BRITISH STANDARD

BS EN
14399-3:2005

High-strength structural bolting assemblies for preloading —

Part 3: System HR — Hexagon bolt and nut assemblies

The European Standard EN 14399-3:2005 has the status of a British Standard

ICS 21.060.10; 21.060.20

BSI
British Standards

National foreword

This British Standard is the official English language version of EN 14399-3:2005. Together with BS EN 14399-1:2005, BS EN 14399-2:2005, BS EN 14399-4:2005, BS EN 14399-5:2005 and BS EN 14399-6:2005, it supersedes BS 4395-1:1969 and BS 4395-2:1969, which are planned to be declared obsolescent in September 2007[1)], and then, together with BS 449 and BS 5950, will be withdrawn upon publication of Eurocode 3. (BS 4395-1:1969 and BS 4395-2:1969 currently support BS 449 and BS 5950.)

The UK participation in the preparation of EN 14399-3 was entrusted by Technical Committee FME/9, Nuts, bolts and accessories/Steering Committee, to its Subcommittee, FME/9/1, Materials, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

Additional information

This part of BS EN 14399 is one of several parts that comprise the BS EN 14399 series of standards. BS EN 14399-1 provides the general requirements to which the other parts, which provide specific requirements regarding manufacture, materials and testing, relate.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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[1)] CEN/TC 185/WG 6 has applied for a two-year extended co-existence period, to "September 2007", and for a corrigendum to amend the second "September 2005" date in the Foreword to EN 14399-3:2005 to "September 2007".

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English version

High-strength structural bolting assemblies for preloading - Part 3: System HR - Hexagon bolt and nut assemblies

Boulonnerie de construction métallique à haute résistance apte à la précontrainte - Partie 3 : Système HR - Boulons à tête hexagonale (vis + écrou)

Hochfeste planmäßig vorspannbare Schraubenverbindungen für den Metallbau - Teil 3: System HR - Garnituren aus Sechskantschrauben und -muttern

This European Standard was approved by CEN on 30 April 2004.

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Foreword

This document (EN 14399-3:2005) has been prepared by Technical Committee CEN/TC 185 “Threaded and non-threaded mechanical fasteners and accessories”, 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 September 2005, and conflicting national standards shall be withdrawn at the latest by September 2005.

This document includes a Bibliography.

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

Introduction

This document on 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 assemblies

	Bolt/nut/washer assembly System HR		**Bolt/nut/washer assembly System HV**
General requirements	EN 14399-1		
Bolt/nut assembly	EN 14399-3		EN 14399-4
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 coating of the assembly is under the control of one 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.

For the time being, the product standards EN 14399-3 to EN 14399-6 are the only European Standards which have regard to the general requirements of EN 14399-1. However, further product standards on

— fit bolts,

— countersunk head bolts, and

— load indicating washers

for the use in high strength structural bolting for preloading are under preparation.

1 Scope

This document specifies, together with EN 14399-1, the requirements for assemblies of high-strength structural bolts and nuts of system HR suitable for preloaded joints with large widths across flats, thread sizes M12 to M36 and property classes 8.8/8 and 10.9/10.

Bolt and nut assemblies to this document have been designed to allow preloading of at least $0{,}7 f_{ub} \times A_s$ [1)] according to ENV 1993-1-1 (Eurocode 3) and to obtain ductility predominantly by plastic elongation of the bolt. For this purpose the components have the following characteristics:

— nut height according to style 1 (see EN ISO 4032)

— thread length of the bolt according to ISO 888

Bolt and nut assemblies to this document include washers according to EN 14399-6 or to EN 14399-5 (under the nut only).

NOTE Attention is drawn to the importance of ensuring that the bolts are correctly used if satisfactory result are to be obtained. For recommendations concerning proper application, reference to ENV 1090-1 is made.

The test method for suitability for preloading is specified in EN 14399-2.

