
International Standard



5003

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Flat bottom railway rails and special rail sections for switches and crossings of non-treated steel — Technical delivery requirements

Rails Vignole et profils spéciaux pour aiguillages en acier non traité pour chemins de fer — Spécifications techniques de livraison

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5003 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in August 1977.

It has been approved by the member bodies of the following countries :

Austria	Hungary	Romania
Belgium	India	South Africa, Rep. of
Brazil	Ireland	Spain
Bulgaria	Italy	Switzerland
Canada	Japan	Turkey
Chile	Korea, Dem. P. Rep. of	United Kingdom
Czechoslovakia	Mexico	USSR
Egypt, Arab Rep. of	Netherlands	Yugoslavia
France	Poland	
Germany, F. R.	Portugal	

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Australia
Sweden
USA

Flat bottom railway rails and special rail sections for switches and crossings of non-treated steel — Technical delivery requirements

1 Scope and field of application

This International Standard specifies the requirements for the quality and the conditions of acceptance for flat bottom railway rails and special rail sections for railway switches and crossings¹⁾. It applies to flat bottom rails of non-treated steel with a linear mass of 35 kg/m or more and to special sections used in association with these flat bottom rails.

NOTE — The purchaser's attention is drawn to the fact that an invitation to tender should normally be accompanied by a definition of the conditions of use and other relevant documents for carrying out the order, and in particular those concerning the application of the clauses in this specification.

2 References

ISO/R 79, *Brinell hardness test for steel*.

ISO 82, *Steel — Tensile testing*.

3 Conditions of manufacture

3.1 Steelmaking process

The steelmaking process shall be at the manufacturer's option. However, the purchaser may request the manufacturer to state, in his tender, the nature and principal characteristics of the process used; the manufacturer shall not alter these without informing the purchaser's representative.

3.2 Master templates and working gauges

The standard section of the rail and all master templates and working gauges required for particular tests shall be provided by the manufacturer, at his own expense, and shall be submitted, for approval, to the purchaser.

Before manufacture, the manufacturer shall submit two sets of master templates, male and female, conforming to the theoretical outline of the rail section to be manufactured, together with two sets of go and no go limit working gauges incorporating the tolerances on the specified dimensions. The master template and, if required, the working gauges shall be stamped after approval by the purchaser's representative. One set of the master templates and working gauges shall remain in the possession of the receiving inspector for the period of acceptance testing.

Only these master templates and working gauges shall be valid for checking purposes.

When the standard rail sections, the master templates and the working gauges have been approved by a purchaser, or by an outside testing agency, these shall be used for the requirements of other purchasers wherever possible.

3.3 Manufacture of the rails

Throughout the production process the manufacturer shall use the best techniques available so that the rails meet the requirements of this specification. Continuously cast blooms may be used in addition to blooms made from ingots.

Precautions shall be taken to avoid the occurrence of hydrogen flakes in steel grades which are susceptible to this defect.

If requested, the manufacturer shall inform the purchaser of the procedure used in order to avoid the presence of hydrogen flakes in rails of the grades of steel in question.

3.4 Marking

The marks on rails shall be as follows :

3.4.1 Obligatory marking

1) It does not apply, in particular, to grooved rails and check rails.

3.4.1.1 Branding

The brand marks shall be in relief and clearly legible. The height of the letters/characters, at the manufacturer's option, shall be at least 20 mm and with a relief of at least 0,5 mm on one side of the web.

- the identifying mark of the manufacturer's works;
- the last two digits of the year of manufacture.

3.4.1.2 Hot-stamped

a) For rails produced from ingots: the height of the characters at the manufacturer's option, shall be at least 15 mm, on one side of the web, where they shall appear at least once, near the end which corresponds to the top of the ingot, and in the order given below:

- the cast identification number;
- the letters A, B, ... Z, in order from the top of the ingot, Z being reserved for the bottom-end rail;
- the ingot number: 1, 2, 3,...

The top and bottom-end samples of rolled bars, for testing, shall be hot-stamped with the cast and ingot numbers and with the letters A or Z, according to whether the top or bottom end crop is implied.

b) For rails produced by continuously casting: the height of the characters at the manufacturer's option, shall be at least 15 mm, on one side of the web, on which they shall appear at least once, in a position to be agreed between the manufacturer and the purchaser (or his representative) and in accordance with a numerical, alphabetical or alphanumerical code from which the following information may be obtained:

- the number of the cast from which the rail was rolled;
- the position of the rail relative to the top of the bloom or continuously cast strand;
- all other positioning gauge marks of the rail in the cast as agreed between the manufacturer and the purchaser.

NOTE — In the event of any hot-stamp marks being removed through cropping, they shall be re-identified by agreement with the purchaser's representative.

3.4.2 Optional marking

3.4.2.1 Branding

The purchaser may specify in the invitation to tender, one or more of the following brand marks in relief:

- an arrow pointing in the direction of the ingot top or the top of the continuously cast strand;
- the number of the month of manufacture in roman numerals or in the corresponding vertical strokes;

— the symbol of the rail section or its mass per unit length, in kilograms per metre;

— the symbol of the steelmaking process in accordance with annex A;

— the symbol of the grade of steel in accordance with annex A.

Some optional relief markings may be replaced by hot-stamped markings by agreement between the manufacturer and the purchaser.

3.4.2.2 Cold stamping

After finishing, the marks specified in 3.4.1 shall be cold stamped on the end cross-section of all rails, at the end corresponding to the top of the ingot.

3.4.3 Identification

The manufacturer shall ensure that rails rolled from continuously cast material can be separately identified from rails produced from ingots. The method of such identification shall be the subject of agreement between the manufacturer and the purchaser.

For sequence continuous casting, the cast shall be considered as including all blooms up to, but excluding, the first bloom which is known to be entirely from the next cast.

3.5 Freedom from defects

The rails shall be free from all detrimental defects, internal and external, i.e. those having an unfavourable effect on the behaviour of the rails in service.

The manufacturer shall ensure the absence of harmful internal defects by control during manufacture. When agreed between the manufacturer and the purchaser, at the time of tender and order, continuous non-destructive testing, appropriate to the manufacturing process and the grade of steel, for example ultrasonic testing, shall be applied. This testing shall be carried out under the sole responsibility of the manufacturer.

The inspector may have surface defects tested by means of a chipping tool and shall decide whether such defects will have any adverse effect on the behaviour of the rail in service.

Any operation carried out, either in the hot or cold state with the object of hiding a defect, is strictly forbidden.

3.6 Finishing

In order to safeguard the intrinsic quality of the rails, cold straightening shall be effected by means of gradual pressure without impact. During straightening, the branding marks shall be protected from the action of the rolls.

The rails shall be cut to length when cold by means of milling or sawing, and the burrs shall be removed without perceptible bevelling of the section.

The holes shall be pierced by drilling, the sides being completely cylindrical and smooth, without burrs and with slightly bevelled edges.

If, for normal operations, and by agreement between the manufacturer and the purchaser, different but equivalent gauges to those given in annexes B to F are used, only the latter shall be used in case of dispute.

3.7 Tolerances

3.7.1 Dimensional tolerances

The methods and means for checking of tolerances for principal dimensions are given in table 1.

3.7.1.1 Rail section

The tolerance values shown in table 1 are for guidance only; they may be modified by agreement between the purchaser and the manufacturer.

Table 1 – Principal dimensions

Values in millimetres

Characteristic		Dimension	Tolerance	Checking methods in accordance with annex
1	Height (<i>H</i>) of rail (measured at the end) ¹⁾	$H < 165$	± 0,5	B
		$165 \leq H < 180$	± 0,7	
		$180 \leq H < 190$	± 0,8	
		$190 \leq H$	± 1,0	
2	Width of flange (<i>L</i>)	$L < 138$	± 1	C
		$138 \leq L < 150$	± 1,1	
		$150 \leq L < 160$	+ 1,1	
		$160 \leq L < 170$	- 1,3	
		$170 \leq L$	± 1,5	
3	Nominal width of rail head (taken at base of gauge corner radius)	$C < 72$	± 0,5	D
		$72 \leq C < 74$	± 0,6	
		$74 \leq C$	± 0,8	
4	Asymmetry (<i>X</i>) of the section ²⁾	$L < 150$	± 1,3	E
		$150 \leq L < 160$	± 1,5	
		$160 \leq L < 170$	± 1,7	
		$170 \leq L$	± 2	
5	Profile of the fishing chamber (except for rails for completely welded tracks) ²⁾	$H < 165$	± 0,5	F
		$165 \leq H < 180$	± 0,7	
		$180 \leq H < 190$	± 0,8	
		$190 \leq H$	± 1	

1) The height of the rail is the distance between the lower face of the flange and the tangent to the rail head parallel to this face.

