INTERNATIONAL STANDARD

**ISO 16872**

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# Short link chains for lifting purposes — Grade VH, fine tolerance for manually operated chain hoists

*Chaînes de levage à maillons courts — Classe VH, tolérance fine pour palans manuels à chaînes*

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web www.iso.org

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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 16872 was prepared by Technical Committee ISO/TC 111, *Round steel link chains, chain slings, components and accessories*, Subcommittee SC 1, *Chains and chain slings*.

# Short link chains for lifting purposes — Grade VH, fine tolerance for manually operated chain hoists

## 1 Scope

This International Standard specifies the requirements for Grade VH, fine-tolerance hoist chains, for use as load chains in manually operated chain hoists and consisting of round steel short link chains, electrically welded and heat treated, tested to and compliant with the ISO 1834 general conditions of acceptance.

NOTE Butt welding and flash butt welding are defined in ISO 4063.

The range of nominal sizes of hoist chains covered by this International Standard is from 3 mm to 13 mm, for use in the temperature range −10 °C to 150 °C.

## 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 148-1, *Metallic materials — Charpy pendulum impact test — Part 1: Test method*

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

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

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 7500-1:2004, *Metallic materials — Verification of static uniaxial testing machines — Part 1: Tension/compression testing machines — Verification and calibration of the force-measuring system*

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 1834 and the following apply.

**3.1**
**gauge length**
specified multiple pitch length of chain

## 4 General conditions of acceptance

The hoist chain shall comply with the requirements of ISO 1834 as well as those of this International Standard.

# 5 Dimensions

## 5.1 Nominal size, $d_n$

A selection of nominal sizes is presented in Table 1. Other nominal sizes may be used provided that the dimensions and tolerances are calculated in accordance with Annex A.

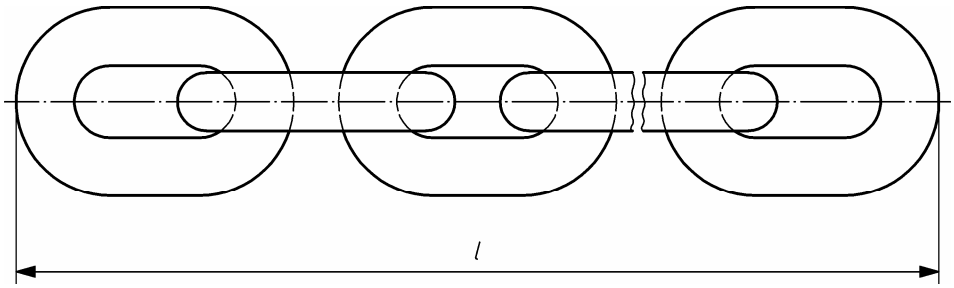
**Table 1 — Typical dimensions** (see Figure 1)

