

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 screws 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

JIS B 1117:1995, Slotted set screws

JIS B 1118:1995, Square head set screws

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

JIS B 1177:1995, Hexagon socket set screws

**Engineering Materials – Screws for Agricultural Machines
– Specifications and Applications**

1 Scope

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

2 Application

Screws are used for fastening materials permanently or semi-permanently. When mentioned in contrast to bolts, screws are used without assembling with nuts.

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 and Applications

4 Definitions**4.1****fastener**

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

4.2**screw**

an externally threaded fastener capable of being inserted into holes in assembled parts, of mating with preformed internal thread or forming its own thread, and of being tightened or released by torquing the head

4.3**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

4.4**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; the length of a headless fastener is the distance from one extreme end to the other in a line parallel to the axis

4.5

right-hand thread

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

4.6

left-hand thread

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

4.7

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

4.8

proof load

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

4.9

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

4.10

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

4.11

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

5.1 Types of screws based on its head shall be as illustrated in Figure 1. Figure 2 shows the different types of recesses for screw heads. Types of screw point are shown in Figure 3.

5.2 Screws on the basis of function shall be qualified into the following categories: machine screws, cap screws, wood screws, tapping and setscrews, and miscellaneous types. For the purpose of this standard, only machine screws and setscrews presented in Table 1 shall be covered.

