International Standard 610

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

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 chaîne et rabots à charbon

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (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 set up 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 610 was developed by Technical Committee ISO/TC 82, *Mining*, and was circulated to the member bodies in March 1978.

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

Austria	India	South Africa, Rep. of
Belgium	Iran	Sweden
Bulgaria	Italy	Turkey
Czechoslovakia	Mexico	United Kingdom
France	New Zealand	USSR
Germany, F.R.	Poland	

The member body of the following country expressed disapproval of the document on technical grounds :

Australia

This International Standard cancels and replaces ISO Recommendation R 610-1967, of which it constitutes a technical revision.

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INTERNATIONAL STANDARD ISO 610-1979 (E)/ERRATUM

TC 82

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ERRATUM

Page 1

Top of page: "Draft International Standard" should read "International Standard".

Page 7

Replace figure 3 by the new figure given below. The dimension *d* should refer to the maximum width of the cross-hatched part of the hardened steel insert and not the maximum width of the insert.

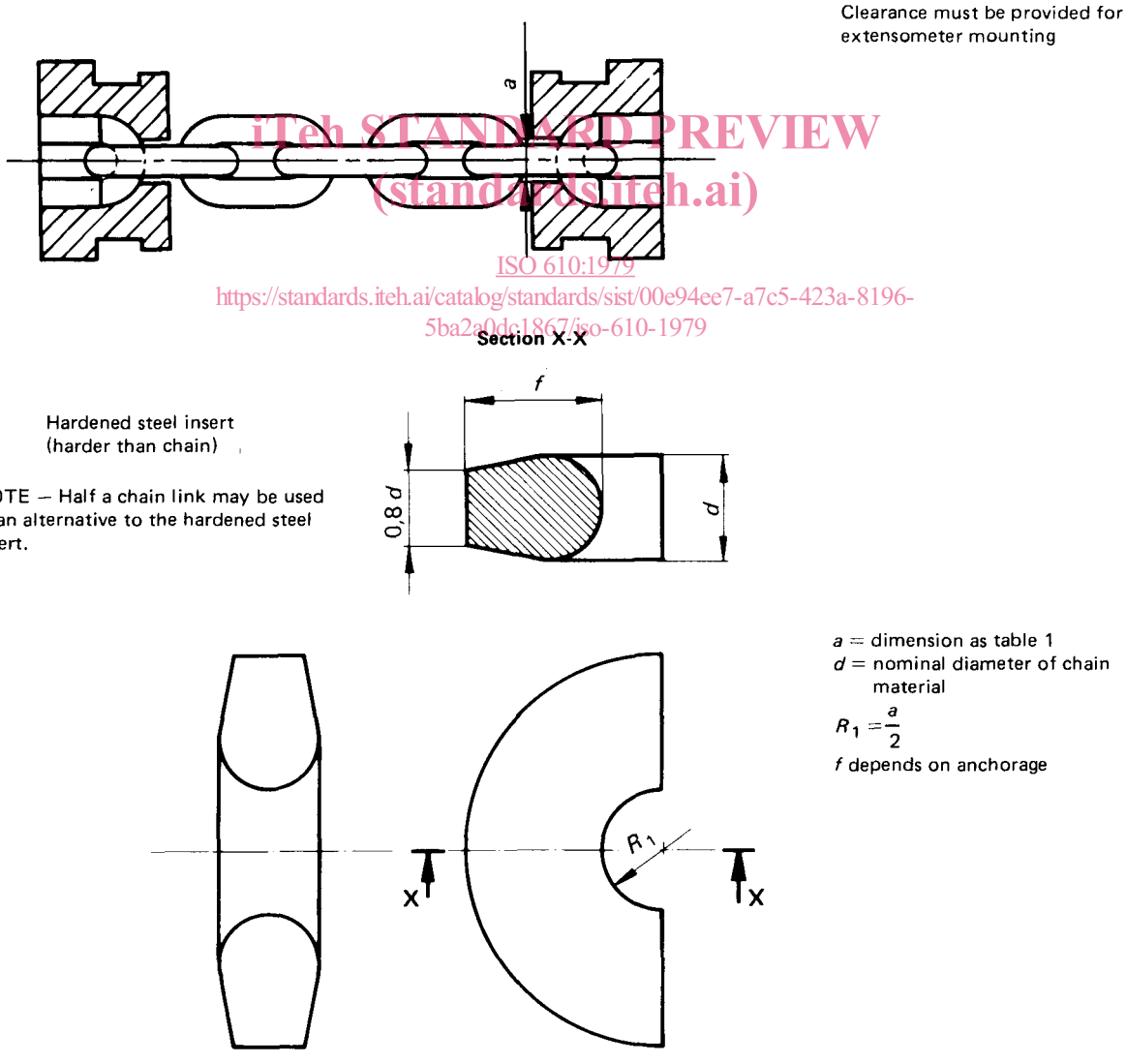


FIGURE 3 – **Chain anchorage for static tensile test**

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

1 SCOPE AND FIELD OF APPLICATION

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 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 REFERENCES

ISO 83, *Steel - Charpy impact test (U-notch).*

ISO/R 147, *Load calibration of testing machines for tensile testing of steel.*

