

JIS

JAPANESE
INDUSTRIAL
STANDARD

Translated and Published by
Japanese Standards Association

JIS E 5402-1 : 2005

(JARI/JSA)

**Railway rolling stock — Solid wheel —
Part 1 : Quality requirements**

ICS 45.060.01 ; 77.140.99

Reference number : JIS E 5402-1 : 2005 (E)

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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 and the Minister of Land, Infrastructure and Transport through deliberations at the Japanese Industrial Standards Committee as the result of proposal for revision of Japanese Industrial Standard submitted by Japan Association of Rolling Stock Industries (JARI)/ 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 E 5402-1 : 1998 is replaced with this Standard.

In the establishment of this Standard, ISO 1005-6 : 1994 *Railway rolling stock material—Part 6 : Solid wheels for tractive and trailing stock—Technical delivery conditions* was wholly adopted, but at the same time, in order to avoid the users' confusion caused by major revision of the previous edition JIS E 5402 : 1989 which had been widely used over the previous few decades, some contents specified in the said previous edition were included in the original International Standard in the form of "addition of clause" or "addition of contents" to the extent of the minimum required, thus increasing the users' options. At that time, however, a comparison table between International Standard and Japanese Industrial Standard was not provided so the degree of correspondence to the International Standard was not clarified.

In this revision, this comparison table has been made to clarify the degree of correspondence to the International Standard and some specification contents have been modified in view of the recent performance of the work.

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's 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.

JIS E 5402 series consists of the following 2 parts under the general title "*Railway rolling stock—Solid wheel*" :

Part 1 : Quality requirements

Part 2 : Dimensional and balancing requirements

Date of Establishment: 1998-07-25

Date of Revision: 2005-07-11

Date of Public Notice in Official Gazette: 2005-07-11

Investigated by: Japanese Industrial Standards Committee

Standards Board

Technical Committee on Railways and Rolling Stock

JIS E 5402-1 : 2005, First English edition published in 2006-03

Translated and published by: Japanese Standards Association
4-1-24, Akasaka, Minato-ku, Tokyo, 107-8440 JAPAN

In the event of any doubts arising as to the contents,
the original JIS is to be the final authority.

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Printed in Japan

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Railway rolling stock—Solid wheel— Part 1 : Quality requirements

Introduction This Japanese Industrial Standard has been prepared based on the second edition of *ISO 1005-6 Railway rolling stock material—Part 6 : Solid wheels for tractive and trailing stock—Technical delivery conditions* published in 1994 without any modification of the technical contents for the corresponding parts, but with some additions of the specifications that are unique to Japanese Industrial Standard.

The portions given sidelines or dotted underlines are the matters modified from the original International Standard. A list of modifications with the explanations is given in Annex 2 (informative).

1 Scope

1.1 This part of **JIS E 5402** specifies requirements for the manufacture and supply of rolled, forged or cast solid wheels of unalloy steels for tractive and trailing railway rolling stock in accordance with tables 1 and 1A and clause 4.

This Standard provides categories of material and related quality testing requirements ; testing categories A and B and dimensional tolerance categories Y and Z for wheels of table 1, and also testing categories C and D and dimensional tolerance category J for wheels of table 1A.

Remarks 1 The most obvious difference among categories A, B, C and D is the specification of the mechanical properties ;

- in the case of category A, on the basis of tensile and impact test ;
- in the case of category B, on the basis of hardness test ;
- in the case of category C, on the basis of tensile test ;
- in the case of category D, on the basis of tensile and hardness tests.

2 For the difference among the values of the tolerance categories Y, Z and J, see the following standards.

JIS E 4504

JIS E 5402-2 : (see especially tables 4 and 4A)

3 Usual applications of the testing categories A, B, C and D and tolerance categories Y, Z and J of wheels are as follows :

a) railway systems where frequent and high-speed passenger transportation is predominant

1) the combination of testing category A with tolerance category Y

2) the combination of testing category D with tolerance category J

b) railway systems where freight transportation is predominant

1) the combination of testing category B with tolerance category Z

2) the combination of testing category C with tolerance category J

1.2 In addition to this part of JIS E 5402, the requirements of JIS G 0404 are applicable.

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

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.

