International Standard 7593

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

Chain slings assembled by methods other than welding — Grade T(8)

Élingues à chaînes assemblées par d'autres méthodes que le soudage — Classe T(8)

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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.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

International Standard ISO 7593 was prepared by Technical Committee ISO/TC 111, *Round steel link chains, lifting hooks and accessories*.

Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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INTERNATIONAL STANDARD ISO 7593-1986 (E)

Chain slings assembled by methods other than welding — Grade T(8)

1 Scope and field of application

This International Standard specifies the requirements, method of rating and testing of single-, two-, three- and four-branch[1] chain slings assembled by methods other than welding, using grade T(8) chain conforming to ISO 1834 and ISO 3076, together with the appropriate range of components.

This International Standard does not apply to chain slings assembled by welding (see ISO 4778), to slings designed to have branches of unequal nominal reach, to endless slings, or to slings designed for special applications.

2 References

ISO 643, *Steels — Micrographic determination of the ferritic and austenitic grain size.*

ISO 1834, *Short link chain for lifting purposes — General conditions of acceptance.*

ISO 3056, *Non-calibrated round steel link lifting chain and chain slings — Use and maintenance.*

ISO 3076, *Short link chain for lifting purposes — Grade T(8), non-calibrated, for chain slings, etc.*

ISO 4778, *Chain slings of welded construction — Grades M(4), S(6) and T(8).*

ISO 7597, *Forged steel lifting hooks with point and eye for use with steel chains of grade T(8).*

ISO 8539, *Forged steel lifting components for use with grade T(8) chain.*

3 Definitions

3.1 chain sling : An assembly consisting of chain or chains joined to upper and lower terminal fittings suitable according to the requirements of this International Standard for attaching loads to be fitted to the hook of a crane or other lifting machine. (See figures 1 to 4.)

3.2 master link : A link forming the upper terminal fitting of a chain sling by means of which the sling is attached to the hook of a crane or other lifting machine. (See figures 1 to 4.)

3.3 intermediate master link : A link used to connect one or two branches of a sling to a master link. (See figures 3 and 4.)

3.4 mechanical joining device : A means of connection, which does not depend on welding, between a chain and another component. It may be integral with the component or be a separate component. (See figure 5.)

3.5 lower terminal : A link, hook or other device fitted at the end of a branch of a sling, remote from the master link or upper terminal.

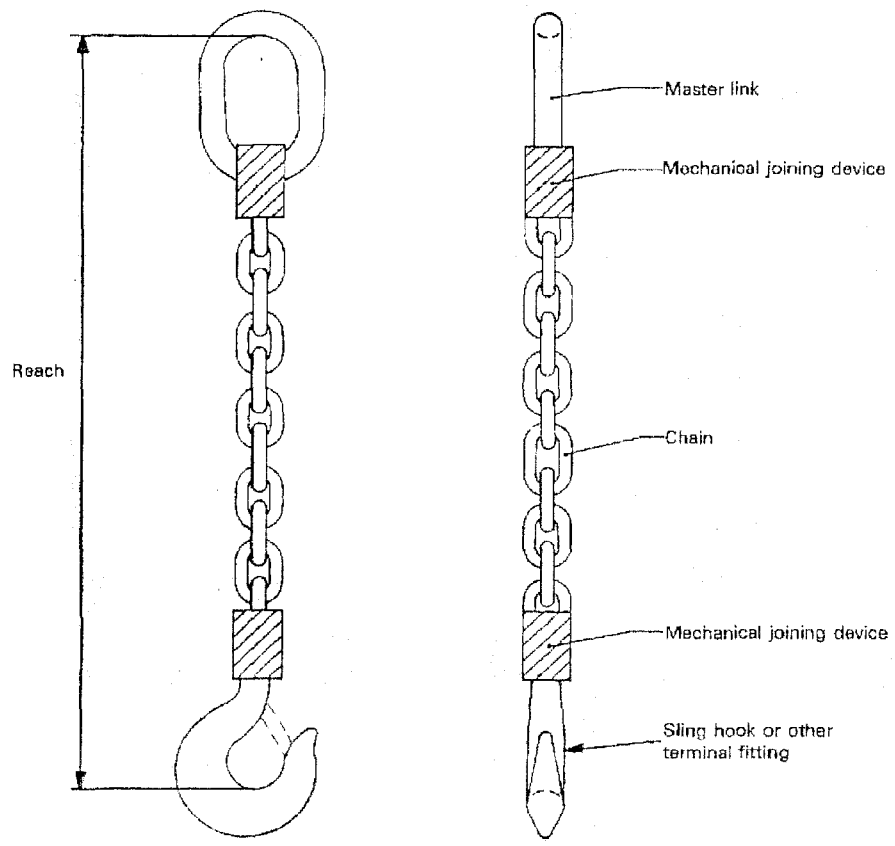
3.6 proof force, F_p : A force applied as a test to the whole sling or a force applied as a test to a section of a sling. (See clause 11.)

3.7 working load limit (WLL) : The maximum mass which a sling is designed to sustain in general service.

3.8 working load (WL) : The maximum mass which a sling should be used to sustain in a particular stated service.

