BS EN 14399-10:2018

BSI Standards Publication

High-strength structural bolting assemblies for preloading

Part 10: System HRC - Bolt and nut assemblies with calibrated preload

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National foreword

This British Standard is the UK implementation of EN 14399-10:2018. It supersedes BS EN 14399-10:2009, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee FME/9/-/2, Fasteners for structural bolting.

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

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High-strength structural bolting assemblies for preloading - Part 10: System HRC - Bolt and nut assemblies with calibrated preload

Boulonnerie de construction métallique à haute résistance apte à la précontrainte - Partie 10 : Système HRC - Boulons (vis + écrou + rondelle) à précontrainte calibrée

Hochfeste vorspannbare Garnituren für Schraubverbindungen im Metallbau - Teil 10: System HRC - Garnituren aus Schrauben und Muttern mit kalibrierter Vorspannung

This European Standard was approved by CEN on 22 October 2017.

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European foreword

This document (EN 14399-10:2018) has been prepared by Technical Committee CEN/TC 185 “Fasteners”, the secretariat of which is held by BSI.

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of an identical text or by endorsement, at the latest by November 2018 and conflicting national standards shall be withdrawn at the latest by November 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document supersedes EN 14399-10:2009.

In comparison with EN 14399-10:2009, the following modifications have been made:

— Table 1 containing the overview of the marking of components of bolting assemblies for preloading was added;

— specifications for the designation of the bolting assemblies have been revised;

— dimensions and markings of HRC bolts with countersunk heads have been added;

— dimensions and limiting values of M36 diameter bolts and nuts have been added;

— the requirement for the coefficient of variation has been revised.

EN 14399 consists of the following parts, under the general title *High-strength structural bolting assemblies for preloading*:

— *Part 1: General requirements*

— *Part 2: Suitability for preloading*

— *Part 3: System HR — Hexagon bolt and nut assemblies*

— *Part 4: System HV — Hexagon bolt and nut assemblies*

— *Part 5: Plain washers*

— *Part 6: Plain chamfered washers*

— *Part 7: System HR — Countersunk head bolt and nut assemblies*

— *Part 8: System HV — Hexagon fit bolt and nut assemblies*

— *Part 9: System HR or HV — Direct tension indicators for bolt and nut assemblies*

— *Part 10: System HRC — Bolt and nut assemblies with calibrated preload*

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, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the 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(s) assemblies. These solutions consist of two different types (HR and HV) of bolt/nut/washer assemblies, see Table 1. Both types are well proven and it is the responsibility of the experts using structural bolting whether they use the one or the other type.

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

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

For the same reason it is important that coating of the bolting assemblies is under the control of one manufacturer.

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

It should be pointed out that compared to ISO 272 the width 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 eccentrically 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 was common practice in Europe.

Table 1 — Composition of high-strength structural bolting assemblies and component marking

Type of bolting assembly		**System HR**				**System HV**		**System HRC**	
General requirements		EN 14399–1							
Suitability for preloading		EN 14399–2 and, if any, additional testing specified in the product standard							
Bolt and nut		EN 14399–3		EN 14399–7		EN 14399–4	EN 14399–8	EN 14399–10	
Marking	Bolt	HR8.8	HR10.9	HR8.8	HR10.9	HV10.9	HVP10.9	HRC10.9	
	Nut	HR8 or HR10	HR10	HR8 or HR10	HR10	HV10	HV10	HR10	HRD10
Washer(s)		EN 14399–5 [a] or EN 14399–6				EN 14399–6			EN 14399–5 [a] or EN 14399–6
Marking		H or HR [b]				H or HV [b]		H or HR [b]	H or HR [b] or HD [c]
Direct tension indicator and nut face washer or bolt face washer, if any		EN 14399–9						Not applicable	
Marking	Direct tension indicator	H8	H10	H8	H10	H10			
	Nut face washer	HN				HN			
	Bolt face washer	HB		Not applicable		HB			

[a] EN 14399–5 can only be used under the nut.

[b] At the choice of the manufacturer.

[c] Mandatory mark for washers with enlarged outer diameter according to EN 14399-5 only.

1 Scope

This document specifies, together with EN 14399-1 and EN 14399-2, the requirements for assemblies of high-strength structural bolts and nuts of system HRC suitable for preloaded joints, with hexagon head (large width across flats), cup head or countersunk head, thread sizes M12 to M36 and property class 10.9/10.

Bolting assemblies in accordance with this document 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 plastic elongation of the bolt. For this purpose the components have the following characteristics:

— regular nut height according to style 1, see EN ISO 4032; or

— nut with height $m = 1\ D$;

— thread length of the bolt according to ISO 888.

Bolting assemblies in accordance with 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 bolting assemblies are correctly used if satisfactory results are to be obtained. For recommendations concerning proper application, reference to EN 1090–2 is made.

General requirements and requirements for suitability for preloading are specified in EN 14399-2 and in Clause 8 of this document.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

EN 14399-2:2015, *High-strength structural bolting assemblies for preloading — Part 2: Suitability for preloading*

EN 14399-3, *High-strength structural bolting assemblies for preloading — Part 3: System HR — Hexagon bolt and nut assemblies*

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

EN ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs with specified property classes — Coarse thread and fine pitch thread (ISO 898-1)*

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

EN ISO 898-2, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 2: Nuts with specified property classes — Coarse thread and fine pitch thread (ISO 898-2)*

EN ISO 3269, *Fasteners — Acceptance inspection (ISO 3269)*

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

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

EN ISO 10684, *Fasteners — Hot dip galvanized coatings (ISO 10684)*

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*

ISO 3508, *Thread run-outs for fasteners with thread in accordance with ISO 261 and ISO 262*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
shear wrench
non-impacting electric or manual tool, equipped with two co-axial sockets which react by torque one against the other:

— the outer socket which engages the nut rotating clockwise;

— the inner socket which engages the spline-end of the bolt (i.e. bi-hexagonal) rotating anticlockwise;

Note 1 to entry: The shear wrench operates as follows:

— during the tightening operation of an assembly, the socket in rotation is the one that finds the least resistance to it;

— from the outset and right up to the final tightening stage, the outer socket on the nut rotates clockwise while the inner socket holds the spline-end without rotating, the result being that the bolt assembly is progressively tightened by the increasing torque applied to the nut;

— at the final stage of tightening, i.e. when the torsional resistance plateau of the break-neck section is attained, the inner socket rotates anticlockwise while the outer socket on the nut provides the reaction without rotating;

— the bolt assembly installation is complete when the spline-end shears off at the break-neck section.

