BRITISH STANDARD

BS EN
14399-4:2005

High-strength structural bolting assemblies for preloading —

Part 4: System HV — Hexagon bolt and nut assemblies

The European Standard EN 14399-4:2005 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 14399-4:2005. Together with BS EN 14399-1:2005, BS EN 14399-2:2005, BS EN 14399-3:2005, 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which are planned to be declared obsolescent in September 2007[1)], and then, together with BS 449 and BS 5950, will be withdrawn upon publication of Eurocode 3.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 14399-4 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 14399-4:2005 to "September 2007".

Summary of pages

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EUROPEAN STANDARD

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EN 14399-4

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ICS 21.060.10; 21.060.20

English version

High-strength structural bolting assemblies for preloading - Part 4: System HV - Hexagon bolt and nut assemblies

Boulonnerie de construction métallique à haute résistance apte à la précontrainte - Partie 4 : Système HV - Boulons à tête hexagonale (vis + écrou)

Hochfeste planmäßig vorspannbare Schraubenverbindungen für den Metallbau - Teil 4: System HV - Garnituren aus Sechskantschrauben und -muttern

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

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 Central Secretariat 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 Central Secretariat has the same status as the official versions.

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Foreword

This document (EN 14399-4:2005) 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 structuring 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, the 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 coatings 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 HV suitable for preloaded joints with large widths across flats, thread sizes M 12 to M 36 and property classes 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 deformation of the engaged threads. For this purpose the components have the following characteristics:

— nut height approximately 0,8 d

— bolt with short thread length

Bolt and nut assemblies according 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.

Clamp lengths for the bolt/nut/washer assemblies are given in the normative Annex A.

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).*

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

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

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

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

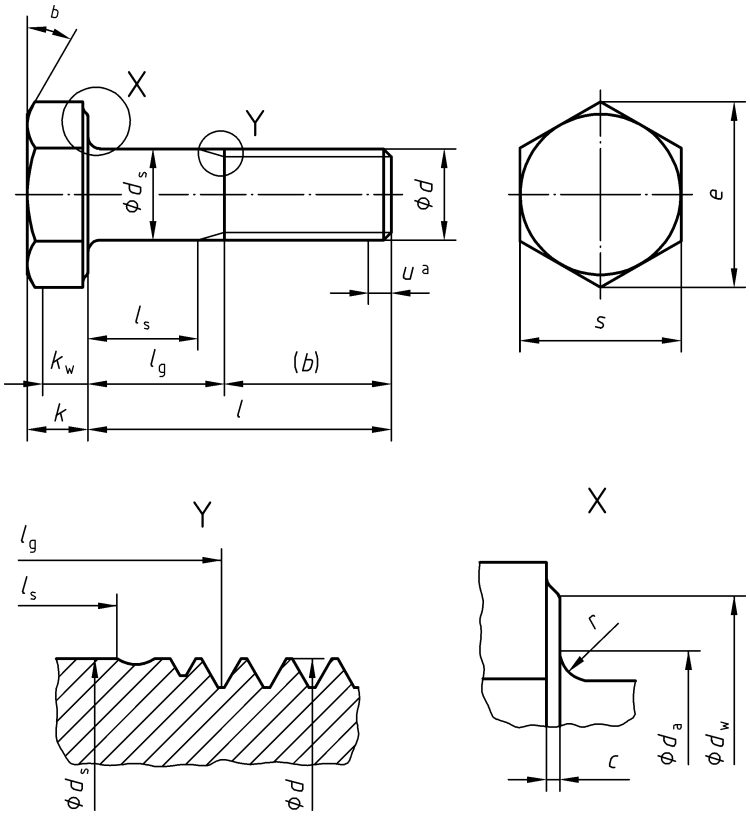
ISO 965-2, *ISO general purpose metric screw threads — Tolerances — Part 2: Limits of sizes for general purpose external and internal screw threads — Medium quality.*

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	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.	12	16	20	22	24	27	30	36
	min.	11,3	15,3	19,16	21,16	23,16	26,16	29,16	35
	max.	12,7	16,7	20,84	22,84	24,84	27,84	30,84	37
d_w	min.	20,1	24,9	29,5	33,3	38,0	42,8	46,6	55,9
	max.	c	c	c	c	c	c	c	c
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

l			l_s and l_g[d]															
			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.
35	33,75	36,25	6,75	12														
40	38,75	41,25	11,75	17	6	12												
45	43,75	46,25	16,75	22	11	17	4,5	12										
50	48,75	51,25	21,75	27	16	22	9,5	17	8,5	16								
55	53,5	56,5	26,75	32	21	27	14,5	22	13,5	21								
60	58,5	61,5	31,75	37	26	32	19,5	27	18,5	26	12	21						
65	63,5	66,5	36,75	42	31	37	24,5	32	23,5	31	17	26						
70	68,5	71,5	41,75	47	36	42	29,5	37	28,5	36	22	31	20	29				
75	73,5	76,5	46,75	52	41	47	34,5	42	33,5	41	27	36	25	34	20,5	31		
80	78,5	81,5	51,75	57	46	52	39,5	47	38,5	46	32	41	30	39	25,5	36		
85	83,25	86,75	56,75	62	51	57	44,5	52	43,5	51	37	46	35	44	30,5	41	21	33
90	88,25	91,75	61,75	67	56	62	49,5	57	48,5	56	42	51	40	49	35,5	47	26	38

