

Fastening Hardware

1/30/21 FCA Workshop!

Zoom Recordings

Part 1

Part 2

(sorry I accidentally sliced it)

Terminology

Fastener head types: countersunk, counterbore, & regular

Countersunk:

- Needed when the surface needs to be flush. Ex ^



Regular/
universal:



Material

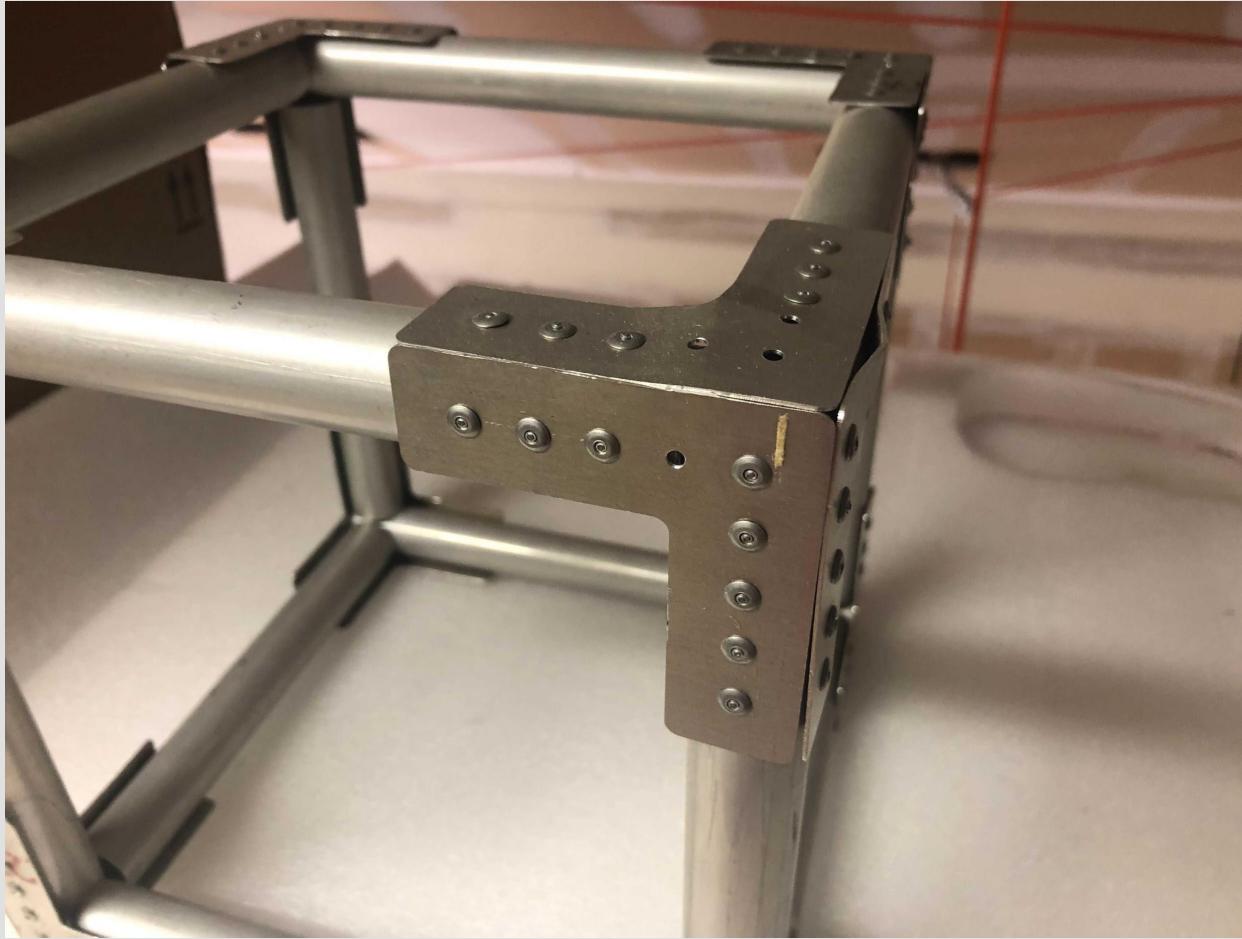
Steel: usually stronger

- Yes it works with aluminum.
- Galvanic Corrosion:
- Preventable!
 - Vitamin C added on there
 - And steel rusts with water so double whammy
- Most Rivets/ Bolts come in this



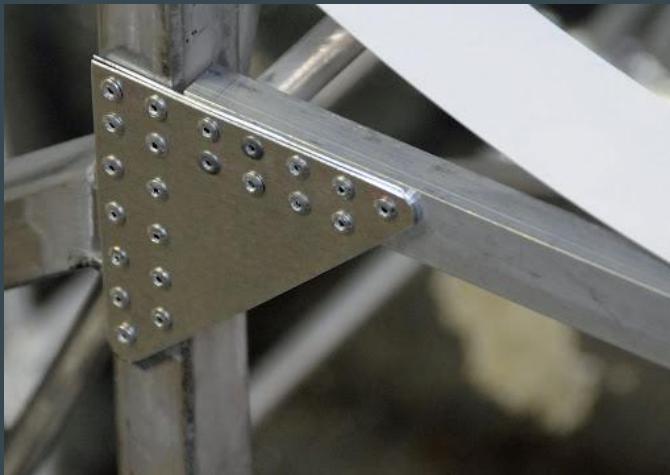
Can find strength when finding your rivet

Rivets



Where are they used?

