

# MATERIAL ALLOWABLE STRENGTH DATA

## Design Allowables Data Sheet

- A Metallic Materials
- B Threaded Fasteners
- C Wire Ropes and Cables
- D Wood
- E Rivets

Issue Status		
Iss No.	Date	Change Description
1	29/06/06	Initial Issue, Metallic Materials Only
2	11/07/06	Following Sections Added: Threaded Fasteners Wire Ropes & Cables Wood
3	07/06/07	Following Section Added: Rivets
4	27/06/07	Notes on Blind Rivets added.  Following Steels Added:  S510 S514 S515 T45

## MATERIAL ALLOWABLE STRENGTH DATA

5	01/11/07	Correction to lb.in to N.mm conversion factor. Affects bolt and plywood bending allowables.
6	18/01/08	Notes on 4340 temper levels added
7	14/02/14	

# MATERIAL ALLOWABLE STRENGTH DATA

## A Metallic Materials

### IMPORTANT: Guidelines For Use

1. The Design Allowable strengths presented here are taken from Data Sources acceptable to the LAA.

Within each material designation, considerable variation in properties may occur, due to the factors listed below. The values chosen represent the worst case figures from all of the cases provided by the relevant Data Sources.

As worst case data is provided, it may be possible for any specific case, to find allowables considerably higher than those given. Using low allowables will increase the weight of the item being designed.

If weight-saving is of high importance in the design, then it is recommended that the user goes directly to the original Data Sources to obtain higher allowables.

For example, for small modifications or repair schemes, the weight penalty involved in using these allowable, will be small, but for a major mod or a completely new airframe design, the weight penalty may be significant.

2. Where these LAA design allowables are used in a submission or report to the LAA, the user should include a reference to this data sheet.
3. All of the figures given are for room temperature applications only. The user should seek relevant specific data for elevated temperature applications.
4. For each material designation, a list of heat treatments and temper conditions is provided. The design allowable given is the worst case for all of the conditions listed. If the user has a material condition not listed, the LAA allowable should not be used, and a relevant specific figure obtained elsewhere.
5. Yield strengths should be compared with Limit Loads, and Ultimate strengths should be compared with Ultimate Loads.
6. The Young's Modulus figures quoted are lowest value. This will be conservative when using the value to calculate buckling loads.

## MATERIAL ALLOWABLE STRENGTH DATA

7. The density figures quoted are lowest value. This WILL NOT be conservative from a weight estimation point of view.
8. Down factored allowables must be used in the heat affected zone of welded structures. If not given on this data sheet for the material in question, then the LAA allowable should not be used and a relevant specific figure obtained elsewhere.
9. The correct abbreviation for each quantity, in the applicable Data Source, is given.

### Factors Affecting Design Allowables from Data Sources

- Material Shape and Form:- The thickness of a material can have a large effect on it's allowable strength. The way in which it was formed (e.g. rolled or extruded) can also have an influence.
- Anisotropy:- The strength of some metals can vary dependent on the direction of the applied load, relative to the crystal structure (i.e. grain) of the metal.
- Heat Treatment:- Heat treatment or temper conditions can have a dramatic effect on the properties of metal alloys.
- Statistical Basis:- Design data is generated from large numbers of physical tests. The more samples tested, the higher the confidence that can be assigned to the figures obtained. The statistical basis of the data concerns the number of samples, and the way in which the resulting data is manipulated to obtain the design allowable. The three bases usually quoted are named A, B and S. The LAA design allowables are the lowest figure of all the bases quoted in the Data Source.

## MATERIAL ALLOWABLE STRENGTH DATA

### Contents

#### Steels

AISI 4130 (Normalised, tempered & stress relieved)  
AISI 4130 (Quenched & tempered)  
AISI 4130 Welded allowables  
AISI 4340  
S 96  
S 99  
S 510  
S 514  
S 515  
T 45

#### Aluminium Alloys

AISI 2014  
AISI 2024  
AISI 6061  
AISI 7075  
L 114  
L 163 (was L 72)  
L 168 (was L 65)

## MATERIAL ALLOWABLE STRENGTH DATA

### Steels

Material Designation		4130	
Data Source Reference		Mil-Hdbk-5 Iss H Table 2.3.1.0(C1)	
Available Forms		Sheet, Strip, Plate & Tubing	
Heat Treatments and Tempers		Normalised, Tempered & Stress- Relieved	
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ω	0.283
	g/cm <sup>3</sup>		7.83
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	90
	MPa		621
Tensile Yield Strength	ksi	F <sub>ty</sub>	70
	MPa		483
Ultimate Shear Strength	ksi	F <sub>su</sub>	54
	MPa		372
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	190
	MPa		1310
Yield Bearing Strength	ksi	F <sub>bry</sub>	120
	MPa		827

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		4130	
Data Source Reference		Mil-Hdbk-5 Iss H Table 2.3.1.0(C2)	
Available Forms		Tubing	
Heat Treatments and Tempers		Quenched & Tempered	
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ω	0.283
	g/cm <sup>3</sup>		7.83
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	125
	MPa		862
Tensile Yield Strength	ksi	F <sub>ty</sub>	100
	MPa		689
Ultimate Shear Strength	ksi	F <sub>su</sub>	75
	MPa		517
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	194
	MPa		1338
Yield Bearing Strength	ksi	F <sub>bry</sub>	146
	MPa		1007

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		4130	
Data Source Reference		Mil-Hdbk-5 Iss H Table 8.2.2.1.1 (a)	
Available Forms		-	
Heat Treatments and Tempers		Welded (Heat Affected Zone) No heat treatment after welding.	
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	72
	MPa		496
Ultimate Shear Strength	ksi	F <sub>su</sub>	43
	MPa		296



## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		4340	
Data Source Reference		Mil-Hdbk-5 Iss H Table 2.3.1.0(f1)	
Available Forms		Bar, Forging & Tubing	
Heat Treatments and Tempers		Quenched & Tempered <b>N.B SEE NOTE BELOW</b>	
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ω	0.283
	g/cm <sup>3</sup>		7.83
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	260
	MPa		1793
Tensile Yield Strength	ksi	F <sub>ty</sub>	217
	MPa		1496
Ultimate Shear Strength	ksi	F <sub>su</sub>	156
	MPa		1076
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	347
	MPa		2392
Yield Bearing Strength	ksi	F <sub>bry</sub>	312
	MPa		2151

### NOTE

4340 can be obtained in a variety of heat treatment conditions.

This reference quotes the HIGHEST only.

Contact LAA Engineering if using a lower heat treatment or normalised 4340.

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		S 96	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Bars & Forgings	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.6
	GPa		204
Density	lb/in <sup>3</sup>	ρ	0.284
	g/cm <sup>3</sup>		7.86
Ultimate Tensile Strength	ksi	f <sub>t</sub>	123
	MPa		849
Tensile Yield Strength	ksi	t <sub>2</sub>	99
	MPa		680
Ultimate Shear Strength	ksi	f <sub>so</sub>	81
	MPa		560
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	141
	MPa		973

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		S 99	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Bars & Forgings	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ρ	0.284
	g/cm <sup>3</sup>		7.86
Ultimate Tensile Strength	ksi	f <sub>t</sub>	176
	MPa		1215
Tensile Yield Strength	ksi	t <sub>2</sub>	157
	MPa		1080
Ultimate Shear Strength	ksi	f <sub>so</sub>	112
	MPa		770
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	242
	MPa		1667

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		S 510	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Sheet & Strip	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	30.0
	GPa		207
Density	lb/in <sup>3</sup>	ρ	0.286
	g/cm <sup>3</sup>		7.92
Ultimate Tensile Strength	ksi	f <sub>t</sub>	62.4
	MPa		430
Tensile Yield Strength	ksi	t <sub>2</sub>	37.0
	MPa		255
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	65.0
	MPa		448

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		S 514	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Sheet & Strip	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ρ	0.285
	g/cm <sup>3</sup>		7.89
Ultimate Tensile Strength	ksi	f <sub>t</sub>	111.7
	MPa		770
Tensile Yield Strength	ksi	t <sub>2</sub>	91.3
	MPa		630
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	137.0
	MPa		945

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		S 515	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Sheet & Strip	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	29.0
	GPa		200
Density	lb/in <sup>3</sup>	ρ	0.285
	g/cm <sup>3</sup>		7.89
Ultimate Tensile Strength	ksi	f <sub>t</sub>	66.7
	MPa		460
Tensile Yield Strength	ksi	t <sub>2</sub>	
	MPa		
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	
	MPa		

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		T 45	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Tube	
Heat Treatments and Tempers			
Young's Modulus	X 10 <sup>3</sup> ksi	E	28.4
	GPa		196
Density	lb/in <sup>3</sup>	ρ	0.285
	g/cm <sup>3</sup>		7.89
Ultimate Tensile Strength	ksi	f <sub>t</sub>	101.5
	MPa		700
Tensile Yield Strength	ksi	t <sub>2</sub>	89.9
	MPa		620
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	123.1
	MPa		849

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		T45	
Data Source Reference		British Aircraft Corporation Basic Materials Data Sheet 1.2.9	
Available Forms		Tube Ø not less than 0.5"	
Heat Treatments and Tempers		Welded (Heat Affected Zone) No heat treatment after welding.	
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	67.2
	MPa		463
Ultimate Shear Strength	ksi	F <sub>su</sub>	50.4
	MPa		347



## MATERIAL ALLOWABLE STRENGTH DATA

### Aluminium Alloys

Material Designation		2014	
Data Source Reference		Mil-Hdbk-5 Iss H Tables 3.2.1.0 (b1,b2,c1,d,e,f)	
Available Forms		Bars, Rods and Shapes, rolled, drawn or hand- finished. Die and Hand Forgings. Clad Figures Included.	
Heat Treatments and Tempers		T6, T651, T6510, T6511, T652 and T62.	
Young's Modulus	X 10 <sup>3</sup> ksi	E	10.5
	GPa		72
Density	lb/in <sup>3</sup>	ω	0.101
	g/cm <sup>3</sup>		2.80
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	56
	MPa		386
Tensile Yield Strength	ksi	F <sub>ty</sub>	47
	MPa		324
Ultimate Shear Strength	ksi	F <sub>su</sub>	35
	MPa		241
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	83
	MPa		572
Yield Bearing Strength	ksi	F <sub>bry</sub>	71
	MPa		490

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		2024	
Data Source Reference		Mil-Hdbk-5 Iss H Tables 3.2.3.0 (b1,b2,b3,e1,e2, e3,e4,g,i1,i2 i3,j1,j2)	
Available Forms		Sheet, Plate & Drawn Tubing. Bar & Rod, rolled, drawn or cold finished. Extruded Shapes. Clad Figures Included.	
Heat Treatments and Tempers		T3, T351, T3510, T3511, T36, T361, T4, T42, T6, T62, T72, T81, T851, T8510, T8511, T861	
Young's Modulus	X 10 <sup>3</sup> ksi	E	9.5
	GPa		66
Density	lb/in <sup>3</sup>	ϖ	0.100
	g/cm <sup>3</sup>		2.77
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	39
	MPa		269
Tensile Yield Strength	ksi	F <sub>ty</sub>	29
	MPa		200
Ultimate Shear Strength	ksi	F <sub>su</sub>	24
	MPa		165
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	64
	MPa		441
Yield Bearing Strength	ksi	F <sub>bry</sub>	36
	MPa		248

