Bend test* (MOD)

The symbol (MOD), as defined in **ISO/IEC Guide 21** indicates that the original International Standard has been modified.

2 Normative reference The following standard contains provisions which, through reference in this text, constitute provisions of this Standard. The most recent edition of the standard (including amendments) indicated below shall be applied.

JIS G 0202 *Glossary of terms used in iron and steel (testing)*

3 Terms and definitions For the purposes of this Standard, the definitions given in JIS G 0202 and the following definition apply.

3.1 test force force applied to test piece for the purpose of testing

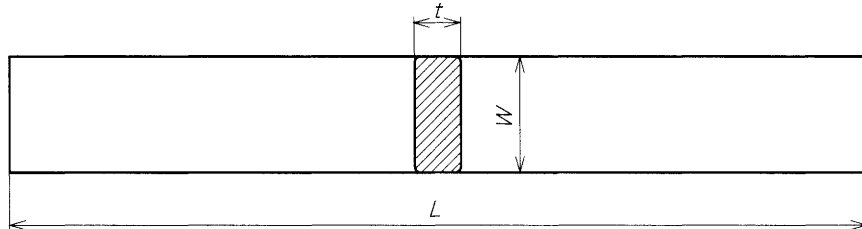
4 Principle of testing The bend test consists of submitting a test piece of round, square, rectangular or polygonal cross-section to plastic deformation by bending without changing the direction of loading until a specified angle of bend is reached, and is to examine whether there are cracks or other defects on the outer surface of curvature of the test piece. The axes of two legs of the test piece remain in a plane perpendicular to the axis of bending without torsion. In the case of 180° bending, two lateral surface may, depending on the requirements of the material standard, lie flat against each other or may be parallel at a specified distance, an insert being used to control this distance.

5 Shape of test pieces and sampling and preparation of test pieces

5.1 General Test pieces are divided into test pieces No. 1, test pieces No. 2 and test pieces No. 3 and their dimensions are as given in **5.2**, **5.3** and **5.4**. The sampling and preparation of test pieces shall be specified in each material standard of relevant Japanese Industrial Standard and, unless specified otherwise, any deformation or heating unnecessary for being test piece shall not be allowed.

In accordance with the agreement between the purchaser and the supplier, the thickness and width of the test pieces may be larger than the values specified in 5.2, 5.3 and 5.4.

5.2 Test piece No. 1 This type of test pieces is used mainly for the bend test of metal plate, bar and square material of thickness of 3 mm or more (see figure 1).



t : thickness (original thickness)

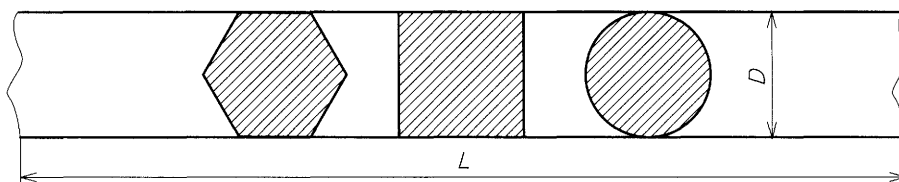
W : width (20 mm to 50 mm)

L : length (according to the thickness of the test piece and the testing apparatus used)

Figure 1 Test piece No. 1

If the specified thickness cannot be obtained, the maximum width possible to obtain shall be taken. If the original thickness is more than 25 mm, the test piece of the thickness which is reduced by shaving one side face may be used. In this case, however, the thickness of the test piece shall be 25 mm or more. When bending the test piece of this type, the surface not processed by machining is placed on the outside of curvature. The side surface produced by cutting process shall be machined when necessary.

5.3 Test piece No. 2 This type of test pieces is used mainly for the bend test of steel bar and non-ferrous material bar (see figure 2).



D^a): diameter (in case of circular cross-section) or inscribed circle diameter (in case of multi-angle cross-section)

Note ^a) Shall be the original dimension.

L : length (length is determined according to D of the test piece and the testing apparatus used)

Figure 2 Test piece No. 2

If the original diameter or inscribed circle diameter is more than 30 mm, according to the testing apparatus, the surface of original material may be reduced, remaining a part of it, by machining until coming to the inscribed circle diameter 25 mm or more (see figure 3).

In bending the test piece of this type, the surface not machined is placed on the outside of curvature.