- Gussets
 - Brackets that add strength + reinforcement to the attachment
 - Attached with bolts, rivets, and/or welds
 - A small plate attached to different parts of the truss
 - Helps to move stresses from one part to another
- Materials
- A May blog post details some of our history with gussets



Blind vs Bucked

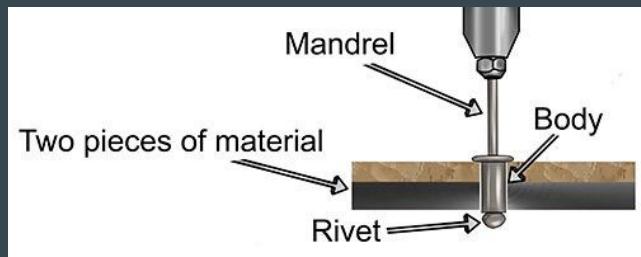
Blind Rivets:

- Used when you can't see the backside of whatever you're riveting
- A "mandrel" is pulled up by rivet gun which deforms the rivet on one side, squeezing material outwards until the mandrel snaps off
- Flexible, reliable (but not as reliable as buck rivets), less chances of damaging surfaces, and quick/easy to install, removable



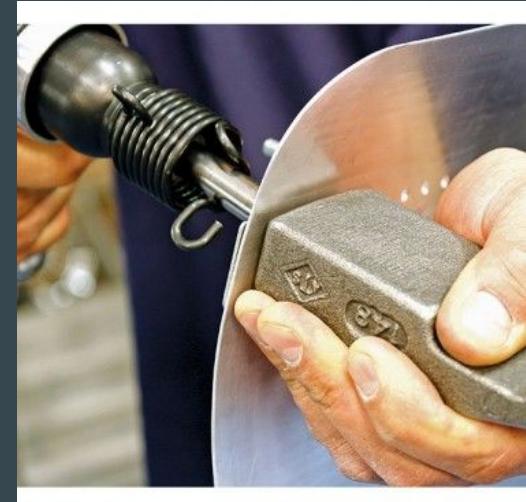
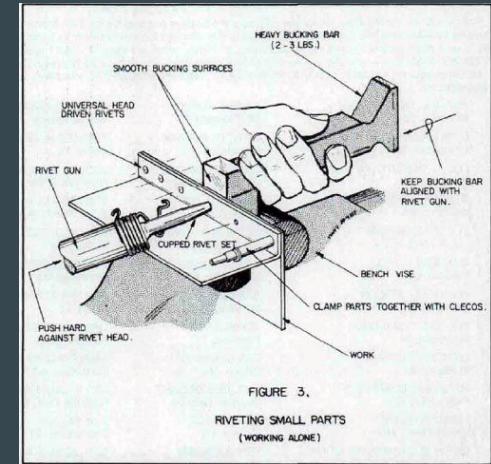
Buck Rivets:

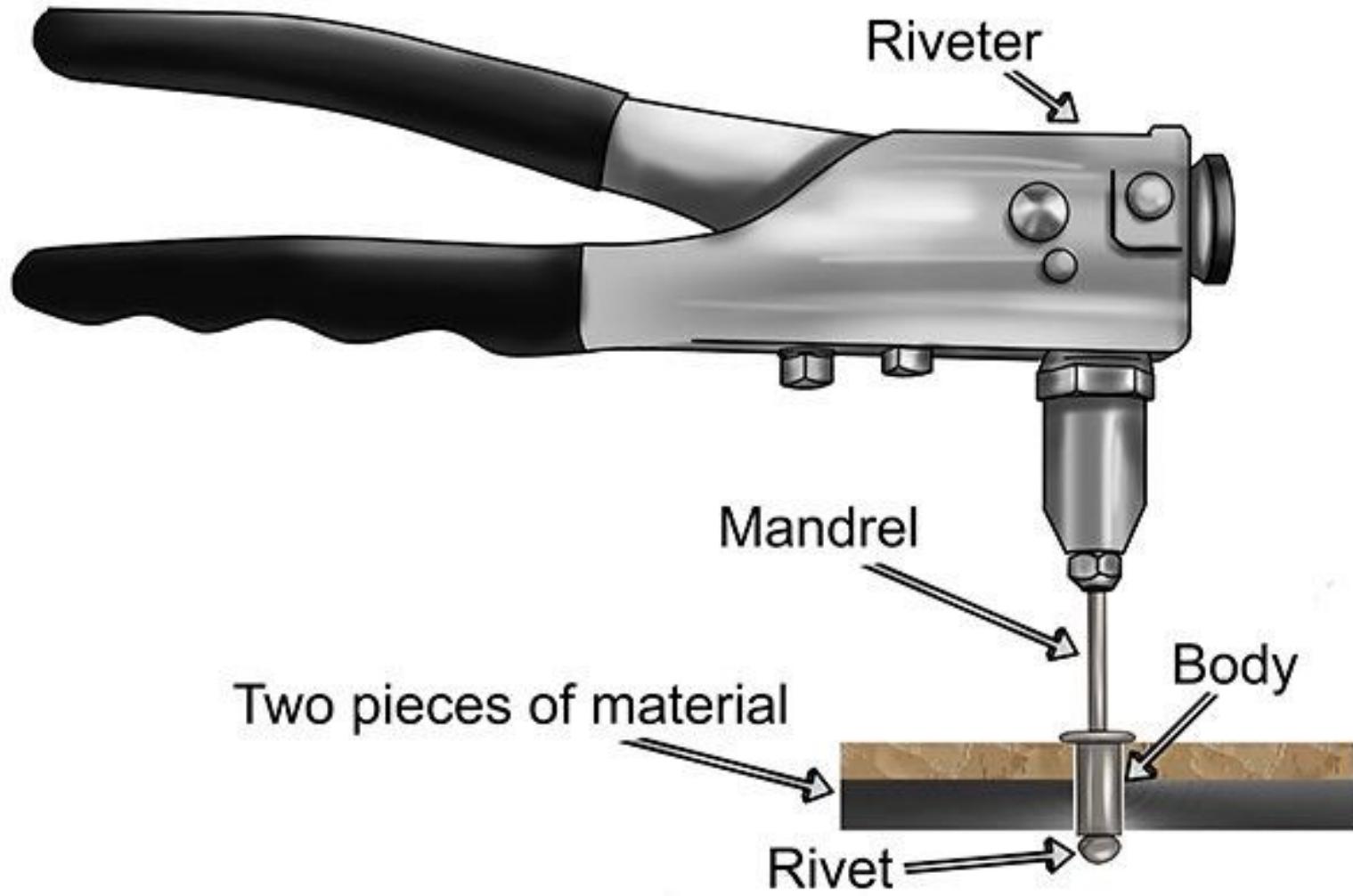
- Basic type of rivet, can't be used unless you have access to the backside whatever you're riveting
- Basic shaft and head, insert like normal and use a hammer to flatten the shaft and secure the rivet
- Very very strong, permanent, is a little more work than blind rivets, and the process could be dangerous on sensitive surfaces



