

ISO

INTERNATIONAL ORGANIZATION FOR STANDARDIZATION

ISO RECOMMENDATION R 630

STRUCTURAL STEELS

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see also 1052

BRIEF HISTORY

The ISO Recommendation R 630, *Structural Steels*, was drawn up by Technical Committee ISO/TC 17, *Steel*, the Secretariat of which is held by the British Standards Institution (BSI).

Work on this question by the Technical Committee began in 1957 and led, in 1965, to the adoption of a Draft ISO Recommendation.

In February 1966, this Draft ISO Recommendation (No. 918) was circulated to all the ISO Member Bodies for enquiry. It was approved, subject to a few modifications of an editorial nature, by the following Member Bodies:

Australia	India	Spain
Austria	Japan	Sweden
Belgium	Korea, Rep. of	Switzerland
Canada	New Zealand	Turkey
Chile	Norway	U.A.R.
Czechoslovakia	Poland	United Kingdom
Denmark	Portugal	U.S.S.R.
France	Republic	Yugoslavia
Germany	of South Africa	
Hungary	Romania	

Two Member Bodies opposed the approval of the Draft:

Italy
Netherlands

The Draft ISO Recommendation was then submitted by correspondence to the ISO Council, which decided, in November 1967, to accept it as an ISO RECOMMENDATION.

STRUCTURAL STEELS

1. SCOPE

This ISO Recommendation applies to heavy and medium plates (3 mm and over), wide flats, bars and hot-rolled sections, generally used in the delivery condition and normally intended for bolted, riveted or welded structures (see Annex). Table 1 shows which are the grades and qualities covered by this ISO Recommendation and Table 2, their relevant chemical composition and mechanical properties.

This ISO Recommendation does not cover steels intended for boilers or pressure vessels.

TABLE 1. — Grades and qualities

Grades	Qualities			
	A	B	C	D
Fe 33	—	—	—	—
Fe 37	×	×	×	×
Fe 42	×	×	×	×
Fe 44	×	×	×	×
Fe 52	—	×	×	×

TABLE 2. — Chemical composition and mechanical properties

Grades	Qualities	Chemical composition		Tensile properties			Bend test	Impact test		
		Ladle	Product *	R_e	R_m	$A\%$		at ambient temperature **	at 0°C	at -20°C ***
Fe 33	0				×		×			
Fe 37	A	×	×	×	×	×	×	×		
	B	×	×	×	×	×	×	×		
	C	×	×	×	×	×	×	×	×	
	D	×	×	×	×	×	×	×		×
Fe 42	A	×	×	×	×	×	×	×		
	B	×	×	×	×	×	×	×		
	C	×	×	×	×	×	×	×	×	
	D	×	×	×	×	×	×	×		×
Fe 44	A	×	×	×	×	×	×	×		
	B	×	×	×	×	×	×	×		
	C	×	×	×	×	×	×	×	×	
	D	×	×	×	×	×	×	×		×
Fe 52	B	×	×	×	×	×	×	×		
	C	×	×	×	×	×	×	×	×	
	D	×	×	×	×	×	×	×		×

* Verifications of the chemical composition on the product are not carried out unless specified on the order.

** For quality B steels, the impact value need be determined only if required by the order.

*** By agreement between the producer and the purchaser, the impact value of 2.8 kgf.m fixed for the V-notch test piece can be verified at temperatures below -20°C and down to -50°C.

2. CHARACTERISTICS OF GRADES AND QUALITIES

2.1 Chemical composition

2.1.1 *Ladle analysis.* The composition limits for analysis carried out on the ladle sample are given in Table 3 and are maximum values.

2.1.2 *Product analysis.* This analysis can be requested by the purchaser, in which case it should be specified on the order. The composition limits are given in Table 3 and are maximum values.

The analysis is carried out on a sample for chemical analysis taken from the test pieces used for the verification of the mechanical properties—or from a corresponding location—and over the whole thickness of the product (see diagrams in section A.3 of Annex).

