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High-strength structural bolting assemblies for preloading – Part 8: System HV – Hexagon fit bolt and nut assemblies English version of DIN EN 14399-8:2008-03

Hochfeste planmäßig vorspannbare Schraubenverbindungen für den Metallbau –
Teil 8: System HV –
Garnituren aus Sechskant-Passschrauben und Muttern
Englische Fassung DIN EN 14399-8:2008-03

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National foreword

This standard has been prepared by Technical Committee CEN/TC 185 “Fasteners” (Secretariat: DIN, Germany).

The responsible German body involved in its preparation was the *Normenausschuss Mechanische Verbindungselemente* (Fasteners Standards Committee), Technical Committee NA 067-03-04 AA *Schraubenverbindungen für den Stahlbau*.

The European Standards referred to in clause 2 of the EN have been published as the corresponding DIN EN Standards with the same number. The DIN Standards corresponding to the International Standards referred to in clause 2 of the EN are as follows:

ISO 261	DIN ISO 261
ISO 965-2	DIN ISO 965-2
ISO 965-5	DIN ISO 965-5

Amendments

This standard differs from DIN 7999:1983-12 as follows:

a) Bolts and nuts are now specified as being part of an assembly.

b) Normative references have been updated.

c) Nominal size M36 has been included.

d) Dimension b (thread length) has been amended.

e) For shaft diameter d_s, limiting values have been specified.

f) Values for $d_{w\,min}$ have been modified.

g) Dimension e_{min} for nominal sizes M12 and M20 has been modified.

h) Values for k_{min}, k_{max} and $k_{w\,min}$ have been specified.

i) Values for r_{min} have been modified.

j) The width across flats s_{max} for nominal sizes M12 and M20 has been modified and values for s_{min} have been specified for all nominal sizes.

k) Specifications for bolts and nuts have been given in more detail.

l) Details relating to suitability tests have been included.

m) Designations in the figure of the bolt have been modified.

n) Values for l_s and l_g have been modified.

o) The clamp length has been redefined and clamp length values changed accordingly.

p) Information on masses is no longer included.

Previous editions

DIN 7999: 1982-03, 1983-12

National Annex NA
(informative)

Bibliography

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

DIN ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads; medium quality*

DIN ISO 965-5, *ISO general purpose metric screw threads — Tolerances — Part 5: Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing*

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 14399-8

December 2007

ICS 21.060.01

English Version

High-strength structural bolting assemblies for preloading - Part 8: System HV - Hexagon fit bolt and nut assemblies

Boulonnerie de construction métallique à haute résistance apte à la précontrainte - Partie 8: Système HV - Boulons ajustés à tête hexagonale (vis + écrou)

Hochfeste planmäßig vorspannbare Schraubenverbindungen für den Metallbau - Teil 8: System HV - Garnituren aus Sechskant-Passschrauben und Muttern

This European Standard was approved by CEN on 10 November 2007.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN Management Centre has the same status as the official versions.

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Foreword

This document (EN 14399-8:2007) has been prepared by Technical Committee CEN/TC 185 “Fasteners”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by June 2008, and conflicting national standards shall be withdrawn at the latest by June 2010.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

Introduction

This document for structural bolting reflects the situation in Europe where two technical solutions exist to achieve the necessary ductility of bolt/nut/washer assemblies. These solutions utilize different systems (HR and HV) of bolt/nut/washer assemblies, see Table 1. Both systems are well proved and it is up to the experts responsible for structural bolting whether they use the one or the other system.

It is however important for the performance of the assembly to avoid mixing up the components of both systems. Therefore bolts and nuts for both systems are standardized in one single part of this European Standard each and the marking of the components of the same system is uniform.

Table 1 — Systems of bolt/nut/washer(s) assemblies

	Bolt/nut/washer(s) assembly System HR		**Bolt/nut/washer(s) assembly System HV**
General requirements	EN 14399-1		
Bolt/nut assemblies	EN 14399-3, EN 14399-7		EN 14399-4, EN 14399-8
Marking	HR		HV
Property classes	8.8/8	10.9/10	10.9/10
Washer(s)	EN 14399-5 or EN 14399-6		EN 14399-5 or EN 14399-6
Marking	H		H
Suitability test for preloading	EN 14399-2		EN 14399-2

Preloaded bolted assemblies are very sensitive to differences in manufacture and lubrication. Therefore it is important that the assembly is supplied by one manufacturer who is always responsible for the function of the assembly.

