INTERNATIONAL STANDARD

ISO 610

Second edition
1990-08-15

High-tensile steel chains (round link) for chain conveyors and coal ploughs

Chaînes en acier à haute résistance à la traction (à maillons ronds) pour convoyeurs à chaînes et rabots à charbon

Reference number
ISO 610:1990(E)

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.

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.

International Standard ISO 610 was prepared by Technical Committee ISO/TC 82, *Mining*.

This second edition cancels and replaces the first edition (ISO 610:1979), of which it constitutes a technical revision. All references to ISO/R 147 have been replaced by a reference to ISO 7500-1.

Annexes A, B, C, D, E and F of this International Standard are for information only.

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

High-tensile steel chains (round link) for chain conveyors and coal ploughs

1 Scope

This International Standard specifies the requirements for a range of high-grade special purpose calibrated, high-tensile, electrically welded, steel chains (round link) for use with machines and equipment in mining, such as the following:

a) conveyors, flexible and rigid, of the chain type, chain belt conveyors, gate end and stage loaders;

b) coal ploughs, coal cutters and power loaders;

c) bucket elevators;

d) other similar machines used in mines.

This International Standard covers a size range from 14 mm to 30 mm. Three grades of quality (B, C and D) are specified with regard to the mechanical properties of chain. The values given for grade D in tables 3, 4, 7 and 8 are, however, provisional.

Chains covered by this International Standard are not designed for lifting appliances, such as cranes and slings.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 643:1983, *Steels — Micrographic determination of the ferritic or austenitic grain size.*

ISO 7500-1:1986, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tensile testing machines.*

3 Definitions

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

3.1 size of chain: The nominal diameter d of the steel wire or bar from which the chain is made.

3.2 breaking force: The maximum force which a sample of finished chain withstands during the course of a tensile test to destruction.

3.3 test force: The specified force to which a sample of the finished chain has to be subjected without exceeding the stated elongation.

3.4 proof force: The specified force to which, after processing (see 3.6), the whole of the chain has to be subjected without significant permanent deformation or damage.

This force may be re-applied to the whole of the new chain or to any part thereof by the purchaser or by his inspector at their discretion.

3.5 percentage elongation: The extension expressed as a percentage of the gauge length.

3.6 processing: Any treatment of the chain subsequent to welding, for example heat treatment, calibration or surface treatment.

3.7 calibration: The application of force to the whole of the chain during the production process to control the link dimensions.

3.8 elastic limit: The maximum force which can be applied to the chain without producing permanent deformation.

3.9 setting force: The force applied to hold the sample under tension while the gauge length is marked and/or the extensometer is fitted.

NOTE 1 Other technical terms are illustrated in the force-extension diagram given in annex A .

3.10 inspector: The representative of the purchaser.

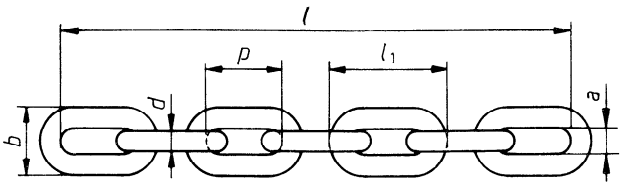


Figure 1 — Dimensions of chains

4 Dimensions of chains

The dimensions of chains shall be as shown in figure 1 and figure 2 and table 1.