ISO 1005-6 : 1994 *Railway rolling stock material—Part 6 : Solid wheels for tractive and trailing stock—Technical delivery conditions* (MOD)

2 Normative references The following standards contain provisions which, through reference in this text, constitute provisions of this Standard. If the indication of the year of publication is given to these referred standards, only the edition of the indicated year constitutes the provision of this Standard but the revision and amendment made thereafter do not apply. The normative references without the indication of the year of coming into effect apply only to the most recent edition (including amendments).

JIS B 7503 *Dial gauges*

JIS E 4504 *Wheelsets for railway rolling stock—Quality requirements*

Remarks : ISO 1005-7 : 1982 *Railway rolling stock material—Part 7 : Wheelsets for tractive and trailing stock—Quality requirements* is equivalent to the said standard.

JIS E 5402-2 *Railway rolling stock—Solid steel wheel—Part 2 : Dimensional and balancing requirements*

Remarks : ISO 1005-8 : 1994 *Railway rolling stock material—Part 8 : Solid wheels for tractive and trailing stock—Dimensional and balancing requirements* is equivalent to the said standard.

JIS G 0303 *General rules for inspection of steel*

JIS G 0404 *Steel and steel products—General technical delivery requirements*

Remarks : ISO 404 : 1992 *Steel and steel products—General technical delivery requirements* is equivalent to the said standard.

JIS G 0415 *Steel and steel products—Inspection documents*

Remarks : ISO 10474 : 1991 *Steel and steel products—Inspection documents* is identical with the said standard.

JIS G 0416 *Steel and steel products—Location and preparation of samples and test*

pieces for mechanical testing

Remarks : *ISO 377 : 1997 Steel and steel products—Location and preparation of samples and test pieces for mechanical testing* is identical with the said standard.

JIS G 1211 Iron and steel—Methods for determination of carbon content

Remarks : *ISO 437 : 1982 Steel and cast iron—Determination of total carbon content—Combustion gravimetric method* is equivalent to the said standard.

ISO 9556 : 1989 Steel and iron—Determination of total carbon content—Infrared absorption method after combustion in an induction furnace is equivalent to the said standard.

JIS G 1212 Iron and steel—Methods for determination of silicon content

Remarks : *ISO 439 : 1994 Steel and iron—Determination of total silicon content—Gravimetric method* is equivalent to the said standard.

ISO 4829-1 : 1986 Steel and cast iron—Determination of total silicon content—Reduced molybdosilicate spectrophotometric method—Part 1 : Silicon contents between 0.05 and 1.0 % is equivalent to the said standard.

ISO 4829-2 : 1988 Steel and iron—Determination of total silicon content—Reduced molybdosilicate spectrophotometric method—Part 2 : Silicon contents between 0.01 and 0.05 % is equivalent to the said standard.

JIS G 1213 Iron and steel—Methods for determination of manganese content

JIS G 1214 Iron and steel—Methods for determination of phosphorus content

Remarks : *ISO 10714 : 1992 Steel and iron—Determination of phosphorus content—Phosphovanadomolybdate spectrophotometric method* is equivalent to the said standard.

JIS G 1215 Iron and steel—Methods for determination of sulfur content

JIS G 1219 Iron and steel—Methods for determination of copper content

Remarks : *ISO 4946 : 1984 Steel and cast iron—Determination of copper content—2.2—Diethylenetriamine spectrophotometric method* is equivalent to the said standard.

JIS G 1253 Iron and steel—Method for spark discharge atomic emission spectrometric analysis

JIS G 1257 Iron and steel—Methods for atomic absorption spectrometric analysis

JIS Q 9001 Quality management systems—Requirements

Remarks : *ISO 9001 Quality management systems—Requirements* is identical with the said standard.

JIS Z 2201 Test pieces for tensile test for metallic materials

Remarks : **ISO 6892** : 1984 *Metallic materials—Tensile testing* is equivalent to the said standard.

JIS Z 2241 *Method of tensile test for metallic materials*

Remarks : **ISO 6892** : 1984 *Metallic materials—Tensile testing* is equivalent to the said standard.

JIS Z 2242 *Method for Charpy pendulum impact test of metallic materials*

Remarks : **ISO 83** : 1976 *Steel—Charpy impact test (U-notch)* is equivalent to the said standard.

JIS Z 2243 *Brinell hardness test—Test method*

Remarks : **ISO/DIS 6506-1** : 1996 *Metallic materials—Hardness test—Brinell test* is equivalent to the said standard.