2) In the case of asymmetric sections, points 4 and 5 should be the subject of a particular agreement concerning the referee gauges.

NOTE – In the case of high speed tracks, the question of tolerances shall be the subject of special agreement between the purchasing railway and the manufacturer.

Table 2 – Supplementary tolerances for defining working gauges and templates

Characteristic	Tolerance
Thickness of web	+1 - 0,5 mm
Inclination of the fishing surfaces*	± 3,6 %
Other dimensions	same tolerance <i>H</i>

* In the event of dispute, for those rails where the section has plane fishing surfaces, it is mandatory to use the gauge given in annex F for checking the inclination of those surfaces; the gauge is also used for checking the height of the fishing chamber.

3.7.1.2 Length of rails

The length tolerances, being dependent upon the track-laying method used, shall be subject to agreement between the purchaser and the manufacturer. The tolerances for flat bottom rails shall, however, be within the following ranges :

a) Minimum :

Length of rails

- up to and including 18 m : ± 2 mm
- above 18 and up to and including 24 m : ± 3 mm
- above 24 and up to and including 36 m for fish plated track : ± 4 mm
- above 24 and up to and including 36 m for welded track : ± 6 mm
- above 36 m : to be agreed

b) Maximum : ± 25 mm

3.7.1.3 End squareness

Table 3 — End squareness

Values in millimetres

In the vertical axis	$H < 180$	0,6
	$180 \leq H < 190$	0,7
	$190 \leq H$	0,8
In the horizontal direction	$L < 150$	0,5
	$150 \leq L < 160$	0,6
	$160 \leq L < 170$	0,7
	$170 \leq L$	0,8

3.7.1.4 Diameter of holes

Table 4 — Diameter of holes

$\phi \leq 30$ mm	$\phi > 30$ mm
$\pm 0,5$ mm	$\pm 0,7$ mm

3.7.1.5 Position of the centre of the holes relative to the end of the rail and the base of the flange

Table 5 — Position of holes

$\phi \leq 30$ mm	$\phi > 30$ mm
$\pm 0,5$ mm	$\pm 0,7$ mm

In case of dispute the diameters and position of the fishing holes shall be checked with gauges of the type given in annexes G and H.

3.7.2 Straightness tolerance

If the purchaser so requests, the straightness of the ends shall be checked with a straight-edge of length 1,5 m in accordance with annex J :

a) In the vertical plane

When the deviation has the effect of raising the end, the maximum lift permitted is 0,8 mm.

When the deviation has the effect of lowering the end, the maximum dip permitted is 0,8 mm.

b) In the horizontal plane, the maximum permitted deviation is 0,8 mm.

In all cases the maximum deviation shall be as far away from the ends as possible.

Between the two ends the straightness shall be judged by eye.

For welded track, the tolerance on straightness shall be agreed between the purchaser and the manufacturer.

Rails showing a deflection in excess of any of the tolerances indicated above may be straightened by means of a press and then re-checked.

4 Conditions of acceptance

4.1 Supervision

The purchaser's representative shall be entitled to observe, at all reasonable times, the method of manufacture, to be present at all the tests relating to the casts intended for his railway and to examine the results obtained from such tests.

He shall be entitled to carry out all necessary checks to ensure that the manufacture is strictly in accordance with the stipulated conditions.

The supervision shall be carried out in such a way as not to interfere with the operation of the works.

The manufacturer shall be bound to advise the purchaser, at least 5 days in advance, of his plans for rolling. This period shall be increased to 15 days if the supply is intended for a railway not belonging to the country of manufacture.

4.2 Submission for acceptance

In the case of ingots, the purchaser (or his representative) shall indicate, prior to rolling, those ingots from which samples are to be taken for acceptance testing in accordance with the previously agreed number of tests. These samples shall be grouped according to cast and shall remain available until completion of the acceptance testing operations of the rails from the corresponding casts.

In the case of continuously cast material, the manufacturer shall advise the purchaser (or his representative) of the positions in the casts and strands from which test samples have been taken.

The acceptance procedures shall not interfere with the normal operation of the works.

If a cast is rolled in several batches, the tests carried out on the part of the cast rolled first may be considered as valid for the remainder of the cast provided that this is agreed between the purchaser and the manufacturer.

4.3 Type of tests

Apart from the surface inspection to which the rails shall be subjected, their quality shall be ascertained by various tests as follows :

Table 6 – Tests

Mandatory tests	Optional tests, as agreed between purchaser and manufacturer
Chemical analysis	Macroscopic or "nick and break"
Tensile test*	Falling weight

* If required, a Brinell hardness test, for information only.

In the case of ingots, the tensile test shall be made on the bottom end sample, unless otherwise agreed.

In the case of continuous casting, the choice of sampling location in the cast and in the strand is at the manufacturer's option. The location of the test specimens may, however, be specified by the purchaser in agreement with the manufacturer.

The initial test pieces and re-test pieces shall not be selected from known "overlap" or "changeover" material, where sequence continuous casting is involved. Tests shall only be taken from "overlap" or "changeover" material in order to verify this material, if an adjoining cast or part cast has been withdrawn because it failed to meet the specification.

The methods of testing and the conditions under which the tests are carried out, in so far as they are not defined by this International Standard, shall correspond to the standards in force in the country of manufacture.

4.4 Test samples

The samples selected in accordance with 4.2 and 4.3 intended for the preparation of test pieces shall be marked and stamped under the supervision of the purchaser's representative.

If, during the preparation of the test pieces, any marks or stamps have been removed, they shall be replaced on the actual test pieces under control of this representative.

The test pieces shall be machined in the cold state and shall not be subjected to any hammering operation or cold deformation or hardening or annealing.

The relative position of the samples for various tests in the rolled ingot is indicated in figure 1.

4.5 Chemical analysis

4.5.1 Type of tests

The results of the ladle analysis carried out, by the manufacturer for each cast, shall be submitted to the receiving inspector to enable him to verify that the composition of the steel conforms to that shown in table 7 in 4.5.3.

The receiving inspector shall be present, whenever he considers it necessary, at these analyses carried out by the manufacturer.

If the purchaser considers it necessary to carry out check analyses, the necessary samples shall be taken, in the presence of the inspector, from the ladle samples selected by the latter and, having been suitably provided with all necessary marks for their identification, sent without delay to a laboratory in the country of manufacture or, if so stipulated in the invitation to tender, to a laboratory agreed upon by both parties.

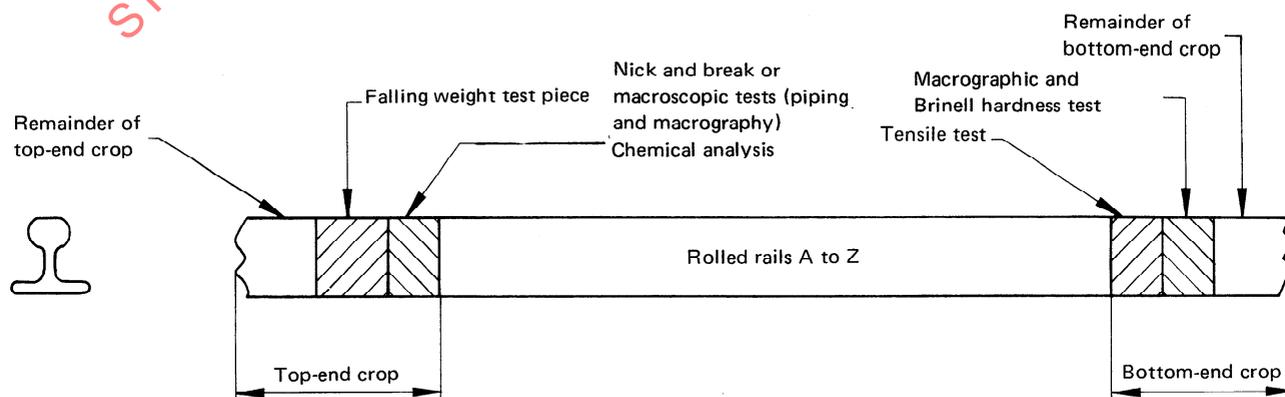


Figure 1 – Location of samples

4.5.2 Extent of tests

The manufacturer shall provide a certificate giving the chemical composition, on ladle samples, of every cast forming part of the order to be tested. These analyses shall include the percentages of carbon, manganese, silicon, phosphorus and sulphur.