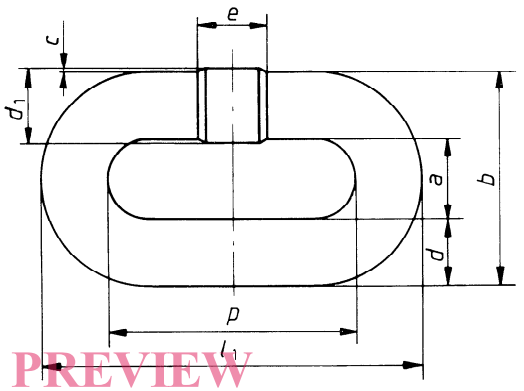


Figure 2 — Chain link dimensions

Table 1 — Chain link dimensions and mass

Dimensions in millimetres

1	2	3	4	5	6	7	8	9	10	11	12
Diameter of material in the finished link		Pitch		Width		Length		Weld			Mass per unit length
Nominal diameter d	Tolerance	Nominal p	Tolerance	Inside a min.	Outside b max.	Nominal l_1	Tolerance	Allowable offset c max.	Diameter d_1 max.	Length e	≈ kg/m
14	± 0,4	50	± 0,5	17	48	78	+ 0,5 − 1,3	0,4	15	10	4
18	± 0,5	64	± 0,6	21	60	100	+ 0,6 − 1,6	0,5	19,5	13	6,6
22	± 0,7	86	± 0,9	26	74	130	+ 0,9 − 2,3	0,7	23,5	15,5	9,5
24	± 0,8	86	± 0,9	28	79	134	+ 0,9 − 2,5	0,7	26	17	11,6
24	± 0,8	87,5	± 0,9	28	79	135,5	+ 0,9 − 2,5	0,7	26	17	11,5
26	± 0,8	92	± 0,9	30	86	144	+ 0,9 − 2,5	0,8	28	18	13,7
30	± 0,9	108	± 1	34	98	168	+ 1 − 2,8	0,9	32,5	21	18

4.1 Material diameter

4.1.1 Diameter of material in the link

The diameter d of the material in the link (except at the weld) shall be as stated in column 1 of table 1, subject to the tolerance shown in column 2.

The tolerance on the diameter of material in the link shall be applied to the average of two diameters measured at right angles in the same section.

4.1.2 Weld diameter

The diameter of the weld d_1 shall be not less than the actual diameter of the steel adjacent to the weld, nor shall it exceed the diameter stated in column 10 of table 1.

The weld offset c shall not exceed the actual diameter of the wire by more than the value stated in column 9 of table 1, and shall not be below the surface of the wire.

4.1.3 Position and extent of weld

The weld or welds shall be positioned equidistant about the centre of one or both legs of the link. The area affected dimensionally by welding shall not exceed the value given in column 11 of table 1.

4.2 Pitch

The nominal pitch p of the link shall be as stated in column 3 of table 1, and shall be subject to the tolerances shown in column 4 of that table.

4.3 Width of link

4.3.1 Inside width

The minimum inside width a of the link shall be as shown in column 5 of table 1, except at the weld.

4.3.2 Outside width

The maximum outside width b of the link shall be as shown in column 6 of table 1, except at the weld.

4.4 Length of link

The nominal length l_1 of the link shall be as stated in column 7 of table 1 and shall be subject to the tolerances stated in column 8 of that table. This is the theoretical length of the link and may be greater than the actual overall length due to flattening during manufacture.

4.5 Multiple pitch length

4.5.1 Nominal multiple pitch length

The nominal multiple pitch length l (see figure 1 and annex B, annex C and annex D) is the nominal pitch of the chain multiplied by the number of links specified. The number of links per length (being an odd number) shall be stated at the time of ordering.

4.5.2 Tolerance on actual multiple pitch length

The actual multiple pitch length of the chain shall be measured on the chain in the finished condition under the setting force stated in table 5. (See 6.5.3.)

The length so measured shall not vary from the sum of nominal inside lengths (i.e. pitches) of the individual links by more than

$$\pm \frac{p}{100}(1 + 0{,}15n)$$

where

p is the nominal pitch;

n is the specified number of links.

4.6 Matching of lengths

Where chain is required in short lengths having a specified number of links for use in double or triple chain conveyors, it shall be ordered and supplied in "matched lengths".

When measured under the setting force stated in table 5, the difference between any two matched lengths shall not be greater than:

a) 0,1 % of the multiple pitch length, for lengths up to 2 m;

b) 0,15 % of the multiple pitch length, for lengths greater than 2 m.

