

Industrial building and copper material



**ASSIGN
BUSTER**

1. Introduction

“ I grow more intense as I age.”

(Florida Scott-Maxwell)

Copper is one of the most durable and aesthetically pleasing roofing and cladding options available for domestic to bigger commercial and industrial buildings. The copper forms a protective barrier around it as soon as it reacts to the atmosphere. This allows the material to improve and to stand against the test of time.

2. Aim

The aim of this report is to introduce the reader to copper as a roofing material in the building industry. Standing seam copper roofing and cladding to multi-storey buildings will be the focus of this report.

3. Why copper?

Copper is used in the building industry because of its durability and the ease of instalment and workability. A properly installed copper roof will outlast other types of roofing systems. Copper is 100%recyclableand does not lose any quality whether in a raw state or after it was used as a manufactured product. According to the Copper Development Association (CDA. 2010), copper is one of the most recycled metals, roughly 80% of the copper ever mined is still used in some form today.

4. History of copper roofs

Copper has been a very important material to man since ancient times. So much so that one of the main stages of mankind’s history is named after a

copper alloy, bronze-age. Copper and its many alloys have had a vital role in many civilizations.

In the Roman period it was mined in Cyprus, this resulted to the metal being named Cyprium, this name was later shortened to Cuprum and ultimately we know it in English as copper.

Today, most copper is mined from open cast mines around the world. The copper is extracted from smelting large amounts of copper ore, before being refined to the copper we use and know. In the early 18th century about 90% of the world's copper was smelted in South Wales (COPPER Africa. 2010).

Copper has been used as a waterproof roofing material since ancient times. It can be seen on roofs and domes on today's buildings. It is recognizable by its greenish colour. This colouring is because of the atmosphere reacting with the copper to form a protective barrier against corrosion around it. Initially, exposed Copper atoms react with the air to form the pink oxide, this is called cuprite. This slowly oxidizes more to the black oxide, called tenorite. When this black oxide gets wet it reacts with sulfur dioxide and carbon dioxide from the air to ultimately form the patina, which gives it a green glimmer.

Technology and improved techniques make copper the perfect building material for roofing, cladding and the accessories going with roofing systems. More and more pre-fabricated copper products on the market have reduced the cost and this enabled copper to be used in more buildings than in the past.

5. Types of roofing systems.

Copper roofs have been known to last for over 700 years; the substructure rather than the copper itself ultimately fails. The ductility and malleability of copper allows it to form over irregular roof forms and structures. Domes and other curved roof shapes are a speciality when it comes to copper.

New tools and construction methods have been introduced that give support to the quick, correct, and cost-effective installation of copper roofs.

Types of copper roofing systems include:

5. 1. Standing Seam Roofing

Standing seam, the most common system, roofing consists of pre-fabricated or in-situ formed pans. The copper pans are joined together with double locked standing seams. Copper cleats lock into these seams to fix the roofing to the base structure. This method prevents the pans or sheets from slipping down the roof.

5. 2. Batten Seam Roofing

Batten seam roofing consists of copper pans that run parallel to the angle of the roof and are separated by wood battens. The battens are then covered with copper copings that are fixed to the battens. These copings lock the loose pans into adjacent pans.

5. 3. Chevron Roofing

A common Chevron roof design is based on normal batten seam construction, but secondary battens are fixed to the roof. These extra battens are purely decorative and do not add to the functionality or structure of the roof.

5. 4. Flat Seam Roofing

Flat seam roofing systems are generally used on roofs that are flat or have a very low pitch. Flat seam roofing is constructed of rectangular copper sheets. Two neighbouring sides of the sheets are folded over and two are folded under to lock them in place. Copper cleats are then installed seams to make the roof waterproof.

5. 5. Horizontal Seam Roofing

Horizontal seam roofs consist of copper pans that run horizontally across the roof pitch. At each fixing point or edge a step is used to allow neighbouring pans to lock successfully.

5. 6. Mansard Roofing

A Mansard roof is, based and is very similar to standing seam or batten seam construction.