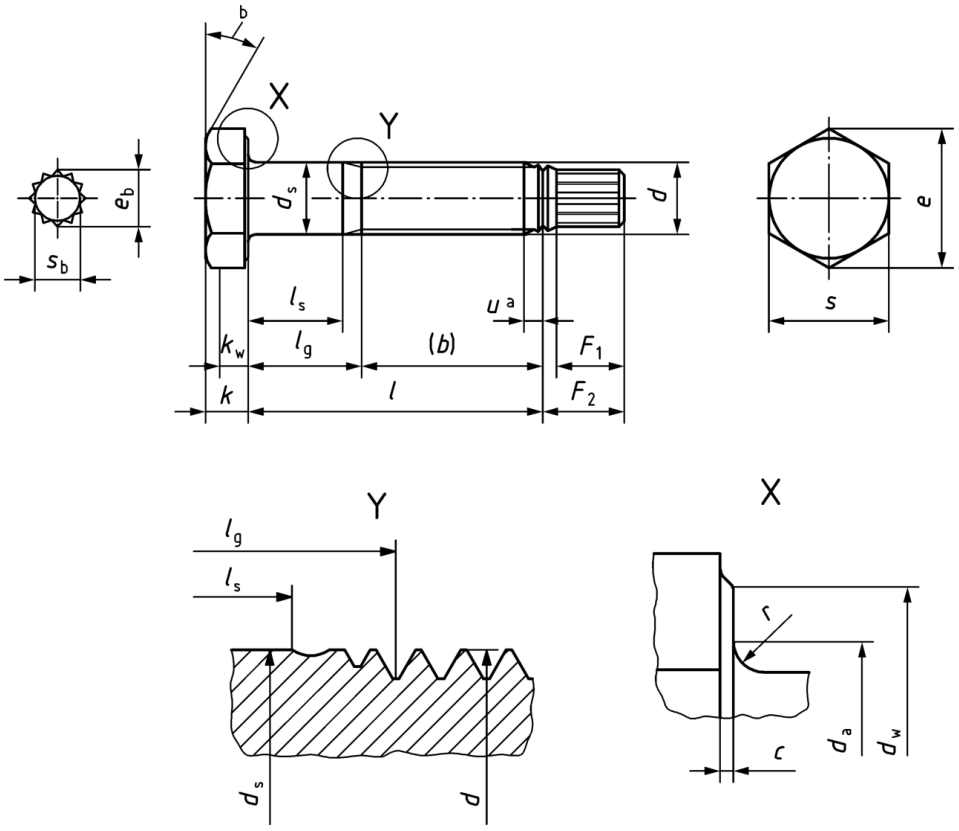
4 Bolts

4.1 Dimensions of bolts

See Figures 1 to 3 and Tables 2 to 5.

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

For coated bolts, the dimensions apply prior to coating.



Key

a incomplete thread $u \leq 2\ P$

b 15° to 30°

Figure 1 — Bolt HRC with hexagon head

Table 2 — Dimensions of hexagon bolts

Dimensions in millimetres

Thread d		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
P [a]		1,75	2	2,5	2,5	3	3	3,5	4
b (ref)	[b]	30	38	46	50	54	60	66	78
	[c]	—	44	52	56	60	66	72	84
	[d]	—	—	65	69	73	79	85	97
c	max.	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
d_a	max.	15,2	19,2	24,4	26,4	28,4	32,4	35,4	42,4
d_s	max.	12,70	16,70	20,84	22,84	24,84	27,84	30,84	37,00
	min.	11,30	15,30	19,16	21,16	23,16	26,16	29,16	35,00
d_w	max.	[e]							
	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
k	nom.	7,5	10,0	12,5	14,0	15,0	17,0	18,7	22,5
	max.	7,95	10,75	13,40	14,90	15,90	17,90	19,75	23,55
	min.	7,05	9,25	11,60	13,10	14,10	16,10	17,65	21,45
k_w	min.	4,9	6,5	8,1	9,2	9,9	11,3	12,4	15,0
r	min.	1,2	1,2	1,5	1,5	1,5	2,0	2,0	2,0
s	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31,0	35,0	40,0	45,0	49,0	58,8

l			l_s and l_g [f g]															
nom.	min.	max.	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$
35	33,75	36,25	—	7														
40	38,75	41,25	—	7	—	8												
45	43,75	46,25	6,25	15	—	8												
50	48,75	51,25	11,25	20	—	8	—	10	—	10								
55	53,50	56,50	16,25	25	—	8	—	10	—	10								
60	58,50	61,50	21,25	30	12	22	—	10	—	10	—	12	—	12				
65	63,50	66,50	26,25	35	17	27	—	10	—	10	—	12	—	12				
70	68,50	71,50	31,25	40	22	32	11,5	24	—	10	—	12	—	12	—	14		
75	73,50	76,50	36,25	45	27	37	16,5	29	12,5	25	—	12	—	12	—	14		

