Foreword

The formulation of this National Standard was initiated by the Agricultural Machinery Testing and Evaluation Center (AMTEC) under the project entitled "Enhancing the Implementation of AFMA Through Improved Agricultural Engineering Standards" which was funded by the Bureau of Agricultural Research (BAR) of the Department of Agriculture (DA).

This standard has been technically prepared in accordance with PNS 01-4:1998 (ISO/IEC Directives Part 3:1997) – Rules for the Structure and Drafting of International Standards. It provides specifications and proper application of bolts and nuts for agricultural machines.

The word “shall” is used to indicate requirements strictly to be followed in order to conform to the standard and from which no deviation is permitted.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that certain course of action is preferred but not necessarily required.

In the preparation of this standard, the following references were considered:

Hummel, B. L. (Ed.) 1967. Machine design, Fastening and joining, Vol. 39 No. 34. Penton Publishing Co., Cleveland, Ohio.

ISO 262:1998, ISO general purpose metric screw threads – Selected sizes for screws, bolts, and nuts

ISO 273:1979, Fasteners – Clearance holes for bolts and screws

ISO 888:1976, Bolts, screws, and studs – Nominal lengths and thread lengths for general purpose bolts

JIS B 1052:1998, Mechanical properties of steel nuts

JIS B 1057:1994, Mechanical properties of non-ferrous metal fasteners

Engineering Materials – Bolts and Nuts for Agricultural Machines – Specifications and Applications

1 Scope

This standard establishes specifications and provides technical information for the proper application of bolts and nuts for agricultural machinery.

2 Application

Bolts and nuts are used for fastening materials permanently or semi-permanently. The use of bolts provides easy assembly and disassembly of a joint.

3 Reference

The following normative reference contains provisions which, through reference in this text, constitute provisions of this standard:

PAES 314:2002, Engineering Materials – Washers for Agricultural Machines – Specifications

4 Definitions

4.1
fastener
a mechanical device designed specifically to hold, join, or maintain equilibrium of single or multiple components

4.2
bolt
an externally threaded fastener designed for insertion through holes in assembled parts, and normally tightened or released by torquing a nut

4.3
nut
a block or sleeve having an internal thread designed to assemble with the external thread on a bolt, screw, stud or other threaded part

4.4
nominal size
the designation used for the purpose of general identification; for external and internal threaded fasteners nominal size usually is the basic major diameter of the thread; for unthreaded fasteners, nominal size is usually the basic body diameter

4.5
length of fastener
the length of a headed fastener is the distance from the intersection of the largest diameter of the head with the bearing surface to the extreme end of the fastener, measured parallel to the axis of the fastener

4.6
right-hand thread
a thread which winds in a clockwise and receding direction from the starting end, when viewed from that end

4.7
left-hand thread
a thread which winds in a counterclockwise and receding direction from the starting end, when viewed from that end

4.8
proof load
the specified load which the fastener must withstand without any indication of permanent deformation after the load is released

4.9
pitch
the distance (in millimeters), measured parallel to the thread axis, between corresponding points on adjacent thread forms in the same axial plane on the same side of the axis

4.10
major diameter
for a straight thread, this is the diameter of the imaginary cylinder bounding the crest of an external thread or the root of an internal thread

4.11
minor diameter
for a straight thread, this diameter is the imaginary cylinder bounding the root of an external thread or the crest of an internal thread

4.12
pitch diameter
for a straight thread, this is the diameter of the imaginary cylinder whose surface passes through the thread profiles in such a way to make the widths of the thread ridge and the thread groove equal

5 Types of bolts

Types of bolts are shown in Figure 1.