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		6061	
Data Source Reference		Mil-Hdbk-5 Iss H Tables 3.6.2.0 (b1,b2,c1,d,e,f g).	
Available Forms		Sheet, Plate, Drawn Tube & Pipe. Rods & Special Shapes, rolled, drawn or cold finished. Die & Hand Forgings. Extruded Rod, Bar & Shapes.	
Heat Treatments and Tempers		T4, T42, T451, T4510, T4511 T6, T62, T651, T6510, T6511, T652	
Young's Modulus	X 10 <sup>3</sup> ksi	E	9.9
	GPa		68
Density	lb/in <sup>3</sup>	ϖ	0.098
	g/cm <sup>3</sup>		2.71
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	26
	MPa		179
Tensile Yield Strength	ksi	F <sub>ty</sub>	12
	MPa		83
Ultimate Shear Strength	ksi	F <sub>su</sub>	16
	MPa		110
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	42
	MPa		290
Yield Bearing Strength	ksi	F <sub>bry</sub>	22
	MPa		152

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		7075	
Data Source Reference		Mil-Hdbk-5 Iss H Tables 3.7.4.0 (b1,b2,b3,b4,c1 c2,c3,c4,c5,d,e1, e2,f1,f2,g1,g2,g3, g4)	
Available Forms		Sheet & Plate. Bar, Rods & Shapes, rolled, drawn or cold finished. Die & Hand Forgings. Extruded Rods, Bars and Shapes. Clad Figures Included.	
Heat Treatments and Tempers		T6, T62, T651,T6510, T6511, T652, T73, T7351, T73510, T73511, T7352, T76, T7651, T76510, T76511	
Young's Modulus	X 10 <sup>3</sup> ksi	E	9.3
	GPa		64
Density	lb/in <sup>3</sup>	ω	0.101
	g/cm <sup>3</sup>		2.80
Ultimate Tensile Strength	ksi	F <sub>tu</sub>	56
	MPa		386
Tensile Yield Strength	ksi	F <sub>ty</sub>	44
	MPa		303
Ultimate Shear Strength	ksi	F <sub>su</sub>	35
	MPa		241
Ultimate Bearing Strength	ksi	F <sub>bru</sub>	84
	MPa		579
Yield Bearing Strength	ksi	F <sub>bry</sub>	68
	MPa		469

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		L114	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Tube	
Heat Treatments and Tempers		T6	
Young's Modulus	X 10 <sup>3</sup> ksi	E	10.2
	GPa		70
Density	lb/in <sup>3</sup>	ρ	0.098
	g/cm <sup>3</sup>		2.70
Ultimate Tensile Strength	ksi	f <sub>t</sub>	45
	MPa		310
Tensile Yield Strength	ksi	t <sub>2</sub>	35
	MPa		240
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	47
	MPa		324

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		L163 (Previously L72)	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Clad Sheet & Strip	
Heat Treatments and Tempers		T3	
Young's Modulus	X 10 <sup>3</sup> ksi	E	9.6
	GPa		66
Density	lb/in <sup>3</sup>	ρ	0.101
	g/cm <sup>3</sup>		2.79
Ultimate Tensile Strength	ksi	f <sub>t</sub>	56
	MPa		385
Tensile Yield Strength	ksi	t <sub>2</sub>	36
	MPa		245
Ultimate Shear Strength	ksi	f <sub>so</sub>	
	MPa		
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	57
	MPa		392

## MATERIAL ALLOWABLE STRENGTH DATA

Material Designation		L168 (previously L65)	
Data Source Reference		ESDU 00-932 Iss 2. 1988	
Available Forms		Bars & Extruded Sections	
Heat Treatments and Tempers		T6, T651	
Young's Modulus	X 10 <sup>3</sup> ksi	E	10.4
	GPa		72
Density	lb/in <sup>3</sup>	ρ	0.101
	g/cm <sup>3</sup>		2.80
Ultimate Tensile Strength	ksi	f <sub>t</sub>	57
	MPa		394
Tensile Yield Strength	ksi	t <sub>2</sub>	51
	MPa		351
Ultimate Shear Strength	ksi	f <sub>so</sub>	30
	MPa		209
Ultimate Bearing Strength	ksi		
	MPa		
Yield Bearing Strength	ksi	b <sub>10</sub>	63
	MPa		432

## MATERIAL ALLOWABLE STRENGTH DATA

### B Threaded Fasteners

#### IMPORTANT: Guidelines For Use

1. The Design Allowable strengths presented here are taken from Data Sources acceptable to the LAA. Unlike the metallic material properties above, they may be used for new design work without weight penalty.
2. Where these LAA design allowables are used in a submission or report to the LAA, the user should include a reference to this data sheet.
3. All of the figures given are for room temperature applications only. The user should seek relevant specific data for elevated temperature applications.
4. Ultimate strengths should be compared with Ultimate Loads.
5. The Tensile Strengths given can only be generated with full nuts and heads. Where thin materials are being joined, the pull-through strength of the materials may also be the limiting factor.
6. The Shear Strengths given can only be generated on the plain shank of the bolt. The thread should not be loaded in shear. The bearing and shear-out strength of the materials being joined should also be checked.
7. Where bolts are loaded simultaneously in tension and shear, the interaction curves given must be used to establish the combined strength of the bolt.

The interaction curves are calculated using the following equation:-

$$\frac{x^3}{a^3} + \frac{y^2}{b^2} = 1$$

Where

x = Shear load

y = Tension load

a = Allowable pure shear load

b = Allowable pure tension load



# **MATERIAL ALLOWABLE STRENGTH DATA**

## Contents

Imperial Fasteners

AN Bolts

High Strength Internal Wrenching Bolts

Metric Fasteners

TBC

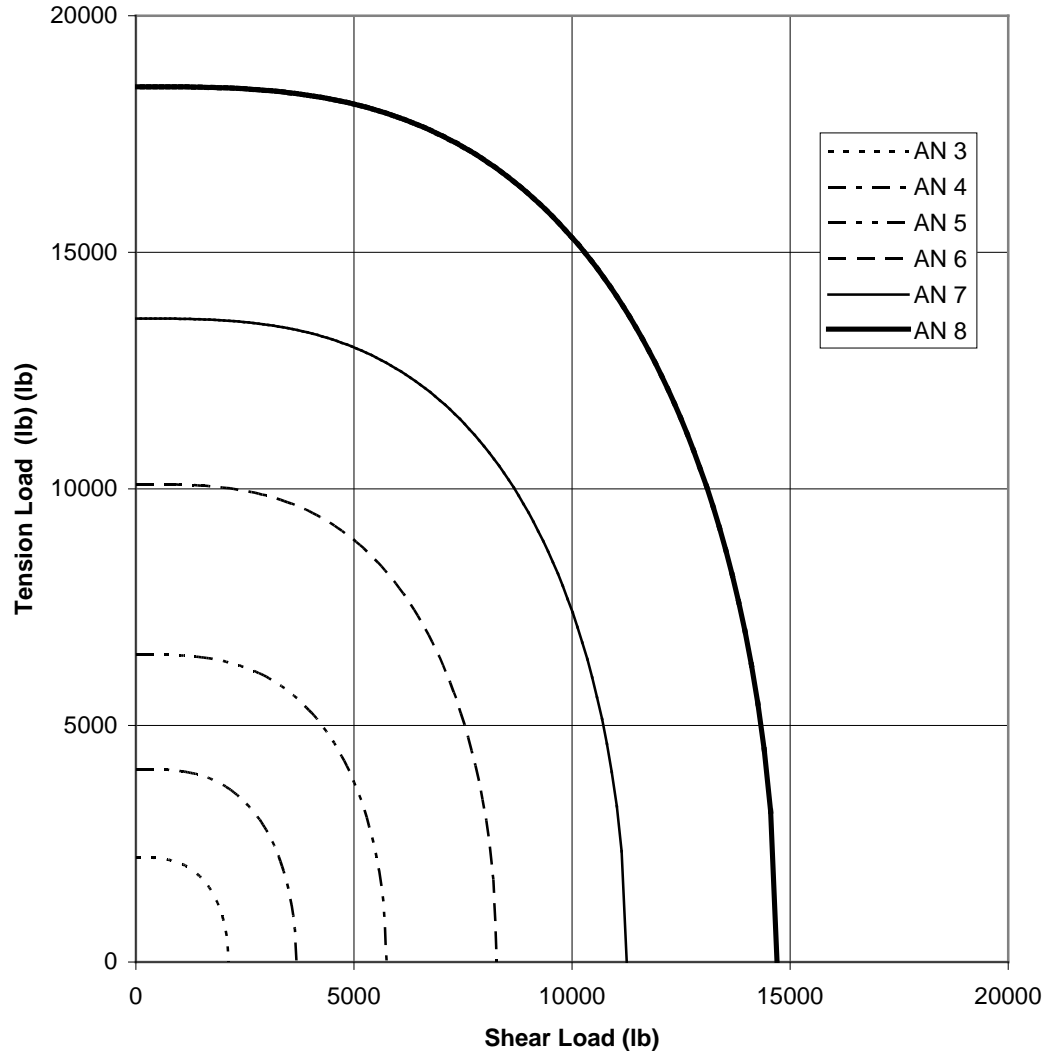
## MATERIAL ALLOWABLE STRENGTH DATA

### Imperial Fasteners

AN Bolts						
References:						
Mil-Hdbk-5 Iss H Analysis & Design of Flight Vehicle Structures E.F. Bruhn						
Material Properties:						
Ultimate Tensile Strength >125 ksi (862 MPa)						
Ultimate Shear Strength >75 ksi (517 MPa)						
Modulus of Rupture >180 ksi (1241 MPa)						
Bolt Dia	Ultimate Tensile Strength		Ultimate Single Shear Strength		Ultimate Bending Moment	
	in	lb	N	lb	N	lb.in
0.190 (AN3)	2210	9831	2126	9457	121	13673
1/4 (AN4)	4080	18149	3680	16369	276	31188
5/16 (AN5)	6500	28913	5750	25577	539	60907
3/8 (AN6)	10100	44927	8280	36831	932	105316
7/16 (AN7)	13600	60496	11250	50042	1480	167240
1/2 (AN8)	18500	82292	14700	65389	2210	249730

# MATERIAL ALLOWABLE STRENGTH DATA

## AN Bolt Shear-Tension Interaction Curves



## MATERIAL ALLOWABLE STRENGTH DATA

### High Strength Internal Wrenching Bolts

E.g.

MS 20004 thru MS 20024

MS 21262

MS 24675 thru MS 24678

NAS 563 thru NAS 572

NAS 1223 thru NAS 1235

NAS 1266 thru NAS 1270

#### References:

Mil-Hdbk-5 Iss H

Analysis & Design of Flight Vehicle Structures E.F. Bruhn

#### Material Properties:

Ultimate Tensile Strength >160 ksi (1103 MPa)

