AJAX FASTENERS

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Ajax Fasteners

Designed and produced by R.W.Graphics Pty Ltd.

Note: Due to research and development, products are continually improved.
This may lead to the specifications being changed without notice.

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Foreword

Ajax Fasteners is Australia's largest manufacturer and distributor of quality industrial fasteners. When specifying Ajax products you are protected, not only by the appropriate headmarks that conform to Australian standards, but by the unique Tracelink® system which covers the Ajax Fasteners High Tensile and Structural range.

This Handbook has been prepared by Ajax Fasteners to provide users of fasteners with dimensional and technical details of standard products which are in regular production. General technical information relating to bolt and thread specifications, breaking loads, finishes, bolted joint design and tightening practices are also included.

While the items shown in table 1 are those in regular production at the publication date and the commonly used sizes are normally stocked, this Handbook is not a stock list. An inquiry should be made as to stock availability on specific products when planning a new project, from your Ajax Fasteners Accredited Distributor.

Ajax bolts and nuts are, in most cases manufactured to meet the requirements of the appropriate Australian Standard. American DIN or British Standards are adopted for some products not covered by an Australian Standard. The Ajax Standard for products not covered by any of these National Standards adopts/sets the dimensions and properties in common usage in the Australian Engineering Industry.

In many cases, products made to different nations standards are identical or such differences as exist do not affect functional interchangeability.

The range of fasteners listed in this Handbook will be found to satisfy the majority of applications, but where a special part is required Ajax Fasteners Technical Staff are available to advise on selection and design of the most suitable product. A large number of special fasteners are produced regularly for a wide range of applications.

Ajax Fasteners is also equipped to produce small

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Thread Forms and Fits

All standard Ajax screw threads are made in accordance with the latest issues of the thread specifications shown in Table 2. Other dimensional features conform with the specifications listed in Table 1.

Standard products unless specifically requested are manufactured to the Australian Standard (AS) specifications which are designed to ensure interchangeability with corresponding International (ISO) American (ANSI/ASME) and British (BS) standards.

Table 2 Thread Specifications

Screw thread system	Specification	Title
British Standard Whitworth B.S.W.	AS 3501-1987	Parallel Screw Threads of Whitworth Form
Unified National Fine UNF	AS 3635 -1990	Unified Screw Threads
Unified National Coarse UNC		
ISO Metric Coarse Pitch Series	AS 1275 -1985	Metric Screw Threads for Fasteners
ISO Metric Fine Pitch Series	AS 1721-1985	General Purpose Metric Screw Threads

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Testing of Bolts and Nuts

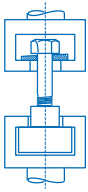

FIGURE 7

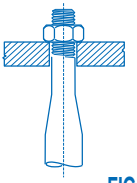

FIGURE 8

The normal mechanical properties of metals; tensile strength, proof stress, 0.2% yield stress, elongation, reduction of area; are determined on reduced section (proportional) test pieces. While these properties and testing methods can be applied to bolt materials, it is the usual practice to test bolts in their full size to more adequately reproduce the conditions under which they will be used in service. This procedure of tensile testing bolts in their full size is recognised and adopted by many standardizing bodies, including the International Organization for Standardization **(ISO),** British Standards Institution, Standards Association of Australia, American Society for Testing and Materials **(ASTM)** and Society of Automotive Engineers **(SAE).**

The bolt is screwed into a tapped attachment (Figure 7) with six full threads exposed between the face of the attachment and the unthreaded shank. The bolt head is initially supported on a parallel collar for the proof load test, and a tapered or wedge collar for the second stage when it is broken in tension.

In this test, the bolt load is calculated from the tensile strength of the material, and the Tensile Stress Area of the thread. The Tensile Stress Area is the area calculated is based on the mean of the minor and pitch diameters of the thread. Tensile Stress Areas for common sizes and thread forms will be found in Tables 5-14.

The test, as indicated above, is carried out in two stages:

(1) Proof Load Test.

This consists of applying a proof load (derived from a "proof load" stress) with the bolt head supported on a parallel collar. The bolt length is measured accurately before and after application of the proof load. It is required that the bolt shall not have permanently extended. A 0.0005" or 12.5 micrometers allowance is made for errors of measurements. This test provides a guide to the load to which the bolt will behave elastically.

(2) Wedge Tensile Test.

The bolt is assembled as described previously but with the head supported on a tapered wedge collar. The angle of the wedge is varied for bolt diameter and grade, and for bolts with short or no plain shank length, but in most cases for bolts up to 1" or 20mm diameter it is 10°. The bolt is loaded

Testing of Bolts and Nuts

until it fractures, and the breaking load must be above the specified minimum. The load is calculated from the tensile strength of the material and the Tensile Stress Area of the thread.

