INTERNATIONAL STANDARD

ISO 6932

Second edition
2001-11-15

Cold-reduced carbon steel strip with a maximum carbon content of 0,25 %

Feuillards en acier au carbone laminés à froid avec teneur maximale en carbone égale à 0,25 %

Reference number
ISO 6932:2001(E)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 6932 was prepared by Technical Committee ISO/TC 17, *Steel*, Subcommittee SC 12, *Continuous mill flat rolled products*.

This second edition cancels and replaces the first edition (ISO 6932:1986), which has been technically revised.

Cold-reduced carbon steel strip with a maximum carbon content of 0,25 %

1 Scope

1.1 This International Standard applies to cold-reduced carbon steel strip with a maximum carbon content of 0,25 %, furnished to two levels of closer tolerances than cold-reduced carbon steel sheet, with specific quality, specific hardness requirements or mechanical properties, specific edge and specific finish.

NOTE This International Standard does not apply to the product in narrow widths known as cold-reduced carbon steel sheet slit from wider widths (ISO 3574), nor does it include cold-reduced carbon steel strip with a carbon content over 0,25 % (ISO 4960).

1.2 Cold-reduced carbon steel strip is produced with a maximum of the specified carbon not exceeding:

— 0,15 % for material specified to mechanical properties;

— 0,25 % for material specified to temper (hardness) requirements.

1.3 This product is commonly produced in thicknesses of 6 mm and under, and in widths up to 600 mm, in coils and cut lengths.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 6507-1:1997, *Metallic materials — Vickers hardness test — Part 1: Test Method*

ISO 6508-1:1999, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

ISO 6892:1998, *Metallic materials — Tensile testing at ambient temperature*

ISO 7438:1985, *Metallic materials — Bend test*

3 Terms and definitions

For the purposes of this International Standard, the following terms and definitions apply.

3.1
cold-reduced carbon steel strip
product manufactured from hot-rolled, descaled coils by cold reducing to the desired thickness on a single-stand mill or on a tandem mill consisting of several single stands in series

3.2
cold reduction
process of reducing the thickness of the strip at room temperature whereby the amount of reduction is greater than that used for a **skin pass** (see 3.9)

3.3
aluminum killed
steel which has been deoxidized with aluminum sufficient to prevent the evolution of gas during solidification

3.4
annealing
process of heating to and holding at a suitable temperature and then cooling at a suitable rate, for such purposes as lowering hardness, facilitating cold working, producing a desired microstructure or obtaining desired mechanical, physical or other properties

3.4.1
box annealing
annealing in a sealed container under conditions that minimize oxidation

NOTE The strip is usually heated slowly to a temperature below the transformation range, but sometimes above or within it, and is then cooled slowly.

3.4.2
continuous annealing
annealing the strip in continuous strands through a furnace having a controlled atmosphere, followed by controlled cooling

3.5
normalizing
heating to a suitable temperature above the transformation range and then cooling in air to a temperature substantially below the transformation range

NOTE In bright normalizing the furnace atmosphere is controlled to prevent oxidation of the strip surface.

3.6
temper
designation by number or term to indicate the hardness as a minimum, as a maximum or as a range

NOTE The tempers are obtained by the selection and control of chemical composition, by amounts of cold reduction, by thermal treatment and by a skin pass.

3.7
dead soft
condition describing annealed strip produced without definite control of stretcher-straining or fluting

NOTE It is suitable for drawing and other applications where such surface characteristics are not objectionable.

3.8
surface finish
degree of smoothness or lustre of the strip

3.9
skin pass
light cold rolling of the product resulting in an increase in hardness and some loss in ductility

NOTE The purpose of skin passing is to minimize the appearance of coil breaks, stretcher strains and fluting, or to control shape, or to obtain the required surface finish.

4 Conditions of manufacture

4.1 Physical properties

Temper requirements according to Table 1 or mechanical properties according to Table 2 may be specified as included in this International Standard, but not both since there is no direct correlation.

4.1.1 Cold-reduced carbon steel strip specified to mechanical properties is produced to the following commercial and drawing quality designations:

— CR21: commercial quality

— CR22: drawing quality

— CR23: deep drawing quality

— CR24: deep drawing quality aluminum killed

4.1.2 Cold-reduced carbon steel strip specified to temper requirements is produced to the following temper designations:

— No. 1: (hard)

— No. 2: (half hard)

— No. 3: (quarter hard)

— No. 4: (skin-passed)

— No. 5: (dead soft)

4.2 Steelmaking

The processes used in making the steel and in manufacturing cold-reduced carbon strip are left to the discretion of the manufacturer. On request, the purchaser shall be informed of the steelmaking process being used.