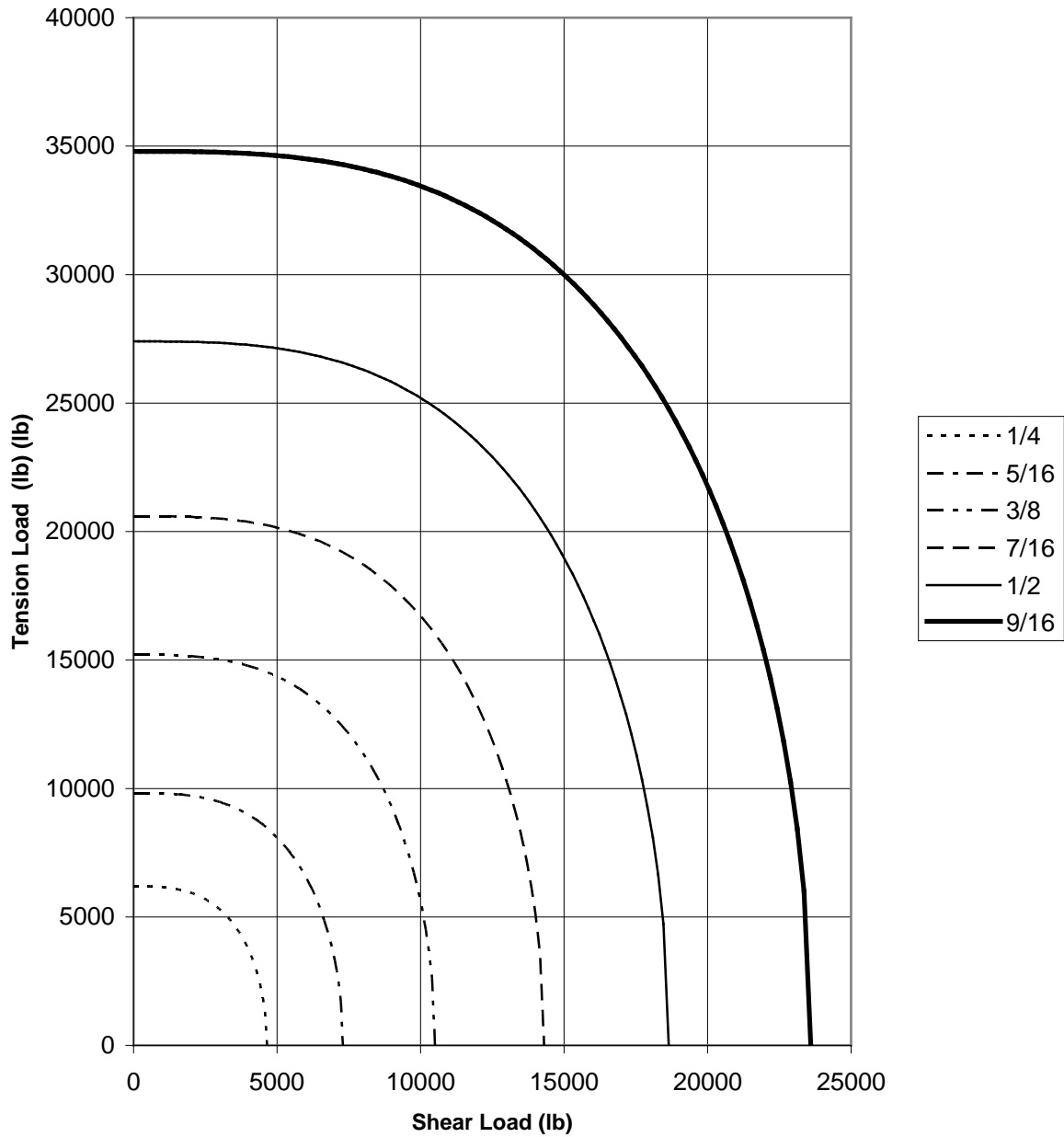
Ultimate Shear Strength >95 ksi (655 MPa)

Material spec => MIL-B-8831

Bolt Dia	Ultimate Tensile Strength		Ultimate Single Shear Strength		Ultimate Bending Moment	
	lb	N	lb	N	lb.in	N.mm
in						
1/4	6190	27534	4650	20684		
5/16	9820	43682	7300	32472		
3/8	15200	67613	10500	46706		
7/16	20600	91633	14300	63610		
1/2	27400	121881	18650	82959		
9/16	34800	154798	23600	104978		

## MATERIAL ALLOWABLE STRENGTH DATA

High Strength Internal Wrenching Bolt Shear-Tension Interaction Curves



## MATERIAL ALLOWABLE STRENGTH DATA

### C Wire Ropes and Cables

#### IMPORTANT: Guidelines For Use

1. The Design Allowable strengths presented here are taken from Data Sources acceptable to the LAA. Unlike the metallic material properties above, they may be used for new design work without weight penalty.
2. Where these LAA design allowables are used in a submission or report to the LAA, the user should include a reference to this data sheet.
3. All of the figures given are for room temperature applications only. The user should seek relevant specific data for elevated temperature applications.
4. Ultimate strengths should be compared with Ultimate Loads.
5. The LAA have adopted the requirements of BCAR CAP 482, Section S (Small Light Aeroplanes), with respect to the load capabilities of Steel Wire Ropes & Cables.  
i.e.  
"An ultimate factor of safety of 2.0 on nominal cable strength must be applied to cables used for structural applications and for all primary control systems."



## MATERIAL ALLOWABLE STRENGTH DATA

### Contents

#### Flexible Cables

Mil-W-83420 Type A  
Mil-W-83420 Type B  
Mil-C-18375

#### Non-flexible Cables

Mil-W-87161

## MATERIAL ALLOWABLE STRENGTH DATA

### Flexible Cables

Reference:							
AC 43.13-1B Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair. FAA. September 8, 1998							
Wire Rope Cable Nominal Dia.	Construction	Minimum Breaking Strength					
		MIL-W-83420 Type A		MIL-W-83420 Type B		MIL-C-18375	
(in)		(lb)	(N)	(lb)	(N)	(lb)	(N)
1/32	3x7	110	489	110	489		
3/64	7x7	270	1201	270	1201		
1/16	7x7	480	2135	480	2135	360	1601
1/16	7x19	480	2135	480	2135		
3/32	7x7	920	4092	920	4092	700	3114
3/32	7x19	1000	4448	920	4092		
1/8	7x19	2000	8896	1760	7829	1300	5783
5/32	7x19	2800	12455	2400	10676	2000	8896
3/16	7x19	4200	18683	3700	16458	2900	12900
7/32	7x19	5600	24910	5000	22241	3800	16903
1/4	7x19	7000	31138	6400	28469	4900	21796
9/32	7x19	8000	35586	7800	34696	6100	27134
5/16	7x19	9800	43593	9000	40034	7600	33806
11/32	7x19	12500	55603				
3/8	7x19	14400	64054	12000	53379	11000	48930
7/16	6x19 <sup>IWRC</sup>	17600	78289	16300	72506	14900	66279
1/2	6x19 <sup>IWRC</sup>	22800	101419	22800	101419	19300	85851
9/16	6x19 <sup>IWRC</sup>	28500	126774	28500	126774	24300	108092
5/8	6x19 <sup>IWRC</sup>	35000	155688	35000	155688	30100	133891
3/4	6x19 <sup>IWRC</sup>	49600	220632	49600	220632	42900	190829
7/8	6x19 <sup>IWRC</sup>	66500	295807	66500	295807	58000	257997
1	6x19 <sup>IWRC</sup>	85400	379878	85400	379878	75200	334506
1-1/8	6x19 <sup>IWRC</sup>	106400	473291	106400	473291		
1-1/4	6x19 <sup>IWRC</sup>	129400	575600	129400	575600		
1-3/8	6x19 <sup>IWRC</sup>	153600	683247	153600	683247		
1-1/2	6x19 <sup>IWRC</sup>	180500	802904	180500	802904		



## MATERIAL ALLOWABLE STRENGTH DATA

### Non-Flexible Cables

Reference:							
AC 43.13-1B Acceptable Methods, Techniques and Practices - Aircraft Inspection and Repair. FAA. September 8, 1998							
Wire Rope Cable Nominal Dia.	Construction	Minimum Breaking Strength					
		MIL-W-87161 Types A&B					
(in)		(lb)	(N)	(lb)	(N)	(lb)	(N)
1/32	1x7	185	823				
3/64	1x7	375	1668				
3/64	1x19	375	1668				
1/16	1x7	500	2224				
1/16	1x19	500	2224				
5/64	1x19	800	3559				
3/32	1x19	1200	5338				
7/64	1x19	1600	7117				
1/8	1x19	2100	9341				
5/32	1x19	3300	14679				
3/16	1x19	4700	20907				
7/32	1x19	6300	28024				
1/4	1x19	8200	36475				
5/16	1x19	12500	55603				
3/8	1x19	17500	77844				

## MATERIAL ALLOWABLE STRENGTH DATA

### D Wood

#### IMPORTANT: Guidelines For Use

1. The Design Allowable strengths presented here are taken from ANC-18 Design of Wood Aircraft Structures, June 1951, from the U.S. Department of Defense. This is a data source acceptable to the LAA. Unlike the metallic material properties above, they may be used for new design work without weight penalty. For new design and major modifications and repair, the user is strongly advised to familiarise themselves with the analysis techniques for wooden structures, described in the above reference.
2. Where these LAA design allowables are used in a submission or report to the LAA, the user should include a reference to this data sheet.
3. All of the figures given are for room temperature applications only. The user should seek relevant specific data for elevated temperature applications.
4. The basic material properties are given at 15% moisture content and are for use with aircraft for use in temperate climates. For aircraft used in tropical wet or dry climates, the user should seek other relevant data.
5. Ultimate strengths should be compared with Ultimate Loads. Proportional Limit Stresses (where available) should be compared with Limit Loads
6. The Modulus of Rupture in bending should only be used directly as given in the table for solid rectangular cross-section wooden beams. For other cross-sections a form factor must be applied to the figure given. See ANC-18 for form factor equations and tables.
7. Interaction curves are given in ANC-18 for wooden spars in combined bending and compression.
8. The 45 degree in-plane shear strength of plywood is dependent on whether the face grain is in tension or compression. The lower of the two values is used here.



## MATERIAL ALLOWABLE STRENGTH DATA

### Contents

#### Solid Wood

Sitka Spruce  
Douglas Fir

#### Ply

Birch-Birch

## MATERIAL ALLOWABLE STRENGTH DATA

### Solid Wood

Species of Wood		Sitka Spruce		Douglas Fir (Normal)	
		psi	MPa	psi	MPa
Tension	Ultimate Strength (Parallel To Grain)	9400	64.8	10900	75.2
	Ultimate Strength (90 Deg To Grain)	170	1.2	140	1.0
Compression	Proportional Limit Stress (Parallel To Grain)	3530	24.3	4220	29.1
	Ultimate Strength (Parallel To Grain)	4700	32.4	5600	38.6
	Ultimate Strength (90 Deg To Grain)	740	5.1	1020	7.0
Shear	Ultimate Strength (Parallel To Grain)	990	6.8	950	6.6
Bending	Proportional Limit Stress	5300	36.5	5900	40.7
	Modulus of Rupture	9400	64.8	10900	75.2

## MATERIAL ALLOWABLE STRENGTH DATA

### Plywood

Birch - Birch 3 Ply			Nominal Thickness (in)						
			0.035	0.070	0.100	0.125	0.155	0.185	
Veneer Thickness (in)	Face & Back		0.011	0.020	0.030	0.034	0.040	0.047	
	Core		0.011	0.030	0.040	0.060	0.080	0.095	
Ultimate Tensile Strength	Parallel to Face Grain	Psi	10070	8630	9060	8020	7550	7510	
		MPa	69.4	59.5	62.5	55.3	52.1	51.8	
	90 deg to Face Grain	Psi	5030	6470	6040	7080	7550	7590	
		MPa	34.8	44.6	41.6	48.8	52.1	52.3	
Compression	Ultimate	Parallel to Face Grain	Psi	4430	3840	4020	3590	3400	3380
			MPa	30.5	26.5	27.7	24.8	23.4	23.3
		90 deg to Face Grain	Psi	2350	2950	2780	3200	3400	3410
			MPa	16.2	20.3	19.2	22.1	23.4	23.5
	Proportional Limit	Parallel to Face Grain	Psi	3130	2710	2840	2540	2400	2390
			MPa	21.6	18.7	19.6	17.5	16.5	16.5
		90 deg to Face Grain	Psi	1670	2090	1960	2260	2400	2410
			MPa	11.5	14.4	13.5	15.6	16.5	16.6
Bending	Ultimate	Parallel to Face Grain	Lb.in*	2.53	9.69	20.08	30.14	45.26	64.33
			N.mm**	11.3	43.1	89.3	134.1	201.4	286.2
		90 deg to Face Grain	Lb.in*	0.562	3.031	5.638	11.015	18.728	26.906
			N.mm**	2.5	13.5	25.1	49.0	83.3	119.7
	Proportional Limit	Parallel to Face Grain	Lb.in*	4.27	4.88	10.11	15.17	22.78	32.38
			N.mm**	19.0	21.7	45.0	67.5	101.3	143.6
		90 deg to Face Grain	Lb.in*	0.243	1.526	2.838	5.544	9.426	13.542
			N.mm**	1.1	6.8	12.6	24.7	41.9	60.3