TABLE 3. — Chemical composition

Grades	Qualities	C max. %		P max. %		S max. %	
		Ladle	Product	Ladle	Product	Ladle	Product
Fe 33	0						
Fe 37	A	0.20	0.25	0.08	0.100	0.06	0.075
	B *	0.20	0.25	0.06	0.075	0.05	0.062
	C	0.17	0.20	0.05	0.055	0.05	0.055
	D	0.17	0.20	0.045	0.050	0.045	0.050
Fe 42	A	0.25	0.31	0.08	0.100	0.06	0.075
	B *	0.22	0.27	0.06	0.075	0.05	0.062
	C	0.20	0.23	0.05	0.055	0.05	0.055
	D	0.20	0.23	0.045	0.050	0.045	0.050
Fe 44	A	0.25	0.31	0.08	0.100	0.06	0.075
	B *	0.22	0.27	0.06	0.075	0.05	0.062
	C	0.20	0.23	0.05	0.055	0.05	0.055
	D	0.20	0.23	0.045	0.050	0.045	0.050
Fe 52	B	0.22	0.25	0.06	0.065	0.05	0.055
	** C	0.20 ***	0.23 ***	0.05	0.055	0.05	0.055
	D	0.20 ***	0.23 ***	0.045	0.050	0.045	0.050

* In the case of steel other than rimming steel, the percentages on the product are as follows:

Fe 37-B	C = 0.23	P = 0.065	S = 0.055
Fe 42-B	C = 0.25	P = 0.065	S = 0.055
Fe 44-B	C = 0.25	P = 0.065	S = 0.055

** Fe 52: The maximum ladle percentages of manganese and silicon are respectively 1.50 and 0.55

When the manganese content exceeds 1.5 % and is less than 1.65 % the formula $C + \frac{Mn}{6} \leq 0.45$ may be applied if stated on the order.

*** For products thicker than 16 mm, a maximum carbon content of 0.22% for ladle analysis and 0.25% for product analysis is permitted.

2.2 Mechanical properties

The mechanical properties should be as stated in Table 4 when they are determined on test pieces obtained according to the requirements of clause 4.4.

TABLE 4. — Mechanical properties

Grades	Qualities	Mechanical properties							Impact test	
		R_e kgf/mm ² , min. ⁽¹⁾			R_m kgf/mm ²	$A\%$ ($L_0 = 5.65\sqrt{S_0}$) min. ⁽²⁾		180° bend ⁽³⁾ mandrel dia.	Type of test piece and test temperature	Energy min. kgf·m *
		$e \leq 16$	$16 < e < 40$	$40 < e < 63$		$e \leq 40$	$40 < e < 63$			
Fe 33	0				52 max.			3a***		
Fe 37	A	24	23	22	37 to 45	26	25	2 a	—	—
	B	24	23	22	37 to 45	26	25	2 a	V at ambient temp. ⁽⁵⁾	2.8 **
	C	24	23	22	37 to 45	26	25	2 a	V at 0 °C	2.8 **
	D	24	23	22	37 to 45	26	25	2a ⁽⁴⁾	V at -20 °C	2.8 **
Fe 42	A	26	25	24	42 to 50	23	22	3 a	—	—
	B	26	25	24	42 to 50	23	22	3 a	V at ambient temp. ⁽⁵⁾	2.8 **
	C	26	25	24	42 to 50	23	22	3 a	V at 0 °C	2.8 **
	D	26	25	24	42 to 50	23	22	3a ⁽⁴⁾	V at -20 °C	2.8 **
Fe 44	A	28	26	25	44 to 52	23	22	3 a	—	—
	B	28	26	25	44 to 52	23	22	3 a	V at ambient temp. ⁽⁵⁾	2.8 **
	C	28	26	25	44 to 52	23	22	3 a	V at 0 °C	2.8 **
	D	29	27	26	44 to 52	23	22	3 a	V at -20 °C	2.8 **
Fe 52		$e \leq 16$	$16 < e < 30$	$30 < e \leq 50$		$e \leq 30$	$30 < e \leq 50$			
	B	36	35	34	50 to 62	22	21	3 a	V at ambient temp. ⁽⁵⁾	2.8 **
	C	36	35	34	50 to 62	22	21	3 a	V at 0 °C	2.8 **
	D	36	35	34	50 to 62	22	21	3 a	V at -20 °C	2.8 **

* Average of values obtained on at least 3 test pieces and not more than 6 test pieces.

** A value of 2.8 kgf·m corresponds to an impact of 3.5 kgf·m/cm².

*** a = thickness of the bend test piece.

⁽¹⁾ In qualities Fe 37-A and B, Fe 42-A and B and Fe 44-A and B, for plates and for flats wider than 400 mm, these values can be reduced by 2 kgf/mm². When, however, it is required in the order that the yield stress values shown for these products in the table should be maintained, the upper limit of the range of tensile strength may be exceeded by 3 kgf/mm².

⁽²⁾ For transverse test pieces, for plates and for flats wider than 400 mm, these values may be reduced by 2 points.

⁽³⁾ For transverse test pieces, for plates and for flats wider than 400 mm, these values may be increased by 0.5 a except for grade Fe 33-0.