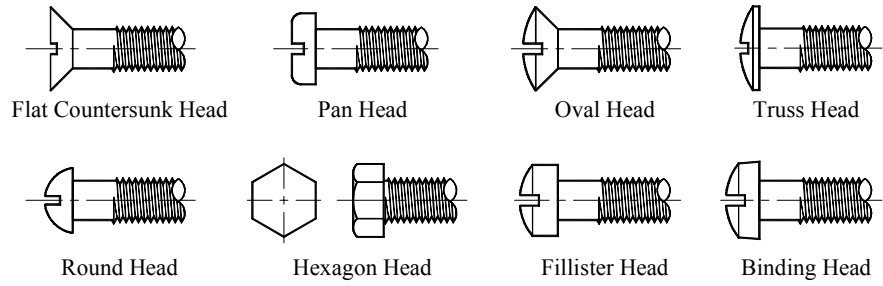


Figure 1 – Types of screw head

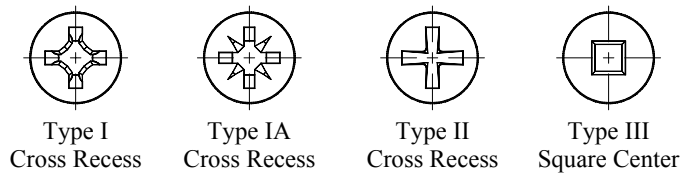


Figure 2 – Types of recess

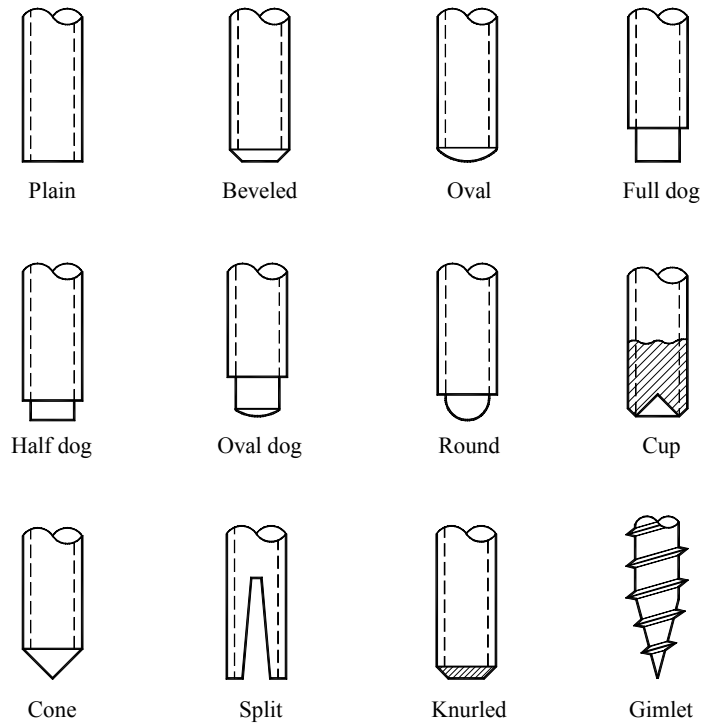


Figure 3 – Types and shapes of screw point

Table 1 – Types of screws covered in this standard

Types	Uses
Machine screws	
Hexagonal head	General purposes.
Hexagonal flange head	Used to increase the bearing area thus distributing the fastener load over a large area, particularly on soft materials such as aluminum.
Pan head	For applications where space is restricted making impossible to use a wrench for tightening.
Flat countersunk head	When space is restricted making impossible to use a wrench for tightening, and where a flat surface is required.
Oval countersunk head	When space is restricted making impossible to use a wrench for tightening, where a flat surface is required. This type shall be recommended for machine parts that are always disassembled.
Setscrews	
Square head	General purposes.
Slotted head	When space is restricted making impossible to use a wrench for tightening and for applications that requires no protruding parts of the machine.
Hexagon socket head	For applications that require no protruding parts of the machine. The use of this type allows easy assembly and disassembly of machine parts.

6 Machine screws

6.1 Nomenclature

Nomenclature and designation of dimensions of machine screws shall conform to Figures 4 to 8.

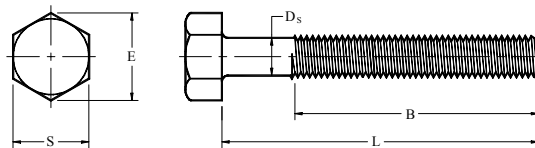


Figure 4 – Hexagonal head

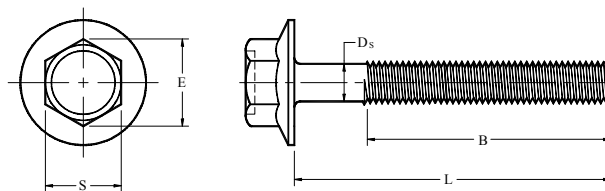


Figure 5 – Hexagonal flange

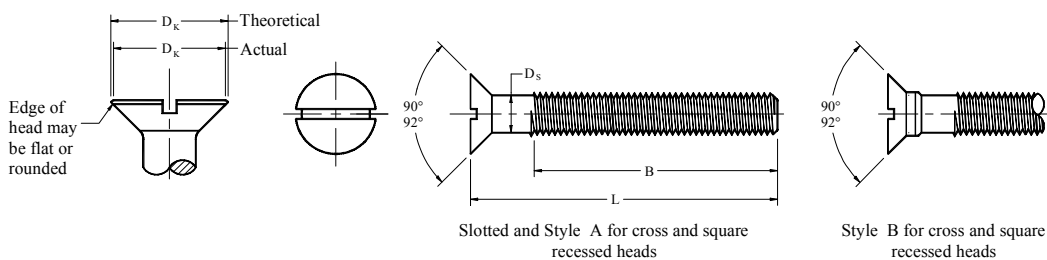


Figure 6 – Flat countersunk head

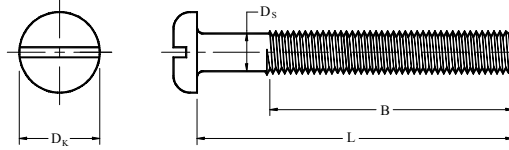


Figure 8 – Pan head

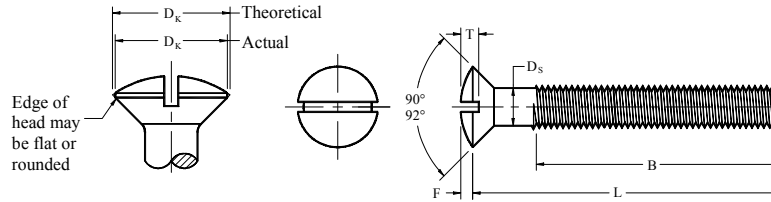


Figure 7 – Oval countersunk head

6.2 Dimensions

6.2.1 Pitch

Selected pitch and nominal diameters of machine screws are presented in Table 2.

