INTERNATIONAL STANDARD

ISO 3266

Second edition
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Forged steel eyebolts grade 4 for general lifting purposes

Anneaux à tige de classe 4 en acier forgé pour applications générales de levage

Reference number
ISO 3266:2010(E)

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Contents

Page

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.

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 3266 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 3266:1984), which has been technically revised.

Introduction

This document is a type-C standard as stated in ISO 12100.

The equipment concerned as well as the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this International Standard.

When provisions of this type-C standard are different from those which are stated in type-A or type-B standards, the provisions of this type-C standard take precedence over the provisions of the other standards, for equipment that have been designed and built according to the provisions of this type-C standard.

Forged steel eyebolts grade 4 for general lifting purposes

1 Scope

This International Standard specifies the general characteristics, performance and critical dimensions necessary for interchangeability and compatibility with other components, of forged steel eyebolts grade 4 for general lifting purposes. These eyebolts can be used for axial and inclined loading.

This International Standard specifies the dimensions of the eyes of eyebolts permitting direct connection with shackles of the same working load limit as those defined in ISO 2415. These dimensions also allow designs with a larger eye which can permit direct connection with sling hooks of similar working load limit.

This International Standard covers all significant hazards, hazardous situations and events relevant to eyebolts grade 4 as defined in Clause 4.

This International Standard is applicable to eyebolts grade 4 for use in the temperature range of −20 ºC to 200 ºC.

This International Standard is not applicable to eyebolts which are not forged in one piece.

This International Standard is not applicable to forged steel eyebolts grade 4 manufactured before the date of its publication as an International Standard.

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 148-2, *Metallic materials — Charpy pendulum impact test — Part 2: Verification of testing machines*

ISO 261, *ISO general purpose screw threads — General plan*

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

ISO 965-1, *ISO general purpose metric screw threads — Tolerances — Part 1: Principles and basic data*

ISO 6506-1, *Metallic materials — Brinell hardness test — Part 1: Test method*

ISO 6508-1, *Metallic materials — Rockwell hardness test — Part 1: Test method (scales A, B, C, D, E, F, G, H, K, N, T)*

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*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

EN 10228-1, *Non-destructive testing of steel forgings — Part 1: Magnetic particle 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
nominal size
thread size
size related to the nominal diameter of the thread, d, of an eyebolt

3.2
working load limit
WLL
maximum mass that an eyebolt is authorized to sustain along its centreline axis in general lifting service

3.3
traceability code
series of letters and/or numbers marked on an eyebolt that enables its manufacturing history, including the identity of the cast of steel used, to be traced

3.4
proof force
force applied to the eyebolt during the manufacturing proof test

3.5
breaking force
maximum force reached during the static tensile test of the eyebolt at which the eyebolt fails to retain the load

3.6
axial loading
F_a
loading along the centreline axis of the eyebolt

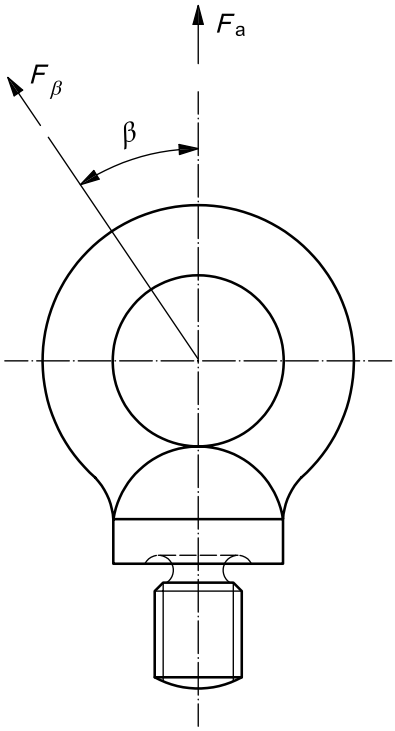
See Figure 1.

3.7
inclined loading
F_β
loading at an angle β to the centreline axis

See Figure 1.