6. Standing Seam Copper Roofing and Cladding

Standing seam, the most common system, roofing consists of pre-fabricated or in-situ formed pans. The pans and are joined together with double locked standing seams. Copper cleats lock into these seams to fix the roofing to the base structure. This method prevents the pans or sheets from slipping down the roof.

When preformed copper pans are used, they are joined at the top and lower ends by slanting seams. In-situ formed pans involve the use of copper sheets on rolls which are shaped into pans by electrical pan formers. This allows one to form long, continuous pans, this eliminates the need for seams, but if this

method is used, one must allow for expansion joints due to the expansion and contraction properties of the copper.

6. 1. General design considerations

6. 1. 1. High Winds

In areas where high winds occur, the roof design must be evaluated to make sure the roof can resist the wind forces. High winds can put great positive or negative pressures on roofs, especially the edges, so the detailing must ensure that the roof is secure.

6. 1. 2. Heavy Rain

Where heavy rain is likely, the designer must give allot of thought and attention to the slope, seam details, valleys, gutters and downpipes of the roof. The seam heights can be adjusted if it is necessary.

6. 1. 3. Ice and Snow

In areas where there is allot of ice and snow, the designer should make provision for the loads that act on the roof from the weight of the snow or ice. Increasing the slope so that the snow can slide of the roof must be considered.

6. 1. 4. Temperature Range

When the temperature fluctuates, the copper and any adjacent materials will expand and contract in different ways. This should be taken into consideration. This is important when installing components with potential limits to movement in one direction.

6. 1. 5. Building Orientation

Consideration should be given to the relationships between the roof and the direction wind, rain, and sun. The issues discussed above will depend on the orientation of the building.

6. 1. 6. Staining

Staining occurs when water that was in contact with the copper runs off and gets absorbed by other materials. Staining of the other materials can be avoided with good design.

Copper salts form on the surface of a copper sheet due to the natural weathering of copper. When these salts are mixed with rain water and the water run on to other materials, it will cause the typical green stains. To prevent such stains, the designer must take all options into consideration to prevent run-off onto other adjacent materials. One can use a clear, silicon-based finish on cement surfaces to help protect the surface during the first and most harsh weathering of the copper.

6. 1. 7. Patination

The natural weathering process that leads to the green patina to form on the exposed copper takes a lot of years. There are processes available to speed up this process.

6. 2. Material

6. 2. 1. Types of copper in the building industry

Copper in the building industry is 99.9 % pure copper. There are three different types of copper used in the building industry, namely:

6. 2. 1. 1. Deoxidized copper

This is copper that contains no oxygen. It is used in plumbing applications where welding is required or for engineering purposes.

6. 2. 1. 2. Fire refined tough pitch copper

This copper contains oxygen and is stronger than deoxidized copper. It has higher thermal and electrical conductivity and has a higher resistance to corrosion than deoxidized copper. This type of copper is used mainly for roof and cladding applications.

6. 2. 1. 3. Electrolytic tough pitch copper

This copper contains fewer impurities than fire refined tough pitch copper and is used for electrical conductors because of its high.

6. 2. 1. 4. Lead-Coated Copper

Lead-coated copper is a strong, lightweight, durable and easy to install, gray metal finish option of copper. It does not add to the life of a copper roof, but it provided another colour to architectural copper applications. In-addition, the gray finish offers a solution to the staining issue. The run-off of this metal is less than that of conventional copper, and it doesn't stain the other materials.

6. 2. 2. Hardness in Copper Sheets

6. 2. 2. 1. Quarter-hard is defined by its ability to be bent back onto itself along the grain boundary without breaking.

6. 2. 2. 2. Half-hard can be bent 90°.

6. 2. 2. 3. Soft is good for decorative applications.

The hardness of the metal determines the application. If your copper project involves supporting any kind of weight, stick to harder tempers.

6. 2. 3. Cold Rolled Copper Sheets

Copper comes in many forms and strengths. It is very important to specify the correct grading and type of copper to be used with the specific application. Copper used for a standing seam roofing system comes as a sheet, rolled up in a spool, called roofing copper (Copalcor). The width of the sheet is 600mm and comes in thicknesses of 0. 50 to 0. 70mm.