Dimensions in millimetres

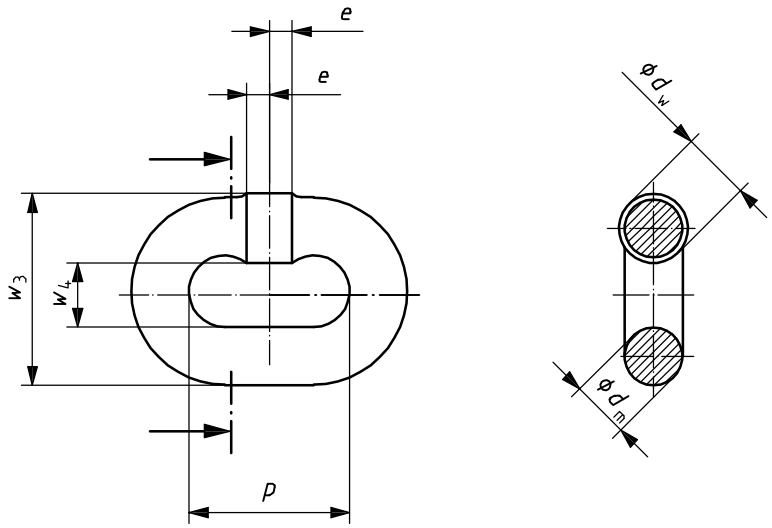
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| Nominal size | Diameter tolerance | Nominal pitch | | Width | | | Gauge length | | Weld diameter | |
| | | | | Internal | External | Internal | | | | |
| | | | | Type 2 | Types 1 and 2 | Type 1 | | | Types 1 and 2 | Type 2 |
| $d_n$ | | $p_n$ | Tolerance | $w_1$ | $w_3$ | $w_4$ | $11 \times p_n$ | Tolerance | $d_w$ | $G$ |
| | | | | min. | max. | min. | | | max. | max. |
| 3 | ± 0,2 | 9 | 0,18 | 3,8 | 10,7 | 3,6 | 99 | 0,5 | 3,3 | 3,8 |
| 4 | ± 0,2 | 12 | 0,25 | 5 | 14,3 | 4,8 | 132 | 0,6 | 4,3 | 5 |
| 5 | ± 0,2 | 15 | 0,3 | 6,3 | 17,9 | 6,0 | 165 | 0,8 | 5,4 | 6,3 |
| 6,3 | ± 0,3 | 18,9 | 0,4 | 7,9 | 22,6 | 7,6 | 208 | 1,0 | 6,8 | 7,9 |
| 7,1 | ± 0,3 | 21,3 | 0,4 | 8,9 | 25,4 | 8,5 | 234 | 1,1 | 7,7 | 8,9 |
| 8 | ± 0,3 | 24 | 0,5 | 10 | 28,6 | 9,6 | 264 | 1,3 | 8,6 | 10 |
| 9 | ± 0,4 | 27 | 0,5 | 11,3 | 32,2 | 10,8 | 297 | 1,4 | 9,8 | 11,3 |
| 10 | ± 0,4 | 30 | 0,6 | 12,5 | 35,8 | 12,0 | 330 | 1,6 | 10,8 | 12,5 |
| 11,2 | ± 0,4 | 33,6 | 0,7 | 14 | 40,1 | 13,4 | 370 | 1,8 | 12,1 | 14 |
| 12,5 | ± 0,5 | 37,5 | 0,7 | 15,6 | 44,8 | 15,0 | 413 | 2,0 | 13,5 | 15,6 |
| 13 | ± 0,5 | 39 | 0,8 | 16,3 | 46,6 | 15,6 | 429 | 2,1 | 14,1 | 16,3 |

Typical dimensions for a range of nominal sizes are given here, calculated and rounded in accordance with the formulae specified in Annex A, based upon a nominal pitch of $3d_n$. Other nominal sizes may be used, provided that the dimensions and tolerances are calculated in accordance with Annex A. While the nominal link pitch is based upon $3d_n$, this may be varied up to a maximum of $3{,}3d_n$, subject also to the tolerances specified in Annex A.

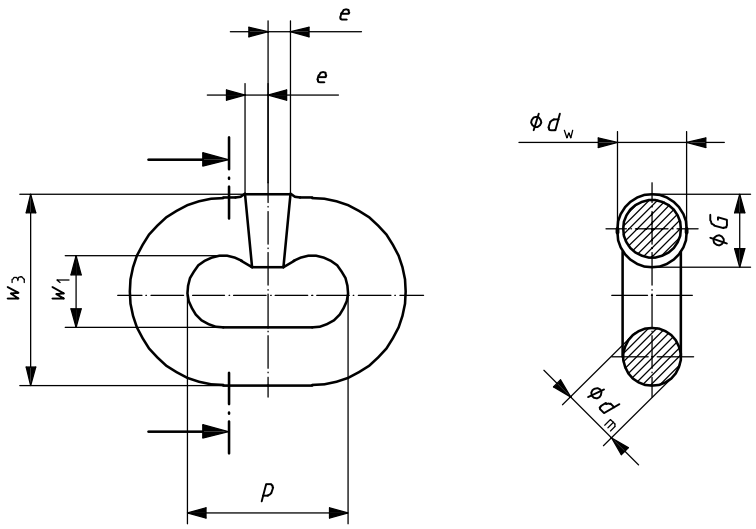
NOTE Tolerances are usually divided into +2/3 and −1/3 for both the pitch (column 4) and the standard gauge length (column 9).




**a) Multiple pitch length**




**b) Type 1 — Link dimensions**




**c) Type 2 — Link dimensions**

**Key**

$l$ multiple pitch length
$p$ pitch (internal link length)
$d_m$ measured diameter of material, except at weld
$d_w$ measured diameter of material at weld (type 1 welded chain)
weld dimension perpendicular to plane of link (type 2 welded chain)
$G$ dimension in other planes as per individual chain specification (type 2 welded chain)
$e$ length affected by welding, on either side of centre link
$w_1$ internal link width away from weld (type 2)
$w_3$ external link width over weld (types 1 and 2)
$w_4$ internal link width at weld (type 1)

**Figure 1 — Link and chain dimensions**

## 5.2 Material diameter and tolerance

The definition of material diameter and method of measurement shall be in accordance with ISO 1834. The tolerances of the diameter are given in A.1.

