INTERNATIONAL STANDARD

ISO 8539

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Forged steel lifting components for use with Grade 8 chain

Accessoires de levage en acier forgé pour utilisation avec des chaînes de Classe 8

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Foreword

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International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. 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.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 8539 was prepared by Technical Committee ISO/TC 111, *Round steel link chains, chain slings, components and accessories*, Subcommittee SC 3, *Components and accessories*.

This second edition cancels and replaces the first edition (ISO 8539:1986), of which it is a technical revision.

Introduction

The components covered by this International Standard are normally supplied to be part of a sling, but they may also be used for other applications. In such instances, it is important that the components design be checked to ensure its fitness for the intended use.

Forged steel lifting components for use with Grade 8 chain

1 Scope

This International Standard specifies general requirements for forged steel components of Grade 8 up to 63 t working load limit (WLL), mainly for use in

— chain slings in conformance with ISO 4778 and ISO 7593,

— steel wire rope slings in conformance with ISO 7531, and

— textile slings

intended for lifting objects, materials or goods.

This International Standard is not applicable to hand forged components and welded links, nor is it applicable to other welded components.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 643, *Steels — Micrographic determination of the apparent grain size*

ISO 7500-1, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

EN 10025-2:2004, *Hot rolled products of structural steels — Part 2: Technical delivery conditions for non-alloy structural steels*

EN 10228-1, *Non-destructive testing of steel forgings — Part 1: Magnetic partical inspection*

EN 10228-2, *Non-destructive testing of steel forgings — Part 2: Penetrant testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
working load limit
WLL
maximum mass that a component is authorized to sustain in general lifting service

3.2
manufacturing proof force
MPF
force applied to the component during the manufacturing proof test

3.3
breaking force
BF
maximum force reached during the static tensile test of the component, at which the component fails to retain the load

3.4
traceability code
series of letters and/or numbers marked on a component that enables its manufacturing history, including the identity of the cast of steel used, to be traced

3.5
competent person
designated person, suitably trained, qualified by knowledge and practical experience, and with the necessary instruction to enable the required test and examination to be carried out

NOTE ISO 9001:2008, 6.2.2 gives guidance on training

3.6
lot
specified number of components from which samples are selected for testing purposes, and which have been manufactured from the same cast of steel and subjected to the same heat treatment process

4 Safety requirements

4.1 General

4.1.1 Articulation

The dimensions of the forged steel components shall be such as to ensure articulation so that the force imposed is transmitted in the intended direction.

4.1.2 Relative movement

Parts of mechanical joining devices, such as pins and their securing elements, shall be so designed and manufactured that, after assembly, no unintended displacement can occur.

The effects of wear, corrosion of securing elements or rough usage should be considered.

4.2 Materials

4.2.1 General

Within the limitations given in 4.2.2 to 4.2.4 the manufacturer shall select the type of steel to be used so that the finished component, when suitably heat-treated, conforms to the mechanical properties specified in this International Standard.

4.2.2 Type of steel

The steel shall be produced by an electric process or by an oxygen blown process.

4.2.3 Deoxidation

The steel shall be fully killed as defined in EN 10025-2:2004, 6.2.2, shall be stabilized against strain-age embrittlement, and shall have an austenitic grain size of 5 or finer when tested in accordance with ISO 643.

To ensure the forged steel components are stabilized against strain-age embrittlement during services, the steel shall contain at least 0,025 % aluminium.

4.2.4 Chemical composition

The steel shall contain alloying elements in sufficient quantities so that the finished component, when heat-treated in accordance with 4.3, not only conforms to the mechanical properties specified in this International Standard, but also possesses low temperature ductility adequate for working satisfactorily in the temperature range −40 °C to +400 °C.

The steel shall contain at least two of the three alloying elements, in the minimum percentages specified in Table 1.

Table 1 — Chemical composition of alloying elements

Element	**Minimum mass content** (in percent by mass) **as determined by cast analysis**
Nickel	0,40
Chromium	0,40
Molybdenum	0,15

The steel shall contain no more sulfur and phosphorus than the limits given in Table 2.

Table 2 — Sulfur and phosphorus content

Element	**Maximum mass content** (in percent by mass) **as determined by**	
	Cast analysis	**Check analysis**
Sulfur	0,025	0,030
Phosphorus	0,025	0,030

4.3 Heat treatment

Each component shall be hardened from a temperature above the relevant AC3 point and tempered before being subjected to the manufacturing proof force (MPF). The tempering temperature shall be a minimum of 400 °C.