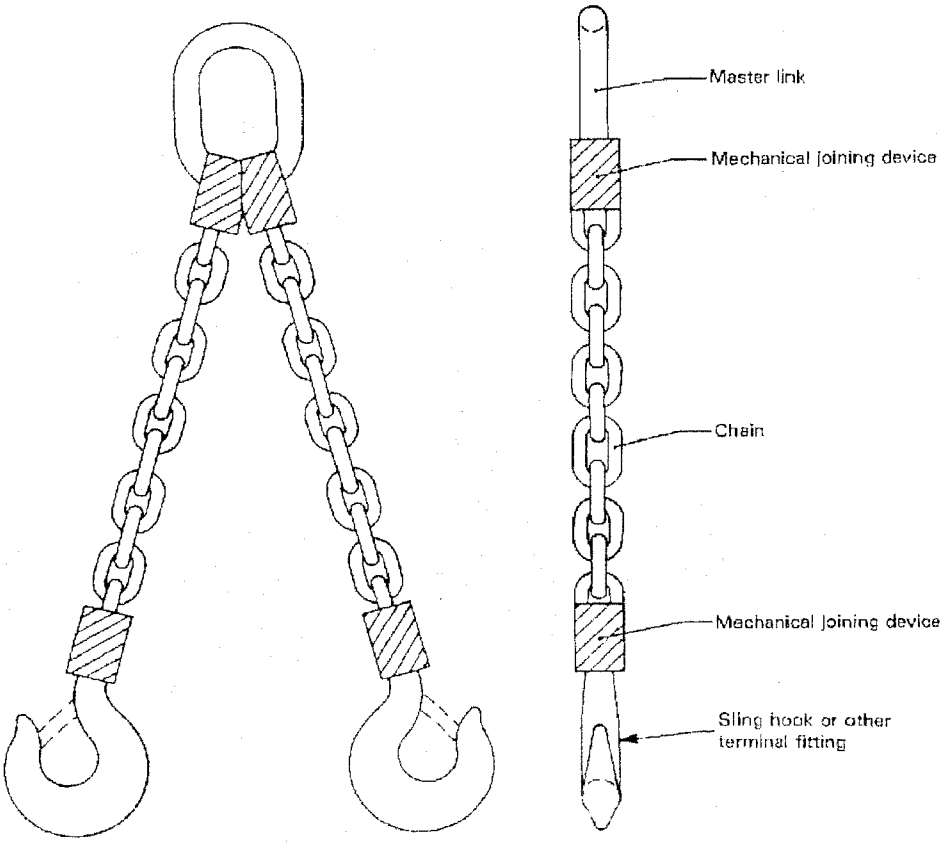
3.9 competent person : A designated person, qualified by knowledge and practical experience, and with the necessary instructions to enable the required examination to be carried out. (See clause 9.)

1) The term "branch" or "leg" may be used.



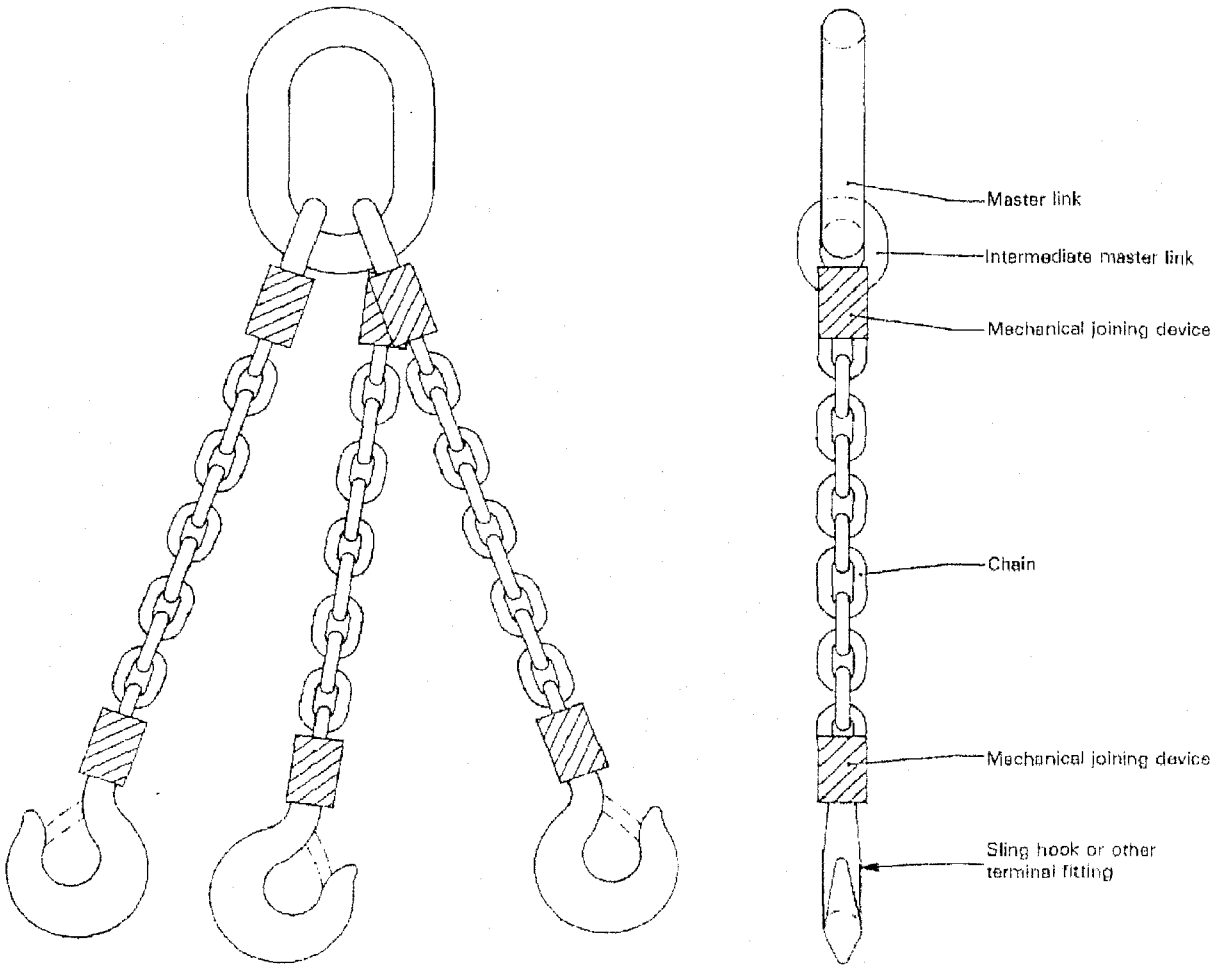
NOTE — The sling shown in figure 1 is an example of a typical form of a single-branch sling; figure 1 is intended to illustrate the terms used, but is not intended to limit the design of the sling.