The diameter tolerance for each of the selected nominal sizes shall be as listed in Table 1, column 2. These and all other nominal size material diameter tolerances shall be calculated in accordance with A.1.

## 5.3 Pitch and widths

The dimensions and tolerances of the pitch and widths of the individual links as shown in Figure 1 shall be calculated in accordance with A.2.

The tolerances of multiple pitch lengths shall be calculated in accordance with A.2 and based on a gauge length of 11 links.

The dimensions and tolerances for the selected nominal sizes shall be as listed in Table 1.

The nominal link pitch, $p_n$, is based upon $3d_n$ (where $d_n$ is the nominal size of the chain). This can be varied up to a maximum of 3,3 $d_n$. The nominal link pitch, $p_n$, shall be subject to the tolerances specified in Annex A.

## 5.4 Weld diameter

The maximum diameter at the weld shall not exceed the following:

— for Type 1 welded hoist chain, the maximum diameter at the weld shall not be in excess of 8 % above the nominal size in any direction;

— for Type 2 welded hoist chain, the maximum diameter at the weld shall not be in excess of 8 % above the nominal size in any direction perpendicular to the plane of the link, and 25 % in the other planes;

— the maximum diameter at the weld for the selected nominal sizes shall be as listed in Table 1, columns 10 and 11;

— the diameter of the steel at the weld shall nowhere be less than the actual diameter of the steel adjacent to the weld.

## 5.5 Length dimensionally affected by welding

The length dimensionally affected by welding shall not extend by more than $0{,}6d_n$ to either side of the centre of the link (see Figure 1).

# 6 Material and manufacture

## 6.1 Quality of material

### 6.1.1 General

Within the limitations given in 6.1.2 to 6.1.5, it is the responsibility of the manufacturer of the chain to select the type of steel to be used so that the finished hoist chain, when suitably heat treated, complies with the mechanical properties specified in this International Standard.

### 6.1.2 Type of steel

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

### 6.1.3 Deoxidation

The steel shall be fully killed and shall be made in conformity with a suitable deoxidation process in order to obtain an austenitic grain size of 6 or finer when tested in accordance with ISO 643.

To ensure the fine-tolerance hoist chain is stabilized against strain-age embrittlement during services, the steel shall contain at least 0,025 % aluminium.

### 6.1.4 Chemical composition

The steel shall contain alloying elements in sufficient quantities so that the finished hoist chain, when heat treated in accordance with 6.2, complies with the mechanical properties specified in this International Standard.

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

**Table 2 — Sulfur and phosphorus content**

| Element | Max. content (% by mass) as determined by | |
|---|---|---|
| | Cast analysis | Check analysis |
| Sulfur (S) | 0,020 | 0,025 |
| Phosphorus (P) | 0,020 | 0,025 |
| Sum of S + P | 0,035 | 0,045 |

### 6.1.5 Finished condition

In its finished condition as supplied to the manufacturer of the chain, the steel shall comply with the requirements of 6.1.2 to 6.1.4 as determined by check analysis on the rod, wire or finished link.

## 6.2 Heat treatment

Fine-tolerance hoist chains shall be hardened from a temperature above the $Ac_3$ point and tempered before being subjected to the manufacturing proof force.

## 6.3 Working load limits (WLL)

Table 3 gives values for the WLL, calculated on the bases given in Annex A for selected nominal sizes.

For nominal sizes not included in Table 3, the values for the working load limit shall be calculated in accordance with Annex A.

**Table 3 — Working load limits (WLL)**

| Nominal size $d_n$ | Working load limits WLL t |
|---|---|
| 3 | 0,36 |
| 4 | 0,63 |
| 5 | 1,0 |
| 6,3 | 1,6 |
| 7,1 | 2,0 |
| 8 | 2,5 |
| 9 | 3,15 |
| 10 | 4,0 |
| 11,2 | 5,0 |
| 12,5 | 6,3 |
| 13 | 6,7 |

## 6.4 Mechanical properties

### 6.4.1 Manufacturing proof force (MPF)

All hoist chains shall be subjected to the MPF calculated on the bases given in Annex A. For selected nominal sizes, values are given in Table 4.

