Building Basics

A New Generation

The evolution of aircraft rivets

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IN AIRCRAFT CONSTRUCTION RIVETS are the primary fastener used to connect two pieces of metal. Aluminum rivets are light, strong, and resistant to corrosion. Their proper installation is easy to check, and their failure is easy to detect during a visual inspection, and their installation hasn't changed much since World War II. The rivet gun and bucking are still the process' primary tools.

In the last decade the aviation industry has introduced several new rivet head styles and stronger alloys, especially for rivets used in building large aircraft. Because homebuilders might benefit from the new generation of rivets, we'll discuss them along with the traditional styles.

Reading Rivets

In addition to making it easy to order rivets, their part numbers tell you a lot about them. Here are a few examples of the more common part numbers. Remember, AN (Army/Air Force-Navy) part numbers are being superseded by military specification (or standard) part numbers. For example, AN426AD3-4 is now MS20426AD3-4.

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Let's dissect this part number: MS20470AD3-5. MS means military standard (or specification). The number, 20470, describes the head style; in this case it's a universal head. AD says the rivet is made of an alloy (2117 Al). The last two numbers give the diameter of the rivet's shank in 32nds of an inch and the shank's length (or reach) in 16ths of an inch. In this case, the rivet is 3/32 inch in diameter, and it's 5/16 inch long.

Let's try this one: NAS1097D5-7. NAS stands for National Aerospace Standard, the number, 1097, identifies the rivet's head style (reduced countersunk head), and the D says it's made of an alloy (2017 Al). The same measurement standards apply, so this rivet is 5/32 inch in diameter and it's 7/16 inch long.

Alloy Code - A
Alloy - 1100 or 3003 Aluminum
Head Marking - None
Shear Strength - 10 KSI
Non-Structural Uses Only

Alloy Code - B
Alloy - 5056 Aluminum
Head Marking - Raised Cross
Shear Strength - 28 KSI

Alloy Code - AD
Alloy - 2117 Aluminum
Head Marking - Dimple
Shear Strength - 30 KSI

Alloy Code - D
Alloy - 2017 Aluminum
Head Marking - Raised Dot
Shear Strength - 38 KSI
38 KSI When Driven As Received
34 KSI When Re-Heat Treated

Alloy Code - DD
Alloy - 2024 Aluminum
Head Marking - Two Bars
Shear Strength - 41 KSI
Must Be Driven in "W" Condition
(Ice-Box)

Alloy Code - E, [KE*] *Boeing Code
Alloy - 7050 Aluminum
Head Marking - Raised Ring
Shear Strength - 43 KSI
Replacement For DD Rivet
To Be Driven in "T" Condition

Alloy Code - M
Alloy - Monel
Head Marking - None on Flush Head

Two Dimples on Universal Head
Shear Strength - 54 KSI

Rivet Types

Standard Head Types

100° Flush
MS20426
BACR15BA

Universal
MS20470
BACR15BB

Reduced Head Types

Boeing
BACR15CE

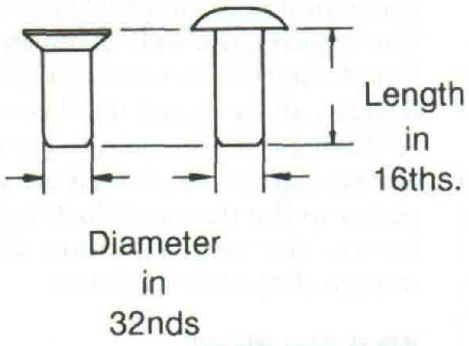
(Called Shear or Skin Rivets)

NAS
NAS1097

Modified 120°
MS14218
BACR15FV

(Briles)

Reduced Universal
BACR15FT



One more: BACR15FV5KE5. BACR identifies a Boeing Aerospace Company Rivet with an FV head style (modified 120-degree countersunk head). This rivet has a shank diameter of 5 (5/32 inch), it's made of an alloy with the code KE (7050 Al), and its length is 5 (5/16 inch).

Rivet Alloy

Because it's relatively strong but easy to drive, the AD—2117 alloy—rivet is perhaps the most common one in use today, and you can identify it by the dimple on its head.

The 2017 (D) and 2024 (DD) alloys are sometimes called icebox rivets because you need to heat-treat them before you drive them. These rivets will remain soft if you put them in a freezer after the heat treatment. Once they warm up to room temperature, you have approximately 15 minutes to drive them.

One of the newer aluminum rivet alloys is 7050, and it's called an E rivet or a KE rivet. The E rivet is 30 percent stronger than an AD rivet, a replacement for the DD rivet, and still relatively easy to drive with the rivet gun. You can identify an E rivet by the raised ring on its head.

Rivet Heads

There are two types of rivet heads, protruding and flush.

The MS20470 universal (protruding) head rivet superseded the AN470 rivet, and it replaced the flat head and brazier head rivets. Universal head rivets are the first choice for all riveting operations. They come in several different alloys, but the most commonly used alloy is 2117 (AD).