The number of ladle samples to be analysed is as follows :

- 1 per cast for casts of ≤ 150 t;
- 2 per cast corresponding to the beginning and the end of the cast for casts > 150 t. This number may be reduced to 1, if agreed between the manufacturer and the purchaser.

The purchaser shall reserve the right to check, whenever he considers it necessary, the chemical composition in the ratio of one analysis per batch of 20 casts for casts ≤ 150 t and one analysis per batch of 10 casts for casts > 150 t.

4.5.3 Results to be obtained

The chemical composition of the steel, together with the limits of C, Mn, Si, P and S, shall be as given in table 7.

The chemical analyses are carried out on ladle samples.

4.5.4 Re-tests

When it is established, after verification, that a result of a check ladle analysis differs from the specified requirements, two new check analyses shall be carried out, by an approved laboratory; these shall be made on two whole cross-section cuts from the top end of two different rail bars, originating in the cast or part cast corresponding to the ladle sample checked.

If the results of these two new analyses are in agreement with the values given in table 8 the cast or part cast is acceptable.

Otherwise, the cast or part cast is rejected. In addition, the purchaser shall reserve the right to carry out further new check analyses on ladle samples belonging to the same batch of 20 or respectively 10 casts (see 4.5.2) at the cast or part cast rejected. If the results of these analyses come within the specified requirements, the corresponding casts are accepted. Otherwise, the procedure described in the first and second paragraphs above applies.

For sequence continuous castings, if a cast fails to meet the requirements of this International Standard, then the "overlap" or "changeover" material at the end of the previous cast shall be either rejected or subjected to a re-test.

Table 7 – Chemical composition and mechanical properties

Quality		Chemical composition				Mechanical properties**		
		C %	Mn %	Si %	P max. %	S max. %	R_m min. N/mm ²	A %***
1	A	0,50 to 0,70	0,60 to 1,00	0,07 to 0,35	0,05	0,05	680	10 for 5d
	B	0,40 to 0,60	0,80 to 1,25	0,05 to 0,35	0,05	0,05		14 for 5d
2	A	0,62 to 0,82	0,60 to 1,10	0,10 to 0,35	0,05	0,05	780	9 for 5d
	B	0,50 to 0,70	0,95 to 1,25	0,10 to 0,35	0,05	0,05		12 for 5d
3	A	0,60 to 0,80	0,80 to 1,30	0,10 to 0,50	0,05	0,05	880	8 for 5d
	B	0,55 to 0,75	1,30 to 1,70	0,10 to 0,50	0,05	0,05		10 for 5d

* Minor modifications in chemical composition may be agreed between the manufacturer and the purchaser to achieve the specified minimum mechanical properties for the rail section ordered and the manufacturing process used.

** These values apply, unless otherwise agreed, as specified in 4.3.

*** These elongation values apply when the test is carried out

- a) either more than 48 h after machining of the test piece; or
- b) after an effusion treatment of the test piece agreed between the manufacturer and the purchaser. In this case it is recommended that the treatment be carried out at a temperature of 100 °C for 1 h.

However, these elongation values may be modified by agreement between the manufacturer and the purchaser when the sampling and test conditions are different from those specified in this International Standard.

Table 8 – Chemical composition (re-test)

Quality		C	Mn	Si	P max.	S max.
		%	%	%	%	%
1	A	0,47 to 0,73	0,55 to 1,05	0,04 to 0,38	0,06	0,06
	B	0,37 to 0,63	0,75 to 1,30	0,04 to 0,38	0,06	0,06
2	A	0,59 to 0,85	0,55 to 1,15	0,07 to 0,38	0,06	0,06
	B	0,47 to 0,73	0,90 to 1,30	0,07 to 0,38	0,06	0,06
3	A	0,57 to 0,83	0,75 to 1,35	0,07 to 0,53	0,06	0,06
	B	0,52 to 0,78	1,25 to 1,75	0,07 to 0,53	0,06	0,06

4.6 Falling weight test

4.6.1 Type of tests

This test is carried out on a short length of unnotched rail by means of a guided falling weight with the following characteristics :

- mass of falling weight : normally 1 000 kg; this mass may vary in accordance with formula (1);
- height of drop : measured from the top level of the rail-head and varying in accordance with formula (1);
- rail test piece : 1 300 mm minimum length, its base resting simply on two bearers;
- distance between bearers : 1 000 mm from centre-line to centre-line.

The guides shall be rigid, level and vertical and so arranged as to ensure that friction during the fall of the weight is reduced to a minimum.

The falling weight shall be symmetrical in mass and shape about the plane of the guides; its centre of gravity shall be as low as possible in this plane, and vertically exactly central between the two guides.

The release gear shall not cause any sideways movement of the falling weight when it is set in motion.

The striking face of the weight shall be curved as part of a cylinder with its axis horizontal, in the plane of the guides and its shape shall be as indicated in figure 2.

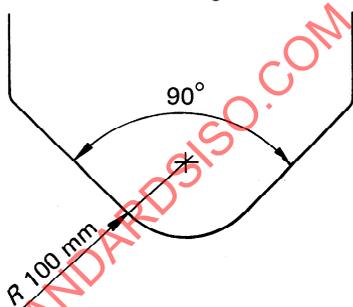


Figure 2 — Shape of striking face

The mass of the metal anvil block shall be not less than 10 000 kg and its supporting base shall be sufficiently rigid. The bearers designed to receive the test piece shall be firmly fixed to the anvil block and shall be shaped as indicated in figure 3.

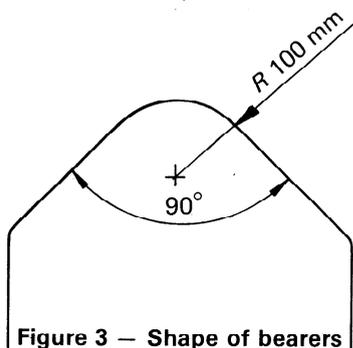


Figure 3 — Shape of bearers

The striking face of the falling weight and the upper part of the bearers shall be trued-up or replaced as soon as they become distorted.

For this test, the test piece shall be at ambient temperature but in any case above 10 °C.

A single blow is used. For Vignole rails, the height of fall H (expressed in metres) varies with the mass per unit length of the rail M_r (expressed in kilograms per metre) and the mass of the falling weight M_m (expressed in kilograms) according to the formula

$$H \times M_m = 150 M_r$$

For special profiles for switches, the height of fall of the falling weight is defined by the formula

$$H = 0,24 \frac{I_x}{V^2}$$

where

H is the height of fall, expressed in metres;

I_x is the moment of inertia about the horizontal axis x passing through the neutral fibre, expressed in centimetres to the fourth power;

V is the distance between the neutral axis and the furthest fibre, expressed in centimetres.

NOTE — If the height calculated as above is incompatible with the available equipment, the mass of the falling weight should be increased.

4.6.2 Extent of tests

On test per cast shall be carried out on a falling weight test piece taken as specified in 4.2, 4.3 and 4.4.

By agreement between the manufacturer and purchaser, the frequency of tests may be increased with a maximum of one test per 50 t sampled from different ingots or strands.

4.6.3 Results to be obtained

The test pieces shall withstand, without fracture or cracking, the specified test.

The deflection obtained may be recorded for information.

4.6.4 Re-tests

If a falling weight test gives an unsatisfactory result, the procedure is as follows :

4.6.4.1 In the case of ingots

4.6.4.1.1 Re-tests shall be carried out :

- a) on a short piece cut from the same rail at a distance from the first test piece corresponding to at least 300 kg of metal;

b) on two test pieces, both of them taken, at the manufacturer's option, either from the top end samples or the top of the A rails originating from the two ingots adjacent to the ingot from which the unsatisfactory test result stems. In the case of bottom poured ingots these two ingots shall be from the same bottom poured group.

4.6.4.1.2 If all re-tests are satisfactory, the remainder of the ingot and the cast shall be accepted.

4.6.4.1.3 If the re-test specified in 4.6.4.1.1 a) is a satisfactory, the remainder of the corresponding ingot shall be accepted.

4.6.4.1.4 If only the re-test specified in 4.6.4.1.1 a) is unsatisfactory, a re-test shall be made on a test piece from the same ingot cut out at a distance from the previous test piece corresponding to at least 300 kg of metal. This second re-test shall give the specified results, otherwise all the rails from this ingot shall be rejected, the remainder of the cast being accepted.