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 493, *Fasteners — Surface discontinuities — Nuts.*

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

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

EN 14399-2, *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).*

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

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

ISO 148, *Steel — Charpy impact test (V-notch).*

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

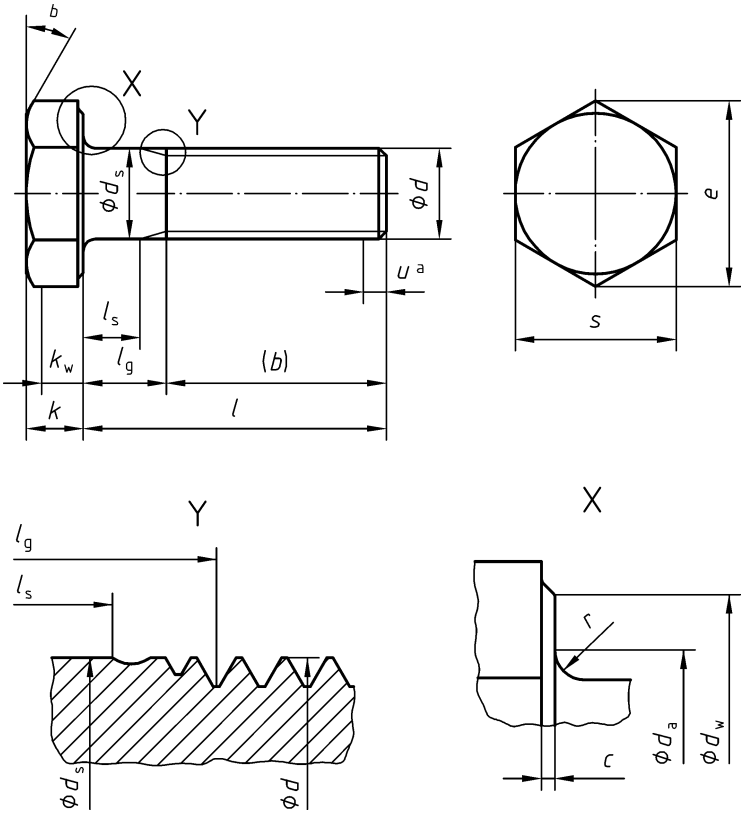
ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality.*

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 Bolts

3.1 Dimensions of bolts

See Figure 1 and Table 2



NOTE The difference between l_g and l_s should not be less than 1,5 P.

Key

a Incomplete thread $u \leq 2P$
b 15° to 30°

Figure 1 — Dimensions of bolts

Table 2 — Dimensions of bolts [a]

Dimensions in millimetres

Thread d		**M12**	**(M14)**[b]	**M16**	**(M18)**[b]	**M20**
P [c]		1,75	2	2	2,5	2,5
b (ref.)	d	30	34	38	42	46
	e	—	40	44	48	52
	f	—	—	—	—	65
c	max.	0,8	0,8	0,8	0,8	0,8
	min.	0,4	0,4	0,4	0,4	0,4
d_a	max.	15,2	17,2	19,2	21,7	24,4
d_s	max.	12,70	14,70	16,70	18,70	20,84
	min.	11,30	13,3	15,30	17,3	19,16
d_w	max.	g	g	g	g	g
	min.	20,1	22	24,9	27,7	29,5
e	min.	23,91	26,17	29,56	32,95	35,03
k	nom.	7,5	8,8	10	11,5	12,5
	max.	7,95	9,25	10,75	12,4	13,40
	min.	7,05	8,35	9,25	10,6	11,60
k_w	min.	4,9	5,85	6,5	7,42	8,1
r	min.	1,2	1,2	1,2	1,5	1,5
s	max.	22	24	27	30	32
	min.	21,16	23,16	26,16	29,16	31

Table 2 (*continued*)

Dimensions in millimetres

Thread d			**M12**		**(M14)**[b]		**M16**		**(M18)**[b]		**M20**	
l			l_s and l_g [h, j]									
			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.
35	33,75	36,25	6	11,25								
40	38,75	41,25	6	11,25			8	14				
45	43,75	46,25	6,25	15			8	14			10	17,5
50	48,75	51,25	11,25	20	7	13	8	14			10	17,5
55	53,5	56,5	16,25	25	11	21	8	14			10	17,5
60	58,5	61,5	21,25	30	16	26	12	22	9	16,5	10	17,5
65	63,5	66,5	26,25	35	21	31	17	27	10,5	23	10	17,5
70	68,5	71,5	31,25	40	26	36	22	32	15,5	28	11,5	24
75	73,5	76,5	36,25	45	31	41	27	37	20,5	33	16,5	29
80	78,5	81,5	41,25	50	36	46	32	42	25,5	38	21,5	34
85	83,25	86,75	46,25	55	41	51	37	47	30,5	43	26,5	39
90	88,25	91,75	51,25	60	46	56	42	52	35,5	48	31,5	44
95	93,25	96,75	56,25	65	51	61	47	57	40,5	53	36,5	49
100	98,25	101,75	61,25	70	56	66	52	62	45,5	58	41,5	54
110	108,25	111,75			66	76	62	72	55,5	68	51,5	64
120	118,25	121,75			76	86	72	82	65,5	78	61,5	74
130	128	132			80	90	76	86	69,5	82	65,5	78
140	138	142			90	100	86	96	79,5	92	75,5	88
150	148	152			100	110	96	106	89,5	102	85,5	98
160	156	164			110	120			99,5	112		
170	166	174										
180	176	184										
190	186	194										
200	196	204										