Except for grade CR24, the deoxidation practice shall be at the discretion of the manufacturer unless otherwise agreed at the time of ordering.

Table 1 — Temper and hardness requirements for cold-reduced carbon steel strip

Temper	Thickness, e mm	Hardness			
		Rockwell B scale HRB	Rockwell R30T scale HR30T	Rockwell 15T scale HR15T	Vickers HV
No. 1 (hard)	$e \leqslant 0{,}36$	—	—	90 min.	185 min.
	$0{,}36 < e \leqslant 1{,}0$	—	76 min.	—	185 min.
	$e > 1{,}0$	84 min.	—	—	162 min.
No. 2 [a] (half-hard)	$e \leqslant 0{,}36$	—	—	83,5 to 88,5	125 to 165
	$0{,}36 < e \leqslant 1{,}0$	—	63,5 to 73,5	—	125 to 165
	$e > 1{,}0$	70 to 80	—	—	125 to 165
No. 3 [a] (quarter-hard)	$e \leqslant 0{,}36$	—	—	80 to 85	107 to 137
	$0{,}36 < e \leqslant 1{,}0$	—	56,5 to 66,5	—	107 to 137
	$e > 1{,}0$	60 to 75	—	—	107 to 137
No. 4 [a,b] (skin-passed)	$e \leqslant 0{,}36$	—	—	82 max.	116 max.
	$0{,}36 < e \leqslant 1{,}0$	—	60 max.	—	116 max.
	$e > 1{,}0$	65 max.	—	—	116 max.
No. 5 [a,b] (dead-soft)	$e \leqslant 0{,}36$	—	—	78,5 max.	100 max.
	$0{,}36 < e \leqslant 1{,}0$	—	53 max.	—	100 max.
	$e > 1{,}0$	55 max.	—	—	100 max.

a Rockwell and Vickers hardness values apply to aluminum-killed steels. For non-killed steel (rimmed or capped) or semi-killed steels, the values apply only at the time of shipment.

b Nos. 4 and 5 temper may be ordered with a carbon range of 0,15 % to 0,25 %. In each instance, the maximum hardness requirement is established by agreement.

Table 2 — Mechanical property requirements for cold-reduced carbon steel strip [a]

Quality designation	Condition of delivery [b]	R_e max [c]	R_m [d]	A min %	
		N/mm^2	N/mm^2	L_o = 80 mm [e]	L_o = 50 mm
CR21	HK [f]	—	—	—	—
	TC	—	410 max.	28	32
	HK270	—	410 max.	28	32
	HK290	—	290 to 430	18	24
	HK390	—	390 to 540	—	—
	HK490	—	490 to 640	—	—
	HK590	—	590 to 740	—	—
	HK690	—	690 min.	—	—
CR22	TC	—	370 max.	32	35
	HK270	250	370 max.	32	35
	HK290	355	290 to 410	21	25
	HK390	—	390 to 510	5	13
	HK490	—	490 to 620	—	—
	HK590	—	590 min.	—	—
CR23	TC	—	350 max.	36	38
	HK270	225 [g]	350 max.	36	38
	HK290	325	290 to 390	23	27
	HK390	—	390 to 490	6	14
	HK490	—	490 to 600	—	—
	HK590	—	590 min.	—	—
CR24	TC	—	350 max	36	38
	HK270	225 [g]	350 max	36	38
	HK290	325	290 to 390	23	27
	HK390	—	390 to 490	6	14
	HK490	—	490 to 590	—	—
	HK590	—	590 to 690	—	—

a Longitudinal test pieces:

R_e yield strength

R_m tensile strength

A percentage elongation after fracture

L_o gauge length on test piece

S_o original cross-sectional area of gauge length

1N/mm^2 = 1 MPa

b Conditions of delivery: HK, cold-reduced; TC, annealed; HK270, skin-passed; HK290 to HK690, cold-reduced various amounts.

c For thickness 0,7 mm and less the specified maximum yield strength values are increased by 20 N/mm^2.

d Minimum tensile strength values for condition of delivery HK, TC and HK270 would normally be expected to be 270 N/mm^2.

e Minimum elongation values are reduced by 2 % for thicknesses 0,5 mm to 0,7 mm inclusive and by 4 % for thicknesses less than 0,5 mm.

f There are no mechanical property requirements for this condition.

g For thicknesses 1,5 mm and greater the yield strength is 235 N/mm^2 maximum.