## MATERIAL ALLOWABLE STRENGTH DATA

- \* Per inch width
- \*\* Per mm width

## MATERIAL ALLOWABLE STRENGTH DATA

Birch - Birch 3 Ply			Nominal Thickness (in)					
			0.035	0.070	0.100	0.125	0.155	0.185
Shear	0/90 deg	Psi	2840	2490	2020	1800	1630	1510
		MPa	19.6	17.2	13.9	12.4	11.2	10.4
	+/- 45 deg	Psi	2300	2790	2660	2970	3100	3100
		MPa	15.9	19.2	18.3	20.5	21.4	21.4

## MATERIAL ALLOWABLE STRENGTH DATA

Birch - Birch 5 Ply			Nominal Thickness (in)						
			0.160	0.190	0.225	0.250	0.315	0.375	
Veneer Thickness (in)	Face & Back		0.030	0.034	0.040	0.047	0.060	0.060	
	Cross Bands		0.034	0.047	0.060	0.060	0.080	0.095	
	Core		0.030	0.030	0.030	0.047	0.040	0.080	
Ultimate Tensile Strength	Parallel to Face Grain	Psi	8600	7710	7220	7070	7550	7740	
		MPa	59.3	53.2	49.8	48.7	52.1	53.4	
	90 deg to Face Grain	Psi	6500	7390	7880	7130	7550	7360	
		MPa	44.8	51.0	54.3	49.2	52.1	50.7	
Compression	Ultimate	Parallel to Face Grain	Psi	3830	3460	3260	3570	3400	3180
			MPa	26.4	23.9	22.5	24.6	23.4	21.9
		90 deg to Face Grain	Psi	2960	3330	3530	3230	3400	3320
			MPa	20.4	23.0	24.3	22.3	23.4	22.9
	Proportional Limit	Parallel to Face Grain	Psi	2700	2440	2300	2520	2400	2450
			MPa	18.6	16.8	15.9	17.4	16.5	16.9
		90 deg to Face Grain	Psi	2090	2350	2490	2280	2400	2340
			MPa	14.4	16.2	17.2	15.7	16.5	16.1
Bending	Ultimate	Parallel to Face Grain	Lb.in*	42.64	57.04	79.84	102.28	163.17	207.97
			N.mm**	189.7	253.8	355.2	455.0	725.9	925.2
		90 deg to Face Grain	Lb.in*	22.78	35.09	50.41	57.97	91.48	153.43
			N.mm**	101.3	156.1	224.3	257.9	407.0	682.6
	Proportional Limit	Parallel to Face Grain	Lb.in*	21.46	29.01	40.18	51.48	82.12	104.68
			N.mm**	95.5	129.1	178.8	229.0	365.3	465.7
		90 deg to Face Grain	Lb.in*	11.47	17.66	25.37	29.18	46.04	77.22
			N.mm**	51.0	78.6	112.9	129.8	204.8	343.5



## MATERIAL ALLOWABLE STRENGTH DATA

- \* Per inch width
- \*\* Per mm width

## MATERIAL ALLOWABLE STRENGTH DATA

Birch - Birch 5 Ply								
			Nominal Thickness (in)					
			0.160	0.190	0.225	0.250	0.315	0.375
Shear	0/90 deg	Psi	2290	2070	1890	1800	1620	1500
		MPa	15.8	14.3	13.0	12.4	11.2	10.3
	+/- 45 deg	Psi	2800	3060	3170	2990	3100	3050
		MPa	19.3	21.1	21.9	20.6	21.4	21.0

## MATERIAL ALLOWABLE STRENGTH DATA

### E Rivets

#### IMPORTANT: Guidelines For Use

The Design Allowable strengths presented here are taken from Data Sources acceptable to the LAA.

Where these LAA design allowables are used in a submission or report to the LAA, the user should include a reference to this data sheet.

All of the figures given are for room temperature applications only. The user should seek relevant specific data for elevated temperature applications.

Yield strengths should be compared with Limit Loads, and Ultimate strengths should be compared with Ultimate Loads. Strengths are provided in metric and imperial units.

Joint allowables assume an edge distance of at least 2 x rivet diameter.

All joints are assumed to be rigid and no rotation about a single rivet is allowed.

When calculating shears in a rivet group, if the applied shear load does not pass through the centroid of the group, then the shear required to counter this induced torque must also be considered.

For solid rivets:

The following upset dimensions are assumed:-

Diameter  $\geq 1.3$  x shank dia. ( $\geq 1.4$  x dia for  
7050 rivets)

Head Height  $\geq 0.3$  x shank dia.

Yield is defined as a joint permanent set of 0.04 x rivet diameter.

For Protruding Head Solid Rivets:

The lower of the rivet allowable shear strength and the sheet material allowable bearing strength should be used as the joint allowable strength.

## MATERIAL ALLOWABLE STRENGTH DATA

A table of rivet allowable single shear strengths is provided.

Rivet allowable shear strengths need to be modified where the rivet is subject to high bearing stresses as a result of being set in thin sheet material. Thin sheet is defined as follows:-

Single Shear Joints      $t/D < 0.33$   
Double Shear Joints      $t/D < 0.67$

A table of shear strength correction factors is provided.

Sheet material allowable bearing strength data is provided for  $t/D \geq 0.18$  . For  $t/D < 0.18$  strength tests should be performed.

The bearing strength data is provided for a nominal sheet material with an allowable bearing stress of 100 ksi. For actual sheet materials, multiply the table strength figure by:-

$$\frac{\text{actual material bearing strength in ksi}}{100}$$

For Flush Head Solid Rivets:

A table is provided for each rivet/sheet combination with the lowest of the bearing or shear allowable quoted for each rivet size.

The sheet gauge quoted in the tables is that of the countersunk sheet.

When the non-countersunk sheet is thinner than the countersunk sheet, the allowable bearing strength for it should be calculated (as per a protruding rivet case ). This should then be compared with the countersunk sheet allowable from the table, and the lower of the two values used.

Note that different allowables are obtained, based on whether the joint is machine countersunk or dimpled. In the dimpled joints, the dimpling can carry some of the shear load.

## MATERIAL ALLOWABLE STRENGTH DATA

### Blind Rivets:

There are too many different types of blind rivet and similar fastener, to provide a significant sample of properties here. When any type of fastener is used, care should be taken to source associated design strengths. For aerospace specification fasteners, the manufacturer may be able to supply appropriate data, however beware of "typical", "average" or similar data, as this will not represent worst case conservative data. Commercial fasteners should be avoided wherever possible, as it is even less likely that appropriate data will be available.

In the event of doubt over the suitability of design data, please consult LAA Engineering. In some cases it may be necessary to generate a strength test programme to obtain design strengths of a suitable confidence level.

### Rivets in Tension:

As a general rule it is unacceptable design practice to use rivets as primarily tensile fasteners. Rivets may be used to carry small tensile loads, incidental to their shear carrying function.

The following applications are examples of rivets carrying incidental tensile loads:-

Skin joints to ribs and frames, seeing aerodynamic suction forces.

Attachment of panels that operate in a post-buckled condition.

Attachment of pressurised skins.

Tables of allowable ultimate strengths are provided for solid rivets in applications similar to those above.

The allowables provided assume no load reversal in the joint.

If load reversal is present, the allowables should be reduced by 75%

Combined shear and tensile loads should be assessed using the following interaction formula.

## MATERIAL ALLOWABLE STRENGTH DATA

$$R_t^2 + R_s^2 = 1$$

Redundancy should be provided in riveted joints, so that at least 1 rivet may be considered to have failed (due to improper installation) without the joint strengths being exceeded by limit or ultimate loads.

# MATERIAL ALLOWABLE STRENGTH DATA

## Contents

### Solid Rivets

#### Protruding Head

Rivet Single Shear Strengths  
Rivet Designations and Material Shear Strengths  
Shear Strength Correction Factors for Thin Sheets  
Bearing Strength of Sheet on Rivets

#### Flush Head

##### 100 deg Head

###### In Dimpled Al Sheet

MS20426AD  
MS20426D  
MS20426DD

###### In Machine Countersunk Al Sheet

MS20426AD  
MS20426D  
MS20426DD  
NAS1097-E  
MS20426E

##### 120 deg Shear Head

###### In Dimpled Al Sheet

###### In Machine Countersunk Al Sheet

BRFS-D  
BRFS-AD  
BRFS-DD  
MS14218E  
MS14218AD

##### 120 deg Tension Head

###### In Machine Countersunk Al Sheet

MS14219E

## MATERIAL ALLOWABLE STRENGTH DATA

### Tensile Behaviour of Solid Rivets

#### Protruding Head

AN470, AN442

#### Flush Head

100 deg Head

In Dimpled Al Sheet

AN 426

In Machine Countersunk Al Sheet

AN 426

### Blind Rivets



## MATERIAL ALLOWABLE STRENGTH DATA

### Solid Rivets

#### Protruding Head Rivets

##### Single Shear Strength (lb)

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2 (b)

Rivet Designation	Rivet Size (in)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
B	99	203	363	556	802	1450	2290	3275
AD	106	217	389	596	860	1555	2455	3510
D	134	275	493	755	1085	1970	3115	4445
DD	145	297	532	814	1175	2125	3360	4795
E (or KE in NAS Spec'n)	152	311	558	854	1230	2230	3520	5030
M	183	376	674	1030	1490	2695	4260	6085
T	187	384	687	1050	1515	2745	4340	6200
-	317	651	1165	1785	2575	4665	7375	10500

##### Single Shear Strength (N)

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2 (b)

Rivet Designation	Rivet Size (in)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
B	446	903	1616	2476	3571	6457	10198	14585
AD	471	966	1732	2653	3829	6924	10933	15632
D	596	1224	2195	3361	4831	8773	13873	19796
DD	645	1322	2369	3625	5232	9463	14964	21355
E (or KE in NAS Spec'n)	676	1384	2484	3803	5477	9931	15676	22402
M	815	1674	3000	4587	6635	12002	18972	27100
T	832	1709	3058	4676	6747	12225	19328	27613
-	1411	2800	5188	7949	11467	20776	32845	46764

## MATERIAL ALLOWABLE STRENGTH DATA

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2 (b)

Rivet Designation	Rivet Material		Material Shear Strength (Driven Condition, B-Basis)	
	Undriven	After Driving	(ksi)	(MPa)
B	5056-H32	5056-H321	28	193
AD	2117-T4	2117-T3	30	206
D	2017-T4	2017-T4	38	262
DD	2024-T4	2024-T31	41	282
E (or KE in NAS Spec'n)	7050-T73	7050-T731	43	296
M	Monel	Monel	52	358
T	Ti-45Cb	Ti-45Cb	53	365
-	A-286	A-286	90	620

## MATERIAL ALLOWABLE STRENGTH DATA

### Rivet Shear Strength Correction Factor for Thin Sheet Materials

Note:- The sheet thickness is that of the thinnest sheet for single shear joints and the middle sheet of double shear joints.

