

The Role Of

COPPER, BRASS AND BRONZE

In Architecture & Design

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Copper, mankind's "first" metal, has played a critical role in the design and architecture of all types of structures for thousands of years. In ancient Egypt, massive doors to the temple of Amen-Re at Karnak were clad with copper. In the third century B.C. in Sri Lanka, copper roof shingles sparkled in the sunlight atop the nine-story Loha Maha Paya temple. Centuries later, copper and its alloys were an integral part of European medieval architecture. Today, some 10,000 years after copper was first discovered, architects and designers are finding new and innovative ways to incorporate the "green metal" into their designs.

The building industry has long valued the beauty, longevity and practicality of copper. It is one of the few architectural metals commonly used without the application of a coating or finish applied to retain and enhance its natural appeal and long life. Its high ductility makes it easily formable—so it is easy to work with and ideal for cladding complicated details and shapes. Copper is also natu-

rally resistant to weathering and decay, and can be alloyed with other commonly available metals to increase its strength and performance characteristics, color, and tarnish resistance. In addition, copper is an important material for sustainable, green building projects.

Exterior Architectural Copper

For centuries, modern craftsmen and designers have utilized copper's inherent benefits to create durable, long-lasting building systems to protect the building and its occupants from the weather, in aesthetically pleasing and architecturally significant ways. From cathedrals to castles, and homes to offices, copper has played an important role in the exterior and interior design of buildings. That role continues today in all varieties of institutional, commercial and residential construction, both pub-

lic and private. Copper's long life, high durability and easy installation make it ideal for both low-slope and pitched roofing systems, along with such architectural enhancements as domes, spires and vaults.

Copper's beauty and protection doesn't stop there. It is frequently used to clad walls and other surfaces, bringing its striking traditional look to other interior and exterior building surfaces. Its excellent corrosion resistance combined with its durability and formability offer advantages in routing water through its uses in flashings, copings, gutters and downspouts.

Though a variety of copper alloys and product forms can be used to accomplish all of these tasks, the copper most commonly used for architectural applications is UNS alloy C11000. It is 99.9% pure, and meets ASTM B370 specifications. For architectural applications, it is usually used in





either strip or sheet form, with strip being less than 24" in width, and sheet being greater than 24" wide, up to 48". Both sheet and strip are available in various thicknesses, specified by ounce weight per square foot per the ASTM standard (see Table 1). Architectural copper is available in six tempers: soft, cold rolled, cold rolled and high yield, half hard, three quarters hard, and full hard. Copper's temper determines its ductility, and thus how it forms or how well it holds its shape without additional support.

Soft temper copper is very malleable and best suited for applications like intricate ornamental work. With the development of cold rolling, the gauge or thickness of the copper could be reduced without compromising its durability and low maintenance properties—producing light weight, stronger copper product forms that maintain much of the formability and ease of installation of soft temper for building systems where intricate detail is not needed. Because of its excellent mix of strength and formability, cold rolled is the most common copper temper currently used in building construction.

Copper's long service life and low maintenance properties have lead to its application for a variety of building systems and types. However, it is copper's beauty that has long made it an industry favorite. From bright, shiny copper at new installation, through stages of dark penny brown, to tones of soft green—copper's weathering characteristics bring buildings to life.

Copper Design And Installation

Visionary designers continue to use copper's living beauty as a focal point for their work. On exterior surfaces, copper's weathering is a result of the interaction between copper and the environment. In harsh locales and industrial areas, copper is likely to oxidize or patinate at a faster than normal rate due to higher concentrations of pollutants and acidic moisture in the air, thus reaching a fully patinated, soft green state more quickly than in other areas. In arid climates, the lack of moisture may postpone development of the green patina indefinitely, leaving the copper surface suspended as a deep penny brown. The orientation, and slopes of the surfaces also affect weathering—lower slopes tend to patinate more rapidly, while adjacent steep slopes or vertical surfaces patinate slower.

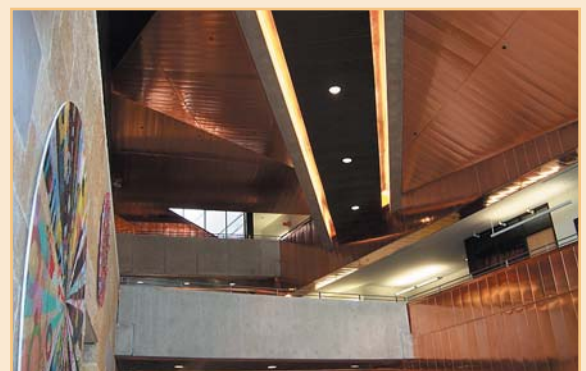
Designers must account for copper's weathering as it may affect other building surfaces. As rainwater washes over the copper surface, the removal of small amounts of copper salts from the patina can stain nearby light-colored, porous surfaces

green. Successful designs incorporate small gutters and other design elements to control rainwater runoff to building elements or areas that will not be affected.