Figure 1 — Single-branch sling



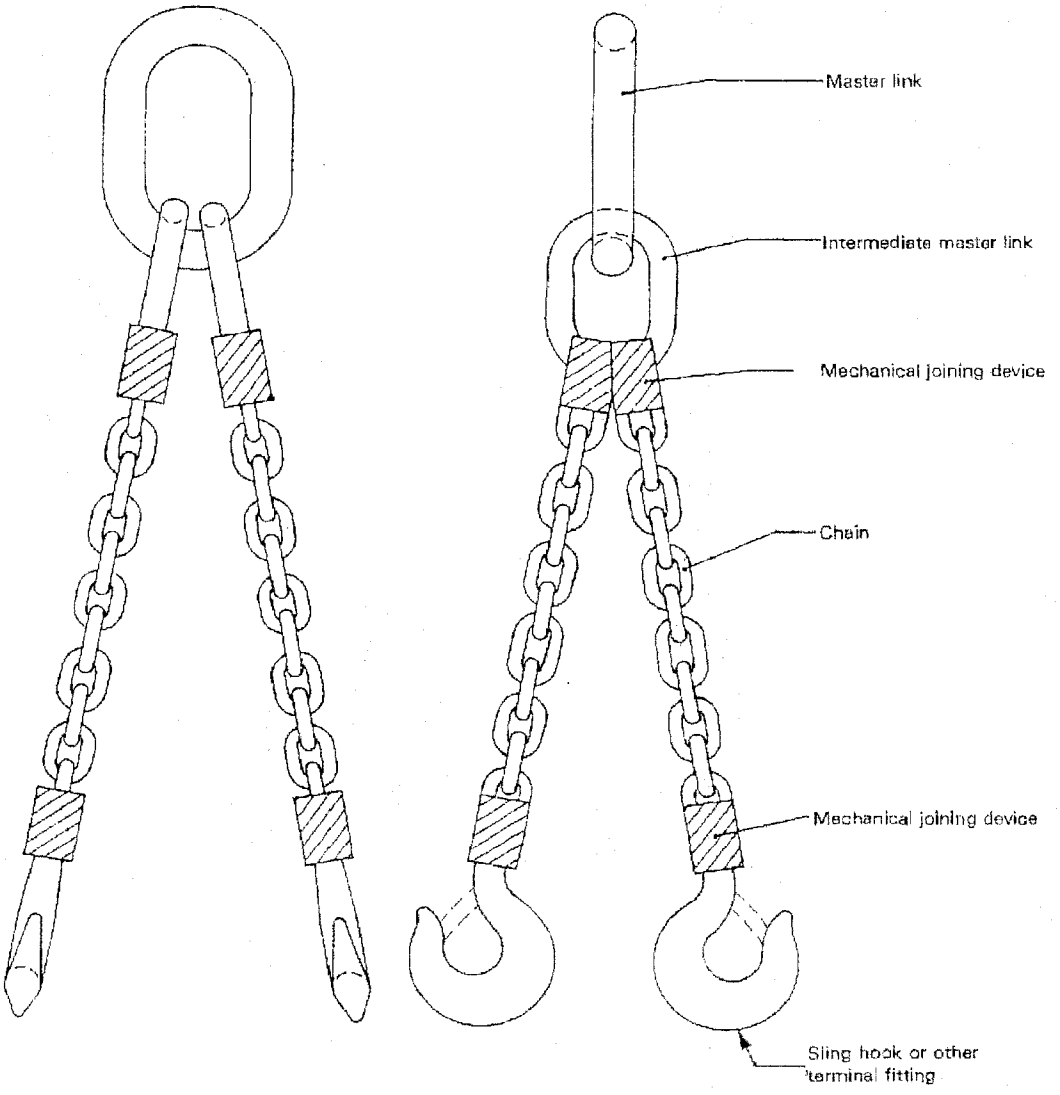
NOTE — The sling shown in figure 2 is an example of a typical form of a double-branch sling; figure 2 is intended to illustrate the terms used, but is not intended to limit the design of the sling.