**Table 4 — Manufacturing proof forces (MPF) and breaking forces (BF)**

| 1 | 2 | 3 |
|---|---|---|
| Nominal size $d_n$ | Manufacturing proof forces MPF $F_{MP}$ kN min. | Breaking forces BF $F_B$ kN min. |
| 3 | 8,8 | 14,1 |
| 4 | 15,7 | 25,1 |
| 5 | 24,5 | 39,3 |
| 6,3 | 39 | 62,3 |
| 7,1 | 49,5 | 79,2 |
| 8 | 62,8 | 101 |
| 9 | 79,5 | 127 |
| 10 | 98,2 | 157 |
| 11,2 | 123 | 197 |
| 12,5 | 153 | 245 |
| 13 | 166 | 265 |

### 6.4.2 Breaking force (BF) and total ultimate elongation (A)

Samples of hoist chain in the finished condition shall have a breaking force at least equal to that calculated on the bases given in Annex A. For selected nominal sizes, values are given in Table 4.

On completion of the tensile test, the minimum total ultimate elongation shall be in accordance with the values given in Table 5.

### 6.4.3 Bend deflection

Single-link samples shall withstand the minimum deflection specified in Table 5 and shall be free from visible defects.

### 6.4.4 Surface hardness

The surface hardness at each of the two measuring points as shown in Figure 3 shall be at least equal to the specified values in Table 5.

### 6.4.5 Toughness

A Charpy V notch test on the material of the hoist chain shall achieve a $KV$ toughness of at least 45 J at a test temperature of 0 °C. The samples shall be heat treated so as to achieve the same hardness and material ultimate tensile strength as the finished hoist chain. The test shall be carried out on three samples, each of which shall achieve the minimum value.

The lowest service temperature ($T$) of the chain shall be $T \geqslant \text{NDT} - T - 20\ \text{K}$, as a result of ISO/TR 23602. Based on a correlation between $KV$ shift and the NDT-$T$ shift, a $KV$-$T$ master curve with the requirement of $KV$ (0 °C) $\geqslant$ 45 J results in a value $\text{NDT} - T - 20\ \text{K}$ of $\leqslant -10$ °C. Therefore, a lowest temperature during operation of $-10$ °C is possible.

The above tests shall be repeated if the steel manufacturer or type of steel is changed.

**Table 5 — Mechanical properties**

| Mechanical property | Requirement |
|---|---|
| Specified minimum mean stress at breaking force, $F_B$: $\frac{2(F_B)}{\pi {d_n}^2}$ | 1 000 N/mm$^2$ |
| Specified minimum mean stress at manufacturing proof force, $F_{MP}$: $\frac{2(F_{MP})}{\pi {d_n}^2}$ | 625 N/mm$^2$ |
| Percentage ratio of specified minimum mean stress at manufacturing proof force, $F_{MP}$, to specified minimum mean stress at breaking force, $F_B$: $\frac{F_{MP}}{F_B}$ % | 62,5 % |
| Specified minimum total ultimate elongation | 17,0 % |
| Specified minimum bend deflection, $f$ | $0{,}8 d_n$ |
| Specified maximum mean stress at working load limit | 250 N/mm$^2$ |
| Specified minimum surface hardness | 430 HV10 |
| Specified minimum $KV$ toughness at 0 °C | 45 J |
| The stresses given in this table are obtained by dividing the force by the total cross-section of both sides of the link, i.e. they are mean stresses. The stress is in fact not uniform and, particularly at the extrados at the crown, the maximum fibre stress is considerably greater.<br>The values for the working load can be selected to comply with national regulations but in no case shall they exceed the values for the working load limit in Table 3. | |

# 7 Verification of safety requirements

## 7.1 Size of lot and selection of samples

The size of the lot from which samples shall be selected shall be 200 m. An excess fraction of the length of lot shall be considered as a separate lot. Samples shall be selected in accordance with ISO 1834.

## 7.2 Manufacturing proof force, breaking force and total ultimate elongation

### 7.2.1 Static tensile test

The testing machine and test procedure for the static tensile test shall be as specified in ISO 1834.

The equipment used in the tests specified in 7.2.3 and 7.3.1 shall comply with ISO 7500-1:2004, Class 1.

### 7.2.2 Manufacturing proof force — Acceptance criteria

All the hoist chain shall be subject to the manufacturing proof force specified in 6.4.1.

### 7.2.3 Breaking force and total ultimate elongation — Acceptance criteria

On completion of the static tensile test, the requirements of 6.4.2 shall be met.

## 7.3 Bend deflection

### 7.3.1 Bend test

The test equipment and procedure shall be as specified in ISO 1834.