3.8
lot
specified number of eyebolts 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

NOTE Adapted from ISO 8539:2009, definition 3.6.



Key

F_a axial loading

F_β inclined loading

β inclined loading angle

Figure 1 — Axial and inclined loading of an eyebolt

4 List of significant hazards

This clause contains all the significant hazards, risk areas and hazardous situations and events as far as they are dealt with in this International Standard, identified by risk assessment as significant according to ISO 14121-1 for this type of machinery and which require action to eliminate or reduce the risk. See Table 1.

Table 1 — Hazards and associated requirements

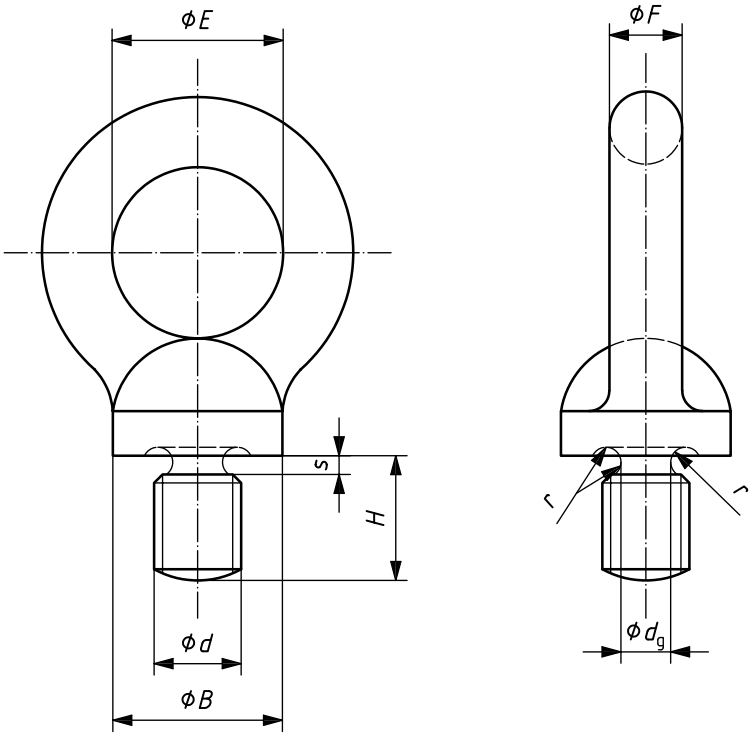
Hazards identified in Annex A of ISO 14121-1:2007	Causes of failure	Relevant clause of this International Standard
Injury or death due to being hit by a falling load arising from failure of the eyebolt from the following causes:	Inadequate strength and toughness	7 8 9 10 11 12 13
	Dimensional incompatibility and errors of fitting	5 6 7 14
	Incorrect selection	14 15 16 Annex A
	Inadequate information for use	14 16

5 Dimensions and tolerances

The dimensions of the eyebolt shall conform to the requirements of Figure 2 and Table 2.

A positive local deviation of roundness of +5 % is permitted in respect of the internal diameter, E.

A tolerance of symmetry of 5 % on the diameter, F, is permitted.



Key

B diameter of collar
d nominal thread diameter
d_g shank diameter
E internal diameter of the eye
F diameter of cross section of the eye
H height from underside of collar to end of threaded shank
r radius of under cut and thread run-out
s distance from underside of collar to the first thread