The tempering conditions shall be at least as effective as a temperature of 400 °C maintained for a period of 1 h.

A method of verification is as follows. After the components have been reheated to and maintained for 1 h at 400 °C and then cooled to room temperature, they should conform in the finished condition to Columns 3 and 4 of Table 3.

Surface hardening shall not be permitted for load-bearing parts of the component.

4.4 Manufacturing methods and workmanship

4.4.1 Manufacture

Each forged part of a component shall be forged hot in one piece. Excess metal from the forging operation shall be removed cleanly, leaving the surface free of sharp edges. After heat treatment, furnace scale shall be removed.

Edges of machined surfaces shall be rounded to eliminate cutting edges and to ensure attainment of mechanical properties of the component.

Welding shall not be used during the manufacture of components unless

a) none of the parts to be welded are load bearing,

b) the area affected by the weld is not to be subjected to load under normal operating conditions or under any foreseeable misuse of the component, or

c) the welding is completed before heat treatment.

Care should be taken during welding to ensure that the mechanical properties of any load-bearing parts of the finished component are not affected.

All welds shall be smoothly finished.

4.4.2 Surface finish

The finished condition of components shall include any surface finish.

NOTE Components are supplied in various surface finishes, e.g. descaled, electroplated or painted.

4.5 Mechanical properties

4.5.1 Manufacturing proof force

Components, including load-bearing pins, if used, shall be able to withstand the manufacturing proof force (MPF) specified in Table 3. Following removal of the force, the dimensions shall be within the tolerances specified on the component manufacturer's drawings.

4.5.2 Breaking force

Components, including load-bearing pins, if used, shall have a breaking force (BF) at least equal to that specified in Table 3.

On completion of the static tensile test, components shall show evidence of deformation.

4.5.3 Fatigue resistance

Components, including load-bearing pins, if used, with a working load limit up to 32 t, shall withstand, without breaking, at least 20 000 cycles of application of the force range specified in 5.2.5.

Table 3 — Code number, working load limits and mechanical properties

1	2	3	4
Code number [a]	**Working load limit** WLL t	**Manufacturing proof force** [b] MPF kN	**Breaking force** [b] BF kN (min)
3	0,25	6,1	9,8
4	0,5	12,3	19,6
5	0,8	19,6	31,4
6	1,12	27,5	43,9
7	1,5	36,8	58,8
8	2	49	78,5
9	2,5	61,3	98,1
10	3,15	77,2	124
11	3,75	91,9	147
13	5,3	130	208
14	6	147	235
16	8	196	314
18	10	245	392
19	11,2	275	439
20	12,5	306	490
22	15	368	588
23	16	392	628
25	20	490	785
26	21,2	520	832
28	25	613	981
32	31,5	772	1 240
36	40	981	1 570
40	50	1 230	1 960
45	63	1 540	2 470

[a] The code is the same as the nominal diameter of chain.

[b] The mechanical properties specified in Table 3 are calculated on the basis specified in Annex A. It is common practice for manufacturers to round MPF and BF up to higher values that may appear in their published catalogues.

5 Verification of safety requirements

5.1 Qualification of personnel

All testing and examination, shall be carried out by a competent person.

5.2 Type examination and type tests

5.2.1 General

In order to prove the design, material, heat treatment and method of manufacture, each size of component in the finished condition shall be type tested to demonstrate that the components possess the mechanical properties specified in this International Standard.

Any change of design, specification of material, heat treatment, method of manufacture or any dimension outside normal manufacturing tolerances that may lead to a modification of the articulation, relative movement or mechanical properties shall require that the type examination specified in 5.2.2 and the type tests specified in 5.2.3 to 5.2.5 are carried out on the modified components.

The tests specified in 5.2.3 to 5.2.5 shall be carried out on three samples of each size of component of each design, material, heat treatment and method of manufacture.

In the tests specified in 5.2.3 to 5.2.5, the force shall be applied to the component axially without shock. Components designed for use in textile slings shall be tested (other than in fatigue) so that the force is applied through the appropriate textile element.

The test equipment used in the tests specified in 5.2.3 to 5.2.5 shall conform to Class 1 specified in ISO 7500-1.

5.2.2 Examination for articulation and relative movement

One sample of each design shall be visually examined for conformity to the requirements of 4.1.1 and 4.1.2.