4.6.4.1.5 If one or both of the re-tests specified in 4.6.4.1.1 b) is/are unsatisfactory, the following procedure shall be carried out :

a) In the case of top poured ingots each ingot shall be tested, and in the case of unsatisfactory results the corresponding ingots shall be re-tested in accordance with the procedure specified in 4.6.4.1.1 a) and 4.6.4.1.4;

b) In the case of bottom poured ingots one ingot of each bottom poured group shall be tested, and in the case of an unsatisfactory result all ingots shall be tested and any ingot giving unsatisfactory results shall be re-tested in accordance with the procedure specified in 4.6.4.1.1 a) and 4.6.4.1.4.

4.6.4.2 In the case of continuous casting

In the event of failure of a falling weight test on continuously cast material, two further samples taken from the same strand shall be tested. These samples shall be taken one from each side of the original sample at positions decided by the manufacturer. At least one of the two re-tests shall be made on the

same bloom as that which failed the test, and material from between the two re-test positions shall be rejected. If both re-tests are satisfactory then all remaining rails from the strand of that cast shall be accepted.

In the event of failure of one or both re-tests, the reason for failure may be investigated by the manufacturer. When the reasons for failure are established to the satisfaction of the purchaser (or his representative) further re-tests may be carried out by agreement between the manufacturer and the purchaser for acceptance of the remainder of the material.

NOTE — If a manufacturer does not have the necessary equipment available for carrying out a falling weight test under conditions specified in this International Standard, the test may be replaced by another falling weight test suitable for his own equipment and the conditions of which have been agreed with the purchaser.

4.7 Tensile tests

4.7.1 Type of test

The tensile test pieces shall be cut when cold and have their centres at a point 0 situated at 1/4 of the width and in the upper 2/5 of the height of the rail-head as shown in figure 4.

They shall be cylindrical in shape of a diameter of 10 mm, i.e. a cross-section of 78,5 mm². The gauge length shall be 50 mm and the calibrated portion between 60 and 70 mm.

The tensile test shall be carried out in accordance with ISO 82.

The following shall be recorded for each test piece :

- the breaking load;
- the elongation after fracture.

4.7.2 Extent of tests

For casts greater than 50 t, one test per cast shall be made unless otherwise agreed.

For casts of 50 t, or less, one test per four casts shall be made; a Brinell hardness test shall be carried out on the remaining three casts.

$$\alpha = \frac{1}{4} \text{ of width}$$

$$\beta = \frac{2}{5} \gamma$$

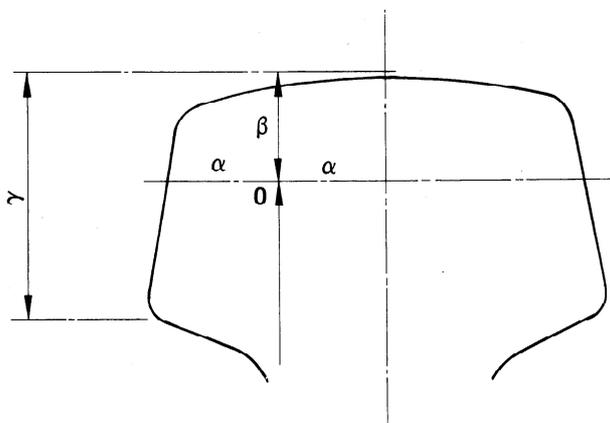


Figure 4 — Location of tensile test pieces

4.7.3 Results to be obtained

The results to be obtained shall be in accordance with table 7 in 4.5.3.

4.7.4 Re-tests

4.7.4.1 In the case of ingots

In the event of a test failure, two further re-tests shall be made on samples selected at the discretion of the manufacturer, from the bottom end crop of two other Z rails from the same cast, unless otherwise agreed between the manufacturer and purchaser.

If any one of the tests is not satisfactory, the Z rails of the cast shall be rejected; the receiving inspector shall then select two or these Z rails and take from the top end of each a further tensile test piece. If the result of the tensile test on either of these test pieces is unsatisfactory, the cast shall be rejected.

When the tensile test is made on a single cast per batch of four, and if this test is not satisfactory, a test shall be made, under the same conditions on each of three other casts of the batch. The above re-test procedure shall apply to any cast for which the tensile test is unsatisfactory.

4.7.4.2 In the case of continuously cast material

In the event of an unsatisfactory result from the initial tensile test on continuously cast rails, then two re-tests may be made. The first re-test shall be made on rails from the same strand, and the second re-test on rails from another strand of the same cast.

The re-tests shall not be made on rails rolled from changeover blooms of sequence continuous casting.

If the two re-tests are satisfactory the cast shall be accepted.

In the event of failure of one or both re-tests, the reasons for failure may be investigated by the manufacturer. When the reason for failure is established to the satisfaction of the purchaser (or his representative) then further re-tests may be carried out by agreement between the manufacturer and the purchaser for acceptance of the remainder of the material.

4.8 Macroscopic test

4.8.1 Type of test

The tests consist of :

- a) an examination with the naked eye, of the cleaned surface cut from the top-end crop, in order to detect the existence of any shrinkage cavity;
- b) the taking of a sulphur print (Baumann method) by the application, to the cleaned surfaces of the top and bottom-end crops, of bromide or POP paper, previously impregnated with a solution of sulphuric acid.

The sections intended to be used for these tests shall be cold-sawn from the top and bottom-end crops, in accordance with the inspector's instructions. They shall then be sufficiently cleaned on one surface to obtain a sharp impression.

In the case of continuous casting, the sampling position within each strand and cast shall be at the manufacturer's option. However, the position of the test pieces may be specified by the purchaser, in agreement with the manufacturer.

The initial and re-test pieces shall not be selected from known "overlap" or "changeover" zones, when sequence casting is involved. Tests shall only be made in these zones if all or part of the adjoining cast has been rejected because it failed to meet the requirements of this International Standard.

4.8.2 Extent of tests

If the macrographic test is required, the purchaser shall indicate, in the invitation to tender, the number of macroscopic tests to be carried out; this number shall be a minimum of one at the top end per 500 t of metal and a maximum of one at the top end and one at the bottom end per 100 t.

When the casts are bottom-poured, no macrographic tests are carried out on bottom-end crops.

For continuously cast material the maximum is two tests per cast.

4.8.3 Results to be obtained

4.8.3.1 The examination of the cleaned face of the cross-section shall not reveal any open cavities.

4.8.3.2 The prints obtained shall not reveal defects more marked than those of the standard diagrams shown in (or equivalent to those shown in) the album attached to this standard (annex K).

Experience shows that despite the method of working laid down in 4.8.1 b) for obtaining sulphur prints, the latter vary in intensity of colour, which cannot, therefore, be regarded as a firm criterion. Only contrasts appearing on the same print can be regarded as of value. With regard to prints with central segregation, the prints in figures 14 and 15 may be considered together, particularly as regards the width and the length of segregation areas. This applies particularly in the case of prints with inverse segregation, as in figures 16 and 17. The print in figure 18 for sub-surface blowhole indications should be interpreted from a qualitative point of view, without relying completely on the actual number of sub-surface blowholes.

Sulphur prints (Baumann type) from rails rolled from continuously cast material appear to give different indications from those from conventional rails. Until an album of standard diagrams is established for rails rolled from continuously cast material, the permissible deviations from the existing standard diagrams for rails from ingots shall be the subject of negotiation between the manufacturer and the purchaser (or his representative).

4.8.4 Re-tests

4.8.4.1 Piping

4.8.4.1.1 In the case of ingots

If the examination of the cleaned surface of a section reveals the existence of a cavity, a check-test shall be carried out, at the inspection bank, on the ends of the rails in question.

If this examination does not reveal cavities, the rail is accepted; if a cavity is revealed, a top-end piece of the "A" rail in question shall be rejected, corresponding to at least 300 kg of metal, and a re-test shall be carried out on the top-end section of A rails from two other ingots of the same cast selected by the inspector.

If both re-tests are satisfactory, the A rails of the cast are accepted. Otherwise, a visual examination shall be made, at the inspection bank, on the ends of all A rails in the cast and the rails showing any cavity shall be rejected.

4.8.4.1.2 In the case of continuously cast material, in the event of failure of a macroscopic examination on continuously cast material carried out as in 4.8.3.1, two further samples taken from the same strand shall be tested. These samples shall be taken one from each side of the original samples at positions decided by the manufacturer. At least one of the two re-tests shall be taken from the same bloom as the failed test and material from between the two re-test positions shall be rejected. If both re-tests are satisfactory then all remaining rails from that strand of the cast shall be accepted.

