

## **Control Cables 101**

RAA

CONTROL CABLES ARE A VERY IMPORTANT part of our aircraft – some use cables for all flight controls and some use pushrods for everything except the rudder. Somewhere there might be a builder who has incorporated fly by wire with servos, and that fellow can ignore the AC 43-13 requirement for an annual 100 hour cable inspection.

The basic AC 43-13 inspection is with a cotton-gloved hand or a rag attached to a long rod. These are run over all cables to search for a snag that indicates a broken strand. Even one broken strand in a critical area requires replacement. Critical areas are the pulleys and fairleads or anywhere the cable is flexed or rubbed. One broken strand within one foot of a swaged cable fitting is also a failure that requires replacement. For the full story on inspecting and maintaining cables read AC 43-13 either online or in a paper copy available from aviation suppliers. There are thirteen pages devoted just to cables.

### **PREMADE CABLES**

If you decide that a cable needs to be replaced, there are two methods. The simplest and most expensive is to have someone make it for you. Spruce offers this service and a typical ten foot galvanized 1/8" cable will cost around sixty dollars. The tolerance is +/- 1/8" which means that you will inevitably use turnbuckles for final adjustment and tensioning. These days turnbuckles cost in the range of \$50 so if you are building from scratch it might be advisable to buy the cables first and make the airplane fit them.

### **SHOP MADE CABLES**

The alternative is to make your own cables, which is not as daunting a task as one might imagine. The typical cable is 1/8" 7x19 galvanized with a break strength of 2000 pounds. There are commercial cables that have the same break strength, but real aircraft cables are lubricated as part of the manufacturing process, and domestic cable available from aircraft suppliers has specs that can be believed. Offshore cables from across the Pacific can have the same claimed break strength but they are sometimes more brittle than domestic cable. Stainless aircraft cable is also available but it has lower break strength at 1760 pounds, so if substituting you should do your homework to ensure that it will be strong enough. Stainless work hardens and is initially stiffer so unless the plane is operated in a salt environment there is little reason to use it.



Top left: A thimble eye loop in 1/8" cable, formed with the Swage-It AC 43-13 requires three squeezes with ridges between each, with a little ridge each side. Lower left: Prepare the thimble by spreading the tips to ~.100° separation. Above, begin by cutting some test pieces. The \$350 swagers include a cable cutter.

### THE BASICS

To make your own cables you will need end fittings, a tool to swage them, and a gauge to ensure that the swaging has been done to the correct diameter.

The most common end fitting is an eyelet with a steel thimble to protect the wire, held in place with a copper sleeve that is swaged to hold everything tight. For galvanized cable the sleeve is plain copper while for stainless it is plated copper.

The raw galvanized aircraft cable itself is ~\$1.50 per foot; a thimble will cost a quarter, and a copper sleeve will cost fifty cents. If you need a shackle (forked end) it adds about \$15. Still it will be half the price of a premade cable, and if you work carefully to get the correct length you can eliminate some of the turnbuckles.

### MAKING A CABLE

Let's make a 1/8" 7x19 cable with one eyelet end and one forked end. An eyelet end requires one AN 100-4 thimble if you use plated steel or AN 100C-4 thimble if you wish stainless. You will also need one bare copper sleeve MS 51844-

44 to be used on galvanized cable, or MS 51844-24 for zinc plated copper to be used on stainless.

The sleeves are commonly called Nicos (short for Nicopress) although this is a brand name but it has become generic, like Aspirin. Buy twice as many Nicos and thimbles as you think you need. They are cheap.

### CUTTING CABLE

The next consideration is how to cut the cable. Proper cable cutters are available even from home improvement stores, and do an effective job because the cutting surfaces are notched, surrounding the cable and forcing it together while shearing. A sharp cold chisel and a smooth steel block will also do an effective job if the hammer is in the range of five pounds. Practice cutting short pieces until you can cleave the cable in one blow, and resharpen the chisel if necessary. A sidecutter will do a ragged job and a torch is strictly verboten.

### TEST PIECES

Before making your first real cable, cut off half a dozen short

test pieces of cable and be prepared to use up a few Nicos and thimbles to learn the technique of swaging.

