
**Round steel short link chains for
lifting purposes — Medium tolerance
sling chains — Grade 4, stainless steel**

*Chaînes de levage en acier de section ronde à maillons courts —
Chaînes de élingue de tolérance moyenne — Classe de qualité 4, acier
inoxydable*

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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. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

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

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

This second edition cancels and replaces the first edition (ISO 1835:1980), which has been technically revised. The main changes compared to the previous edition are as follows:

- change of material requirements towards stainless steel;
- modernization of the document structure and layout, following the structure already implemented in the latest publications of ISO/TC 111/SC 1;
- consideration of current nominal diameters of chain and requirements;
- environmental aspects have been considered.

Round steel short link chains for lifting purposes — Medium tolerance sling chains — Grade 4, stainless steel

1 Scope

This document specifies the requirements for medium tolerance sling chains of grade 4 from stainless steel for use preferably in chain slings of grade 4 from stainless steel or for other lifting purposes.

The range of nominal diameter, d_n , covered by this document is from 4 mm to 22 mm.

These sling chains are round steel short link chains with a nominal pitch, $p_n = 3 \times d_n$, electrically welded, solution-annealed and tested. They are for use in the temperature range -100 °C to $+400\text{ °C}$. They comply with the general conditions of acceptance of ISO 1834.

NOTE 1 Because sling chains are solution-annealed in the finished condition, they can be used without restrictions with regard to the corrosion resistance of the steels according to 5.2. Higher grades of stainless steel chains are achieved by cold drawing of the wire prior to the chain manufacturing. Therefore, solution annealing is not possible without reduction of strength. The weld seam, in particular, represents a critical area with regard to the corrosion resistance.

NOTE 2 Resistance butt welding and flash welding are listed in ISO 4063.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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 1834, *Short link chain for lifting purposes — General conditions of acceptance*

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

ISO 13385-1, *Geometrical product specifications (GPS) — Dimensional measuring equipment — Part 1: Callipers; Design and metrological characteristics*

ISO 16143-2, *Stainless steels for general purposes — Part 2: Corrosion-resistant semi-finished products, bars, rods and sections*

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

4 Dimensions, masses and designation

4.1 Dimensions and masses

The bases for calculation of the values for the dimensions listed in [Table 1](#) are given in [Annex A](#).

The bases for calculation of the values for the mass per metre listed in [Table B.1](#) are given in [Annex B](#).

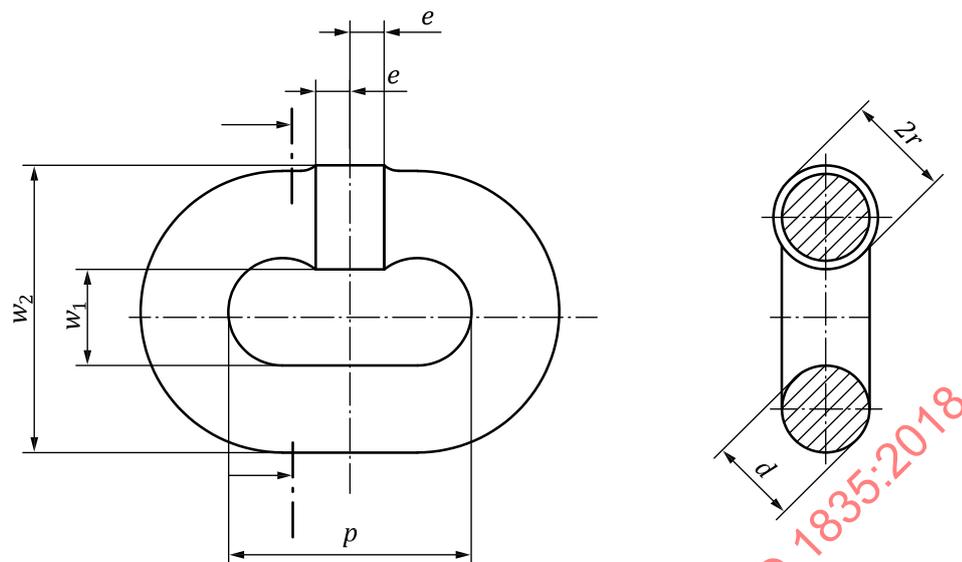
The nominal diameter, d_n , of the sling chain corresponds to the nominal diameter of the steel wire as presented in ISO 16124, or bar as presented in ISO 1035-1, from which the sling chain is made.