In the event of failure of one or both re-tests, the reason for failure may be investigated by the manufacturer. When the reason for failure is established to the satisfaction of the purchaser (or his representative) further re-tests may be carried out by agreement between the manufacturer and the purchaser for acceptance of the remainder of the material.

4.8.4.2 Sulphur prints

4.8.4.2.1 In the case of ingots

When a top-end or bottom-end print is unsatisfactory, a length of the rail in question (top-end or bottom-end as appropriate), corresponding to at least 300 kg of metal shall be rejected and a re-test shall be carried out on the top end section of the A rail or the bottom-end section of the Z rail of two other ingots selected by the inspector from the same cast.

If the two re-tests are satisfactory, the A or Z rails (as the case may be) from that cast shall be accepted. Otherwise, a length corresponding to 300 kg of metal shall be rejected from each of these A or Z rail bars. In the latter case, two new re-tests shall be carried out on the new top-end section of the A rail bar or the bottom-end section of the Z rail bar (as the case may be), of any two other ingots selected by the inspector from the same cast. The two re-tests shall be satisfactory, otherwise all the rails from that cast shall be entirely rejected.

However, the manufacturer may propose to the purchaser that a macrographic test at the top end or bottom end, as appropriate, be carried out on each ingot.

4.8.4.2.2 In the case of continuously cast material

In the event of an unsatisfactory result from the initial macroscopic examination carried out as in 4.8.3.2 then two re-tests may be carried out. The first re-test shall be made on rails of the same strand and the second re-test on rails from another strand of the same cast.

Re-tests shall not be made on rails rolled from changeover blooms from a sequence continuous cast.

If both re-tests are satisfactory, the cast shall be accepted.

In the event of failure of one or both re-tests the reason for failure may be investigated by the manufacturer. When the reason for failure is established to the satisfaction of the purchaser (or his representative) then further re-tests may be carried out by agreement between the manufacturer and the purchaser for acceptance of the remainder of the material.

4.9 Nick and break test

If this test is required, the following procedure shall be applied :

4.9.1 Type of tests

A short length of rail may be taken in the hot condition. The sample shall be allowed either to air cool completely, or air cool to approximately 600 °C (i.e. below the lower transformation point) and then rapidly cooled. Alternatively the test sample may be obtained from a cold rail.

In order to break the test sample, a sharp notch shall be made in the centre of the test sample; with a suitable press or impact testing machine, a force shall then be applied, with the notch on the tension side.

4.9.2 Extent of tests

4.9.2.1 In the case of ingots

A minimum of one test for every 500 t shall be carried out, with a maximum of one test per 50 t. The test sample shall be taken from the position specified in 4.4.

4.9.2.2 In the case of continuously cast material

The test frequency shall be as for ingot material, and the sample position as given in 4.3 for continuously cast material.

4.9.3 Results to be obtained

The fractured cross-section of the rail sample shall be visually examined. The fracture shall not show any laminations, filiform piping, cavities or gross non-metallic inclusions.

4.9.4 Re-tests

4.9.4.1 In the case of ingots

If a nick and break test shows unsatisfactory results, then the top end piece of the ingot in question, corresponding to at least 300 kg of metal, shall be rejected and a further test carried out on this rail. In addition, re-tests shall be carried out on the top end section of A rails from two other ingots of the same cast or part cast represented by the original sample.

If all these re-tests are satisfactory, then all A rails of the cast or part cast shall be accepted.

If any one of these re-tests is unsatisfactory, then the top ends of all A rails in the cast, or part cast, represented by the original sample, shall be re-tested and, if necessary, shall be broken at intervals of at least 300 kg of metal, until satisfactory results are obtained.

4.9.4.2 In the case of continuously cast material

If a nick and break test shows unsatisfactory results, then two further samples, taken from the same strand as the original sample, shall be tested. These check samples shall be taken one from each side of the original test sample, at positions decided upon by the manufacturer. At least one of the two re-tests shall be made on the same bloom as that which has failed the test and material from between the two re-test positions shall be rejected. If both re-tests are satisfactory then all remaining rails from that strand shall be accepted.

In the event of failure of one or both re-tests, the reasons for failure may be investigated by the manufacturer. When the reasons for failure are established to the satisfaction of the purchaser (or his representative), further re-tests may be carried out by agreement between the manufacturer and the purchaser, for acceptance of the remainder of the material.

4.10 Brinell hardness test

4.10.1 Type of test

If a Brinell hardness test is required, an impression shall be made on the crown of a test sample cut as indicated in 4.4. The test shall be carried out in accordance with ISO/R 79.

The test conditions shall be as follows :

- ball diameter : 10 mm
- load : 3 000 kg
- period of application : 15 s

4.10.2 Extent of tests

One test per cast; possibly on the test pieces which have been used for the macroscopic tests.

Where a tensile test has to be carried out for each cast in accordance with 4.7.2, it is unnecessary to stipulate the Brinell hardness test for these casts.

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Annex A

Marking

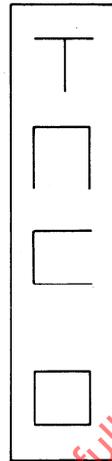
A.1 Symbols of steelmaking processes

Thomas process

Basic Siemens-Martin process

Electric arc process

Basic oxygen process

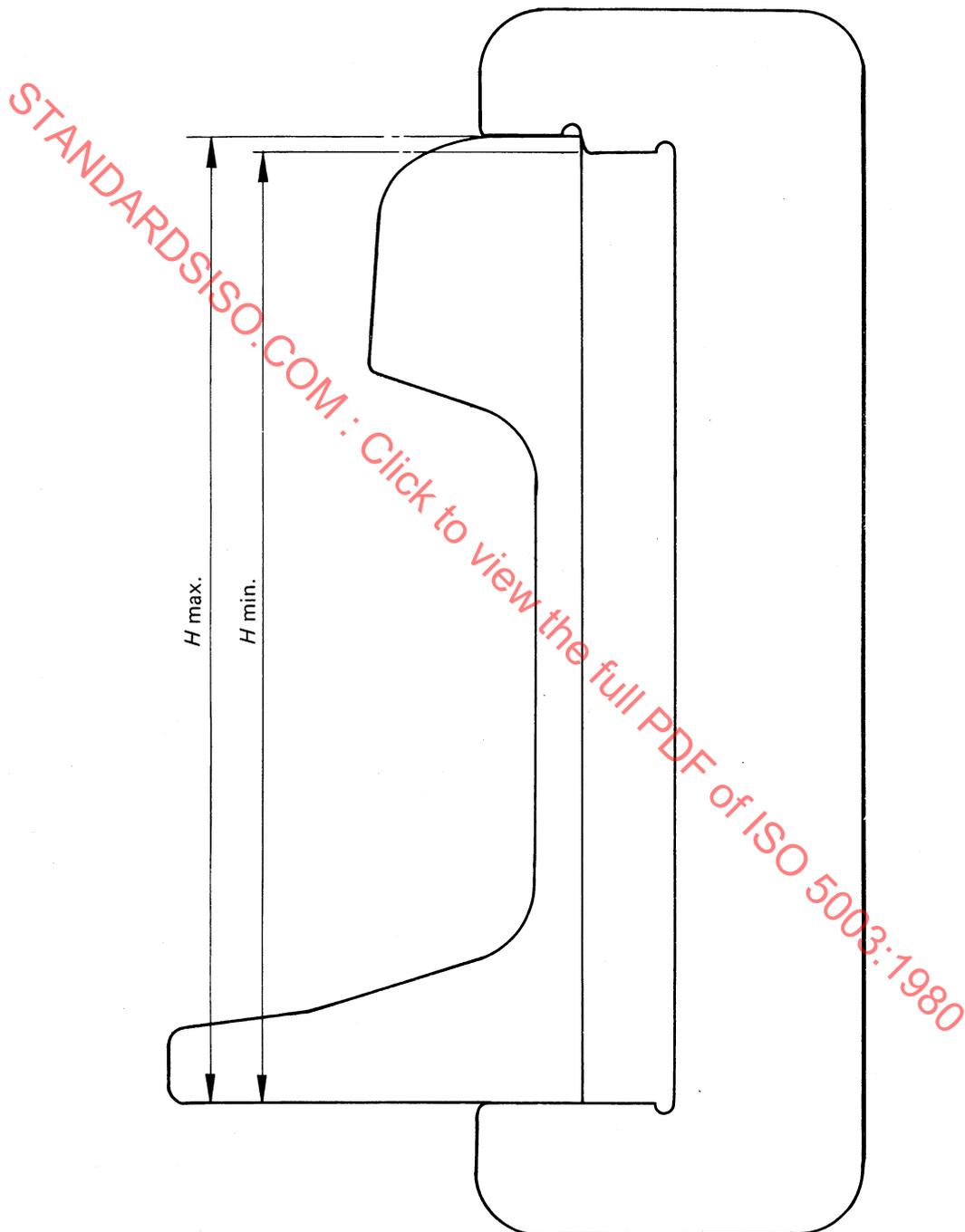


A.2 Steel grade symbols

Qualities	Symbols
1 A B	} No symbol
2 A B	} _____
3 A B	} _____ _____

Annex B

Referee gauge for height

Figure 5 — Referee gauge for height (H)

NOTE — This gauge shall be made from wear-resistant material.

