Department of Environment and Heritage Protection

MINOR REPAIRS—METAL WORK

This technical note provides a brief description of the most common metals used in building and the appropriate methods to care for and conserve metals when carrying out minor repairs approved under the General Exemption Certificate—Queensland Heritage Places.

Background

Metals have been widely used in traditional building construction as structural elements, claddings, roof plumbing, decoration, hardware, fixings, fencing and sculpture.

Repairs under General Exemption

Metals will deteriorate through corrosion, abrasion, fatigue, creep, heat, distortion or connection failure. Repair works to metals are not always straightforward and are therefore limited under General Exemption. Metal repairs will most often require the involvement of a structural engineer or at least a skilled tradesperson with expertise in metals and structure to determine the cause of the problem and appropriate remedial works. Repair works to metal sculpture will require advice from a metals conservator.

Metal repairs permitted under General Exemption include:

- maintenance cleaning
- in-situ patching of all metals
- recasting of broken, missing or seriously corroded elements to match the original
- repairing to retain the function of the element
- refixing palisade fencing stays
- resetting palisade fence shafts in molten lead.

Separate guidelines for minor repairs to metal roofing and drainage systems, and steel-framed windows and doors are contained in other technical notes.

Assessing damage

Before undertaking repairs understand the cause of the failure and eliminate where possible.

Factors that need to be considered when assessing metal repairs include:

- how the structure was put together and whether it is working in compression or tension
- which members are primary (load bearing), secondary or decorative
- what parts (footings, fastenings, bolts and rivets) are vulnerable, for example, fixing heads may be in good condition but the shank may be corroded
- whether there are water traps causing corrosion
- whether movement is evident through broken castings or failed fastenings.

Good practices to adopt when undertaking repairs to metals:

- Retain as much of the existing material as possible by repairing, reinforcing and consolidating rather than replacing.
- Use reversible processes wherever possible.
- Use additional materials to strengthen, reinforce, prop, tie or support.
- Use traditional materials and techniques wherever possible. New work should be distinguishable from old on close inspection.
- Make a record of the element or area before, during and after work.

Keep records

Record all repairs, replacements and additions made to metal work.

Maintenance and cleaning

Carry out regular inspections and maintain metals in good working order. Regular maintenance is the most economic and practical way of extending the life of a place. Rectifying problems promptly will limit further damage or decay and will keep maintenance costs down.

The methods for cleaning and maintaining metals depend on the type of metal, for example, corrosion on ferrous metals needs to be removed and the metal coated with a protective finish, whereas most non-ferrous metals corrode to form a stable protective layer that should not be removed.

When cleaning metal work:

- identify the type of metal
- test cleaning method on a sample area
- prepare surface appropriately—this is essential for a protective paint system to perform properly
- remove all dust and paint affected by rust before priming and painting metal work.

Paintwork

Do not paint over rust—it is a waste of time and money. Sometimes it will be necessary to remove defective paint as the detail of metalwork can be lost under many layers of paint. Total paint removal on metal work is not covered by General Exemption.

Corrosion

Most metals slowly oxidise when exposed to atmospheric conditions. Rusting iron and steel produce reddish iron oxide. Some metals are more resistant than others to this process and remain largely unaffected. Air pollutants, acid rain, salts and the presence of dissimilar metals accelerate the process of corrosion. In coastal environments, metals corrode rapidly under the influence of airborne salts and high humidity.

Ferrous metals

Ferrous metals, iron and steel, corrode to form rust, which only adheres loosely to the surface and is many times the original volume of the metal. Therefore, it is important to regularly maintain protective coatings such as paint on ferrous metals and any defects need to be rectified as soon as they are observed.

Non-ferrous metals

In non-ferrous metals such as copper, lead, zinc and aluminium, corrosion is a stable process and forms a thin, adherent and protective patina that should not be removed and does not require painting.

