



The Art of COILED WIRE FABRIC

Flexibility and form on a large scale

by Andrew Schoenheit

Photo © Jeremy Green

SOME OF THE MOST ATTENTION-GETTING PROJECTS THESE DAYS INVOLVE ARCHITECTURAL COILED-WIRE FABRIC—A MORE AFFORDABLE ALTERNATIVE TO TRADITIONAL WOVEN MESH THAT DELIVERS EQUAL OR SUPERIOR AESTHETICS, FUNCTIONALITY, AND PERFORMANCE.

Traditional woven mesh is usually made from stainless steel, copper, or brass. It is handcrafted on industrial looms, custom-made, and found in both interior and exterior applications. It is often used as a design element, space divider, or exterior cladding—and is a heavyweight, durable product suited for large-scale projects.

Woven mesh can shield windows and openings while still allowing air to flow through without completely obstructing views.

Architectural coiled-wire fabric, on the other hand, looks and performs in the same manner, but comes with a far lower installed cost made possible by its unique design: interlocked strands of wire shaped into a coil form. This spiraling imparts it with structure and spring-like characteristics that allow for greater degrees of tensions and compression without permanent deformation.

Why go coiled?

Architectural coiled-wire fabric systems can serve numerous functions, from diffusing light and

Even when customized attachment systems are necessary, coiled-wire fabric's lightness and flexibility offers opportunities to visually experiment with the material.

aesthetic impacts to fall protection, screening, ventilating, and security. Interior applications appropriate for these assemblies include:

- media walls;
- barriers;
- ceilings;
- merchandising displays;
- partitions;
- curtains;
- security screens;
- infills;
- signage; and
- light diffusers.

Exterior applications include:

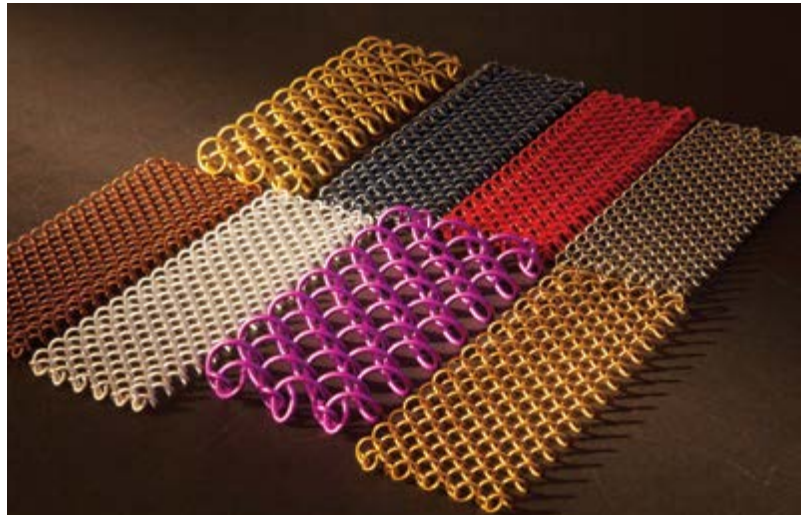
- awnings;
- living walls;
- canopies;
- claddings;
- partitions;
- curtains;
- façades; and
- water features.

In comparison to traditional woven mesh for the same applications, these assemblies are much lighter and have reduced structural embed requirements. The fabric is manufactured in a wider range of metals, gauges, scales, finishes, and colors; further, its manufacturing method allows for panel sizes with unlimited width and a coil length limited only by shipping restrictions.

Coiled-wire fabric provides color and texture, and reacts beautifully to light. Many architects and designers are embracing these systems, especially for the fact they—along with their engineered attachment systems—enable even projects with modest budgets to achieve unique design visions.

Traditional woven metal mesh

As for woven metal mesh, there are two broad types: rigid and flexible. Rigid (or flat) mesh contains wires running in the warp direction, combined with wires inserted in the fill direction. The material obtains its stability via the friction



created between the warp and the fill, typically by a crimp created where the wires intersect. Any shape integrated into the material would be created via forming or bending. Fabrication is normally required to finish off the edges of the material, and there is more frequently a frame required around the perimeter. There are typically length and width limitations driven by the loom sizes.

There are two types of flexible woven mesh products. The first is fabricated via cable strands (running in the warp direction) connected to rods sitting between the cable strands. The other takes wire and forms a flat spiral which is then interconnected (typically via welding) with rods. These systems typically have length and width limitations determined by the tooling used in the manufacturing process. The material is flexible and can be bent or formed in one direction that is limited by the way the material is oriented.

Engineered attachment systems

For coiled-wire fabric, engineered attachment systems are primarily manufactured from steel to achieve certain objectives:

- present the panels in a specific manner (*e.g.* curved or flat);
- hold the panels in a static state or enable motion; and

Architectural coiled-wire fabric's spiraling gives the material structure and spring-like characteristics, allowing numerous applications in both form and function.