⁽⁴⁾ For products up to and including 16 mm thickness, these values are reduced by 0.5 a in the case of grade Fe 37 and by 1 a in the case of grade Fe 42.

⁽⁵⁾ For quality B steels, the impact value need be determined only if stated on the order.

3. MANUFACTURE

3.1 Process of manufacture

The process of manufacture, except for qualities 0 and A, may be specified on the order after agreement between the purchaser and the supplier.

When the process of manufacture is not stated on the order, it is left to the choice of the producer; it should, however, be stated on his advice note to the purchaser (see Annex and ISO Recommendation R 404, *General Technical Delivery Requirements for Steel*).

3.2 Defects

Internal or surface defects not prejudicial to the uses or proper application of the product should not be ground for rejection or claim.

3.2.1 Removal of surface defects

3.2.1.1 Less important defects can be removed by the producer by grinding, provided that the thickness is not reduced locally by more than 4% (with a maximum of 3 mm) in relation to its nominal value. For reductions greater than 4%, but not exceeding 7%, the agreement of the purchaser or his representative is necessary.

3.2.1.2 More important defects, that cannot be corrected by the method stated in clause 3.2.1.1 above, may, with the agreement of the purchaser or his representative, be corrected by grinding or chipping followed by welding, subject to the following conditions:

- (a) after complete removal of the defect and before welding, the thickness should not have been reduced by more than 20% of its nominal value;
- (b) the welding should be carried out by skilled welders and approved by the purchaser, according to a procedure suited to the grade of steel and accepted by the purchaser;
- (c) the extra thickness of the weld metal should be removed by grinding.

In the case of flat products, if the repair by welding has been carried out on a rough product in the "as rolled" condition, a normalizing treatment should be considered. If the welding repair has been carried out on a product already normalized, another normalizing treatment is always necessary.

4. INSPECTION REQUIREMENTS

Rolled products covered by this ISO Recommendation should be the subject of a technical inspection which will involve only the verification of the chemical composition and mechanical properties defined in Tables 3 and 4. It is not usual to require this for grade Fe 33-0. The verifications of chemical composition on the product and of the impact values at ambient temperature (for rimming steel) are only carried out if required by the order.

4.1 Inspection unit

If inspection is required by the order, the inspection unit is drawn from the following:

- (a) the batch *: all grades or qualities except qualities C and D; or
- (b) the cast: all grades.

The method of batching should be stated on the order.

* A batch is defined as the product of one or several casts of similar quality and grade rolled into one class of product and submitted for inspection at the same time.

The inspection unit is

- 20 t or fraction thereof for acceptance by batches;
- 40 t or fraction thereof for acceptance by cast.

4.2 Number and nature of tests

For each inspection unit or thickness range as shown in Table 4, a series of tests is carried out comprising

- 1 tensile test (or 2, in accordance with clause 4.3.1 (b)),
- 1 bend test (or 2, in accordance with clause 4.3.1 (b)),
- 3 impact tests at 0 °C for quality C, and 3 tests at -20 °C for quality D, and, if specified on the order
- 1 product analysis,
- 3 impact tests at ambient temperature for quality B (rimming steel only).

4.3 Selection of test samples

The purchaser or his representative may choose the products from which are selected the test samples for the verification of the properties.

In the absence of any indication by the purchaser, the following procedure should be adopted:

4.3.1 Tensile and bend tests. If the thickness of the products comprising the inspection unit

- (a) does not differ by more than 10 mm, the series of test samples should be taken from a product of average thickness,
- (b) differs by more than 10 mm, one series of test samples should be taken from the thinnest product and another from the thickest product.

4.3.2 Impact test. The test samples should be taken from the thickest product.

For quality D, if stated on the order, a test sample should be taken from each product in the delivery condition.

4.4 Position and orientation of test samples for test pieces (see diagrams in section A.3 of Annex)

4.4.1 Plates and flats wider than 400 mm. The test samples are so taken that the axis of the test piece is midway between the axis in the direction of rolling and the edge of the rolled product.

4.4.1.1 The axis of tensile and bend test pieces may be longitudinal or transverse to the direction of rolling.

4.4.1.2 The axis of impact test pieces is always parallel to the direction of rolling.

- 4.4.2 *Sections, joists and wide flats having a width of 400 mm or less.* The longitudinal axis of the test pieces is parallel to the direction of rolling.

The test samples are so taken that the axis of the test piece is 1/3 from the outer edge of the half flange (for joists) or of the flange (for sections), or, in the case of small sections, as near as possible to this position. When non-rimming steel is used, it is permissible, in the case of sections having tapered flanges, to take the test samples from the 1/4 position of the web.