Figure 2 — Double-branch sling



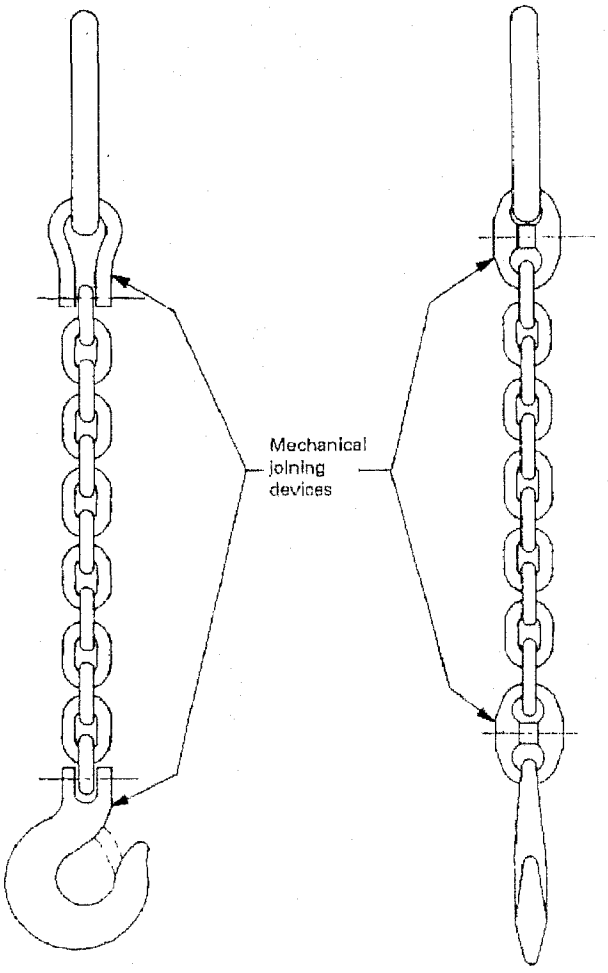
NOTE — The sling shown in figure 3 is an example of a typical form of a three-branch sling; figure 3 is intended to illustrate the terms used, but is not intended to limit the design of the sling.

Figure 3 — Three-branch sling



NOTE — The sling shown in figure 4 is an example of a typical form of a four-branch sling; figure 4 is intended to illustrate the terms used, but is not intended to limit the design of the sling.

Figure 4 — Four-branch sling



NOTE — Typical examples of mechanical joining devices are shown in figure 5; the examples illustrated are not intended to limit the design of mechanical joining devices.

Figure 5 — Mechanical joining devices

4 Designations

4.1 General

The designations laid down in 4.2 to 4.5 should be used in specifying slings which comply with this International Standard.

4.2 Nominal size

The nominal size of a chain sling is the nominal size of the short link chain used in its manufacture.

4.3 Reach of sling

The reach of a branch of the finished sling is the effective length from the inside of the lower terminal fitting to the inside of the upper terminal fitting. (See figure 1.)

4.4 Grade of sling

The nominal grade of a sling, for the purpose of its designation in accordance with this International Standard, shall be the same as the grade of the chain used, i.e. T(8). (See clause 1.)

4.5 Rating

The rating of the chain sling shall be as specified in clause 10 and table 2 or 3.

5 Design and construction

5.1 Some examples of chain sling configurations complying with this International Standard are shown in figures 1 to 4.

5.2 Egg- or pear-shaped links, i.e. those having differing radii at either end, shall only be used as master links or as lower terminals provided that the link cannot be inverted and wedging action is prevented, e.g. by using forged links with integral joining devices. Welded master links for lower terminals shall be parallel-sided, unless similar safeguards can be introduced to prevent wedging action.

5.3 The system shall be designed and manufactured so that when the system is assembled in accordance with the system manufacturer's instructions, the unintentional disconnection of any of its component parts cannot occur.

6 Dimensions, tolerances and mechanical properties

6.1 Chain

The dimensions and tolerances of the chain shall be in accordance with ISO 3076.

6.2 Master links and intermediate master links

6.2.1 The inside dimensions and the section of the material shall be such that

a) the master link fits on a crane hook with a working load limit 1,25 times greater than that of the sling;

b) the inside width of the master link is not less than 1,2 times the maximum width of the crane hook defined in a);

c) for slings with hooks as lower terminals, unless another means of securing the hooks when not loaded is provided, the inside dimensions and section are such as to allow the lower terminals to be hooked into the master link while it is on a hook as defined in a).

6.2.2 Master links and intermediate master links may be of round or other suitable section, but the section of the material shall be chosen so that

a) after proof loading (see clause 11), the master link and intermediate master links do not show any significant permanent deformation;

b) the total ultimate elongation shall be at least 17 %[1];

c) the minimum ultimate strength shall be twice the proof force (see clause 11).

6.3 Lower terminal links

6.3.1 The dimensions of the lower terminal links shall be such as to ensure free articulation of the links.

6.3.2 The section of the material shall be such that

a) after proof loading (see clause 11), the lower terminal links do not show any significant permanent deformation;

b) the total ultimate elongation shall be at least 17 %[1];

c) the minimum ultimate strength shall be not less than that specified for the chain.

NOTE — A method for calculating the section of parallel-sided master links, intermediate master links and lower terminal links is given in ISO 4778.

6.4 Mechanical joining device

The assembled mechanical joining device shall have load-carrying capabilities not less than those of the chain with which it is connected in a sling assembly. Load-carrying capabilities include, for example, working load limit, proof force and minimum ultimate strength.

1) This value does not apply to forged links having integral mechanical joining devices. However, in such cases, sufficient elongation should be achieved to demonstrate the ductility of the links.

6.5 Tolerances on reach

6.5.1 When constructing the sling, the actual reach of each branch shall be the nominal reach ordered by a purchaser $^{+\,2}_{0}$ chain link pitches.

6.5.2 When constructing a multi-branch sling, the difference in reach between the longest and shortest branches when measured under equivalent tension shall not exceed 10 mm for nominal reaches up to 2 m. For nominal reaches in excess of 2 m, the tolerance may be increased by 5 mm per metre.