Table 2 (*continued*)

Dimensions in millimetres

Thread d		M22	M24	M27	M30	M36
P [c]		2,5	3	3	3,5	4
b (ref.)	d	50	54	60	66	78
	e	56	60	66	72	84
	f	69	73	79	85	97
c	max.	0,8	0,8	0,8	0,8	0,8
	min.	0,4	0,4	0,4	0,4	0,4
d_a	max.	26,4	28,4	32,4	35,4	42,4
d_s	max.	22,84	24,84	27,84	30,84	37,00
	min.	21,16	23,16	26,16	29,16	35,00
d_w	max.	g	g	g	g	g
	min.	33,3	38,0	42,8	46,6	55,9
e	min.	39,55	45,20	50,85	55,37	66,44
k	nom.	14	15	17	18,7	22,5
	max.	14,90	15,90	17,90	19,75	23,55
	min.	13,10	14,10	16,10	17,65	21,45
k_w	min.	9,2	9,9	11,3	12,4	15,0
r	min.	1,5	1,5	2,0	2,0	2,0
s	max.	36	41	46	50	60
	min.	35	40	45	49	58,8

Table 2 (*concluded*)

Dimensions in millimetres

Thread d			M22		M24		M27		M30		M36	
l			l_s and l_g [h, j]									
			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.
30	28,95	31,05										
35	33,75	36,25										
40	38,75	41,25										
45	43,75	46,25										
50	48,75	51,25	11	18,5								
55	53,5	56,5	11	18,5	12	21						
60	58,5	61,5	11	18,5	12	21	13,5	22,5				
65	63,5	66,5	11	18,5	12	21	13,5	22,5				
70	68,5	71,5	11	18,5	12	21	13,5	22,5	15	25,5		
75	73,5	76,5	12,5	25	12	21	13,5	22,5	15	25,5		
80	78,5	81,5	17,5	30	12	21	13,5	22,5	15	25,5		
85	83,25	86,75	22,5	35	16	31	13,5	22,5	15	25,5	18	30
90	88,25	91,75	27,5	40	21	36	15	30	15	25,5	18	30
95	93,25	96,75	32,5	45	26	41	20	35	15	25,5	18	30
100	98,25	101,75	37,5	50	31	46	25	40	16,5	34	18	30
110	108,25	111,75	47,5	60	41	56	35	50	26,5	44	18	30
120	118,25	121,75	57,5	70	51	66	45	60	36,5	54	22	42
130	128	132	61,5	74	55	70	49	64	40,5	58	26	46
140	138	142	71,5	84	65	80	59	74	50,5	68	36	56
150	148	152	81,5	94	75	90	69	84	60,5	78	46	66
160	156	164			85	100	79	94	70,5	88	56	76
170	166	174			95	110	89	104	80,5	98	66	86
180	176	184			105	120	99	114	90,5	108	76	96
190	186	194			115	130	109	124	100,5	118	86	106
200	196	204			125	140	119	134	110,5	128	96	116

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

[a] For hot-dip galvanized bolts, the dimensions apply before galvanizing.

[b] Non-preferred sizes

[c] P is the pitch of thread

[d] For lengths $l_{nom.} \leq 125$ mm.

[e] For lengths 125 mm < $l_{nom.} \leq 200$ mm.

[f] For lengths $l_{nom.} > 200$ mm.

[g] $d_{w\,,\,max.} = s_{actual.}$

[h] $l_{g\,,\,max.} = l_{nom.} - b$

$l_{s\,,\,min.} = l_{g,\,max.} - 5P$

[j] When $l_{s,\,min.}$ as calculated by the formula in [h] is less than $0{,}5d$ then its value shall be $0{,}5d$ and $l_{g,\,max} = l_{s,\,min} + 3P$. Bolts with shortened thread length are shown above the stepped line.

