
International Standard 6930

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION • МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ ПО СТАНДАРТИЗАЦИИ • ORGANISATION INTERNATIONALE DE NORMALISATION

High yield strength flat steel products for cold forming

Produits plats en acier à haute limite d'élasticité pour formage à froid.

First edition — 1983-09-15

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UDC 669.14.018.254-41

Ref. No. ISO 6930-1983 (E)

Descriptors : iron- and steel products, high yield strength steels, cold working, manufacturing, acceptance inspection, marking, delivery conditions, surface defects, chemical composition, mechanical properties.

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of developing International Standards is carried out through ISO technical committees. Every member body interested in a subject for which a technical committee has been authorized 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.

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 6930 was developed by Technical Committee ISO/TC 17, *Steel*, and was circulated to the member bodies in August 1982.

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

Austria	Iran	South Africa, Rep. of
Belgium	Italy	Spain
Bulgaria	Japan	Sweden
Canada	Korea, Dem. P. Rep. of	Switzerland
China	Korea, Rep. of	Tanzania
Czechoslovakia	Mexico	Turkey
Egypt, Arab Rep. of	Netherlands	United Kingdom
France	Norway	USA
Germany, F. R.	Poland	USSR
India	Romania	Venezuela

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

Australia
New Zealand

High yield strength flat steel products for cold forming

1 Scope

This International Standard specifies the method of manufacture, the acceptance testing and the marking of high yield strength flat steel products for cold forming.

2 Field of application

2.1 This International Standard applies to plate hot-rolled on reversing mills and to hot-rolled wide-flats having a thickness of 3 mm and over, made of weldable high yield strength steel for cold forming.

2.2 It does not apply to weldable structural steels, whether or not of special quality, which are covered by other International Standards, namely

- structural steels (ISO 630);
- high yield strength flat steel products (ISO 4950);
- hot-rolled steel sheet of higher yield strength with improved formability (ISO 5951).

3 References

ISO 82, *Steel — Tensile testing*.

ISO/R 85, *Bend test for steel*.

ISO 148, *Steel — Charpy impact test (V-notch)*.

ISO/R 377, *Selection and preparation of samples and test pieces for wrought steel*.

ISO 404, *Steel and steel products — General technical delivery requirements*.

ISO 630, *Structural steels*.

ISO 2566/1, *Steel — Conversion of elongation values — Part 1 : Carbon and low alloy steels*.

ISO 4950/1, *High yield strength flat steel products — Part 1 : General requirements*.

ISO 4950/2, *High yield strength flat steel products — Part 2 : Products supplied in the normalized or controlled rolled conditions*.

ISO 4950/3, *High yield strength flat steel products — Part 3 : Products supplied in the heat-treated (quenched + tempered) condition*.

ISO 5951, *Hot-rolled steel sheet of higher yield strength with improved formability*.

4 Manufacture

4.1 Steelmaking process

Unless otherwise agreed when ordering, the steelmaking process is left to the discretion of the manufacturer; it shall, however, be possible to disclose it to the purchaser, if he so requests, at the time of the delivery.

4.2 Method of deoxidation

All steels for cold forming are fine grain killed.

4.3 Production process

Unless otherwise agreed when ordering, the production process is left to the discretion of the manufacturer.

4.4 Delivery condition

The plate is supplied after undergoing a thermomechanical treatment at the discretion of the manufacturer.

Unless specially agreed when ordering, the products are generally supplied with their surface as rolled. On request, they may be delivered with descaled surfaces. However, it is necessary to take into account the fact that certain descaling processes are liable to modify the cold-forming properties.

Descaled products may be delivered with their surfaces protected, by agreement with the purchaser. The type of the protection shall be indicated on the order.

4.5 Surface condition

Products shall present a smooth surface corresponding to the rolling method used.

5 Characteristics of grades and qualities

5.1 Chemical composition

5.1.1 Cast analysis

5.1.1.1 The ladle analysis shall be in accordance with the limits specified in table 1.

Table 1 — Chemical composition (ladle analysis)

Grade	C % max. ¹⁾	Mn % max.	P % max.	S % max.
FeE 275	0,12	1,30	0,030	0,030
FeE 355	0,12	1,65	0,030	0,030
FeE 420	0,12	1,65	0,030	0,030
FeE 490	0,12	1,70	0,030	0,030
FeE 560	0,12	1,80	0,030	0,030

1) Higher contents — up to a maximum of 0,18 % — are permitted in so far as the mechanical characteristics defined in table 3 as well as the forming properties and weldability are not impaired.