JIS Z 2246 *Shore hardness test—Test method*

ISO 1580 : 1994 *Slotted pan head screws—Product grade A (Annex A)*

ISO 4032 : 1999 *Hexagon nuts, style 1—Product grades A and B (Annex A)*

ISO/TS 4949 : 2003 *Steel names based on letter symbols*

ISO 4960 : 1986 *Cold-reduced carbon steel strip with a carbon content over 0.25 %*

ISO 5948 : 1994 *Railway rolling stock material—Ultrasonic acceptance testing*

ISO 6933 : 1986 *Railway rolling stock material—Magnetic particle acceptance testing*

ISO/TR 9769 : 1991 *Steel and iron—Review of available methods of analysis*

3 Information to be supplied by the purchaser The purchaser shall designate the following information at the time of his enquiry and order. Designation of items **a)** to **f)** is a requirement. Items **g)** to **o)** are optional, and may additionally be stated as necessary.

- a) The number of this part of **JIS E 5402**
- b) The grade of steel (see table 1 or 1A)
- c) The type of heat treatment (see 4.2 and 6.5)
- d) The testing category (see 4.3 and 7.3.1)
- e) The dimensions of the wheel (see 5.4)
- f) The degree of finish and the tolerance category (see 4.4 and 4.5)

The purchaser may state the following in his enquiry and order :

- g) If, for wheels to be delivered in the normalized or quenched and tempered condition, lower phosphorus and sulfur contents are required [see table 1 Note (5)]
- h) If the tape size shall be measured and marked (see 5.6 and 7.8.4)

- i) If any special marking is required (see 5.6)
- j) If, for cast wheels, any specific manufacturing process is required (see 6.2.2)
- k) If shot peening is required (see 6.8)
- l) Whether optional tests and checks shall be carried out and, if so, which ones (see table 2 or 2A), together with the following additional information
 - in the case of hardness survey tests : whether the total wear depth is not less than 35 mm (see 7.7.3.4)
 - in the case of static balancing tests : whether the amount and position of residual imbalance shall be marked and whether, in the case of trailing stock, methods of correction other than those specified in 6.6 may be applied
- m) If optional dimensional checks are required and, if so, the number of wheels to be inspected [see table 2, Note ⁽³¹⁾]
- n) If, for the inspection of the manufacture and various quality requirements, the responsibility shall be other than that specified in 7.1.1, last paragraph
- o) If protection against corrosion is required and, if so, the method to be used (see 8.1)

4 Classification The solid wheels are classified according to the grade of steel, the heat-treatment condition on delivery, the testing category, the degree of finish, the tolerance category and any optional requirements of the purchaser.

4.1 Grades of steel The text covers the following grades of steel in accordance with the properties given in table 1 or 1A.

- a) **rolled or forged wheels** : C grades of table 1 and all grades of table 1A ;
- b) **cast wheels** : GC grades of table 1.

4.2 Types of heat-treatment condition on delivery Depending on the agreements of the order, the wheels are supplied

- a) normalized or normalized and tempered (symbol N of table 1) ; or
- b) rim quenched and tempered (symbol T of table 1 and S and R of table 1A).

In special less critical cases, forged or rolled wheels can also be delivered untreated (no symbol). In this case, the mechanical properties are to be agreed at the time of enquiry and order.

In special cases, immersion quenched and tempered wheels may also be supplied (symbol E).

4.3 Testing category Wheels may be supplied according to testing categories A, B, C and D (see 1.1 Remarks, table 1 or 1A).

4.4 Degree of finish See clause 4 of **JIS E 5402-2** for definitions of "unmachined wheels", "rough machined wheels", "raw wheels", "half finished wheels" and "finished

wheels".

Remarks : The degrees of finish are referred to in this part of JIS E 5402 by using the terms most commonly used in this country. The table given in Annex 1 compares the commonly used terms and the terms specified in ISO.

4.5 Tolerance category For the tolerance category 1.1 Remarks of JIS E 5402-2 applies.

5 Requirements

5.1 Chemical composition

5.1.1 The chemical composition of the wheels shall comply with the requirements given in table 1 or 1A.

5.1.2 Unless otherwise agreed, the requirements for the results of the product analysis shall be considered to be complied with when the results of the cast analysis are in accordance with the relevant specifications in table 1 or 1A.