Annex C

Referee gauge for flange width

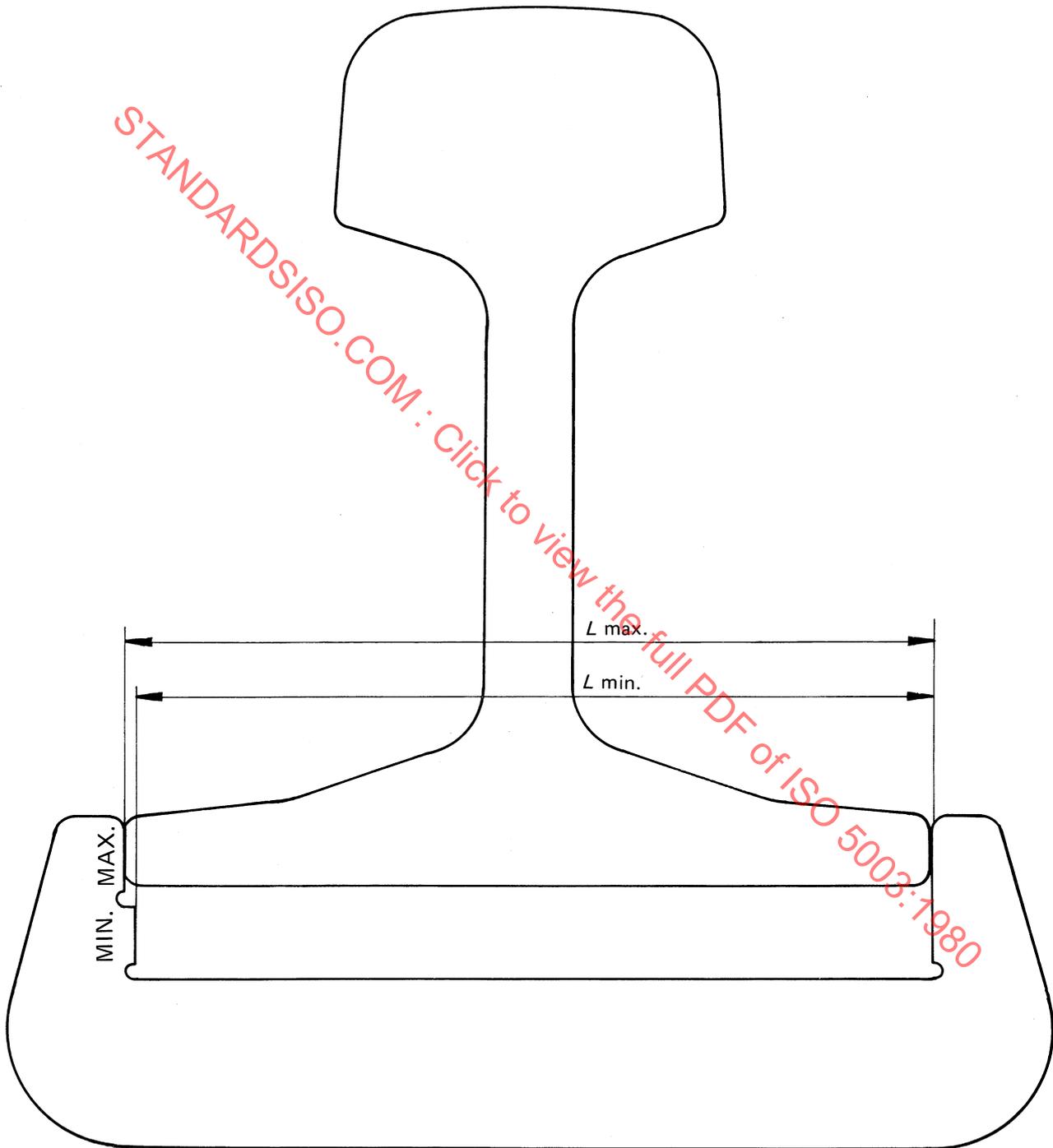


Figure 6 — Referee gauge for flange width (L)

NOTE — This gauge shall be made from wear-resistant material.