For the same reason it is important that the coating of the assembly is under the control of the manufacturer.

Beside the mechanical properties of the components, the functionality of the assembly requires that the specified pre-load can be achieved if the assembly is tightened with a suitable procedure. For this purpose a test method for the suitability of the components for preloading was created which will demonstrate whether the function of the assembly is fulfilled.

It should be pointed out that compared to ISO 272 the widths across flats (large series) for M12 and M20 have been changed to 22 mm and 32 mm respectively. These changes are justified by the following reasons.

Under the specific conditions of structural bolting the compressive stresses under the bolt head or nut for the sizes M12 may become too large with the width across flats of 21 mm, especially if the washer is fitted excentrically to the bolt axis.

For the size M20 the width across flats of 34 mm is very difficult to be produced. The change to 32 mm is primarily motivated by economics but it should also be pointed out that the width across flats of 32 mm is already common practice in Europe.

Attention is drawn to the importance of ensuring that the bolts are correctly used if satisfactory results are to be obtained. For recommendations concerning proper application, reference to prEN 1090-2 is made.

1 Scope

This document belongs to the suite of European Standards EN 14399 and is designed to be read in conjunction with EN 14399-1 for:

— general requirements;

— testing for conformity evaluation;

— evaluation of conformity;

— regulatory marking;

for assemblies of high-strength structural fit bolts and nuts of system HV suitable for preloaded joints with, thread sizes M12 to M36 and bolt property class 10.9 and EN 14399-2 for suitability testing.

This part gives requirements for:

— dimensions;

— associated washer(s) according to EN 14399-6;

— performance and suitability tests

for assemblies with thread sizes M12 to M36 and bolt property class 10.9.

Assemblies of hexagon fit bolts with shaft diameter ($d + 1$ mm) and nuts according to this part of this European Standard have been designed to allow preloading of at least 0,7 $f_{ub} \times A_s$[1)] according to EN 1993-1-8 (Eurocode 3) and to obtain ductility predominantly by deformation of the engaged thread. For this purpose the components have the following characteristics:

— nut height approximately 0,8 d;

— hexagon fit bolt with short thread length.

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.

EN 1993-1-8, *Eurocode 3: Design of steel structures — Part 1-8: Design of joints*

EN 10045-1, *Metallic materials - Charpy impact test - Part 1: Test method*

EN 14399-1:2005, *High-strength structural bolting assemblies for preloading - Part 1: General requirements*

EN 14399-2:2005, *High-strength structural bolting assemblies for preloading - Part 2: Suitability test for preloading*

EN 14399-5, *High-strength structural bolting assemblies for preloading - Part 5: Plain washers*

EN 14399-6, *High-strength structural bolting assemblies for preloading - Part 6: Plain chamfered washers*

EN 20898-2, *Mechanical properties of fasteners - Part 2: Nuts with specified proof load values - Coarse thread (ISO 898-2:1992)*

1) f_{ub} is the nominal tensile strength (R_m) and A_s is the nominal stress area of the bolt.

EN 26157-1, *Fasteners - Surface discontinuities - Part 1: Bolts, screws and studs for general requirements (ISO 6157-1:1988)*

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs (ISO 898-1:1999)*

EN ISO 3269, *Fasteners - Acceptance inspection (ISO 3269:2000)*

EN ISO 4759-1, *Tolerances for fasteners - Part 1: Bolts, screws, studs and nuts - Product grades A, B and C (ISO 4759-1:2000)*

EN ISO 6157-2, *Fasteners - Surface discontinuities - Part 2: Nuts (ISO 6157-2:1995)*

EN ISO 10684, *Fasteners - Hot dip galvanized coatings (ISO 10684:2004)*

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

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

ISO 965-2, *ISO general purpose metric screw threads - Tolerances - Part 2: Limits of sizes for general purpose external and internal screw threads - Medium quality*

ISO 965-5, *ISO general purpose metric screw threads - Tolerances - Part 5: Limits of sizes for internal screw threads to mate with hot-dip galvanized external screw threads with maximum size of tolerance position h before galvanizing*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 14399-1:2005 and EN 14399-2:2005 apply.