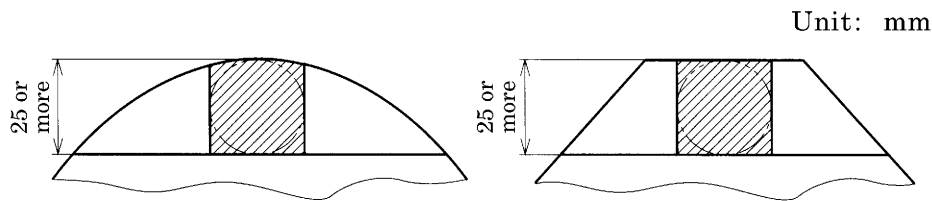
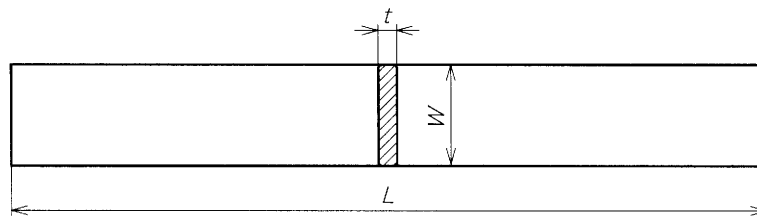


Figure 3 Machining at the time of the test piece of the diameter or inscribed circle diameter more than 30 mm and when the reduction is necessary

5.4 Test piece No. 3 This type of test pieces is used mainly for the bend test of metal plate of the thickness less than 3 mm (see figure 4).



t : thickness (original thickness)

W : width (15 mm to 50 mm)

L : length (according to the thickness of test piece and testing apparatus used)

Figure 4 Test piece No. 3

If the specified width cannot be obtained, the maximum width possible to be obtained shall be taken. The side surface produced by cutting process shall be machined when necessary.

5.5 Finish of edges The edges of the rectangular test piece shall be rounded as given in table 1 when necessary.

Table 1 Finish of edges

Unit: mm

Thickness of test piece	Roundness (radius)
Less than 10	1.0 or under
10 or over to and excluding 15	1/10 or under of thickness
15 or over to and excluding 50	1.5 or under
50 or over	3.0 or under

5.6 Test pieces from forgings, castings and semi-finished products The shape and sampling of the test pieces forgings, castings and semi-finished products are defined in material standards or agreement between the purchaser and the supplier.

6 Testing method

NOTE : During the test, adequate safety measures and guarding equipment shall be provided.

6.1 Press bending method The test by press bending method shall be as follows.

- a) The supports and the mandrel of the former shall be parallel to each other. The surfaces of the former and supports which will come in contact with the test piece may be coated with lubricant (oil, etc.).
- b) The tip of the former shall have a cylindrical surface of the radius equal to the inside radius specified, and the length of the cylindrical surface shall be greater than the width of the test piece.
- c) The part of supports which comes in contact with the test piece shall be of a cylindrical surface with the radius 10 mm or more.
- d) The distance between the supports shall conform to the formula (1) (see figure 5). The tolerance on the distance between the supports shall be as shown in table 2.

