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JAPANESE INDUSTRIAL STANDARD

Steel Forgings—General Technical Requirements

JIS G 0306—1988

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In the event of any doubt arising,
the original Standard in Japanese is to be final authority.

JAPANESE INDUSTRIAL STANDARD

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Steel Forgings — General Technical Requirements

G 0306-1988

1. Scope

This Japanese Industrial Standard specifies the general rules commonly applied to manufacture, tests, and inspections of steel forgings.

Remark: In this Standard, the units and numerical values in { } are in accordance with the International System of Units (SI), and appended herein for reference only.

The conventional units and numerical values in this Standard shall be replaced by those in the SI units which will be effective 1, Jan. 1991.

2. Definitions

The definitions of the main terms used in this Standard shall be as follows:

- (1) steel forgings The steel ingots, or steel products manufactured from the steel ingots by means of forging, rolling, or combination of both forging and rolling, which are hot-worked through such process as press, hammer, forging roll, ring mill, etc., and then are generally heat-treated to give specified mechanical properties.
- (2) shaft-shaped object The objects such as straight axle, bossed axle, flanged axle, or pinion with axle, which gives circular-shape section, and whose longitudinal length exceeds the outside diameter, or their equivalents. The objects thought to be deformed shaft are contained.
- (3) cylinder-shaped object The objects whose forged shape is cylindrical and whose longitudinal length exceeds the outside diameter. The cylinder-shaped forgings require hollow forging, however, which are made cylinder-shape by only punching or mechanical working are excluded.
- (4) ring-shaped object The objects whose forged shape is ring and whose longitudinal length is not more than its outside diameter. The ring-shaped forgings require hole-widening forging, however, the ring made by only punching or mechanical working is excluded.
- (5) disc-shaped object The objects whose forged shape is disc or the equivalent (including the one having partly irregularity), and whose longitudinal length is not more than its outside diameter. The disc-shaped forgings require upsetting forging as a final process, however, the disc-shaped object made by cutting shaft-shaped material is excluded.

Applicable Standards: See page 26.

3. Manufacture Method

3.1 Steel Ingot Steel ingot is manufactured from killed steel which has been cut off sufficiently to eliminate harmful pipe and segregation.

3.2 Forging Forging shall be conducted by hot-working process on iron ingot by means of a press, hammer, forging roll, ring mill, etc. The steel products manufactured from the steel ingot by means of forging, rolling, or the combined both forging and rolling may be used instead of steel ingot.

Hot working and forging ratio shall be as follows:

- (1) Hot Working Hot working shall be carried out such that every part of a steel forging is uniformly worked up to its center, and be processed to obtain final shape and dimension in which the metal flow is suitable as far as possible to the stress appearing during its use.
- (2) Forging Ratio⁽¹⁾ The forging ratio for steel forgings shall conform to the following (a) to (d).
 - (a) In the case of shaft-shaped and cylinder-shaped steel forgings; when only forging is applied, the main body shall be hot-worked with not less than 3 S and other parts with not less than 1.5 S; and when rolling and forging are applied, the main body shall be hot-worked with not less than 5 S and other parts with not less than 3 S.
 - (b) In the case of ring-shaped steel forgings, they shall be hot-worked for not less than 3 S with hole-broadening forging by a press, hammer, or ring mill.
 - (c) In the case of disc-shaped steel forgings, when being forged owing to only upsetting of steel ingot, they shall be hot-worked with not less than 1/3 U; and when other than the above-mentioned, also hot-worked with not less than 1/3 U.
 - (d) In the case of forging ratio applied to other than above (a) to (c), the agreement between the parties relating to delivery shall be observed.

Note ⁽¹⁾ Refer to JIS G 0701.

3.3 Heat Treatment Heat treatment shall conform to the description in each Standard.

In the cases where hot working is carried out after steel forgings are heat-treated, they shall be again heat-treated as specified.

3.4 Repair by Welding The defects found during inspection can be repaired by welding in accordance with the consultation between the parties related to delivery.

4. Test Methods

4.1 Chemical Analysis

4.1.1 Chemical Components The chemical components shall be determined by the cast analysis, unless otherwise specified. Provided, in the case of purchaser's request, the product analysis may be carried out instead.

The elements to be analyzed shall conform to the specification in each Standard.

4.1.2 Sampling Sampling shall conform to the following:

- (1) The sample for cast analysis shall generally be taken from each melt by necessary amount at the middle of the whole pouring.
- (2) The sample for product analysis shall be generally taken in accordance with 3. in JIS G 0321. Instead, however, the remaining materials of a test piece for mechanical test may be used for chemical analysis.