7 Materials and heat treatment

7.1 General

The material and heat treatment used in the manufacturer of load-bearing components shall comply with the following requirements :

a) the chain shall comply with the requirements specified in ISO 3076;

b) components which are covered by relevant ISO International Standards, e.g. ISO 7597, shall comply with the requirements specified in those International Standards;

c) components for use with grade T(8) chain which are not covered by ISO International Standards shall comply with the material requirements specified in 7.2.

7.2 Material requirements for components not covered by ISO International Standards

7.2.1 Quality of material

7.2.1.1 General

The steel shall be produced by the open-hearth, the electric or an oxygen-blown process and shall possess reliable forging quality.

In its finished state, as supplied to the component manufacturer, the steel shall comply with the requirements specified in 7.2.1.2, as determined by check analysis on the billet, bar or finished component.

7.2.1.2 Specific requirements

The steel shall be fully killed and shall contain alloying elements in sufficient quantities to guarantee the mechanical properties of the component after appropriate heat treatment. The alloy steel used shall contain at least two of the following alloying elements :

— nickel;

— chromium;

— molybdenum.

Its content of sulfur and phosphorus shall be restricted as specified in table 1.

Table 1 — Sulfur and phosphorus content

Element	Maximum content, % (m/m), as determined by	
	cast analysis	check analysis
Sulfur	0,035	0,04
Phosphorus	0,035	0,04

The steel shall be made in conformity with fine grain practice in order to obtain an austenitic grain size of 5 or finer when tested in accordance with ISO 643. This could be achieved, for example, by ensuring that it contains sufficient aluminium or an equivalent element to permit the manufacture of components stabilized against strain-age embrittlement during service; a minimum value of 0,02 % (m/m) of metallic aluminium is given for guidance.

Within the limitations specified above, it is the responsibility of the component manufacturer to select steel so that the finished component, suitably heat-treated, complies with the requirements for the mechanical properties specified in this International Standard.

7.2.2 Heat treatment

Before proof-loading, components shall be heat treated in such a way as to achieve the required mechanical and metallurgical properties.

Components can be used up to a maximum temperature of 400 °C (see ISO 3056) without impairment or change to their metallurgical and mechanical properties when returned to room temperature. When requested, for verification, sample components shall be tested after they have been re-heated to 400 °C, maintained at that temperature for 1 h and then cooled to room temperature.

8 Manufacturing methods and workmanship

8.1 Master links, intermediate master links and lower terminals

These components shall be forged, or formed and welded.

Welding methods (where applicable), workmanship and form shall be such that the mechanical properties in clause 6 are achieved.

8.2 Manufacturing test force

In the course of manufacture, the heat-treated components, other than chain, shall be subjected to a force at least equal to the proof force specified in clause 11. Chain complying with ISO 3076 has been subjected to a force of at least 60 % of the minimum ultimate strength (see ISO 3076 : minimum breaking force).

8.3 Assembly

The assembly of the sling should only be undertaken by persons acting in accordance with the chain and component manufacturers' instructions.

8.4 Test data

Upon request to prove design, the chain or component manufacturer shall supply test data representing an actual test on any component, equivalent to that supplied.

9 Final examination

Following completion of the assembly of the sling,

a) the sling shall, when required by agreement between purchaser and supplier or where required by national regulations, be subjected to the proof force test in accordance with clause 11 and subsequently examined by a competent person (11.2); or,

b) in other cases, the sling shall be visually examined by a competent person to ensure freedom from defects provided that each component has been certified as having been tested with a force at least equal to the manufacturing test force (see 8.2).

10 Rating

10.1 Single-branch slings

Single-branch slings shall be rated at a working load limit equal to that of the chain used in their construction.

10.2 Multi-branch slings

NOTE — This sub-clause applies to symmetrically distributed loads.

10.2.1 General

There are two alternative methods of rating multi-branch slings, i.e.

— **Uniform load method** (see 10.2.2 and table 2)

The slings are rated at a uniform working load limit for any angle between branches of 0° to 90° (0° to 45° to the vertical) or, additionally, at a uniform working load limit for any angle between branches of 90° to 120° (45° to 60° to the vertical).

— **Trigonometric method** (see 10.2.3 and table 3)

The slings are rated at a working load limit according to the particular angle between branches at which the sling is to be used; for this purpose, reference is usually made to trigonometric tables.

10.2.2 Uniform load method

10.2.2.1 Double-branch slings

For all angles between branches from 0° to 90° (0° to 45° to the vertical), the working load limit (WLL) is given by the formula

$$\text{WLL} = 1{,}4 \times \text{WLL of a single branch}$$

When additionally marked for angles between branches of 90° to 120° (45° to 60° to the vertical), the working load limit (WLL) is given by the formula

$$\text{WLL} = \text{WLL of a single branch}$$

10.2.2.2 Three- and four-branch slings

For all angles between branches from 0° to 90° (0° to 45° to the vertical), the working load limit (WLL) is given by the formula

$$\text{WLL} = 2{,}1 \times \text{WLL of a single branch}$$

When additionally marked for angles between branches of 90° to 120° (45° to 60° to the vertical), the working load limit (WLL) is given by the formula

$$\text{WLL} = 1{,}5 \times \text{WLL of a single branch}$$

NOTE — In the case of a three-branch sling, the angle between branches shall be taken as twice the angle to the vertical, i.e. $2 \times \beta$. (See figure 7.)

In the case of a four-branch sling, the angle between branches shall be that between diagonally opposite branches.