If the purchaser requires chain with tighter matching tolerances, they shall be the subject of special agreement between the purchaser and the manufacturer. An example of tighter matching tolerances is given in annex C.

4.7 Mass

The approximate mass per metre of single chain calculated on nominal dimensions is stated in column 12 of table 1.

5 Material and manufacture

5.1 Quality of material

The chain shall be made from steel which, in its finished state as supplied to the chain manufacturer, shall meet the following requirements:

a) The steel shall be fully killed and shall possess reliable welding properties.

b) The content of sulfur and phosphorus shall be as shown in table 2.

Table 2 — Content of sulfur and phosphorus

Element	Cast analysis		Check analysis	
	Quality B	Qualities C and D	Quality B	Qualities C and D
Sulfur, max.	0,040 %	0,030 %	0,045 %	0,035 %
Phosphorus, max.	0,035 %	0,030 %	0,040 %	0,035 %

c) The steel shall be of such composition as to guarantee the mechanical properties of the chain after appropriate heat treatment. For grades C and D, an alloy steel containing alloying elements (such as nickel, chromium and molybdenum) shall be used. Care shall be exercised in the choice of steel so that the achievement of high ultimate tensile stress in the material does not result in the disproportionate loss of other properties, particularly notch toughness.

d) The steel shall be made in conformity with fine grain practice to give an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be accomplished, for example, by ensuring that it contains sufficient aluminium or an equivalent element to allow the manufacture of chain stabilized against strain age embrittlement during service; a minimum value of 0,020 % metallic aluminium is quoted for guidance, and to safeguard weldability, a maximum of 0,055 %. For grade B chain, however, this may be slightly relaxed, a grain size of 4 being acceptable.

Within the above limitations it shall be the responsibility of the chain maker to select the steel so that the finished chain, suitably heat treated, possesses the specified mechanical properties.

The steel wire or bar used for the links shall be cleanly finished and shall be free from harmful flaws and surface defects. If requested by the purchaser, the following information shall be supplied:

a) the method of steel manufacture and the steelmaker's cast analysis;

b) an analysis of steel millings taken from, and representative of, a link which formed part of a length tested to destruction.

5.2 Heat treatment

Chain complying with this International Standard shall be heat treated in the course of manufacture. Heating to an appropriate temperature above the critical point (Ac_3) of the steel used shall form part of such heat treatment.

5.3 Workmanship

Fins caused by welding shall be removed and welds shall be smoothly finished. Any links which on visual examination show detrimental fissures, notches or similar faults shall be rejected unless the faults can be rectified by means agreed between the purchaser and manufacturer.

5.4 Links inserted in the course of manufacture

Any links which have been inserted shall be processed and inspected so as to ensure that every link in the chain is in a uniform condition.

5.5 Condition at delivery

Unless otherwise agreed between purchaser and manufacturer, chains shall be supplied unpolished and free from any coating. Different quality grades may, however, be identified by markings or by colours (see 7.2.1).

Surface finishes such as the following shall be specified at the time of ordering:

— rust preventive coating;

— polished finish;

— coloured coating;

— rumbling without abrasives.

5.6 Method of marking

Where inspection marking (see 7.2.2) or identification marking (see 7.2.1) is applied by means of stamping the chain,

a) impressed marks shall be placed on the straight sides of the links and shall in no case coincide with the weld;

b) the stamps shall have a concave surface and the indentation shall be neither too sharp nor of excessive depth.

5.7 Inspection

The whole of the finished chain shall be given a thorough visual examination by the manufacturer's competent personnel. Any fractured or defective links shall be replaced (see 5.4).

6 Test requirements

6.1 General

The dimensions and basic mechanical properties required for each size and grade of chain are summarized in table 1 and table 3. The forces stated in table 4 (for each size and grade of chain) apply to tests carried out by the manufacturer and/or the inspector, in the course of final acceptance tests.

6.2 Proof loading

The manufacturer shall proof load all chain to at least 90 % of the test force specified in table 4. If this requirement is met during the calibration process, then no separate proof load is necessary.