Preferred nominal diameters are given in [Table 1](#), column 1. Other nominal diameters may be used, provided the corresponding dimensions and tolerances are calculated in accordance with [Annex A](#).

Table 1 — Dimensions

Dimensions in millimetres

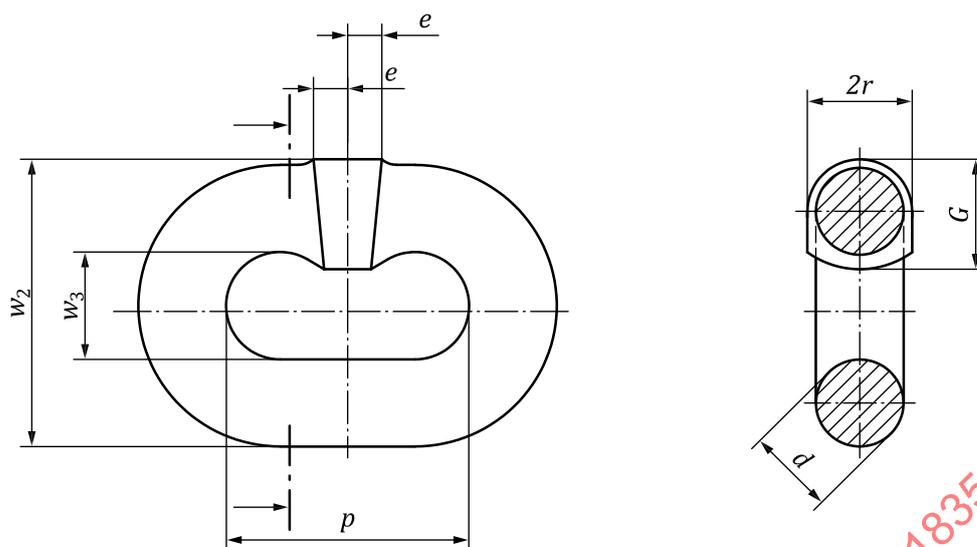
1	2	3	4	5	6	7	8	9
Diameter d		Pitch p		Internal	External	Internal	Weld dimension	
Nominal	Tolerance	Nominal	Tolerance	Type 1	Types 1 and 2	Type 2	Types 1 and 2	Type 2
d_n		p_n		w_1 min.	w_2 max.	w_3 min.	$2r$ max.	G max.
4	±0,2	12	±0,4	5,2	14,8	5,0	4,4	5,0
6	±0,2	18	±0,5	7,8	22,2	7,5	6,6	7,5
8	±0,3	24	±0,7	10,4	29,6	10,0	8,8	10,0
10	±0,4	30	±0,9	13,0	37,0	12,5	11,0	12,5
13	±0,5	39	±1,2	16,9	48,1	16,3	14,3	16,3
16	±0,6	48	±1,4	20,8	59,2	20,0	17,6	20,0
18	±0,7	54	±1,6	23,4	66,6	22,5	19,8	22,5
20	±0,8	60	±1,8	26,0	74,0	25,0	22,0	25,0
22	±0,9	66	±2,0	28,6	81,4	27,5	24,2	27,5

**Key**

- p pitch
- d diameter (measured opposite to the weld)
- r radius at the weld
- e length affected by welding
- w_1 internal width at the weld
- w_2 external width over the weld