Figure 2 — Dimensions of eyebolts

Table 2 — Dimensions of eyebolts

1	2	3	4	5	6	7	8
Nominal size Nominal diameter of thread d mm	**Axial working load limit** WLL t	E min. $20 \times \sqrt{\text{WLL}}$ mm	H $1{,}5d$ mm	F max. $14 \times \sqrt{\text{WLL}}$ mm	r min. mm	B min. $(26 \times \sqrt{\text{WLL}}) + 5$ mm	s $0{,}25d$ mm
8	0,2	9	12	6	1	17	2
10	0,32	11	15	8	1	20	3
12	0,4	13	18	9	1	21	3
16	0,8	18	24	13	1	28	4
20	1,6	25	30	18	1	38	5
24	2,5	32	36	22	2	46	6
30	4	40	45	28	2	57	8
36	6,3	50	54	35	3	70	9
42	8	57	63	40	3	79	11
48	10	63	72	44	3	87	12
52	12,5	71	78	49	3	97	13
56	16	80	84	56	4	109	14
64	20	89	96	63	4	121	16
Nominal diameter of thread $\times$ pitch $d \times P$							
72×6	25	100	108	70	4	135	18
80×6	32	113	120	79	4	152	20
90×6	40	126	135	89	5	169	23
100×6	50	141	150	99	5	189	25

6 Screw threads

The threads of the shanks shall comply with ISO 261, coarse pitch series, tolerance class 6 g to ISO 965-1.

Dimension d_g equals the minor diameter of the thread minus 0,3 mm.

The portion of the thread at the end of the screw thread shall have a run-out and the collar shall be recessed as shown in Figure 2.

7 Workmanship

The eyebolt, including the shank, shall be forged in one piece without welding. The underside of the collar shall be machined in true alignment at right-angles to the axis of the shank. The shank shall be screwed concentrically with the outside diameter of the collar. The thread run-out and recess shall be smoothly radiused and free from surface irregularities.

8 Material

8.1 General

The steel shall be produced by an electric or an oxygen-blown process. In its finished state, as supplied to the eyebolt manufacturer, the steel shall conform to the requirements specified in 8.2 as determined by a cast or check analysis on the bar or the finished eyebolt.

8.2 Specific requirements

The steel shall be fully killed, shall be suitable for forging and shall be capable of being heat treated to obtain the mechanical properties required by this International Standard.

Its content of sulfur and phosphorous shall be restricted as specified in Table 3.

Table 3 — Sulfur and phosphorous content

Element	**Maximum content** (in percent by mass) **as determined by**	
	cast analysis	**check analysis**
Sulfur	0,025	0,04
Phosphorus	0,030	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 eyebolts stabilized against strain–age embrittlement during service; a minimum value of 0,025 % of total aluminium is given for guidance.

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

8.3 Charpy impact test

A Charpy V-notch impact test shall be carried out in accordance with ISO 148-1 and ISO 148-2 on eyebolts of all sizes.

Three samples shall be tested at a temperature of −20 °C and shall have a minimum average impact value of 27 J. For tests where the size of eyebolt is too small to provide a suitable test piece, tests may be carried out on sample material which shall be of the same specification and heat treatment.

Where eyebolts are required for use at temperatures below −20 °C or above 200 °C, the manufacturer should be consulted.

No individual test shall be less than 2/3 of the specified minimum average value.

9 Heat treatment

After forging, each eyebolt shall either be hardened from a temperature above the AC3 point and tempered, or normalized from a temperature above the AC3 point, before being subjected to the manufacturing proof force. The tempering temperature shall be a minimum of 475 °C.

The tempering conditions shall be at least as effective as a temperature of 475 °C maintained for a period of 1 h.

10 Hardness

10.1 Hardness requirement

The eyebolt shall have a maximum Brinell hardness value of 214 HBW or a maximum Rockwell hardness value of 96 HRB when tested in accordance with 10.2.

10.2 Hardness testing

To determine the Brinell hardness value, the tests shall be carried out in accordance with ISO 6506-1 using, where practical, a 10 mm steel ball and a force of 29,42 kN (HBW 10/3 000).

To determine the Rockwell hardness value (HRB), the tests shall be carried out in accordance with ISO 6508-1.

Precautions shall be taken to ensure that the surface tested is representative of the material and that its hardness is not affected by decarburizing, carburization or by the method used for preparing the test surface.

11 Mechanical properties

The mechanical properties of the eyebolts in terms of proof force, minimum breaking force and deformation test for inclined loading shall be as specified in Table 4.