4.1.3 Analysis Method and Analysis Value Analysis method shall conform to the specification in each Standard. Analysis value shall be represented in percentage, and be rounded off in accordance with JIS Z 8401 after calculating one more figure than the effective last place that has been specified.

When carbon equivalent is calculated, the total value of the values obtained by the formula specified in each Standard, shall be rounded off in accordance with JIS Z 8401.

4.2 Mechanical Tests

4.2.1 Type of Tests Type of tests shall conform to the specification in each Standard.

4.2.2 Taking Method and Number of Specimens and Test Pieces, and Test Methods The taking method and number of specimens and test pieces, and test methods shall conform to the following (1) and (2).

(1) Steel Forgings for Pressure Vessels

- (1.1) Taking of Specimens Specimens shall be taken from the body of steel forging or the superfluous part of the body. When the conditions shown in (a) to (d) are satisfied, however, separately forged specimens may be submitted to the test in conformity with the agreement between the parties relating to delivery.
 - (a) The specimens shall be prepared from steel ingot, blooms, billets, or slubs which are the same melt as steel forgings and are to be hot-worked similarly to the steel forging.
 - (b) Their maximum forging ratio shall be not more the minimum forging ratio of the steel forging.
 - (c) They shall be simultaneously heat-treated in the same heat-treatment furnace as the steel forgings.
 - (d) Their thickness and diameter shall be not less than the maximum thickness or the maximum diameter of the steel forging.

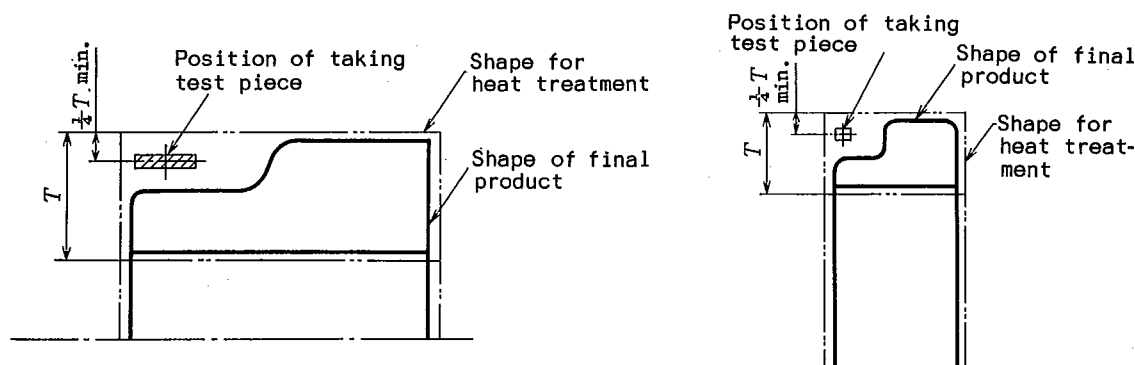
(1.2) Taking of Test Pieces The taking of test pieces shall conform to the following:

- (1.2.1) Direction of sampling of test pieces shall be parallel with the direction of main forging process.
- (1.2.2) The center of the test piece taken from the steel forgings or the austenitic stainless steel forgings, which are annealed, normalized, or normalized-and-tempered, shall be inside not less than $1/4 T$. In this case, T means the maximum thickness or diameter of steel forging or separately-forged specimen measured when being heat-treated.

Fig. 1 shows the example of gist of sampling of the test piece.

Fig. 1. Example of Gist of Sampling a Test Piece: $1/4 T$

- (1) When Main Forging Direction Is along Axis (2) When Main Forging Direction Is along Circular Circumference



- (1.2.3) The test piece of steel forging, which is normalized by quick cooling and then is either tempered or quenched-and-tempered, shall be taken from the position in conformity with either one of the following:

- (a) The center of a test piece is off not less than $1/4 T$ from the first heat-treated surface and not less than T from the second heat-treated surface.

Fig. 2 shows the example of gist to take the test piece.

- (b) When a test piece is taken from the complicatedly shaped steel forging which is formed or mechanically worked up to the form similar to product before heat treatment, the center of the test piece is off from the heat-treated surface not less than the largest distance (t_{max}) between the high-stressed surface previously appointed and the heat-treated surface that is nearest to the above surface, and be off not less than twice t_{max} from the second heat-treated surface. The center of the test piece, however, must be off not less than 20 mm from the first heat-treated surface

and not less than 40 mm from the second heat-treated surface.
Fig. 3 shows the example of gist to take the test piece.