Bucked Rivets

- Need a Buck Bar
- Need Air Hammer
-





Brands

Cherrymax Rivets

- Extremely strong
- Extremely expensive (\$0.60/ per)
- Super used in Aerospace Industry
- Not off aircraft spruce → go to their website, find what you need, look it up online

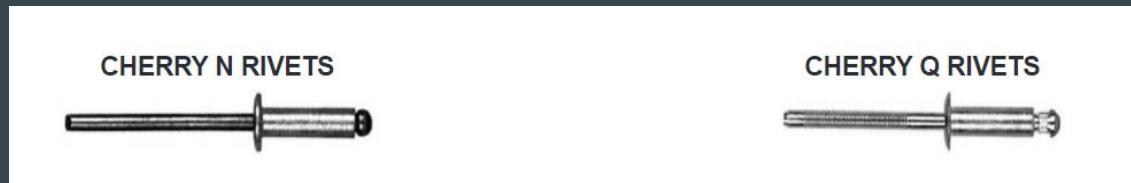


Mechanical Properties *

Materials		Ultimate Shear Strength	Maximum Temperature
Sleeve	Stem		
5056 Aluminum	Alloy Steel	50,000 psi	250° F
5056 Aluminum	CRES	50,000 psi	250° F
Monel	CRES	75,000 psi	900° F
Inco 600	Inco X-750	75,000 psi	1400° F

Cherry rivets

- Aircraft spruce
- Less structural members
 - Still really strong
- Would have done our fuselage out of them if we were still gusseting it
- Less expensive (\$0.40/ea)



Nomenclature

Cherrymax Rivets:

Part Numbering System

Part Number Example: CR3 24 2 -6 -04

CR3 CherryMAX® Rivet

24 Rivet Type & Material Combination - see [Product Catalog](#)

2 Head Style

Odd Number = Protruding Head

Even Number = Flush Head

-6 Rivet Diameter *in 32nds of an inch (-6 = 6/32 = 3/16)*

-04 Maximum Grip Length *in 16ths of an inch (-04 = 4/16 = 1/4)*

Every Company/ Attachment has one.

Find it off [Aircraft Spruce](#) and scroll all the way down.

Ex. [Cherry Rivet](#)

Things to look out for:

- Material
- Diameter
- Grip length
- Ok literally everything jk

Rivet Guns

Big Daddy Rivet Gun for CherryMax
→ stronger

Pneumatic Riveter

- Does all the work for you!



In use!



How To **USE A RIVETER**

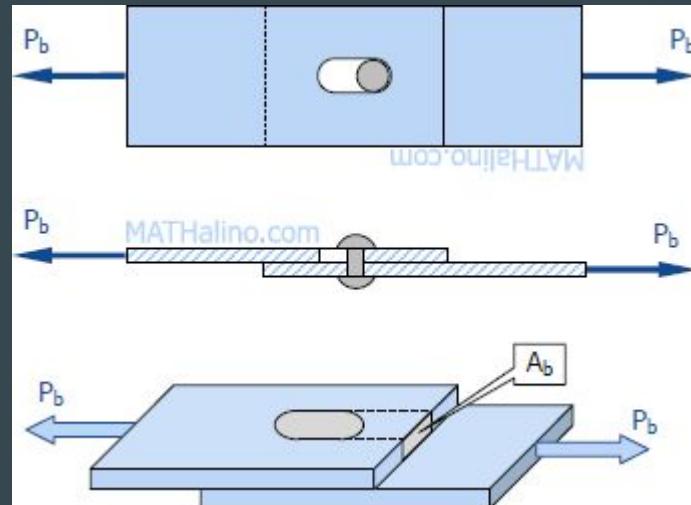
Choosing the Right One

Dimensions

- $1.5 \text{ (diameter)} < \text{length of the rivet stem}$
- Diameter: Depends how strong you need it
 - Stress Calculator!!!

It's a function of bearing strength:

- Basically. Will the rivet tear out?

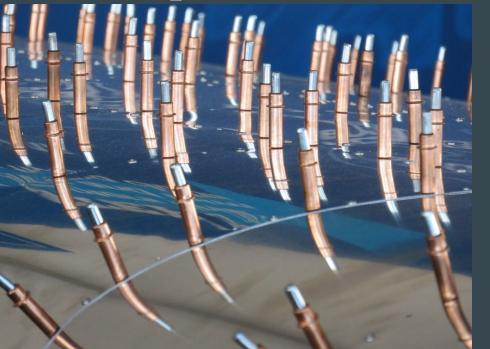


Holes + Cleco

- Rivets need a blind hole to go into
- Find hole diameter off the rivet company
 - They might just give you drill #

Clecos

- Hold the sheet in place before riveting



Drill bit numbers
are nationwide.



DRILL	INCH	MM
1	0.228	5.79
2	0.221	5.61
3	0.213	5.41
4	0.209	5.31
5	0.205	5.21
6	0.204	5.18
7	0.201	5.11
8	0.199	5.05
9	0.196	4.98
10	0.193	4.90
11	0.191	4.85
12	0.189	4.80
13	0.185	4.70
14	0.182	4.62
15	0.180	4.57
16	0.177	4.50
17	0.173	4.39
18	0.170	4.32
19	0.166	4.22
20	0.161	4.09
21	0.159	4.04
22	0.157	3.99
23	0.154	3.91
24	0.152	3.86
25	0.150	3.81
26	0.147	3.73
27	0.144	3.66
28	0.140	3.56
29	0.136	3.45
30	0.1285	3.26
31	0.120	3.05
32	0.116	2.95
33	0.113	2.87
34	0.111	2.82
35	0.110	2.79
36	0.1065	2.71
37	0.104	2.64
38	0.1015	2.58
39	0.0995	2.53
40	0.098	2.49