After proof loading, all chain shall be subjected to a thorough visual examination by the manufacturer's competent personnel. Any fractured or defective links shall be replaced (see 5.4).

Table 3 — Mechanical properties — Basic table

Mechanical properties	Quality grade of chain		
	B	C	D
Minimum breaking stress, N/mm² (MPa)	630	800	1 000
Stress at test force, N/mm² (MPa)	500	640	800
Ratio $\frac{\text{test force}}{\text{min. breaking force}}$, %	80	80[1)]	80[1)]
Maximum elongation at test force, %	1,4	1,6	1,9
Minimum total elongation at fracture, %	12	12	12

1) By agreement between purchaser and manufacturer, the ratio of test force to minimum breaking force for grade C and D quality chains of 26 mm and 30 mm may be reduced from 80 % to 75 %.

Table 4 — Mechanical properties — Specified test forces

Nominal size and pitch of chain	Grade B		Grade C		Grade D	
	Breaking force, min.	Test force	Breaking force, min.	Test force	Breaking force, min.	Test force
mm × mm	kN	kN	kN	kN	kN	kN
14 × 50	190	150	250	200	310	250
18 × 64	320	260	410	330	510	410
22 × 86	480	380	610	490	760	610
24 × 86	570	460	720	580	900	720
24 × 87,5	570	460	720	580	900	720
26 × 92	670	540	850	680[1)]	1 060	850[1)]
30 × 108	890	710	1 130	900[1)]	1 410	1 130[1)]

1) By agreement between purchaser and manufacturer, the ratio of test force to minimum breaking force for grade C and D quality chains of 26 mm and 30 mm may be reduced from 80 % to 75 %.

6.3 Selection of samples

Unless otherwise specified by the purchaser, the following sampling arrangements shall apply. This shall not preclude the inspector asking for such further samples as he may deem necessary.

a) Test samples shall be selected at random, shall be in the same condition as the bulk of the chain and shall be free from any coating which might obscure defects.

b) For sampling purposes, the chain shall be divided into lots, one lot measuring 200 m of chain or 200 lengths of chain of 1 m or less each; an excess fraction is to be considered as a complete lot.

c) In the case of chains supplied in long lengths, the samples should initially be taken from each end of the finished chain. If considered necessary by the inspector, samples may be taken from any point along the length of the chain.

d) Dimensional tests: five individual links shall be taken at random from each lot of finished chain.

e) Static tensile tests: two samples shall be taken from each lot of finished chain. For 14 and 18 mm chain, each sample shall contain seven links. For 22 mm and above, each sample shall contain five links.

f) Bend test: a single link sample shall be taken from each lot.

g) Fatigue tests: one sample of three links shall be taken from five lots or from the order if less than five lots.

h) Notch impact tests: three single links shall be taken from five lots or from the order if less than five lots.

6.4 Dimensional tests

The requirements of clause 4 for link dimensions shall be verified.

6.5 Static tensile test

6.5.1 Testing machine

The testing machine used shall be such as to satisfy the requirements of this test procedure and shall be in accordance with class 1 of ISO 7500-1 or equivalent national standard.

The testing machine shall be used only within its appropriate range as shown by the test certificate for the machine.

The straining mechanism of the testing machine shall be sufficiently long to allow a test sample of chain of the full length of the testing bed to be subjected to the test load without the necessity for taking a fresh hold to complete the strain.

The testing machine shall be equipped with an autographic recorder which permits a force-extension diagram to be derived during the test (see annex A).

The diagram produced by the autographic recorder on the machine shows the relative movements between the machine crossheads.

6.5.2 Chain anchorages

The anchorages for the chain sample shall be as shown in figure 3.

6.5.3 Elongation under test force

The test shall be carried out in the following manner:

Insert the sample into the anchorages of the testing machine and subject it to a force equal to half the test force stated in table 4.

Then decrease the force to the setting force stated in table 5.