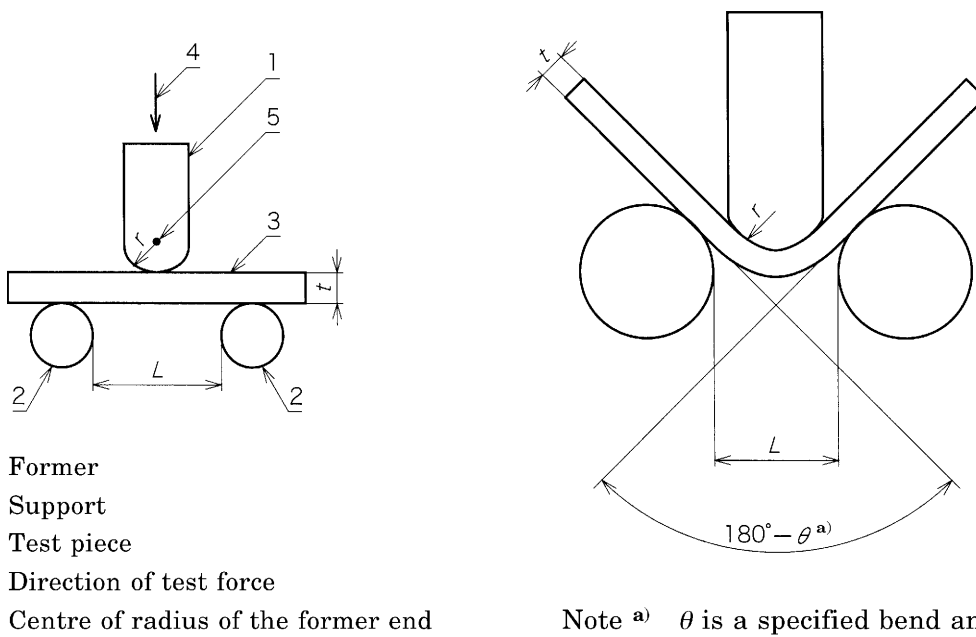
$$L = 2r + 3t \dots\dots\dots (1)$$

where, L : distance between two supports (mm)
 r : inside radius (mm)
 t : thickness, diameter or diameter of the inscribed circle of test piece (mm)

Table 2 Tolerance on distance between supports

Unit: mm

Thickness, diameter or diameter of the inscribed circle of test piece (t)	Tolerance
Over 10	$\pm \frac{t}{2}$
<u>10 or under</u>	<u>± 5</u>



- 1 Former
- 2 Support
- 3 Test piece
- 4 Direction of test force
- 5 Centre of radius of the former end

Note a) θ is a specified bend angle.

Figure 5 Press bending method

- e) The bend angle to be formed by the method shown in figure 5 shall be up to approximately 170°. When the bend angle is 180°, the test piece shall be compressed, after being bent to 170° by means of the method shown in figure 5, on both ends towards one another by means of an insert having a thickness two times the specified inside radius, as shown in figure 6.

In figure 5, when the distance between two supports is made as $L = 2r + 2t$ and the tolerance on the distance between supports is as given in table 3, the test piece shall be deemed to have been bent to 180° when pressed until it passes through the clearance between the supports.

Table 3 Tolerance on distance between supports

Unit: mm

Thickness, diameter or diameter of the inscribed circle of test piece (<i>t</i>)	Tolerance	
	+ side	- side
Over 10	$\frac{t}{2}$	0
10 or under	5	0

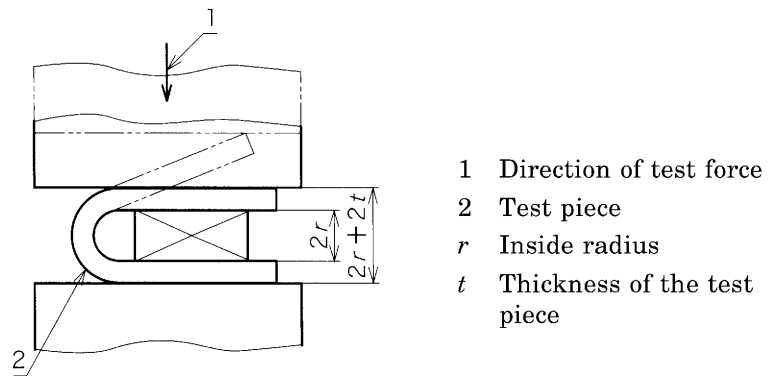


Figure 6 180° bending

- f) In the case of close contact bending, the test piece shall be closed by the method shown in figure 7, after being bent to approximately 170° with a suitable inside radius.