Photos courtesy Cascade Architectural



For London, England's TwoRuba, AfroditiKrassa selected architectural coiled-wire fabric to define spaces.

- achieve specific performance requirements (including attachment frequency, solar shading, or impact resistance).

Even when customized attachment systems are necessary, coiled-wire fabric's lightness and flexibility offers opportunities to visually experiment with the material. The functional results include reduced installation time, reduced labor costs, and a far less structurally demanding system. Additionally, pre-engineered attachment systems are delivered with shorter lead times than most other architectural exterior and interior systems.

Defining flexible space and creating drama

When the Hilton Tower Bridge in London, England, recently decided to build a bar/lounge called TwoRuba, it turned to interior design studio, AfroditiKrassa Ltd. The firm selected an architectural coiled-wire fabric system as an "innovative design element," employing it to define flexible space that "transforms seamlessly" from casual coffee house during the day to a sleek bar and lounge at night.

"We chose an innovative, eco-friendly, and hardwearing bronze 'drapery' to work alongside a central catwalk area that links all three levels of the bar from which the entire space is articulated," said the studio's founder, Afroditi Krassa, of the project, which opened in September 2014. "To emphasize this strong sense of direction, lighting pendants rhythmically dress the ceiling and guide customers through the space."

Similarly, architectural coiled-wire fabric systems were installed in the newest iPic Theater locations on this side of the Atlantic. Recognized

for their architecturally striking décor, these luxury cinemas attract a prestigious roster of celebrity clientele and moviegoers. The complete experience, which includes chef-driven cuisine served directly to customers inside the theater, more closely resembles the feeling of stepping into a stylish hotel or lounge versus a traditional movie theater.

The coiled-wire fabric can be viewed when entering the new iPic Theater on Wilshire Boulevard in the Westwood area of Los Angeles. The dramatic effect begins inside the lobby where guests are treated to the images of fabled movie stars projected onto the assembly.

The suspended coiled-wire fabric consists of 19-gauge galvanized steel with 4.8-mm ($\frac{3}{16}$ -in.) scale. The fabric features three different finishes—antique copper, satin bronze, and silver-toned—and is affixed to the ceiling using an engineered attachment system in a curved orientation.

Canvas and catalyst

A nearby project, the Vermont luxury high-rise apartments and retail space, uses a coiled-wire fabric system in an undulating profile as both the façade to its parking garage and as the canvas for a work of art entitled, "Los Angeles Opens its Heart of Compassion." In this case, Venice, California-based Cliff Garten served as both architect and artist.

A suspended 6.1-m (20-ft) tall sculpture is the centerpiece; it is made of 100 laser-cut aluminum 'lotus petals' extending outward from a steel armature. The sculpture is framed by the coiled-wire fabric assembly, described as a 23 x 14-m (75 x 45-ft) 'screen' by the design studio. Light-emitting diodes (LEDs) showcase the art from the front, side, and back. As described in a Cliff Garten Studio publication:

The sculpture is bathed in an intense white light, while the screen and its corresponding line drawing move through a light show of rich, changing colors. The swells of color captured by the curving screen deepen in relation to the amount of natural daylight.

Completed earlier this year, the Vermont is located in Los Angeles' Koreatown neighborhood. Garten, who described the material as "intriguing," says the use of the lotus blossom image was meant to reflect a recurrent theme in Korean art.

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Vert.



Antoine Predock Architect Studio chose coiled-wire fabric for a multi-panel assembly at the U.S. Courthouse in El Paso, Texas.

Reducing complexity and consumption

The U.S. Courthouse in El Paso, Texas, provides a telling example of how architectural coiled-wire fabric differs from traditional woven mesh. The building's shimmering, multi-panel assembly adds intricate texture in keeping with the architect's mission to mirror the local history and geology.

"One of the primary materials in the building is copper, so the system allowed us to use that material to shade the large expanses of glass near the building entry," says Paul Fehlau, executive senior associate at Antoine Predock Architect Studio (Albuquerque, New Mexico). "It is not as rigid, and it is simpler."

Fehalu further explains what he means by simpler.

"It hangs like fabric and has a very distinctive three-dimensional aspect that you really cannot get with woven meshes," he says. "This allows you to suspend it from the top with a very simple detail and just let it drape, as compared to meshes that need additional support to keep them in place. There really isn't anything else like it."

Aesthetics aside, another advantage to installing architectural coiled-wire fabric is its positive impact on a building's energy consumption through passive solar shading. As demonstrated by third-party engineering tests conducted by Interface Engineering (Portland, Oregon), coiled-wire fabric assemblies in exterior applications can reduce a building's energy consumption by as much as 12.3 percent.¹

The testing also determined the coiled fabric system "significantly" improves thermal comfort when used as an exterior scrim in conjunction with standard-performance double-pane glazing. Further, the study found the system reduces direct sun penetration even in zero percent fullness mode.