6. 2. 4. Corrosion Resistance

Copper does not respond to water, but it gradually reacts with the oxygen in the atmosphere. This results in a brown-black copper oxide deposit forming on the surface. This creates a protective layer on the surface that prevents the copper against additional corrosion. Verdigris, a green layer of copper carbonate can be seen on aged copper constructions, like on the Statue of Liberty.

6. 2. 5. Electrical and Thermal Conductivity

Copper and its alloys are excellent conductors of electricity and heat. Copper is the most common of all metals in these applications because of its great properties. Copper alloys have less electrical and thermal conductivity than pure copper.

6. 2. 6. Ease of Fabrication

Copper can be shaped to the required form and dimensions by any of the common fabricating processes. It is normally rolled, pressed, extruded, forged and formed at high temperatures.

6. 2. 7. Joining

Mechanical fasteners, such as screws, bolts, and rivets are the simplest joining method. They typically do not need specific tools for installation, and it can be taken apart and be reassembled again.

Adhesives can also be used in some applications. The strength and reliability of the bond depends on the surface preparation, adhesive selection, and the design of the joint.

The three common ways of joining copper and alloys are soldering, brazing, and welding. Where a water tight seal is required, soldering may be used. Lead or tin-based filler metals are typically used. Soldered joints typically depend on mechanical fasteners for strength. This method is used for sealing joints in gutters, roofing, and flashings. Because the filler material does not match copper in colour, soldering should just be used in hidden joints.

Brazing is the most preferred method for joining copper pipes and tubes. Colour matching is a problem again.

The final metallurgical joining method, welding, is seldom used with copper. Welding uses high temperature or pressure to fuse the metals together.

6. 2. 8. Finishes

There are three generic categories of finishes for copper alloys.

6. 2. 8. 1. Mechanical treatments

Mechanical treatments are finishes that are typically applied at the shop by mechanical means. They usually affect only the surface of the copper. There are five standard mechanical designated finishes:

* As Fabricated:

This is the finish after its production process, such as rolling, extrusion, or casting.

* Buffed:

Polishing the copper to a smooth, mirror-like appearance. This is the brightest mechanical finish available.

* Directional Textured:

Wheel or belt polishing with fine aggregates is required for this finish and results in a continuous pattern of very fine, almost parallel scratches.

* Non-directional Textured:

This matte finish is mainly used on castings. The copper is usually sandblasted to achieve a certain degree of roughness.

* Patterned:

A process in which a copper alloy sheet is pressed between two rolls to produce a pattern.

6. 2. 8. 2. Chemical treatments

6. 2. 8. 3. Coatings.

6. 3. Preparation

6. 3. 1. Surface Preparation

The surface preparation is the same for all copper roofing systems. The surface must be dry, smooth and free from any sharp edges or objects like nails or screws.

6. 3. 2. Supporting Substrate

Standing seam roofing and cladding requires the installation of a backing substructure that support the copper finish layer,

This substrate usually consists of 20 – 22mm S. A. P tongue and grooved boarding fixed to the main structure. However, any substrate can be installed, as long as the copper has the necessary support. Other backing options include:

- * Chipboard

- * Plywood

This decking can be fixed to any main structure like steel or concrete. The design must, however, provide for the installation and fixing of the wood substrate.

6. 3. 3. Fastening the pans to the substrate

There are three ways of fixing the copper sheets to the substrate namely:

6. 3. 3. 1. Cleating

This is the most frequently used fixing method, because it allows the copper to move, because of expansion and compression under different temperatures. Cleating minimizes the potential for buckling. The cleats are usually spaced at a minimum of 600mm centre to centre and are fixed to the substructure with 2. 8 x 22 mm copper clout-headed nails.

6. 3. 3. 2. Nailing

Nails are used to fix the cleats to the substrate or in special cases where no movement is wanted, usually at base flashing or at eave strips. Only one edge of a strip should be nailed, to allow movement at the other end of the strip. All nails should be flathead, wire slating nails made from hard copper, brass, or bronze.

