

Should loops be designed with stranded or solid wire? What is the real difference?

It is common knowledge in our industry that loops should be designed with stranded wire – but is that really the best option?

It is a simple fact that when you compare the electrical characteristics of a solid wire vs. stranded wire of the same gauge the solid wire will have less resistance than the stranded wire. This means that solid wire will offer better loop performance. So why use stranded wire at all? Well the one great advantage that stranded wire has over solid wire is its flexibility. Flexibility is needed for the lead-in run of the loop. So the lead-in should always be made with stranded wire.

Stranded Wire Issues

- Stranded wire will have higher resistance than solid wire of the same diameter because the cross-section of the stranded wire is not all copper.
- The longer or thinner the wires the greater the resistance.

Can the loop portion itself be made of solid wire? Yes, because once the loop is installed, it will not be able to move or flex. There is little need for flexibility in the loop section specifically. There are other advantages to having the loop section made with solid wire including:

- Generally solid conductor cables have lower DC resistance and lower susceptibility to high-frequency effects based on their larger skin diameter alone.
- Solid wire is less likely to be affected by ground vibrations.
- When laying a loop over rebar the rigid characteristics of solid wire will mean less chance the loop will fall below the rebar when concrete is poured.
- Solid wire holds its shape when bent, which means it's easier to shape the wire into your desired loop pattern.
- Solid wire is more rugged and has less surface area which is exposed to attack by corrosives which means it has better protection against the environment.
- Solid conductor cables can support longer transmission runs and higher data rates than their stranded cable counterparts because of skin effect.
- Solid wire is less expensive than stranded wire. *Better performing loop at a better price!*

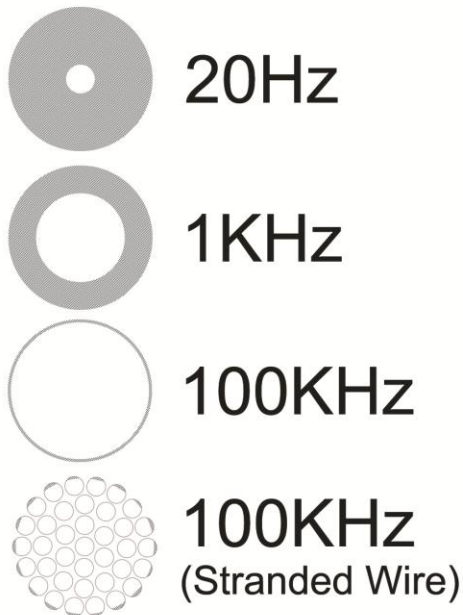
We at BD Loops always say that loops are simple technology – which they are. However, there are some complex details that need to be addressed when designing loops that pertain to the way current flows through loops. These details that need to be considered are *insertion loss* and *skin effect*.

Insertion Loss/Attenuation is a measurement of loss in transmission signal strength between two points on a cable. Insertion loss is essentially a way to measure and understand how resistance in a conductor

will affect a signal travelling through a conductor. In the case of a loop this would mean measuring the signal loss that occurs from one of the lead-in wires to the other. Attenuation is measured in decibels (dB) if there is too much voltage loss (attenuation) the signals quality will diminished to the point it is unintelligible by the time it reaches the other end of the cable. The amount of Insertion loss depends on two major factors the gauge of the wire, and the length of the wire. Higher gauge (thinner) wires have more insertion loss than lower gauge (thicker) wires. Overall stranded copper wires will have 20%-50% more insertion loss than solid conductor wires.

Another point to consider when weighing the pros and cons of solid wire vs. stranded wire is **skin effect**. Skin effect describes the interesting way that AC (alternating current) travels down conductors, at higher frequencies the current only travels through the outer edge of a round conductor. The easiest way to imagine what skin effect looks like is to think of the current travelling only around the outer skin of a conductor – the conductor is used like a hollow tube, all the copper in the center of the conductor is ignored.

Skin Effect Visualized



■ Current penetration of conductor.

As you can see in the image as the frequency increases less of the conductor is used. At about 100kHz the signal only travels through the skin. Loop detector frequencies range from 10kHz to 150kHz, skin effect diminishes the quality of the signal at these frequencies. In the case of stranded wire the skin effect will not take place on each strand – but just the outside of the stranded bundle. Skin effect is another example where solid wire shines, solid wire is less prone to high frequency issues, and can support longer runs and higher data rates than stranded wire.

Another advantage of using solid wire in the loop portion is ease of installation. Solid wire is rigid, easy to form, and holds its shape well. When using a solid wire preformed loop in a concrete pour you are able to lay the loop directly on the rebar offsetting it from the rebar pattern and pour concrete over it. Because of the rigidity of solid wire the loop will not fall below the rebar pattern like a less rigid stranded wire loop would. When stranded wires are used

for the loop portion in a concrete pour the

manufacturer will often instruct you to tie the loop wire to 1"-2" rigid PVC conduit or other stand-offs so that the loop will not be pushed down below the rebar when concrete is poured. Besides making the installation more complex, this also introduces air pockets into the concrete pour.

Knowing the advantages of solid wire vs. stranded wire the best performing inductance loops would have the loop section made out of solid wire for increased performance, and the lead-in made out of stranded wire for better flexibility and ease of running through conduit.

This is why BD Loops has been designing their preformed loops using both solid and stranded wires since they first introduced their direct burial loop over 14 years ago. Maybe that is one of the reasons why BD Loops is the #1 preferred supplier of preformed loops for the gate and door industry. We think profits should never be considered over performance.

Want to delve more into insertion loss and skin effect? There are abundant free resources online that cover the electrical characteristics of wire. Here are a few to get started with:

Insertion loss/attenuation:

<https://www.andcable.com/files/UnderstandingStrandedandSolidWiring.pdf>

Skin effect:

https://www.st-andrews.ac.uk/~www_pa/Scots_Guide/audio/skineffect/page1.html

BD Loops is a manufacturer of preformed direct burial and saw-cut inductance loops for the gate, door, and parking industries. With over 15 years in business the quality of BD Loops is unparalleled. BD Loops products are available through over 400 distributors in the U.S. and Canada. BD Loops offers 58 standard preformed loop sizes, all standard and custom loop sizes are ready to be shipped the same day. The company has several letters of recommendation testifying their professionalism and design, and is a member of the following associations: AFA, IDA, NAFC, NOMMA, IPI, CODA, and IMSA. Feel free to call BD Loop's knowledgeable staff with any questions about loops or their applications. By visiting the BD Loops website (www.BDLoops.com) you are sure to [learn something new](#) whether if you are new to installing loops or a veteran installer. While you are at the BDLoops.com website sign up for our free informative [monthly installer newsletter](#). Use our [distributor locator](#) to find a distributor near you.