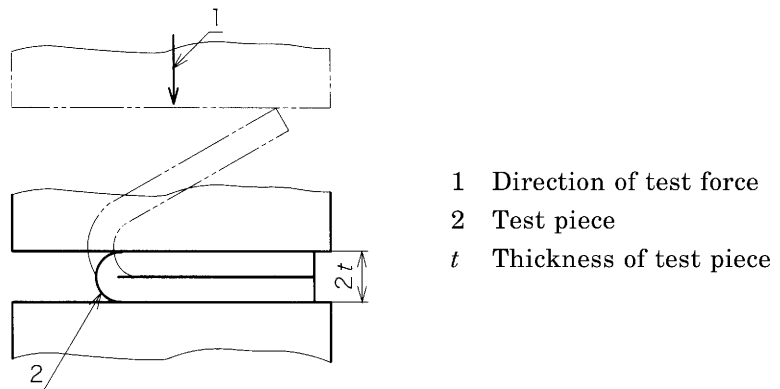
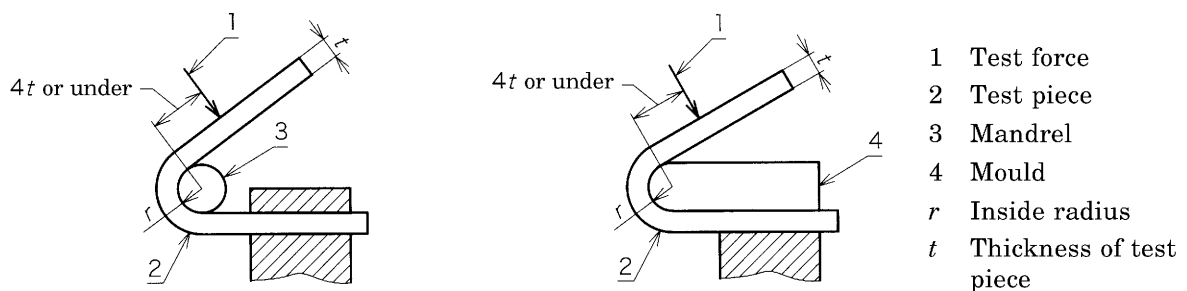


Figure 7 Close contact bending

6.2 Winding The test by winding shall be as follows.

- a) As shown in **a)** or **b)** of figure 8, one side of the test piece is pressed and other side is wound around a mandrel or wound by a specified angle so that the appropriate middle part of the test piece is formed as specified.

The position to which the test force is applied is as shown in **a)** and **b)** of figure 8.

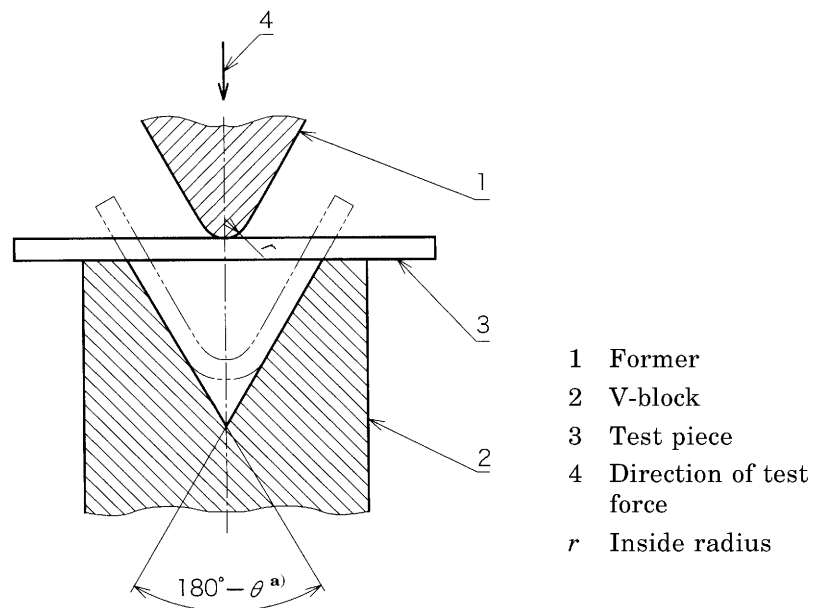


a) Case of using mandrel b) Case of using mould

Figure 8 Winding method

- b) In the case of the bend angle of 180° and of the especially small inside diameter or close contact bending, the both ends of test piece push each other until coming to a specified inside radius or coming in close contact by means of the method shown in figure 6 or figure 7, after bending up to 180° with a suitable inside radius in such a manner as shown in figure 8.

6.3 V-block method The test force shall be applied gradually to the test piece placed on the V-block by putting the mandrel on its middle part to be bent to specified form (see figure 9). The V-block method shall be used when specified by the material standard of each relevant Japanese Industrial Standard. The shape and dimension of the V-block and mandrel shall be as specified in the material standard.



Note ^{a)} θ is a specified bend angle.

Figure 9 V-block method

6.4 Test temperature The test temperature shall be within a range of 10°C to 35°C and when requiring temperature control specifically, it shall be $(23 \pm 5)^\circ\text{C}$. However, if specified in the material standards of Japanese Industrial Standards, it shall be observed.