Table 2 – Selected sizes of screws

Nominal diameter, <i>D</i> (mm)	Pitch, <i>P</i> (mm)		Nominal diameter, <i>D</i> (inches)	Threads per inch	
	Coarse	Fine		Coarse	Fine
2	0.40				
2.5	0.45				
3	0.50				
4	0.70				
5	0.80				
6	1.0		1/4	20	28
8	1.25	1.0	5/16	18	24
10	1.5	1.25	3/8	16	24
12	1.75	1.5	1/2	13	20

6.2.2 Basic dimensions

Basic dimensions of machine screws shall conform to Tables 3-7.

Table 3 - Slotted and cross and square recessed flat countersunk head machine screws

All dimensions in millimeters

Nominal screw size and thread pitch	Slotted and style A		Style B	Head Diameter, <i>D_K</i>	
	Body diameter, <i>D_S</i>		Body diameter, <i>D_S</i>	Theoretical sharp	
	Max	Min	Min	Max	Min
M2x0.4*	2.00	1.65	1.65	4.4	4.1
M2.5x0.45	2.50	2.12	2.12	5.5	5.1
M3x0.5	3.00	2.58	2.58	6.3	5.9
M3.5x0.6	3.50	3.00	3.00	8.2	7.7
M4x0.7	4.00	3.43	3.43	9.4	8.9
M5x0.8	5.00	4.36	4.36	10.4	9.8
M6x1.0	6.00	5.21	5.21	12.6	11.9
M8x1.25	8.00	7.04	7.04	17.3	16.5
M10x1.5	10.00	8.86	8.86	20.0	19.2

NOTE All recessed head heat-treated steel screws of property class 9.8 or higher strength have the Style B head form. Recessed head screws other than those specifically designated to be Style B have the Style A head form.

* This size is not specified for Type III square recessed flat countersunk heads; Type II cross recess is not specified for any size.

Table 4 - Slotted and cross and square recessed oval countersunk head machine screws

All dimensions in millimeters

Nominal screw size and thread Pitch	Body diameter, D_S		Head diameter, D_K	
	Max	Min	Max	Min
M2x0.4*	2.00	1.65	4.4	4.1
M2.5x0.45	2.50	2.12	5.5	5.1
M3x0.5	3.00	2.58	6.3	5.9
M3.5x0.6	3.50	3.00	8.2	7.7
M5x0.8	5.00	4.36	10.4	9.8
M6x1.0	6.00	5.21	12.6	11.9
M8x1.25	8.00	7.04	17.3	16.5
M10x1.5	10.00	8.86	20.0	19.2

* This size is not specified for Type III square recessed oval countersunk heads; Type cross recess is not specified for any size.

Table 5 - Slotted and cross and square recessed pan head machine screws

All dimensions in millimeters

Nominal screw size and thread pitch	Body diameter, D_S		Head diameter, D_K	
	Max	Min	Max	Min
M2x0.4*	2.00	1.65	4.0	3.7
M2.5x0.45	2.50	2.12	5.0	4.7
M3x0.5	3.00	2.58	5.6	5.3
M3.5x0.6	3.50	3.00	7.0	6.6
M4x0.7	4.00	3.43	8.0	7.6
M5x0.8	5.00	4.36	9.5	9.1
M6x1.0	6.00	5.21	12.0	11.5
M8x1.25	8.00	7.04	16.0	15.5
M10x1.5	10.00	8.86	20.0	19.4

* This size is not specified for Type III square recessed pan heads, Type II recess is not specified for any size.

Table 6 - Hexagonal head machine screws

All dimensions in millimeters

Nominal screw size and thread pitch	Body diameter, D_S		Width across flats, S		Width across corners, E
	Max	Min	Max	Min	Min
M2x0.4	2.00	1.65	3.20	3.02	3.38
M2.5x0.45	2.50	2.12	4.00	3.82	4.28
M3x0.5	3.00	2.58	5.00	4.82	5.40
M3.5x0.6	3.50	3.00	5.50	5.32	5.96
M4x0.7	4.00	3.43	7.00	6.78	7.59
M5x0.8	5.00	4.36	8.00	7.78	8.71
M6x1.0	6.00	5.21	10.00	9.78	10.95
M8x1.25	8.00	7.04	13.00	12.73	14.26
M10x1.5	10.00	8.86	16.00	15.73	17.62
M12x1.75	12.00	10.68	18.00	17.73	19.86