3.2 Specification for bolts and reference standard

Table 3 — Specifications for bolts and reference standards

Material		Steel
General requirements		EN 14399-1
Thread	Tolerance	6g[a]
	International Standards	ISO 261, ISO 965-2
Mechanical properties	Property class	8.8 or 10.9
	European Standard	EN ISO 898-1
Impact strength	Value	$K_{V,\,min}$ = 27 J at – 20 °C
	Test piece[b]	ISO 148
	Test	EN 10045-1
Tolerances	Product grade	C except: dimensions c and r. Tolerance for lengths ≥ 160 mm: ± 4,0 mm
	International Standard	EN ISO 4759-1
Surface finish[c]	normal	as processed[d]
	hot dip galvanized	EN ISO 10684
	others	to be agreed[e]
Surface discontinuities		Limits for surface discontinuities as specified in EN 26157-1.
Acceptability		For acceptance procedure, see EN ISO 3269.

[a] The tolerance class specified applies before hot-dip galvanizing. Hot-dip galvanized bolts are intended for assembly with oversize tapped nuts.

[b] The location of charpy V-notch test pieces in the bolt shall be as specified in EN ISO 898-1.

[c] 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.

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

[e] 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 alloy are not permitted.

3.3 Marking of bolts

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

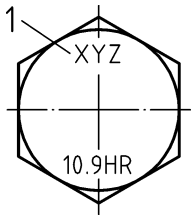
a) property class marking in accordance with EN ISO 898-1 and the letters HR.

EXAMPLE 1 10.9 HR

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 bolt marking:

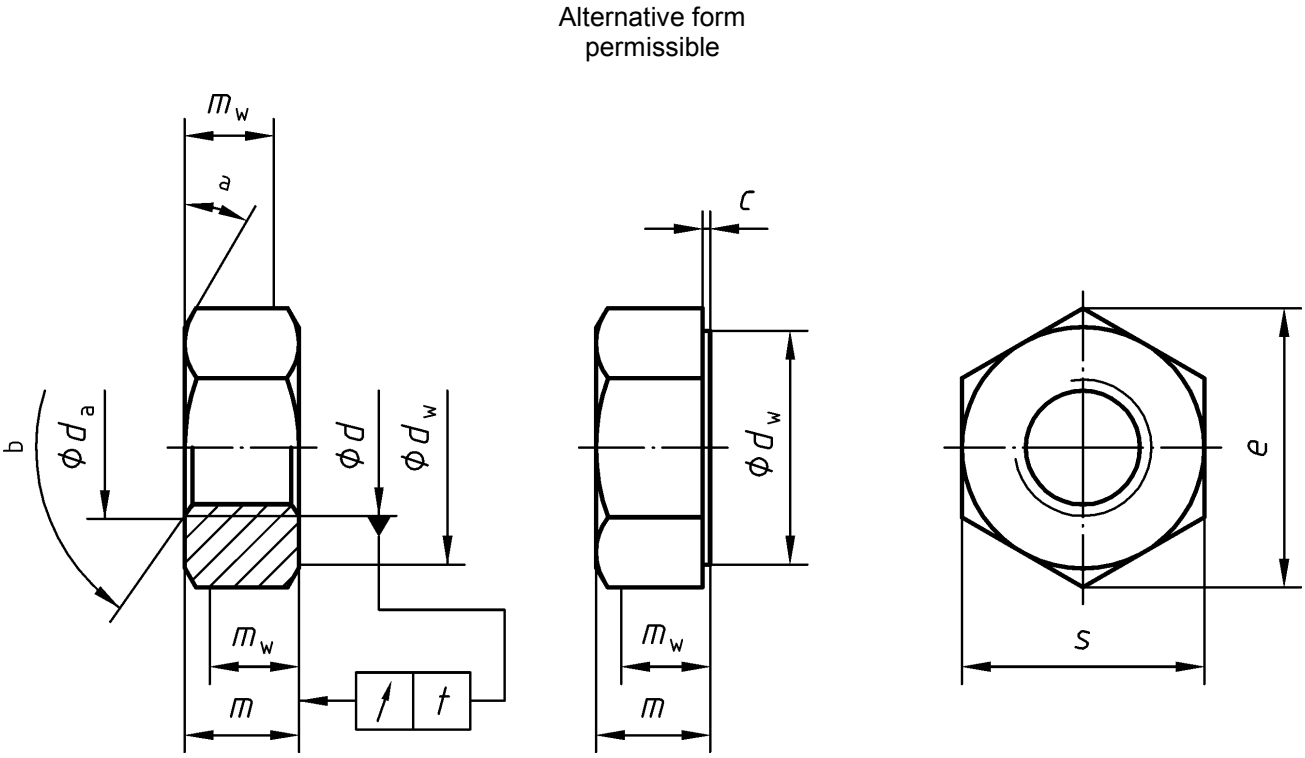


Key
1 Identification mark of the manufacturer of the assembly

4 Nuts

4.1 Dimensions of nuts

See Figure 2 and Table 4



Key

a 15° to 30°
b 110° to 130°

Figure 2 — Dimensions of nuts

Table 4 — Dimensions of nuts [a]

Dimensions in millimetres

Thread d		M12	(M14)[b]	M16	(M18)[b]	M20	M22	M24	M27	M30	M36
P[c]		1,75	2	2	2,5	2,5	2,5	3	3	3,5	4
d_a	max.	13	15,1	17,3	19,5	21,6	23,7	25,9	29,1	32,4	38,9
	min.	12	14	16	18	20	22	24	27	30	36
d_w	max.	d	d	d	d	d	d	d	d	d	d
	min.	20,1	21,86	24,9	27,70	29,5	33,3	38,0	42,8	46,6	55,9
e	min.	23,91	27,12	29,56	32,95	35,03	39,55	45,20	50,85	55,37	66,44
m	max.	10,8	12,8	14,8	15,8	18	19,4	21,5	23,8	25,6	31
	min.	10,37	12,1	14,1	15,1	16,9	18,1	20,2	22,5	24,3	29,4
m_w	min.	8,3	9,7	11,3	12,1	13,5	14,5	16,2	18,1	19,5	22,4
c	max.	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8	0,8
	min.	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
s	max.	22	24	27	30	32	36	41	46	50	60
	min.	21,16	23,16	26,16	29,16	31	35	40	45	49	58,8
t		0,38	0,42	0,47	0,52	0,58	0,63	0,72	0,80	0,87	1,05

[a] For hot dip galvanized nuts the above dimensions apply before galvanizing.

[b] Non-preferred sizes.

[c] P is the pitch of thread.

[d] $d_{w,\,max.} = s_{actual}$.

4.2 Specification for nuts and reference standards

Table 5 — Specifications for nuts and reference standards

Material		Steel
General requirements		EN 14399-1
Thread	Tolerance	6H or 6AZ
	International Standards	ISO 261, ISO 965-2, ISO 965-5
Mechanical properties	Property class	8[a] or 10[a]
	European Standard	EN 20898-2
Tolerances	Product grade	B except dimensions m and c
	International Standard	EN ISO 4759-1[b]
Surface finish	normal	as processed[c]
	hot dip galvanized	EN ISO 10684
	others	to be agreed[d]
Surface discontinuities		Limits for surface discontinuities as specified in EN 493.
Acceptability		For acceptance procedure, see EN ISO 3269.

[a] For proof load values, see 4.3. All other mechanical properties as specified in EN 20898-2.

[b] Except tolerance on perpendicularity of bearing face, see tolerance t in Table 4.

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

[d] 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.

4.3 Proof load values of nuts

Table 6 — Proof load values of nuts

Thread d	Nominal stress area of standard test mandrel A_s	Property class	
		8	10
		Tolerance class 6H or 6AZ	Tolerance class 6H or 6AZ
	mm^2	Proof load $(A_s \times S_p)$, N	
M12	84,3	84 300	97 800
(M14)	115	115 000	133 400
M16	157	157 000	182 100
(M18)	192	192 000	222 700
M20	245	245 000	284 200
M22	303	303 000	351 200
M24	353	353 000	409 500
M27	459	459 000	532 400
M30	561	561 000	650 800
M36	817	817 000	947 700

NOTE The proof load values are based on the following stresses under proof load:

— for nuts of property class 8: 1 000 N/mm^2
— for nuts of property class 10: 1 160 N/mm^2

Where nuts are to be accepted on the basis of hardness values, the appropriate limits are those given in Table 7.