Clecos

CLECO

Trick  Tools

Temporary
Panel Fasteners



Activity! 20 mins

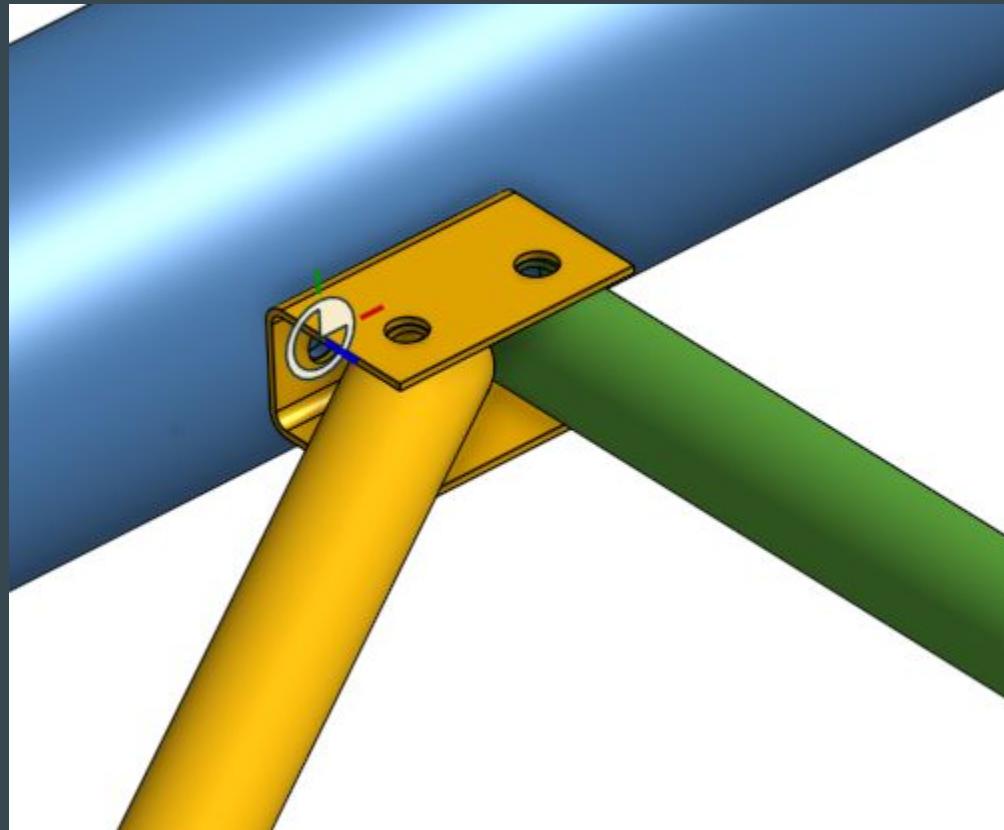
- Design your own attachment!
- Use rivets to attach tubes to a gusset

Find:

- Exact rivet (part number)
- Make a CAD, detailed drawing, number line of length of rivet

Attachment

- Any! You can do right, or make your own



Option for Attachment
- [Onshape link](#)

Order of choosing a rivet

- Design Attachment
- Find grip length
- Find rivet with good grip length → what is the drill size
- Design the attachment with the intended drill size

Log → link things!!! CherryMax Catalog

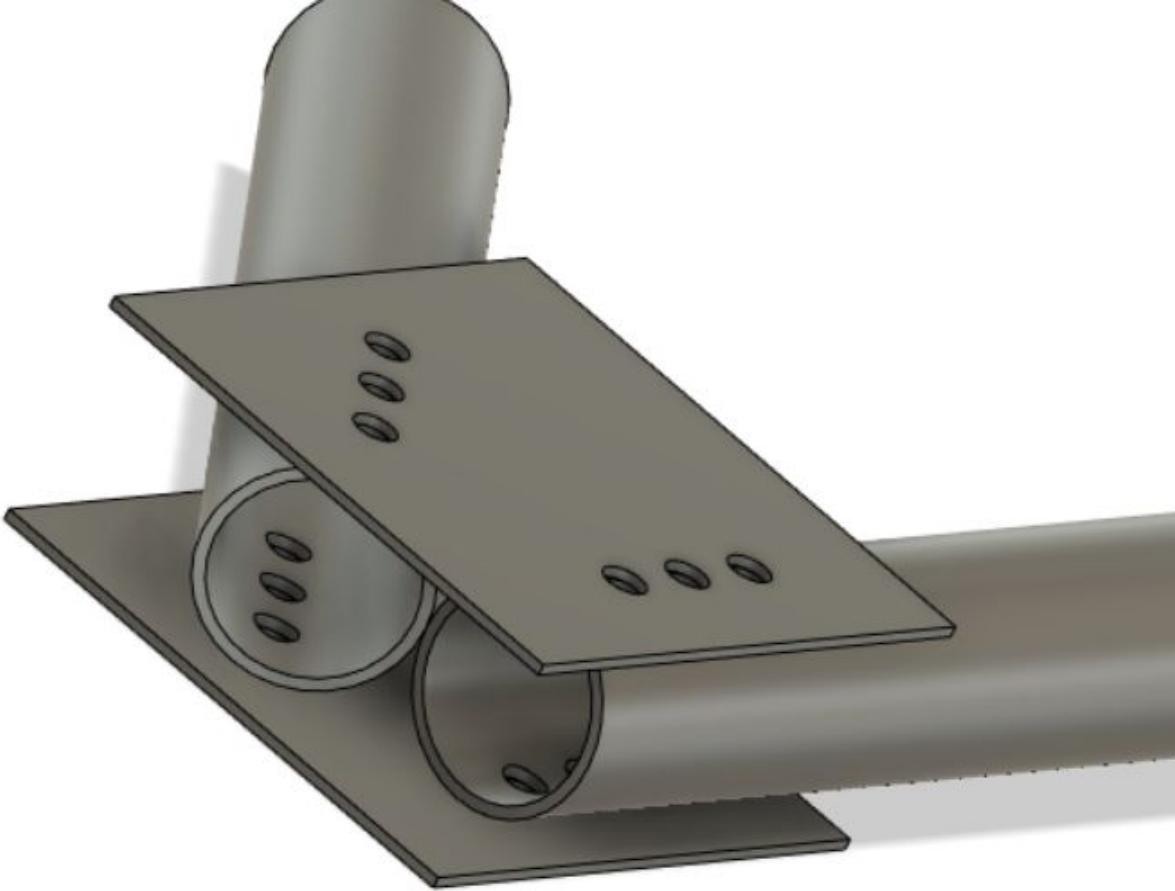
Name	Rivet part number	Grip Length	Strength	Diameter	Sheet Width	Notes
Harish	BSP-41	.337 inch	220	1/8"		Is smexy
Sheelyn	CR3212	0.063-0.125		0.126"		
Bruno	BSC-46			1/8"		
Ashley	BSPQ-42	1/8"	325	1/8"		
Kyle	BSP-48			1/8"		
Lucas	BSPS-42	0.063-0.125		1/8"		
Keaton						
Maya	CR3213 - 4-02	0.063 - 0.125	50,000 PSI	3/16"	0.03125" (1/32)	