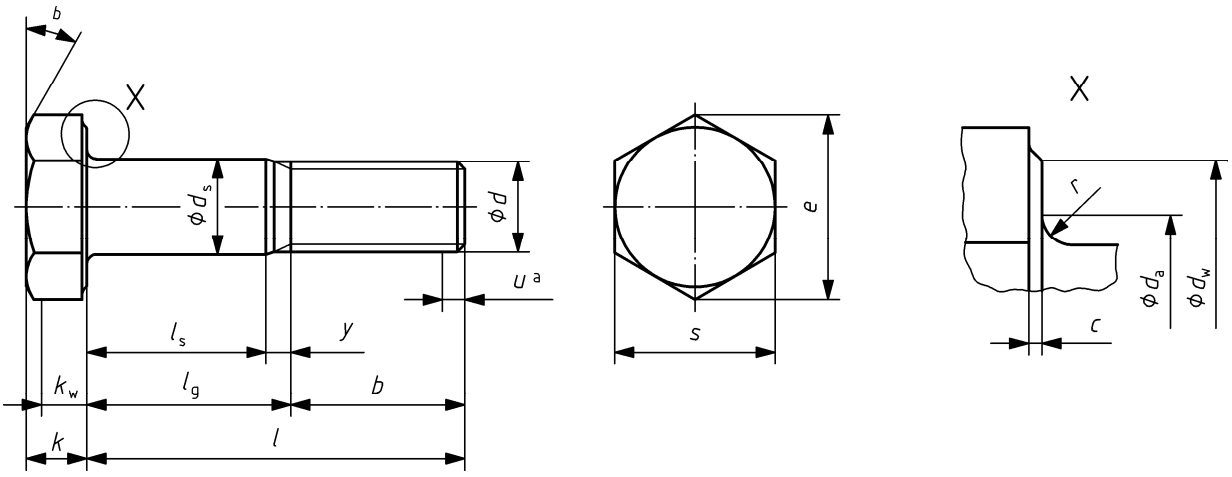
4 Fit bolts

4.1 General

The test method for suitability for preloading shall be as specified in EN 14399-2.

4.2 Dimensions of fit bolts

Dimensions see Figure 1 and Table 2, clamp length see Figure 2 and Table 3.



a incomplete thread $u \leq 2P$

b 15° to 30°

Figure 1 — Dimensions of fit bolts

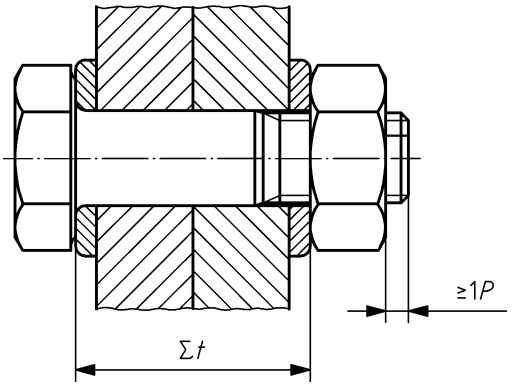


Figure 2 — Clamp length Σt

Table 2 — Dimensions of fit bolts[a]

Dimensions in millimetres

Thread d		M12	M16	M20	M22	M24	M27	M30	M36
P^{b}		1,75	2	2,5	2,5	3	3	3,5	4
b	(ref.)	23	28	33	34	39	41	44	52
c	min.	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
	max.	0,6	0,6	0,8	0,8	0,8	0,8	0,8	0,8
d_a	max.	15,2	19,2	24	26	28	32	35	41
d_s	nom.	13	17	21	23	25	28	31	37
	min. [c]	12,74	16,74	20,71	22,71	24,71	27,71	30,67	36,67
	max. [c]	12,85	16,85	20,84	22,84	24,84	27,84	30,83	36,83
d_w	min.	20,1	24,9	29,5	33,3	38,0	42,8	46,6	55,9
	max.	d	d	d	d	d	d	d	d
e	min.	23,91	29,56	35,03	39,55	45,20	50,85	55,37	66,44
k	nom.	8	10	13	14	15	17	19	23
	min.	7,55	9,25	12,1	13,1	14,1	16,1	17,95	21,95
	max.	8,45	10,75	13,9	14,9	15,9	17,9	20,05	24,05
k_w	min.	5,28	6,47	8,47	9,17	9,87	11,27	12,56	15,36
r	min.	1,2	1,2	1,5	1,5	1,5	2	2	2
s	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31	35	40	45	49	58,8
y	max.	6,5	7,5	8,5	8,5	10,0	10,0	11,5	13,0