4.3 Chemical Composition

4.3.1 General

The chemical composition (heat analysis) shall not exceed the values given in Tables 3 and 4.

4.3.2 Heat analysis

A heat analysis of each heat of steel shall be made by the manufacturer to determine compliance with the requirements of Tables 3 and 4. When requested, at the time of ordering, this analysis shall be reported to the purchaser or his representative.

4.3.3 Product analysis

A product analysis may be made by the purchaser to verify the specified analysis of the product and shall take into consideration any normal heterogeneity. Non-killed steels (such as rimmed or capped) are not technologically suited to product analysis. For killed steels, the sampling method and deviation limits shall be agreed upon between the interested parties at the time of ordering.

Table 3 — Chemical composition (heat analysis)

Values as percentages by mass

Temper or quality designation	**Carbon (C)** max.	**Manganese (Mn)** max.	**Phosphorus (P)** max.	**Sulfur (S)** max.
Temper Nos. 1,2,3	0,25	0,60	0,035	0,04
Temper Nos. 4,5	0,15	0,60	0,035	0,04
CR21	0,15	0,60	0,05	0,05
CR22	0,12	0,50	0,04	0,04
CR23	0,10	0,45	0,03	0,03
CR24	0,08	0,45	0,03	0,03

Table 4 — Limits on additional chemical elements [a]

Elements max. %	Heat analysis	Product analysis
Cu [b]	0,20	0,23
Ni [b]	0,20	0,23
Cr [b,c]	0,15	0,19
Mo [b,c]	0,06	0,07
Nb [d]	0,008	0,018
V [d]	0,008	0,018
Ti [d]	0,008	0,018

[a] Each of the elements listed in this table shall be included in the report of the heat analysis. When the amount of copper, nickel, chromium or molybdenum present is less than 0,02 %, the analysis may be reported as "< 0,02 %".

[b] The sum of copper, nickel, chromium and molybdenum shall not exceed 0,50 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

[c] The sum of chromium and molybdenum shall not exceed 0,16 % on heat analysis. When one or more of these elements are specified, the sum does not apply; in which case, only the individual limits on the remaining elements will apply.

[d] Heat analysis greater than 0,008 % may be supplied after agreement between producer and consumer.

4.4 Weldability

This product is suitable for welding if appropriate welding conditions are selected. As carbon content increases above 0,15 %, spot welding becomes increasingly difficult.

4.5 Application

It is desirable that cold-reduced steel strip be identified for fabrication by the name of the part or by intended application, which shall be compatible with the temper or mechanical properties specified. Proper identification of the part may include visual examination, prints or description, or a combination of these.

4.6 Mechanical properties

4.6.1 Hardness

When the temper designation is specified and at the time the steel is made available for shipment, the hardness shall be as stated in Table 1 when it is determined on test pieces obtained in accordance with the requirements of clause 6.

4.6.2 Tensile properties

When the mechanical property designation is specified and at the time the steel is made available for shipment, the tensile properties shall be as stated in Table 2 when they are determined on test pieces obtained in accordance with the requirements of clause 6.

4.7 Oiling

As a deterrent to rusting, a coating of oil is usually applied to the product. The oil is not intended as a drawing or forming lubricant and should be easily removable with degreasing chemicals. The product may be ordered not oiled, if required, in which case, the supplier has limited responsibility if oxidation occurs.

4.8 Edges

The desired edge number shall be specified as in 4.8.1 to 4.8.6.

4.8.1 No. 1 edge

A prepared edge of a specified contour (round or square) that is produced when a very accurate width is required or when an edge condition suitable for electroplating is required, or both.

4.8.2 No. 2 edge

A natural mill edge carried through the cold rolling from the hot-rolled carbon steel strip without additional processing of the edge.

4.8.3 No. 3 edge

An approximately square edge, produced by slitting, on which the burr is not eliminated. Normal coiling or piling does not necessarily provide a definite positioning of the slitting burr.

4.8.4 No. 4 edge

A rounded edge produced by edge rolling either the natural edge of hot-rolled carbon steel strip or slit-edge material. This edge is produced when the width tolerances and edge condition are not as exacting as for No. 1 edge.

4.8.5 No. 5 edge

An approximately square edge produced from slit-edge material on which the burr is eliminated, usually by rolling or filing.

4.8.6 No. 6 edge

A square edge produced by edge rolling the natural edge of hot-rolled carbon steel strip or slit-edge material. This edge is produced when the width tolerance and edge condition are not as exacting as for the No. 1 edge.