Each single-link sample shall be bent by a deflection $f$, as given in Table 5 and shown in Figure 2. Following the removal of the force, the link sample shall be examined by a competent person.

Where necessary, a surface coating may be removed after the bend test to enable this examination to be carried out.

### 7.3.2 Bend deflection — Acceptance criteria

On completion of the bend test, the requirements of 6.4.3 shall be met.

## 7.4 Hardness test

The number of samples for surface hardness testing shall be related to chain size as specified in ISO 1834, and each sample shall consist of three single links.

Each sample link shall be subjected to surface hardness testing carried out in accordance with ISO 6507-1, with measurements taken at two points as shown in Figure 3.

Special jigging shall be used to ensure that the curvature of the link surface does not affect the validity of the measurements taken. Each result shall meet the requirements of 6.4.4.

## 7.5 Toughness of chain test material

### 7.5.1 Toughness test

Samples shall be tested in accordance with ISO 148-1.

### 7.5.2 Toughness test — Acceptance criteria

The requirements of 6.4.5 shall be met.

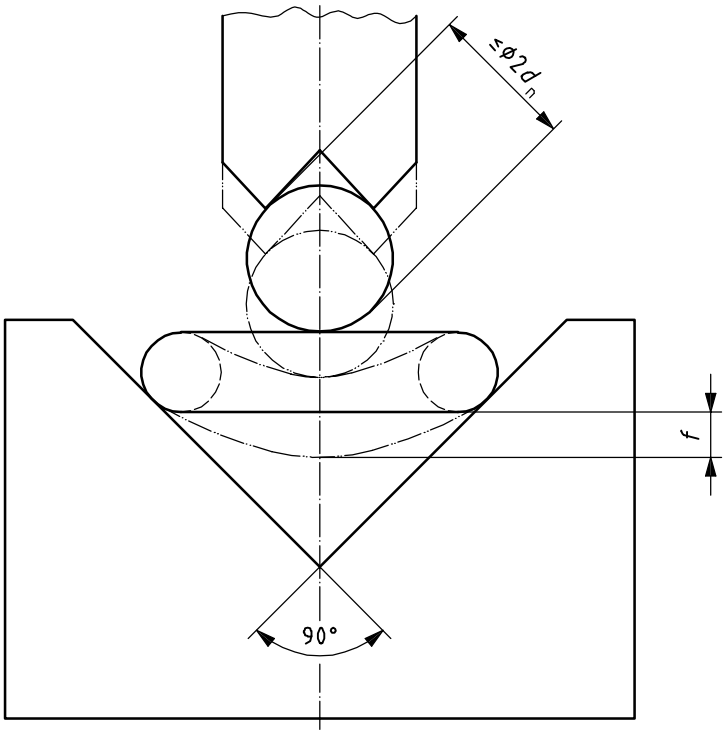



**Figure 2 — Bend deflection, $f$**

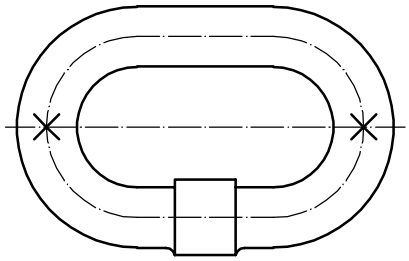


**Figure 3 — Hardness test measurement points**

## 8 Marking

### 8.1 Grade marking

The grade mark for the fine-tolerance hoist chain is “VH”. The marking shall conform to ISO 1834 and shall be applied as specified in that International Standard.

### 8.2 Identification marking

The identification marking shall be as specified in ISO 1834.

### 8.3 Inspection marking

The inspection marking shall be as specified in ISO 1834.

## 9 Manufacturer's certificate

The manufacturer shall, if required, supply a certificate of test and examination containing the information detailed in ISO 1834 with every supply of hoist chain.

## 10 Information for assembly into the hoist and for use

### 10.1 General

The following information is to assist the manufacturer to prepare information for assembly of the hoist chain into the hoist and for its use. The manufacturer can provide additional information but, in order to perform satisfactorily in service, the following is normally the minimum required.

### 10.2 Assembly of hoist chain into the hoist

To ensure a smooth running of the fine-tolerance hoist chain over the pocket wheels without unusual impacts, the driven pocket wheels and idle pocket wheels shall be designed to suit the fine-tolerance hoist chain.

The fine-tolerance hoist chain shall be guided smoothly and without twist into and out of the pocket wheels.