Figure 1 — Chain link — Type 1

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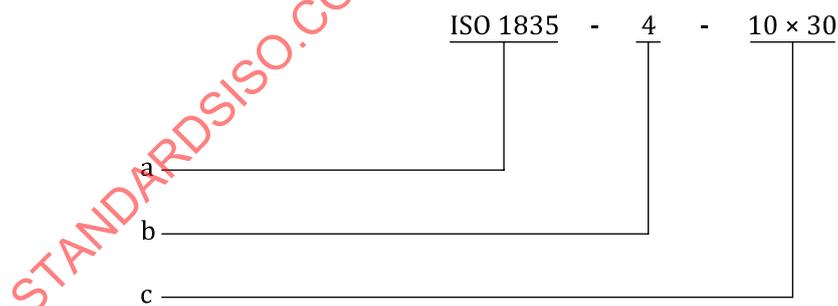
Key

- p pitch
- d diameter (measured opposite to the weld)
- r radius at the weld
- G dimension at the weld
- e length affected by welding
- w_2 external width over the weld
- w_3 internal width away from the weld

Figure 2 — Chain link — Type 2

4.2 Designation

Figure 3 shows the general format for a designation to be used.



Key

- a ISO number block.
- b Grade of sling chain.
- c Size of sling chain.

Figure 3 — Designation

5 Requirements

5.1 General

The sling chain shall comply with the requirements of ISO 1834 as well as those of this document.

5.2 Material

The steel used shall be austenitic stainless steels with molybdenum and shall be resistant against intergranular corrosion, for example the steel with the ISO name X6CrNiMoTi17-12-2 and the ISO number 4571-316-35-I according to ISO 15510.

After solution annealing intergranular corrosion is unlikely at a service temperature of +400 °C and with an extra low carbon content of the steel. To avoid this corrosive attack under severe service conditions and with higher carbon contents of the steel, a stabilization with titanium is recommended.

NOTE 1 The resistance against pitting corrosion can be increased by alloying with molybdenum.

NOTE 2 According to ISO 15510 (see Table A.1), the above-mentioned stainless steel is also well known under the number S31635, where 35 means titanium added. Internationally equivalent numbers of the steel are X6CrNiMoTi17-12-2; 1.4571; AISI/SAE 316Ti and UNS S31635.

5.3 Heat treatment

All sling chains shall be solution annealed within a temperature range of 1 020 °C to 1 120 °C according to ISO 16143-2 and cooled rapidly by water before being subjected to the manufacturing proof force (MPF).

5.4 Surface condition

For an enhanced corrosion resistance, the sling chains shall be pickled after heat treatment to get a constant smooth surface.

NOTE An improved corrosion resistance and smooth surface condition require the passivation of the surface by pickling after heat treating.

5.5 Dimensions

5.5.1 Diameter

The dimensions and tolerances for the diameter, d , shall be as given in [Table 1](#), columns 1 and 2 calculated in accordance with [Annex A](#).

5.5.2 Pitch

The dimensions and tolerances for the pitch, p , shall be as given in [Table 1](#), columns 3 and 4 calculated in accordance with [Annex A](#).

5.5.3 Width

The dimensions for the width, w_1 , w_2 and w_3 shall be as given in [Table 1](#), columns 5, 6 and 7 calculated in accordance with [Annex A](#).

5.5.4 Weld dimensions

The dimensions for the weld, $2r$ and G , shall be as given in [Table 1](#), columns 8 and 9 calculated in accordance with [Annex A](#).

5.5.5 Length dimensionally affected by welding

The length dimensionally affected by welding, e , (see [Figures 1](#) and [2](#)) shall not extend by more than $0,6 \times d_n$ to either side of the centre of the chain link.

5.6 Working load limit (WLL)

[Table 2](#) gives values for the working load limit (WLL), calculated on the basis given in [Annex A](#). For other nominal diameters, the values for the working load limit shall be calculated in accordance with [Annex A](#).