12 Type test

12.1 General

The type tests described in this clause are designed to demonstrate that eyebolts certified by the manufacturer as conforming to this International Standard possess the mechanical properties specified in this International Standard. The purpose of these tests is to verify that the design, material, heat treatment and method of manufacture of each size of finished eyebolt, including protective coating if applied, meet the requirements of this International Standard. Any change in the design, material specification, heat treatment, method of manufacture, including protective coating if applied, or in any dimension outside normal manufacturing tolerances which may lead to a modification of the mechanical properties as defined in Clause 11 shall require that the type tests specified in 12.2 and 12.3 be carried out on the modified eyebolt.

The tests specified in 12.2 and 12.3 shall be carried out on each size of eyebolt of each design, material, heat treatment and method of manufacture including protective coating if applied.

In the tests specified in 12.2 and 12.3 the force shall be applied without shock using a test machine fitting having a diameter not greater than 50 % of the internal eye diameter, E.

Table 4 — Mechanical properties

1	2	3	4	5 [a]	6 [a]	7 [a]
Nominal size Nominal diameter of thread d mm	**Working load limit** WLL t	**Axial proof force** kN	**Minimum axial breaking force** kN	**Maximum working load of a pair when** $0 < \beta \leqslant 45°$ $(1{,}4 \times \text{WLL})$ t	**Angled proof force of a pair when** $\beta = 45°$ kN	**Minimum angled breaking force of a pair when** $\beta = 45°$ kN
8	0,2	4	8	0,28	5,6	11,2
10	0,32	6,4	12,5	0,44	9	18
12	0,4	8	16	0,56	11,2	22,4
16	0,8	16	32	1,12	22,4	44,8
20	1,6	32	63	2,24	44,8	89,6
24	2,5	50	100	3,5	70	140
30	4	80	160	5,6	112	224
36	6,3	125	250	8,82	176,4	352,8
42	8	160	320	11,2	224	448
48	10	200	400	14	280	560
52	12,5	250	500	17,5	350	700
56	16	320	630	22,4	448	896
64	20	400	800	28	560	1 120
Nominal diameter of thread $\times$ pitch $d \times P$						
72×6	25	500	1 000	35	700	1 400
80×6	32	630	1 250	44,8	896	1 792
90×6	40	800	1 600	56	1 120	2 240
100×6	50	1 000	2 000	70	1 400	2 800

[a] The values given in Columns 5 to 7 are for a pair of eyebolts used for inclined loading and are based on the assumption that the eyebolt collars are screwed down on the face and the eyes are in the plane of the lifting sling with a tolerance of $\pm 5°$. In order to achieve this alignment of the eye, it may be necessary to insert shims (spacing washers) which should not exceed, in thickness, half the pitch of the relevant screw thread. Under no circumstances should the eyebolt be over-tightened in an attempt to achieve correct alignment. Figure A.1 illustrates the required alignment for a pair of eyebolts used for inclined loading. For complex applications using three or more eyebolts, there are other factors which may influence the working load. For such applications, a competent person, who can assess the various factors, should be consulted.

12.2 Deformation resistance test

Three samples shall be tested and each shall be capable of withstanding the forces specified in Columns 3 and 6 of Table 4. The test equipment shall be accurate to Class 1 specified in ISO 7500-1:2004.

After the test force has been removed, there shall be no deformation of the diameter of the eye exceeding 0,5 % of the initial dimension and no deformation of the shank.

All three samples shall pass the deformation test in order to ensure that the eyebolt of the size submitted for type testing conforms to this International Standard.

Each size of eyebolt requires two tests, to the forces specified in Columns 3 and 6 respectively. Both tests may be done on the same eyebolt. The angled test may be performed on one sample at a time provided that the force applied to the eyebolt is equal to that applied when tested as a pair.

12.3 Static strength test

Three samples shall be tested and each shall have a minimum axial breaking force at least equal to the minimum value specified in Table 4.

If all three samples pass the test, the eyebolt of the size submitted for type testing conforming to with this International Standard.