Thread d			**M12**		**M16**		**M20**		**M22**		**M24**		**M27**		**M30**		**M36**	
80	78,50	81,50	41,25	50	32	42	21,5	34	17,5	30	—	12	—	12	—	14		
85	83,25	86,75	46,25	55	37	47	26,5	39	22,5	35	16	31	—	12	—	14	—	16
90	88,25	91,75	51,25	60	42	52	31,5	44	27,5	40	21	36	15	30	—	14	—	16
95	93,25	96,75	56,25	65	47	57	36,5	49	32,5	45	26	41	20	35	—	14	—	16
100	98,25	101,75	61,25	70	52	62	41,5	54	37,5	50	31	46	25	40	16,5	34	—	16
110	108,25	111,75			62	72	51,5	64	47,5	60	41	56	35	50	26,5	44	—	16
120	118,25	121,75			72	82	61,5	74	57,5	70	51	66	45	60	36,5	54	22	42
130	128,00	132,00			76	86	65,5	78	61,5	74	55	70	49	64	40,5	58	26	46
140	138,00	142,00			86	96	75,5	88	71,5	84	65	80	59	74	50,5	68	36	56
150	148,00	152,00			96	106	85,5	98	81,5	94	75	90	69	84	60,5	78	46	66
160	156,00	164,00							91,5	104	85	100	79	94	70,5	88	56	76
170	166,00	174,00									95	110	89	104	80,5	98	66	86
180	176,00	184,00									105	120	99	114	90,5	108	76	96
190	186,00	194,00									115	130	109	124	100,5	118	86	106
200	196,00	204,00									125	140	119	134	110,5	128	96	116

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

[a] P is the pitch of thread.

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

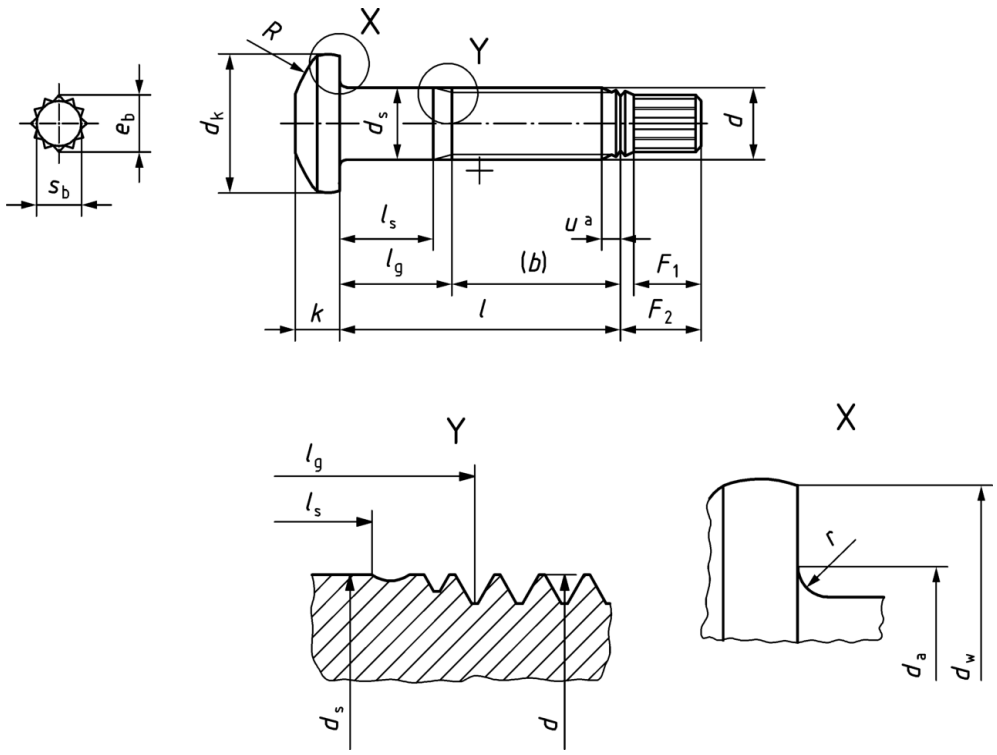
[c] For lengths 125 mm < $l_{nom} \leq 200$ mm.

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

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

[f] $l_{g\,max} = l_{nom} - b$; $l_{s\,min} = l_{g\,max} - 5\,P$

[g] When $l_{s\,min}$ as calculated by the formula in [f] is less than 0,5 d, then the bolts shall be fully threaded, and in this case $l_{g\,max}$ is equal to a_{max} as specified in ISO 3508 for product grade C, i.e. 4 P. Fully threaded bolts are shown above the bold stepped line.



Key

a incomplete thread $u \leq 2\ P$

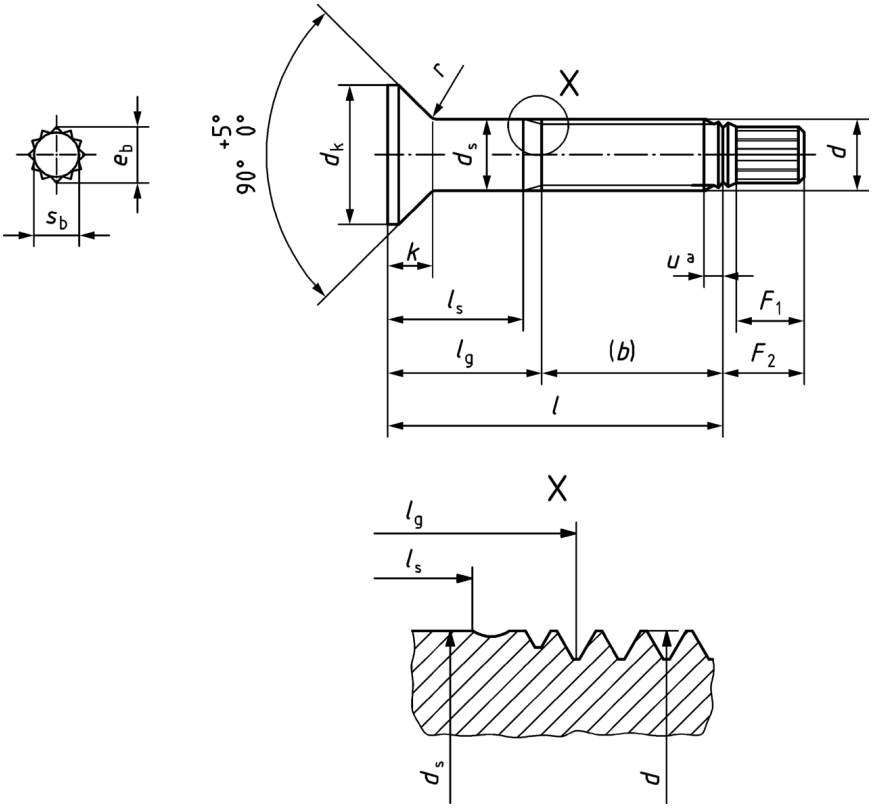
Figure 2 — Bolt HRC with cup head

Table 3 — Dimensions of cup head bolts [a]