Table 2 (*concluded*)

Dimensions in millimetres

Thread d			M12		M16		M20		M22		M24		M27		M30		M36	
l			l_s and l_g [d]															
			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.
95	93,25	96,75	66,75	72	61	67	54,5	62	53,5	61	47	56	45	54	40,5	51	31	43
100	98,25	101,75			66	72	59,5	67	58,5	66	52	61	50	59	45,5	56	36	48
105	103,25	106,75			71	77	64,5	72	63,5	71	57	66	55	64	50,5	61	41	53
110	108,25	111,75			76	82	69,5	77	68,5	76	62	71	60	69	55,5	66	46	58
115	113,25	116,75			81	87	74,5	82	73,5	81	67	76	65	74	60,5	71	51	63
120	118,25	121,75			86	92	79,5	87	78,5	86	72	81	70	79	65,5	76	56	68
125	123	127			91	97	84,5	92	83,5	91	77	86	75	84	70,5	81	61	73
130	128	132			96	102	89,5	97	88,5	96	82	91	80	89	75,5	86	66	78
135	133	137					94,5	102	93,5	101	87	96	85	94	80,5	91	71	83
140	138	142					99,5	107	98,5	106	92	101	90	99	85,5	96	76	88
145	143	147					104,5	112	103,5	111	97	106	95	104	90,5	101	81	93
150	148	152					109,5	117	108,5	116	102	111	100	109	95,5	106	86	98
155	153	159					114,5	122	113,5	121	107	116	105	114	100,5	111	91	103
160	158	164							118,5	126	112	121	110	119	105,5	116	96	108
165	163	169							123,5	131	117	126	115	124	110,5	121	101	113
170	168	174									122	131	120	129	115,5	126	106	118
175	173	179									127	136	125	134	120,5	131	111	123
180	178	184									132	141	130	139	125,5	136	116	128
185	182,7	189,6									137	146	135	144	130,5	141	121	133
190	187,7	194,6									142	151	140	149	135,5	146	126	138
195	192,7	199,6									147	156	145	154	140,5	151	131	143
200	197,7	204,6											150	159	147,5	156	136	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] $d_{w,\,max.} = s_{actual}$

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

$l_{s,\,min.} = l_{g,\,max.} - 3P$

3.2 Specifications for bolts and reference standards

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	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 ≥ 155 mm: $^{+\,IT\,17}_{-\,1/2\,IT\,17}$
	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 the 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 alloys are not permitted.

3.3 Marking of bolts

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

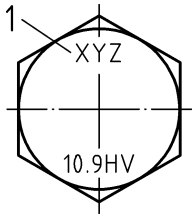
a) property class marking in accordance with EN ISO 898-1 and the letters HV.

EXAMPLE 1 10.9 HV

b) 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:

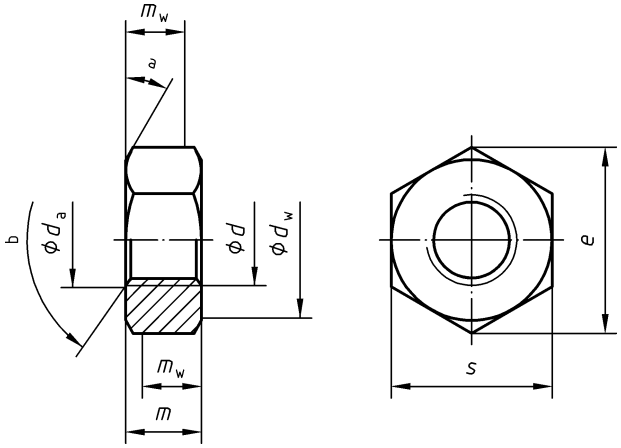


Key
1 Identification mark of the manufacturer of the assembly

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

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	10
	European Standard	EN 20898-2
Tolerances	Product grade	B
	International Standard	EN ISO 4759-1
Surface finish	normal	as processed[a]
	hot dip galvanized	EN ISO 10684
	others	to be agreed[b]
Surface discontinuities		Limits for surface discontinuities as specified in EN 493.
Acceptability		For acceptance procedure, see EN ISO 3269.

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

[b] 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 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.

4.4 Marking of nuts

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

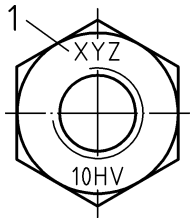
a) property class marking in accordance with EN 20898-2 and the letters HV.