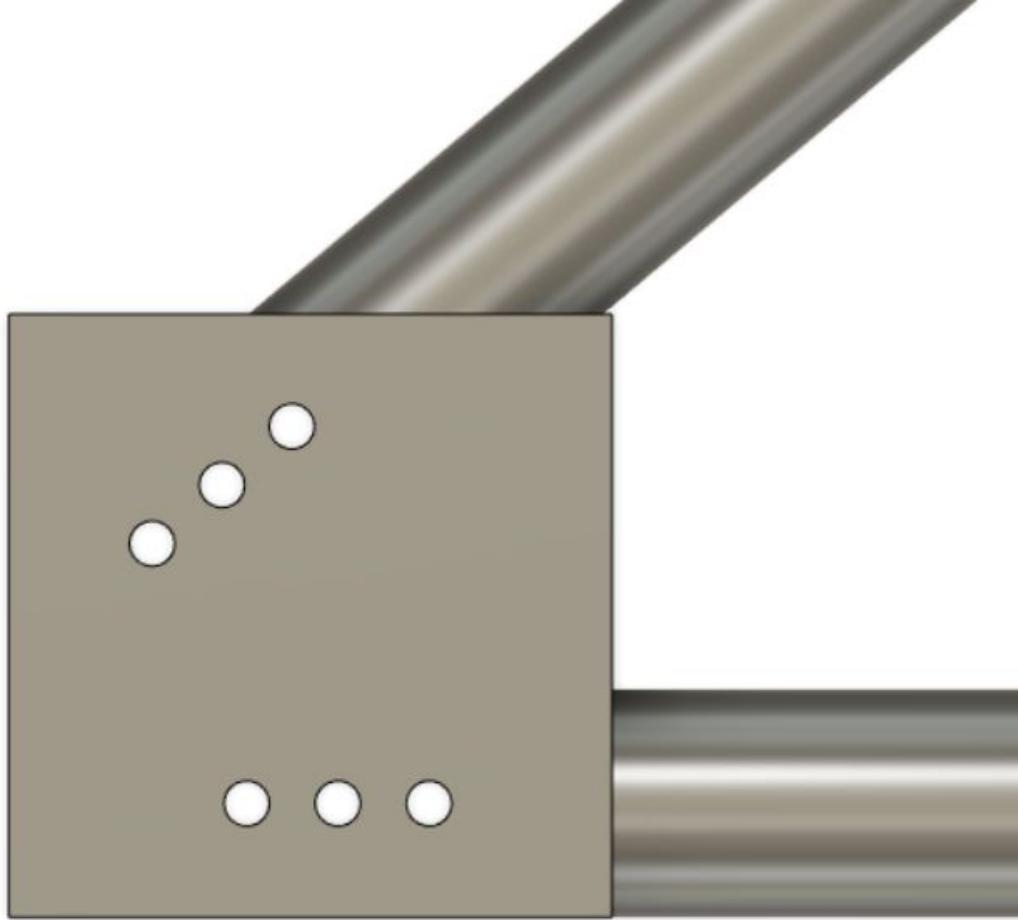
Log → link things!!! CherryMax Catalog

Name	Rivet part number	Grip Length	Strength	Diameter	Sheet Width	Notes
Jasmine	CR3213-5-4	.5	50,000 psi	5/32	.125	
Agastya						

Universal, CherryMax Rivets

Grip Limits 1/16		-4(1/8") Diameter			-5(5/32") Diameter			-6(3/16") Diameter			-8(1/4") Diameter		
Min.	Max.	Dash no.	+.000 L -.030	K max	Dash No.	+.000 L -.030	K max	Dash No.	+.000 L -.030	K max	Dash No.	+.000 L -.030	K max
.062	.062	4-01	.161	.38	5-01	.187	.41	6-01	.219	.47	—	—	—
.063	.125	4-02	.224	.45	5-02	.230	.47	6-02	.262	.51	8-02	.315	.59
.126	.187	4-03	.287	.51	5-03	.293	.53	6-03	.325	.57	8-03	.378	.65
.188	.250	4-04	.349	.57	5-04	.355	.59	6-04	.387	.64	8-04	.440	.72
.251	.312	4-05	.412	.63	5-05	.418	.65	6-05	.450	.70	8-05	.503	.78
.313	.375	4-06	.474	.70	5-06	.480	.72	6-06	.512	.76	8-06	.565	.84
.376	.437	4-07	.537	.76	5-07	.543	.77	6-07	.575	.82	8-07	.628	.90
.438	.500	4-08	.599	.82	5-08	.605	.84	6-08	.637	.88	8-08	.690	.97
.501	.562	4-09	.662	.88	5-09	.668	.90	6-09	.700	.95	8-09	.753	1.03
.563	.625	—	—	—	5-10	.730	.96	6-10	.762	1.01	8-10	.815	1.09
.626	.687	—	—	—	5-11	.793	1.02	6-11	.825	1.07	8-11	.878	1.15
.688	.750	—	—	—	—	—	—	6-12	.887	1.13	8-12	.940	1.22
.751	.812	—	—	—	—	—	—	6-13	.950	1.19	8-13	1.003	1.28
.813	.875	—	—	—	—	—	—	—	—	—	8-14	1.065	1.34