If one of the samples fails, two further samples shall be tested and both shall pass the test in order for the eyebolt of the size submitted for type testing conforming to this International Standard. If two or three samples fail the test, the eyebolt of the size submitted for type testing does not conform to this International Standard.

This test may be carried out on the same eyebolt used for the deformation test.

13 Manufacturing tests

13.1 Manufacturing proof test

For the manufacturing proof test, the test equipment, accurate to Class 1 specified in ISO 7500-1:2004, shall apply a force at least equal to the proof force specified.

After heat-treatment and de-scaling, each eyebolt shall sustain the appropriate proof force specified in Table 4. 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 eyebolt embrittlement, e.g. acid cleaning or electroplating, the proof force shall be re-applied in the finished condition.

13.2 Non-destructive test

The forged surfaces 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 eyebolt subjected to tensile stresses, in all foreseeable service conditions.

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

CAUTION — Care should be taken when removing indications 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.

13.3 Test regime and acceptance criteria

13.3.1 General

The maximum size of a lot shall be as given in Table 5 for the ranges of nominal sizes indicated.

Table 5 — Number of eyebolts in a lot

Nominal size mm	Maximum number in a lot
8 to 20	1 000
24 to 48	500
52 to 100	200

13.3.2 Static strength test sampling

The manufacturer shall subject one sample per lot to the static strength test as defined in 12.3. If the sample meets the appropriate requirements then, subject to complying with 13.3.3, 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 12.3. If both of these sample meet the appropriate requirements then, subject to complying with 13.3.3, 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.

13.3.3 Manufacturing test regime

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

a) Applying the proof force test to all eyebolts in the lot specified in Table 5 in accordance with 13.1 plus non-destructive testing of 3 % of the lot of eyebolts in accordance with 13.2.

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

b) Applying the non-destructive test to all the eyebolts in the lot specified in Table 5 in accordance with 13.2 plus proof force testing of 3 % of the lot of eyebolts in accordance with 13.1.

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

14 Marking

Each eyebolt shall be legibly and indelibly marked in a manner which will not impair the mechanical properties of the eyebolt. This marking shall include at least the following information:

a) the manufacturer's identification mark or symbol;

b) the nominal size, i.e. nominal diameter of thread as shown in Column 1 of Table 2, e.g. 24;

c) the axial working load limit in general service as shown in Column 2 of Table 2, e.g. WLL 2,5 t;

d) the traceability code to enable any particular eyebolt or batch of eyebolts to be identified with the manufacturer's certificate;

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

15 Manufacturer's declaration

15.1 When the type testing specified in Clause 12 has been carried out with satisfactory results, the manufacturer can issue declarations of conformity for eyebolts of the same nominal dimensions, size, material, heat treatment and method of manufacture, including protective coating if applied, as the eyebolts tested.

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 and all relevant data concerning the eyebolts which have satisfied the type tests. This record shall also include the manufacturing specifications which shall apply to subsequent production.

Any change in material specification, method of manufacture, including protective coating, heat treatment or any dimension outside of normal manufacturing tolerances which may lead to a modification of the mechanical properties as specified in Clause 11 shall be considered as a design change. Tests in accordance with Clause 12 shall be required before the manufacturer is permitted to issue declaration of conformity for any modified design.

15.2 The manufacturer shall provide a declaration with each consignment of eyebolts giving the following information for the consignment:

a) the business name and the full address of the manufacturer and, where applicable his authorized representative;

b) the number of this International Standard, i.e. ISO 3266;

c) the quantity and description of the eyebolt;

d) the traceability code to enable any particular eyebolt or batch of eyebolts to be identified;

e) the working load limit, expressed in tonnes;

f) the proof force applied, expressed in kilonewtons;

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

The declaration shall declare that each eyebolt complies with this International Standard and is within the manufacturer’s specification of the type tested eyebolt(s). It shall also state the name and address of the testing establishment if different from the manufacturer.