To avoid deformation of the last link of the fine-tolerance hoist chain, the chain-connecting parts of the hoist shall be so designed as to permit at least 5 % free movement relative to the inside width of the chain link.

### 10.3 Hoist chain use

Fine-tolerance hoist chain shall not be used in the manufacture of chain slings. Also, the fine-tolerance chain in a hoist shall not be used in basket or choke hitch.

Fine-tolerance hoist chain should not be adversely affected by temperatures down to −10°C, and no reduction in the working load limit is therefore necessary on this account. Where such fine-tolerance hoist chain is to be used at temperatures below this temperature, the manufacturer shall be consulted.

For the same reasons, fine-tolerance hoist chain shall not be galvanized or subjected to any plating processes without the approval of the manufacturer.

The fine-tolerance hoist chain shall not be allowed to pick up dirt, etc. that would impair its free movement.

In order to attain maximum service life of fine-tolerance hoist chain, adequate lubrication, particularly in the interlink contact areas, is necessary.

### 10.4 Inspection

The procedures to be followed by the operator for the inspection of fine-tolerance hoist chain at intervals in service shall be in accordance with the hoist manufacturer's instructions, covering inspection, discard criteria and records.

NOTE Further general guidance on hoist chain inspection procedures is given in ISO 7592:1983, Annex B.

# Annex A
(normative)

# Bases for the calculation of mechanical properties and tolerances on dimensions

## A.1 Diameter tolerance

It shall be $\pm$ 4 % of the nominal size of chain.

## A.2 Nominal pitch, multiple pitch and width

The dimensions specified in Table 1 are based on the following relations:

— nominal pitch, $p_n$, based upon $3d_n$ with a maximum nominal value of $3{,}3d_n$;

— minimum internal width $w_4 = 1{,}2d_n$ at the weld;

— minimum internal width $w_1 = 1{,}25d_n$ away from the weld;

— maximum external width $w_3 = 3{,}75d_n$ over the weld.

The permissible tolerance for one pitch, $p_n$, or multiple pitch, $L$, is based on the following tolerance formula:

$$\left(\frac{1{,}65}{n} + 0{,}33\right) \text{ in percent}$$

where $n$ is the number of chain links ($n = 11$ is the standard gauge length).

This tolerance is usually divided into +2/3 and $-1/3$ for both the pitch and the standard gauge length.

The dimensions given in Table 1 are fully calculated values, rounded to the nearest 0,1 mm for values up to 100 mm. Values $\geqslant$ 100 mm are rounded to the nearest 1 mm. The dimensions and tolerance for nominal sizes other than those given in Table 1 shall be calculated using the above relations.

## A.3 Weld diameter

The diameter at the weld shall not exceed $1{,}08d_n$ ($d_w$ for Types 1 and 2) or $1{,}25d_n$ ($G$ for Type 2).

## A.4 Formulae and rounding rules for calculation of WLL, MPF and BF

**A.4.1** The formula for the calculation of the values for the working load limits, such as those listed for selected nominal sizes in Table 3, is as follows:

$$\text{WLL} = 0{,}040\ 044\ 1 d_{\text{n}}^2 \qquad \text{in tonnes}$$

The values given in Table 4, column 2 are from the R 40 series of preferred numbers and represent the nearest lower R 40 value relative to the full calculated value of WLL.

**A.4.2** The formula for the calculation of the minimum values for the manufacturing proof force (MPF), $F_{\text{MP}}$, as listed for selected nominal sizes in Table 4, is as follows:

$$F_{\text{MP}} = 0{,}981\ 747\ 7 d_{\text{n}}^2 \qquad \text{in kilonewtons}$$

The rounding convention used is to round to 0,1 kN up to 100 kN, and to 1 kN for values of 100 kN up to 1 000 kN.

**A.4.3** Similarly, the formula for the calculation of the minimum values, $F_{\text{B}}$, for the breaking force (BF) is as follows:

$$F_{\text{B}} = 1{,}570\ 796\ 3 d_{\text{n}}^2 \qquad \text{in kilonewtons}$$

The rounding convention used is, as in A.4.2, to round to 0,1 kN up to 100 kN, and to 1 kN for values of 100 kN up to 1 000 kN.

# Bibliography

[1] ISO 4063, *Welding and allied processes — Nomenclature of processes and reference numbers*

[2] ISO 7592:1983, *Calibrated round steel link lifting chains — Guidelines to proper use and maintenance*

[3] ISO/TR 23602, *Toughness of chain steels*

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