Annex D

Referee gauge for nominal width of head

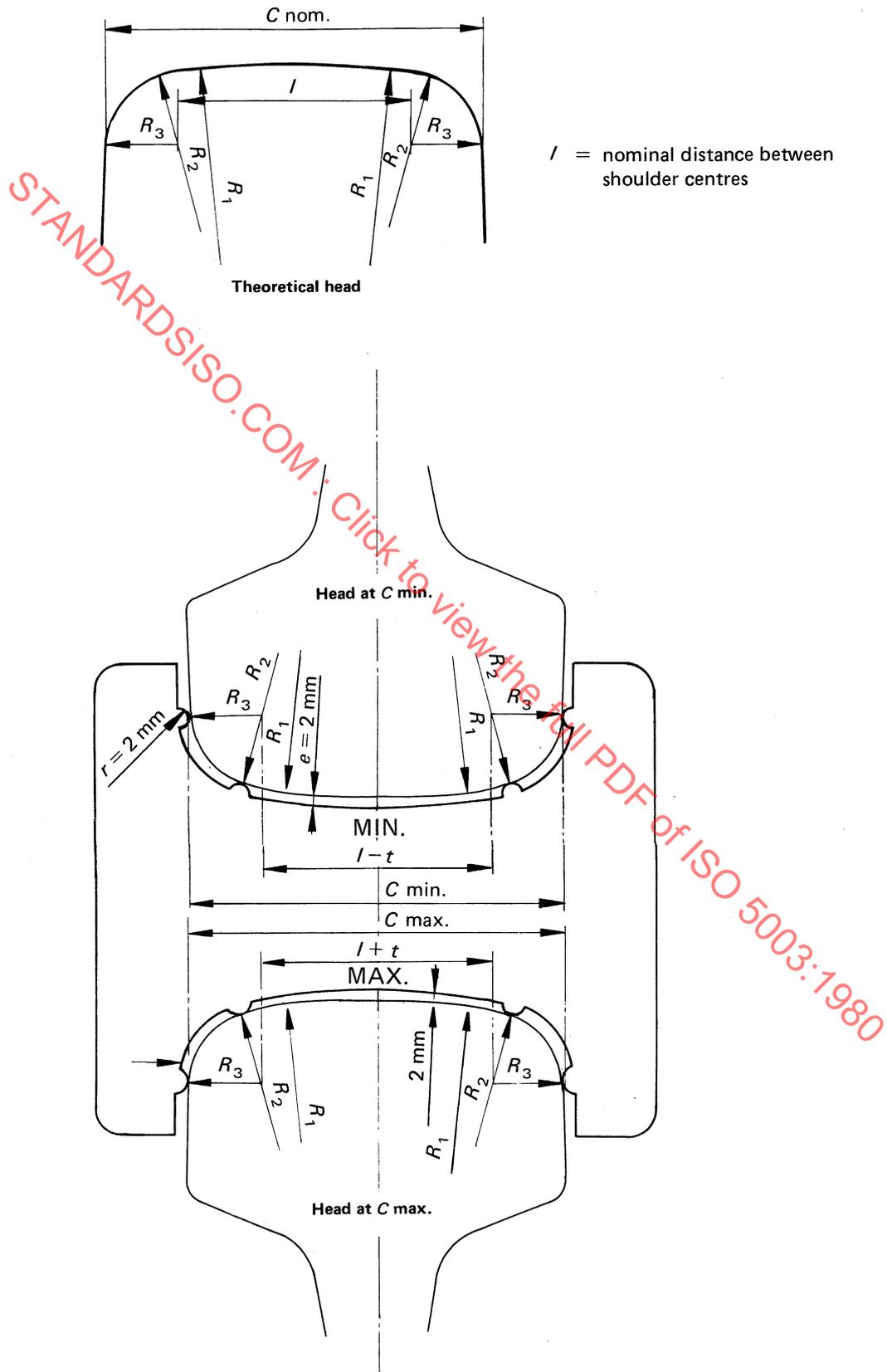
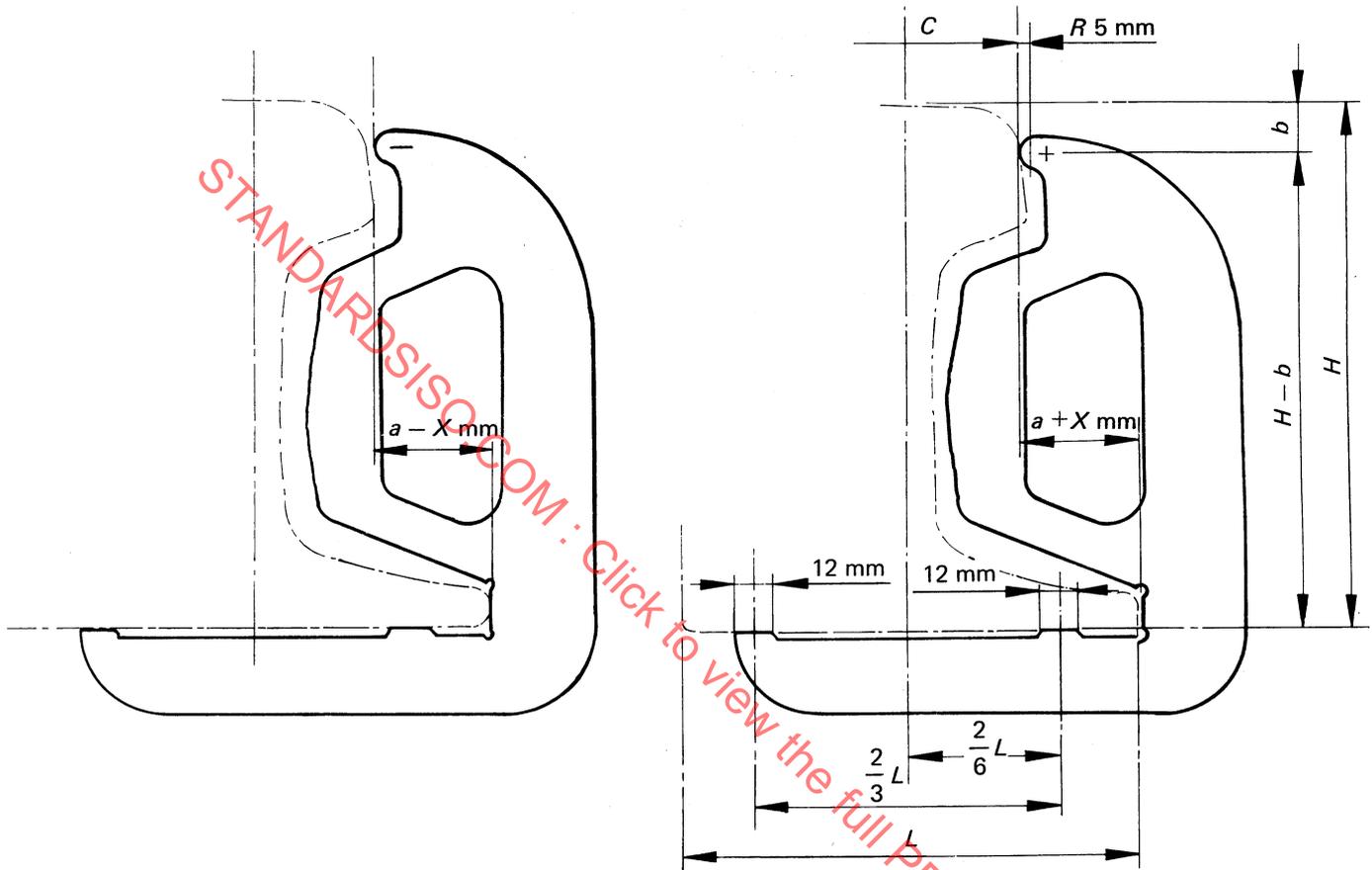


Figure 7 – Referee gauge for nominal width of head

Annex E

Referee gauge for asymmetry



- The gauge (-) applied against the flange bottom is pushed sideways towards the rail
- The stop (-) shall not touch the head

- The gauge (+) applied against the flange bottom is pushed sideways towards the rail
- The stop (+) shall touch the head

H : height of rail

L : width of flange

C : nominal width of head

a : distance between the right-angle projections on the flange bottom, from its end, and from the bottom of the gauge corner radius of the head crown :

$$a = \frac{L - C}{2}$$

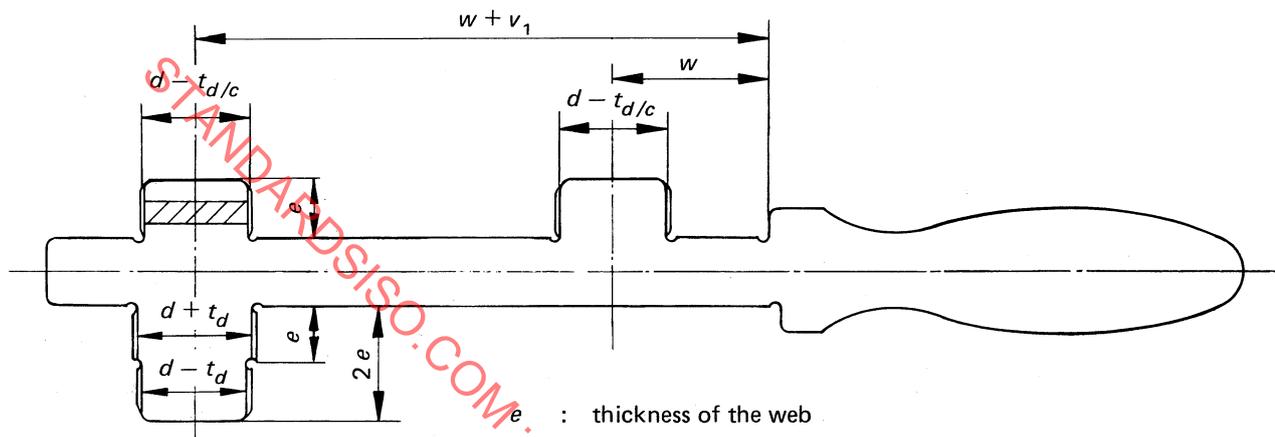
X : asymmetry depends on the section, according to the general table of tolerances, see table 1, item 4

b : height in relation to the top of the rail, from the bottom of the gauge corner radius of the head crown (in making the template $H - b$ may be rounded off to the nearest millimetre)

Figure 8 — Referee gauge for asymmetry

Annex G

Referee gauge for distance between holes and railend, and hole diameter



- e : thickness of the web
 - t_d : tolerance for diameter of holes
 - t_c : tolerance for centring and positioning of holes
 - $t_{d/c}$: combined tolerance for diameter of holes and centring of holes horizontally
- $$t_{d/c} = (t_c + t_d/2) \times 2$$