Table 2 (*continued*)

Dimensions in millimetres

Thread d			M12		M16		M20		M22		M24		M27		M30		M36	
l			l_s [f] and l_g [e]															
			l_s	l_g	l_s	l_g	l_s	l_g	l_s	l_g	l_s	l_g	l_s	l_g	l_s	l_g	l_s	l_g
nom.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
50	48,75	51,25	20,5	27														
55	53,5	56,5	25,5	32														
60	58,5	61,5	30,5	37														
65	63,5	66,5	35,5	42	29,5	37												
70	68,5	71,5	40,5	47	34,5	42												
75	73,5	76,5	45,5	52	39,5	47	33,5	42										
80	78,5	81,5	50,5	57	44,5	52	38,5	47	37,5	46								
85	83,25	86,75	55,5	62	49,5	57	43,5	52	42,5	51								
90	88,25	91,75	60,5	67	54,5	62	48,5	57	47,5	56	41	51						
95	93,25	96,75	65,5	72	59,5	67	53,5	62	52,5	61	46	56	44	54				
100	98,25	101,75			64,5	72	58,5	67	57,5	66	51	61	49	59				
105	103,25	106,75			69,5	77	63,5	72	62,5	71	56	66	54	64	49,5	61		
110	108,25	111,75			74,5	82	68,5	77	67,5	76	61	71	59	69	54,5	66		
115	113,25	116,75			79,5	87	73,5	82	72,5	81	66	76	64	74	59,5	71		
120	118,25	121,75			84,5	92	78,5	87	77,5	86	71	81	69	79	64,5	76		
125	123	127			89,5	97	83,5	92	82,5	91	76	86	74	84	69,5	81	60	73
130	128	132					88,5	97	87,5	96	81	91	79	89	74,5	86	65	78
135	133	137					93,5	102	92,5	101	86	96	84	94	79,5	91	70	83
140	138	142					98,5	107	97,5	106	91	101	89	99	84,5	96	75	88
145	143	147					103,5	112	102,5	111	96	106	94	104	89,5	101	80	93
150	148	152					108,5	117	107,5	116	101	111	99	109	94,5	106	85	98
155	153	159					113,5	122	112,5	121	106	116	104	114	99,5	111	90	103
160	158	164							117,5	126	111	121	109	119	104,5	116	95	108
165	163	169							122,5	131	116	126	114	124	109,5	121	100	113
170	168	174									121	131	119	129	114,5	126	105	118
175	173	179									126	136	124	134	119,5	131	110	123
180	178	184									131	141	129	139	124,5	136	115	128
185	182,7	189,6									136	146	134	144	129,5	141	120	133
190	187,7	194,6											139	149	134,5	146	125	138
195	192,7	199,6											144	154	139,5	151	130	143
200	197,7	204,6											149	159	144,5	156	135	148

NOTE The popular lengths are defined in terms of lengths $l_{s\ min}$ and $l_{g\ max}$.

a For hot-dip galvanized bolts, the dimensions apply before galvanizing.
b P is the pitch of thread.
c Corresponding to tolerance class b11.
d $d_{w\ max.} = s_{actual}$
e $l_{g\ max.} = l_{nom.} - b$
f $l_{s\ min.} = l_{g\ max.} - y_{max}$

Table 3 — Clamp length Σt[a]

