

Architectural Uses Of Copper

An evaluation of stormwater pollution loads and alternative best management practices

1. Introduction

This report describes common architectural uses of copper, and then estimates how much of this copper corrodes and is released into the Palo Alto RWQCP service area as rainfall runoff. Best management practices are presented for reducing the amounts of these copper releases.

2. Copper Architectural Features

Builders use copper because of its appearance, ease of construction, weather-tightness, flexibility, fire resistance, and longevity. Although more expensive to

purchase, copper is seen as a wise choice for buildings with a long design life.

For example, one local builder recently selected copper flashings and gutters to install with a slate roof that is expected to last 100+ years.

Another local contractor used copper gutters



and downspouts in a remodel project because the owners wanted to achieve the architectural appearance of European buildings dating to the late 1800s.

Both of these Palo Alto residential projects had budgets exceeding \$1 million, highlighting the kind of building in this area where the use of copper features is most likely. Schools, offices, and retail buildings also employ copper materials.

2.1 Copper Roofs & Appurtenances



Copper roofs and flashing are fabricated into standard or custom shapes by a number of manufacturers. Roof panels (see photo at left) are commonly from 0.4 to 1.0 m (16 to 36 in) wide, and up to 3.1 m (10 ft) long, with other sizes available via special order.

Historically, copper roof panels have been soldered, overlapped, or physically seamed together. Panels today usually have formed edges that add strength and provide a simple, water-tight way of joining adjacent pieces.^[1]

Copper shingles and unseamed copper panels are also used for roofing. These items are installed in an overlapping pattern, from the eaves up to the crown of the roof, in much the same way as wood or composition shingles.

Exhibit 1 shows that copper roofs have a warranted life that is 2-1/2 times that of steel roofs, and that copper costs 2 to 6 times more than steel. Actual service life for both materials can significantly exceed these warranties and will probably be longer than that of the structure itself if care and skill are used to install the roof, and if local environmental conditions are favorable.^[1, 2, 11]

Exhibit 1
Comparison of Metal Roofing Materials

Type	Warranted Life	Format	Cost
Copper	50 Yrs	Panels Shingles	\$27 / sqm (\$2.50 / sqft) \$50 / sqm (\$4.60 / sqft)
Patina Copper (Factory-Applied)	50 Yrs	Panels Shingles	\$38 / sqm (\$3.50 / sqft) \$70 / sqm (\$6.40 / sqft)
Coated Steel [8] (Copper Color)	20 - 30 Yrs	Panels, Shingles	\$11 / sqm (\$1.00 / sqft)
Coated Steel (Patina Color)	20 - 30 Yrs	Panels, Shingles	\$13 / sqm (\$1.20 / sqft)

Notes: Costs are per unit area for an order of 930 sqm (10,000 sqft). Shipping and installation add 25% to 50% more. Panels are attached to roof using clips and screws made of same material as roof. Shingles are attached with nails or screws of same material as roof. Maintenance/replacement of steel roof panels may occur more frequently than copper (thus costing more), and may involve chemicals to strip and re-apply the coating.^[43]

Copper roof and flashing pieces come with either a bare metal finish, or with a factory-applied weathered appearance (i.e., a "patina"). Copper pieces of either type are special order items that are not stocked in local building supply stores.



For example, one specialty contractor in San José does keep a small stock of copper pieces in its shops for repair work, but typically orders new materials needed by each project. Job orders of this type are particularly important for pre-patinated panels so that colors can be matched. ^[3]

Chemicals are available to accelerate the aging of bare copper so that a light-green patina finish develops more quickly than the 7 to 10 years required for normal weathering. Suppliers indicate that these field-applied solutions require great skill to handle correctly, cost about \$5.00 per sqm (\$0.50 per sqft), and are most often used for small copper features rather than entire roofs. Use of such chemicals has a relatively high risk of soil or groundwater contamination during construction. ^[3, 4]



Anecdotes told by contractors, building inspectors, and local suppliers suggest that less than 2% of the roofs (equivalent to 0.05% of the net roof area) in the San Francisco Bay region are made of copper sheets or have copper flashing. The project team contacted roofing associations, trade publications, suppliers, insurers, building

departments, and property tax agencies in an effort to learn how many roofs are constructed of copper or with copper flashing. Unfortunately, these entities only have limited records of roofing types (e.g., identifying a roof only as built-up

asphalt, composition shingle, metal, or wood). None of the sources are able to say with certainty how many copper roofs exist in the United States, much less in the Palo Alto RWQCP service area.