4.9 Surface finish

The finish is specified normally as one of 4.9.1 to 4.9.4.

4.9.1 No. 1 or matte (dull) finish

A finish without lustre, produced by rolling on rolls toughened by mechanical, electrical or chemical means. This finish is especially suitable for lacquer or paint adhesion, and is beneficial in aiding drawing operations by reducing the contact friction between the die and the strip.

4.9.2 No. 2 or regular bright finish

A finish produced by rolling on rolls having a moderately smooth finish. It is suitable for many requirements, but not generally applicable to bright plating.

4.9.3 No. 3 or best bright finish

A finish generally of high lustre, produced by selective rolling practices, including the use of specially prepared rolls. This is a high quality finish and is particularly suited for bright plating. The production of this finish requires extreme care in processing and extensive inspection.

4.9.4 No. 4 or mirror finish

A finish of special high lustre, produced on specially polished rolls mainly for highly decorative plating purposes. The production of this finish requires extreme care in processing and extensive inspection.

5 Dimensional tolerances

Dimensional tolerances applicable to cold-reduced carbon steel strip shall be as given in Tables 5 to 10 inclusive. When required, special tolerances shall be as agreed between the manufacturer and the purchaser.

The tolerances on flatness for cut-to-length cold-reduced carbon steel strip shall be a maximum of 10 mm in any 1 000 mm of length. Any further requirements for flatness shall be agreed between the manufacturer and purchaser at the time of ordering. The tolerance on flatness is taken to be the greatest difference between the cut length resting on a plane horizontal base and a measuring rule laid in the direction of the longitudinal axis.

Table 5 — Thickness tolerances[a] for cold-reduced carbon steel strip ordered to nominal thickness, coils and cut lengths

Values in millimetres

Specified thickness, e	Tolerance [b] for specified width, b					
	$b \leqslant 125$		$125 < b \leqslant 250$		$250 < b \leqslant 600$	
	N	F	N	F	N	F
$e \leqslant 0{,}15$	± 0,01	± 0,01	± 0,02	± 0,015	—	—
$0{,}15 < e \leqslant 0{,}25$	± 0,02	± 0,015	± 0,02	± 0,015	—	—
$0{,}25 < e \leqslant 0{,}40$	± 0,02	± 0,015	± 0,03	± 0,02	± 0,03	± 0,02
$0{,}40 < e \leqslant 0{,}60$	± 0,03	± 0,02	± 0,03	± 0,02	± 0,04	± 0,03
$0{,}60 < e \leqslant 0{,}80$	± 0,04	± 0,03	± 0,04	± 0,03	± 0,05	± 0,035
$0{,}80 < e \leqslant 1{,}00$	± 0,04	± 0,03	± 0,05	± 0,035	± 0,05	± 0,035
$1{,}00 < e \leqslant 1{,}50$	± 0,05	± 0,035	± 0,06	± 0,045	± 0,07	± 0,055
$1{,}50 < e \leqslant 2{,}50$	± 0,06	± 0,04	± 0,07	± 0,055	± 0,08	± 0,06
$2{,}50 < e \leqslant 4{,}00$	± 0,07	± 0,05	± 0,08	± 0,06	± 0,10	± 0,08
$4{,}00 < e \leqslant 6{,}00$	± 0.09	± 0,06	± 0,10	± 0,08	± 0,12	± 0,09

[a] Thickness is measured at any point on the strip not less than 20 mm from a side edge for mill edge strip and not less than 10 mm from a side edge for sheared edge strip. For widths of mill edge strip 40 mm or less and sheared edge strip 20 mm wide or less, measurements are made on the centreline of the strip. Measurement must not be made on top of the shear burr.

[b] N indicates normal tolerances; F indicates fine tolerances.

Table 6 — Width tolerances of edge Nos. 1,4,5, and 6 for cold-reduced carbon steel strip

Values in millimetres

Edge No.	Specified width, b	Specified thickness		Width tolerance
		min.	max.	
1	$b \leqslant 200$	—	3,0	± 0,13
4	$b \leqslant 25$	0,6	5,0	± 0,38
4	$25 < b \leqslant 50$	0,6	6,0	± 0,65
4	$50 < b \leqslant 150$	1,0	6,0	± 1,20
5	$b \leqslant 100$	—	3,0	± 0,13
5	$100 < b \leqslant 500$	0,4	3,0	± 0,25
5	$500 < b \leqslant 600$	0,6	2,0	± 0,38
6	$b \leqslant 25$	0,6	5,0	± 0,38
6	$25 < b \leqslant 50$	0,6	6,0	± 0,65
6	$50 < b \leqslant 150$	1,0	6,0	± 1,20