Table 7 - Hexagonal flange head machine screws

All dimensions in millimeters

Nominal screw size and thread pitch	Body diameter, D_S		Width across flats, S		Width across corners, E
	Max	Min	Max	Min	Min
M2x0.4	2.00	1.65	3.00	2.84	3.16
M2.5x0.45	2.50	2.12	3.20	3.04	3.39
M3x0.5	3.00	2.58	4.00	3.84	4.27
M3.5x0.6	3.50	3.00	5.00	4.82	5.36
M4x0.7	4.00	3.43	5.50	5.32	5.92
M5x0.8	5.00	4.36	7.00	6.78	7.55
M6x1.0	6.00	5.21	8.00	7.78	8.66
M8x1.25	8.00	7.04	10.00	9.78	10.89
M10x1.5	10.00	8.86	13.00	12.72	14.16
M12x1.75	12.00	10.68	15.00	14.72	16.38

6.2.3 Available length

For flat countersunk head screws and oval countersunk head screws, the nominal length is the distance from the upper surface of the head to the extreme end of the shank including the chamfer, radius, or cone point. For hexagonal, hexagonal flange, and pan head the nominal length is the distance from the underside of the head to the extreme end of the shank, including chamfer, radius, or cone point. Recommended nominal length of machine screws shall conform to Table 8.

Table 8 - Recommended nominal screw length for machine screws

Nominal screw length, mm	Nominal screw size, mm									
	M2	M2.5	M3	M3.5	M4	M5	M6	M8	M10	M12
2.5	PH									
3	X	PH								
4	X	X	PH							
5	X	X	X	PH						
6	X	X	X	X	PH					
8	X	X	X	X	X	PH				
10	X	X	X	X	X	X	X			
13	X	X	X	X	X	X	X	X		
16	X	X	X	X	X	X	X	X	X	
20	X	X	X	X	X	X	X	X	X	H
25		X	X	X	X	X	X	X	X	H
30			X	X	X	X	X	X	X	H
35				X	X	X	X	X	X	H
40					X	X	X	X	X	H
45						X	X	X	X	H
50						X	X	X	X	H
55							X	X	X	H
60							X	X	X	H
65								X	X	H
70								X	X	H
80								X	X	H
90									X	H

NOTE X - Signifies screws of all head styles covered in this standard.
P - Signifies pan head screws.
H - Signifies hexagonal and hexagonal flange head screws.

7 Setscrews

7.1 Nomenclature

Nomenclature and designation of dimensions of setscrews shall be as illustrated in Figures 9 and 10.