6.5 Bending angle and bending inside radius The bending angle specified in the material standards shall be the lowest limit at any time and bending shall be made up to larger angle than it. When the inside radius of bending is specified, it shall be the higher limit and bending is made with the lower inside radius than it.

7 Interpretation of results The interpretation of the bend test shall be carried out according to the requirements of the material standard. When these requirements are not specified, absence of cracks visible without the use of magnifying aids is considered as evidence that the test piece withstood the bend test.

8 Test report When the test report is necessary, the information to be reported is selected from the following in accordance with the agreement between the purchaser and the supplier.

- a) reference to this Standard
- b) identification of the test piece (type of material, cast number, direction of the test piece axis relative to a product, etc.)
- c) shape and dimensions of the test piece
- d) test method
- e) any deviation from this Standard
- f) test result

Annex A (informative)

Determination of the bend angle from the measurement of the displacement of the former

Introduction This Annex (informative) is to supplement the matters related to the text and not to constitute the provisions of this Standard.

This Annex specifies the determination of the bend angle of a test piece under the test force. The direct measurement of this angle is complicated. For this reason, the method of calculation of this angle from the measurement of the displacement (f) of the former is described. The bend angle (α) of the test piece under the test force can be determined from the displacement of the former and the values given in figure A.1, as follows.

$$\sin \frac{\alpha}{2} = \frac{p \times c + W \times (f - c)}{p^2 + (f - c)^2}$$

$$\cos \frac{\alpha}{2} = \frac{W \times p - c \times (f - c)}{p^2 + (f - c)^2}$$

- where,
- a : bend angle of the test piece
 - p : distance between the centre of support and the vertical axis of the former after the test
 - c :
 $25 + a + \frac{D}{2}$
 a : thickness of the test piece
 D : diameter of the tip of the former
 - W : $\sqrt{p^2 + (f - c)^2 + c^2}$
 - f : displacement of the former from the position before the test

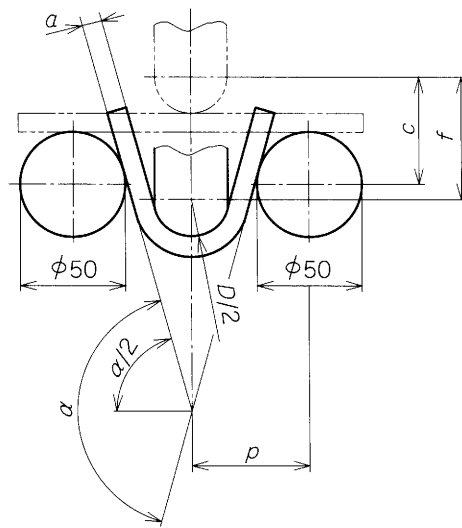


Figure A.1 Values for calculation of bend angle α

Annex JA (informative)

Comparison table between JIS and corresponding International Standard

JIS Z 2248 : 2006 <i>Metallic materials—Bend test</i>		ISO 7438 : 2005 <i>Metallic materials—Bend test</i>				
(I) Requirements in JIS		(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause	(V) Justification for the technical deviation and future measures	
Clause	Content	International Standard number	Clause	Classification by clause	Detail of technical deviation	
1	Scope The method of bend test for metallic materials is specified.	1	1	Deletion	There is no technical differences.	No proposal for revision is expected to ISO because there is no technical differences in particular.
2	Normative references					
3	Terms and definitions test force	2	2	Alteration	In ISO Standard, symbols and designations are given in one table together, however in JIS , they are given in each figure.	Alteration in layout only and therefore, there is no technical differences.
4	Principle of testing	3	3	Addition	The method of evaluation after bending which has been conventionally specified in former JIS is added.	Proposal to ISO for revision is examined.

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures	
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation		
5 Shape of test pieces and sampling and preparation of test pieces	5.1 General	5	Test piece General	Length of the test piece Depends on the equipment and the thickness of the test piece.	Deletion	Not specified in JIS, however, there is no particular technical sense.	There is no technical differences in particular.	
	5.2 Test piece No. 1							
	5.3 Test piece No. 2							
	5.4 Test piece No. 3							
	5.5 Finish of edges	5.5 Edges of rectangular test pieces	5.2	Thickness of test piece less than 10 mm or over	Roundness of edges 1.0 mm or under 50 mm or over 1.5 mm or under 3.0 mm or over	Alteration	The width of the plate test piece of which thickness is under 3 mm is 15 mm to 25 mm in ISO Standard, however, it is made up to 50 mm where severer test is required in JIS.	Proposal to ISO for revision is examined.