- (c) When a test piece is taken from the steel forging which is heat-treated with attaching heat buffer, the heat treatment is carried out after welding the heat buffer, measuring not less than $T \times T$ in section area and not less than $3T$ in its length, of carbon steel or low-alloy steel, at the end surface where the test piece will be taken, prior to heat treatment. After heat treatment, at nearly central part of length way of the buffer, specimen is cut from steel forging so as to contain the buffer surface which is covered with distance equivalent to $1/3$ length, and a test piece is taken from this specimen. The center of the test piece shall be off not less than 15 mm from the buffer surface and not less than $1/4 T$ from the heat-treated surface.

Fig. 4 shows example of gist to take the test piece.

- (d) When a test piece is taken from the separately forged specimen, it is taken from the specimen, measuring T (thickness) $\times 2T$ (width) $\times 2T$ (length) at least, at the position which is off not less than $1/4 T$ from the first heat-treated surface and not less than T from the another heat-treated surface.

Fig. 5 shows the example of gist to take the test piece.

Fig. 2. Example of Gist to Take Test Piece: $1/4 T \times T$

- (1) When Main Forging Direction Is along Axis (2) When Main Forging Direction Is among Circular Circumference

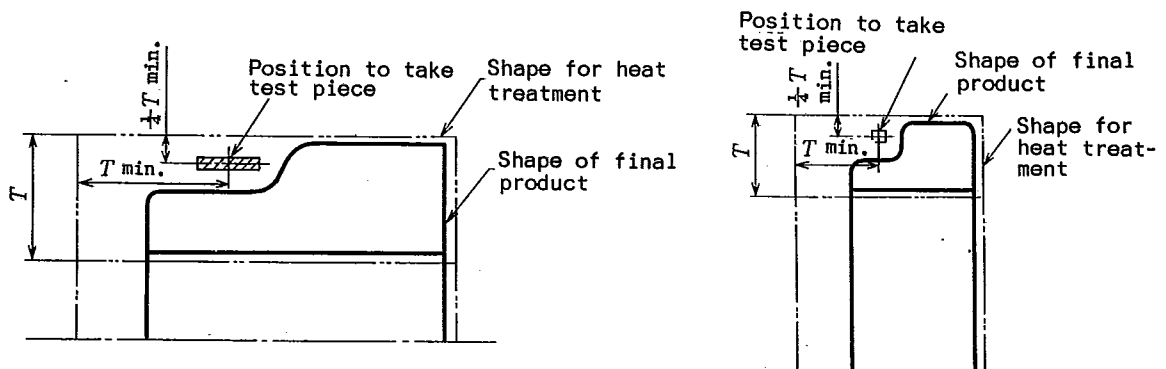


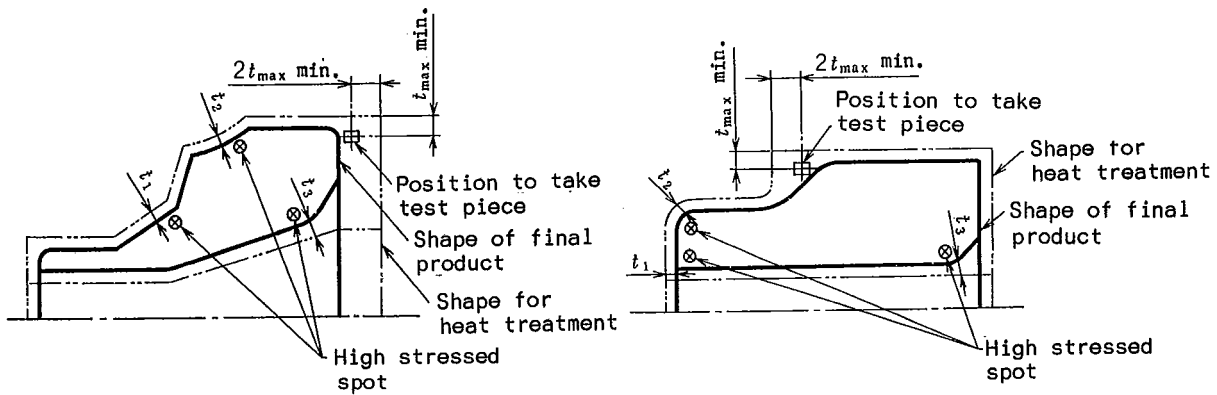
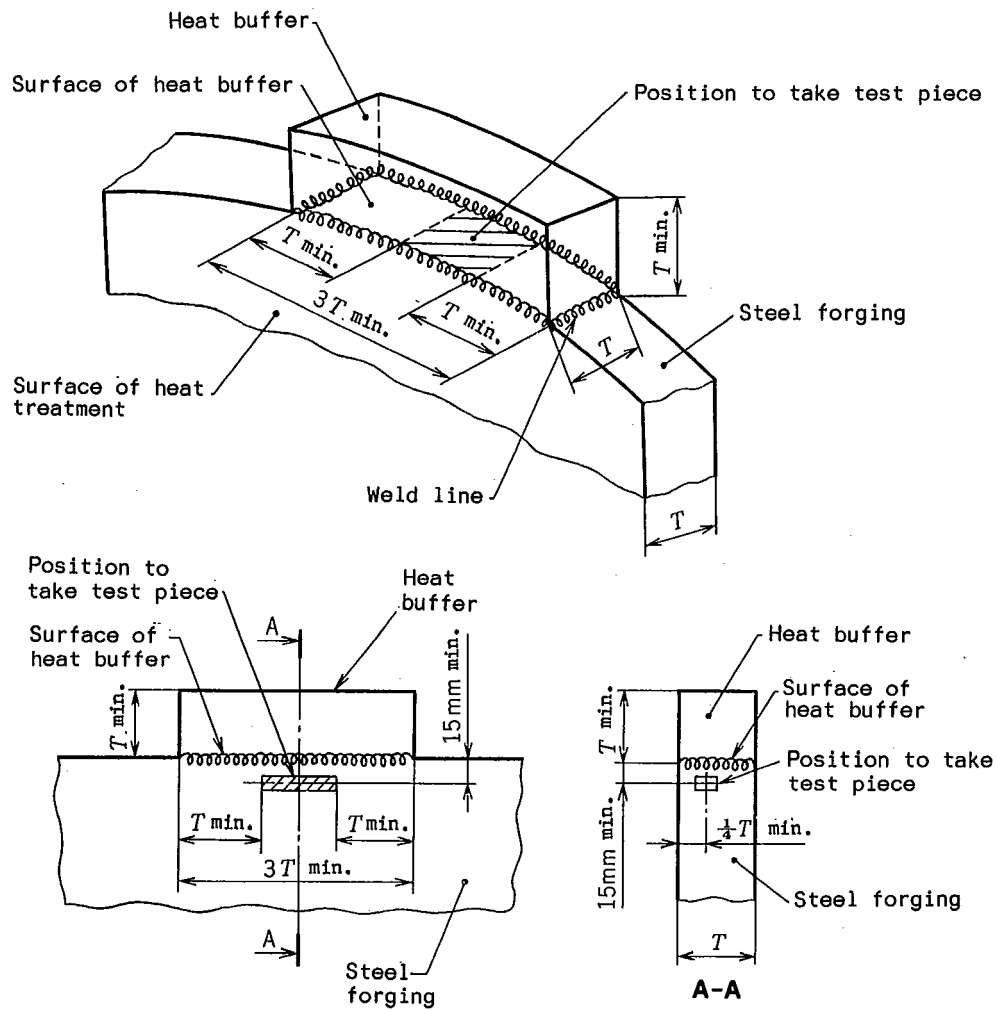