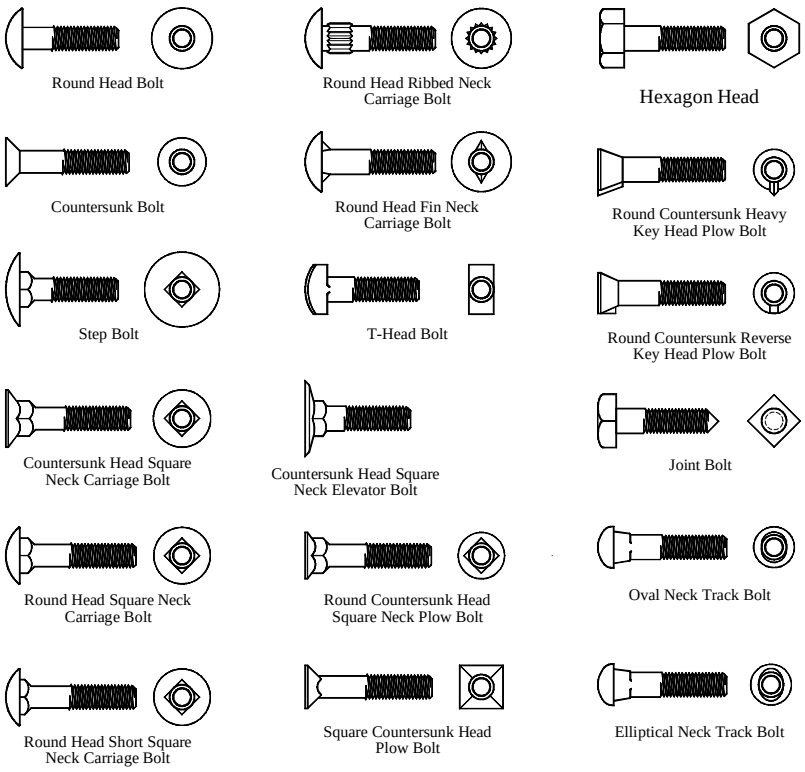


Figure 1 – Types of Bolts

6 Types of nuts

Types of nuts are shown in Figure 2.

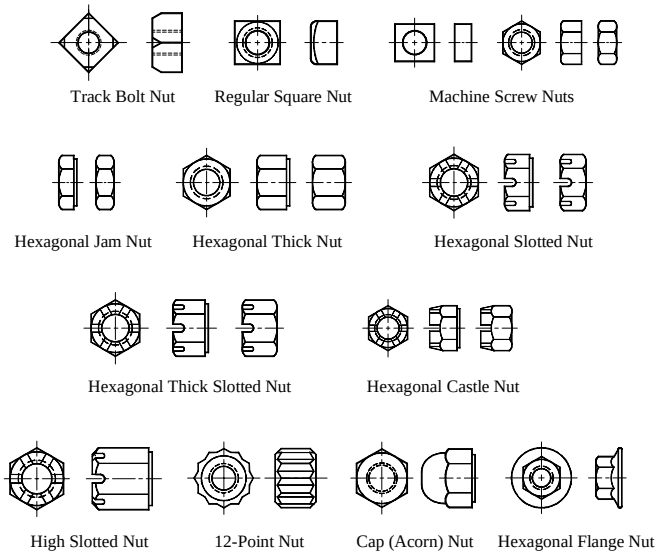
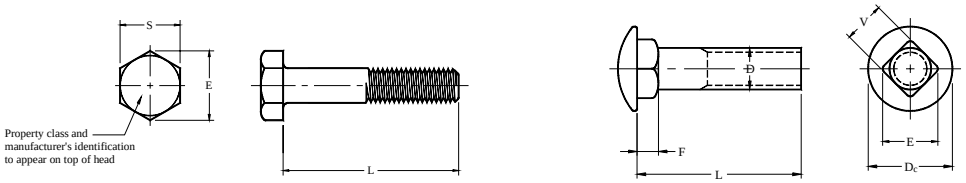


Figure 2 – Types of nuts

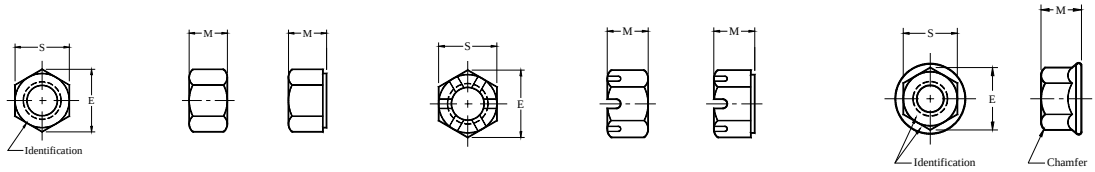
7 Nomenclature

Figures 3 and 4 shows the nomenclature of bolts and nuts, respectively. For the purposes of this standard, only bolts and nuts specified in Table 1 shall be covered.