- 4.4.3 *Rounds, squares, wide flats, hexagons and other similar products.* The longitudinal axis of the test pieces is parallel to the direction of rolling.

For small sizes, the test piece consists of a length of the product (the impact test piece receiving nevertheless the necessary machining).

In other cases, the test samples are so taken that the axis of the test piece lies as nearly as possible

- for a non-cylindrical test piece, at 1/3 of the half width,
- for a cylindrical test piece, at 1/3 from the outside of the half-diagonal or of the half-diameter.

- 4.4.4 *Circular, square and rectangular hollow sections.* The longitudinal axis of the test piece is parallel to the direction of rolling.

For small sizes the tensile test piece consists of a length of the product, the ends of the length being plugged for grips, if necessary.

Tensile test pieces of strips cut from round hollow sections are tested in the curved condition, but the ends may be flattened cold for grips.

For square and rectangular hollow sections the test pieces are cut from any side midway between and excluding the corners.

5. TEST METHODS

- 5.1 **Tensile test** (see ISO Recommendation R 82, *Tensile Testing of Steel*).

The test piece used is the proportional non-cylindrical or cylindrical test piece having an original gauge length given by the formula $L_0 = 5.65 \sqrt{S_0}$, where S_0 is the cross-sectional area of the gauge length portion of the test piece.

The non-cylindrical test piece of rectangular cross-section has a maximum width on the gauge length portion of 40 mm, its thickness being that of the product. However, if the thickness of the product exceeds 30 mm, the test piece can be reduced to 30 mm by planing or milling on one face only.

The cylindrical test piece has a diameter of 10 to 30 mm, the original gauge length being determined by the above formula.

The non-proportional test piece with a fixed original gauge length (200 mm) can be used in conjunction with a conversion table. In cases of dispute, however, only the results obtained on a proportional test piece will be valid.

- 5.1.1 The yield stress, as covered by this ISO Recommendation, corresponds to the stress at which there is for the first time a hesitation, a stop or a recoil of the measuring apparatus. The speed of the testing machine is defined in ISO Recommendation R 82.

- 5.2 **Bend test** (see ISO Recommendation R 85, *Bend Test for Steel*).

The test piece of rectangular section has a width greater than or equal to 30 mm, its thickness being that of the product. If, however, the thickness of the product exceeds 30 mm, the test piece can be reduced to 30 mm by planing on one face only. In this case, the bend is so made that the remaining rolled surface is on the outside of the bend.

5.3 Impact test

The impact test is normally carried out on products having a thickness greater than or equal to 12 mm. The test piece is so machined that one face is not more than 1 mm from the original rolled surface; the direction of the notch is perpendicular to the rolled surfaces.

If stated on the order, impact tests may be carried out on products having a thickness less than 12 mm *, the energy values being fixed by agreement.

This test is carried out using a V-notch test piece (see ISO Recommendation R 148, *Beam Impact Test (V-notch) for Steel*, the value for consideration being the arithmetic mean of the results obtained on 3 test pieces taken side by side in the same product, unless there are reasons for an additional test (see clause 5.5).

5.4 Cancellation of tests

When, owing to any fault in carrying out the test, the test does not give the results specified, it is cancelled. By fault is understood defective machining, incorrect mounting in the testing machine, malfunctioning of the machine or any other similar faults independent of the metal itself.

5.5 Additional tests **

If, during the course of inspection, a test does not give the required result, additional tests, unless otherwise agreed, can be made as follows:

When a test piece having a defect gives the required results, the batch is accepted, but the corresponding product can be submitted to an examination for soundness.

5.5.1 Tensile and bend tests

5.5.1.1 Defective test piece: unsatisfactory results. From the same product a test piece is taken for an additional test of the same type. If the result of this test does not meet the requirements, the product is rejected, but a further test of the same type is carried out on test pieces taken from two other products of the same batch of the same thickness. If one of these two tests does not give satisfactory results, the batch is rejected (see section 6); if, however, both the further tests are satisfactory, the batch is accepted.

5.5.1.2 Sound test piece: unsatisfactory results. The corresponding product is rejected and two further tests are carried out under the same conditions and with the same provisos as above (see clause 5.5.1.1).

5.5.2 Impact test. If the average of the first 3 results recorded is less than the specified value, a further determination is made on 3 additional test pieces taken from the same product.

* However, it is conceded that products having a nominal thickness of between 10 and 12 mm may require an impact test, one or both of the rolled surfaces being left on the test piece.

** See also the Annex of ISO Recommendation R 404, *General Technical Delivery Requirements for Steel*.