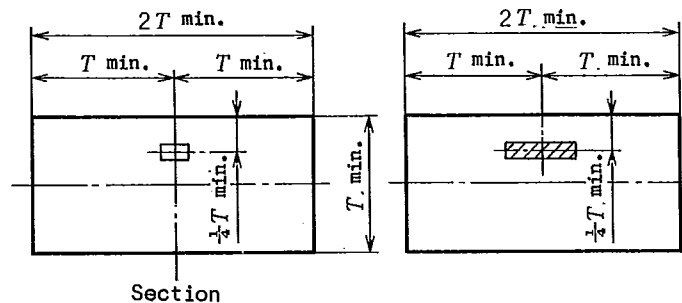
Fig. 3. Example of Gist to Take Test Piece: $t_{\max} \times 2 t_{\max}$ Fig. 4. Example of Gist to Take Test Piece
(Case of using heat buffer)

Fig. 5. Example of Gist to Take Test Piece
(Case of using separately forged specimen)



- (1.2.4) Unless otherwise specified, the specimen must not be processed, which may give any influence on mechanical properties, after being taken out from a steel forging.
- (1.2.5) The test piece for tensile test shall be of No. 14 A type test piece specified in JIS Z 2201.
- (1.2.6) The test piece for impact test shall be of No. 4 type test piece specified in JIS Z 2202.
- (1.2.7) Superfluous part of the test piece for tensile test is available for hardness test.
- (1.3) Number of Specimens and Test Pieces The number of specimens and test pieces shall conform to the following (a) to (c). In cases where a lot of steel forgings are forged and heat-treated after connecting each other, the whole connected is treated as one forging.
- The unit weight, whole length, and length along axial direction, which are measured when being heat-treated, shall not contain that of the superfluous part of the body. One set of test pieces comprises one piece for tensile test, three for impact test, and one for hardness test. When there is no specification on impact test and hardness test, however, the test pieces for them do not need to be taken.
- (a) The number of specimens and test pieces from carbon steel forgings shall conform to Table 1.