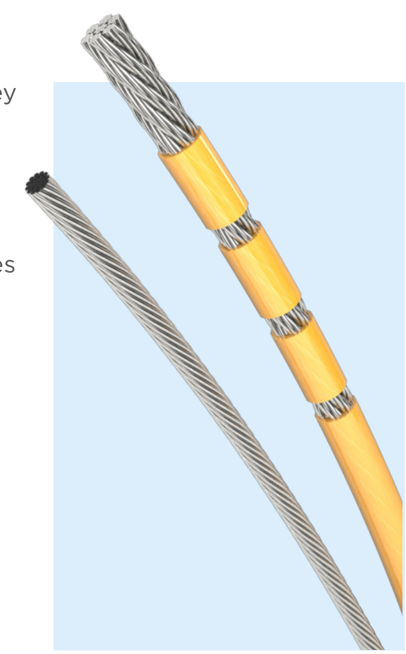
Engineering Stranded and Cabled Wire Constructions for Medical Devices

A guidewire that reaches its target, an orthopaedic cable that holds a bone fragment in place, a pacing lead that survives an exceptionally large number of flex cycles, and an atherectomy drive shaft that transmits torque without buckling. Though different applications, they all share the same underlying component: a length of small-diameter wire arranged into a specific stranded or cabled geometry. Each of these wires addresses a unique engineering problem by trading flexibility, breakload, and torque against one another.

The work of specifying a strand or cable is not simply picking a stock part off a list. It is choosing where on the flexibility-strength-torque spectrum the application sits and then constructing the wire form that meets the criteria.

Distinguishing strand from cable

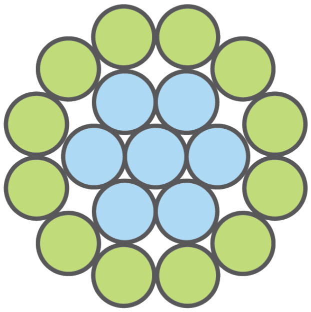


Though strand and cable are used interchangeably in casual conversation, they are not interchangeable in engineering.

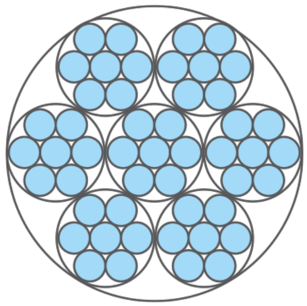
A **strand** is a single helical winding of round wires with individual filaments, or filars, wrapping around a central core wire. The most common strand constructions are 1x7, which is six wires around one core in a single layer, and 1x19, which is 18 wires around one core in two layers. The first number indicates the strand count and the second indicates filar count per strand.

A **cable** refers to multiple strands twisted together. A 7x7 cable is seven 1x7 strands twisted around one another, while a 7x19 cable is seven 1x19 strands. Our most complex routinely produced construction is a 37x37 architecture, which contains 1,369 filars in a single component.

The structural distinction matters because cables and strands behave differently under load. A 1x19 strand and a 7x7 cable differ in total filar count and, as a result, exhibit different mechanical responses to bending, tension, and torsion. The cable's hierarchical winding gives it more flexibility at a given outside diameter, while the strand's tighter packing gives it more axial strength. That distinction is the foundation of every downstream decision.



1 x 19 strand

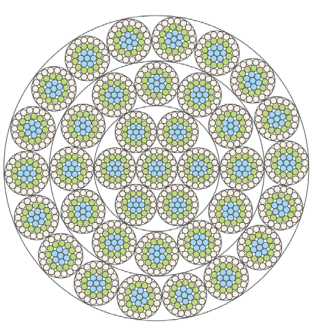


7 x 7 cable

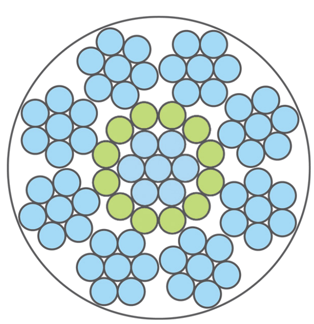
The central trade-off

At a fixed outside diameter, increasing the number of filars in a stranded construction increases flexibility and decreases break strength. These properties move in opposition because the same geometric change drives both. A higher filar count means each wire is smaller, can bend more freely, and contributes less to the total cross-sectional area of load-bearing metal. The result is a more compliant component that can weaken at a lower axial load.

A 1x7 stainless steel strand at a given outside diameter will exhibit the highest breakload and the lowest flexibility among common constructions. A 7x7 cable at the same outside diameter trades meaningful breakload strength for greater flexibility. A 7x19 cable trades even more. By the time the construction reaches the most complex 37x37 architecture, the component is highly flexible but the break load per unit cross-section has dropped well below the simpler strand alternatives. Torque transmission scales with this surface as well, generally in the same direction as breakload, but with construction-specific exceptions that matter at the device level.