Hexagonal bolt **Round head square neck bolt**

Figure 3 – Nomenclature of bolts



Hexagonal nut **Hexagonal slotted nut** **Hexagonal flange nut**

Figure 4 – Nomenclature of nuts

Table 1 – Types of bolts and nuts covered in this standard

Types	Uses
Bolts	
Hexagonal head	General purpose
Round head square neck	When the side of the head is not accessible for a wrench or a screw driver. Also used for aesthetic purposes and when the machine requires a smooth surface.
Nuts	
Hexagonal	General purpose
Hexagonal slotted	For conditions where it necessitates the insertion of a pin in the bolt which serves as a lock in the fastener assembly.
Hexagonal flange	Used to increase the bearing area thus distributing the fastener load over a large area, particularly on soft materials such as aluminum

8 Dimensions

8.1 Pitch

Selected pitch and nominal diameters of bolts and nuts are presented in Table 2.

Table 2 – Selected sizes of bolts and nuts

Nominal diameter, *D* (mm)	Pitch, *P* (mm)			Nominal diameter, *D* (inches)	Threads per inch	
	Coarse	Fine			Coarse	Fine
5	0.80					
6	1.0			1/4	20	28
8	1.25	1.0		5/16	18	24
10	1.5	1.25	1.0	3/8	16	24
12	1.75	1.5	1.25	1/2	13	20
14	2.0	1.5		9/16	12	18
16	2.0	1.5		5/8	11	18
20	2.5	2.0	1.5	3/4	10	16
24	3.0	2.0		1	8	12
30	3.5	2.0		1 ¼	7	12
36	4.0	3.0		1 ½	6	12

8.2 Basic dimensions

Dimensions of bolts shall conform to Tables 3 and 4. Dimensions of nuts shall conform to Tables 5-7.

Table 3 – Basic dimensions of hexagonal bolts

Dimensions in millimeters

Nominal diameter *(D)* and thread pitch	Width across flats, *S*		Width across corners, *E*	
	Max	Min	Max	Min
M5 x 0.8	8.00	7.64	9.24	8.63
M6 x 1	10.00	9.64	11.55	10.89
M8 x 1.25	13.00	12.57	15.01	14.20
M10 x 1.5	16.00	15.57	18.48	17.59
M12 x 1.75	18.00	17.57	20.78	19.85
M14 x 2	21.00	20.16	24.25	22.78
M16 x 2	24.00	23.16	27.71	26.17
M20 x 2.5	30.00	29.16	34.64	32.95
M24 x 3	36.00	35.00	41.57	39.55
M30 x 3.5	46.00	45.00	53.12	50.55
M36 x 4	55.00	53.80	63.51	60.79

Table 4 – Basic dimensions of round head square neck bolts

Dimensions in millimeters

Nominal diameter *(D)* X thread pitch	Head diameter, D_c	Square depth, *F*		Square width across flats, *V*		Square width across corners, *E*	
	Max	Max	Min	Max	Min	Max	Min
M5 x 0.8	11.8	3.1	2.5	5.48	4.88	7.75	6.34
M6 x 1	14.2	3.6	3.0	6.48	5.88	9.16	7.64
M8 x 1.25	18.0	4.8	4.0	8.58	7.85	12.13	10.20
M10 x 1.5	22.3	5.8	5.0	10.58	9.85	14.96	12.80
M12 x 1.75	26.6	6.8	6.0	12.70	11.82	17.96	15.37
M14 x 2	30.5	7.9	7.0	14.70	13.82	20.79	17.97
M16 x 2	35.0	8.9	8.0	16.70	15.82	23.62	20.57
M20 x 2.5	43.0	10.9	10.0	20.84	19.79	29.47	25.73
M24 x 2.5	51.0	13.1	12.0	24.84	23.79	35.13	30.93