Table 7 — Width tolerance for edge No. 2 (mill) for cold-reduced carbon steel strip

Values in millimetres

Specified width, b	Width tolerance [a]
$b \leqslant 100$	± 1,5
$100 < b \leqslant 200$	± 2,0
$200 < b \leqslant 400$	± 2,5
$400 < b \leqslant 500$	± 3,0
$500 < b < 600$	± 4,0

[a] The values specified do not apply to the uncropped ends of a mill edge coil within 7 m inclusive of both ends.

Table 8 — Width tolerances for edge No. 3 (slit) for cold-reduced carbon steel strip

Values in millimetres

Specified width, b	Width tolerance for specified thickness, e			
	$e \leqslant 1,5$	$1,5 < e \leqslant 2,5$	$1,5 < e \leqslant 4,5$	$1,5 < e \leqslant 6,0$
$b \leqslant 100$	± 0,20	± 0,25	± 0,35	± 0,40
$100 < b \leqslant 200$	± 0,25	± 0,30	± 0,45	± 0,50
$200 < b \leqslant 300$	± 0,30	± 0,35	± 0,50	± 0,50
$300 < b \leqslant 450$	± 0,40	± 0,45	± 0,60	± 0,70
$450 < b < 600$	± 0,50	± 0,50	± 0,60	± 0,70

Table 9 — Length tolerances for cold-reduced carbon steel strip

Values in millimetres

Specified width, b	Tolerance for specified length, l		
	$600 < l \leqslant 500$	$1\,500 < l \leqslant 3\,000$	$l \leqslant 3\,000$
$b \leqslant 300$	$^{+10}_{0}$	$^{+15}_{0}$	$^{+20}_{0}$
$300 < b \leqslant 600$	$^{+15}_{0}$	$^{+20}_{0}$	$^{+25}_{0}$

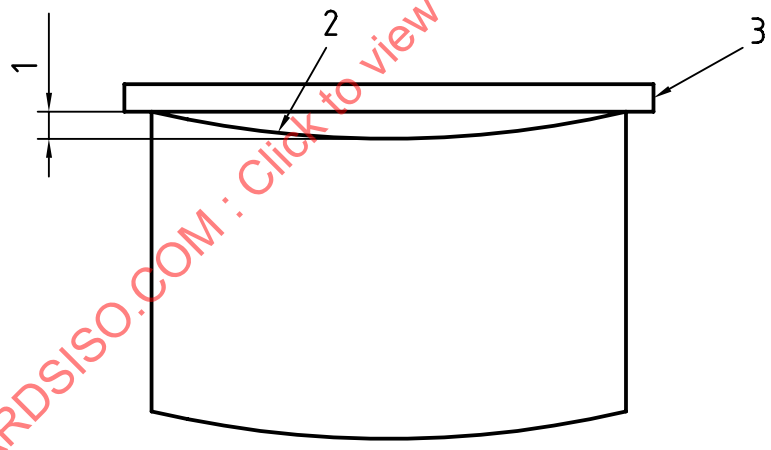
Table 10 — Camber [a] tolerances for cold-reduced carbon steel strip, for coils and cut lengths, applicable to all types of edges

Values in millimetres

Width, b	Camber tolerance [b]
$10 < b \leqslant 40$	25 max. in any 2 000 length
$40 < b \leqslant 600$	10 max. in any 2 000 length

a Camber is the greatest deviation of a side edge from a straight line, the measurement being taken on the concave side with a straightedge as shown in Figure 1.

b The values do not apply to the uncropped ends of a mill edge coil within 7 m inclusive of both ends.



Key

1 Edge camber

2 Side edge (concave side)

3 Straightedge

NOTE In those cases where it is not practical to measure the tolerance as given in Table 9, the camber tolerance, t_2, may be calculated from the equation.

$$t_2 = (l_2/l_1) \times t_1$$

where:

l_1 is the standard length in Table 9 (2 000 mm);

l_2 is the non-standard length;

t_1 is the camber tolerance in Table 9.

Figure 1 — Measurement of camber

6 Sampling

6.1 Hardness or tensile test

One representative sample for the hardness or tensile test required in Table 1 or Table 2, shall be taken from each lot of strip for shipment. A lot consists of 50 t or less of strip of the same designation rolled to the same thickness and temper or mechanical properties.