Dimensions in millimetres

Thread d			M12		M16		M20		M22		M24		M27		M30		M36	
l			Σt_{min}[b] and Σt_{max}[c]															
nom.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
50	48,75	51,25	31	36														
55	53,5	56,5	36	41														
60	58,5	61,5	41	46														
65	63,5	66,5	46	51	42	47												
70	68,5	71,5	51	56	47	52												
75	73,5	76,5	56	61	52	57	48	53										
80	78,5	81,5	61	66	57	62	53	58	52	57								
85	83,25	86,75	66	71	62	67	58	63	57	62								
90	88,25	91,75	71	76	67	72	63	68	62	67	59	64						
95	93,25	96,75	76	81	72	77	68	73	67	72	64	69	61	66				
100	98,25	101,75			77	82	73	78	72	77	69	74	66	71				
105	103,25	106,75			82	87	78	83	77	82	74	79	71	76	69	74		
110	108,25	111,75			87	92	83	88	82	87	79	84	76	81	74	79		
115	113,25	116,75			92	97	88	93	87	92	84	89	81	86	79	84		
120	118,25	121,75			97	102	93	98	92	97	89	94	86	91	84	89		
125	123	127			102	107	98	103	97	102	94	99	91	96	89	94	83	88
130	128	132					103	108	102	107	99	104	96	101	94	99	88	93
135	133	137					108	113	107	112	104	109	101	106	99	104	93	98
140	138	142					113	118	112	117	109	114	106	111	104	109	98	103
145	143	147					118	123	117	122	114	119	111	116	109	114	103	108
150	148	152					123	128	122	127	119	124	116	121	114	119	108	113
155	153	159					128	133	127	132	124	129	121	126	119	124	113	118
160	158	164							132	137	129	134	126	131	124	129	118	123
165	163	169							137	142	134	139	131	136	129	134	123	128
170	168	174									139	144	136	141	134	139	128	133
175	173	179									144	149	141	146	139	144	133	138
180	178	184									149	154	146	151	144	149	138	143
185	182,7	189,6									154	159	151	156	149	154	143	148
190	187,7	194,6											156	161	154	159	148	153
195	192,7	199,6											161	166	159	164	153	158
200	197,7	204,6											166	171	164	169	158	163

NOTE The popular lengths are defined in terms of lengths Σt_{min} and Σt_{max}.

[a] For proper function of the preloaded bolted joint the following condition for the clamp length Σt shall be fulfilled:
$(l_{g\,max} + 2\,P) < \Sigma t < (l_{min} - P - m_{max})$, where P is the pitch of thread and m_{max} is the maximum nut height according to Table 5.
The values of Σt_{min} and Σt_{max} specified in Table 3 are within this range.
The Σt_{max} values are specified on the condition that the minimum bolt protrusion beyond the unloaded nut face shall be 1 P.

4.3 Specifications for bolts and reference standards

Table 4 — Specifications for bolts and reference standards

Material		Steel
General requirements		EN 14399-1[a]
Thread	Tolerance	6g[b]
	International Standards	ISO 261, ISO 965-2
Mechanical properties	Property class	10.9
	European Standard	EN ISO 898-1
Impact strength	Value	$K_{V,min}$ = 27 J at -20°C
	Test specimen[c]	ISO 148-1
	Test	EN 10045-1
Tolerances	Product grade	C except: dimension c Tolerance for lengths ≥ 155 mm: $^{+\mathrm{IT17}}_{-0,5\mathrm{IT17}}$
	International Standard	EN ISO 4759-1
Surface finish[d]	normal	as processed[e]
	hot dip galvanized	EN ISO 10684
	others	to be agreed[f]
Surface discontinuities		Limits for surface discontinuities are covered in EN 26157-1.
Acceptability		For acceptance procedure, see EN ISO 3269.

[a] For the time being EN 14399-1 refers only to EN 14399-3 and EN 14399-4 as far as dimensions and mechanical characteristics of the components and functional characteristics of the assemblies are concerned. Such references shall also apply to EN 14399-8.

[b] The tolerance class specified applies without surface finish. Hot-dip galvanized bolts are intended for assembly with oversize tapped nuts.

[c] The preparation of the test specimens with V-notch in the fastener shall be as specified in EN ISO 898-1.

[d] Attention is drawn to the need to consider the risk of hydrogen embrittlement in the case of bolts of property class 10.9, when selecting an appropriate surface treatment process (e.g. cleaning and coating), see the relevant coating standards.

[e] "As processed" means the normal finish resulting from manufacture with a light coating of oil.

[f] Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.

4.4 Marking of hexagon fit bolts

High-strength structural bolts according to this part of this European Standard shall be marked with:

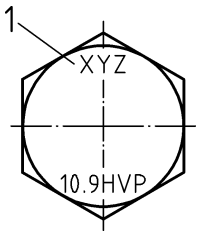
a) property class marking in accordance with EN ISO 898-1 and the letters HVP.

EXAMPLE 1 10.9 HVP

b) the identification mark of the manufacturer of the assembly.

It is permissible for the marking to be either embossed or indented on the top surface of the head.