Table 5 – Basic dimensions of hexagonal nuts styles 1 and 2

Dimensions in millimeters

Nominal diameter *(D)* and thread pitch	Width across flats, *S*		Width across corners, *E*		Thickness, *M*			
					Style 1		Style 2	
	Max	Min	Max	Min	Max	Min	Max	Min
M5 x 0.8	8.00	7.78	9.24	8.79	4.70	4.40	5.10	4.80
M6 x 1	10.00	9.78	11.55	11.05	5.20	4.90	5.70	5.40
M8 x 1.25	13.00	12.73	15.01	14.38	6.80	6.44	7.50	7.14
M10 x 1.5	16.00	15.73	18.45	17.77	8.40	8.04	9.30	14.60
M12 x 1.75	18.00	17.73	20.78	20.03	10.80	10.37	12.00	16.60
M14 x 2	21.00	20.67	24.25	23.36	12.80	12.10	14.10	19.60
M16 x 2	24.00	23.67	27.71	26.75	14.80	14.0	16.40	22.50
M20 x 2.5	30.00	29.16	34.64	32.95	18.00	16.90	20.30	27.70
M24 x 3	36.00	35.00	41.57	39.55	21.50	20.20	23.90	33.20
M30 x 3.5	46.00	45.00	53.12	50.85	25.60	24.30	28.60	42.70
M36 x 4	55.00	53.80	63.51	60.79	31.00	29.40	34.70	51.10

Table 6 – Basic dimensions of hexagonal slotted nuts

Dimensions in millimeters

Nominal diameter *(D)* and thread pitch	Width across flats, *S*		Width across corners, *E*		Thickness, *M*	
	Max	Min	Max	Min	Max	Min
M5 x 0.8	8.00	7.78	9.24	8.79	5.10	4.80
M6 x 1	10.00	9.78	11.55	11.05	5.70	5.40
M8 x 1.25	13.00	12.73	15.01	14.38	7.50	7.14
M10 x 1.5	16.00	15.73	18.45	17.77	9.30	14.60
M12 x 1.75	18.00	17.73	20.78	20.03	12.00	16.60
M14 x 2	21.00	20.67	24.25	23.36	14.10	19.60
M16 x 2	24.00	23.67	27.71	26.75	16.40	22.50
M20 x 2.5	30.00	29.16	34.64	32.95	20.30	27.70
M24 x 3	36.00	35.00	41.57	39.55	23.90	33.20
M30 x 3.5	46.00	45.00	53.12	50.85	28.60	42.70
M36 x 4	55.00	53.80	63.51	60.79	34.70	51.10

Table 7 – Basic dimensions of hexagonal flanged nuts

Dimensions in millimeters

Nominal diameter *(D)* and thread pitch	Width across flats, *S*		Width across corners, *E*		Thickness, *M*	
	Max	Min	Max	Min	Max	Min
M5 x 0.8	8.00	7.78	9.24	8.79	5.10	4.80
M6 x 1	10.00	9.78	11.55	11.05	5.70	5.40
M8 x 1.25	13.00	12.73	15.01	14.38	7.50	7.14
M10 x 1.5	15.00	14.73	17.32	16.64	10.0	13.60
M12 x 1.75	18.00	17.73	20.78	20.03	12.00	16.60
M14 x 2	21.00	20.67	24.25	23.36	14.10	19.60
M16 x 2	24.00	23.67	27.71	26.75	16.40	22.50
M20 x 2.5	30.00	29.16	34.64	32.95	20.30	27.70

8.3 Length

The length of the bolts shall be that all the threads of the nut engage with two to three threads over. Recommended diameter length combinations for hexagonal and square head round neck bolts are presented in Tables 8 and 9, respectively.