**PREPARING THE THIMBLE**

AC 43-13 has an illustration that shows the ends of the thimble as being spread apart, in the range of .100". The thimbles I bought had the tips touching so I spread them apart with a screwdriver. Some AME's suggest to snip off the pointy ends but if you are

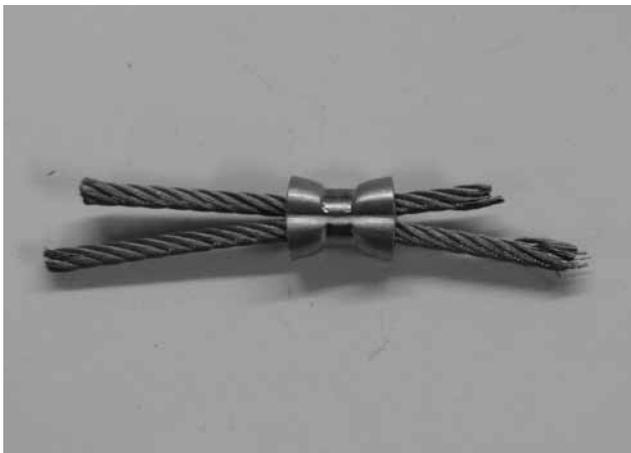
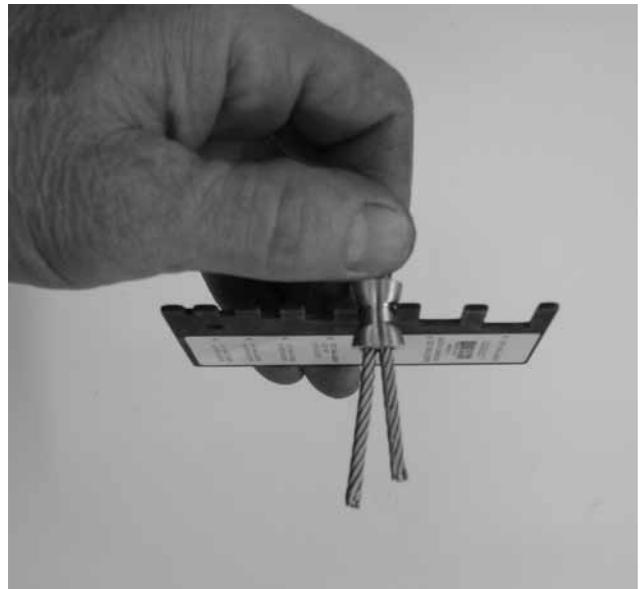
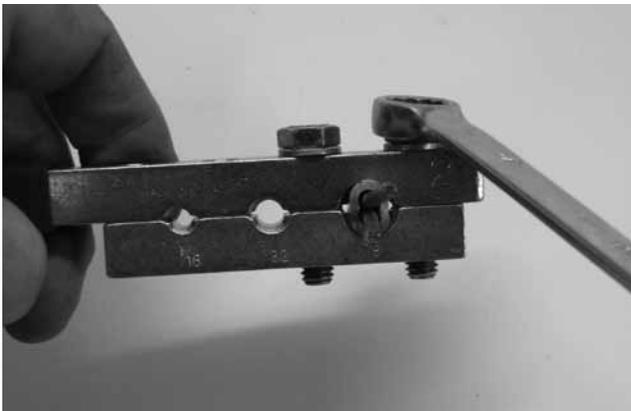
using plated steel this leaves the tips exposed to rusting.

**CHOOSE YOUR WEAPON**

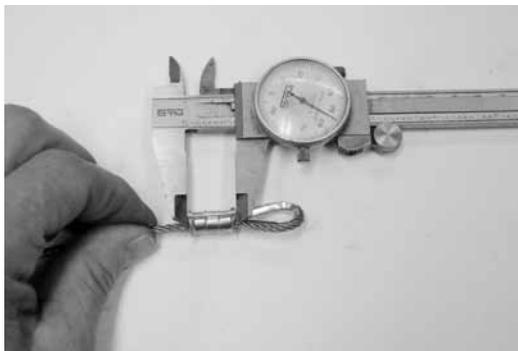
The gold standard for swaging tools looks like a bolt cutter, and is made by Loos or Nicopress. Each costs in the range of \$350, difficult to justify for one use. Many chapters have one for members' use, and some AME's will reluctantly lend theirs. These tools are accurate and straightforward but they

are large, so they are difficult to use in confined quarters. The best way to use them is to clamp one leg horizontally in a vise and pull the other leg downwards. If you have borrowed a tool be sure to protect it from scratching by using cloth on the vise jaws. Stay away from the fence tools sold at hardware chains.