EXAMPLE 2 of bolt marking (see Figure 3):



Key
1 identification mark of the manufacturers of the assembly

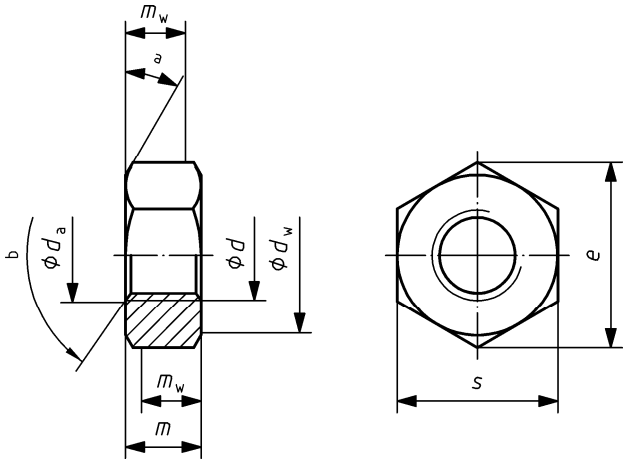
Figure 3 — Example for marking of a bolt

5 Nuts

NOTE This nut is identical with the nut specified in EN 14399-4.

5.1 Dimensions of nuts

See Figure 4 and Table 5.



a 15° to 30°
b 110° to 130°

Figure 4 — Dimensions of nuts

Table 5 — Dimensions of nuts[a]

Dimensions in millimetres

Thread d		M12	M16	M20	M22	M24	M27	M30	M36
P[b]		1,75	2	2,5	2,5	3	3	3,5	4
d_a	max.	13	17,3	21,6	23,7	25,9	29,1	32,4	38,9
	min.	12	16	20	22	24	27	30	36
d_w	max.	c	c	c	c	c	c	c	c
	min.	20,1	24,9	29,5	33,3	38,0	42,8	46,6	55,9
e	min.	23,91	29,56	35,03	39,55	45,20	50,85	55,37	66,44
m	nom = max.	10	13	16	18	20	22	24	29
	min.	9,64	12,3	14,9	16,9	18,7	20,7	22,7	27,7
m_w	min.	7,71	9,84	11,92	13,52	14,96	16,56	18,16	22,16
s	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31	35	40	45	49	58,8

a For hot-dip galvanized nuts, the dimensions apply before galvanizing.
b P is the pitch of thread.
c $d_{w\,max.} = s_{actual}$.

5.2 Specification for nuts and reference standards

Table 6 — Specifications for nuts and reference standards

Material		Steel
General requirements		EN 14399-1[a]
Thread	Tolerance	6H or 6AZ
	International Standards	ISO 261, ISO 965-2, ISO 965-5
Mechanical properties	Property class	10
	European Standard	EN 20898-2
Tolerances	Product grade	B
	International Standard	EN ISO 4759-1
Surface finish	normal	as processed[b]
	hot dip galvanized	EN ISO 10684
	others	to be agreed[c]
Surface discontinuities		Limits for surface discontinuities are covered in EN ISO 6157-2.
Acceptability		For acceptance procedure, see EN ISO 3269.

[a] For the time being EN 14399-1 refers only to EN 14399-3 and EN 14399-4 as dimensions and mechanical characteristics of the components and functional characteristics of assembly are concerned. Such references shall also apply to EN 14399-8.

[b] "As processed" means the normal finish resulting from manufacture with alight coating of oil.

[c] Other coatings may be negotiated between the purchaser and the manufacturer provided they do not impair the mechanical properties or the functional characteristics. Coatings of cadmium or cadmium alloys are not permitted.

5.3 Decarburization of the nut thread

The decarburization of the nut thread, when measured in analogy to external threads as given in EN ISO 898-1, shall not exceed G = 0,015 mm.

5.4 Marking of nuts

High-strength structural nuts according to this part of this European Standard shall be marked with:

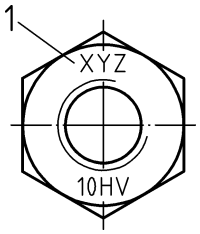
a) property class marking in accordance with EN 20898-2 and the letters HV.

EXAMPLE 1 10 HV

b) the identification mark of the manufacturer of the assembly.

The marking shall be indented on either bearing face.

EXAMPLE 2 of nut marking (see Figure 5):



Key

1 identification mark of the manufacturer of the assembly

Figure 5 — Example for marking of a nut

6 Designation of the fit bolt/nut assembly

EXAMPLE 1 Designation of an assembly for high strength structural bolting, system HV, consisting of a hexagon fit bolt with large width across flats, with thread M16, nominal length *l* = 80 mm and property class 10.9 and a hexagon nut with large width across flats, with thread M16 and property class 10:

Hexagon fit bolt/nut assembly EN 14399-8 — M16 × 80 — 10.9/10 — HVP

If surface finishes other than "as processed" are required, the specified surface finish shall be added to the designation.