Table 2 — Working load limit (WLL)

1	2
Nominal diameter d_n mm	Working load limit WLL t
4	0,25
6	0,56
8	1,00
10	1,60
13	2,65
16	4,00
18	5,00
20	6,30
22	7,50

5.7 Mechanical properties

5.7.1 General

Sling chains according to this document shall comply with the mechanical requirements as given in [Table 3](#).

Table 3 — Mechanical requirements

1	2	3	4
Nominal diameter d_n mm	Manufacturing proof force (MPF) F_{MP} kN min.	Breaking force (BF) F_B kN min.	Bend deflection f mm min.
4	5,0	10,0	3,2
6	11,2	22,4	4,8
8	20,0	40,0	6,4
10	31,5	63,0	8
13	53,0	106	10
16	80,0	160	13
18	100	200	14
20	125	250	16
22	150	300	18

5.7.2 Manufacturing proof force (MPF)

All sling chains shall be subjected to the manufacturing proof force (MPF), at least equal to the value specified in [Table 3](#), column 2, calculated on the bases given in [Annex A](#).

5.7.3 Breaking force (BF)

Samples of sling chains shall withstand the minimum value for the breaking force (BF) specified in [Table 3](#), column 3, calculated on the bases given in [Annex A](#).

5.7.4 Bend deflection, f

Samples of single chain links shall withstand the minimum value for the deflection, f , specified in [Table 3](#), column 4, calculated on the bases given in [Table 4](#) and shall be free from visible defects.

5.7.5 Total ultimate elongation, A

On completion of the tensile test, the minimum total ultimate elongation, A , shall be in accordance with the value given in [Table 4](#).

Table 4 — Mechanical properties

Line	Mechanical property	Requirement
1	Specified nominal stress at breaking force (BF)	$\sigma_{BF} = 400 \text{ N/mm}^2$
2	Specified nominal stress at manufacturing proof force (MPF)	$\sigma_{MPF} = 200 \text{ N/mm}^2$
3	Percentage ratio of specified nominal stress at manufacturing proof force (MPF) to the specified nominal stress at breaking force (BF)	$\frac{\sigma_{MPF}}{\sigma_{BF}} = 50 \%$
4	Specified minimum total ultimate elongation	$A_{\min} = 30 \%$
5	Specified nominal bend deflection	$f = 0,8 \times d_n$
6	Specified nominal stress at working load limit (WLL)	$\sigma_{WLL} = 100 \text{ N/mm}^2$

6 Tests

6.1 General

The tests shall be performed on the finished sling chain.

Apart from the dimension test (according to [6.4](#)), they are conducted as destructive tests (according to [6.5](#) and [6.6](#)) on samples taken lot by lot.

6.2 Size of lot

One lot comprises a manufacturing unit of 200 m. Any started manufacturing unit is deemed to be one lot.

6.3 Sampling

Samples shall be selected in accordance with ISO 1834.

6.4 Dimension test

The dimensions of the chain links as specified in [Table 1](#) shall be checked using a calliper according to ISO 13385-1.

6.5 Tensile test

6.5.1 Testing machine

The testing machine shall be as specified in ISO 1834 and shall comply with class 1 of machine range specified in ISO 7500-1.

The testing machine shall be equipped with an autographic recorder to record a force-extension-diagram.

6.5.2 Procedure

6.5.2.1 General

The test procedure shall be as specified in ISO 1834.

6.5.2.2 Manufacturing proof force (MPF)

Based on the Hooke's law the value for the manufacturing proof force is at the end of the straight line in the force-extension diagram.

NOTE For further information, see ISO 1834.

6.5.2.3 Breaking force (BF)

The value for the breaking force is at the maximum of the curve in the force-extension diagram.

NOTE For further information, see ISO 1834.