The test requires that, in addition to meeting the specified minimum breaking load, fracture must occur in the thread or plain shank with no fracture of the head shank junction. The bolt head must, therefore, be capable of conforming with the required wedge taper angle without fracturing at its junction with the shank. This latter requirement provides a very practical test for ductility.

Where the capacity of available testing equipment does not permit testing of bolts in full size, a hardness test is carried out. This is performed on a cross section through the bolt thread at a distance of 1 x diameter from the end.

(3) Proof Load Test for Nuts.

The preferred method of testing nuts follows that of bolts in adoption of a test in full size to measure the load which the nut will carry without its thread stripping. This is also referred to as a Proof Load Test and it was traditional for the nut "Proof Load Stress" to be the same as the specified minimum tensile strength of the mating bolt. This "rule of thumb" still applies for products to the older standards such as BSW commercial and unified high tensile precision nuts. Metric nuts to AS 1112 – 1980 were designed with greater knowledge of bolt/nut assembly behaviour to satisfy the functional requirement that they could be used to tighten (by torque), a mating bolt of the same strength class up to its actual (not specification minimum) yield stress without the assembly failing by thread stripping. To satisfy this design requirement both the thickness/diameter ratio and proof load stress were increased and now vary with diameter.

The nut is assembled on a hardened, threaded mandrel (Figure 8) and the proof load applied in an axial direction. The nut must withstand this load without failure by stripping or rupture, and be removable from the mandrel after the load is released.

Again, where nut proof loads exceed the capacity of available testing equipment, it is usual to carry out hardness tests on the top or bottom face of the nut.

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Strength-Grade Designations for American Standard Fasteners

Table 4 American SAE Standard (AS 2465 is identical for Grades 2, 5, 8 only).

SAE Grade	Head Marking	Diameter	Tensile Strength lbf/in² (min.)	"Proof Load" Stress lbf/in²	Rockwell Hardness
1 (Note 6)		1/4" to 1.1/2"	60,000	33,000	B70-B100
2 (Note 6)		1/4" to 3/4" Over 3/4" to 1.1/2"	74,000 60,000	55,000 33,000	B80-B100 B70-B100
4 (Note 6)	None (studs only)	1/4" to 1.1/2"	115,000	65,000	C22-C32
5 (Note 1)		1/4" to 1" Over 1" to 1.1/2"	120,000 105,000	85,000 74,000	C25-C34 C19-C30
5.1 (Note 2 & 6)		No.6 to 5/8"	120,000	85,000	C25-C40
5.2 (Note 3 & 6)		1/4" to 1"	120,000	85,000	C26-C36

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Strength-Grade Designations for American Standard Fasteners

Table 4 Continued, American SAE Standard (AS 2465 is identical for Grades 2, 5, 8 only).

SAE Grade	Head Marking	Diameter	Tensile Strength lbf/in² (min.)	"Proof Load" Stress lbf/in²	Rockwell Hardness
7 (Note 4 & 6)		1/4" to 1.1/2"	133,000	105,000	C28-C34
8 (Note 5)		1/4" to 1.1/2"	150,000	120,000	C33-C39
8.1 (Note 6)	None (studs only)	1/4" to 1.1/2"	150,000	120,000	C32-C38
8.2 (Note 6)		1/4" to 1"	150,000	120,000	C33-C39

Notes:

1. Medium carbon steel, quenched and tempered.
2. Sems (captive washer) assemblies. These are of low or medium carbon steel, quenched and tempered.
3. Low carbon boron steel, quenched and tempered.
4. Medium carbon alloy steel, quenched and tempered. Thread rolled after heat treatment.
5. Medim carbon alloy steel, quenched and tempered.
6. Not available from stock.

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Breaking and Yield Loads of Ajax Bolts and Set Screws

Ajax Metric Hexagon Precision
Bolts and Set Screws
(AS 1110-1995 / AS 4291.1-1995 Property Class 10.9)

Table 12

Based on:

Tensile Strength	=	1040 MPa min	(150340 lbf/in^2)	Sizes M5 – M39 incl.
Yield Stress	=	940 MPa min	(136340 lbf/in^2)	Sizes M5 – M39 incl.
Proof Load Stress	=	830 MPa	(120330 lbf/in^2)	Sizes M5 – M39 incl.