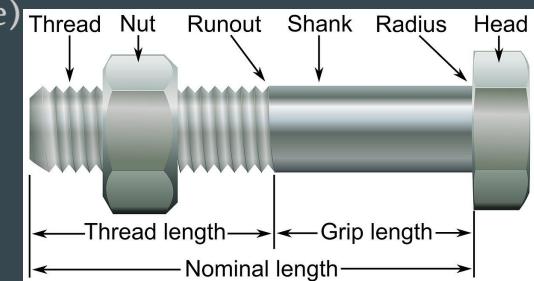




Bolts

AN bolts

- Army/Navy (standard) bolts (AN)
- Can be used for tensile or shear/load
- Usually made of steel or aluminum alloy
- Hardware store bolts have a tensile strength of 50,000-60,000 psi and bend easily, these have 125,000+ psi
- Make sure you don't accidentally buy counterfeit AN bolts
- Naming:
- ANd(H)-g(A)
 - AN → Army/Navy
 - d → diameter of bolt in x/16in (16ths of an inch)
 - H → shows if head of bolt is drilled for safety wire (no H=no drilled hole)
 - g → grip length
 - A → shank is not drilled for a cotter pin (no A= drilled for pin)



AN365-5

5/16"

AN365-4

AN365-3



AN310-5

AN310-4

AN310-3



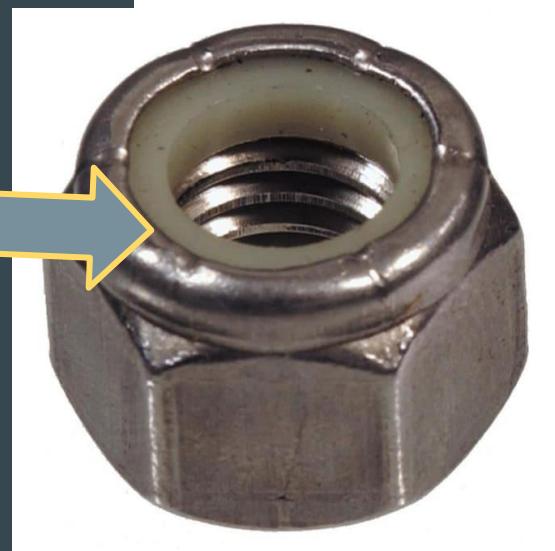
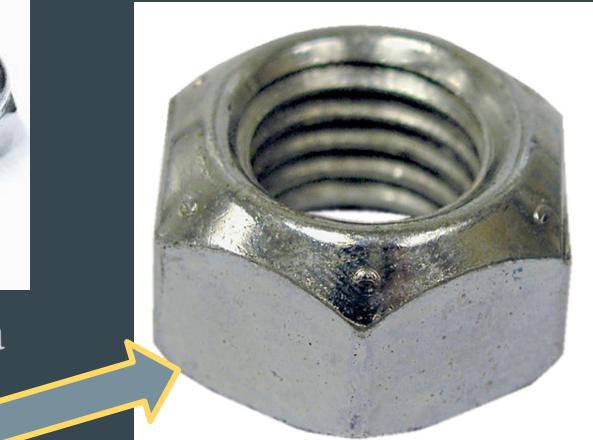
MS21042-5

MS21042-4

MS21042-3

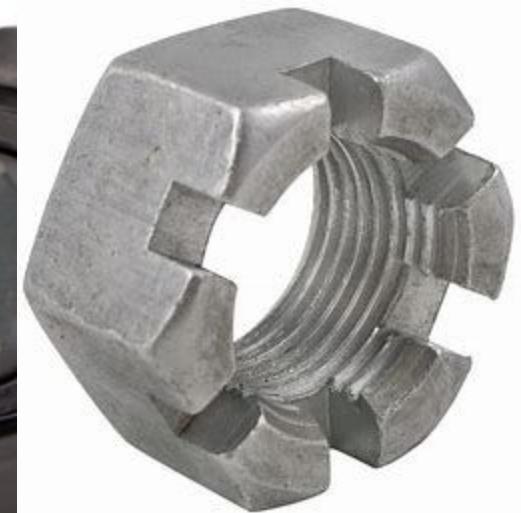
Lock nuts aka Nylock nuts

- Doesn't loosen if vibrated or twisted
- There are lots of different more specific kinds, usually a hex nut
- All-Metal lock nuts have a crimped top that makes it harder to loosen
- Nylon lock nuts have a ring of nylon that deforms and holds the nut in place
- Very strong + secure, can be hard to remove

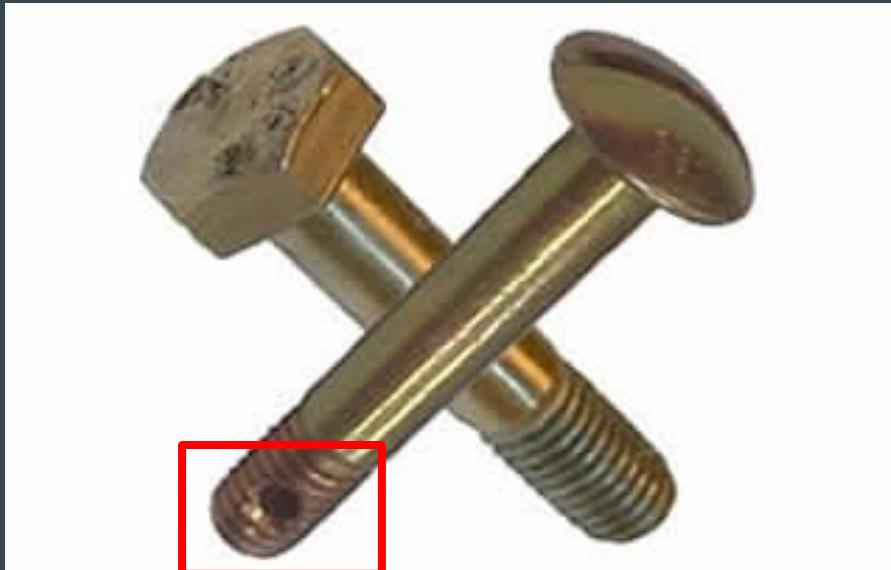


Castle nuts

- 2 Parts: Castle nut & Cotter pin
- Relies on friction and a Cotter pin to Stay in place
- Some bolts have a **hole** in the shank To allow for the cotter pin to pass
The cotter pin passes underneath the Castle nut, making sure that the nut doesn't screw itself off
- A very secure method of attaching nuts to bolts, although expensive (0.7\$ - 6\$ each), does require a little more work than other methods (bending cotter pins for more security) but all in all is an excellent method



Castle Nut Necessities



Washers + Lock Washers

MUST be used with all bolts

- Washers:
 - Flat disk metal disk with hole in the middle
 - Creates more surface area → protects tubing/metal
 - Same pounds, more area → lower psi
- Lock Washer
 - Create tension and keep the nut from coming loose