6.5.2.4 Total ultimate elongation, A

The value for the total ultimate elongation, in percent, is based on the value of the total extension at fracture, shown at the end of the curve in the force-extension diagram and calculated in accordance with ISO 1834.

6.6 Bend test

6.6.1 Testing machine

The testing machine shall be as specified in ISO 1834 for the static tensile test and shall comply with class 1 of machine range specified in ISO 7500-1.

The testing machine shall be equipped with an autographic recorder to record a force-deflection-diagram.

6.6.2 Procedure

6.6.2.1 General

The test procedure shall be as specified in ISO 1834.

6.6.2.2 Bend deflection

Each single link sample shall be bent by a deflection, f , as given in [Table 3](#), column 4, and shown in [Figure 4](#).

The value for the bend deflection, f , is at the end of the curve in the force-deflection diagram, see [Figure C.1](#) in [Annex C](#).

Following the removal of the force, the link sample shall be examined by a competent person as specified in ISO 1834.

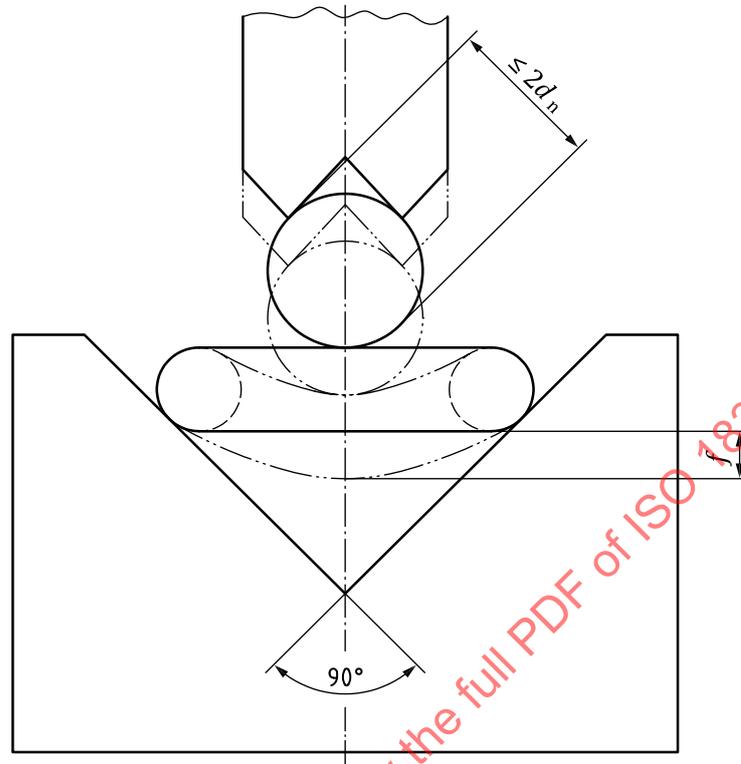


Figure 4 — Bend deflection, f

7 Marking

7.1 Grade marking

The grade mark for the medium tolerance sling chain is "4". The marking shall conform to ISO 1834 and shall be applied as specified in ISO 1834.

7.2 Manufacturer's marking

The manufacturer's mark shall be applied as specified in ISO 1834 as additional marking.

An additional mark shall be applied which indicates that the sling chain is manufactured from stainless steel.

7.3 Traceability marking

The traceability mark shall be applied as specified in ISO 1834 as additional marking.

8 Manufacturer's certificate

The manufacturer shall, if required, supply a certificate of testing and examination with every supply of sling chain containing the information detailed in ISO 1834 and which contains additionally the traceability code corresponding to the traceability marking.

9 Use

Concerning the handling, inspection and maintenance of medium tolerance sling chains from stainless steel according to this document the manufacturer shall be consulted.

10 Environmental aspects

In general, medium tolerance sling chains from stainless steel according to this document are highly durable without loss of quality in the course of their service life.

Due to the material used, the sling chains are 100 % recyclable at the end of their life cycle (removal from service), as they can be melted down completely to produce new materials.