While copper's excellent corrosion resistance makes it an outstanding weather barrier, it also makes the consideration of its interaction with other building metals important. Copper is a highly noble (cathodic) metal, meaning that it is highly resistant to corrosion when in contact with other metals. However, the low



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unexposed



4 years



4 months



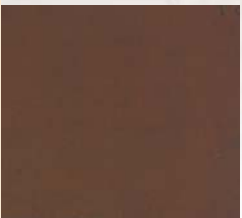
5 years



8 months



7 years



1 year



10 years



2 years



15 years



3 years



25-30 years



nails, rivets, etc.) to attach copper to a structure. Appropriate fasteners should be made of copper, copper alloys or stainless steel. In addition, designers and installers must be cognizant to prevent rain runoff from copper so it does not pass over or collect on others metals, such as in aluminum or galvanized steel gutters and downspouts.

Fastener selection and spacing, as well as proper substrate selection are important in ensuring the long life of copper systems. Fastening and cleating systems and copper jointing systems must account for the thermal expansion and contraction of the copper. Combinations of fixed and expansion cleats, expansion joints and proper substrate materials based on industry standard recommendations (see sidebar) can easily insure a long lasting, trouble free system.



building. A sustainable material must be durable and long lasting. Copper, brass and bronze used for exterior applications can last for a hundred years or more, even in harsh environments. In addition, copper and its alloys are virtually 100% recyclable.

Sustainability takes into account that, with the exception of solar and wind-based energies, natural resources are finite materials. Although there is a limited amount of copper available to be mined and used, it is estimated that only a fraction of all known mineral reserves have been mined. With this much copper still available and because copper has such a high level of recyclability, it can be considered a "renewable finite material".

nobility of metals such as galvanized steel, steel and aluminum means that these anodic metals can suffer corrosion when in contact with copper. It is important that designers and installers use appropriate fasteners (screws,

Copper & Green Building

The idea of "building green" began as a grassroots initiative focused on increasing the efficiency of buildings and their use of energy, natural resources and materials. Sustainable materials are a key element of green



A Vision In Copper

The recently-completed City Hall in Austin, TX, is an excellent example of copper's sustainable architectural properties. Antoine Predock, AIA's 2006 Gold Medal Recipient, was the visionary behind this unique structure that opened to the public in November 2004. Clad almost entirely in copper, it is one of the first government buildings in Texas to achieve Leadership in Energy and Environmental Design (LEED) Gold certification, the second highest ranking available from the United States Green Building Council (USGBC).

Approximately 66,000 sq. ft. of copper was used in creating the interior and exterior of the building. Due to the low level of impurities in Austin's air, including corrosive sulphur oxides, the exterior copper is not expected to patinate to its familiar pale green color for some time, perhaps 30 years or more. Until that happens, the metal will slowly darken while it gradually accumulates the visible effects of weather, wind and water, as the architect intended. One of the city's initial requirements was that the building be designed to reflect its surroundings; another was that it be constructed from materials that could last 100 years or more. Natural copper cladding easily meets both of these challenges.

According to David May, president of D.R. Kidd Co., the sheet metal contractor for the project,



Typical Dimensions of Copper Sheet & Strip

	Weight per S.F. in Ounces	Width (Inches)	Length (Inches)
Sheet Copper	12	30, 36	96, 120
	16	30, 36	96, 120
	20	30, 36	96, 120
	24	30, 36	96, 120
	32	30, 36	96, 120
	48	30, 36	96, 120
Strip Copper	16	10, 12, 14, 15, 16, 18, 20, 24	96, 120
	20	20, 24	96, 120
	24	20, 24	96, 120
	32	20, 24	96, 120

Table 1

"Copper provides a wonderful membrane for us to work with. The beauty of copper is its flexibility—it can be used for almost any type of covering and cladding application."

The roof and upper exterior of Austin City Hall are completely wrapped in uncoated copper. The copper used to cover the interior ceilings was coated with mineral oil to reduce oxidation and maintain its natural red color. The rest of the interior copper will be allowed to age naturally and patinate over time.

In the auditorium that houses the City Council chamber, copper is used both as an aesthetic enhancement and to regulate acoustics. Strategically placed on the chamber's walls and roof are a number of copper "clouds," which are actually sophisticated acoustic constructions designed to absorb sound and reduce echoing. Their ethereal presence also helps to spatially "shape" the chamber, making the

high ceiling seem lower and creating a more intimate area within the large, open space.

In July 2006, the USGBC bestowed its Gold LEED Certification on Austin's City Hall. Certification is based on earning LEED points in six overall categories. Austin earned six points in the Materials And Resources category, which rates the amount of non-renewable materials used in construction as well as the percentage of materials that contain recycled and pre- and post-consumer content, such as copper.

"I am delighted that Austin City Hall, the community's cornerstone of democracy and civic involvement, has received this great recognition," stated Mayor Will Wynn. "Sustainability is a civic virtue that the city strives for in many different areas. It reflects our success, which is something that all Austinites can take pride in achieving."

Copper In Interior Architecture And Design

One inevitable aspect of interior design is that it evokes certain feelings in occupants. Copper has

long been recognized for its ability to promote an atmosphere of tranquility and calm. According to Leatrice Eiseman, executive director of the Pantone Color Institute, "Copper and the varied-color copper alloys invite a nurturing feeling, and in the stressful times we are living in, the need to embody warmth resonates with a lot of people."