#### Single Shear Correction Factors

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.1 (b)

Sheet Thickness (in)	Rivet Dia (in)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
0.016	0.964	-	-	-	-	-	-	-
0.018	0.981	0.912	-	-	-	-	-	-
0.020	0.995	0.933	-	-	-	-	-	-
0.025	1.000	0.970	0.920	-	-	-	-	-
0.032	-	1.000	0.964	0.925	-	-	-	-
0.036	-	-	0.981	0.946	0.912	-	-	-
0.040	-	-	0.995	0.964	0.933	-	-	-
0.045	-	-	1.000	0.981	0.953	-	-	-
0.050	-	-	-	0.995	0.970	0.920	-	-
0.063	-	-	-	1.000	1.000	0.961	0.922	-
0.071	-	-	-	-	-	0.979	0.944	0.909
0.080	-	-	-	-	-	0.995	0.964	0.933
0.090	-	-	-	-	-	1.000	0.981	0.953
0.100	-	-	-	-	-	-	0.995	0.972
0.125	-	-	-	-	-	-	1.000	1.000

#### Double Shear Correction Factors

Sheet Thickness (in)	Rivet Dia (in)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
0.016	0.687	-	-	-	-	-	-	-
0.018	0.744	0.518	-	-	-	-	-	-
0.020	0.789	0.585	-	-	-	-	-	-
0.025	0.870	0.708	0.545	-	-	-	-	-
0.032	0.941	0.814	0.687	0.560	-	-	-	-
0.036	0.969	0.857	0.744	0.630	0.518	-	-	-
0.040	0.992	0.891	0.789	0.687	0.585	-	-	-
0.045	1.000	0.924	0.834	0.744	0.653	-	-	-
0.050	-	0.951	0.870	0.789	0.708	0.545	-	-
0.063	-	1.000	0.937	0.872	0.808	0.679	0.550	-
0.071	-	-	0.966	0.909	0.852	0.737	0.622	0.508
0.080	-	-	0.992	0.941	0.891	0.789	0.687	0.585
0.090	-	-	1.000	0.969	0.924	0.834	0.744	0.653
0.100	-	-	-	0.992	0.951	0.870	0.789	0.708
0.125	-	-	-	1.000	1.000	0.935	0.870	0.805

## MATERIAL ALLOWABLE STRENGTH DATA

0.160	-	-	-	-	-	0.992	0.941	0.891
0.190	-	-	-	-	-	1.000	0.981	0.939
0.250	-	-	-	-	-	-	1.000	1.000

### Bearing Strength of Sheet on Rivets (lb)

Notes:- Sheet material has a nominal bearing strength of 100 ksi. (689 MPa)

Sheet Thickness (in)	Rivet Dia (in)							
	Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.1 (a)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
0.012	80	-	-	-	-	-	-	-
0.016	107	-	-	-	-	-	-	-
0.018	121	173	-	-	-	-	-	-
0.020	134	192	-	-	-	-	-	-
0.025	168	240	321	-	-	-	-	-
0.032	214	307	411	509	-	-	-	-
0.036	241	346	462	572	688	-	-	-
0.040	268	384	514	636	764	-	-	-
0.045	302	432	578	716	860	-	-	-
0.050	335	480	642	795	955	1285	-	-
0.063	422	605	810	1002	1203	1619	2035	-
0.071	476	682	912	1129	1356	1825	2293	2741
0.080	536	768	1028	1272	1528	2056	2584	3088
0.090	603	864	1156	1431	1719	2313	2907	3474
0.100	670	960	1285	1590	1910	2570	3230	3860
0.125	838	1200	1606	1988	2388	3212	4038	4825
0.160	1072	1536	2056	2544	3056	4112	5168	6176
0.190	1273	1824	2442	3021	3629	4883	6137	7334
0.250	1670	2400	3210	3975	4775	6425	8075	9650

### Bearing Strength of Sheet on Rivets (N)

Notes:- Sheet material has a nominal bearing strength of 100 ksi. (689 MPa)

Sheet Thickness (in)	Rivet Dia (in)							
	Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.1 (a)							
	1/16	3/32	1/8	5/32	3/16	1/4	5/16	3/8
0.012	356	-	-	-	-	-	-	-
0.016	476	-	-	-	-	-	-	-
0.018	538	770	-	-	-	-	-	-
0.020	596	854	-	-	-	-	-	-
0.025	747	1068	1428	-	-	-	-	-
0.032	952	1366	1828	2264	-	-	-	-
0.036	1072	1539	2055	2544	3060	-	-	-
0.040	1192	1708	2286	2829	3398	-	-	-
0.045	1343	1922	2571	3185	3825	-	-	-
0.050	1490	2135	2856	3536	4248	5716	-	-
0.063	1877	2691	3603	4457	5351	7202	9052	-
0.071	2117	3034	4057	5022	6032	8118	10200	12193
0.080	2384	3416	4573	5658	6797	9146	11494	13736

## MATERIAL ALLOWABLE STRENGTH DATA

0.090	2682	3843	5142	6365	7646	10289	12931	15453
0.100	2980	4270	5716	7073	8496	11432	14368	17170
0.125	3728	5338	7144	8843	10622	14288	17962	21463
0.160	4768	6832	9146	11316	13594	18291	22988	27472
0.190	5663	8114	10863	13438	16143	21721	27299	32623
0.250	7429	10676	14279	17682	21240	28580	35919	42925

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Dimpled Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (c)

Rivet Type		MS20426AD									
Sheet Material		2024-T3 2024-T42 2024-T62 2024-T81		2024-T3 2024-T42		2024-T62 2024-T81		2024-T86 7075-T6			
Rivet Dia (in)		3/32	1/8	5/32	3/16	5/32	3/16	1/8	5/32	3/16	
Sheet Thickness (in)		Ultimate Strength, lb									
		0.016	177	-	-	-	-	-	-	-	-
		0.020	209	299	-	-	-	-	302	-	-
		0.025	217	360	474	-	462	-	383	462	-
		0.032	217	388	568	722	596	725	388	596	725
		0.040	217	388	596	839	596	862	388	596	862
0.050	217	388	596	862	596	862	388	596	862		
Rivet Shear Strength		217	388	596	862	596	862	388	596	862	
Sheet Thickness (in)		Yield Strength, lb									
		0.016	154	-	-	-	-	-	-	-	-
		0.020	184	257	-	-	-	-	257	-	-
		0.025	209	315	324	-	324	-	315	410	-
		0.032	-	367	430	512	430	512	367	525	640
		0.040	-	-	506	644	-	644	-	-	782
0.050	-	-	-	757	-	-	-	-	-		

Rivet Type		MS20426AD									
Sheet Material		2024-T3 2024-T42 2024-T62 2024-T81		2024-T3 2024-T42		2024-T62 2024-T81		2024-T86 7075-T6			
Rivet Dia (in)		3/32	1/8	5/32	3/16	5/32	3/16	1/8	5/32	3/16	
Sheet Thickness (in)		Ultimate Strength, N									
		0.016	787	-	-	-	-	-	-	-	-
		0.020	930	1330	-	-	-	-	1343	-	-
		0.025	965	1601	2108	-	2055	-	1704	2055	-
		0.032	965	1726	2527	3212	2651	3225	1726	2651	3225
		0.040	965	1726	2651	3732	2651	3834	1726	2651	3834
0.050	965	1726	2651	3834	2651	3834	1726	2651	3834		
Rivet Shear Strength		965	1726	2651	3834	2651	3834	1726	2651	3834	
Sheet Thickness (in)		Yield Strength, N									
		0.016	685	-	-	-	-	-	-	-	-
		0.020	818	1143	-	-	-	-	1143	-	-
		0.025	930	1401	1441	-	1441	-	1401	1824	-
0.032	-	1632	1913	2277	1913	2277	1632	2335	2847		

## MATERIAL ALLOWABLE STRENGTH DATA

	0.040	-	-	2251	2865	-	2865	-	-	3479
	0.050	-	-	-	3367	-	-	-	-	-

## MATERIAL ALLOWABLE STRENGTH DATA

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (d)

Rivet Type		<b>MS20426D</b>								
Sheet Material		2024-T3 2024-T42			2024-T86 7075-T6			2024-T62 2024-T81		
Rivet Dia (in)		5/32	3/16	1/4	5/32	3/16	1/4	5/32	3/16	1/4
Sheet Thickness (in)		Ultimate Strength, lb								
	0.025	419	-	-	530	-	-	419	-	-
	0.032	600	681	-	672	822	-	600	681	-
	0.040	738	905	845	755	1000	1108	738	905	1108
	0.050	755	1090	1332	755	1090	1508	755	1090	1508
	0.063	755	1090	1695	755	1090	1803	755	1090	1803
	0.071	755	1090	1853	755	1090	1930	755	1090	1930
Rivet Shear Strength		755	1090	1970	755	1090	1970	755	1090	1970
Sheet Thickness (in)		Yield Strength, lb								
	0.025	336	-	-	450	-	-	336	-	-
	0.032	483	546	-	581	-	-	483	546	-
	0.040	589	730	845	675	705	978	589	730	845
	0.050	681	888	1187	-	867	1508	681	888	1187
	0.063	-	-	1415	-	1007	1803	-	-	1415
	0.071	-	-	1656	-	-	1930	-	-	1656
0.080	-	-	1870	-	-	1970	-	-	1870	

Rivet Type		<b>MS20426D</b>								
Sheet Material		2024-T3 2024-T42			2024-T86 7075-T6			2024-T62 2024-T81		
Rivet Dia (in)		5/32	3/16	1/4	5/32	3/16	1/4	5/32	3/16	1/4
Sheet Thickness (in)		Ultimate Strength, N								
	0.025	1864	-	-	2358	-	-	1864	-	-
	0.032	2669	3029	-	2989	3656	-	2669	3029	-
	0.040	3283	4026	3759	3358	4448	4929	3283	4026	4929
	0.050	3358	4849	5925	3358	4849	6708	3358	4849	6708
	0.063	3358	4849	7540	3358	4849	8020	3358	4849	8020
	0.071	3358	4849	8243	3358	4849	8585	3358	4849	8585
Rivet Shear Strength		3358	4849	8763	3358	4849	8763	3358	4849	8763
Sheet Thickness (in)		Yield Strength, N								
	0.025	1495	-	-	2002	-	-	1495	-	-
	0.032	2148	2429	-	2584	-	-	2148	2429	-
	0.040	2620	3247	3759	3003	3136	4350	2620	3247	3759
0.050	3029	3950	5280	-	3857	6708	3029	3950	5280	



## **MATERIAL ALLOWABLE STRENGTH DATA**

0.063	-	-	6294	-	4479	8020	-	-	6294
0.071	-	-	7366	-	-	8585	-	-	7366
0.080	-	-	8318	-	-	8763	-	-	8318

## MATERIAL ALLOWABLE STRENGTH DATA

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (e)

Rivet Type		<b>MS20426DD</b>					
Sheet Material		2024-T3 2024-T42		2024-T62 2024-T81		2024-T86 7075-T6	
Rivet Dia (in)		3/16	1/4	3/16	1/4	3/16	1/4
Sheet Thickness (in)		Ultimate Strength, lb					
	0.032	744	-	786	-	786	-
	0.040	941	879	982	1300	982	1300
	0.050	1110	1359	1152	1705	1152	1705
	0.063	1175	1727	1175	2010	1175	2010
	0.071	1175	1883	1175	2125	1175	2125
	0.080	1175	2025	1175	2125	1175	2125
0.090	1175	2125	1175	2125	1175	2125	
Rivet Shear Strength		1175	2125	1175	2125	1175	2125
Sheet Thickness (in)		Yield Strength, lb					
	0.032	582	-	649	-	786	-
	0.040	666	879	816	962	982	978
	0.050	738	1308	961	1308	1152	1543
	0.063	925	1564	1068	1564	1175	1958
	0.071	-	1711	-	1711	-	2125
	0.080	-	1928	-	-	-	-
0.090	-	2121	-	-	-	-	

Rivet Type		<b>MS20426DD</b>					
Sheet Material		2024-T3 2024-T42		2024-T62 2024-T81		2024-T86 7075-T6	
Rivet Dia (in)		3/16	1/4	3/16	1/4	3/16	1/4
Sheet Thickness (in)		Ultimate Strength, N					
	0.032	3309	-	3496	-	3496	-
	0.040	4186	3910	4368	5783	4368	5783
	0.050	4938	6045	5124	7584	5124	7584
	0.063	5227	7682	5227	8941	5227	8941
	0.071	5227	8376	5227	9452	5227	9452
	0.080	5227	9008	5227	9452	5227	9452
0.090	5227	9452	5227	9452	5227	9452	
Rivet Shear Strength		5227	9452	5227	9452	5227	9452
Sheet Thickness (in)		Yield Strength, N					
	0.032	2589	-	2887	-	3496	-
	0.040	2963	3910	3630	4279	4368	4350
	0.050	3283	5818	4275	5818	5124	6864
	0.063	4115	6957	4751	6957	5227	8710
0.071	-	7611	-	7611	-	9452	