ISO/R 643, *Micrographic determination of the austenitic grain size of steels.*

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

3.10 inspector : The representative of the purchaser.

4 DIMENSIONS OF CHAINS

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

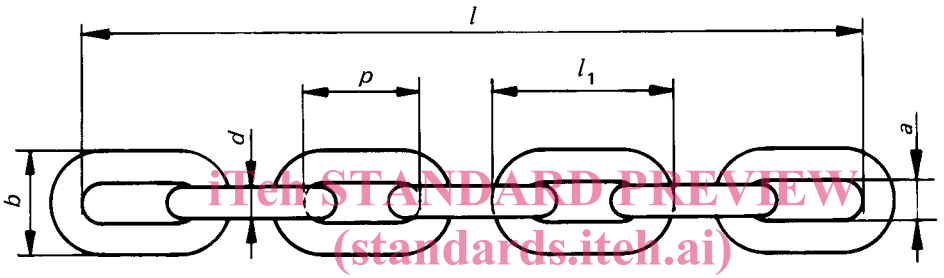


FIGURE 1 – **Dimensions of chains**

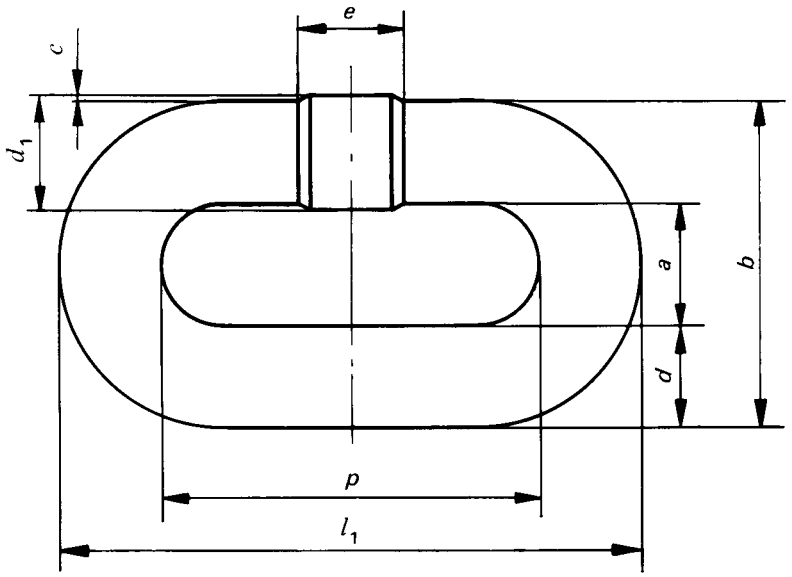


FIGURE 2 – **Chain link dimensions**

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** ≈ kg/m
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*	
14	± 0,4	50	± 0,5	17	48	78	+ 0,5 − 1,3	0,4	15	10	4,0
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	± 1,0	34	98	168	+ 1,0 − 2,8	0,9	32,5	21	18,0

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 annexes B, C and 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

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

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) for lengths up to 2 m : 0,10 % of the multiple pitch length;

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

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 sulphur and phosphorus shall be as shown in table 2.

TABLE 2 – **Content of sulphur and phosphorus**

Element	Cast analysis		Check analysis	
	Quality B	Qualities C and D	Quality B	Qualities C and D
Sulphur, 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/R 643. This could be accomplished, for example, by ensuring that it contains sufficient aluminium or 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 :

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

2) 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 Conditions 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 those listed below 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 tables 1 and 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.