The declaration shall be authenticated by a signature and shall state the name and status of the signatory.

16 Information for use

The manufacturer shall provide specific information for the use of eyebolts. In particular, this information shall cover the intended use, the instructions for assembly, use and maintenance and the limits of use. Annex A provides guidance.

Annex A
(informative)

Recommendations for the selection, care and use of eyebolts

A.1 Use of eyebolts

Eyebolts may be used up to the marked working load limit, for axial loading only. Eyebolts may also be used for inclined loading provided that the WLL is reduced by the appropriate factors (see Table 4). In inclined loading the load should be applied within ± 5° of the plane of the eye (see A.2.2). The size of the eye in an eyebolt to this standard may be too small to provide a direct connection to a hook. If this is the case, a shackle is normally used for this attachment. Eyebolts should not be used outside of the temperature range –20 °C to 200 °C without consulting the manufacturer.

A.2 Correct fitting of eyebolts

A.2.1 General

Eyebolts should only be selected and fitted by a trained person who should inspect the eyebolt before fitting (see A.3) and should verify that the eyebolt thread and the tapped hole into which it is to be screwed are free from debris and are compatible. The contacting surface around the tapped hole should be smooth, clean, flat, perpendicular to the thread axis and large enough to accept the eyebolt. The eyebolt should be firmly screwed down without over-tightening. If a single eyebolt is used for lifting a load which is liable to revolve or twist, a swivel type hook should be used to prevent the eyebolt unscrewing. Care should be taken to ensure that the tapped hole has sufficient threaded length to engage the eyebolt shank fully and that the material of the tapping is of adequate strength. This is particularly important when screwing eyebolts into blind holes, as it is essential to ensure that the collar is fully seated before the eyebolt thread reaches the bottom of the tapped hole.

A.2.2 Fitting pairs of eyebolts

The plane of the eye of each of a pair of eyebolts should ideally be within ± 5° of the plane containing the axes of the two eyebolts (see Figure A.1). If at first this condition is not fulfilled, it can be achieved by the insertion of shims which should not exceed in thickness, half the pitch of the relevant screw thread, or by machining the contacting surface. Under no circumstances should the eyebolt be over-tightened in an attempt to achieve correct alignment. Care should also be taken to avoid an alignment whereby the application of the angular load tends to unscrew the eyebolt from its seating. The correct method of slinging using a pair of eyebolts is shown in Figure A.2. A sling should not be reeved directly through the eyebolts or through shackles fitted to the eyebolts (see Figure A.3) as by this method the angular loading of the eyebolt is considerably increased.

A.3 Inspection

Eyebolts should be regularly inspected with particular attention to the following features:

a) the marking, as detailed in Clause 14, should be legible;

b) threads should be free from wear, corrosion and damage;

c) there should be no debris present in the thread;

d) there should be no distortion of the eyebolt, i.e. bent shank, deformed eye, reduced diameter at the undercut, nor should any damage, i.e. nicks, cracks, gouges, or corrosion, be present.

A.4 Storage and handling

Eyebolts should be handled with care and normal precautions should be taken to protect the machined surfaces, i.e. the thread and underside of the collar. To protect the machined surfaces and to prevent corrosion, eyebolts should be lightly oiled or greased and stored in a dry place.