Dimensions in millimetres

Thread d		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
d_k	min.	21,0	27,0	34,0	38,5	43,0	48,0	52,0	66,0
d_w	min.	20	26	33	37	41	46	50	61
k	nom.	8	10	13	14	15	17	19	23
	max.	8,8	10,8	13,9	14,9	15,9	17,9	20,0	24,0
	min.	7,2	9,2	12,1	13,1	14,1	16,1	18,0	22,0
R	nom.	18	20	22	23	25	27	30	36

[a] For all other dimensions, see Table 2.



Key

a incomplete thread $u \leq 2\ P$

Figure 3 — Bolt HRC with countersunk head

Table 4 — Dimensions of countersunk head bolts

Dimensions in millimetres

Thread d		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
P [a]		1,75	2	2,5	2,5	3	3	3,5	4
b (ref)	[b]	30	38	46	50	54	60	66	78
	[c]	—	44	52	56	60	66	72	84
	[d]	—	—	65	69	73	79	85	97
d_s	max.	12,70	16,70	20,84	22,84	24,84	27,84	30,84	37,00
	min.	11,30	15,30	19,16	21,16	23,16	26,16	29,16	35,00
d_k	max.	24	32	40	44	48	54	60	72
	min.	23,16	31,16	39,00	43,00	47,00	53,00	58,80	70,80
k	nom.	8,0	10,0	13,0	14,0	16,0	17,5	19,5	23,0
	max. [g]	8,75	10,75	13,90	14,90	16,90	18,40	20,55	24,05
	min. [h]	7,25	9,25	12,10	13,10	15,10	16,60	18,45	21,95
r	max.	1,6	1,6	2,0	2,0	2,0	2,5	2,5	2,5
	min.	1,2	1,2	1,5	1,5	1,5	2,0	2,0	2,0
l		l_s and l_g [e f]							

nom.	min.	max.	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$	$l_{s\,min}$	$l_{g\,max}$
45	43,75	46,25	—	15														
50	48,75	51,25	—	15														
55	53,50	56,50	16,25	25	—	18												
60	58,50	61,50	21,25	30	—	18												
65	63,50	66,50	26,25	35	—	18	—	23	—	24								
70	68,50	71,50	31,25	40	22	32	—	23	—	24								
75	73,50	76,50	36,25	45	27	37	—	23	—	24	—	28						
80	78,50	81,50	41,25	50	32	42	—	23	—	24	—	28	—	29,5				
85	83,25	86,75	46,25	55	37	47	26,5	39	—	24	—	28	—	29,5				
90	88,25	91,75	51,25	60	42	52	31,5	44	27,5	40	—	28	—	29,5	—	33,5		
95	93,25	96,75	56,25	65	47	57	36,5	49	32,5	45	—	28	—	29,5	—	33,5		
100	98,25	101,75	61,25	70	52	62	41,5	54	37,5	50	31	46	—	29,5	—	33,5		
110	108,25	111,75			62	72	51,5	64	47,5	60	41	56	35	50	—	33,5	—	39
120	118,25	121,75			72	82	61,5	74	57,5	70	51	66	45	60	36,5	54	—	39
130	128,00	132,00			76	86	65,5	78	61,5	74	55	70	49	64	40,5	58	—	39
140	138,00	142,00			86	96	75,5	88	71,5	84	65	80	59	74	50,5	68	—	39
150	148,00	152,00			96	106	85,5	98	81,5	94	75	90	69	84	60,5	78	46	66

Thread d			**M12**		**M16**		**M20**		**M22**		**M24**		**M27**		**M30**		**M36**	
160	156,00	164,00			106	116	95,5	108	91,5	104	85	100	79	94	70,5	88	56	76
170	166,00	174,00									95	110	89	104	80,5	98	66	86
180	176,00	184,00									105	120	99	114	90,5	108	76	96
190	186,00	194,00									115	130	109	124	100,5	118	86	106
200	196,00	204,00									125	140	119	134	110,5	128	96	116

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

[a] P is the pitch of thread.

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

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

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

[e] $l_{g\,max} = l_{nom} - b$; $l_{s\,min} = l_{g\,max} - 5\,P$

[f] When $l_{s\,min}$ as calculated by the formula in [e] is less than $k_{nom} + 0{,}5d$ then the bolts shall be fully threaded, and in this case $l_{g\,max}$ is equal to $k_{nom} + 4\,P$, where $4\,P$ is the value of a_{max} as specified in ISO 3508 for product grade C. Fully threaded bolts are shown above the bold stepped line.

[g] k_{max} includes the height of embossed marking, if any.

[h] k_{min} excludes the height of embossed marking, if any.

Table 5 — Dimensions of spline-end

Dimensions in millimetres

Thread d		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
Width across flats of spline-end, s_b [a]	nom.	7,7	11,3	14,1	15,4	16,8	19,0	21,1	25,4
	max.	8,0	11,6	14,4	15,7	17,1	19,3	21,4	25,7
	min.	7,4	11,0	13,8	15,1	16,5	18,7	20,8	25,1
Width across corners of spline-end, e_b [b]	min.	8,36	12,43	15,60	17,06	18,65	21,13	23,50	28,50
Length of spline-end, F_1	min.	11,0	13,0	15,0	15,5	16,0	19,0	21,0	25,0
Break off length, F_2	max.	16,0	18,0	20,0	21,0	21,5	24,0	26,0	31,0

[a] For hot-dip galvanized bolts, the dimensions apply before galvanizing except for $s_{b\,max}$ which applies after galvanizing.