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
6 Testing method	<p>NOTE: Safety measures to be taken.</p> <p>6.1 Press bending method</p> <p>a) Concerning points for equipment and test pieces</p> <p>b) Specification of the former</p> <p>c) Specification of the radius of the support</p> <p>d) Distance between supports and tolerance thereof</p> <p>e) Bending method</p> <p>In the case of 180° bending, an insert is put after bending up to 170°.</p> <p>f) In the case of close contact bending, the test piece is bent first up to 170°.</p>	6	<p>Warning—Safety measures to be taken.</p> <p>Figure 1</p> <p>Test speed (1±0.2) mm/s is specified in case of dispute.</p>	Identical			
		6.2		Deletion		The pressing rate under a referee is not specified in JIS .	Waiting the thought of referee method to be popular in JIS , it will be examined to take it in JIS .
		6.3		Addition		In ISO Standard, bending up to 170° is not specified. In the case of JIS where the test conditions are constant, and the evaluation of result is superior.	Proposal to ISO for revision is examined.
		6.4					

(I) Requirements in JIS		(II) International Standard number	(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures
Clause	Content		Clause	Content	Classification by clause	Detail of technical deviation	
6 Testing method (concluded)	<p>6.2 Winding</p> <p>a) Winding method and the position at which the test force is applied are specified.</p> <p>b) Concerning points for the case of 180° in bend angle and of small inside radius close contact bending</p> <p>6.3 V-block method</p> <p>Detail concerning points for the testing method are specified. The use is allowed only when specified in material standards.</p> <p>6.4 Test temperature</p> <p>Specified to be 10 °C to 35 °C and 23 °C±5 °C when the temperature control is required in particular.</p> <p>6.5 Bending angle and bending inside radius</p>	6.2 6.3 6.4		Addition	In JIS , the position at which the test force is applied and concerning points for 180° bending are added in the same way as the former JIS .	Proposal to ISO for revision is examined.	
		6.2 6.3 6.4		Addition	In JIS , the use is allowed only when designated in the material standards. The expression refers the actual market condition.	Technical difference is slight.	
		6.1		Addition	In JIS , if specified in material standard, the observance of the specification is added.	Technical difference is slight.	
		7.2		Identical	—	—	

(I) Requirements in JIS		(II) International Standard number		(III) Requirements in International Standard		(IV) Classification and details of technical deviation between JIS and the International Standard by clause		(V) Justification for the technical deviation and future measures	
Clause	Content	Clause	Content	Classification by clause	Detail of technical deviation	Classification by clause	Detail of technical deviation	Justification for the technical deviation and future measures	
7 Interpretation of results		7.1		Identical	—	Identical	—	—	
8 Test report	When the test report is necessary, information is selected from the following. a) reference to this Standard b) identification of the test piece c) shape and dimensions of the test piece d) test method e) any deviation from this Standard f) test result	8	Information is selected from the following for the test report. a) a reference to this International Standard b) identification of the test piece c) shape and dimensions of the test piece d) test method e) any deviation from this International Standard f) test result	Alteration	In JIS, the necessary items are allowed to be selected in accordance with the agreement between the purchaser and the supplier.	Alteration	In JIS, the necessary items are allowed to be selected in accordance with the agreement between the purchaser and the supplier.	Technical difference is slight.	
Annex A (informative)	Determination of the bend angle from the measurement of the displacement of the former	Annex A (informative)							

Designated degree of correspondence between JIS and International Standard (ISO 7438 : 2005) : MOD

NOTE 1 Symbols in sub-columns of classification by clause in the comparison table indicate as follows:

- Identical: Identical in technical contents.
- Deletion: Deletes specification item(s) or content(s) of International Standard.
- Addition: Adds specification item(s) or content(s) which are not included in International Standard.
- Alteration: Alters specification content(s) which are included in International Standard.

NOTE 2 Symbol in column of designated degree of correspondence between JIS and International Standard in the comparison table indicates as follows:

- MOD: Modifies International Standard.

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