7.2 Dimensions

7.2.1 Pitch

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

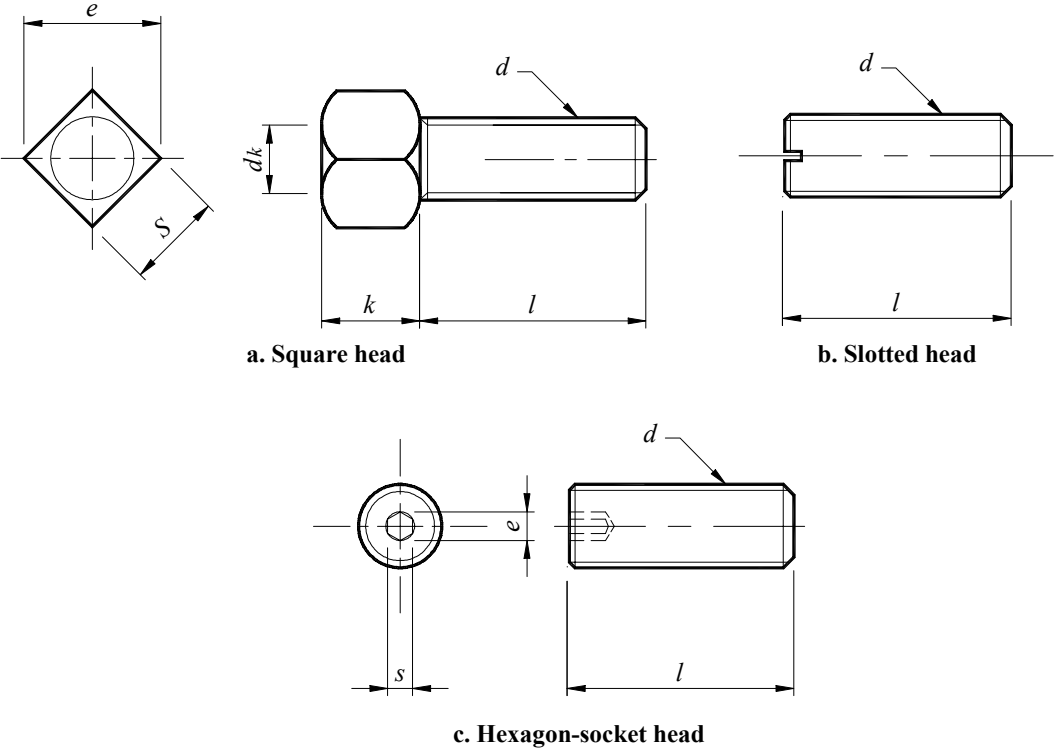


Figure 9 – Nomenclature and types of setscrew head

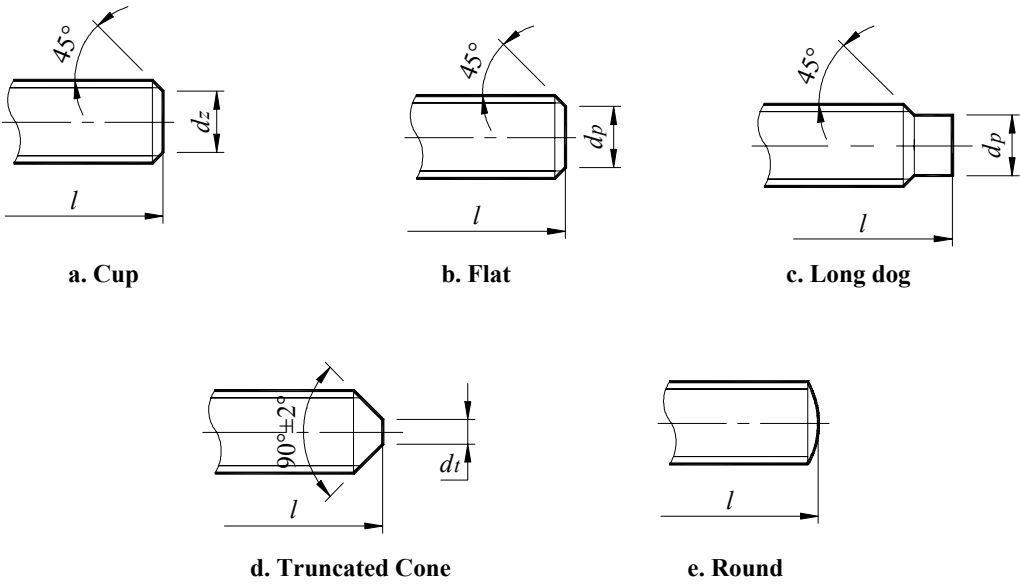


Figure 10 – Types of setscrew point

7.2.2 Basic dimensions

Basic dimensions of setscrews shall conform to Tables 9 and 10.

Table 9 – Hexagon head setscrews

Nominal screw size and thread pitch	Width across flats, <i>S</i>		Width across corners, <i>E</i>	Nominal screw size and thread pitch	Width across flats, <i>S</i>		Width across corners, <i>E</i>
	Max	Min	Min		Max	Min	Min
M2x0.4	0.902	0.889	1.003	M6x1.0	3.071	3.020	3.44
M2.5x0.45	1.295	1.270	1.427	M8x1.25	4.084	4.020	4.58
M3x0.5	1.545	1.520	1.73	M10x1.5	5.084	5.020	5.72
M4x0.7	2.045	2.020	2.3	M12x1.75	6.095	6.020	6.86
M5x0.8	2.560	2.520	2.87				

Table 10 – Square head setscrews

Nominal screw size and thread pitch	Width across flats, <i>S</i>		Width across corners, <i>E</i> ²	Nominal screw size and thread pitch	Width across flats, <i>S</i>		Width across corners, <i>E</i>
	Max	Min	Min		Max	Min	Min
M4x0.7	4	4.97	3.82	M8x1.25	8	10.10	7.78
M5x0.8	5	6.27	4.82	M10x1.5	10	12.70	9.78
M6x1.0	6	7.37	5.82	M12x1.75	12	15.20	11.73

7.2.3 Available length

Recommended nominal length of setscrews shall conform to Table 11-13.