Size	Tensile Stress Area of Thread*	Proof Load of Bolt		Breaking Load of Bolt (Min.)	
	mm^2	kN	lbf	kN	lbf
M5	14.2	11.8	2655	14.8	3325
M6	20.1	16.7	3755	20.9	4700
M8	36.6	30.4	6835	38.1	8565
M10	58.0	48.1	10810	60.3	13555
M12	84.3	70	15750	87.7	19720
M14	115	95.5	21470	120	26970
M16	157	130	29225	163	36650
M18	192	159	35750	200	44960
M20	245	203	45650	255	57330
M22	303	252	56650	315	70820
M24	353	293	65870	367	82510
M27	459	381	85650	477	107230
M30	561	466	104760	583	131060
M33	694	570	128140	722	162310
M36	817	678	152420	850	191090
M39	976	810	182100	1020	229310

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Design of Bolted Joints for General Engineering

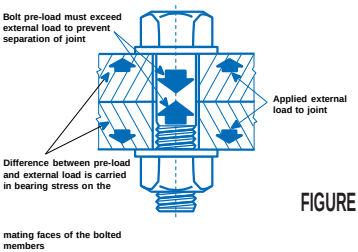

FIGURE 9

Selection of Tensile Strength of Bolts

Bolted joints in which strength is the main design consideration, can, in most cases, be more economically designed when a high tensile bolt is used rather than a mild steel bolt. Fewer bolts can be used to carry the same total load, giving rise to savings not only from the cost of a smaller number of bolts, but also machining where less holes are drilled and tapped, and assembly where less time is taken.

Selection of Coarse and Fine Threads

In practically all cases the coarse thread is a better choice. The course threads provide adequate strength and great advantages in assembly over fine threads. The former are less liable to become cross threaded, start more easily, particularly in awkward positions, and require less time to tighten.

In cases where fine adjustment is needed, the fine thread should be used. Providing bolts are tightened to the torque specified in tables 21-26 there should be no tendency to loosen under conditions of vibration with either coarse or fine threads.

Types of Loading on Joints

Examine the forces being applied to the joint to decide which of the following types fits the conditions.

a) Joints carrying direct tensile loads (See Fig. 9).

b) Joints carrying loads in shear (See Fig. 10-11). Types 1 and 2.

c) Flexible gasket joints for sealing liquids or gases under pressure (See Fig. 12).

Joints Carrying Direct Tensile Loads

(1) Safety Factor. Apply a safety factor according to the nature of the loading. Except in the case of the flexible gasket joint, the safety factor on a bolt differs from most other applications in that it does not affect the stress of the bolt, but refers to the factor by which the sum of the preload on all the bolts comprising the joint exceeds the design load applied. Regardless of the nature of the load, the bolts should still be preloaded to 65% of their yield stress using the recommended torque values as set out in table 21-26.

Design of Bolted Joints for General Engineering

$$\text{Safety Factor} = \frac{\text{Sum of preload on all the bolts comprising the joint}}{\text{Design applied load}}$$

For design purposes, the preload on each bolt should be taken according to the bolt size and bolt material as shown in Tables 21 to 26 and the safety factor selected from the following table:—

Table 17

Nature of Loading	Safety Factors*
Steady Stress	1.5 – 2
Repeated Stress gradually applied shock	2 – 3.5 4.5 – 6

**Applies to joints with direct tensile loads only, and assumes all bolts are tightened to 65% of the yield stress.*

(2) Total Required Preload†.

Determine this from safety factor (S) and applied load (L).
Total required preload F = S x L

(3) Selection of Bolt Material, Bolt Size, Number of Bolts.

By selecting a suitable bolt size and bolt material, the required number of bolts can be determined from —

$$N = \frac{F}{f}$$

Where N is the number of bolts, F is the total required preload and f is the recommended preload (see Tables 21-26) on the bolt for the particular size and material selected.

(4) Specify Tightening Torque.

Ensure that the bolts are fully tightened to the torque recommended in Tables 21-26 for the particular bolt size and material.

(5) Positioning of the Bolts.

The bolts should be placed as near as possible to the line of direct tensile load. By doing this, secondary bending stresses in the bolts and bolted members are reduced to a minimum.

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†**Note:** At time of publication there are no "Allowable Stress" code provisions for general mechanical engineering design of bolted joints. This information is provided for guidance only.

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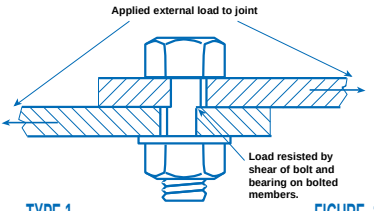
Design of Bolted Joints for General Engineering



TYPE 1 FIGURE 10

Joints Carrying Loads in Shear

The design procedure for mechanical joints carrying this type of loading can be based on the well established practice laid down for structural joints carrying static loads, provided the design loads are increased by adequate factors to allow for cyclic loads, shock and other identifiable loads. These factors will vary considerably according to the application, and must be based on the designer's experience. Bolted joints carrying loads in shear fall into two types:—

1. Joints in which the load is transferred through the bolted members by bearing of the member on the shank of the bolt and shear in the bolt.
2. Friction type joints, where the load is transferred by the friction developed between the members by the clamping action of the bolts.