37 x 37 cable



1 x 19 + 8 (1 x 7) cable

Outside diameter ranges from 0.051 mm [0.002 in] on the standard small end to 4.7625 mm [0.1875 in] on the large end, with sizes outside these limits available on a case-by-case basis. Across that range, the construction determines whether the component lives at the flexible end of the curve, the strong end, or somewhere intentionally between.

This is why a typical strands-and-cables specification process does not begin by choosing a construction first. Rather than starting with, “I need a 7x19 cable,” the process starts by defining what the component must do:

- Required breakload
- Maximum outside diameter
- Flexibility requirements
- Material or alloy needed

Once those criteria are defined, the appropriate construction follows from the application constraints.

The alloy choice

Whereas construction handles geometry, alloy handles the metallurgy. The strandable material set is broad, encompassing multiple grades of stainless steel, cobalt-chromium alloys, Nitinol, titanium, tungsten, DFT® wire constructions, and other high-performance alloys.

Cobalt-chromium alloys covered by ASTM F562, such as Fort Wayne Metals’ 35N LT™, are preferred when fatigue life is the governing property. Examples include pacing leads, neurostimulation leads, and other implantable conductors that see millions of stress-strain cycles over their service life. The melt practice for the 35N LT™ alloy , introduced in the early 2000s with controlled inclusion content, further extends fatigue performance for the most demanding leadwire applications.

DFT® wire constructions consist of a core material enveloped by a surrounding material. When used as individual filars, they combine the properties of both materials. For example, the strength of a stainless steel outer layer with the conductivity of a silver core. Other high-performance alloy options, including titanium and various refractory metals, are also available for applications with more specialized requirements.

Rotary swaging

Construction and alloy define the as-built behavior. A secondary process called rotary swaging, sometimes called compaction, modifies that behavior after the strand is formed.

Swaging passes a finished strand or cable through a rotary die that radially compresses the strand's or cable's outside diameter. The mechanical effect is to push the individual filars against one another, close the interstitial gaps between them, and produce a more solid cross-section. The exterior surface becomes smoother along the length of the spool.

The functional consequences follow from the geometry change. A swaged strand has higher breakload than the unswaged construction at the same final size because more metal cross-section is engaged in carrying axial load. It is stiffer in bending because the filars can no longer rearrange against one another to accommodate curvature. It also slides more easily against surrounding components because the surface is smoother. Because compaction varies with construction — e.g., a 1x7 swages differently than a 7x19 — the outside diameter reduction is chosen to achieve the target properties, not applied as a fixed percentage.

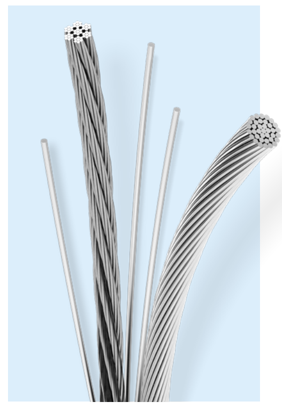
Swaging tends to suit designs that need the breakload profile of a less-flexible construction without going to a different construction. When the device requires maximum flexibility at a given outside diameter, other approaches may be worth exploring. The same property that swaging gives up, namely the filars' ability to slide and reorganize under bending, is the one that flexible applications depend on.

From application to specification

Turning an application requirement into a buildable specification starts with three parameters: the alloy required by the device environment, the minimum acceptable breakload under axial test, and the maximum acceptable outside diameter.

With these three numbers, the universe of qualifying constructions narrows. An online configurator tool published by Fort Wayne Metals accepts these three inputs and returns the set of standard constructions that satisfy them, along with the maximum breakload each construction achieves at the specified outside diameter. For design windows that fall inside standard production capability, this is usually enough to converge on a starting construction quickly.

Designs that fall at the edge of standard capability — such as extremely small outside diameters, unusual material combinations, or unique architectures — typically require direct engineering collaboration.



Microcable diameters below the standard window are one example of an edge case the configurator may not fully address. That does not mean anything outside the standard window is impossible to produce. Rather, the standard window covers most applications, while less typical designs benefit from a more in-depth engineering discussion.

Examples of use cases

The applications cover a wide range of mechanical demands. In orthopaedic surgery, strands and cables secure bone fragments and ligament reconstructions. The requirement is high breakload, moderate flexibility, and corrosion resistance. Simpler strand constructions in cobalt-chromium or implantable stainless steel cover most cases.

Strands are used in a variety of minimally invasive instruments, including guidewires, stylets, and endoscopic devices. These devices require flexibility for navigation through tortuous anatomy, combined with enough stiffness for pushability, and enough torsional rigidity for tip orientation.

In cardiac pacing and neurostimulation leads, the conductor experiences hundreds of millions of flex cycles over its implant life. The dominant property is fatigue resistance, and the alloy choice, typically a controlled-melt 35N LT™ alloy, matters as much as the construction.