Table 7 — Hardness values of nuts, if specified

Nut	Hardness limits
property class 8, tolerance class 6H	as specified in EN 20898-2 for property class 8
property class 10, tolerance class 6H or 6AZ	as specified in EN 20898-2 for property class 10
property class 8, tolerance class 6AZ, hot dip galvanized	260 HV to 353 HV (24 HRC to 36 HRC)

4.4 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.

4.5 Marking of nuts

High-strength structural nuts according to this document shall be marked with:

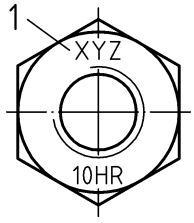
a) property class marking in accordance with EN 20898-2 and the letters HR.

EXAMPLE 1 10 HR

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

The marking shall be indented on either bearing face of chamfered nuts and shall be either indented or embossed on the non-bearing face of washer faced nuts.

EXAMPLE 2 nut marking:



Key
1 Identification mark of the manufacturer of the assembly

5 Designation of the bolt/nut assembly

EXAMPLE 1 Designation of a bolt/nut assembly for high strength structural bolting for preloading, system HR, consisting of a hexagon head 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:

Bolt/nut assembly EN 14399-3 — M16 x 80 — 10.9/10 — HR

If surface finishes other than "as processed" are required, the specified surface finish shall be added to the designation, e.g. for hot dip galvanizing (tZn):

Bolt/nut assembly EN 14399-3 — M16 x 80 — 10.9/10 — HR — tZn

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

EXAMPLE 2 Designation of a hexagon head bolt with large width across flats for high strength structural bolting for preloading, system HR, with thread M16, nominal length *l* = 80 mm and property class 10.9:

Hexagon head bolt EN 14399 -3 — M16 × 80 — 10.9 — HR

If hexagon nuts according to this document are required for other purposes, for example for the use with studs, they may be ordered separately and shall then be designated as follows:

EXAMPLE 3 Designation of a hexagon nut with large width across flats for high strength structural bolting for preloading, system HR, with thread M16 and property class 10:

Hexagon nut EN 14399-3 — M16 — 10 — HR

6 Associated washers

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

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

7.1 General

The functional characteristics of the bolt/nut/washer(s) assembly according to 7.2 to 7.5 shall be achieved when tested in accordance with EN 14399-2.

Four full threads (in addition to the thread run out) shall remain clear between the bearing surface of the nut and the unthreaded part of the shank.

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

There shall be sufficient suitable lubricant on the nuts or on the bolts and washers in the as delivered condition, to ensure that seizure will not take place on tightening the assembly and that the required preload is obtained.

7.2 Maximum individual value of the bolt force during tightening test ($F_{\text{bi max}}$)

The following applies:

$$F_{\text{bi max}} \geq 0{,}9\ f_{\text{ub}} \times A_{\text{s}}$$

where

f_{ub} is the nominal tensile strength (R_{m})

A_{s} is the nominal stress area of the bolt.

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

The values indicated in Table 8 are for information only.

Table 8 — Values for $\Delta\Theta_1$

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

[a] $\Sigma\, t$ is the total thickness of the clamped parts including washer(s).

7.4 Angle by which the nut (or bolt) 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 9 apply.

Table 9 — Values for $\Delta\Theta_2$

Grip length Σt[a]	$\Delta\Theta_2$ min.
$\Sigma t < 2\,d$	210°
$2\,d \le \Sigma t < 6\,d$	240°
$6\,d \le \Sigma t \le 10\,d$	270°

[a] Σt is the total thickness of the clamped parts including washer(s).

7.5 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)

7.5.1 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 $0{,}10 \le k_i \le 0{,}16$.

7.5.2 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

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

with

$$k_i = \frac{M_i}{F_p \times d}$$

where

M_i is the individual value of the applied torque

F_p is the specified preload

d is the nominal bolt diameter

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

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

where

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

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] ENV 1090-1, *Execution of steel structures — Part 1: General rules and rules for buildings.*

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[3] EN ISO 4032, *Hexagon nuts, style 1 - Product grades A and B (ISO 4032:1999).*

[4] EN ISO 4753, *Fasteners - Ends of parts with external ISO metric screw thread (ISO 4753:1999).*

[5] ISO 272, *Fasteners - Hexagon products - Widths across flats.*

[6] ISO 888, *Bolts, screws and studs — Nominal lengths, and thread lengths for general purpose bolts.*

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