[b] $e_{b\,min} = 1{,}13\,s_{b\,min}$

NOTE Dimensions of the break-neck of the bolt are not specified for the following reasons: dimensions and tolerances of the break-neck are defined by the manufacturer of the bolt according to material, manufacturing process and lubrication. The precise dimensions and tolerances of the break-neck ensure that the specified preload is achieved when the fracture of the spline-end of the bolt occurs under torsional stress.

4.2 Specification for bolts and reference standards

Table 6 — Specifications for bolts and reference standards

Material		Steel
General requirements		EN 14399–1 and EN 14399–2
Thread	Tolerance class	6g [a]
	International Standards	ISO 261, ISO 965-2
Mechanical properties	Property class	10.9
	European Standard	EN ISO 898-1
Tolerances	Product grade	C except: dimensions *c* and *r*. Tolerance for lengths ≥ 160 mm: ± 4,0 mm
	European Standard	EN ISO 4759-1
Finish – Coating [b]	Uncoated	as processed [c]
	Hot dip galvanized	EN ISO 10684
	Others	to be agreed [d]
	Additional protection against corrosion	After tightening, the non-coated area appearing at the end of the bolt resulting from the fracture of the spline-end may be protected against corrosion by applying an efficient protective treatment (e.g. by a complementary zinc-rich paint).
Surface integrity		Limits for surface discontinuities as specified in EN 26157–1.
Acceptability		For acceptance procedure, see EN ISO 3269.

[a] The tolerance class specified applies to bolts without or before any coating. Hot-dip galvanized bolts are intended for assembly with nuts tapped oversize to 6AZ.

[b] 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.

[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 alloy are not permitted.

4.3 Marking of bolts

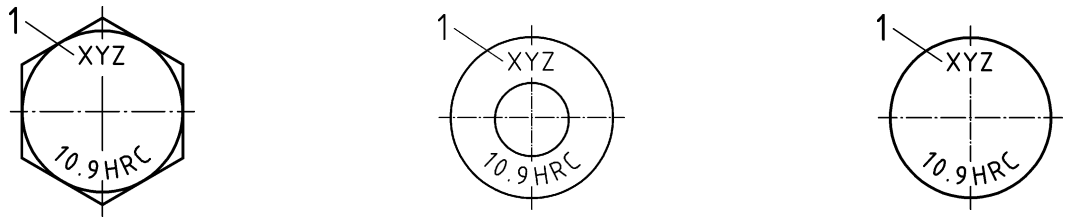
High-strength structural bolts according to this part of this document shall be marked with:

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

EXAMPLE 10.9 HRC

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

It is permissible for the marking to be either embossed or indented on the top surface of the head. For bolt markings, see Figure 4.



a) Example of bolt marking for hexagonal head **b) Example of bolt marking for cup head** **c) Example of bolt marking for countersunk head**

Key

1 identification mark of the manufacturer of the bolting assembly

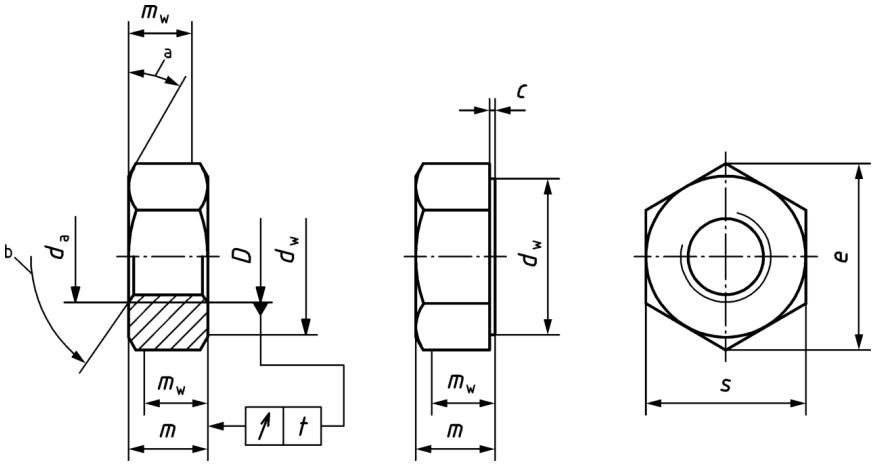
Figure 4 — Example of bolt marking

5 Nuts

5.1 Dimensions of nuts

See Figure 5 and Tables 7 and 8.

Alternative form permissible



Key

[a] 15° to 30°

[b] 110° to 130°

Figure 5 — Dimensions of the nut

For coated nuts, the above dimensions apply prior to coating.

Table 7 — Dimensions of regular nuts (HR)

Dimensions in millimetres

Thread D		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
P [a]		1,75	2	2,5	2,5	3	3	3,5	4
d_a	max.	13,0	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.	[b]							
	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	max.	10,80	14,80	18,00	19,40	21,50	23,80	25,60	31,00
	min.	10,37	14,10	16,90	18,10	20,20	22,50	24,30	29,40
m_w	min.	8,3	11,3	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
	min.	0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4
s	max.	22	27	32	36	41	46	50	60
	min.	21,16	26,16	31,00	35,00	40,00	45,00	49,00	58,80
t		0,38	0,47	0,58	0,63	0,72	0,80	0,87	1,05

[a] P is the pitch of thread.

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

When nuts with height $m = 1\,D$ are used, they shall be in accordance with Table 7, except for dimensions m and m_w which shall be in accordance with Table 8.