10.2.3 Trigonometric method

10.2.3.1 Double-branch slings

The working load limit (WLL) for double-branch slings is given by the formula

$$\text{WLL} = 2 \times \text{WLL of a single branch} \times \cos\beta$$

10.2.3.2 Three- and four-branch slings

The working load limit (WLL) for three- and four-branch slings is given by the formula

$$\text{WLL} = 3 \times \text{WLL of a single branch} \times \cos\beta$$

NOTE — In the case of a four-branch sling, if proper measures are taken to achieve the equal distribution of the load between each branch, all four branches can be considered as supporting the load. The rating of a four-branch sling may, in such circumstances, be based on the formula

$$\text{WLL} = 4 \times \text{WLL of a single branch} \times \cos\beta$$

10.3 Nominal rating

Unless otherwise specified, the nominal rating of any multi-branch sling, whether rated by the uniform load or trigonometric method, shall be the working load limit for that sling when used at an angle of 90° between the branches (45° to the vertical).

NOTE — A master link designed for use in a sling rated by the uniform load method is not necessarily suitable for use in a sling rated by the trigonometric method.

Table 2 — Working load limits calculating using uniform load method of rating
(see figure 7)

Working load limits in tonnes

Nominal size of chain[1]	Working load limits (WLL) for				
	single-branch slings	double-branch slings		three- and four-branch slings	
		$0° < \alpha < 90°$ $0° < \beta < 45°$	$90° < \alpha < 120°$ $45° < \beta < 60°$	$0° < \alpha < 90°$ $0° < \beta < 45°$	$90° < \alpha < 120°$ $45° < \beta < 60°$
6	1,1	1,5	1,1	2,3	1,6
7	1,5	2,1	1,5	3,1	2,2
8	2	2,8	2	4,2	3
10	3,2	4,4	3,2	6,7	4,8
13	5,4	7,5	5,4	11,3	8,1
16	8	11,2	8	16,8	12
18	10	14	10	21	15
19	11,5	16,1	11,5	24,1	17,2
20	12,5	17,5	12,5	26,2	18,7
22	15,5	21,7	15,5	32,5	23,2
23	16,9	23,6	16,9	35,4	25,3
25	20	28	20	42	30
26	21,6	30,2	21,6	45,3	32,4
28	25	35	25	52,5	37,5
32	32	44,8	32	67,2	48
36	40	56	40	84	60
40	60	70	50	105	75
45	63	88,2	63	132,3	94,5

1) Nominal diameter, d_n, in millimetres

NOTES

1 The values of WLL for single-branch slings are derived from the full calculated values (see the annex).

2 The values of WLL for multi-branch slings are calculated from the values for single-branch slings multiplied by the appropriate factors specified in 10.2.2 and rounded down to one place of decimals.

Table 3 — Working load limits calculated using trigonometric method of rating (see figure 7)

Working load limits in tonnes

Nominal size of chain[1]	Working load limits (WLL) for single-branch slings	double-branch slings				three- or four-branch slings			
		α = 30° β = 15°	α = 60° β = 30°	α = 90° β = 45°	α = 120° β = 60°	α = 30° β = 15°	α = 60° β = 30°	α = 90° β = 45°	α = 120° β = 60°
6	1,1	2,1	1,9	1,5	1,1	3,1	2,8	2,3	1,6
7	1,5	2,8	2,5	2,1	1,5	4,3	3,8	3,1	2,2
8	2	3,8	3,4	2,8	2	5,7	5,1	4,2	3
10	3,2	6,1	5,5	4,5	3,2	9,2	8,3	6,7	4,8
13	5,4	10,4	9,3	7,6	5,4	15,6	14	11,4	8,1
16	8	15,4	13,8	11,3	8	23,1	20,7	16,9	12
18	10	19,3	17,3	14,1	10	28,9	25,9	21,2	15
19	11,5	22,2	19,9	16,2	11,5	33,3	29,8	24,3	17,2
20	12,5	24,1	21,6	17,6	12,5	36,2	32,4	26,5	18,7
22	15,5	29,9	26,8	21,9	15,5	44,9	40,2	32,8	23,2
23	16,9	32,6	29,2	23,9	16,9	48,9	43,9	35,8	25,3
25	20	38,6	34,6	28,2	20	57,9	51,9	42,4	30
26	21,6	41,7	37,4	30,5	21,6	62,5	56,1	45,8	32,4
28	25	48,2	43,3	35,3	25	72,4	64,9	53	37,5
32	32	61,8	55,4	45,2	32	92,7	83,1	67,8	48
36	40	77,2	69,2	56,5	40	115,9	103,9	84,8	60
40	50	96,5	86,6	70,7	50	144,8	129,9	106	75
45	63	121,7	109,1	89,6	63	182,5	163,6	133,6	94,5

1) Nominal diameter, d_n, in millimetres

NOTES

1 The values of WLL for single-branch slings are derived from the full calculated values (see the annex).

2 The values of WLL for multi-branch slings are calculated from the values for single-branch slings multiplied by the appropriate factors specified in 10.2.3 and rounded down to one place of decimals.

3 Attention is drawn to the note in 10.2.3.2 permitting the higher rating of four-branch slings in certain circumstances. These values have not been included in table 3.

11 Proof force

11.1 General

When required by agreement between purchaser and supplier or by national regulations [see a) in clause 9], assembled slings with accessories shall be subjected to a proof force test. Multi-branch slings shall be tested in sections. Each individual section shall be subjected to a force equivalent to twice its working load limit, in accordance with 11.2.

11.2 Proof force factors

Sections of sling assemblies shall be subjected to proof forces, in kilonewtons, equivalent to loads calculated by multiplying the working load limit of the relevant chain size by the factors given in table 4.