Table 8 – Recommended diameter length combinations for hexagonal bolts

Nominal length *(L)*, mm	Diameter x Pitch						
	M16 x 2	M20 x 2.5	M22 x 2.5	M24 x 3	M27 x 3	M30 x 3.5	M36 x 4
45	X						
50	X	X					
55	X	X	X				
60	X	X	X	X			
65	X	X	X	X	X		
70	X	X	X	X	X	X	
75	X	X	X	X	X	X	
80	X	X	X	X	X	X	X
85	X	X	X	X	X	X	X
90	X	X	X	X	X	X	X
95	X	X	X	X	X	X	X
100	X	X	X	X	X	X	X
110	X	X	X	X	X	X	X
120	X	X	X	X	X	X	X
130	X	X	X	X	X	X	X
140	X	X	X	X	X	X	X
150	X	X	X	X	X	X	X

NOTE: Recommended diameter-length combinations are indicated by the symbol X.

Table 9 – Recommended diameter length combinations for round head square neck bolts

Nominal length *(L)*, mm	Diameter x Pitch								
	M5 x 0.8	M6 x 1	M8 x 1.25	M10 x 1.5	M12 x 1.75	M14 x 2	M16 x 2	M20 x 2.5	M24 x 3
10	X								
12	X	X							
16	X	X	X						
20	X	X	X	X					
25	X	X	X	X	X				
30	X	X	X	X	X	X	X		
35	X	X	X	X	X	X	X		
40	X	X	X	X	X	X	X	X	
45	X	X	X	X	X	X	X	X	X
50	X	X	X	X	X	X	X	X	X
60		X	X	X	X	X	X	X	X
70			X	X	X	X	X	X	X
80			X	X	X	X	X	X	X
90				X	X	X	X	X	X
100				X	X	X	X	X	X
110					X	X	X	X	X
120					X	X	X	X	X
130						X	X	X	X
140						X	X	X	X
150							X	X	X

NOTE: Recommended diameter-length combinations are indicated by the symbol X. Bolts with lengths above heavy cross lines are threaded full length

9 Materials

Mechanical properties of steel bolts shall conform to Table 10. Mechanical properties of steel nuts shall conform to Table 11. Table 12 specifies the bolt and nut combination for steel fasteners. Table 13 and 14 specifies the minimum tensile load of steel and non-ferrous metals bolts, respectively.

Table 10 – Mechanical properties of steel bolts

Grade designation			Min. tensile strength, N/mm^2	Brinell hardness	Material
Metric*	**SAE**	**ASTM**			
4.6	1	A307	400	207	Low or medium carbon
4.8	2	A307	420	241	Low or medium carbon
5.8	3		500	269	Low or medium carbon
8.8	5	A 449 or A325 type 1	800	302	Medium-carbon, quenched and tempered
9.8			900	321	Medium-carbon, quenched and tempered
10.9	8	A354 Grade BD	1040	352	Low-carbon martensite, quenched and tempered
12.9		A574	1200		Alloy, quenched and tempered
*Metric grade is *xx.x* where *xx* is approximately one-hundredth of the minimum tensile strength in N/mm^2 and *.x* is the ratio of the minimum yield strength to the minimum tensile strength					

.

Table 11 – Mechanical properties of steel nuts

Grade designation	4	5	8	9	10	12
Proof load, N/mm^2	400	500	800	900	1040	1200
NOTE: The strength grade designation system for steel nuts is a number, which is one-hundredth of the specified proof load stress in N/mm^2.						

Table 12 – Recommended bolt and nut combination

Grade of bolt	4.6	4.8	5.6	5.8	8.8	9.8	10.9	12.9
Recommended grade of nut	4	4	5	5	8	9	10	10