5.2 Mechanical properties The mechanical properties of the wheels shall comply with the requirements given in table 1 or 1A.

5.3 Appearance and soundness

5.3.1 General

5.3.1.1 The wheels shall be sound throughout and without any defects detrimental to their use.

5.3.1.2 Those portions remaining black (unmachined) shall blend smoothly into any machined portions.

The finish of the machined surfaces shall, unless otherwise specified by the purchaser, be in accordance with clause 5 of JIS E 5402-2.

5.3.2 Acceptance standard for magnetic particle test When magnetic particle testing according to ISO 6933 is required (see table 2), the evaluation of magnetic particle discontinuity indications shall be based on an acceptance standard that is agreed upon when ordering. As far as possible, the position, shape, size, orientation and distribution of the discontinuities, and the service conditions for which the wheel is provided, shall be taken into account.

5.3.3 Acceptance standard for ultrasonic acceptance tests When ultrasonic acceptance tests are required (see table 2), the acceptance standard specified in ISO 5948 shall apply, unless otherwise agreed at the time of enquiry and order.

5.4 Machining allowances and dimensional tolerances For the machining allowances and dimensional tolerances, see clause 5 of JIS E 5402-2.

5.5 Residual imbalance When the residual imbalance is to be checked (see table 2 or 2A), the results shall conform to the requirements of clause 5 of JIS E 5402-2 and the

imbalance shall be marked in accordance with 5.6.

5.6 Marking Each wheel shall be supplied with marks as specified in the order or its appended documents.

Unless otherwise specified, each wheel according to table 1 shall receive the following marks :

- a) manufacturer's name or abbreviation ;
- b) cast number, or a serial number which can be identified with the specific cast ;
- c) grade of steel and heat-treatment condition (see 4.2), including, if required, the testing and/or tolerance category ;
- d) date of manufacture (month and last two figures of the year of manufacture) ;
- e) the inspector's mark, if the wheel is in accordance with 7.9 ;
- f) if the static imbalance is to be checked (see table 2) ; the position of imbalance and, if it is specified, the value of the residual imbalance ;
- g) the tape size, if this is to be measured (see 7.8.4).

Unless otherwise specified, the position and size of the marks shall be as follows (for examples, see figures 1 and 2).

The marks pertaining to a) to e) shall, in the case of stamping, be made on a face of the hub, unless otherwise specified in the order. Stamps with acute-angled character forms shall not be used (see 6.4). In the case of cast wheels, the marks pertaining to a) to d) may be cast and the inspector's mark stamped on the flange side of the web.

If static balancing tests were agreed upon at the time of enquiry and order, the position of the imbalance shall be indicated by suitably coloured paint in a radial stripe of about 15 mm width. When required, the imbalance value shall be given in g·m by painted numbers below the end of the stripe.

If measurement of the tape size has been agreed upon at the time of enquiry and order, the tape size shall be clearly painted on the flange web and in characters at least 25 mm in height.

The surface of the wheel shall not have any marks other than those specified in the order or its appended documents in position other than above mentioned.

Unless otherwise specified, each wheel according to table 1A shall receive the following marks :

- h) manufacturer's name or abbreviation ;
- i) month and year of manufacture or their abbreviation ;
- j) cast number ;
- k) if the static imbalance is to be checked, the position of imbalance. Unless designated by the purchaser, the position and size of the marks shall be as follows.

The marks pertaining to h) to k) shall be made on a face plane of the rim side oppo-

site the flange.

If static imbalance tests were agreed upon at the time of enquiry and order, the position of the weightier imbalance shall be indicated by a round mark of 10 mm diameter.