11.3 Post-test examination

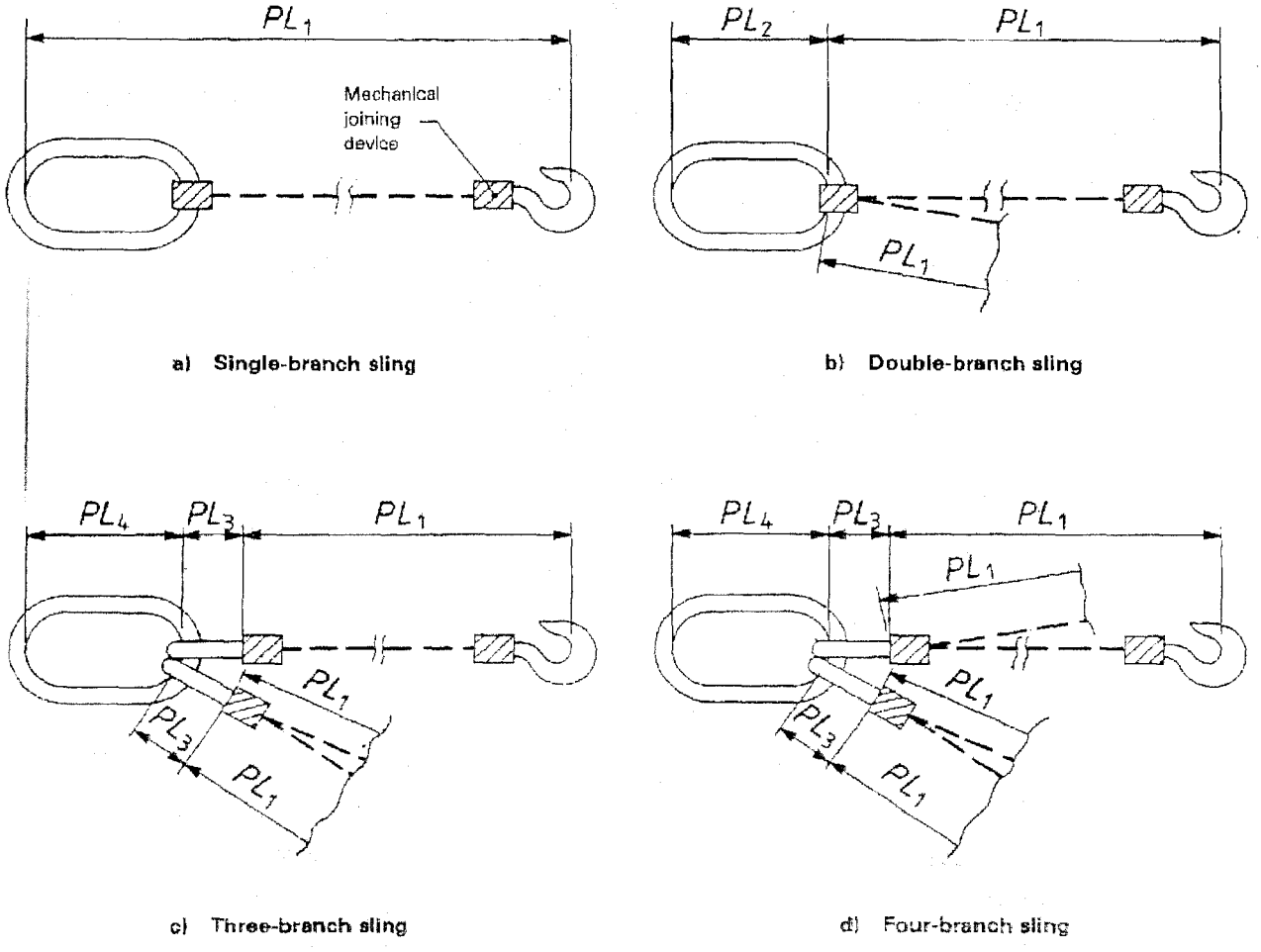
After completion of the proof loading when required under a) in clause 9 and removal of the force, the sling shall be carefully examined by a competent person. Any faulty chain or components shall be replaced, and the sling re-tested and examined.

Table 4 — Proof force factors

Section to which proof force shall be applied (see figure 6)	Uniform load method		Trigonometric method	
	WLL	Proof force factor (2 × WLL)	WLL	Proof force factor (2 × WLL)
PL_1	1	2	1	2
PL_2	1,4	2,8	2	4
PL_3	2	4	2	4
PL_4	2,1	4,2	3*	6**

* If a four-branch sling is rated in accordance with the note in 10.2.3.2, the factor for PL_4 is 4.

** If a four-branch sling is rated in accordance with the note in 10.2.3.2, the factor for PL_4 is 8.



a) Single-branch sling

b) Double-branch sling

c) Three-branch sling

d) Four-branch sling

Figure 6 — Sections of slings to which proof force shall be applied

12 Certificate

Each sling shall be provided with a dated certificate giving the following information :

a) the name of the sling manufacturer, assembler or supplier;

b) the identification number or symbol (see clause 13);

c) the configuration of the sling (see clause 5);

d) the size of chain and grade mark T(8);

e) the nominal reach;

f) the working load limit (WLL);

g) the working load, where stated service demands;

h) a statement that the sling components in the course of manufacture were subjected to the manufacturing test force (see 8.2);

i) in the case of slings proof-tested following assembly [see a) in clause 9], the certificate shall include the following information :

1) the name of the person or establishment which carried out the proof test and final examination,

2) the value of proof force(s) applied;

j) in the case of slings not proof-tested after assembly [see b) in clause 9], the certificate shall include the name of the person or establishment which carried out the visual examination.