6. 3. 3. 3. Screwing

This method is used where the copper must be held in place, such as at a ridge cap in areas with high winds. It is also used to secure copper to brickwork. Screws must have a wide or big head to prevent the screw from cutting into the copper. Lead washers may be used for additional protection. Where the screw must be water tight, a small copper cap is soldered over the screw head.

All fasteners must be of copper or copper alloys to prevent the different materials to react with each other and speed up the corrosion process.

6. 3. 4. Roofing Felt

The entire surface should be covered with an accepted and properly specified underlay material secured to the decking with copper clout nails.

The underlay, which is usually soaked roofing felt, acts as a pillow, as well as providing temporary weather protection for the roof deck.

A sheet of building paper must be applied over the felt. Some roofing felt contains tarmac and, because copper conducts heat, the rising temperatures can cause the tarmac to melt and bond the copper to the roofing felt. This restricts the movement of the copper roof and can result in the failure of the system. The building paper acts as a slip sheet to prevent such bonding.

6. 4. Equipment and Tools

6. 4. 1. Pan formers and seamers

A wide selection of power pan formers and power seamers are available to help with the construction of copper roofs. Power pan formers can take flat sheets of copper and make standing seam roofing pans on site. The machines form high quality, consistent pans in any length. The length is only limited by the contractor's ability to transport and handle the material. Pan formers can work with various sheet widths and can make pans with varying seam heights. The standing seam is typically 150mm high.

Power seamers are used to produce finished standing or batten seams. The seamers clamp onto the sheet of copper and then propel themselves under electrical power to form the seam. They can form seams of almost any length.

6. 4. 2. Panel curving machine

This machine allows the contractor to curve the panels to any radius. Convex or concave forms can be curved.

6. 4. 3. Gutter forming machine

This machine allows the contractor to make gutters on site and install them in workable lengths or sections.

6. 5. Construction and Detailing

This birds-eye view of a standing seam copper roof shows the basic concept.

6. 5. 1. Pans

Standing seam roofing consists of pre-fabricated or in-situ formed pans.

Copper cleats lock into these seams to fix the roofing to the base structure.

This method prevents the pans or sheets from slipping down the roof.

0. 6 mm Copper sheeting with a width of 600 mm is used to form the pans.

The end product is pans of 510 mm wide that is joined by forming a 30 mm double welded standing seam as shown below.

6. 5. 2. The Standing Seam System

6. 5. 3. Detail at Parapet Wall

A copper coping is attached to the higher edge of copper siding using a single lock seam. This cover extends over the parapet and is fixed into a continuous lock strip that is on the back side of the parapet wall.

6. 5. 4. Stepped Flashing Detail

Stepped flashing is used where a sloped roof meets a masonry wall. A typical example is where a brick chimney rises above a roof. The details shown concentrate on such chimney flashings, but apply to other situations as well.

There are two ways of installing stepped flashings. One type uses pieces of copper base flashing installed with each course of shingles.

The second, most common type uses a single copper runner under the roof covering. This runner is attached before the roofing material is installed. The roof portion of this runner flashing has a hooked edge and is cleated at 300 mm c. c. The base flashing is extended up the wall a minimum of 170 mm (two bricks). This requires the cap flashing to be in two pieces, a flashing and a counter flashing.

This stepped flashing is used on the two sloped sides of the chimney. The lower sides are flashed with a copper apron that covers the roof covering.

6. 5. 5. Detail at Valley

This detail shows an option for resolving the waterproofing at a valley of a standing seam roof. The copper roofing overlaps the valley flashing a minimum of 150mm and is folded and fixed into a continuous copper strip. The locking strip is soldered to the valley flashing.

An alternative option is to use a double fold in the valley flashing, as a replacement for of a locking strip. Both methods are shown.

6. 5. 6. Detail at Hip

This detail shows a standing seam of a copper hip roof. This method allows the standing seam to be hidden by a ridge cap which allows for both a clean facade and weather tight seal.