5.2.3 Test for deformation

Three samples shall be tested, and each shall sustain the manufacturing proof force specified for the component in Table 3. Following the removal of the force, the dimensions shall be within the tolerances specified on the component manufacturer's drawings. In no case shall any dimension alter by more than 1,0 % of the initial dimension after the manufacturing proof force has been applied and removed.

5.2.4 Static strength test

Three samples shall be tested and each shall have a breaking force at least equal to the minimum value specified for the component in Table 3.

This test may be carried out on the same components subjected to the deformation test.

It is not necessary to test the component up to its actual breaking force for the specified mechanical properties to be demonstrated. It is sufficient that the minimum value of the breaking force specified is reached and that the component shows evidence of deformation.

5.2.5 Fatigue test

Three samples shall be tested and each shall be able to withstand at least 20 000 cycles of the force range without breaking.

The maximum force applied during each cycle shall be equivalent to 1,5 times the working load limit specified in Table 3 for the component. The minimum force in each cycle shall be positive and less than or equal to 3 kN. The frequency of force applications shall be not greater than 25 Hz.

5.2.6 Acceptance criteria for type examination and type tests

5.2.6.1 Examination for articulation and relative movement

If the sample fails the examination for articulation and relative movement, the component of the size submitted for type examination shall be deemed not to conform to this International Standard.

5.2.6.2 Test for deformation

If any of the three samples fails the test for deformation, the component of the size submitted for type testing shall be deemed not to conform to this International Standard.

5.2.6.3 Static strength test and fatigue test

If all three samples pass the static strength test and fatigue test, the component of the size submitted for type testing shall be deemed to conform to this International Standard.

If one sample fails, two further samples shall be tested and both shall pass the test in order for the component of the size submitted for testing to be deemed to conform to this International Standard.

If two or three samples fail the test, the component of the size submitted for type testing shall be deemed not to conform to this International Standard.

5.3 Manufacturing examination

All finished components shall be visually examined for conformity to the requirements of 4.4.1.

5.4 Manufacturing tests

5.4.1 Manufacturing proof test

For the manufacturing proof test, the test equipment, accurate to Class 1 specified in ISO 7500-1, shall apply a force at least equal to the proof force specified.

After heat-treatment and de-scaling, each component shall sustain the appropriate proof force specified in Table 3. After removal of the force, there shall be no visible defect, and the dimensions shall be within the tolerances specified on the manufacturer's drawing.

Where finishing processes are used that involve a risk of component embrittlement, e.g. acid cleaning or electroplating, the proof force shall be re-applied in the finished condition.

5.4.2 Non-destructive test

The forged surfaces of components, excluding load-bearing pins machined from drawn bar, shall, after heat treatment and de-scaling, be subjected to magnetic particle or dye penetrant examination in accordance with EN 10228-1 and EN 10228-2.

Indications greater than 2 mm in length shall not be permitted in areas of the component subjected to tensile stresses, in all foreseeable service conditions.

Indications may be removed by grinding provided that after removal the component shall conform to the dimensions and tolerances specified by the manufacturer. A final examination shall show no indications greater than 2 mm in length.

Care should be taken to ensure that the direction and roughness of grinding does not create starting points for fatigue failure and cause excessive heating, which may have a local effect on the heat treated condition, or may cause cracks.

5.5 Test regime and acceptance criteria

5.5.1 General

The maximum size of a lot shall be as given in Table 4 for the ranges of nominal sizes indicated.

Table 4 — Number of components in a lot

Code number	Maximum number in a lot
3 to 10	1 000
> 10 to 18	500
> 18	200

5.5.2 Static strength test sampling

The manufacturer shall subject one sample per lot to the static strength test as defined in 5.2.4 and 5.2.6.3. If the sample meets the appropriate requirements then, subject to complying with 5.5.3, the lot shall be deemed to conform to this International Standard.

If the sample fails to meet the requirements then two further samples shall be taken from the same lot and shall be subjected to the static strength test as defined in 5.2.4 and 5.2.6.3. If both of these samples meet the appropriate requirements then, subject to complying with 5.5.3, the lot shall be deemed to conform to this International Standard. If one or both of these samples fail to meet the requirements, the entire lot shall be deemed not to conform to this International Standard.

5.5.3 Manufacturing test regime

The manufacturer shall have the choice between a) and b) as follows.

a) Applying the proof force test to all components in the lot specified in Table 4 in accordance with 5.4.1 plus non-destructive testing of 3 % of the lot of components in accordance with 5.4.2.