13 Marking

13.1 General

The information specified in 13.2 to 13.4 shall be shown on a metal tag or label permanently attached to the master link or to a link immediately adjacent to it. Alternatively, all or part of the information may be marked on the master link provided that the mechanical properties of the link are not significantly impaired.

13.2 Single-branch slings

The following information shall be provided :

a) the working load limit, in kilograms or in tonnes;

b) the individual identification number or symbol (related to the certificate);

c) the grade, T(8);

d) the assembler's name or symbol;

e) the size of chain (optional).

13.3 Slings rated uniformly for use with angles from 0° to 90° between branches (0° to 45° to the vertical)

The following information shall be provided :

a) the working load limit, expressed as follows :

WLL (in kilograms or in tonnes) 0° to 90° (0° to 45° to th vertical);

b) the individual identification number or symbol (related to the certificate);

c) the grade, T(8);

d) the assembler's name or symbol;

e) the size of chain (optional);

f) the number of branches;

g) in addition, the tag or label or a separate tag or label attached in a similar manner may be marked with the working load limit applicable for use at 90° to 120° (45° to 60° to the vertical), expressed as follows :

WLL (in kilograms or in tonnes) 90° to 120° (45° to 60° t the vertical).

13.4 Slings rated for use with trigonometric tables

The following information shall be provided :

a) the working load limit at 90° between the branches (45° to the vertical), expressed as follows :

WLL (in kilograms or in tonnes) at 90° (45° to the vertical

b) the individual identification number or symbol (related to the certificate);

c) the grade, T(8);

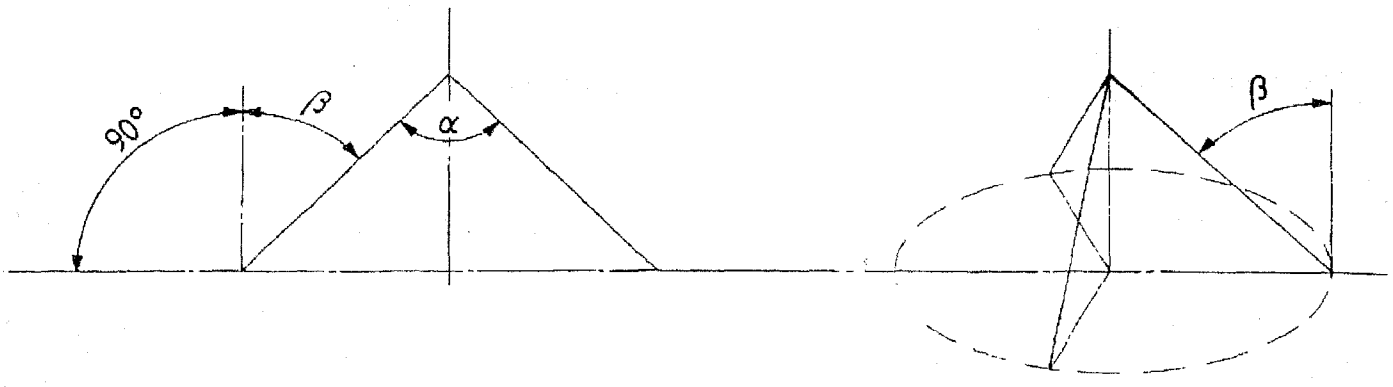
d) the assembler's name or symbol;

e) the size of chain (optional);

f) the number of branches.

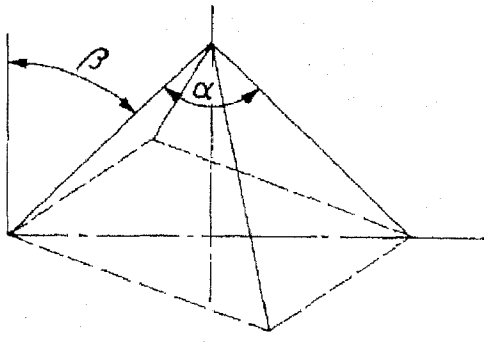
13.5 Loss or detachment of tag or label

If a tag or label containing the information detailed in 13.2 to 13.4 becomes detached, the chain sling may be used only in accordance with the rating shown on a remaining tag or label. If no tag or label remains, the chain sling should be taken out of service, unless the necessary information is marked on the master link itself.



a) Two branches

b) Three branches



c) Four branches

Figure 7 — Inclination of sling branches (see tables 2 and 3)

Annex

Calculated values of working load limit (WLL) for a single-branch sling

Working load limits in tonnes

Nominal size of chain[1]	Full calculated working load limit (WLL)	Working load limits (WLL) as specified in tables 2 and 3
6	1,153 27	1,1
7	1,569 73	1,5
8	2,050 26	2
10	3,203 53	3,2
13	5,413 97	5,4
16	8,201 04	8*
18	10,379 45	10*
19	11,564 75	11,5
20	12,814 13	12,5*
22	15,505 1	15,5
23	16,946 69	16,9
25	20,022 08	20
26	21,655 88	21,6
28	25,115 7	25*
32	32,804 18	32*
36	41,517 79	40*
40	51,256 53	50*
45	64,871 54	63*

1) Nominal diameter, d_n, in millimetres

NOTES

1 The values of full calculated WLL have been determined using the following formulae (the first gives values in newtons and the second in tonnes) :

$$\frac{200 \times \pi d_n^2}{2}$$

$$0{,}032\ 035\ 33\ d_n^2$$

2 The values of WLL as specified in tables 2 and 3 and given in the table above have been derived from the full calculated values, rounded down to one place of decimals, except for those marked with an asterisk (*), which have been rounded down to the nearest preferred number, because the nominal sizes of the chain are also preferred numbers.