Table 13 - Minimum tensile load of steel bolts

Dimensions in Newtons

Material classification	**Diameter x pitch**										
	M5 x 0.8	**M6 x 1.0**	**M8 x 1.25**	**M10 x 1.5**	**M12 x 1.75**	**M14 x 2.0**	**M16 x 2.0**	**M20 x 2.5**	**M24 x 3.0**	**M30 x 3.5**	**M36 x 4.0**
4.6	5,680	8,040	14,640	23,200	33,720	46,000	62,800	98,000	141,200	224,400	326,800
4.8	5,964	8,442	15,372	24,360	35,406	48,300	65,940	-	-	-	-
5.8	7,100	10,050	18,300	29,000	42,150	57,500	78,500	122,500	176,500	-	-
8.8	-	-	-	-	-	-	125,600	196,000	282,400	448,800	653,600
9.8	12,780	18,090	32,940	52,200	75,870	103,500	141,300	-	-	-	-
10.9	14,768	20,904	38,064	60,320	87,672	119,600	163,280	254,800	367,120	583,440	849,680
12.9	17,040	24,120	43,920	69,600	101,160	138,000	188,400	294,000	423,600	673,200	980,400

Table 14 – Minimum tensile load of non-ferrous metal bolts

Dimensions in Newtons

Material symbol	**Diameter x pitch**										
	M5 x 0.8	**M6 x 1.0**	**M8 x 1.25**	**M10 x 1.5**	**M12 x 1.75**	**M14 x 2.0**	**M16 x 2.0**	**M20 x 2.5**	**M24 x 3.0**	**M30 x 3.5**	**M36 x 4.0**
CU1	3,410	4,820	8,780	13,920	20,230	27,600	37,680	58,800	84,720	134,600	196,100
CU2	6,250	8,840	13,540	21,460	31,190	42,550	58,090	90,650	130,600	207,600	302,300
CU3	6,250	8,840	13,540	21,460	31,190	42,550	58,090	90,650	130,600.00	207,600	302,300
CU4	6,670	9,450	17,200	27,260	39,620	46,000	62,800	98,000	141,200	224,400	326,800
CU5	8,380	11,860	21,590	34,220	49,740	67,850	92,630	144,500	208,300	331,000	-
CU6	-	-	16,100	25,520	37,090	50,600	69,080	107,800	155,300	246,800	359,500
CU7	-	-	-	-	-	73,600	100,500	156,800	225,900	359,000	522,900
AL1	3,830	5,430	9,880	15,660	21,080	28,750	39,250	61,250	-	-	-
AL2	4,400	6,230	11,350	17,980	26,130	35,650	43,960	68,600	98,840	157,100	228,800
AL3	4,540	6,430	11,350	17,980	26,130	35,650	48,670	75,950	109,400	173,900	253,300
AL4	5,960	8,440	15,370	24,360	32,030	43,700	59,660	93,100	134,100	213,200	310,500
AL5	6,530	8,250	16,840	26,680	38,780	52,900	72,220	112,700	162,400	258,100	375,800
AL6	7,240	10,250	18,670	29,580	42,990	58,650	80,070	124,900	180,000	286,100	416,700

10 Coatings

Coatings or special finishing for fasteners shall conform to Table 15. A protective coating shall be used only when the fastener is subjected to mildly corrosive conditions. For extremely corrosive conditions, a fastener made of metal that has inherent corrosion resistance should be specified.

Table 15 – Fastener finishes and coatings

Coating or finish	Used on	Coating or finish	Used on
Black oxide, blued	Steel	Dull nickel	Most metals
Rust preventives	All metals	Bright nickel	Most metals
Electrogalvanized zinc	All metals	Black chromate	Zinc-plated or cadmium-plated steel
Hot-dip zinc	All metals		
Chromium plate	Most metals	Passivating	Stainless steel

11 Designation

Bolts shall be identified as ISO Metric by either of the symbols “ISO M” or “M”. Bolts and nuts shall be designated by the following data in the sequence shown: product name, nominal diameter; and thread pitch nominal length (for bolts), steel property class or material specification, and protective coating, if required.

EXAMPLE Hexagonal bolt, M10x1.5x50, Grade5.8, zinc plated
Hexagonal nut, M10x1.5, Grade 5, zinc plated

12 Washers

Use washers as specified in PAES 314:2002.

13 Recommended design practices

13.1 Selection between fine and coarse-thread series

13.1.1 Coarse thread series shall be used for general use; where jar and vibration are not important factors, where disassembly of parts is frequent, and where tapped holes are in metals other than tapped steel. The use of coarse thread series is always recommended over other thread series unless there is a reason for using another.