6. 5. 7. Detail at Gutter

The detail shows the recommended method for the installation of a gutter with copper roofs.

A copper gutter is supported by a brass bracket. The upper edge of the gutter extends at least 150 mm onto the roof and is folded over and held by cleats at 300 mm c. c.

Copper braces at 750 mm centres can be placed at the mid-points between brackets.

If the gutter width is more than 150 mm or in areas with ice and snow, brass straps should also be used to increase the strength of the gutter. These must extend at least 150 mm onto the roof. The area around screws and the strap must be soldered to ensure water tightness.

6. 5. 8. Detail at Ridge

Two options of detailing a ridge are shown. The seams are laid to overlap a minimum of 150 mm from the ridge.

InDetail 1, a copper ridge cap is used to fix the standing seams along the ridge. The ridge cap is locked into the top edges of the copper pans. This allows for expansion and contraction.

InDetail 2, the ridge is created by a wood batten that is clad with a copper cap.

12. 1. 1. Detail at Gable

12. 1. 2. Expansion Great care must be given to the contraction and the expansion of copper due to the thermal characteristics of the material. Detail should always allow for expansion and contraction.

6. 6. Maintenance

Because of copper's long life as a building material it is exposed to long term pollutants or dirt. The main problem of cleaning copper roofing is that you

can permanently stain or damage the copper. The cleaning methods of copper have been perfected over many years.

6. 6. 1. To remove encrusted dirt deposits

The most common cleaning method is to blow the surface with Walnut shell dust at a pressure of about 2 – 3 bar. This forces the dirt crust to lift off the surface without damaging the copper.

6. 6. 2. To clean unevenly patinated copper:

Use a sponge to clean the copper. Use a mixture of six parts concentrated phosphoric acid to one part concentrated nitric acid diluted by 50 percent distilled water.

Leave the acid solution on the copper for one minute. After the minute wash the roof again with a sponge soaked in sodium bicarbonate solution. Rinse off all the acid with fresh water afterwards.

Then you apply ammonium oxalate as a second neutralizer to even out any remains left by the first neutralizer. Rinse off with fresh water afterwards and wipe the cleaned copper with a clean cotton cloth until no colour shows on the cloth. Wipe the surface again with a cloth soaked with mineral spirits until no colour shows on the cloth.

Apply a thin coat of carnauba wax. When the wax wears off, the copper will start its repatination again.

This procedure can be used when you replace sections of a patinated copper roof or when you do an addition to an existing copper roof. Treating the

existing copper roof will let the new addition patinate together with the existing roof, resulting in an even colour for both the old and the new roofs.

7. Availability

When people think about installing a new roof, copper is not a material that normally comes to mind. Nevertheless, copper has been used on roofs for centuries.

The one big disadvantage of copper in South-Africa is that it is expensive and that copper is a material that is stolen and sold for money all around the country.

Copper is a good roofing option and there are many locally available manufacturers. One of the biggest suppliers of copper products is Copalcor.

“ Copalcor offers solutions incorporating a wide range of rolled, extruded and forged non-ferrous metal products for the local and international market. Through ongoing development and expansion the company maintains its position as a leader in the field of service to South African strategic industries and continues to grow as an exporter worldwide”

(Copalcor, 2010)

Copper roofing is a very specialized industry and therefore there is not such a wide variety of copper roofing contractors available in South-Africa. A few manufacturers and contactors are:

Clotan Steel (Pty) Ltd.

Global Roofing Solutions (Pty) Ltd.

<https://assignbuster.com/industrial-building-and-copper-material/>

Cupric Tectonics.

8. Cost

Copper is a very expensive building material. Because copper roofs are very expensive compared to conventional tile roofs, the demand of copper roofs is not so high in South-Africa. Copper is considered a specialized roof and is therefore a specialized construction, this makes copper roofing expensive.

If you consider that a copper roof will outlast almost any other roof and that copper is 100% recyclable, it will be a good investment or addition to any building. It requires almost no maintenance that keeps the cost down.