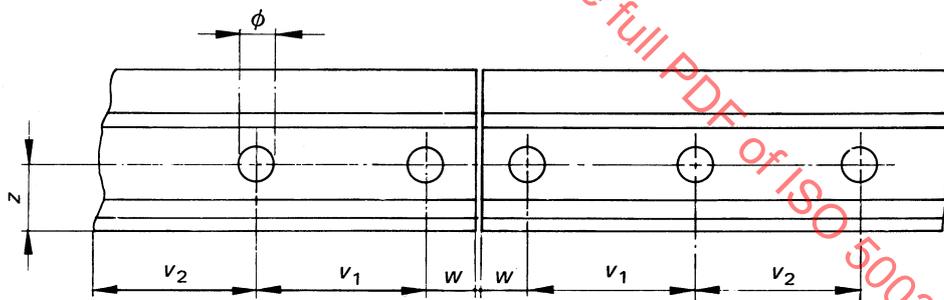
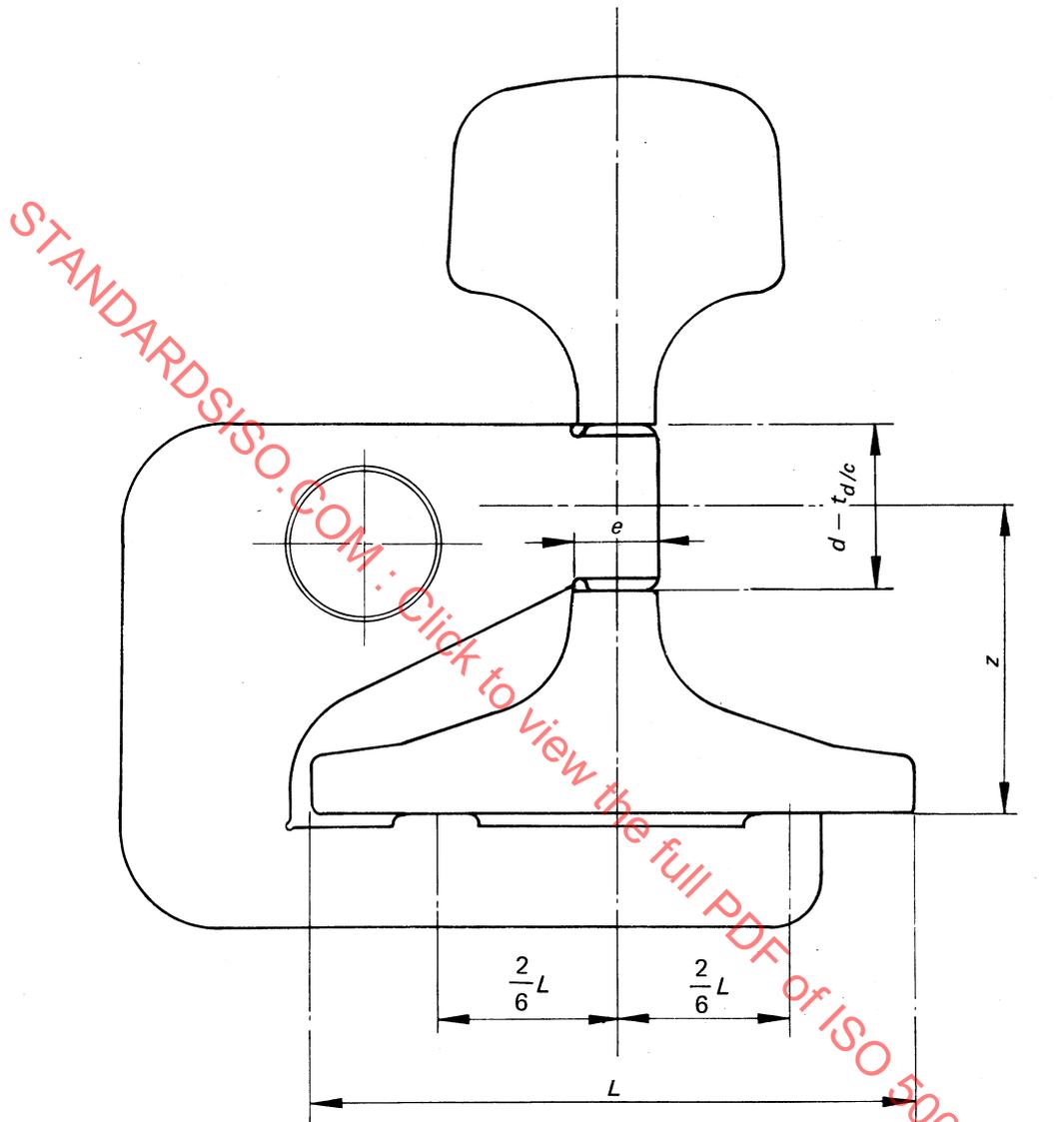


Figure 10 — Referee gauge for distance between holes and railend, and hole diameter

Annex H

Referee gauge for distance between holes and base of rail



- e : thickness of the web
- z : distance between centre of the hole and base of the flange
- d : hole diameter
- t_d : tolerance for diameter of holes
- t_c : tolerance for centring and positioning of holes
- $t_{d/c}$: combined tolerance for diameter of holes and centring of holes vertically

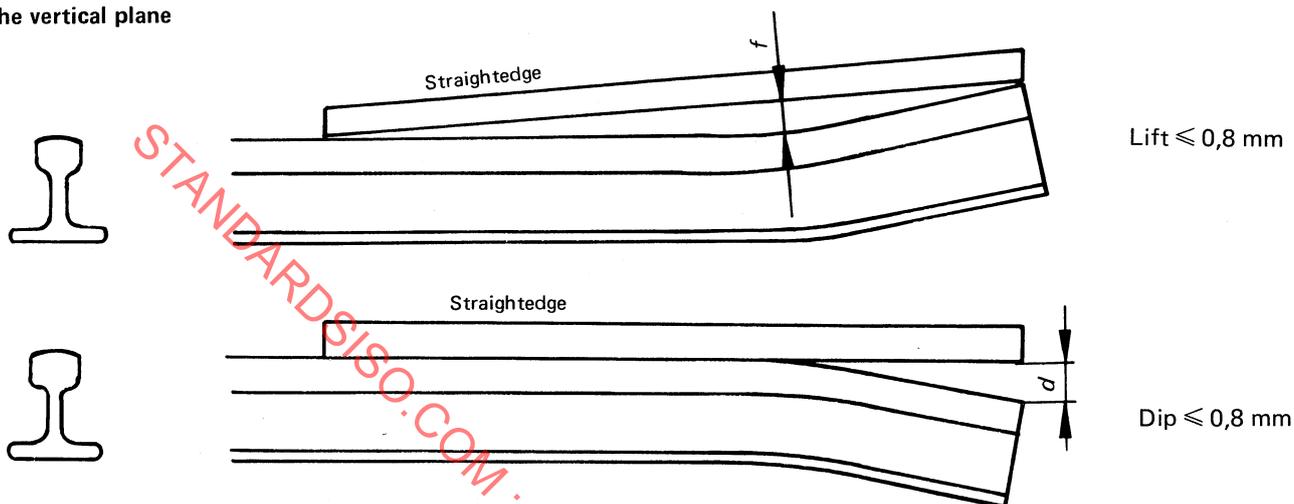
$$t_{d/c} = (t_c + t_{d/2}) \times 2$$

Figure 11 – Referee gauge for distance between holes and base of rail

Annex J

Check on straightness of the ends

In the vertical plane



In the horizontal plane

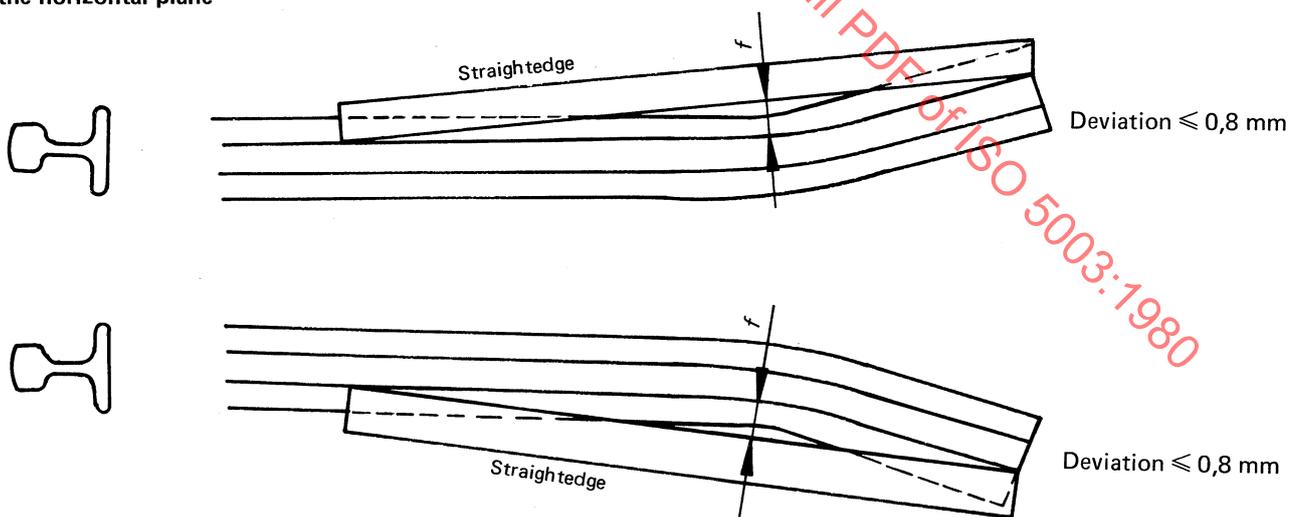


Figure 12 – Check on straightness of ends