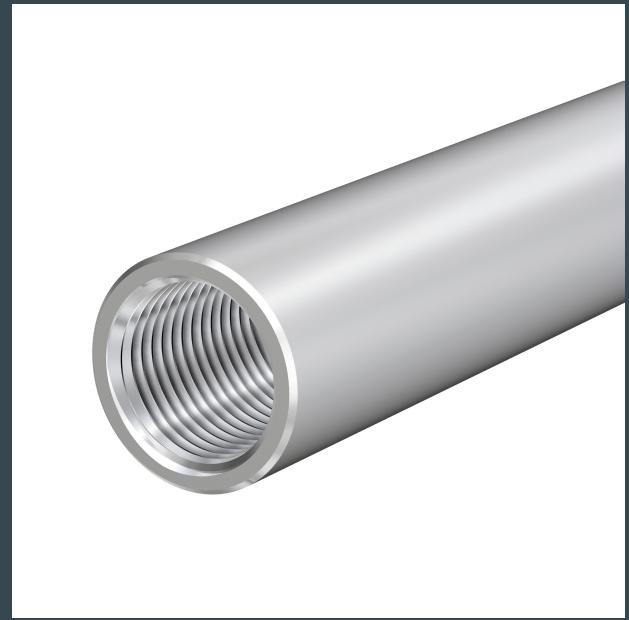


Advantages? When use each?

- Now you cannot just thread things. You need a nut.
- Threading things:

Castle Nuts:

- Better with vibration → heavy duty, aerospace grade
 - Prevents rotation
- Lock nuts: nothing on the final
 - More for prototyping



Activity! 20 mins

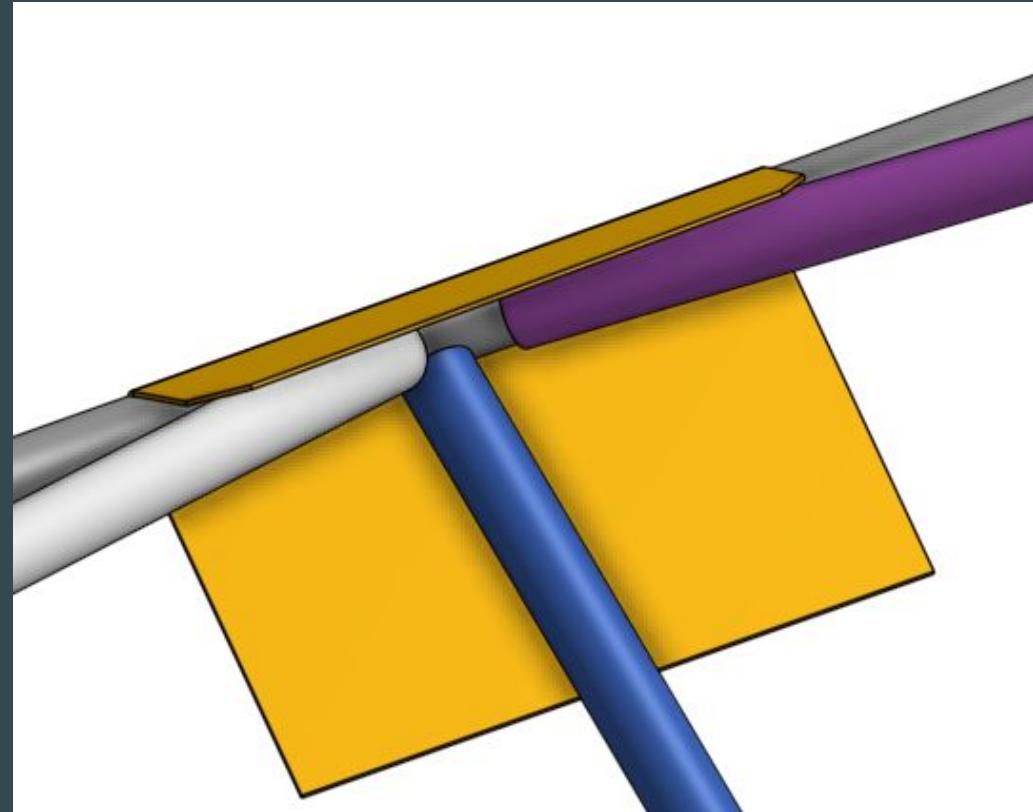
- Yay same thing!
- Design your own attachment!

Find:

- Exact bolt + nut (part number)
- Make a CAD, detailed drawing,
number line of length of rivet

Attachment

- Any! There's some spicy ones
on old versions of the onshape



Option for Attachment
- [Onshape link](#)

Bolt Log → link things!!! → bolt finder

Name	Bolt number	Bolt Type	Total // Shank	Diameter - Thread	Sheet Width	Notes
Sheelyn	AN3(10-32)	AN3				
Harish						
Ashley						
Kyle	<u>AN6-7</u>	AN6	5/16" grip 31/32" Nominal	21/32in	0.3in	
Keaton	AN4-20A	AN4	2 1/32"	0.25"	2mm	
Maya	<u>AN4C-11</u>	AN4	13/16 grip, 1-9/32	¼ - 28	0.03125	

Nut Log → link things!!!

Name	Nut Number	Nut Type	Nut Strength	Diameter - Thread	Notes
Agastya					
Harish					
Ashley					
Kyle					
Keaton	MS51968-2	Steel Hex?	Grade 5	1/4"-28	
Maya	<u>AN310C4</u>	Steel Castle	125,000 PSI	¼-28	

Bolt Log → link things!!! → **bolt finder**

Nut Log → link things!!!