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 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 HV, consisting of a hexagon 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 14399-4 — M16 × 80 — 10.9/10 — HV

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 14399-4 — M16 × 80 — 10.9/10 — HV — tZn

If hexagon nuts according to this part of this standard 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 2 Designation of a hexagon nut with large width across flat for high strength structural bolting for preloading, system HV, with thread M16 and property class 10:

Hexagon nut EN 14399 -4 — M16 — 10 — HV

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

Hexagon head bolt EN 14399 -4 — M16 × 80 — 10.9 — HV

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.

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

Minimum clamp lengths as specified in Annex A.

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 ($F_{bi\,max}$)

The following applies:

$$F_{bi\,max} \geq 0{,}9\ f_{ub} \times A_s$$

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 $f_{ub} \times A_s$ until $F_{bi\ max}$ is reached ($\Delta\Theta_1$)

The values indicated in Table 6 are for information only.

Table 6 — Values for $\Delta\Theta_1$

Clamp length Σt [a]	$\Delta\Theta_1$ min.
$\Sigma t < 2\ d$	90°
$2\ d \le \Sigma t < 6\ d$	120°
$6\ d \le \Sigma t \le 10\ d$	150°
[a] Σt 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 7 apply.

Table 7 — Values for $\Delta\Theta_2$

Grip length Σt [a]	$\Delta\Theta_2$ min.
$\Sigma t < 2\ d$	180°
$2\ d \le \Sigma t < 6\ d$	210°
$6\ d \le \Sigma t \le 10\ d$	240°
[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:

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

$V_k \leq 0{,}10$

Annex A
(normative)

Clamp lengths

See Figure A.1 and Table A.1.

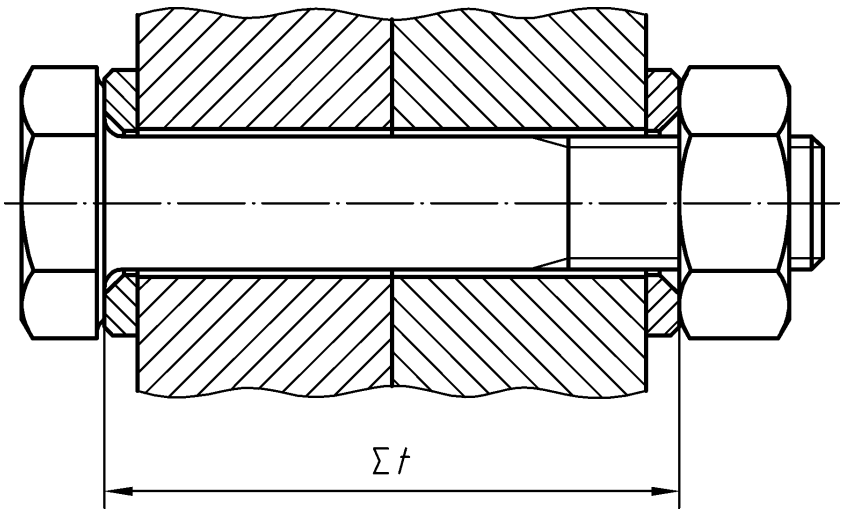


Figure A.1 — Clamp length Σt

Table A.1 — Clamp lengths Σt [a]

Dimensions in millimetres

Thread d			M12		M16		M20		M22		M24		M27		M30		M36	
l			Σt_{min} and Σt_{max}															
nom.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
35	33,75	36,25	16	21														
40	38,75	41,25	21	26	17	22												
45	43,75	46,25	26	31	22	27	18	23										
50	48,75	51,25	31	36	27	32	23	28	22	27								
55	53,5	56,5	36	41	32	37	28	33	27	32								
60	58,5	61,5	41	46	37	42	33	38	32	37	29	34						
65	63,5	66,5	46	51	42	47	38	43	37	42	34	39						
70	68,5	71,5	51	56	47	52	43	48	42	47	39	44	36	41				
75	73,5	76,5	56	61	52	57	48	53	47	52	44	49	41	46	39	44		
80	78,5	81,5	61	66	57	62	53	58	52	57	49	54	46	51	44	49		
85	83,25	86,75	66	71	62	67	58	63	57	62	54	59	51	56	49	54	43	48
90	88,25	91,75	71	76	67	72	63	68	62	67	59	64	56	61	54	59	48	53
95	93,25	96,75	76	81	72	77	68	73	67	72	64	69	61	66	59	64	53	58
100	98,25	101,75			77	82	73	78	72	77	69	74	66	71	64	69	58	63
105	103,25	106,75			82	87	78	83	77	82	74	79	71	76	69	74	63	68
110	108,25	111,75			87	92	83	88	82	87	79	84	76	81	74	79	68	73
115	113,25	116,75			92	97	88	93	87	92	84	89	81	86	79	84	73	78
120	118,25	121,75			97	102	93	98	92	97	89	94	86	91	84	89	78	83
125	123	127			102	107	98	103	97	102	94	99	91	96	89	94	83	88
130	128	132			107	112	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									159	164	156	161	154	159	148	153
195	192,7	199,6									164	169	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 l_t 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 4.

The values of Σt_{min} and Σt_{max} specified in Table A.1 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.

Bibliography

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

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