## MATERIAL ALLOWABLE STRENGTH DATA

	0.080	-	8576	-	-	-	-
	0.090	-	9435	-	-	-	-

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (f)

Rivet Type	MS20426AD				MS20426D			MS20426DD		
Sheet Material	Clad 2024-T42									
Rivet Dia (in)	3/32	1/8	5/32	3/16	5/32	3/16	1/4	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, lb									
	0.032	178	-	-	-	-	-	-	-	-
	0.040	193	309	-	-	-	-	-	-	-
	0.050	206	340	479	-	580	-	-	-	-
	0.063	216	363	523	705	657	859	-	886	-
	0.071	216	373	542	739	690	917	-	942	-
	0.080	216	373	560	769	720	969	-	992	-
	0.090	216	373	575	795	746	1015	1552	1035	1647
	0.100	216	373	575	818	746	1054	1640	1073	1738
	0.125	216	373	575	853	746	1090	1773	1131	1877
	0.160	216	373	575	-	746	1090	1891	1131	2000
0.190	216	373	575	-	746	1090	1970	1131	2084	
Rivet Shear Strength	217	388	596	862	755	1090	1970	1175	2125	
Sheet Thickness (in)	Yield Strength, lb									
	0.032	132	-	-	-	--	-	-	-	-
	0.040	153	231	-	-	-	-	-	-	-
	0.050	188	261	321	-	345	-	-	-	-
	0.063	213	321	402	471	401	515	-	614	-
	0.071	-	348	453	538	481	557	-	669	-
	0.080	-	-	498	616	562	623	-	761	-
	0.090	-	-	537	685	633	746	861	842	1053
	0.100	-	-	-	745	-	854	1017	913	1115
	0.125	-	-	-	836	-	1018	1313	1021	1357
	0.160	-	-	-	-	-	-	1574	-	1694
0.190	-	-	-	-	-	-	1753	-	1925	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (f)

Rivet Type	MS20426AD				MS20426D			MS20426DD		
Sheet Material	Clad 2024-T42									
Rivet Dia (in)	3/32	1/8	5/32	3/16	5/32	3/16	1/4	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, N									
	0.032	792	-	-	-	-	-	-	-	-
	0.040	859	1375	-	-	-	-	-	-	-
	0.050	916	1512	2131	-	2580	-	-	-	-
	0.063	961	1615	2326	3136	2922	3821	-	3941	-
	0.071	961	1659	2411	3287	3069	4079	-	4190	-
	0.080	961	1659	2491	3421	3203	4310	-	4413	-
	0.090	961	1659	2558	3536	3318	4515	6904	4604	7326
	0.100	961	1659	2558	3639	3318	4688	7295	4773	7731
	0.125	961	1659	2558	3794	3318	4849	7887	5031	8349
	0.160	961	1659	2558	-	3318	4849	8412	5031	8896
0.190	961	1659	2558	-	3318	4849	8763	5031	9270	
Rivet Shear Strength	965	1726	2651	3834	3358	4849	8763	5227	9452	
Sheet Thickness (in)	Yield Strength, N									
	0.032	587	-	-	-	-	-	-	-	-
	0.040	681	1028	-	-	-	-	-	-	-
	0.050	836	1161	1428	-	1535	-	-	-	-
	0.063	947	1428	1788	2095	1784	2291	-	2731	-
	0.071	-	1548	2015	2393	2140	2478	-	2976	-
	0.080	-	-	2215	2740	2500	2771	-	3385	-
	0.090	-	-	2389	3047	2816	3318	3830	3745	4684
	0.100	-	-	-	3314	-	3799	4524	4061	4960
	0.125	-	-	-	3719	-	4528	5841	4542	6036
	0.160	-	-	-	-	-	-	7002	-	7535
0.190	-	-	-	-	-	-	7798	-	8563	

**Material in knife edge condition:- Not recommended**

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (n)

Rivet Type	NAS1097-E								
Sheet Material	Clad 2024-T3				Clad 7075-T6				
Rivet Dia (in)	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, lb								
	0.025	227	-	-	-	278	-	-	-
	0.032	326	367	-	-	354	441	-	-
	0.040	437	505	561	-	439	547	661	-
	0.050	466	679	773	908	456	674	823	1120
	0.063	485	717	1005	1275	477	700	980	1330
	0.071	497	731	1025	1500	490	716	999	1570
	0.080	507	747	1045	1750	505	734	1020	1760
	0.090	521	765	1065	1840	520	754	1045	1790
	0.100	531	781	1085	1870	531	774	1070	1825
	0.125	531	814	1135	1935	531	814	1130	1905
	0.160	531	814	1175	2030	531	814	1175	2020
	0.190	531	814	1175	2110	531	814	1175	2115
0.250	531	814	1175	2125	531	814	1175	2125	
Rivet Shear Strength	531	814	1175	2125	531	814	1175	2125	
Sheet Thickness (in)	Yield Strength, lb								
	0.025	192	-	-	-	222	-	-	-
	0.032	283	311	-	-	307	356	-	-
	0.040	349	439	479	-	372	475	542	-
	0.050	398	538	674	767	398	572	724	894
	0.063	462	617	799	1105	431	612	836	1205
	0.071	497	665	857	1310	451	638	867	1400
	0.080	507	720	921	1400	474	666	900	1490
	0.090	521	765	995	1500	499	698	938	1540
	0.100	531	781	1065	1595	525	729	976	1595
	0.125	-	814	1135	1835	-	808	1070	1720
	0.160	-	-	1175	2030	-	-	1175	1895
	0.190	-	-	-	2110	-	-	-	2050
0.250	-	-	-	2125	-	-	-	2125	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (n)

Rivet Type	NAS1097-E								
Sheet Material	Clad 2024-T3				Clad 7075-T6				
Rivet Dia (in)	1/8	5/32	3/16	1/4	1/8	5/32	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, N								
	0.025	1010	-	-	-	1237	-	-	-
	0.032	1450	1632	-	-	1575	1962	-	-
	0.040	1944	2246	2495	-	1953	2433	2940	-
	0.050	2073	3020	3438	4039	2028	2998	3661	4982
	0.063	2157	3189	4470	5671	2122	3114	4359	5916
	0.071	2211	3252	4559	6672	2180	3185	4444	6984
	0.080	2255	3323	4648	7784	2246	3265	4537	7829
	0.090	2318	3403	4737	8185	2313	3354	4648	7962
	0.100	2362	3474	4826	8318	2362	3443	4760	8118
	0.125	2362	3621	5049	8607	2362	3621	5026	8474
	0.160	2362	3621	5227	9030	2362	3621	5227	8985
	0.190	2362	3621	5227	9386	2362	3621	5227	9408
0.250	2362	3621	5227	9452	2362	3621	5227	9452	
Rivet Shear Strength	2362	3621	5227	9452	2362	3621	5227	9452	
Sheet Thickness (in)	Yield Strength, N								
	0.025	854	-	-	-	988	-	-	-
	0.032	1259	1383	-	-	1366	1584	-	-
	0.040	1552	1953	2131	-	1655	2113	2411	-
	0.050	1770	2393	2998	3412	1770	2544	3221	3977
	0.063	2055	2745	3554	4915	1917	2722	3719	5360
	0.071	2211	2958	3812	5827	2006	2838	3857	6228
	0.080	2255	3203	4097	6228	2108	2963	4003	6628
	0.090	2318	3403	4426	6672	2220	3105	4172	6850
	0.100	2362	3474	4737	7095	2335	3243	4341	7095
	0.125	-	3621	5049	8162	-	3594	4760	7651
	0.160	-	-	5227	9030	-	-	5227	8429
	0.190	-	-	-	9386	-	-	-	9119
0.250	-	-	-	9452	-	-	-	9452	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (r)

Rivet Type	<b>MS20426E</b>			
Sheet Material	Clad 2024-T3			
Rivet Dia (in)	1/8	5/32	3/16	1/4
Sheet Thickness (in)	Ultimate Strength, lb			
	0.040	386	-	-
	0.050	419	592	-
	0.063	463	647	870
	0.071	491	680	910
	0.080	521	718	955
	0.090	531	760	1005
	0.100	531	802	1055
	0.125	531	814	1175
	0.160	531	814	1175
0.190	531	814	1175	
Rivet Shear Strength	531	814	1175	2125
Sheet Thickness (in)	Yield Strength, lb			
	0.040	262	-	-
	0.050	327	404	-
	0.063	412	510	612
	0.071	464	574	690
	0.080	517	647	777
	0.090	531	728	875
	0.100	-	794	972
	0.125	-	814	1160
	0.160	-	-	-
0.190	-	-	-	

Material in knife edge condition:- Not recommended



## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (r)

Rivet Type	<b>MS20426E</b>			
Sheet Material	Clad 2024-T3			
Rivet Dia (in)	1/8	5/32	3/16	1/4
Sheet Thickness (in)	Ultimate Strength, N			
	0.040	1717	-	-
	0.050	1864	2633	-
	0.063	2060	2878	3870
	0.071	2184	3025	4048
	0.080	2318	3194	4248
	0.090	2362	3381	4470
	0.100	2362	3567	4693
	0.125	2362	3621	5227
	0.160	2362	3621	5227
0.190	2362	3621	5227	
Rivet Shear Strength	2362	3621	5227	9452
Sheet Thickness (in)	Yield Strength, N			
	0.040	1165	-	-
	0.050	1455	1797	-
	0.063	1833	2269	2722
	0.071	2064	2553	3069
	0.080	2300	2878	3456
	0.090	2362	3238	3892
	0.100	-	3532	4324
	0.125	-	3621	5160
	0.160	-	-	-
0.190	-	-	-	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (s)

Rivet Type	<b>MS20426E</b>			
Sheet Material	Clad 7075-T6			
Rivet Dia (in)	1/8	5/32	3/16	1/4
Sheet Thickness (in)	Ultimate Strength, lb			
	0.040	318	-	-
	0.050	393	492	-
	0.063	440	606	745
	0.071	469	642	840
	0.080	502	683	898
	0.090	531	728	952
	0.100	531	773	1005
	0.125	531	814	1140
	0.160	531	814	1175
0.190	531	814	1175	
Rivet Shear Strength	531	814	1175	2125
Sheet Thickness (in)	Yield Strength, lb			
	0.040	257	-	-
	0.050	330	399	-
	0.063	423	515	607
	0.071	469	586	693
	0.080	502	666	789
	0.090	531	728	896
	0.100	-	773	1005
	0.125	-	814	1140
	0.160	-	-	1175
0.190	-	-	-	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    100 deg Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (s)

Rivet Type	<b>MS20426E</b>			
Sheet Material	Clad 7075-T6			
Rivet Dia (in)	1/8	5/32	3/16	1/4
Sheet Thickness (in)	Ultimate Strength, N			
	0.040	1415	-	-
	0.050	1748	2189	-
	0.063	1957	2696	3314
	0.071	2086	2856	3737
	0.080	2233	3038	3995
	0.090	2362	3238	4235
	0.100	2362	3438	4470
	0.125	2362	3621	5071
	0.160	2362	3621	5227
0.190	2362	3621	5227	
Rivet Shear Strength	2362	3621	5227	9452
Sheet Thickness (in)	Yield Strength, N			
	0.040	1143	-	-
	0.050	1468	1775	-
	0.063	1882	2291	2700
	0.071	2086	2607	3083
	0.080	2233	2963	3510
	0.090	2362	3238	3986
	0.100	-	3438	4470
	0.125	-	3621	5071
	0.160	-	-	5227
0.190	-	-	-	