5.1.1.2 Micro-alloy elements may be added to increase the properties of the steel and to produce a fine grain. If provided for when ordering, the manufacturer shall state the type of steel supplied and the maximum values or ranges of alloy elements added.

5.1.1.3 As the form of sulphide inclusions may have a certain influence on the cold-forming properties of the products, the

manufacturer may, at his discretion, influence the form of inclusions by adding certain elements such as Ce, Ca, or may chose a very low sulphur content for these steels.

5.1.2 Products analysis

This analysis may be requested by the purchaser; in this case it shall be specified when ordering. The limit of permissible ranges for product analysis with respect to the limits for cast analysis given in table 1 are indicated in table 2.

Table 2 — Permissible deviation for the products analysis in relation to the specified ladle analysis

Elements	Permissible deviation %
C (up to 0,18 %)	+ 0,03
Mn	+ 0,15
P	+ 0,005
S	+ 0,005

5.2 Mechanical properties

Table 3 indicates the mechanical properties specified in the delivery conditions defined in 4.4 and determined from test pieces selected according to the specifications of chapter 6.

The values are specified for products of thickness equal to or less than 12 mm. For products having a greater thickness, the mechanical properties shall be the subject of agreement with ordering.

Table 3 — Mechanical properties

Grade	Specified yield strength N/mm ² min.	R N/mm ² min.	A % min. $L_0 = 5,65 \sqrt{S_0}$	Bending at 180° — Mandrel diameter	Impact test (V notch) Energy, J ¹⁾	
					Longitudinal, at -20 °C min ²⁾	
					10 × 10 test piece	10 × 7,5 test piece
FeE 275	275	350	28	0 a ⁴⁾	27	20
FeE 355	355	420	24	1 a	27	20
FeE 420	420	480	21	1 a	27	20
FeE 490	490 ³⁾	540	18	1,5 a	27	20
FeE 560	560	610	15	1,5 a	27	20

1) The values in the table are specified for thicknesses ≥ 6 mm. For thicknesses ≥ 6 mm and < 12 mm, see 6.5.3; for thicknesses < 6 mm, the impact energy values are not prescribed.

The impact energy values are always specified, but are only checked if this is provided for when ordering.

2) The mean of the results obtained from three longitudinal test pieces : no individual value shall be less than 19 J for the 10 × 10 test piece and less than 14 J for the 10 × 7,5 test piece.

3) For thicknesses greater than 8 mm, a minimum yield stress value of 480 N/mm² is admissible.

4) a = thickness of test piece

5.3 Technical properties

5.3.1 Weldability

The steels are weldable by all the appropriate processes when following the rules of the technology.

5.3.2 Bending and cold-edging ability

The bending radius of the products depends on the practical conditions of fabrication, and it is difficult to give a specific minimum bending radius to be respected. However, under normal conditions of use, a bending radius can be provided :

- equal to 1 times the thickness of the plate for grades FeE 275 and FeE 355,
- between 1,5 and 2 times the thickness of the plate for grades FeE 420, FeE 490 and FeE 560.

Attention is drawn to the fact that these values may, under certain conditions, be

- reduced or increased to take into consideration the practical conditions of use (length of the folds, preparation, etc.),
- increased if the products are subjected to certain descaling processes (e.g. shot-blasting).

Furthermore, certain customary precautions shall be taken for grades FeE 490 and FeE 560, (removal of the shearing cross-section at right angles to the folds).

In general terms, and more particularly in the case of difficult bending operations, it is in the interest of the user to consult the manufacturer as to the choice of the quality of steel and the conditions of use.

6 Acceptance conditions

6.1 The rolled products covered by this International Standard may be the subject of an acceptance test under the conditions specified in ISO 404 relating to the mechanical and chemical properties of the product. Verification of the product analysis and of the impact values at -20°C is only carried out by agreement at the time of enquiry and order.

6.2 Acceptance test units

Acceptance test units shall be

- for plate : each batch of 20 t from the same cast, having the same quality and thickness.

6.3 Series of tests

A series of tests shall be carried out for each acceptance unit.

The series of tests shall include

- a tensile test,
- a bend test,

and, if provided for when ordering,

- a series of three impact tests at -20°C for products of thickness equal to or greater than 6 mm,
- a product analysis (see 6.5.6.2).

If the acceptance test by the purchaser or his agent is specified when ordering, he shall select the pieces on which samplings for the inspection of the properties would be made.

6.4 Location and orientation of test pieces (see ISO/R 377)

Sampling shall be carried out in such a way that the axis of the test-piece is equi-distant from the axis of rolling and edge of the rolled product.