The working definition of 'fullness' here is a measurement of the extra material needed to cover a given area when it is wave formed. A flat panel of coiled-wire fabric has zero percent fullness; a panel twice as wide as the area it covers has 100 percent fullness. Interior window curtains often employ increased fullness to increase shading, energy savings, and glare control.

It is also worth noting architectural coiled-wire fabric systems are 100 percent

The iPic Theater in Scottsdale, Arizona, employs coiled-wire fabric as part of its luxury, upscale aesthetic.



Also shown on page 18, the Vermont multi-family/retail complex uses a coiled-wire fabric system in an undulating profile as both the façade to its parking garage and as the canvas for Cliff Garten Studio's art piece, "Los Angeles Opens its Heart of Compassion."

Photo © Jeremy Green

recyclable and part of the Living Building Challenge (LBC) Declare labeling program, which calls itself "the built environment's most rigorous performance standard."² Demanding full materials transparency, it calls for the creation of building projects at all scales to operate as cleanly, beautifully, and efficiently as "nature's architecture."

Material options

The options to specify this metal fabric begin with the selection of wire materials. Except where noted, all these materials are usually available in a wide range of wire gauges and scales.

Low-carbon, mild steel

Low-carbon, mild steel wire with a semi-bright finish boasts relatively high strength and durability, along with a lower price point. The wire conforms

to ASTM A82, *Standard Specification for Steel Wire, Plain, for Concrete Reinforcement*, and can be painted almost any custom color. It is also available from some manufacturers in a softened, annealed version. The annealing, or stress-relieving process, reduces the wire hardness, making it more ductile. The wire has a smooth, bright finish with low memory, making it ideal for high-speed forming.

Galvanized steel

Galvanized steel wire is a mild steel wire with a layer of zinc applied during the wire drawing process. The zinc coating adds a protective, corrosion-resistant layer to the steel conforming to ASTM A641, *Standard Specification for Zinc-coated (Galvanized) Carbon Steel Wire*. Galvanized wire retains all the mild steel's mechanical properties with a high resistance to atmospheric oxidization. The wire is ash-gray in color, but can form a white powder when wet. This wire works best for industrial applications, where relatively high strength and corrosion resistance are required.

Aluminum 5056-H18

Aluminum 5056-H18 is an ideal material for the coiled-wire fabric-weaving process. It features ease of formability, high resistance to corrosion, excellent strength-to-weight ratio, and natural aesthetic qualities. This aluminum wire is very ductile, making it relatively inexpensive to manufacture. Being non-ferrous, the material does not discolor or deteriorate in most climates.

At almost a third the weight of steel, aluminum weaves can cover more area while adding minimal mass to its supports, which further decreases the overall cost. In its bare state, aluminum wire is light silver in appearance, but can be painted any custom hue. Additionally, it can be polished to a more lustrous finish.



Coiled-wire fabric can be viewed when entering the new iPic Theater in Westwood, Los Angeles; it is part of an installation including celluloid legends.

Photo courtesy Cascade Architectural

Aluminized steel

Aluminized steel wire is a corrosion-resistant steel material used primarily for exterior fencing. It is a cheaper, less-attractive alternative to stainless steel with a slightly duller finish and conforms to ASTM A809-08, *Standard Specification for Aluminum-coated (Aluminized) Carbon Steel Wire*. Typically, this is only available in specific scales.

Nickel-plated steel

Nickel-plated steel wire is standard mild steel wire coated with a thin layer of electrolytic nickel. The coating not only offers a brilliant chrome finish, but also helps in resisting corrosion. Typically, this material is used on interior applications where a high-gloss mirrored finish is desired.

Stainless steel

Stainless steel Type 304 is a slightly magnetic, highly corrosion-resistant material with a lustrous metallic finish. Its consistent wire surface quality, relatively high strength, and great corrosion resistance make it attractive for many applications. The wire can be drawn bare or with a black oxide surface. Stainless Steel Type 304 conforms to ASTM A313, *Standard Specification for Stainless Steel Spring Wire*.

Stainless steel Type 316

Type 316 exhibits the highest level of corrosion resistance when compared to all other stainless steel types. It has a slightly higher strength than Type 304 and can handle higher temperatures. In most cases, Type 316 is used for all exterior applications where

relatively high strengths and high resistance to oxidation or eroding is required. The wire can be drawn bare or with a black oxide surface. In its bare state, Type 316 has a lustrous metallic finish. Additionally, the wire can be chemically treated to exhibit an ultra-black satin finish that metallurgically bonds to the stainless wire and does not deteriorate. Stainless steel Type 316 conforms to ASTM A313.