Table 8 — Dimensions of nuts with height *m* = 1 *D* (HRD)

Dimensions in millimetres

Thread *D*		**M12**	**M16**	**M20**	**M22**	**M24**	**M27**	**M30**	**M36**
m	max.	12,35	16,35	20,65	22,65	24,65	27,65	30,65	36,80
	min.	11,65	15,65	19,35	21,35	23,35	26,35	29,35	35,20
m_w	min.	9,32	12,52	15,48	17,08	18,68	21,08	23,48	28,16

5.2 Specification for nuts and reference standards

Table 9 — Specifications for nuts and reference standards

Material		Steel		
General requirements		EN 14399–1 and EN 14399–2		
Thread	Coating of the bolt	Uncoated	Hot dip galvanized	Others
	Tolerance class of the nut	6H	6AZ	6H [a]
	International Standards	ISO 261, ISO 965-2	ISO 261, ISO 965-5	ISO 261, ISO 965-2, ISO 965-5
Mechanical properties	Property class	10 [b]		
	European Standard	EN ISO 898-2		
Tolerances	Product grade	B (for dimensions *m* and *c, see Tables 7 and 8)*		
	European Standard	EN ISO 4759-1 [c]		
Finish — Coating	Uncoated	as processed [d]		
	Hot dip galvanized	EN ISO 10684		
	Others	to be agreed [e]		
Surface integrity		Limits for surface discontinuities are specified in EN ISO 6157-2.		
Acceptability		For acceptance procedure, see EN ISO 3269.		

[a] For other coatings that need an increased fundamental deviation and according to the relevant standard, oversize tapped nuts with a thread tolerance class up to 6AZ may be used.

[b] For mechanical properties other than those specified in EN ISO 898-2, see 5.3, Table 10 for proof load values.

[c] Except tolerance on perpendicularity of bearing face, see tolerance *t* in Table 7.

[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.

5.3 Proof load values of nuts

Table 10 — Proof load values of nuts

Thread D	**Nominal stress area of standard test mandrel** A_s mm²	**Property class 10** Tolerance class 6H to 6AZ	
		Proof load ($A_s \times S_p$), N	
		Regular nuts (HR) to EN 14399–3 [a]	Nuts with height $m = 1\ D$ (HRD) [b]
M12	84,3	97 800	104 900
M16	157	182 100	195 500
M20	245	284 200	305 000
M22	303	351 200	377 200
M24	353	409 500	439 500
M27	459	532 400	571 500
M30	561	650 800	698 400
M36	817	947 700	1 017 100

[a] The proof load values are based on the stress under proof load of 1 160 N/mm².

[b] The proof load values are based on the stress under proof load of 1 245 N/mm².

5.4 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.

5.5 Marking of nuts

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

a) property class marking in accordance with EN ISO 898-2, and

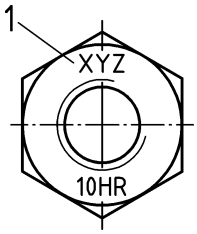
   1) the letters HR for regular nuts in accordance with EN 14399-3, or

   2) the letters HRD for nuts with height $m = 1\ D$.

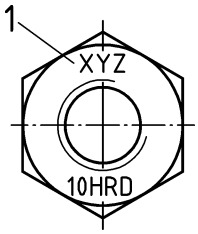
EXAMPLE 10 HR

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

The marking shall be indented on one of the bearing faces of chamfered nuts, or shall be either indented or embossed on the non-bearing face of washer faced nuts. For nut marking see Figure 6.



a) Example of marking for HR nuts



b) Example of marking for HRD nuts

Key

1 identification mark of the manufacturer of the bolting assembly

Figure 6 — Examples of nut marking

6 Designation of bolt/nut assemblies

The designation of bolt/nut assemblies is specified in this clause. The complete designation for bolting assemblies includes washers specified in EN 14399-6 and/or EN 14399-5.

EXAMPLE 1 Designation of a bolt/nut assembly with calibrated preload for high-strength structural bolting for preloading, system HRC, 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 regular nut with large width across flats, with thread M16 and property class 10, with surface finish "as processed", according to k-class K2:

Hexagon bolt/nut assembly EN 14399–10 — HRC — M16 × 80 — 10.9/10 — K2

EXAMPLE 2 Designation of a bolt/nut assembly with calibrated preload for high-strength structural bolting for preloading, system HRC, consisting of a cup head bolt with thread M16, nominal length l = 80 mm and property class 10.9, and a hexagon HRD nut with large width across flats, with thread M16 and property class 10, with hot dip galvanized coating (tZn), according to k-class K0:

Cup head bolt/nut assembly EN 14399–10 — HRC — M16 × 80 — 10.9/10D — tZn — K0

7 Associated washers

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

8 Functional characteristics of bolt/nut/washer(s) assemblies

8.1 General

The bolting assembly shall be delivered in a suitably lubricated condition, to ensure that seizure will not take place during tightening of the assembly and that the required preload is obtained.

The adequacy with which the preload is obtained on tightening calibrated preload bolting assemblies depends on the satisfactory control of the behaviour of two main parameters:

— the lubrication performance;

— the spline-end torsion resistance.

Therefore the functional characteristics of the bolting assemblies with calibrated preload in accordance with EN 14399-2 and with 8.4 shall be achieved, when tested in accordance with 8.2 and 8.3.

Experience has shown that, for certain preloaded bolted connections in metallic structures, installation conditions are such that it is not possible to use the shear wrench. In this case, tightening shall be carried out by using the control torque method and *k*-class K2 (k_m factor and V_k) information, or by using a direct tension indicator in accordance with EN 14399–9.

Before the test, a minimum of four full pitches of complete 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.

8.2 Suitability test for preloading

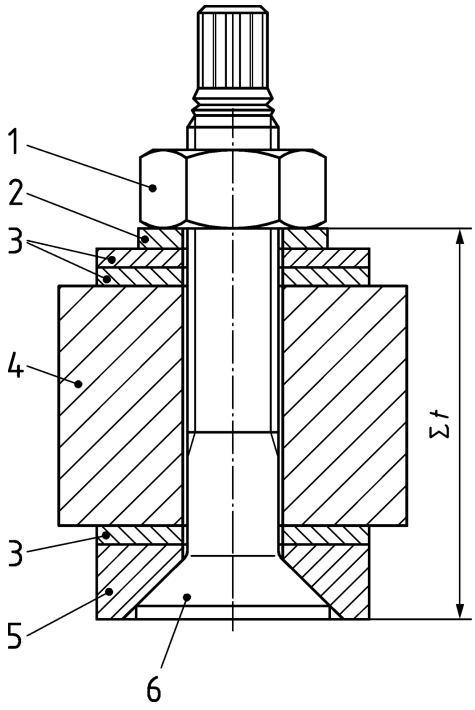
8.2.1 General

Suitability test for preloading shall be in accordance with EN 14399-2, and 8.2 to 8.4.