If hexagon head bolts according to this part of this European Standard are required for other purposes, for example for the use in blind holes, they may be ordered separately and shall then be designated as follows:

EXAMPLE 2 Designation of a hexagon fit bolt with large width across flats, with thread M16, nominal length *l* = 80 mm and property class 10.9:

Hexagon fit bolt EN 14399-8 — M16 × 80 — 10.9 — HVP

7 Associated washers

Bolt/nut assemblies according to this European Standard shall be assembled with washers according to EN 14399-6 or according to EN 14399-5 (under the nut only).

8 Functional characteristics of the fit bolt/nut/washer(s) assembly

8.1 General

The functional characteristics of the fit bolt/nut/washer(s) assembly according to 8.2 to 8.5 shall be achieved when tested in accordance with EN 14399-2.

NOTE For further background information as to these functional characteristics and clamp length see EN 14399-2.

There shall be sufficient suitable lubricant on the nuts or on the fit bolts and washer to ensure that thread seizure will not take place on tightening the assembly and that the required preload is obtained.

The minimum clamp lengths are specified in Table 3.

8.2 Individual value of the maximum bolt force during the tightening test ($F_{bi\ max}$)

The following applies:

$$F_{bi\ max} \geq 0{,}9\, f_{ub} \times A_s \qquad (1)$$

where

f_{ub} is the nominal tensile strength (R_m)
A_s is the nominal stress area of the bolt
$F_{bi\ max}$ is the individual value of the maximum bolt force reached during the tightening test.

8.3 Angle by which the nut has to be turned starting from a preload of $0{,}7\, f_{ub} \times A_s$ until $F_{bi\ max}$ is reached ($\Delta\Theta_1$)

The values specified in Table 7 are for information only.

Table 7 — Values for $\Delta\Theta_1$

Clamp length [a] Σt	$\Delta\Theta_1$ min.
$\Sigma t < 2\ d$	90°
$2\ d \leq \Sigma t < 6\ d$	120°
$6\ d \leq \Sigma t \leq 10\ d$	150°

[a] The clamp length Σt is the total thickness of the clamped parts including washers.

8.4 Angle by which the nut has to be turned starting from a preload of $0{,}7\, f_{ub} \times A_s$ until F_{bi} has dropped again to $0{,}7\, f_{ub} \times A_s$ ($\Delta\Theta_2$)

The values for $\Delta\Theta_2$ specified in Table 8 apply.

Table 8 — Values for $\Delta\Theta_2$

Clamp length Σt	$\Delta\Theta_2$ min.
$\Sigma t < 2\ d$	180°
$2\ d \leq \Sigma t < 6\ d$	210°
$6\ d \leq \Sigma t \leq 10\ d$	240°

[a] The clamp length Σt is the total thickness of the clamped parts including washers.

8.5 Individual values of the k-factor (k_i), mean value of the k-factor (k_m) and coefficient of variation of the k-factor (V_k)

8.5.1 Individual values of the k-factor (k_i) for k-class K1

When k_i-values are required, they shall be in the range of $0{,}10 \leq k_i \leq 0{,}16$.

8.5.2 Mean value of the k-factor (k_m) and coefficient of variation of the k-factor (V_k) for k-class K2

Mean value of the k-factor is given by

$$k_m = \frac{\sum_{i=1}^{n} k_i}{n} \tag{2}$$

with $$k_i = \frac{M_i}{F_p \times d} \tag{3}$$

where

M_i is the individual value of the torque applied

F_p is the specified preload

d is the nominal thread diameter

For the coefficient of variation of the k-factor (V_k) the following applies:

$$V_k = \frac{s_k}{k_m} \tag{4}$$

where

s_k is the standard deviation $\left(s_k = \sqrt{\frac{\Sigma (k_i - k_m)^2}{n-1}} \right)$ (5)

When k_m and V_k are required, the following values apply:

$0{,}10 \le k_m \le 0{,}23$

$V_k \le 0{,}10$

Bibliography

[1] prEN 1090-2, *Execution of steel structures and aluminium structures — Part 2: Technical requirements for the execution of steel structures*