Silver tin-plated steel

Silver tin-plated steel wire is a mild steel wire with a shiny, brilliant silver tin-plated surface. The tin coating is Grade A and conforms to ASTM B339, *Standard Specification for Pig Tin*. Its relatively low cost and attractive finish make it a popular choice for interior draperies and the like.

Solid brass wire

Solid brass wire bears a natural golden color. Its alloy composition is 70 percent copper and 30 percent zinc, and is denoted as “half hard.” As bare wire, brass has a relatively high resistance to corrosion, but can oxidize over time. A clear-coat finish can be added to preserve its natural color if desired. The wire’s anti-magnetic and anti-spark properties, coupled with moderate tensile strength, make it a unique material for special applications. This material conforms to ASTM B36, *Standard Specification for Brass Plate, Sheet, Strip, and Rolled Bar*, and is typically available in just a select set of wire gauges and scales.

Copper-clad steel

Copper-clad steel wire is a mild steel wire with pure copper plating bonded to the wire’s surface. This wire material exhibits a brilliant-red, polished finish when first plated. However, if left bare and untreated, the wire’s appearance will slowly change to brownish hues before ultimately gaining a gray/green patina. By applying a thin layer of clear lacquer, the bright salmon color can be maintained if desired. Suitable for both interior and exterior applications, this wire conforms to ASTM B227, *Standard Specification for Hard-drawn Copper-clad Steel Wire*.

Solid copper

Solid copper wire, like copper-clad steel wire, exhibits a vibrant reddish color when first drawn, but slowly browns to a gray/green patina when left bare and untreated. A clear-coat finish can be added to preserve its natural color if desired. Copper wire has a considerably low tensile strength and is soft, conforming to ASTM B248, *Standard Specification*

At almost a third the weight of steel, aluminum weaves can cover more area while adding minimal mass to its supports, which decreases overall cost.

for General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strip, and Rolled Bar. This material is primarily used in ornamental indoor applications.

High-tensile-strength steel

High-tensile-strength steel wire (*i.e.* music wire) is a high-carbon, cold-drawn wire conforming to ASTM A228, *Standard Specification for Steel Wire, Music Spring Quality*. Its tensile strength ranges from 2172 to 2380 MPa (315 to 345 ksi) and comes bare, zinc-plated, or phosphate-coated. The wire is primarily used in applications requiring high tensile/shear strength, wear resistance, and fatigue strength. It can be painted almost any color, but due to its extreme hardness, can only be woven in certain wire gauges and scales.

Titanium

Titanium wire is used primarily in the chemical industry where extreme lightweight, high corrosive resistance, and low to moderate strength are required. It is available in several different grades—all governed by ASTM B863, *Standard Specification for Titanium and Titanium Alloy Wire*. In its natural state, titanium wire is a dark-silver color. Its specific physical and chemical properties make titanium a

particular material type and can only be woven using certain wire gauges and in a few scales.

Good engineering saves time and money

The weaves for architectural coiled-wire fabric panels tend to share the same fundamental geometry, created by interlocking individual strands of spiraled wire. Various scale can be chosen, but the thickness selection impacts the material's:

- percentage of open area (from 40 to 85 percent);
- textured appearance;
- scale (from to 2.4 to 16 mm [$\frac{3}{32}$ to $\frac{5}{8}$ in.]);
- wire gauge (from 14 to 21); and
- ultimate strength.

The process of specifying includes the selection of an engineered attachment system to install coiled wire fabric. A designer should be able to rely on the manufacturer's judgment to specify the most appropriate one for any particular project.

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Notes

¹ To read the report, prepared for a manufacturer, check out the link in the digital version of this article, found at www.constructionspecifier.com.

² For more information on the program, visit www.declareproducts.com.

ADDITIONAL INFORMATION

Author

Andrew Schoenheit is vice president of sales for Cascade Architectural, manufacturer of Fabricoil coiled-wire fabric systems, and a division of Cascade Coil Drapery Inc. He has more than 15 years of experience in the wire-forming industry including extruding and production, metallurgy, metal finishing, and coatings. Schoenheit is also highly involved in Cascade's research and development, including projects in material testing for tensile and shear, bulk properties, blast and shock tube testing, and analytical modeling of formed-wire materials. He can be reached at andrew@cascadecoil.com.

Abstract

Screens of architectural coiled-wire fabric systems lend a unique aesthetic to exterior and interior spaces. This article concentrates on energy savings and glare control, and touches on thermal comfort and sustainability; it provides

detailed performance information for spaces using high-performance and standard glazing and how they help reduce a total building's energy usage as shades and draperies.

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10 22 13—Wire Mesh Partitions
10 71 00—Exterior Protection

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