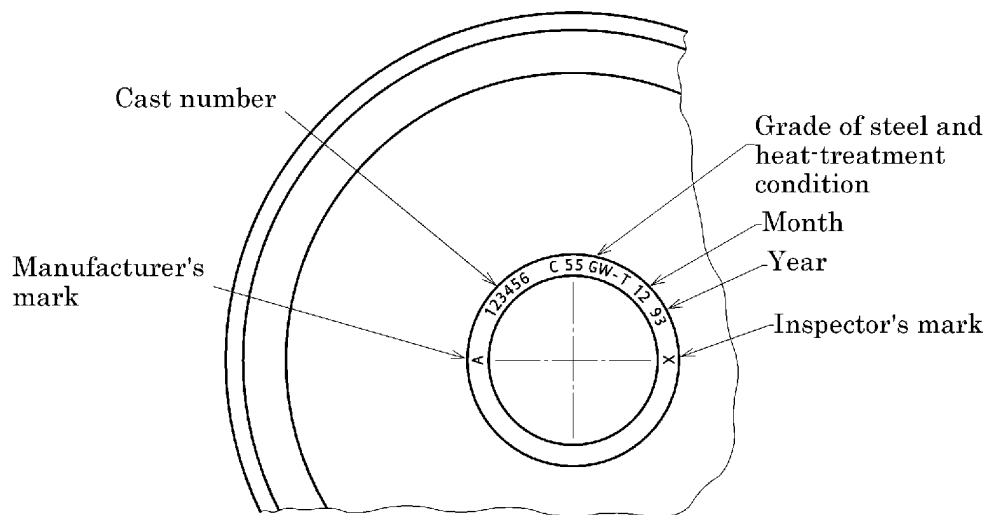


Figure 1 Example for marking of rolled, forged or cast wheels by stamping (see 5.6)

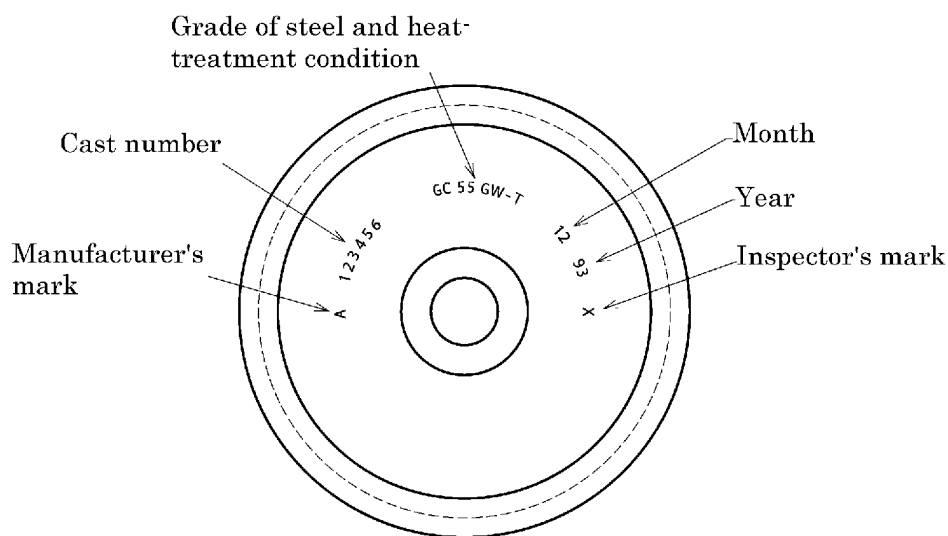


Figure 2 Example for alternative marking of cast wheels with cast-on characters

6 Manufacture

6.1 Steelmaking process The wheels shall be made from steel produced by basic-oxygen, open-hearth, or electric-arc processes ; other processes may be used by agreement between the manufacturer and the purchaser.

The steel shall be killed in the furnace or in the ladle and shall be bottom-poured or continuously cast, unless otherwise agreed.

6.2 Manufacturing process

6.2.1 Rolled or forged wheels Rolled or forged wheels shall be manufactured from ingots or blooms capable of producing two or more wheels after removal of discards. Special individual ingots may only be used with the prior agreement of the purchaser. Cropping and dressing shall be sufficient to eliminate unsound sections of the ingot (see also 6.3).

The sections of ingots or blooms shall be forged, pierced and rough shaped by a hammer or press. They shall be finally shaped by rolling or by die forging supplemented by sizing if necessary.

Suitable precautions shall be taken during hot-working in order to avoid damage of the material by excessive grain growth and by other defects caused by overheating.

Remarks : For the above purpose, the hot-working temperatures and the holding times at these temperatures should not be excessive. As a guideline, hot-working should not be done at temperatures above 1 260 °C and should terminate between 850 °C and 1 000 °C.

After forging or rolling, and, where applicable, sizing and stamping the identification marks, the wheels shall be left to cool. If the steel has not been degassed, suitable precautions, which may include for example slow cooling, shall be taken to avoid the formation of flakes (hydrogen cracking).