For testing countersunk head bolts an adapter as shown in Table 11, Figures 7 and 8 shall be used under the bolt head.

Table 11 — Characteristics of adapters

Nominal bolt diameter	Hole diameter	Outside diameter	Hardness for the adapters
$d \leq$ M14	d + 1 mm	Not less than 3d and sufficient to distribute load adequately to the device	45 HRC to 50 HRC through hardened
M14 < $d \leq$ M24	d + 2 mm		
$d >$ M24	d + 3 mm		



Key

1 nut (turned during tightening)
2 washer of the bolting assembly (prevented from rotating)
3 shim(s)
4 calibrated measuring device
5 adapter
6 bolt head (prevented from rotating)
Σt clamp length

Figure 7 — Test set-up

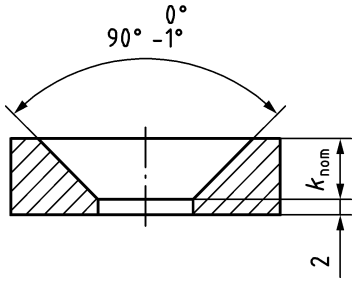


Figure 8 — Adapter

8.2.2 Test results

Evaluation of test results shall be in accordance with EN 14399-2.

$\Delta\theta_2$ shall be measured from the fracture of the spline-end and shall exceed the minimum value of $\Delta\theta_2$ specified in EN 14399-3.

8.3 Suitability test for calibrated preload

This additional part of the suitability test shall be carried out on test assemblies from the same assembly lot as for 8.2, in order to check that the spline-end breaks at the required preload value.

The test conditions specified in EN 14399-2:2015, 6.2, 6.3 and 6.4 shall be used.

The test apparatus shall be according to one of the following:

— either the shear wrench according to 3.1 and the bolt force measurement device, or

— the shear wrench according to 3.1 and the test apparatus defined in EN 14399-2, or

— the test apparatus defined in EN 14399-2 equipped with co-axial sockets designed to fit the spline-end of the bolt, able to turn and break the spline-end similarly to the shear wrench.

This test may be combined with the suitability test for preloading as defined in 8.2.

The tightening stops when the spline-end fractures.

F_{ri} which is the individual value of the bolt force when failure by fracture occurs in the spline-end shall be measured.

8.4 Requirements

For assemblies with HR nuts, the requirements of EN 14399-3, *k*-class K2, apply.

For assemblies with HRD nuts, the requirements of EN 14399-3, *k*-class K0 apply, however K1 or K2 may also be used.

The values for the bolt force at the fracture of the spline-end (F_r) shall fulfil the requirements specified in Table 12. The following requirements apply:

— individual value of $F_{ri} \geq 0{,}7\, f_{ub} \times A_s$

— mean value $F_{r\,mean} \geq 0{,}77\, f_{ub} \times A_s$

— coefficient of variation of F_r:

$V_{Fr} \leq 0{,}06$

with

$$V_{Fr} = \frac{s_{Fr}}{F_{r\,mean}} \tag{1}$$

where

s_{Fr} is the standard deviation.

$$s_{Fr} = \sqrt{\frac{\sum \left(F_{ri} - F_{r\,mean}\right)^2}{n-1}} \tag{2}$$

Five tests shall be carried out.

Table 12 — Limiting values of bolt force at the fracture of the spline-end

Thread d	**Nominal stress area of standard test mandrel** A_s mm²	$F_{r\,min}$ $0,7 \times f_{ub} \times A_s$ [a] N	$F_{r\,mean\,min}$ $0,77 \times f_{ub} \times A_s$ [a] N
M12	84,3	59 010	64 911
M16	157	109 900	120 890
M20	245	171 500	188 650
M22	303	212 100	233 310
M24	353	247 100	271 810
M27	459	321 300	353 430
M30	561	392 700	431 970
M36	817	571 900	629 090

[a] f_{ub} is the nominal tensile strength of the bolt ($R_{m\,nom}$).

Annex A
(informative)

Clamp lengths and grip lengths

Clamp lengths and grip lengths for HRC bolting assemblies (see Figure A.1 and A.2) cannot be absolute. HR or HV assemblies use a simple formula to calculate the minimum clamp length and grip length values as there is no dedicated tool employed to install these bolting systems.

However HRC assemblies are installed with a specific device called a shear wrench. This tooling is designed so the inner socket retracts inside the outer socket as the HRC assembly is installed but the actual distance that it retracts is dependent on the individual tooling's dimensions. When the inner socket reaches the point where it is fully retracted and if the assembly is not fully installed, the shear wrench outer socket keeps rotating until it is eventually forced off the nut. This point should determine the minimum clamp and grip lengths however as each shear wrench design is different, this dimension cannot be definitive.

Due to manufacturing issues, the length of protrusion should be at least the length of 2 thread pitches (instead of 1*P*) measured from the outer face of the nut to the end of the bolt after the spline end shears off. This should also be considered when calculating the maximum clamp and grip lengths.

In addition, the maximum clamp length should take into account the nut height (HR or HRD nuts in the bolting assemblies).

Examples for clamp lengths and grip lengths of HRC assemblies are shown in Figure A.1 and A.2.