In drive shafts for rotational devices, such as atherectomy, thrombectomy, and certain biopsy systems, the construction must transmit torque without windup while still flexing through the access path. Specialized strands meant to carry torsional loads are typical.

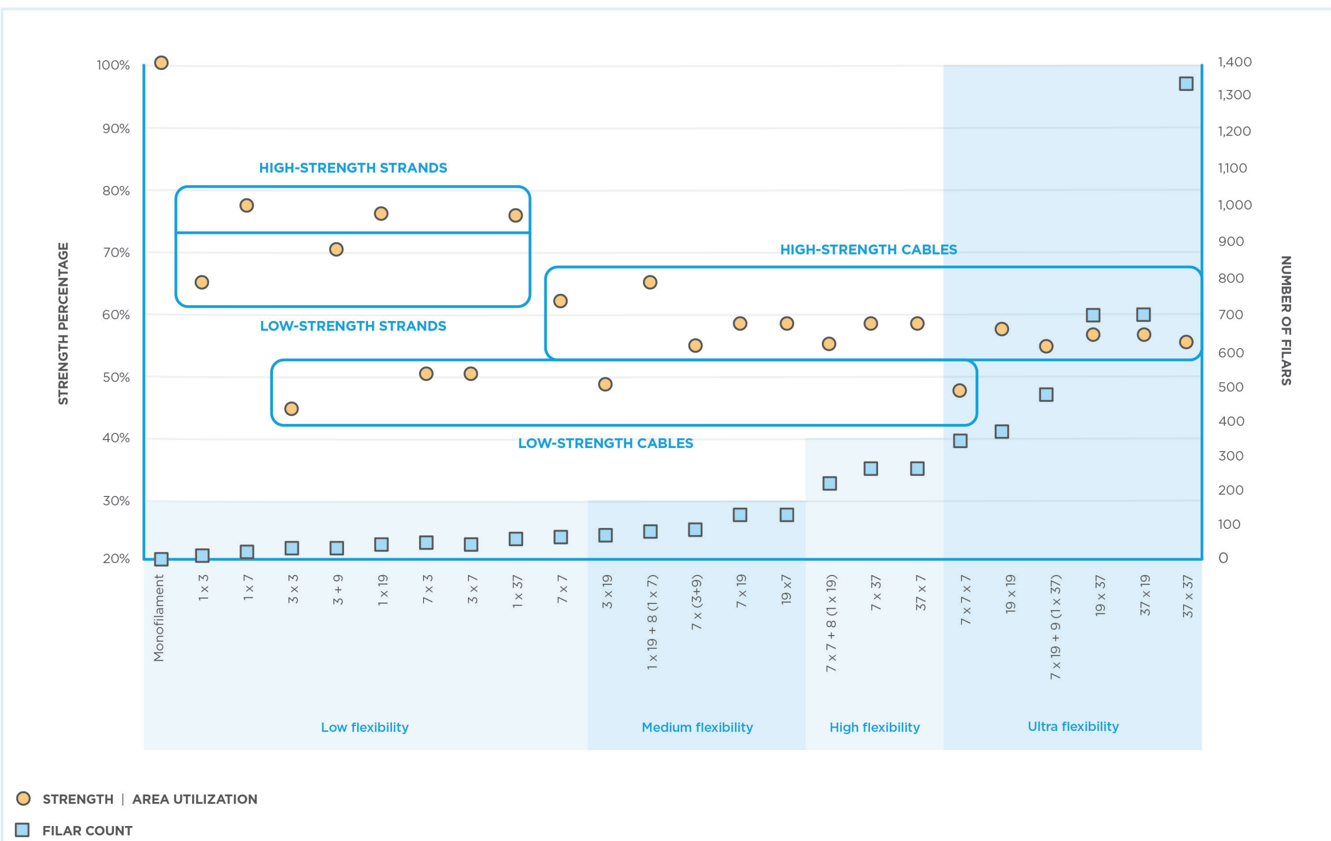
Every stranded construction sits somewhere on a surface defined by flexibility, breakload, and torque, and engineering the right component means knowing where the application lives on that surface and tuning construction, alloy, and post-process to land there.

Construction as a design variable

Specifying a strand or cable is sometimes treated as a routine procurement task handled without close engineering attention. The part number that worked last time gets reordered, and the design moves on. While that strategy works for some products, treating the construction as a design variable opens the same kind of optimization available in every other part of the device.

Switching to a fatigue-optimized alloy may support a simpler geometry. And adding a swaging step may close the gap between an existing construction and the target. While the component may be small, the design around it is not.

To explore standard constructions for your application, visit Fort Wayne Metals' Strands and Cables configurator. Enter your required alloy, breakload, and outside diameter to see qualifying constructions in seconds. For designs that fall outside the standard window, or for any questions about material selection, construction optimization, or application-specific requirements, reach out to our technical experts directly.



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