Copper and its alloys are often used in the design of interior fixtures and decorative enhancements. Handles, doorknobs, lock cylinders, faucets and furniture embellishments are typically made of copper and brass. Copper countertops, range hoods, sinks and other accessories are commonplace in many homes. Recent technological developments have enabled the use of these materials in innovative ways. For example, copper and brass may be woven into textiles used in draperies and other furnishings.

Renowned interior designer Rekha Nambiar recently remarked, "Metal remains an extensively used feature of design. The only difference is that it is now mixed with other mediums, from wood to leather. Metal laminates like copper are being used on everything from walls to furniture. There is a lot of development in this particular aspect of interiors and it's likely to get more and more creative."

Copper's aesthetic appeal is not the only reason for its use in interior applications. In some cases it is even hidden behind walls. Though unseen by occupants, they achieve a great benefit from its radio frequency (RF) shielding properties. With sensitive electronics and computer use on the rise, protection is needed not only from high-voltage and radio-frequency interference, but also from unauthorized surveillance. The same properties that make copper an excellent electrical conductor also enable the metal to absorb radio and magnetic waves, making it an ideal material for RF shielding. Properly designed and constructed copper enclosures can effectively

satisfy most RF shielding needs, from computer and electrical switching rooms to hospital CAT-scan and MRI facilities.

Another characteristic of copper that designers are just beginning to recognize is its inherent anti-microbial properties. Thousands of years ago, before science even knew of the existence of dangerous microorganisms, the Egyptians, Greeks, Romans and Aztecs all used copper compounds as an element in their hygiene and to treat disease.

Today, research at the University Of Southampton, sponsored by the Copper Development Association, has shown that uncoated copper, brass and bronze can eliminate common disease-causing bacteria such as E. coli, streptococcus, staphylococcus and staphylococcus aureus, one of the most virulent strains of drug-resistant bacteria associated with hospital-acquired infections.

The potential for copper-based anti-microbial products is enormous. In the future we could see uncoated copper touch-surfaces throughout hospitals and day-care centers. Anti-microbial materials are also ideal for public facilities, the food processing industry, and heating, ventilation and air conditioning applications. Copper also may play a critical role in the trend towards "healthy homes" that feature allergy-control products and environmentally safe building materials.

Conclusion

It is important to consider the many benefits of copper, brass and bronze when specifying materials for construction and remodeling projects. Combining aesthetic beauty, light weight, strength, durability, ease of installation, and an inherent suitability for green and sustainable building, copper is one material builders and architects can always count on.

CDA Resources For Architects And Designers



The Copper Development Association (CDA), the information, education, market and technical development arm of the copper, brass and bronze industries in the USA, is dedicated to offering the architectural community educational, technical and design assistance on planned or existing projects utilizing copper and copper alloy products.

As a service to building and construction professionals, CDA's architectural regional managers are available to assist in a variety of ways including in-house seminars, project

managers have years of technical experience working with strip, sheet and plate copper, and copper alloys, and are available for consultation at any time.

The CDA Educational Training Series is a popular program among architects and builders. This series features the Installer Training Program, which is designed to provide hands-on training on various architectural sheet copper systems. The course is designed for sheet metal contractors; however, the program is approved by AIA for architectural continuing education.

CDA regional managers are also available for in-house "lunch and learn" seminars that provide an introduction to the architectural uses and applications of copper products. These AIA-approved sessions focus on design basics, common practices and situations to avoid. In addition, CDA also offers a Copper In Interior Architecture seminar that

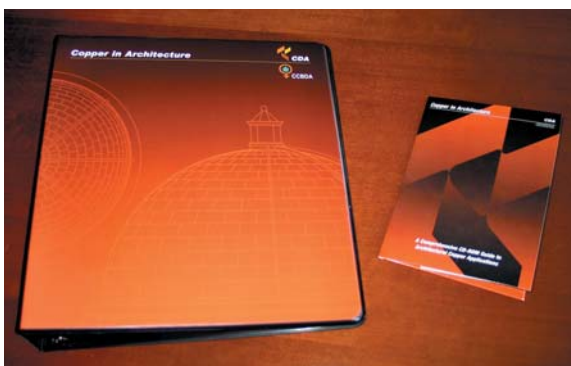
covers important topics like shape choices, coatings and finish options. Each attendee to this seminar

receives a copy of the *Copper Brass Bronze Design Handbook* and the Copper, Brass and Bronze Sample Metal Set.

A valuable tool for every architect is CDA's *Architecture Design Handbook*, a comprehensive overview of copper's properties and applications. The handbook includes:

- Information on the fundamentals of architectural copper and copper alloys.
- Architectural and structural considerations for designers.
- Maintenance requirements.
- Detailed technical data on common architectural details including AutoCad detail files available for download.

For more information on the materials, information and services that CDA offers to help make the best use of copper and copper alloys on projects, or to contact a CDA regional manager, visit CDA's website at www.copper.org.



design assistance, document and specifications review, and contractor recommendations. CDA regional

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