With the sample held under this setting force, mark out a gauge length (see table 5) and attach the extensometer, where used, to the sample. Then raise the force to the test force specified in table 4 at a maximum rate of 20 kN/s. When this test force has been reached, record the amount of extension.

Divide the extension thus measured by the gauge length and multiply by 100.

The percentage total elongation determined in this manner shall not exceed the appropriate value shown in table 3.

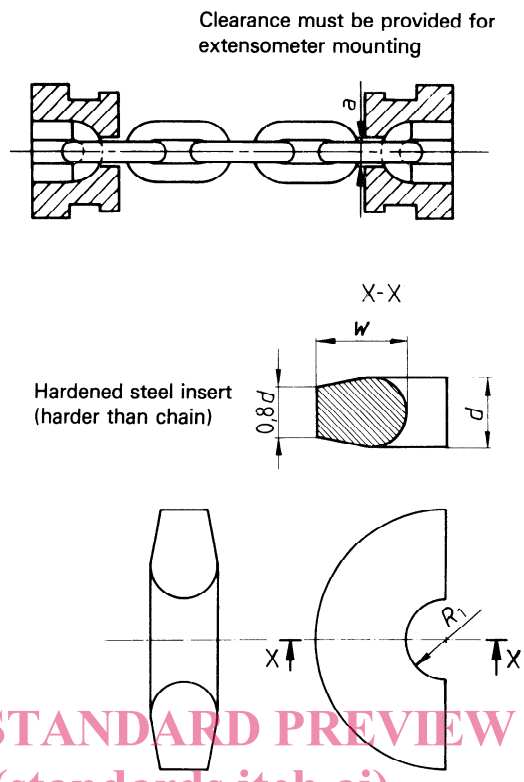
6.5.4 Breaking force

Following the application of the test force (and removal of the extensometer if necessary), raise the force further until the sample fractures.

The breaking force (see definition in 3.2 and annex A) shall be not less than the appropriate force stated in table 4.

6.5.5 Total elongation at fracture

The total elongation at fracture (see annex A) shall be not less than the appropriate value stated in table 3.



a = dimension as table 1

d = nominal diameter of chain material

$R_1 = \frac{a}{2}$

w depends on anchorage

NOTE — Half a chain link may be used as an alternative to the hardened steel insert.

Figure 3 — Chain anchorage for static tensile test

Table 5 — Gauge length and setting force

Nominal size and pitch of chain, mm × mm	**14 × 50**	**18 × 64**	**22 × 86**	**24 × 86** **24 × 87,5**	**26 × 92**	**30 × 108**
Gauge length, mm	200	250	350	350	350	450
Setting force, kN	8	13	19	23	26	35

The total elongation is derived from the force-extension diagram made during the test (see annex A). The value measured is multiplied by 100 and divided by the nominal multiple pitch length of the sample, the result giving the total elongation as a percentage.

6.6 Additional tests

6.6.1 Fatigue test (optional)

6.6.1.1 General

The fatigue test is not mandatory. It is an optional test which may be used as an additional acceptance criterion, subject to agreement between purchaser and manufacturer at the time of order.

6.6.1.2 Principle

Subjection of a length of chain to a repeated force (between a lower limit and an upper limit) at a given frequency.

The number of cycles sustained before the sample breaks constitutes the fatigue resistance (or endurance) of the sample.

6.6.1.3 Conditions of test

Fatigue tests should be performed under the following conditions.

6.6.1.4 Testing machine

The testing machine used and the chain anchorages employed shall be such as to satisfy the requirements of this test procedure. A suitable type of anchorage and the approved design of pin are shown in figure 4 and figure 5. The type and accuracy of the testing machine shall be suitable for applying the forces specified in table 8.

The machine shall be calibrated statically, where appropriate, in accordance with the class 1 requirements of ISO 7500-1. Compensation for dynamic effects should not be based on calculations, but the actual forces on the test piece should be checked occasionally by some electrical measuring device that can be mounted in the machine in series with the sample.