Table 11 – Available length for slotted setscrews

Length, <i>l</i>	Nominal diameter, <i>D</i>									
	M2	M2.5	M3	M3.5	M4	M5	M6	M8	M10	M12
2	AD									
2.5	C	AD								
3	X	BC	ACD							
4	X	X	B	ACD	ACD					
5	X	X	X	X	ACD	ACD				
6	X	X	X	X	X	ACD	ACD			
8	X	X	X	X	X	X	X	ACD		
10	X	X	X	X	X	X	X	X	ACD	
12		X	X	X	X	X	X	X	X	ACD
16			X	X	X	X	X	X	X	X
20				X	X	X	X	X	X	X
25						X	X	X	X	X
30							X	X	X	X
35								X	X	X
40								X	X	X
45									X	X
50									X	X
55										X
60										X

NOTE X – Signifies screws of all types of point for slotted setscrews covered in this standard.
 A – Signifies slotted head setscrews with flat point.
 B – Signifies slotted head setscrews with truncated cone point.
 C – Signifies slotted head setscrews with cup point.
 D – Signifies slotted head setscrews with rounded end.

Table 12 – Available length for square-head setscrews

Length, <i>l</i>	Nominal diameter, <i>D</i>					
	M4	M5	M6	M8	M10	M12
6	X**					
8	X	X*				
10	X	X	X*			
12	X	X	X	X*		
16	X	X	X	X	X**	
20		X	X	X	X	X**
25			X	X	X	X
30				X	X	X
35					X	X
40					X	X
45						X
50						X

NOTE X – Signifies screws of all types of point for square head setscrews covered in this standard.
 ** – Shall not be used for truncated cone point and long dog point.
 * – Shall not be used for long dog point.

Table 13 – Available length for hexagon socket head setscrews

Length, <i>l</i>	Nominal diameter, <i>D</i>								
	M2	M2.5	M3	M4	M5	M6	M8	M10	M12
2	ABC	AC	A						
2.5	X	ABC	ABC	A					
3	X	X	ABC	ABC	A				
4	X	X	X	ABC	ABC	A			
5	X	X	X	X	ABC	ABC	A		
6	X	X	X	X	X	ABC	ABC	A	
8	X	X	X	X	X	X	X	ABC	A
10	X	X	X	X	X	X	X	X	ABC
12		X	X	X	X	X	X	X	X
16			X	X	X	X	X	X	X
20				X	X	X	X	X	X
25					X	X	X	X	X
30						X	X	X	X
35							X	X	X
40							X	X	X
45								X	X
50								X	X
55									X
60									X

NOTE X – Signifies screws of all types of point for hexagon socket setscrews covered in this standard.
 A – Signifies hexagonal head setscrews with flat point.
 B – Signifies hexagonal head setscrews with truncated cone point.
 C – Signifies hexagonal head setscrews with cup point.

8 Materials

Mechanical properties of steel screws shall conform to Table 14. Table 15 and 16 specifies the minimum tensile load for steel and non-ferrous screws, respectively.

Table 14 – Mechanical properties of steel screws

Grade designation			Nominal diameter (mm)	Min. tensile strength (MPa)	Brinell hardness	Material
Metric*	SAE	ASTM				
4.6	1	A307	M5-M36	400	207	Low or medium carbon
4.8	2	A307	M1.6-M16	420	241	Low or medium carbon
5.8	3		M5-M24	500	269	Low or medium carbon
8.8	5	A 449 or A325 type 1	M16-M36	800	302	Medium-carbon, quenched and tempered
9.8			M1.6-M16	900	321	Medium-carbon, quenched and tempered
10.9	8	A354 Grade BD	M5-M36	1040	352	Low-carbon martensite, quenched and tempered
12.9		A574	M1.6-M36	1200		Alloy, quenched and tempered

*Metric grade is xx.x where xx is approximately one-hundredth of the minimum tensile strength in N/mm² and .x is the ratio of the minimum yield strength to the minimum tensile strength