13.1.2 Fine thread series shall be used where jar and vibration (tending to loosen the nut) are present as (e.g. thresher). This thread series shall not be recommended for brittle materials**.**

13.2 Clearance holes

Specifications for clearance holes are presented in Table 16. Normal clearance shall be specified for general purpose applications and should be specified unless special design considerations dictate the need for either a close or loose clearance hole. Close clearance shall be specified only where conditions such as critical alignment of assembled parts, wall thickness or other limitations necessitate use of minimum hole. When close clearance holes are specified, special provision (e.g. countersinking) must be made at the bolt entry side to

permit proper seating of the screw head. Loose clearance shall be specified only for applications where maximum adjustment capability between components being assembled is necessary.

Table 16 – Clearance holes for bolts

Dimensions in millimeters

Nominal bolt diameter *(d)*	Clearance hole, d_h			Thread diameter, *d*	Clearance hole, d_h		
	Close	Normal	Loose		Close	Normal	Loose
5	5.3	5.5	5.8	20	21	22	24
6	6.4	6.6	7	22	23	24	26
8	8.4	9	10	24	25	26	28
10	10.5	11	12	27	28	30	32
12	13	13.5	14.5	30	31	33	35
14	15	15.5	16.5	33	34	36	38
16	17	17.5	18.5	36	37	39	42

13.3 Spacing

Bolts shall be spaced far enough for a handle of a wrench to turn a minimum of 60°.

13.4 Use of right and left-hand thread

Right-hand thread shall be used in almost all fastening applications unless there is a necessity for the use of a left hand thread. Left-hand thread shall be used for rotating members, such that the thread winds in an opposite direction as compared to the rotating member (e.g. impeller shafts for pumps, shaft for rice mill).

14 Markings

14.1 The following information shall be marked on the packaging:

a) Manufacturer’s name, trademark and address

b) Bolt and nut designation

14.2 The metric grade designation shall be engraved or embossed on the head of the bolt:

15 Safety

15.1 The nut material should be softer than the bolt material. Use the appropriate material for the nut.

15.2 Apply proper tension/torque during assembly.

15.3 Make fastener inspection on a periodic basis**.** Inspect fasteners for its quality and tightness.

15.4 Use appropriate tools and tool size in fastening. For hexagonal bolts and nuts, refer to width across flats, *S* in Table 2 for bolts and Tables 3 - 6 for nuts.

15.5 Use washers to distribute the bearing load, to provide a uniform bearing surface, and to prevent marring of the work surface

15.6 Acquire bolts and nuts that are free from flaws and any surface discontinuities (e.g. cracks, seams, laps, burst, etc.).

Annex A
(Informative)

Example of selection of bolts and nuts in tension

A.1 Given parameters

Select a hexagonal bolt and nut for a bolt and nut assembly that is to support a load of 30 kN (Figure A.1). Assume that the bolt material required to meet environmental conditions an allowable tensile strength of 420 MPa. Assume further that the thickness of the plate to fastened is 50 mm and that the joint is not subject to vibration and the conditions require a coarse-thread series.

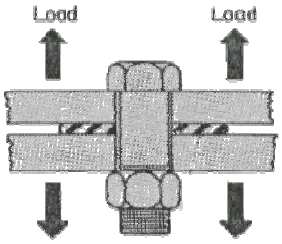


Figure A.1 – Bolt assembly in tension

A.2 Size and grade designation bolt and nut

Given a tensile strength of 420 MPa, the grade designation of the bolt and nut that can be used is grade 4.8 and 4, respectively (see Table 10 and 12). With a given tensile load of 30 kN, the size of the bolt and nut to be used is M12x1.75 (Table 13).

A.5 Clearance hole

From Table 16, the clearance hole shall be 13.5 mm.

A.6 Designation of washer

Designation of and size of washers shall be in accordance with PAES 314:2002. The size of washer to be used is 12 mm, make the assumption of using a plain washer (regular type) with a thickness of 3.50 mm.