6.2.2 Cast wheels Cast wheels shall be manufactured by pouring metal into moulds shaped to produce the wheel contour required, in accordance with a process acceptable to the purchaser and taking into account the requirements of clause 5 of JIS E 5402-2. The upper part of the mould shall have risers, to feed metal back into the wheel during solidification and to produce a sound casting.

Cast wheels shall be permitted to cool in the moulds until they have solidified completely. Following removal of the mould, suitable precautions shall be taken to ensure that the wheels are not damaged by cooling too rapidly. If the steel has not been degassed, suitable precautions, which may include for example slow cooling, shall be taken to avoid the formation of flakes (hydrogen cracking).

6.3 Removal of defective sections Defective sections which do not comply with the soundness characteristics specified in 5.3 shall be removed before or during the manufacture of the wheels.

6.4 Identification of the wheels during manufacture All ingots, sections and wheels shall be suitably marked at each stage of manufacture so that, before delivery, each wheel can be identified as specified in 5.6. Where punched identification marks differ from the final identification marks defined in 5.6, they shall be sufficiently shallow not to remain visible on the finished wheel.

6.5 Heat treatment

6.5.1 The wheels shall undergo the heat treatment specified in the order or its appended documents (see 4.2).

6.5.2 Wheels to be rim quenched and tempered (symbols T, S and R) or immersion quenched and tempered shall be uniformly reheated to the correct temperature to refine the grain structure, and then the rims shall be quenched. Following quenching, the wheels shall be placed in a furnace for tempering to meet the requirements of table 1 or 1A, and subsequently cooled under controlled conditions.

6.6 Machining and correction of imbalance The conditions for machining shall be chosen so that the wheels comply with the requirements for surface quality and tolerances in 5.3 and clause 5 of JIS E 5402-2.

Unless otherwise specified, correction of imbalance shall be obtained by turning off the centre of the fillet between the web and the rim, on the flange side (see figure 3). The thickness of the metal removed shall not exceed 4 mm. The turned surface shall be fully blended into the adjacent surfaces and comply with the requirements for surface roughness in clause 5 of JIS E 5402-2.

Under no circumstances may additional weights be attached.

Drilling of holes for balancing is not permitted for wheels of tractive stock. Prior agreement by the purchaser shall be obtained if this method of balancing is to be used for wheels for trailing stock.

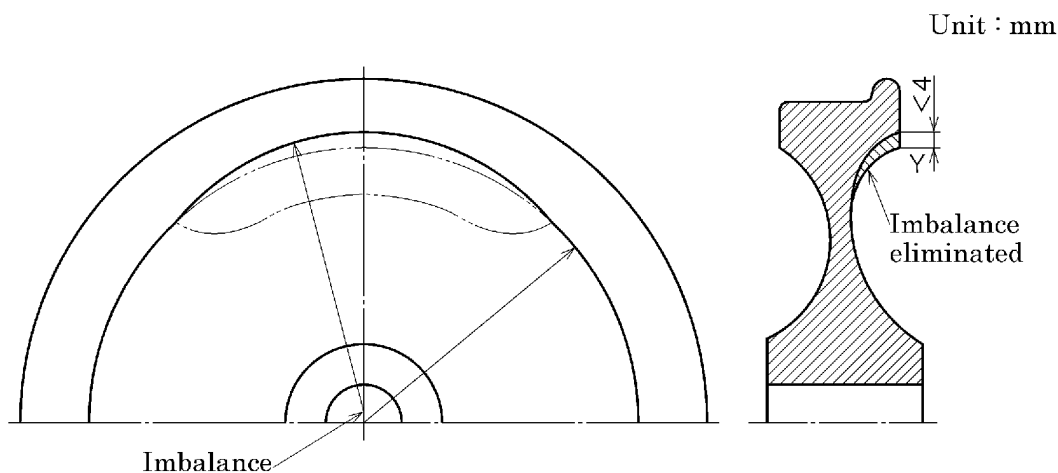


Figure 3 Example for correction of imbalance

6.7 Removal of surface defects

6.7.1 Authorized repairs With the exception of finished sections on which no re-touching is authorized, superficial defects may be eliminated prior to static balancing and shot peening by chipping or machining or by soft grinding, provided that no heat cracking is produced, that the dimensional tolerances are maintained, and that the dressed surface is carefully blended into the adjacent surfaces. Where necessary, it shall be ensured by appropriate means, for example by a magnetic particle test, that any defect is completely eliminated.