6.6.1.5 Chain anchorages

The chain anchorages shall comprise an anchorage pin (as shown in figure 4) and an anchorage fork (as shown in figure 5). The dimensions of the pin are given in table 6.

6.6.1.6 Lower and upper force levels

The chain sample is assembled in the testing machine and subjected to upper and lower force levels appropriate to its size and grade. The forces to be applied are stated in table 8 and these forces are based on approximate stress levels as stated in table 7.

6.6.1.7 Frequency of force application

The frequency of force application shall not be less than 200 cycles per minute and not greater than 1 000 cycles per minute. In case of dispute, check tests shall be carried out at 500 cycles per minute.

6.6.1.8 Criteria of acceptance

Each sample tested shall be deemed satisfactory if its fatigue resistance (or endurance) is not less than 30 000 cycles.

If a result is less than 30 000 cycles, two further samples shall be subjected to the same test; both should have an endurance of not less than 30 000 cycles.

The purchaser and manufacturer may, by agreement, determine the acceptance level for fatigue resistance by a statistical method as outlined in annex E.

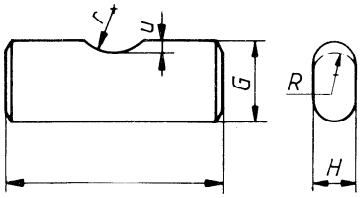
6.6.2 Bend test (optional)

6.6.2.1 General

The bend test is not mandatory. It is an optional test which may be used as an additional acceptance criterion subject to agreement between purchaser and manufacturer, at the time of order.

6.6.2.2 Testing machine

The test shall be carried out on a testing machine as described in 6.5.1.



Length not standardized

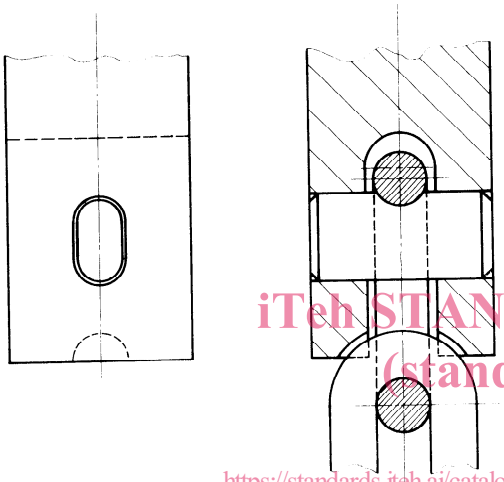
Figure 4 — Anchorage pin

Table 6 — Fatigue test — Anchorage pin dimensions

Dimensions in millimetres

Nominal size and pitch of chain	G $^{0}_{-0,1}$	H ± 0,2	R	r [1]	u [1]
14 × 50	30	14	7	9	1
18 × 64	40	18	9	11	1
22 × 86	50	22	11	13	2
24 × 86	50	24	12	14	2
24 × 87,5	50	24	12	14	2
26 × 92	55	26	13	16	2
30 × 108	60	30	15	18	2

1) Dimensions r and u are optional features.



NOTE — The machine anchorage is not standardized.

Figure 5 — Anchorage fork

Table 7 — Fatigue test — Lower and upper stress levels (approximate)

Grade B N/mm² (MPa)		Grade C N/mm² (MPa)		Grade D N/mm² (MPa)	
Lower	Upper	Lower	Upper	Lower	Upper
50	250	50	330	50	400

Table 8 — Fatigue test — Lower and upper force levels

Nominal size and pitch of chain	Grade B		Grade C		Grade D	
	Lower	Upper	Lower	Upper	Lower	Upper
mm × mm	kN	kN	kN	kN	kN	kN
14 × 50	15	77	15	102	15	123
18 × 64	25	127	25	168	25	204
22 × 86	38	190	38	251	38	304
24 × 86	45	226	45	299	45	362
24 × 87,5	45	226	45	299	45	362
26 × 92	53	265	53	350	53	425
30 × 108	71	353	71	467	71	566