The BACR15FT reduced universal head rivet is similar in design to a universal head rivet, but its head size is reduced to save weight. It's available in several different alloys, but the aluminum 7050 (E) alloy appears to be most common because of its higher strength. Note: You need a special header to install this rivet; if you use a standard 20470 header, you will damage the head of the rivet.

The MS20426, a 100-degree countersunk (flush) head rivet, superseded the AN426 rivet, and it's used where greater aerodynamic smoothness is required. The in-

stalled shear strength of these rivets is lower than universal head rivets, and the most commonly used aluminum alloy is 2117 (AD).

The NAS1097 100-degree reduced countersunk rivet is similar in design to a regular countersunk rivet, but the head size is reduced so that it can be installed in thinner sheet material. This rivet is used in many modern airliners. The most common aluminum alloys are 2117 (AD) and 2017 (D). These rivets sacrifice clamp-up (tension) strength for increased shear strength.

The MS14218 or BACR15FV is a modified 120-degree flush head rivet. One of the more successful new rivet designs by Frank Briles, these rivets are also called Briles rivets. They are used on the latest generation of commercial aircraft. The countersink well is counterbored and then countersunk 120 degrees, and a special set of countersinking tools is required. The fit and strength of these rivets are superior to the standard flush head rivets. The most common aluminum alloy used is 7050 (E).

What Size Rivet?

Among builders a frequent question is, What diameter of rivet should I use, how long does it have to be, and how far must it be from the edge (edge distance or rivet pitch)? In general, the answers are fairly simple.

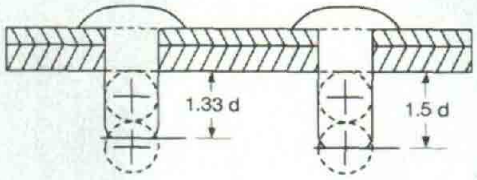
A rivet's shear strength (the force needed to shear or break it) depends (in large part) on its diameter, and in aircraft construction we try to use rivets whose shear strength approximately equals the bearing strength of the metal sheets the rivets are fastening.

Most people don't want to calculate bearing and shear strength, but a simple rule will help. To determine the rivet diameter, multiply the thickness of the thickest sheet times three and choose the next larger rivet size.

For example, if you're going to rivet a sheet of 0.032-inch and a doubler of 0.040-inch together, multiply the thickest sheet times three (3 x 0.040 = 0.120) and choose the next size of rivet. In this case you will select a 1/8-inch (0.125-inch) diameter or number 4 rivet.

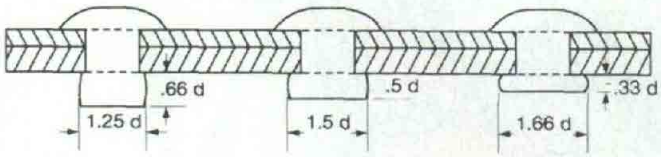
The rivet hole should be perfectly round and approximately 0.003-inch larger than the rivet diameter because the rivet expands when you drive it. There are oversized rivets, which have the same head size but a shank diameter that is 1/64-inch larger. These rivets are an excellent choice for slightly oversized holes (usually created when you drill out a less than perfectly driven standard size rivet). For example an oversized

A, AD, B, DD Rivets



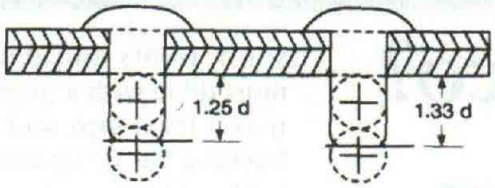
Pre-Drive Protrusion

Formed Head Dimension



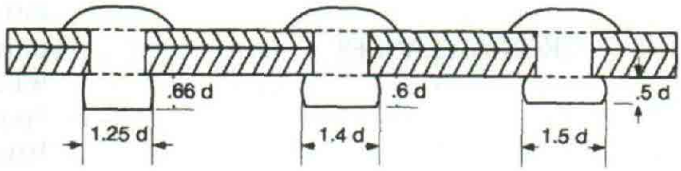
Minimum Preferred Maximum

D, E, (KE), M Rivets



Pre-Drive Protrusion

Formed Head Dimension



Minimum Preferred Maximum

5/32-inch rivet will have the same head size as the regular 5/32-inch rivet, but its shank diameter is 11/64 inch.

When you place the rivet through both sheets, the shank should protrude roughly 1.5 times the rivet's diameter. After you drive the rivet (creating the shop head), it should protrude about half the rivet's diameter.

Edge distance is the space between the edge of the material and the center of the rivet hole. The minimum pitch is two times the rivet's diameter, but don't make it larger than four times the rivet's diameter.

Rivet pitch is the distance between two rivets in the same row. The minimum pitch is three times the diameter, but four to six times the diameter is a safe approach.

Transverse pitch is the distance between two rivets in adjacent rows. The minimum is 75 percent of the rivet pitch, but in many cases people select the same distance for transverse pitch as for rivet pitch.

The one nice thing about building a kit is that the manufacturer has figured these distances and specified the rivets you should use. But learning about the different types of rivets and their use is one of the educational benefits of being a homebuilder.