Load Transfer by Bearing and Shear.

Such joints may be designed using allowable values for shear in the bolts and bearing on the joint members such as those given under the limit states provisions of AS4100. Guidance on bolt shear capacity is given on page 37-40. The lowest strength, whether it be in shear or bearing, is used to compute the required number of bolts to carry the design load.

The allowable values for shear and bearing depend not only on bolt size, but also on the tensile strength of the bolt, and whether the bolt is in a close fitting machined hole (not greater than 0.25mm clearance) or is fitted in a clearance hole (up to 2-3mm clearance).

Careful consideration should be given to the properties of the material in the bolted members to ensure they are capable of withstanding bearing loads. Tensile strength and yield stress of Ajax bolts can be obtained from Tables 5-14. Care must be taken that the pitch of the bolt spacing is sufficient to ensure that the bolted members are not weakened by the bolt holes to the extent that they cannot safely carry the load. To achieve this it may be necessary to use more than one row of bolts. Staggering of bolt holes can minimise reduction of member capacity. If more than two members are bolted together slightly higher values are permitted in bearing on the central member, and the area considered for calculating strength in shear is increased by two or four times for bolts in double or quadruple shear.

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Metric Hexagon Precision Bolts and Set Screws

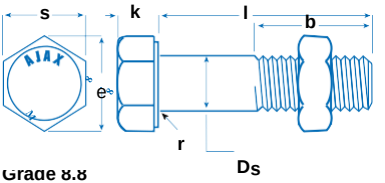

FIGURE 36

Thread, ISO Metric Coarse Series, Class 6g, Property Class 8.8 & 10.9 Dimensions to AS 1110-1995

Table 43

Size D	Pitch of Thread	Body Diameter Ds		Width Across Flats s		Head Thickness k		Across Corners e
		Max.	Min.	Max.	Min.	Max.	Min.	Min.
M5	0.8	5.0	4.82	8.0	7.78	3.65	3.35	8.79
M6	1.0	6.0	5.82	10.0	9.78	4.15	3.85	11.06
M8	1.25	8.0	7.78	13.0	12.73	5.45	5.15	14.38
M10	1.5	10.0	9.78	16.0	15.73	6.58	6.22	17.77
M12	1.75	12.0	11.73	18.0	17.73	7.68	7.32	20.03
M14	2.0	14.0	13.73	21.0	20.67	8.98	8.62	23.35
M16	2.0	16.0	15.73	24.0	23.67	10.18	9.82	26.75
M18	2.5	18.0	17.73	27.0	26.67	11.72	11.28	30.14
M20	2.5	20.0	19.67	30.0	29.67	12.72	12.28	33.53
M22	2.5	22.0	21.67	34.0	33.38	14.22	13.78	37.72
M24	3.0	24.0	23.67	36.0	35.38	15.22	14.78	39.98
M27	3.0	27.0	26.67	41.0	40.38	17.05	16.35	45.63
M30	3.5	30.0	29.67	46.0	45.00	19.12	18.28	50.85
M33	3.5	33.0	32.61	50.0	49.00	20.92	20.08	55.37
M36	4.0	36.0	35.61	55.0	53.80	22.92	22.08	60.79
(M39)	4.0	39.0	38.61	60.0	58.80	25.42	24.53	66.44

All dimensions in Millimetres

( ) AS1110 covers sizes to M36 only. Data for sizes above this is given for information only.

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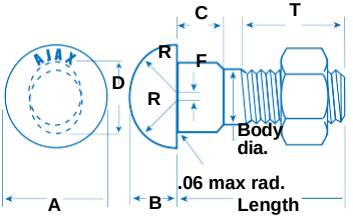
Cup Oval Fishbolts



Threads BSW Free Class
Dimensions to ASE25

FIGURE 46

Table 55(a)

Size	Thrds per Inch	Body Diameter		Head Diameter A		Head Depth		Depth of Oval Neck C		Width of Oval Neck D		Flat on Head F	Rad. R
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Min.	Max.	Nom.	Nom.
7/8	9	0.890	0.860	1.656	1.594	0.781	0.719	0.781	0.719	1.156	1.094	0.125	0.750

For nut dimensions refer to page 101. All dimensions in inches.