TABLE 3 — **Mechanical properties — Basic table**

Mechanical properties		Quality grade of chain		
		B	C	D
Minimum breaking stress	N/mm^2 (MPa)	630	800	1 000
Stress at test force	N/mm^2 (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

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.

TABLE 4 — **Mechanical properties — Specified test forces**

Chain size and pitch mm	Grade B		Grade C		Grade D	
	Breaking force, min. kN	Test force kN	Breaking force, min. kN	Test force kN	Breaking force, min. kN	Test force 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 and 30 mm may be reduced from 80 to 75 %.

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).

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 : 5 individual links shall be taken at random from each lot of finished chain.

e) Static tensile tests : 2 samples shall be taken from each lot of finished chain. For 14 and 18 mm chain, each sample shall contain 7 links. For 22 mm and above, each sample shall contain 5 links.

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

g) Fatigue tests : one sample of 3 links shall be taken from 5 lots or order if less than 5 lots.

h) Notch impact tests : 3 single links shall be taken from 5 lots or order if less than 5 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/R 147 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 N/mm^2 per second. 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*

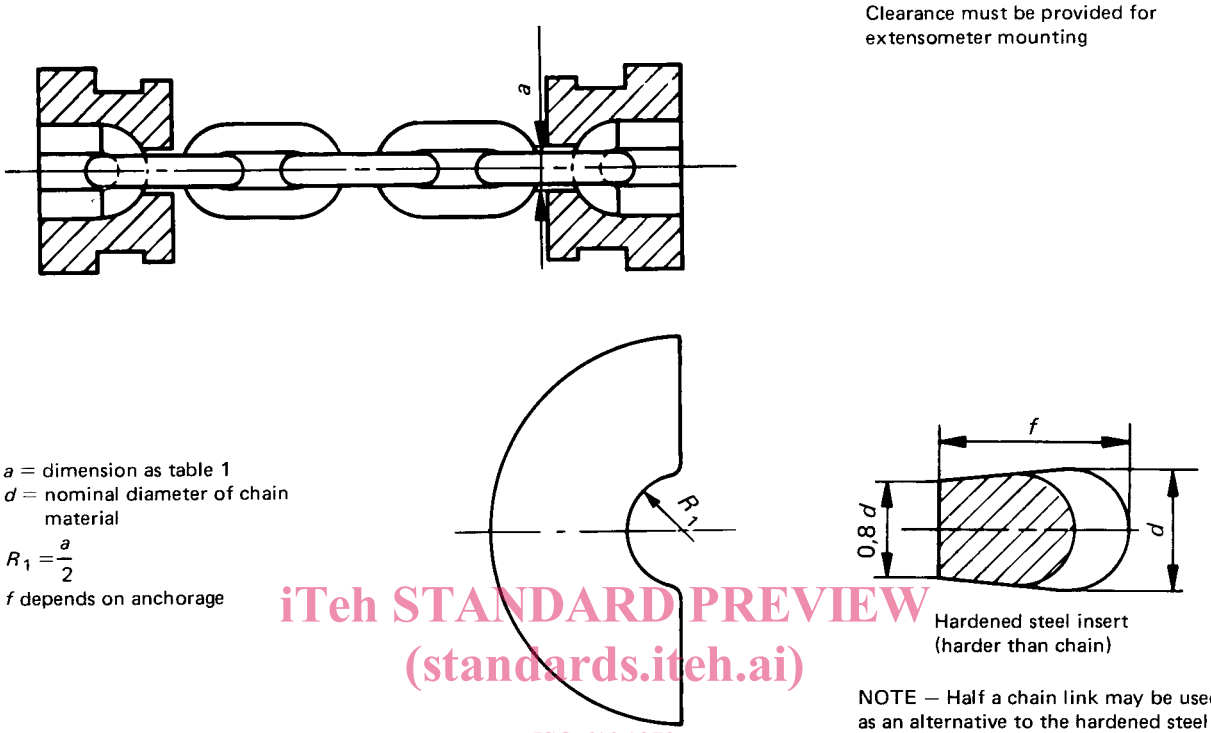
Following the application of the test force (and removal of the extensometer if necessary), raise the force further until the sample fractures.

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.

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



a = dimension as table 1
d = nominal diameter of chain material
$R_1 = \frac{a}{2}$
f 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**

Chain size and pitch	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