Material in knife edge condition:- Not recommended



## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Dimpled Al Sheet

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (i)

Rivet Type	<b>BRFS-D</b>					
Sheet Material	Clad 2024-T3					
Rivet Dia (in)	3/32	1/8	5/32	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, lb					
	0.020	139	-	-	-	-
	0.025	176	233	-	-	-
	0.032	226	300	367	-	-
	0.040	275	378	465	552	-
	0.050	275	477	585	697	930
	0.063	275	494	741	886	1182
	0.071	275	494	755	1005	1338
	0.080	275	494	755	1090	1513
	0.090	275	494	755	1090	1711
	0.100	275	494	755	1090	1902
0.125	275	494	755	1090	1970	
Rivet Shear Strength	275	494	755	1090	1970	
Sheet Thickness (in)	Yield Strength, lb					
	0.020	137	-	-	-	-
	0.025	171	229	-	-	-
	0.032	207	294	359	-	-
	0.040	231	357	453	547	-
	0.050	-	398	550	680	918
	0.063	-	451	614	814	1149
	0.071	-	-	655	857	1295
	0.080	-	-	-	914	1430
	0.090	-	-	-	-	1513
	0.100	-	-	-	-	1592
0.125	-	-	-	-	1790	

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (i)

Rivet Type	<b>BRFS-D</b>				
Sheet Material	Clad 2024-T3				
Rivet Dia (in)	3/32	1/8	5/32	3/16	1/4
Sheet Thickness (in)	Ultimate Strength, N				
	0.020	618	-	-	-
	0.025	783	1036	-	-
	0.032	1005	1334	1632	-
	0.040	1223	1681	2068	2455
	0.050	1223	2122	2602	3100
	0.063	1223	2197	3296	3941
	0.071	1223	2197	3358	4470
	0.080	1223	2197	3358	4849
	0.090	1223	2197	3358	4849
	0.100	1223	2197	3358	4849
0.125	1223	2197	3358	4849	
Rivet Shear Strength	1223	2197	3358	4849	8763
Sheet Thickness (in)	Yield Strength, N				
	0.020	609	-	-	-
	0.025	761	1019	-	-
	0.032	921	1308	1597	-
	0.040	1028	1588	2015	2433
	0.050	-	1770	2447	3025
	0.063	-	2006	2731	3621
	0.071	-	-	2914	3812
	0.080	-	-	-	4066
	0.090	-	-	-	-
	0.100	-	-	-	-
0.125	-	-	-	-	

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (i)

Rivet Type	<b>BRFS-AD</b>					
Sheet Material	Clad 2024-T3					
Rivet Dia (in)	3/32	1/8	5/32	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, lb					
	0.020	119	-	-	-	-
	0.025	144	201	-	-	-
	0.032	171	250	316	-	-
	0.040	204	292	386	474	-
	0.050	217	343	451	571	806
	0.063	217	388	536	675	987
	0.071	217	388	596	737	1073
	0.080	217	388	596	812	1169
	0.090	217	388	596	862	1278
	0.100	217	388	596	862	1371
0.125	217	388	596	862	1550	
Rivet Shear Strength	217	388	596	862	1550	
Sheet Thickness (in)	Yield Strength, lb					
	0.020	119	-	-	-	-
	0.025	144	201	-	-	-
	0.032	171	250	316	-	-
	0.040	204	292	386	474	-
	0.050	217	343	451	571	806
	0.063	-	388	536	675	987
	0.071	-	-	596	737	1073
	0.080	-	-	-	812	1169
	0.090	-	-	-	862	1278
	0.100	-	-	-	-	1371
0.125	-	-	-	-	1550	

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (i)

Rivet Type	<b>BRFS-AD</b>					
Sheet Material	Clad 2024-T3					
Rivet Dia (in)	3/32	1/8	5/32	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, N					
	0.020	529	-	-	-	
	0.025	641	894	-	-	
	0.032	761	1112	1406	-	
	0.040	907	1299	1717	2108	
	0.050	965	1526	2006	2540	3585
	0.063	965	1726	2384	3003	4390
	0.071	965	1726	2651	3278	4773
	0.080	965	1726	2651	3612	5200
	0.090	965	1726	2651	3834	5685
	0.100	965	1726	2651	3834	6099
0.125	965	1726	2651	3834	6895	
Rivet Shear Strength	965	1726	2651	3834	6895	
Sheet Thickness (in)	Yield Strength, N					
	0.020	529	-	-	-	
	0.025	641	894	-	-	
	0.032	761	1112	1406	-	
	0.040	907	1299	1717	2108	
	0.050	965	1526	2006	2540	3585
	0.063	-	1726	2384	3003	4390
	0.071	-	-	2651	3278	4773
	0.080	-	-	-	3612	5200
	0.090	-	-	-	3834	5685
	0.100	-	-	-	-	6099
0.125	-	-	-	-	6895	



## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (k)

Rivet Type	<b>BRFS-DD</b>		
Sheet Material	Clad 2024-T3		
Rivet Dia (in)	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, lb		
	0.040	598	-
	0.050	772	1000
	0.063	994	1300
	0.071	1130	1480
	0.080	1180	1690
	0.090	1180	2120
	0.100	1180	2120
Rivet Shear Strength	1180		
Sheet Thickness (in)	Yield Strength, lb		
	0.040	598	-
	0.050	772	1000
	0.063	949	1300
	0.071	1000	1480
	0.080	1060	1680
	0.090	-	1760
	0.100	-	1850

Rivet Type	<b>BRFS-DD</b>		
Sheet Material	Clad 2024-T3		
Rivet Dia (in)	3/16	1/4	
Sheet Thickness (in)	Ultimate Strength, N		
	0.040	2660	-
	0.050	3434	4448
	0.063	4422	5783
	0.071	5026	6583
	0.080	5249	7517
	0.090	5249	9430
	0.100	5249	9430
Rivet Shear Strength	5249                      9430		
Sheet Thickness (in)	Yield Strength, N		
	0.040	2660	-
	0.050	3434	4448
	0.063	4221	5783
	0.071	4448	6583
	0.080	4715	7473
	0.090	-	7829
	0.100	-	8229

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (m)

Rivet Type	<b>MS14218E</b>							
Sheet Material	Clad 2024-T3							
Rivet Dia (in)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, lb							
	0.025	215	-	-	-	-	-	-
	0.032	307	346	-	-	-	-	-
	0.040	434	478	529	-	-	-	-
	0.050	508	673	732	806	-	-	-
	0.063	536	781	1045	1135	1200	1285	-
	0.071	554	803	1110	1365	1445	1530	1630
	0.080	558	827	1140	1565	1735	1835	1930
	0.090	558	854	1175	1605	1990	2200	2320
	0.100	558	854	1205	1645	2030	2525	2725
	0.125	558	854	1230	1740	2140	2650	3205
	0.160	558	854	1230	1755	2230	2820	3400
0.190	558	854	1230	1755	2230	2840	3525	
Rivet Shear Strength	558	854	1230	1755	2230	2840	3525	
Sheet Thickness (in)	Yield Strength, lb							
	0.025	215	-	-	-	-	-	-
	0.032	307	346	-	-	-	-	-
	0.040	388	478	529	-	-	-	-
	0.050	487	601	721	806	-	-	-
	0.063	536	760	912	1085	1200	1285	-
	0.071	552	803	1030	1225	1377	1530	1630
	0.080	558	827	1140	1385	1554	1755	1930
	0.090	-	854	1175	1560	1750	1970	2200
	0.100	-	-	1205	1645	1950	2200	2445
	0.125	-	-	1230	1735	2140	2650	3060
	0.160	-	-	-	1755	2230	2810	3400
0.190	-	-	-	-	-	2840	3525	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (m)

Rivet Type	MS14218E							
Sheet Material	Clad 2024-T3							
Rivet Dia (in)	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, N							
	0.025	956	-	-	-	-	-	-
	0.032	1366	1539	-	-	-	-	-
	0.040	1931	2126	2353	-	-	-	-
	0.050	2260	2994	3256	3585	-	-	-
	0.063	2384	3474	4648	5049	5338	5716	-
	0.071	2464	3572	4938	6072	6428	6806	7251
	0.080	2482	3679	5071	6961	7718	8162	8585
	0.090	2482	3799	5227	7139	8852	9786	10320
	0.100	2482	3799	5360	7317	9030	11232	12121
	0.125	2482	3799	5471	7740	9519	11788	14257
	0.160	2482	3799	5471	7807	9920	12544	15124
0.190	2482	3799	5471	7807	9920	12633	15680	
Rivet Shear Strength	2482	3799	5471	7807	9920	12633	15680	
Sheet Thickness (in)	Yield Strength, N							
	0.025	956	-	-	-	-	-	-
	0.032	1366	1539	-	-	-	-	-
	0.040	1726	2126	2353	-	-	-	-
	0.050	2166	2673	3207	3585	-	-	-
	0.063	2384	3381	4057	4826	5338	5716	-
	0.071	2455	3572	4582	5449	6125	6806	7251
	0.080	2482	3679	5071	6161	6913	7807	8585
	0.090	-	3799	5227	6939	7784	8763	9786
	0.100	-	-	5360	7317	8674	9786	10876
	0.125	-	-	5471	7718	9519	11788	13612
	0.160	-	-	-	7807	9920	12500	15124
0.190	-	-	-	-	-	12633	15680	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (o)

Rivet Type	<b>MS14218AD</b>						
Sheet Material	Clad 2024-T3						
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	
Sheet Thickness (in)	Ultimate Strength, lb						
	0.020	125	-	-	-	-	
	0.025	153	212	-	-	-	
	0.032	188	263	334	-	-	
	0.040	216	322	408	498	-	
	0.050	217	380	498	609	740	849
	0.063	217	388	588	751	910	1040
	0.071	217	388	596	817	1015	1155
	0.080	217	388	596	862	1125	1290
	0.090	217	388	596	862	1205	1425
	0.100	217	388	596	862	1225	1520
0.125	217	388	596	862	1225	1555	
Rivet Shear Strength	217	388	596	862	1225	1555	
Sheet Thickness (in)	Yield Strength, lb						
	0.020	125	-	-	-	-	
	0.025	153	212	-	-	-	
	0.032	188	263	334	-	-	
	0.040	216	319	408	498	-	
	0.050	217	370	492	609	740	849
	0.063	-	388	574	733	910	1040
	0.071	-	-	596	794	1005	1155
	0.080	-	-	-	842	1090	1275
	0.090	-	-	-	862	1180	1380
	0.100	-	-	-	-	1225	1480
0.125	-	-	-	-	-	1555	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Shear Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (o)

Rivet Type	MS14218AD						
Sheet Material	Clad 2024-T3						
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	
Sheet Thickness (in)	Ultimate Strength, N						
	0.020	556	-	-	-	-	
	0.025	681	943	-	-	-	
	0.032	836	1170	1486	-	-	
	0.040	961	1432	1815	2215	-	
	0.050	965	1690	2215	2709	3292	3777
	0.063	965	1726	2616	3341	4048	4626
	0.071	965	1726	2651	3634	4515	5138
	0.080	965	1726	2651	3834	5004	5738
	0.090	965	1726	2651	3834	5360	6339
	0.100	965	1726	2651	3834	5449	6761
0.125	965	1726	2651	3834	5449	6917	
Rivet Shear Strength	965	1726	2651	3834	5449	6917	
Sheet Thickness (in)	Yield Strength, N						
	0.020	556	-	-	-	-	
	0.025	681	943	-	-	-	
	0.032	836	1170	1486	-	-	
	0.040	961	1419	1815	2215	-	
	0.050	965	1646	2189	2709	3292	3777
	0.063	-	1726	2553	3261	4048	4626
	0.071	-	-	2651	3532	4470	5138
	0.080	-	-	-	3745	4849	5671
	0.090	-	-	-	3834	5249	6139
	0.100	-	-	-	-	5449	6583
0.125	-	-	-	-	-	6917	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Tension Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (p)