Threads ISO Metric Coarse
Dimensions to AS 1085.4-1997

Table 55(b)

Size	Thread pitch	Body Diameter		Head Diameter A		Head Depth		Depth of Oval Neck C		Width of Oval Neck D		Flat on Head F	Rad. R
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Min.	Max.	Nom.	Nom.
M24	3.0	24.8	23.6	46.0	43.0	20	18	20	18	30.5	32.5	–	1

For nut dimensions refer to page 82. All dimensions in millimetres.

Heat Treated Fishbolts

Tensile Strength: 150,000 lbf/in^2 min (1034 MPa)

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Elevator Bolts Four Peg

Threads BSW Free Class

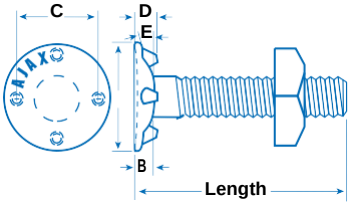

FIGURE 47

Table 56

Size	Threads per Inch	Head Diameter A		Head Depth B		Pitch Dia. of Pegs C		Length of Peg D		Angle Under Head E	
		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
1/4	20	0.697	0.667	0.120	0.100	0.510	0.490	0.156	0.136	17°	13°
5/16	18	0.859	0.829	0.160	0.140	0.635	0.615	0.194	0.174	22°	18°
3/8	16	1.077	1.047	0.194	0.174	0.760	0.740	0.237	0.217	24°	20°

Mechanical Properties:

All dimensions in inches
Tensile Strength: 28 tonf/in^2.
Supplied with nut and washer.

For nut dimensions refer to page 101. All dimensions in inches.

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Hardness Conversion Table

table 71 continued

Vickers Hardness	Rockwell C-Scale 150 kg Load Brale Penetrator	Rockwell B-Scale 100kg Load 1/16" dia. Ball	Brinell Hardness No. 3000kg Load 10mm Ball	Tensile Strength (Approximate)			Shore Sclero scope Hardness No.	Rockwell A-Scale 60 kg Load Brale Penetrator	Rockwell D-Scale 100kg Load Brale Penetrator	Rockwell Superficial Hardness No. Superficial Brale Penetrator		
										15-N Scale 15 kg Load	30-N Scale 30kg Load	45-N Scale 45 kg Load
HV	HRC	HRB	HB	lbf/in² x 1000	tonf/in²	N/mm²		HRA	HRD	HR 15-N	HR 30-N	HR 45-N
528	51	—	496	264	118	1820	68	76.3	63.8	85.9	69.4	56.1
513	50	—	481	255	114	1760	67	75.9	63.1	84.4	68.5	55.0
498	49	—	469	246	110	1700	66	75.2	62.1	85.0	67.0	53.8
484	48	—	451	237	106	1630	64	74.7	61.4	84.5	66.7	52.5
471	47	—	442	229	102	1580	63	74.1	60.8	83.9	65.8	51.4
458	46	—	432	222	99	1530	62	73.6	60.0	83.5	64.8	50.3
446	45	—	421	215	96	1480	60	63.1	57.2	83.0	64.0	49.0
434	44	—	409	208	93	1430	58	72.5	58.5	82.5	63.1	47.8
423	43	—	400	201	90	1390	57	72.0	57.6	82.0	62.2	46.7
412	42	—	390	194	86.5	1340	56	71.5	56.9	81.5	61.3	45.5
402	41	—	381	188	84	1300	55	70.9	46.2	80.9	60.4	44.3
392	40	—	371	181	81	1250	54	70.4	45.4	80.4	59.4	43.1
382	39	—	362	176	78.5	1210	52	69.7	54.6	79.0	58.6	41.9
372	38	—	353	171	76.5	1180	51	69.4	53.8	77.4	57.7	40.8
363	37	—	344	168	75	1160	50	68.9	53.1	68.8	56.8	39.6
354	36	(109.0)	336	162	72.5	1120	49	68.4	52.3	78.3	55.9	38.4
345	35	(108.5)	327	157	70	1080	48	67.7	51.5	77.7	55.0	37.2

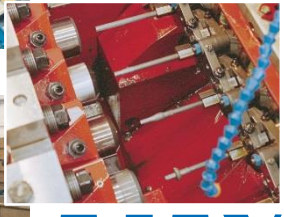
Don't risk it!

SPECIFY AJAX

AJAX FASTENERS NEW PLANT
BRAESIDE VICTORIA.

THE NEDSCHROEF NB416

FORMAX BOLTMAKER



THE NEDSCHROEF BV6

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