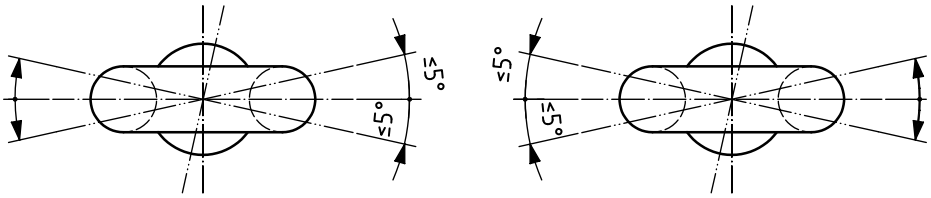


Figure A.1 — Plane view of alignment of eyebolts when used in pairs

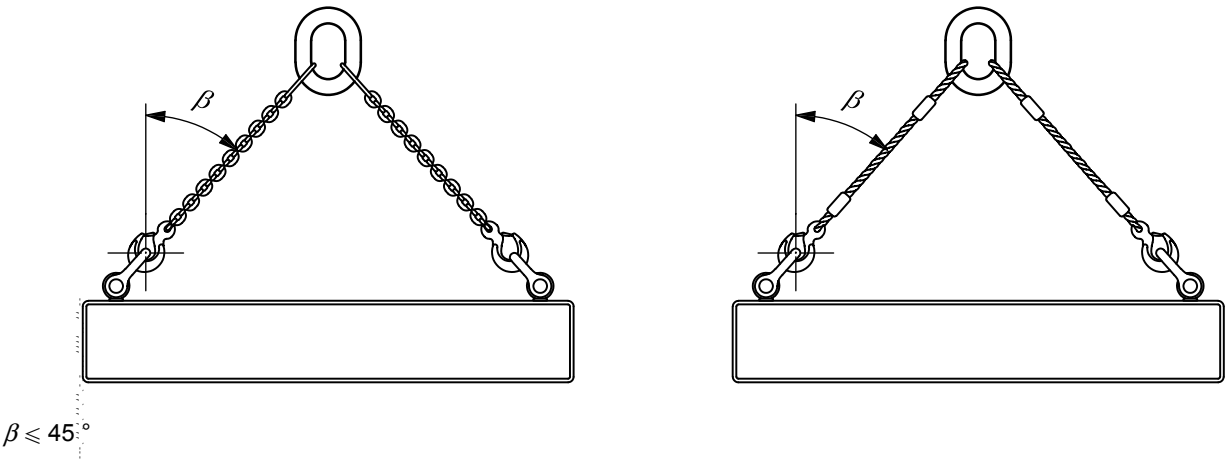


Figure A.2 — Correct method of slinging pairs of eyebolts

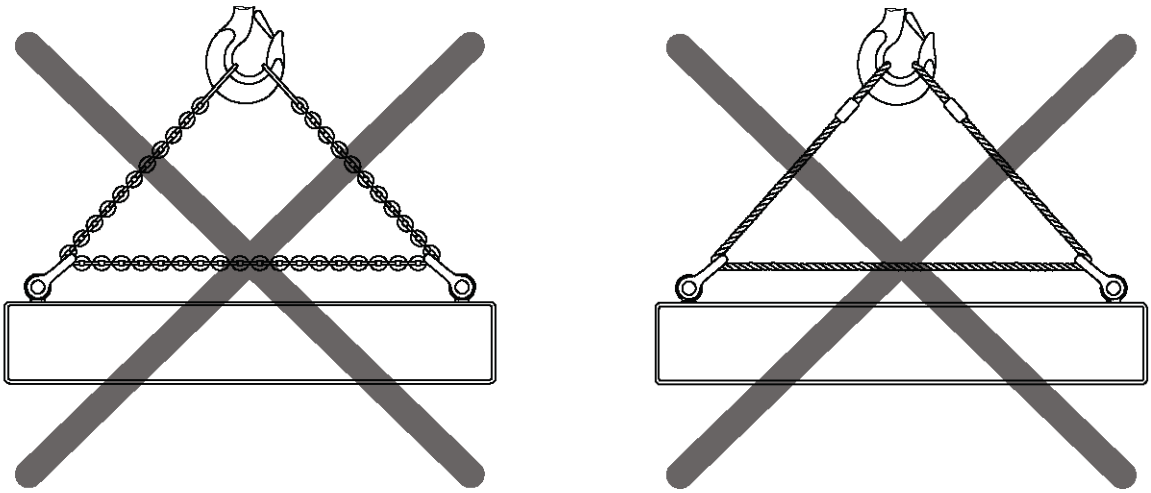


Figure A.3 — Incorrect method of slinging pairs of eyebolts

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