6.4.1 Plate and wide-flat of width equal to or greater than 600 mm

6.4.1.1 The axis of the tensile and bending test pieces shall be transverse to the direction of rolling.

6.4.1.2 The axis of the impact strength test pieces shall always be parallel to the direction of rolling.

6.4.2 Wide-flat less than 600 mm in width

The longitudinal axis of the test-pieces shall be parallel to the direction of rolling. However, if agreed for widths between 450 and 600 mm, a transverse test piece may be used.

6.5 Methods of test — Test pieces

6.5.1 Tensile test (see ISO 82)

The test piece used is generally a prismatic proportional test-piece with a gauge length given by the formula

$$L_0 = 5,65 \sqrt{S_0}$$

where S_0 is the cross-section of the calibrated part of the test piece.

The prismatic test piece of rectangular cross-section shall have a maximum calibrated width of 40 mm, and a thickness equal to that of the product.

6.5.1.1 A non-proportional test piece with a constant initial gauge length may also be used. In this case,

- a) if the gauge length is 200 mm, the specified values for the elongation are

FeE 275	22
FeE 355	20
FeE 420	17
FeE 490	14
FeE 560	12

- b) for other gauge lengths, reference shall be made to a conversion table (see ISO 2566/1).

However, in cases of dispute, only the results obtained with a proportional test-piece shall be taken into consideration.

6.5.1.2 The yield strength specified in the tables is the upper yield stress or the proof stress at 0,5 % (total elongation).

If agreed when ordering that the 0,2 proof stress (non-proportional elongation) or the lower yield stress or the yield stress R_{Lx} is required, the requirements of this International Standard are satisfied if the value obtained for such a measurement attains the yield strength values specified in the tables.

6.5.2 Bend test (see ISO/R 85)

The test piece of rectangular cross-section shall have a width equal to or greater than 30 mm, and a thickness equal to that of the product.

The small cracks on the edges of the test pieces, for the detection of which magnification is necessary, shall not be taken into consideration.

6.5.3 Impact test

6.5.3.1 The impact test shall normally be carried out on products of thickness equal to or greater than 6 mm. The test piece shall be machined in such a way that the surface nearest to the rolling skin is not further than 2 mm from it; the notch shall be perpendicular to the rolling skin.

For products of thickness less than 12 mm, the dimensions of the test pieces shall conform with the specification of ISO 148, i.e. 10 mm × 7,5 mm. However, if agreed when ordering, the test pieces may have a width equal to the thickness of the product, and the energy values to be specified shall be the subject of an agreement.

6.5.3.2 This test shall be carried out using a V notch Charpy impact test piece (see ISO 148), the value for consideration being the arithmetical mean of the results obtained on three adjacent test pieces in the same piece, unless a supplementary test is necessary (see 6.5.5).

6.5.4 Defective tests or test pieces

6.5.4.1 If a test fails to give the prescribed results because of an error in performing the test, it shall be annulled. An error in performing the test is defined as being defective machinery, incorrect mounting in the test machine, poor functioning of the test machine or any other independent anomaly of the metal itself.

6.5.4.2 If a test piece having a defect gives satisfactory results, the batch shall be accepted, but the test piece in question may be subjected to a special examination for fitness.

6.5.5 Supplementary tests

If, during an acceptance test, a test fails to give the results required, it shall lead, unless otherwise agreed, to supplementary tests as stated below :

6.5.5.1 Tensile and bending tests

6.5.5.1.1 If the test piece does not meet the requirements, the piece in question is considered not to conform to the product specification unless two other test pieces from the same piece have been tested and have given satisfactory results. In this case, the test piece and the batch are considered to conform to the product specification.

6.5.5.1.2 If one or both supplementary test pieces do not meet the requirements, the piece in question is considered not to conform to the specification.

In this case, the requirements of clause 7 may be applied.

6.5.5.2 Impact test

6.5.5.2.1 If the average of the three impact strength values is less than the specified minimum average value or if one individual value is less than 70 % of this specified value, three supplementary test pieces shall be taken from the same sample and submitted to a test. The average value of the six results shall be not less than the specified minimum average value. No more than two of the individual values shall be lower than the specified minimum average value and only one individual value may be less than 70 % of this value.

6.5.5.2.2 If the piece put forward for the first time is considered not to conform to the product specification, the remaining material may be accepted, provided that two representative pieces have been subjected to tests conforming to the requirements and have given satisfactory results.

Otherwise, the requirements of clause 7 may be applied.

6.5.6 Chemical analysis

6.5.6.1 In cases of dispute, the method followed for the chemical analysis shall be in accordance with the specifications of the corresponding International Standards. If no International Standard exists, the method to be used shall be the subject of agreement between the interested parties.