2.2 Coated Steel Roofs

Coated steel roofing sheets, shingles (photo), and tiles are available in colors that closely match the red gold of bare copper or the light green of a copper patina. Companion features, such as gutters, downspouts, and appurtenances, are available in matching colors and textures. With proper installation, the expected life of these features should be over 100 years. ^[30]



2.3 Composition Shingles

Composition shingles are constructed in layers that include surface granules, impervious asphalt, and a backing sheet. Limited tests done by the RWQCP indicate that ordinary composition shingles contain about 10 mg/kg of copper, although only a limited amount appears to be released via rainfall. ^[31]

Some composition shingles contain special granules that release copper to limit the growth of roof-top algae or fungus. More commonly used in wet climates such as the southern states and Pacific Northwest, these shingles are visually the same as ordinary ones, and are installed by the same methods. ^[10] The amount of copper in these shingles is about 25 mg/kg, much of which is positioned as granules on the surface where it is released via rainfall for at least ten years, i.e., half the warranted life of the shingles. ^[31]

As shown by Exhibit 2, roofing manufacturers consider algae resistant shingles as a special order item, and price them accordingly. To date there are few algae-resistant shingle roofs in the Bay Area, probably totaling somewhat less than 1% of all buildings (i.e., 0.03% of the net roof area). Marketing efforts are predicted to increase the use of this specialty product. ^[5]

Exhibit 2
Composition Shingle Roofs

<u>Type</u>	<u>Copper Content</u> [31]	<u>Warranty Period</u>	<u>Cost</u>
Regular	10 mg/kg	20 years	\$6.00 / sqm (\$0.55/sqft)
Algae Resistant	25 mg/kg	20 years (algae resist: 10 years)	\$6.35 / sqm (\$0.59/sqft)

Notes: Costs are per unit area for an order of 230 sqm (2,500 sqft). Installation adds 100% or more. Shingles are attached to the roof with galvanized roofing nails. Copper nails are seldom used.

2.4 Gutters and Downspouts

Although specific data are not available, copper drainage features (photo) are known to be used with a variety of different roofing types, and are therefore believed to be somewhat more common in the Bay Area than are complete roofs made of bare copper metal or copper-containing shingles.

Exhibit 3 compares the attributes of gutters and downspouts made of four alternative materials, with copper being the most expensive of these choices.

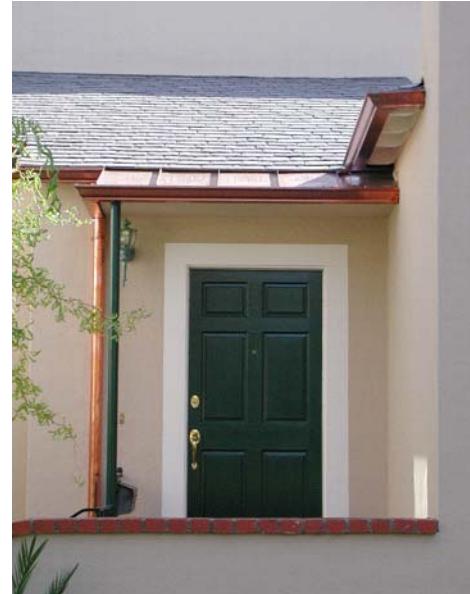


Exhibit 3
Gutters and Downspouts

<u>Type</u>	<u>Warranted Life</u>	<u>Format</u>	<u>Cost</u>
Copper	50 Yrs	3.1 m Lengths (10 Ft)	\$4.90 / m (\$1.50 / LF)
Plastic (PVC)	10 Yrs	6.2 m Lengths (20 Ft)	\$0.33 / m (\$0.10 / LF)
Coated Steel	20 Yrs	3.1 m Lengths (10 Ft)	\$2.30 / m (\$0.70 / LF)
Aluminum	20 Yrs	6.2 m Lengths (20 Ft)	\$0.67 / m (\$0.20 / LF)

Notes: Costs are per unit length for a typical 230 sqm (2,500 sqft) home. Installation adds 100% or more. Attachment to the building is accomplished with brackets and either screws or nails. These fasteners are usually made of copper or galvanized steel.

2.5 Other Copper Features

Copper is used for spires, cupolas, doors, lights, signs, railings, weather vanes and other exterior ornamental features (photo), concrete inserts, water stops, and garden edging strips. Copper releases from these small features are believed to be less significant than that from complete roofs made of copper.

These features appear in perhaps 1% of all structures in the RWQCP service area.



3. Wood Preservatives

3.1 Factory-Preserved Lumber

Wood preservation products are discussed in an earlier RWQCP technical memorandum by Bill Johnson of EIP Associates.^[6] These products often are formulated with either copper arsenate (CCA) or copper quaternary ammonium chloride (ACQ). Factory-preserved wood is pressure treated with one of these compounds, dried, and then shipped to lumber suppliers.^[9]

Factory-preserved lumber is specified by building codes for situations where moisture contact is expected, such as wood foundation sills and exterior decks. Foundation lumber used to construct the typical 2,500 square feet home on a flat lot will require about 3 gallons of factory-applied preservative. Since this product has 0.67 lbs of copper per gallon, the preserved lumber is estimated to contain 2 lbs of copper.

3.2 Wood Preservatives Used During Construction

Exposed areas are created when preserved lumber is sawn or drilled during installation. These areas can be treated at the job site with new preservative that is brushed, wiped, or sprayed onto the wood. Construction of a new 2,500