Rivet Type	MS14219E								
Sheet Material	Clad 2024-T3								
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, lb								
	0.032	210	-	-	-	-	-	-	-
	0.040	279	339	-	-	-	-	-	-
	0.050	310	473	527	-	-	-	-	-
	0.063	311	538	743	819	-	-	-	-
	0.071	311	558	788	979	1065	-	-	-
	0.080	311	558	834	1105	1280	-	-	-
	0.090	311	558	854	1165	1520	1625	-	-
	0.100	311	558	854	1230	1605	1890	2020	2120
	0.125	311	558	854	1230	1755	2145	2580	2965
	0.160	311	558	854	1230	1755	2230	2840	3415
0.190	311	558	854	1230	1755	2230	2840	3525	
Rivet Shear Strength	311	588	854	1230	1755	2230	2840	3525	
Sheet Thickness (in)	Yield Strength, lb								
	0.032	210	-	-	-	-	-	-	-
	0.040	277	339	-	-	-	-	-	-
	0.050	301	468	527	-	-	-	-	-
	0.063	309	538	728	819	-	-	-	-
	0.071	-	543	788	979	1065	-	-	-
	0.080	-	-	823	1100	1280	-	-	-
	0.090	-	-	833	1165	1490	1625	-	-
	0.100	-	-	-	1190	1605	1875	2020	2120
	0.125	-	-	-	-	1705	2145	2580	2945
	0.160	-	-	-	-	-	2200	2765	3390
0.190	-	-	-	-	-	-	-	3455	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Tension Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (p)

Rivet Type	MS14219E								
Sheet Material	Clad 2024-T3								
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, N								
	0.032	934	-	-	-	-	-	-	-
	0.040	1241	1508	-	-	-	-	-	-
	0.050	1379	2104	2344	-	-	-	-	-
	0.063	1383	2393	3305	3643	-	-	-	-
	0.071	1383	2482	3505	4355	4737	-	-	-
	0.080	1383	2482	3710	4915	5694	-	-	-
	0.090	1383	2482	3799	5182	6761	7228	-	-
	0.100	1383	2482	3799	5471	7139	8407	8985	9430
	0.125	1383	2482	3799	5471	7807	9541	11476	13189
	0.160	1383	2482	3799	5471	7807	9920	12633	15191
0.190	1383	2482	3799	5471	7807	9920	12633	15680	
Rivet Shear Strength	1383	2616	3799	5471	7807	9920	12633	15680	
Sheet Thickness (in)	Yield Strength, N								
	0.032	934	-	-	-	-	-	-	-
	0.040	1232	1508	-	-	-	-	-	-
	0.050	1339	2082	2344	-	-	-	-	-
	0.063	1375	2393	3238	3643	-	-	-	-
	0.071	-	2415	3505	4355	4737	-	-	-
	0.080	-	-	3661	4893	5694	-	-	-
	0.090	-	-	3705	5182	6628	7228	-	-
	0.100	-	-	-	5293	7139	8340	8985	9430
	0.125	-	-	-	-	7584	9541	11476	13100
	0.160	-	-	-	-	-	9786	12299	15079
0.190	-	-	-	-	-	-	-	15369	

Material in knife edge condition:- Not recommended

## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Tension Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (q)

Rivet Type	MS14219E								
Sheet Material	Clad 7075-T6								
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, lb								
	0.032	272	-	-	-	-	-	-	-
	0.040	297	455	-	-	-	-	-	-
	0.050	311	522	704	-	-	-	-	-
	0.063	311	558	803	1065	-	-	-	-
	0.071	311	558	832	1140	1435	-	-	-
	0.080	311	558	854	1180	1600	-	-	-
	0.090	311	558	854	1220	1650	2030	-	-
	0.100	311	558	854	1230	1700	2090	2565	2860
	0.125	311	558	854	1230	1755	2230	2740	3295
0.160	311	558	854	1230	1755	2230	2840	3525	
Rivet Shear Strength	311	558	854	1230	1755	2230	2840	3525	
Sheet Thickness (in)	Yield Strength, lb								
	0.032	272	-	-	-	-	-	-	-
	0.040	296	455	-	-	-	-	-	-
	0.050	308	522	704	-	-	-	-	-
	0.063	-	550	802	1065	-	-	-	-
	0.071	-	-	823	1140	1435	-	-	-
	0.080	-	-	845	1170	1600	-	-	-
	0.090	-	-	-	1205	1650	2030	-	-
	0.100	-	-	-	1220	1685	2090	2565	2860
	0.125	-	-	-	-	1740	2195	2715	3295
0.160	-	-	-	-	-	-	2815	3480	

Material in knife edge condition:- Not recommended



## MATERIAL ALLOWABLE STRENGTH DATA

Flush Head    120 deg Tension Heads    Machine Countersunk Al Sheet

Data Source Reference:- Mil-Hdbk-5 Iss. H, Table 8.1.2.2 (q)

Rivet Type	MS14219E								
Sheet Material	Clad 7075-T6								
Rivet Dia (in)	3/32	1/8	5/32	3/16	7/32	1/4	9/32	5/16	
Sheet Thickness (in)	Ultimate Strength, N								
	0.032	1210	-	-	-	-	-	-	-
	0.040	1321	2024	-	-	-	-	-	-
	0.050	1383	2322	3132	-	-	-	-	-
	0.063	1383	2482	3572	4737	-	-	-	-
	0.071	1383	2482	3701	5071	6383	-	-	-
	0.080	1383	2482	3799	5249	7117	-	-	-
	0.090	1383	2482	3799	5427	7340	9030	-	-
	0.100	1383	2482	3799	5471	7562	9297	11410	12722
	0.125	1383	2482	3799	5471	7807	9920	12188	14657
0.160	1383	2482	3799	5471	7807	9920	12633	15680	
Rivet Shear Strength	1383	2482	3799	5471	7807	9920	12633	15680	
Sheet Thickness (in)	Yield Strength, N								
	0.032	1210	-	-	-	-	-	-	-
	0.040	1317	2024	-	-	-	-	-	-
	0.050	1370	2322	3132	-	-	-	-	-
	0.063	-	2447	3567	4737	-	-	-	-
	0.071	-	-	3661	5071	6383	-	-	-
	0.080	-	-	3759	5204	7117	-	-	-
	0.090	-	-	-	5360	7340	9030	-	-
	0.100	-	-	-	5427	7495	9297	11410	12722
	0.125	-	-	-	-	7740	9764	12077	14657
0.160	-	-	-	-	-	-	12522	15480	

Material in knife edge condition:- Not recommended

# MATERIAL ALLOWABLE STRENGTH DATA

## Tensile Behaviour of Rivets

Reference Data Source:- Analysis & Design of Flight Vehicle Structures  
E.F. Bruhn D1.26

### Protruding Head

(AN470 or AN442 in 24ST Alclad or better)

Allowable Ultimate Load / Rivet (lb)								
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Sheet Gauge (in)	0.016	89	-	-	-	-	-	-
	0.020	120	142	-	-	-	-	-
	0.025	159	197	223	-	-	-	-
	0.032	214	269	311	354	-	-	-
	0.040	277	353	420	474	568	-	-
	0.051	277	471	561	649	799	929	-
	0.064	277	495	736	854	1077	1262	-
	0.072	277	495	758	981	1245	1482	1669
	0.081	277	495	758	1094	1440	1721	1952
	0.091	277	495	758	1094	1651	1982	2265
	0.102	277	495	758	1094	1882	2274	2622
	0.125	277	495	758	1094	1982	2890	3353
	0.156	277	495	758	1094	1982	3130	4336
	0.188	277	495	758	1094	1982	3130	4470
0.250	277	495	758	1094	1982	3130	4470	

Allowable Ultimate Load / Rivet (N)								
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Sheet Gauge (in)	0.016	396	-	-	-	-	-	-
	0.020	534	632	-	-	-	-	-
	0.025	707	876	992	-	-	-	-
	0.032	952	1197	1383	1575	-	-	-
	0.040	1232	1570	1868	2108	2527	-	-
	0.051	1232	2095	2495	2887	3554	4132	-
	0.064	1232	2202	3274	3799	4791	5614	-
	0.072	1232	2202	3372	4364	5538	6592	7424
	0.081	1232	2202	3372	4866	6405	7655	8683
	0.091	1232	2202	3372	4866	7344	8816	10075
	0.102	1232	2202	3372	4866	8372	10115	11663
	0.125	1232	2202	3372	4866	8816	12855	14915
	0.156	1232	2202	3372	4866	8816	13923	19287
	0.188	1232	2202	3372	4866	8816	13923	19884
0.250	1232	2202	3372	4866	8816	13923	19884	

## MATERIAL ALLOWABLE STRENGTH DATA

100 deg Flush Head - Dimpled Sheet  
(AN426 in 24ST Alclad or better)

Note:-  $t_{min}$  = Min thickness of countersunk sheet

Allowable Ultimate Load / Rivet (lb)						
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4
Sheet Gauge (in)	0.020	103	-	-	-	-
	0.025	137	168	-	-	-
	0.032	185	233	271	-	-
	0.040	241	305	362	409	-
	0.051	-	408	485	562	694
	0.064	-	446	635	737	931
	0.072	-	-	-	850	1077
	0.081	-	-	-	970	1242
	$t_{min}$	0.020	0.025	0.032	0.040	0.51

Allowable Ultimate Load / Rivet (N)						
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4
Sheet Gauge (in)	0.020	458	-	-	-	-
	0.025	609	747	-	-	-
	0.032	823	1036	1205	-	-
	0.040	1072	1357	1610	1819	-
	0.051	-	1815	2157	2500	3087
	0.064	-	1984	2825	3278	4141
	0.072	-	-	-	3781	4791
	0.081	-	-	-	4315	5525
	$t_{min}$	0.020	0.025	0.032	0.040	0.51

## MATERIAL ALLOWABLE STRENGTH DATA

100 deg Flush Head - Machined Countersunk Sheet  
(AN426 in 24ST Alclad or better)

Note:-  $t_{min}$  = Min thickness of either sheet

Allowable Ultimate Load / Rivet (lb)								
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Sheet Gauge (in)	0.040	191	-	-	-	-	-	-
	0.051	249	319	-	-	-	-	-
	0.064	249	438	501	-	-	-	-
	0.072	249	446	592	653	-	-	-
	0.081	249	446	683	773	-	-	-
	0.091	249	446	683	912	-	-	-
	0.102	249	446	683	985	1275	-	-
	0.125	249	446	683	985	1698	1941	-
	0.156	249	446	683	985	1783	2660	2950
	0.188	249	446	683	985	1783	2817	3827
	0.250	249	446	683	985	1783	2817	4023
$t_{min}$	0.040	0.051	0.064	0.072	0.102	0.125	0.156	

Allowable Ultimate Load / Rivet (lb)								
	Rivet Size (in)	3/32	1/8	5/32	3/16	1/4	5/16	3/8
Sheet Gauge (in)	0.040	850	-	-	-	-	-	-
	0.051	1108	1419	-	-	-	-	-
	0.064	1108	1948	2229	-	-	-	-
	0.072	1108	1984	2633	2905	-	-	-
	0.081	1108	1984	3038	3438	-	-	-
	0.091	1108	1984	3038	4057	-	-	-
	0.102	1108	1984	3038	4381	5671	-	-
	0.125	1108	1984	3038	4381	7553	8634	-
	0.156	1108	1984	3038	4381	7931	11832	13122
	0.188	1108	1984	3038	4381	7931	12531	17023
	0.250	1108	1984	3038	4381	7931	12531	17895
$t_{min}$	0.040	0.051	0.064	0.072	0.102	0.125	0.156	