Table 15 - Minimum tensile load of steel screws

Dimensions in Newtons

Material classification	Diameter x pitch									
	M2 x 0.4	M2.5 x 0.45	M3 x 0.5	M3.5 x 0.6	M4 x 0.7	M5 x 0.8	M6 x 1.0	M8 x 1.25	M10 x 1.5	M12 x 1.75
4.6	828	1,356	2,012	2,712	3,512	5,680	8,040	14,640	23,200	33,720
4.8	869	1,424	2,113	2,848	3,688	5,964	8,442	15,372	24,360	35,406
5.8	1,035	1,695	2,515	3,390	4,390	7,100	10,050	18,300	29,000	42,150
8.8	1,656	2,712	4,024	5,424	7,024	11,360	16,080	29,280	46,400	67,440
9.8	1,863	3,051	4,527	6,102	7,902	12,780	18,090	32,940	52,200	75,870
10.8	2,153	3,526	5,231	7,051	9,131	14,768	20,904	38,064	60,320	87,672
12.9	2,484	4,068	6,036	8,136	10,536	17,040	24,120	43,920	69,600	101,160

Table 16 – Minimum tensile load of non-ferrous metal screws

Dimensions in Newtons

Material symbol	Diameter x pitch									
	M2 x 0.4	M2.5 x 0.45	M3 x 0.5	M3.5 x 0.6	M4 x 0.7	M5 x 0.8	M6 x 1.0	M8 x 1.25	M10 x 1.5	M12 x 1.75
CU1	497	814	1,210	1,630	2,110	3,410	4,820	8,780	13,920	20,230
CU2	911	1,490	2,210	2,980	3,860	6,250	8,840	13,540	21,460	31,190
CU3	911	1,490	2,210	2,980	3,860	6,250	8,840	13,540	21,460	31,190
CU4	973	1,590	2,360	3,190	4,130	6,670	9,450	17,200	27,260	39,620
CU5	1,220	2,000	2,970	4,000	5,180	8,380	11,860	21,590	34,220	49,740
CU6	-	-	-	-	-	-	-	16,100	25,520	37,090
CU7	-	-	-	-	-	-	-	-	-	-
AL1	559	915	1,360	1,830	2,370	3,830	5,430	9,880	15,660	21,080
AL2	642	1,050	1,560	2,100	2,720	4,400	6,230	11,350	17,980	26,130
AL3	662	1,000	1,610	2,170	2,810	4,540	6,430	11,350	17,980	26,130
AL4	867	1,420	2,110	2,850	3,690	5,960	8,440	15,370	24,360	32,030
AL5	952	1,560	2,310	3,120	4,040	6,530	8,250	16,840	26,680	38,780
AL6	1,060	1,760	2,570	3,460	4,480	7,240	10,250	18,670	29,580	42,990

9 Coatings

Coatings or special finishing for fasteners shall conform to Table 17. 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 17 – 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

10 Designation

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

EXAMPLE M8x1.25x30, Slotted Pan Head Machine Screw, Grade 4.8 Steel, Zinc plated

11 Spacing

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

12 Selection between fine and coarse thread series

12.1 The 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.

12.2 The fine thread series shall be used in automotive and aircraft work; especially where jar and vibration (tending to loosen the nut) are present (e.g. pump impeller). This thread series shall not be recommended for brittle materials.

13 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 Clearance holes

Specifications for clearance holes are presented in Table 18. 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 screw 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 18 – Clearance holes for screws

Dimensions in millimeters

Thread diameter, d	Clearance hole, d_h			Thread diameter, d	Clearance hole, d_h		
	Close	Normal, preferred	Loose		Close	Normal, preferred	Loose
2	2.2	2.4	2.6	5	5.3	5.5	5.8
2.5	2.7	2.9	3.1	6	6.4	6.6	7
3	3.2	3.4	3.6	8	8.4	9	10
3.5	3.7	3.9	4.2	10	10.5	11	12
4	4.3	4.5	4.8	12	13	13.5	14.5

15 Washers

Use washers as specified in PAES 314:2002.

16 Markings

16.1 The following information shall be marked on the packaging:

- a) Manufacturer's name, trademark and address
- b) Screw designation

16.2 The metric grade designation shall be engraved/embossed on the head of the screw (for hex and hex flange screw)

17 Safety

17.1 Apply proper tension/torque during assembly.

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

17.3 Use appropriate tools for fastening screws. All slotted machine screw should be driven by an ordinary screw driver, Phillips screw driver should be used to drive a cross recess screw.

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

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