A.7 Bolt length

The length of the bolt is computed by taking the sum of the thickness of material to be fastened (in these case the thickness of the plate equal to 50 mm), washer thickness, nut thickness (see Table 5), and an allowance of thrice the pitch (equal to 5.25). The length is computed as follows:

$$L = 50 + 3.5 + 10.8 + 5.25$$
$$= 69.55mm$$

Thus, use the next higher available length which is 70 mm (From Table 8).

A.8 Bolt and nut specification

The designation of the bolt, nut, and washer to be used are as follows:

Hexagonal bolt, M12x1.75x70, Grade 4.8
Hexagonal nut-style 1, M12x2, Grade 4

Annex B
(Informative)

Example of selection of bolts and nuts in shear

B.1 Given parameters

Select a hexagonal bolt and nut for a clevis that is to support a load of 100 kN (Figure A.1). Assume that the bolt material required to meet environmental conditions has allowable shear strength of approximately 210 MPa and a tensile strength of 420 MPa. Assume that the height of the clevis is 60 mm and that the joint is not subject to vibration and the conditions require a coarse-thread series.

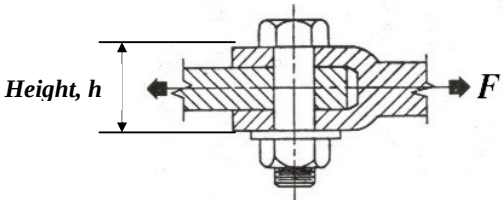


Figure B.1 – Clevis

B.2 Diameter of bolt and nut

B.2.1 The stress area of the bolt can be computed by:

$$A = \frac{F}{S_S} \quad \text{.....[Eq. B.1]}$$

$$A = \frac{\pi d^2}{4} \quad \text{.....[Eq. B.2]}$$

where:

A = stress area, mm^2
F = force (equal to 100,000/2 since there are two shear planes as shown in Figure B.1), N
d^2 = bolt diameter, mm
S_S = allowable shear strength, Pa

B.2.2 By equating equations B.1 and B.2;

$$\frac{\pi d^2}{4} = \frac{F}{S_S} \quad \text{.....[Eq. B.3]}$$

$$d = \sqrt{\frac{4F}{\pi S_S}} \quad \text{.....[Eq..B.4]}$$

Thus:

$$d = \sqrt{\frac{4F}{\pi S_S}}$$

$$= \sqrt{\frac{4 \times 50{,}000}{\pi \times 210{,}000{,}000}}$$

$$= 17.41$$

B.2.3 From Table 2, the diameter of the bolt that can be used is 20 mm.

B.3 Pitch

The pitch of coarse thread-series bolt and nut with a diameter of 20 mm is 2.5 (Table 2).

B.4 Grade designation of bolt

For a tensile strength of 420 MPa, the bolt grade with the next higher tensile strength shall be used. Use a Grade 5.8 bolt (Table 10).

B.5 Grade designation of nuts

The recommended grade of the nut from Table 12 is Grade 5.

B.6 Clearance hole

From Table 16, the clearance hole shall be 22 mm.

B.7 Designation of washer

Designation of and size of washers shall be in accordance with PAES 314:2002. The size of washer to be used is 20 mm, make the assumption of using a plain washer (regular type) with a thickness of 4.60 mm.

B.8 Bolt length

The length of the bolt is computed by taking the sum of the thickness of material to be fastened (in these case the height of the clevis equal to 60 mm), washer thickness, nut thickness (see Table 5), and an allowance of thrice the pitch (equal to 7.5). The length is computed as follows:

$$L = 60 + 4.6 + 18 + 7.5$$
$$= 90.1 mm$$

Thus, use the next higher available length which is 95 mm (From Table 8).

B.9 Bolt and nut specification

The designation of the bolt, nut, and washer to be used are as follows:

Hex bolt, M20x2.5x95, Grade 5.8
Hex nut-style 1, M20x2.5, Grade 5
Plain washer, 20 mm, regular, soft steel