The initial cost for the construction and installation of a copper roof is high but the advantages over shadow the price of the roof.

9. Case study

9. 1. Freedom Park //hapo Museum

Category: Culture

Location: Pretoria, South-Africa

Architect: Office of Collaborative Architects

GAPP Architects / Urban Designers; Mashabane Rose Associates; MMA Architects, Johannesburg, South Africa

Design Architect: Jeremy Rose

Project Architect: Dieter Brandt

9. 1. 1. Project Description

The vision for //hapo (the dream), an interpretive centre and Pan-African archive, was to provide an interactive exhibition space which would convey the history of South Africa over 3. 6 billion years.

The façade of the building is completely clad with copper sheeting. Frans du Toit, managing director of Cupric Tectronics, said that Freedom Park is the first copper-clad building of its size in South Africa.

“ Installing the roof sheeting was challenging because there are so many detailed design elements,” says du Toit. “ We used a specialised machine that rolled the copper into long, straight sheets that were placed directly onto the building.”

The contractor had to change their normal installation methods to suit the specific needs of the design. Because there are almost no straight lines, the installation had some degree of difficulty.

Copper, which fades over time and is already showing visible colour differences on the facade of Freedom Park, was chosen for a number of reasons. Dieter Brandt says that: “ Copper is an African resource,” “ The idea is that the material will age over time and the patina gives a sense of ancientness. We wanted a material with monochromatic feel and we needed a material to blend in with the brickwork that is typical to Salvokop rail village. The metaphor of boulders is enhanced by the varying stages at which the weathering of each copper-clad boulder that is exposed to prevailing weather takes place,” says Brandt.

9. 1. 2. Construction

The specialists in copper roofing and cladding, Cupric Tectonics, used 70 tonnes of copper on the roof and side cladding of the building. The 0.6 mm copper sheets were profiled and installed on site, directly on the building. Over 9000 m² of area was covered with copper supplied by Copalcor. The material is 99% pure phosphorous deoxidized copper alloy. (ASTM B152C 12200 half hard copper). A team of 16 well trained specialists worked on the project to complete the copper installations to the building. This was done to ensure that the long pans did not bend out of shape before it could be installed. The copper forms a natural wave like look, also known as “oil canning”.

A state of the art Schleich manufactured Quadro and profile machine was used to form the pans of the building. The machine was placed on the scaffolding so that the pans could be placed directly on the building for installation.

The method used to install the copper to the building is called double standing seam system. This system is based on concealed fixing which means that there is no fixing through the sheets ensuring a water tight seal that will last for many years.

Due to the size of the building and because the copper pans are formed on site, large pans could be made and fitted directly onto the building. On site, pans are formed by using copper in flat sheets on rolls which are bent into pans by electrical pan formers. Long pans can be made that eliminates the need for transverse seams.

Long Pan construction details are designed to accommodate for the movement as a result of the expansion and contraction over long spans of copper sheets. The points of stress relief are typically accommodated at eaves, transverse joints (if any), and ridge and base conditions by ensuring that the copper sheet is provided with proper clearances and is secured by expansion fastening devices that will not obstruct thermal

Particular building dynamics should be considered before specific copper details are designed. Building expansion joints must be accommodated and properly detailed. Also, building orientation should be taken into consideration. A north sloping roof, for example, will gain more heat than a south sloping roof.

All roof penetrations should allow for expansion in the same amounts as the roof panels, voids or spaces should be filled with loose insulation or compressible joint filler

10. Conclusion

Copper has been use as a roofing material since ancient times. Technology and improved techniques make copper the perfect building material for roofing, cladding and the accessories going with roofing systems. More and more pre-fabricated copper products on the market have reduced the cost and this enabled copper to be used in more buildings than in the past.

Standing Seam Construction offers many advantages. The greatest advantages are that it creates a water tight seal because of no sheets are penetrated with concealed fixing and this allows for fast construction that

reduces labour costs. Copper Standing Seam construction is a long lasting roof construction with a life time of changing aesthetics.