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Annex A (informative)

Bases for calculation

A.1 Dimensions and tolerances

A.1.1 Diameter tolerance

The values for the diameter tolerance are based on $\pm 4\%$ of the nominal diameter, except at the weld.

The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 2.

A.1.2 Pitch and tolerance

The values for the nominal pitch, p_n , are based on $3 \times d_n$. The calculated values are rounded to 1 mm. These rounded values are listed in [Table 1](#), column 3.

The values for the pitch tolerance are based on $\pm 3\%$ of the nominal pitch. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 4.

A.1.3 Width

The values for the internal width of type 1, w_1 , are based on $1,3 \times d_n$. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 5.

The values for the external width of types 1 and 2, w_2 , are based on $3,7 \times d_n$. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 6.

The values for the internal width of type 2, w_3 , are based on $1,25 \times d_n$. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 7.

A.1.4 Weld dimension

The values for the weld dimension of types 1 and 2, $2r$, are based on $1,1 \times d_n$. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 8.

The values for the weld dimension of type 2, G , are based on $1,25 \times d_n$. The calculated values are rounded to 0,1 mm. These rounded values are listed in [Table 1](#), column 9.

A.2 Working load limits and mechanical requirements

A.2.1 General

The specified stresses used in the calculation of values for the working load limit and the mechanical requirements in [Formulae \(A.1\)](#) to [\(A.3\)](#) are nominal stresses as follows:

- a) specified nominal stress at working load limit (WLL) = 100 N/mm²;
- b) specified nominal stress at manufacturing proof force (MPF) = 200 N/mm²;
- c) specified nominal stress at breaking force (BF) = 400 N/mm².

A.2.2 Working load limit (WLL)

The values for the working load limit are based on [Formula \(A.1\)](#):

$$WLL = \frac{2 \times \frac{1}{4} \times \pi \times 100 \times d_n^2}{g \times 1\,000} \quad (\text{A.1})$$

$$WLL = 0,016\,018 \times d_n^2$$

where

WLL is the working load limit, expressed in tonnes;

g is the acceleration due to gravity, expressed in metres per square second (m/s², i.e. 9,806 65).

Based on ISO 2374, the calculated values are rounded down to the nearest lower value of the R40 series of preferred numbers in accordance with ISO 497. These rounded values are listed in [Table 2](#), column 2.

A.2.3 Manufacturing proof force (MPF)

The values for the manufacturing proof force are based on [Formula \(A.2\)](#):

$$F_{MP} = \frac{2 \times \frac{1}{4} \times \pi \times 200 \times d_n^2}{1\,000} \quad (\text{A.2})$$

$$F_{MP} = 0,314\,159 \times d_n^2$$

where F_{MP} is the manufacturing proof force, expressed in kilonewtons.

The calculated values are rounded to the nearest value of the R40 series of preferred numbers in accordance with ISO 497. These rounded values are listed in [Table 3](#), column 2.

A.2.4 Breaking force (BF)

The values for the breaking force are based on [Formula \(A.3\)](#):

$$F_B = \frac{2 \times \frac{1}{4} \times \pi \times 400 \times d_n^2}{1\,000} \quad (\text{A.3})$$

$$F_B = 0,628\,319 \times d_n^2$$

where F_B is the breaking force, expressed in kilonewtons.

The calculated values are rounded to the nearest value of the R40 series of preferred numbers in accordance with ISO 497. These rounded values are listed in [Table 3](#), column 3.

A.2.5 Bend deflection

The values for the bend deflection are based on [Formula \(A.4\)](#):

$$f = 0,8 \times d_n \quad (\text{A.4})$$

where f is the bend deflection, expressed in millimetres.

The calculated values <10 mm are rounded to 0,1 mm. The calculated values ≥ 10 mm are rounded to 1 mm. These rounded values are listed in [Table 3](#), column 4.

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