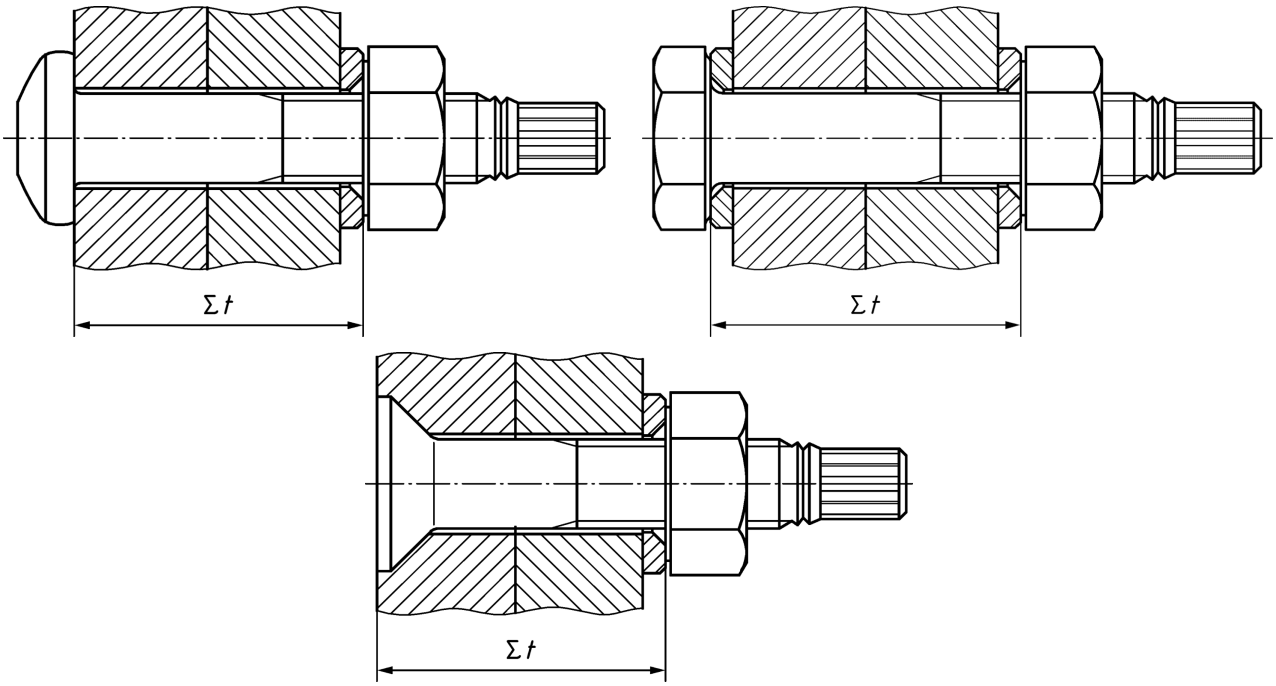


Figure A.1 — Examples for clamp lengths Σ*t*

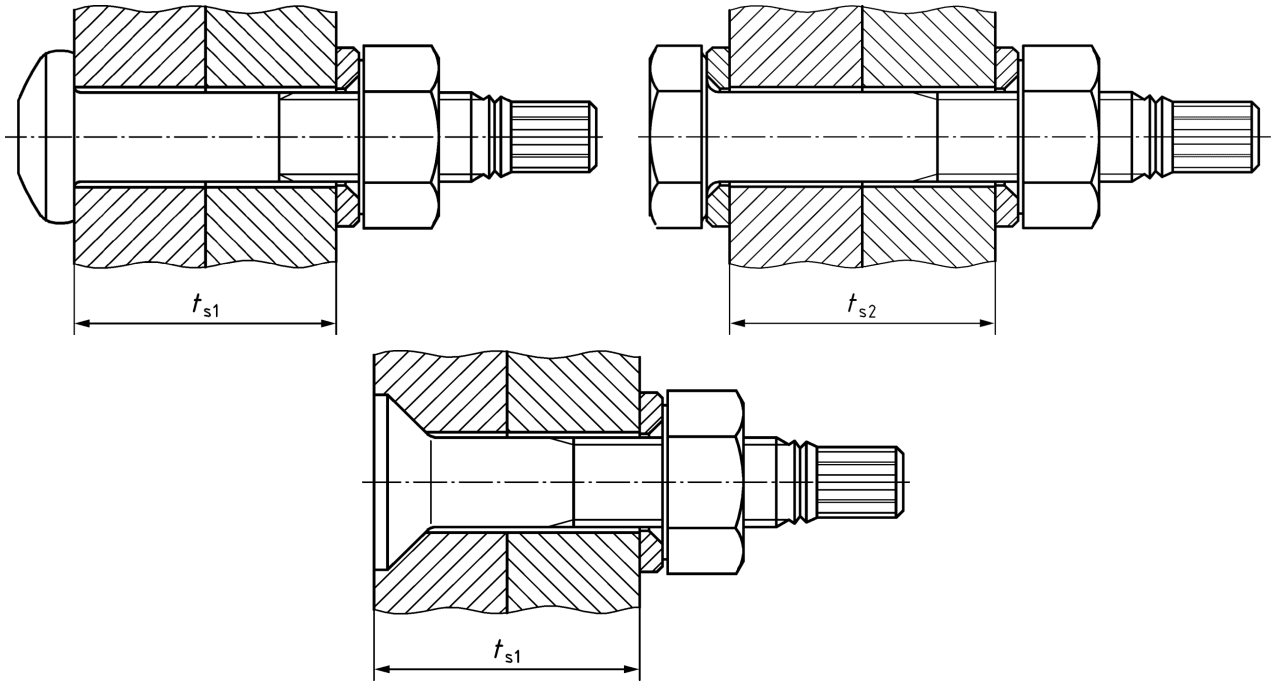


Figure A.2 — Examples for grip lengths t_s

Bibliography

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

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

[3] EN 14399-4, *High-strength structural bolting assemblies for preloading — Part 4: System HV - Hexagon bolt and nut assemblies*

[4] EN 14399-7, *High-strength structural bolting assemblies for preloading — Part 7: System HR — Countersunk head bolt and nut assemblies*

[5] EN 14399-8, *High-strength structural bolting assemblies for preloading — Part 8: System HV — Hexagon fit bolt and nut assemblies*

[6] EN 14399-9, *High-strength structural bolting assemblies for preloading — Part 9: System HR or HV - Direct tension indicators for bolt and nut assemblies*

[7] EN ISO 4032, *Hexagon regular nuts (style 1) — Product grades A and B (ISO 4032)*

[8] ISO 272, *Fasteners — Hexagon products — Widths across flats*

[9] ISO 888, *Fasteners — Bolts, screws and studs — Nominal lengths and thread lengths*

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