

Choosing the Right Wire

With all those options, which one is best?

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Wire antenna are probably the first kind most hams will start out with. They're cheap, easy to make and tune, and practically bomb proof. But, for those who haven't learned wire selection by trial and error, you could probably use some pointers. Before I give any suggestions, it will help if you understand some of the properties of wire which will be important to our discussion.

Mechanical Properties

Strength

Wire strength is probably the first thing most of us think of when examining a piece of wire. This will usually be described as maximum breaking strength or safe working load (SWL). If the former, divide the maximum breaking strength by 3 or 4 to get a SWL. The SWL needs to be strong enough to hold the weight of the antenna itself, any tension you add to it with weights or feed lines, and any ice loading that may occur. There are several calculators online for determining the SWL needed for holding a span of wire.

Weight

The heavier the wire, the stronger it must be to hold itself up, and the more strain it will place on your supports. For a portable antenna, it will also be harder to carry. In amateur antenna setups, aluminum wire will be the lightest, followed by copper, leaving steel as the heaviest.

Flexibility

Stiff wire is usually a pain to work with. EHS steel guy lines are a fine example of what an inflexible wire feels like. Its is not impossible to wok with, but not fun or easy either. Similarly, solid steel wire like used on electric fences will not bend or flex easily—an advantage in some instances. Copper and aluminum bend very easily

and can be knotted or kinked by hand—the later being a blessing and a curse.

Resilience

Usually, wire for antennas should be flexible and resilient. Certain wires are more apt to break when being flexed than others. For instance, I have used 12 gauge aluminum-clad steel wire on electric fences before. Some brands will snap after only one or two sharp 180 degree bends. Others will last several sharp kinks without breaking. Aluminum and copper wires will bend easier than steel without snapping; the difference between those and steel is that steel will usually snap at the break without tension applied, but depending on what type of wire it is, it may act more like copper and just weaken. Aluminum and copper will weaken at the bend (or kink) and break easier under load. Steel will always weaken if it doesn't break, too. (That means you should always be careful not to kink antenna wire regardless of the material.) In my experience, aluminum wire tends to break easier than copper, so you may need to be careful with it when making antennas. It shouldn't go without being said that I've been using an aluminum 80m full-wave loop for over a year without any trouble. But, aluminum wire is more likely to break at twists then thinner steel or copper. Heavy #12 steel usually won't twist at a splice much at all before breaking.

Stranded vs. Solid

Solid wire is generally easier to find. This is certainly the case if you look under the disguise of electric fence wire. You can also find some products—like polywire or poly tape—that are stranded. Speaker wire works, too. Companies like DX Engineering sell larger stranded copper for use on antennas, as well as copper-clad steel (Copperweld). “What does it matter,” you might ask. First, stranded wires will be easier to bend and work with then similarly sized solid wires. Second, the flexibility also gives it some measure of resilience because the individual strands can give and flex a lot more than one solid core will. This can make the wire much less likely to break should it be bent around an insulator or kinked

during installation. Lastly, for the same diameter wire, stranded will have nearly the same breaking strength with decreased risk of breaking at kinks or bends like a solid wire will.

You will frequently find stranded wire used for ground radials or portable antennas. Speaker cable is another source for stranded wire that works as a feed line and antenna if you get creative. (Look up Zip-Cord antennas.)

Ease of Connectivity

Aluminum wire is nice, but it has one big problem: solder doesn't stick to it. Steel can hold solder, but you will usually have to prep the surface with some sand paper first. Copper is as easy as can be to solder, provided it isn't too oxidized (patinaed). That can be cleaned though. As a general rule, you should use some sort of mechanical connection in addition to solder for the electrical connection. Crimp connectors, like used for electric fencing, can work well on steel and aluminum wires. You can sometimes take and splice aluminum wire onto copper so you can solder one end—just remember that the metals are dissimilar and may corrode. Use some anti-oxidant joint compound in any connector as a preventative, and you should try and clean any oxidation off of the conductors before you connect them. (Here is a good article on wire splicing: https://www.w8ji.com/splicing_antenna_wire.htm) Stiff wires are likely to break at or break off weak connections (like those on a PCB) because the connector breaks easier than the wire bends. (By the way, stranded core coax is also better as jumpers than solid core because similarly, the stranded wire will place less strain on the connector.)

Stranded wires work much better when making and breaking a connection frequently. Ring, fork, or bullet terminals, especially the crimp-on kind, make a much better connection with stranded wire than solid. The weaker crimp connectors don't work well on solid wire at all, unless they are soldered as well.

Electrical Properties

Conductivity is the first thing to look at. Copper is one of the most conductive antenna wires you'll find. Aluminum is second to copper, and steel is the worst of just about everything. Not all antennas mind DC conductivity though, so just because steel is a lousy conductor doesn't mean it won't antenna. Also, we are working with RF, not DC. This means we can use the skin effect to our advantage. (The skin effect is where the energy flows on the surface of a conductor at a depth varying with frequency.) Copper-clad steel will act like a solid copper wire for RF, but a steel wire for strength, in effect giving you the best of both worlds. The same principle applies to other clad conductors, like copper clad aluminum or aluminum clad steel. If you find silver-clad anything, the wire will be very conductive at RF, but expect to pay a lot for it!

Antennas like magnetic loops or DDRR's require very high conductivity. This is why you will usually see those made from aluminum, or better yet, copper pipe. Good luck finding one made of solid steel that works.

As a general rule, the thicker the conductor, the wider the bandwidth of the antenna. So to some extent, a larger conductor will give you more bandwidth. But you can also use a bunch of thinner conductors to make a cage dipole like structure—but that's another article.

Personal Recommendations

I've had good results with electric fence polywire before. Its cheap, flexible, strong, and not too hard to make connections on. I would recommend the kind with both copper and stainless steel conductors, but even plain steel will work for most applications.

Polytape is something I haven't tried yet, but I imagine the extra width will help with SWR bandwidth. Solid aluminum wire works okay, but it is a pain to make connections on unless you have a heavy duty crimp tool (like used on electric fences) or you use one of those Western Union splices like from W8JI's article.

THHN copper, like pulled out of scrap Romex cable, works great for VHF-UHF ground plane

antennas. #14 or thicker steel also works okay if that's all you have.

Magnet wire, like that salvaged from an old blender motor, works great for a stealth antenna because its so thin and hard to see. But it isn't very strong either. Copper pipe can be used for a magnetic loop, but the same can be done with scraps of Heliax or aluminum jacketed hardline. (Heliax is comprised of a corrugated copper shield that's more like pipe than cable.) I've also read of using copper wire with one of MFJ's loop tuners.

The important thing is not to let a quest for perfection keep you from experimenting. I've tried many different types of antenna designs using many different materials, and a lot of them of ended up in the junk heap or were dismantled for parts. When in doubt, try it out. You might end up with a great design.

73 and have fun,

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