Name	Nut Number	Nut Type	Nut Strength	Diameter - Thread	Notes
Agastya	CR-664	Normal (not oversize), Made of aluminium	55000 PSI	1/8 in	https://www.aircraftspruce.com/catalog/pages/12-02343.php
Kyle	AN310-6	Steel	200 KSI	3/8-24	
Maya					

USE REFERENCE CHART

Bolt Size	AN960 Flat Washer	AN970 Lg. Area Flat Washer	AN365 Nylon Insert Locknut	AN310 Castle Nut	AN380 Cotter Pin
AN3 ...-10	-3	-3	-1032	-3	-2-2 or longer
AN4 ...-416	-4	-4	-428	-4	-25-2 or longer
AN5 ...-516	-5	-5	-524	-5	-25-3
AN6 ...-616	-6	-6	-624	-6	-3-3 or longer
AN7 ...-716	-7	-7	-720	-7	-3-3 or longer
AN8 ...-816	-8	-8	-820	-8	-3-4 or longer

SAMPLE PART NUMBERS

- AN3-4** Cad-plated, drilled shank
AN3-4A Cad-plated, undrilled
AN3C-4 Stainless steel, drilled shank
AN3C-4A Stainless steel, undrilled

Tubing: 0.625"

Gusset: 0.03125 x 2

Washer: 0.032"

Min grip length: $0.625 + 2(0.03125) + 0.032 = 0.7195$

Bolt: 1/4-28

Castle Nut:

Welding



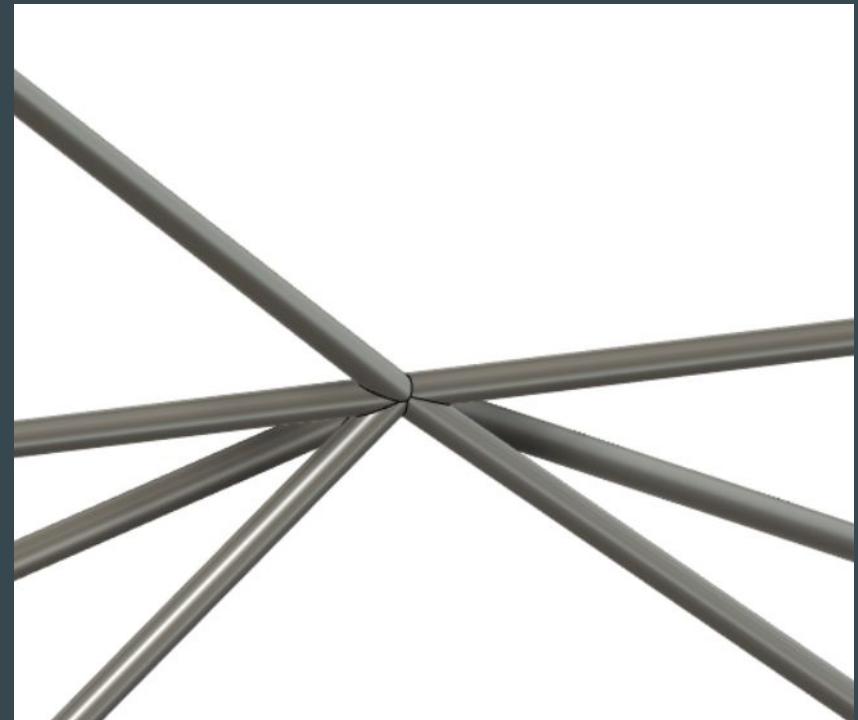
Yay Easy Design Wise

- Must be larger than 25%
- Best with steel → alum liquified
- We use 4130
- [Materials Workshop](#)
- [Welding Blog Post](#)



10 mins → Hop onto Fusion and Create a Welded Structure

- If you don't know fusion → good time for tutorials!
- Create your structure out of lines and 3D sketching
 - Then use pipe tool to weld it
- Bonus points if you use 0.625" OD, 0.035" wall

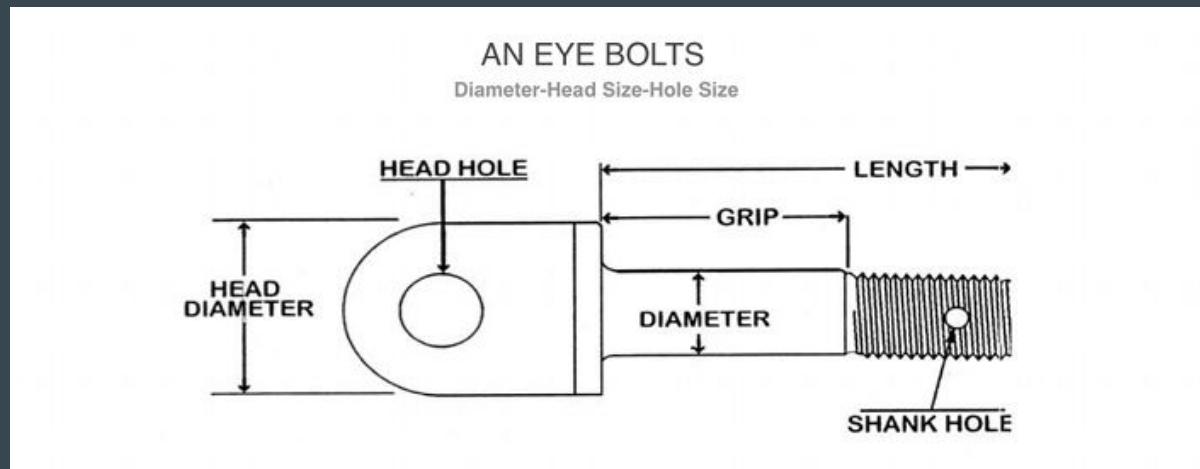


Show them screenshots of structures :cat_smirking:

Msc Attachments

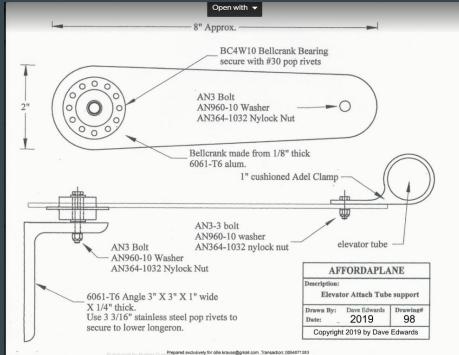
Eye Bolts

- Bolt with a loop at the end
- Secures the “eye” so rope or cable can be attached



Rod End

Well. Cable Attachments are pretty awesome but that's something for another day. (<https://bit.ly/36oa7rq>)



AN663 Double shank ball end terminal



AN664 Single shake ball end terminal



AN665 Rod end terminal



AN666 Threaded cable terminal



AN667 Fork end cable terminal



AN667 Eye end cable terminal