6.2 Bend test

One representative sample for the bend test shall be taken from each lot of strip for shipment. A lot consists of all strip of the same designation rolled to the same thickness and temper or mechanical properties.

7 Mechanical property tests

7.1 Hardness test

The hardness test shall be carried out in accordance with ISO 6507-1 or ISO 6508-1 as applicable.

7.2 Tensile test

The tensile test shall be carried out in accordance with ISO 6892.

7.3 Bend test

The bend test shall be carried out at ambient temperature and in accordance with ISO 7438. The bend test piece shall withstand being bent as shown in Table 11, without cracking on the outside of the bent portion.

Small cracks on the edges of test pieces, and cracks which require magnification to be visible, shall be disregarded.

8 Retests

8.1 Machining and flaws

If any test piece shows defective machining or develops flaws, it shall be discarded and another test piece substituted.

8.2 Additional tests

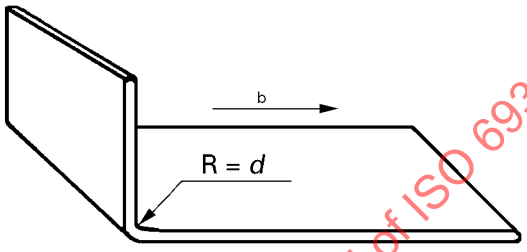
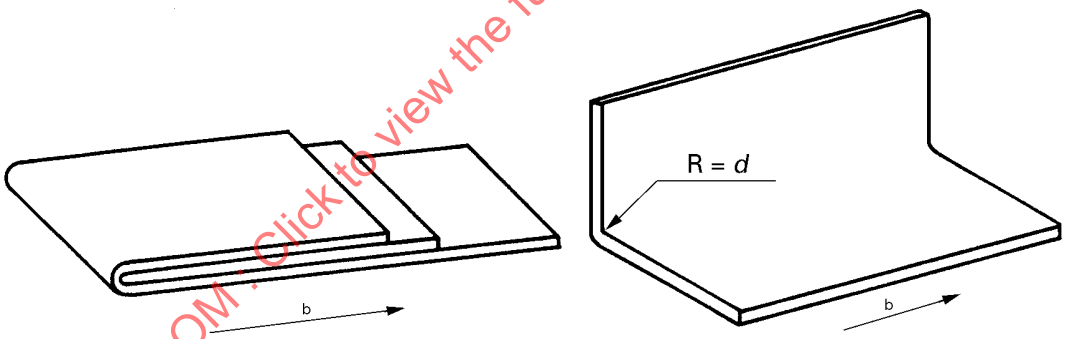
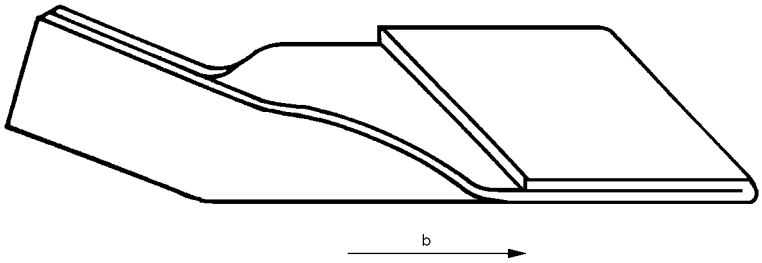
If a test does not give the specified results, two additional tests shall be carried out on the same lot. Both retests shall conform to the requirements of this International Standard, otherwise, the lot may be rejected.

9 Resubmission

The manufacturer may resubmit for acceptance the products that have been rejected during earlier inspection because of unsatisfactory properties, after he has subjected them to a suitable treatment (selection, heat treatment), which, on request, will be indicated to the purchaser. In this case, tests shall be carried out as if they applied to a new batch.

The manufacturer has the right to present the rejected products to a new examination for compliance with the requirements for another temper quality designation, edge or finish.

Table 11 — Bend test requirements, for cold-reduced carbon steel strip

Temper or condition of delivery	Bend test requirement
No. 1 (hard) HK HK490 HK590 HK690	No requirement
No. 2 (half hard) HK290	90° longitudinal bend around a radius of d [a] 
No. 3 (quarter hard) HK390	180° longitudinal bend over the thickness and a 90° transverse bend around a radius of d [a] 
No. 4 (skin-passed) No. 5 (dead soft) HK270 TC	180° flat bend in either the longitudinal or transverse direction 
a d is the radius of the bend test piece. b Direction of rolling.	