There is a much less expensive alternative to the Loos and Nicopress. Aircraft Spruce sells a small hand



*Top left: First test swage is the centre one...and results in a little bow tie (above). Top right: Check the swage with the go-no go gauge. Lower right: Forming a thimble eye begins with centering the Nico and squeezing just enough to trap it in the jaws.*



tool called the Swage-It for \$30, and I bought one for comparison. It looks like the clamp of a brake line flaring tool but with three stations for 1/8, 3/32, and 1/16" Nico's. The two bars are 1/2" square steel and the squeeze force is applied by two 5/16" bolts. I clamped one of the bars in the vise and before use I lubricated the bolt threads with anti-seize compound.

#### POSITION THE NICO

A 1/8" cable must have its Nico squeezed in three places if it is to provide a grip equal to the cable strength. Whether using the squeezer or the Swage-It, the Nico is centered in the jaws with the long axis of the oval hole on the axis of squeeze. A 1/8" Nico has an initial length of 9/16" so with the Swage-It there is 1/32" protruding past each side of the tool. It is important to get it centered and square, so take your time. Tighten the bolts alternately and give the Nico just enough initial squeeze that it does not move around.

#### FORM THE LOOP

Feed the 1/8" cable through the Nico, form a loop, and feed the end back through the Nico. Let the end protrude no less than 1/4" beyond the Nico. Longer is OK but because the Nico grows

in length with each squeeze you will initially want at least 1/4" protruding.

Insert the thimble and pull the loop tight, but not so tight that the tips of the thimble touch the end of the Nico. I pull just enough to have the tips 3/32" from touching the Nico. This clearance diminishes to nearly zero when the Nico has been fully squeezed.

At first it felt as if three hands were necessary to hold everything in place, so I made a little clamp from a small vise grip to hold the cable and thimble together while I positioned everything else. After half a dozen test pieces I became more comfortable and found that the vise grip was not necessary.

If you pull the loop too tight and do not have any initial clearance between the Nico and the thimble, the tips will enter the Nico and the finished loop will end up cocked off to one side. This is why it is important to have the 3/32" initial clearance.

#### MAKING YOUR FIRST CABLE

Rather than cutting the cable to length plus some extra, instead leave the cable on the reel or in the bag while swaging the first end. That way if there is a problem you wasted only six inches. Make your first thimble eye using

*Top down: form the loop with at least 1/4" sticking out of the Nico, insert the thimble and pull the loop until there is 3/32" clearance between the Nico and thimble. Tighten the bolts and then check with the go-no go gauge.*

*Second from top: The second swage is next to the loop. The lever tool makes it easy to see that it is centered so that there will be a ridge each side of the swage. Centre: With the Swage-It the edge of the first swage is placed just outside the edge of the tool. This will position it for the second swage with a little ridge each side. Bottom: The third swage is the mirror of the second. The finished Nico will have four ridges and be 3/4" long.*



*Left: For the second end, if another set of hands is not available, a cleco clamp can help to hold the cable. Right: Here are typical cable ends that Spruce will fit to order, +/- 1/8" length tolerance*

the three swages. If you need an AN 115-21 shackle you can slip it into the loop after the swaging is finished. Sometimes this take a little help from a screwdriver to spring it open enough to slide. It could alternatively have been fitted before making the loop but that means one more loose part to deal with.

#### **THE OTHER END**

This one requires measuring. If you are replacing an existing cable you can whack two nails into a long board or your building table to establish the fitted length. Then replace with your

new cable and make it fit the two nails.

Trap the Nico in your tool, and form the loop around the thimble and back through the Nico, pulling the cable as before but with a much longer tail piece. Remember the 3/32" clearance between the thimble tips and the Nico. If a friend is there he can keep the cable tensioned while you tighten the bolts of the Swage-It. If you do not have anyone available a cleco clamp can hold the cable while you give the Nico a squeeze. Once the first Nico has been squeezed you can remove the cable from the nails and work in the

vises. Next do the squeeze nearest the thimble and lastly the end away from the thimble. Gauge each squeeze and the cable is finished.

If this is a new build the procedure for a rudder cable is to fit the first end in place on the pedal, run the cable down the length of the plane and fit it in place on the rudder horn. The rudder can be clamped, the pedals positioned as required, and the first rudder end Nico can be squeezed in situ and gauged. Then remove the cable and do the second and third squeezes with the tool held in the vise. 

## **RAA Chapter 4975 Annual Fly-In/Drive In Breakfast and Safety Seminar**

May 27th Chatham Ontario (CYCK) Kent Flying Machines. Aviation Flea-Market. Breakfast served from 8:00 to 10:00 am Chatham Municipal Airport 8528 Fourteenth Line RR#2, Merlin, Ontario 1-519-676-345 For more information call Armel at 1-519-798-3286.