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# Tensile Testing Tracer Wire: Solid Copper vs. Copper Clad Steel

## Overview

In April 2007, Hawkeye Industries Inc. tested samples of *12* and *14 AWG* tracer wire to failure in tension. Using an apparatus to apply a known tensile load to the wire, the strength of traditional solid copper (*Cu*) wire was compared to copper clad steel (*CCS*). The tests show definitively that the CCS wire is significantly stronger in tension than standard Cu wire.

## Apparatus & Equipment

The tensile testing apparatus consists of a custom manufactured armature supporting two *0.875 in.* diameter pins. One pin is held fixed, while the other is free to rotate. The tracer wire sample is wrapped around these pins, and a torsional force applied to the free pin. This torsion results in rotation, imparting a tensile load on the specimen.

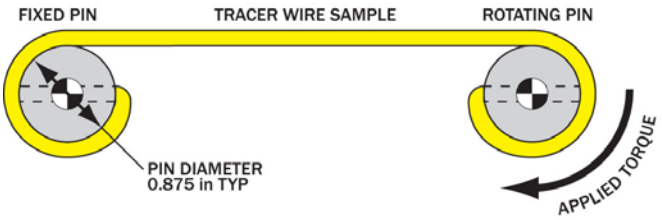


**Figure 1: Schematic of Test Apparatus**
Showing the general geometry and mechanism of the torque-based tensile load measuring apparatus.

Since the diameter of the pin and wire are known, the tension in the wire is simply a function of the torque, measured with a dial indicating torque wrench, on the rotating pin. The torque wrench has resolution of *5 in-lbf*, and is accurate to ±*3% FS*.

## Samples

The following samples were prepared and used in the tensile testing series, for total of 12 tests:

Solid Copper
(3 x) 12 AWG Hawkeye Cu PE Insulated
(3 x) 14 AWG Hawkeye Cu PE Insulated

Copper-Clad Steel
(3 x) 12 AWG Hawkeye CCS PE Insulated
(3 x) 14 AWG Hawkeye CCS PE Insulated

All samples were cut to 22.0 in. long, and the insulation was left in-tact.

## Investigation and Analysis

Three samples of each style of wire in each size are loaded to failure, and the torque at failure is recorded. The average of the three results is then used to determine the ultimate tensile load.

The tension on each wire sample is determined using the following formula:

$$T = \frac{2 \cdot J}{D + d} \qquad (1)$$

Where:
T = Wire Tension (lbf)
J = Measured Torque (in-lbf)
D = Rotating Pin Diameter (0.875 in)
d = Measured Wire Diameter (in.)

## Results

The testing and analysis provided the following results:

| Ultimate Tensile Strength (lbf) | | | | |
|---|---|---|---|---|
| | *Solid Copper* | | *CCS* | |
| Manufacturer | 14 AWG | 12 AWG | 14 AWG | 12 AWG |
| Hawkeye | 135 | 222 | 203 | 338 |

**Table 1: Calculated Tensile Strengths**
These results, calculated using the test data and equation 1, show that the CCS wire is significantly stronger in tension than solid copper

The 14 AWG CCS wire has approximately 50% higher tensile strength than the Cu; and similarly, the 12 AWG CCS has approximately 52% increased tensile strength.

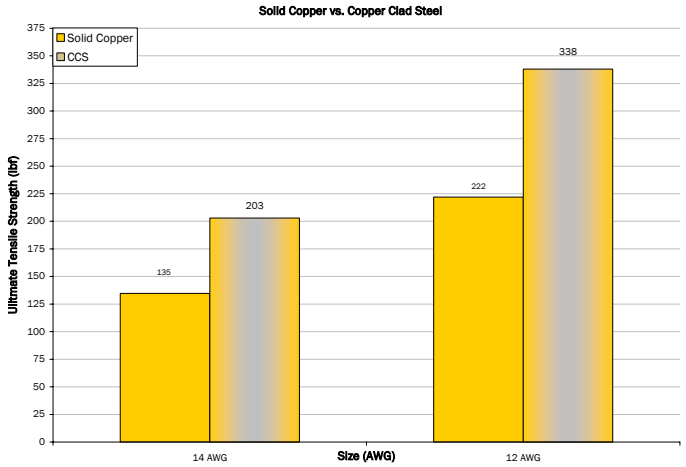


**Figure 2: Graphical Comparison of Cu and CCS Wire in Tension**
The CCS wire is evidently stronger in tension than solid copper wire.

## Conclusion

Copper-Clad Steel (CCS) Tracer wire is significantly stronger in tension than solid copper (Cu) tracer wire, based on the procedures and data resulting from this investigation.