   If all of the 3 % sample of components pass the non-destructive test, then all the components in the lot which also pass the proof force test shall be deemed to conform to this International Standard.

   If any of the 3 % sample fail the non-destructive test, then all the components in the lot shall be subjected to both the non-destructive test and the proof force test. All the components which pass both tests shall be deemed to conform to this International Standard.

b) Applying the non-destructive test to all the components in the lot specified in Table 4 in accordance with 5.4.2 plus proof force testing of 3 % of the lot of components in accordance with 5.4.1.

   If all of the 3 % sample of components pass the proof force test then all the components in the lot which also pass the non destructive test shall be deemed to conform to this International Standard.

   If any of the 3 % sample fail the proof force test, then all the components in the lot shall be subjected to both the non-destructive test and the manufacturing proof force test. All the components which pass both tests shall be deemed to conform to this International Standard.

6 Marking

6.1 Components

Each component shall be legibly and indelibly marked in a place where the marking will not be removed by use and in a manner that will not impair the mechanical properties of the component. The marking shall include at least the following information:

a) the manufacturer's name, symbol or mark;

b) code number, which identifies the WLL of the component (see Table 3);

c) the Grade number "8";

d) the traceability code.

NOTE In certain countries, it might be necessary to add mandatory marking, e.g. CE marking as defined in the applicable European Directive(s).

6.2 Load-bearing pins

Each removable load-bearing pin of 13 mm diameter and above, shall be legibly and indelibly marked with the relevant grade number and manufacturer's symbol in a manner that will not impair the mechanical properties of the pin.

7 Manufacturer's declaration

After all the testing as specified in Clause 5 has been carried out with satisfactory results, the manufacturer shall issue a declaration for components of the same nominal dimensions, size, material, heat treatment and method of manufacture.

The declaration shall include at least the following information:

a) the name and address of the manufacturer or authorized representative, including the date of issue of the declaration and authentication;

b) the number of this International Standard (i.e. ISO 8539);

c) code number;

d) the quantity and description of the component;

e) the Grade number "8";

f) the working load limit, expressed in tonnes;

g) the manufacturing proof force, expressed in kilonewtons;

h) confirmation that the specified minimum breaking force was met or exceeded.

NOTE In certain countries, it might be necessary to add mandatory regulatory marking, e.g. CE marking as defined in the applicable European Directive(s).

The manufacturer shall keep a record, for at least 10 years after the last declaration has been issued, of the material specification, heat treatment, dimensions, test results, quality system in use, and all relevant data concerning the components that have satisfied the type tests, including records of sampling. This record shall also include the manufacturing specifications that shall apply to subsequent production.

8 Instructions for use

The manufacturer shall provide specific instructions for use. The instructions for use shall accompany the components and shall advise on how to assemble and disassemble forged steel components, and how to ensure the correct fit of any pin.

Annex A
(informative)

Calculation of mechanical properties

A.1 Calculated values of manufacturing proof force

The values of manufacturing proof force, MPF, are calculated using Equation (A.1):

$$\text{MPF} = 2{,}5 \times g \times \text{WLL} = 24{,}516\ 63\ \text{WLL} \quad \text{(A.1)}$$

where

MPF is the manufacturing proof force, in kilonewtons;

WLL is the working load limit given in Column 2 of Table 3;

g is the acceleration due to gravity, in metres per second squared (i.e. 9,806 65).

The values in Column 3 of Table 3 have been rounded to the nearest single decimal place up to 100 kN; to the nearest whole number between 100 kN and 1 000 kN, and to the nearest 10 kN above 1 000 kN.

A.2 Calculated values of minimum breaking force

The values of minimum breaking force, BF_{min}, are calculated using Equation (A.2):

$$\text{BF}_{\text{min}} = 4{,}0 \times g \times \text{WLL} = 39{,}226\ 6\ \text{WLL} \quad \text{(A.2)}$$

where

BF_{min} is the minimum breaking force, in kilonewtons;

WLL is the working load limit given in Column 2 of Table 3;

g is the acceleration due to gravity, in metres per second squared (i.e. 9,806 65).

The values in Column 4 of Table 3 have been rounded to the nearest single decimal place up to 100 kN; to the nearest whole number between 100 kN and 1000 kN; and to the nearest 10 kN above 1000 kN.