Galvanic corrosion

Galvanic corrosion occurs between dissimilar metals. If two such metals are in electrical contact through a conducting solution such as water, one of the metals will corrode at a faster rate than it would normally and, at the same time, the other metal will be protected from corrosion. A less reactive metal will corrode preferentially and protect a more reactive metal. The principle behind the galvanising (or zinc coating) of steel is based on this occurrence as zinc corrodes preferentially and protects the steel.

Even if two dissimilar metals are not touching, corrosion can still occur. Water can provide an electrical bridge, or carry in solution a small amount of one metal to the other, where it precipitates or plates out and causes corrosion. Water running off a copper roof into galvanised steel gutters will lead to rapid corrosion of the zinc galvanising and then the steel of the gutters.

It is good conservation practice to minimise the number of metals used externally. If copper is used for the roofs, then replacement gutters and downpipes should also be of copper. Galvanised iron or steel roofs should have galvanised gutters and downpipes. The same rule applies for water supply pipes and other plumbing.

The relative area of the two metals affects galvanic corrosion. A small scratch or hole in the zinc coating on a galvanised steel sheet will ‘heal’ as the ‘throwing power’ of the zinc is sufficient to protect the adjacent steel. Equally, when a galvanised sheet or length of galvanised wire is cut, the exposed steel is protected by the much larger surface area of the zinc coating. But if zinc is lost over a large area (more than a few square centimetres), then the remaining zinc will not be able to protect the bare steel, which will consequently corrode (rust).

Crevice corrosion

Unlike galvanic corrosion, crevice corrosion requires only one metal (and water) to be present. This type of corrosion results from different oxygen concentrations within water lying in a crevice, hence its formal name of oxygen concentration cell corrosion. The water exposed to the air is richer in oxygen than the water deep in the crevice. The metal adjacent to the oxygen-rich water acts as a cathode while the same metal deep in the crevice acts as an anode and so corrodes.

The danger with crevice corrosion is that it always occurs deep inside the crevice, where it may not be seen. A common example of crevice corrosion is the thinning or necking of bolts or rods which pass through wood or metal sections. Keeping these areas dry is important for good maintenance.

Deformation or stress corrosion

A third form of corrosion results from the cold working of metals. The deformed zones, such as a bend in a pipe, corrode more rapidly than the other parts. The head and point of a nail (which have been stressed during manufacture) will corrode faster than the shank.

Distinguishing ferrous metals

Cast iron, wrought iron and steel are the three most common ferrous metals found in places in the Queensland Heritage Register.

Differences in the structure of ferrous metals make them relatively easy to tell apart. Cast iron has a crystalline structure, is generally more massive in appearance than wrought iron, is often used as a repetitive element such as balustrading and has a visible mould line. Wrought iron is fibrous and may have a rolled or hand beaten surface.

Fixing techniques and jointing methods are helpful indicators of the metal type. Steel, wrought iron and cast iron can all be fusion welded (using heat and a filler material or flux) but steel is not generally forge welded (using heat and pressure), which was the usual method for wrought iron. Jointing methods similar to timber construction were also used for wrought iron and cast iron. Friction grip bolts were used for steel.

Decorative ironwork

Decorative ironwork such as iron lace of the nineteenth century was almost all cast iron, which developed from earlier elaborately shaped wrought-iron work. Conserving cast-iron lace often requires the replacement of missing sections. The replacement of missing sections is approved under General Exemption.

Care of cast iron work

If clean and dry, good quality cast iron corrodes very slowly, leaving a thin surface film of rust. There are many cases where doing very little, except the occasional brush clean, is an appropriate conservation approach. This applies particularly to situations such as cast iron grave surrounds in cemeteries located in dry inland areas.

The thin application of fish oil–based coatings is an appropriate treatment, but requires regular reapplication to maintain a cared-for look.

The next level of care is painting. Cast iron is a very brittle material, and any high impact or stress may cause it to fracture. It needs careful handling and protection from damage if heavy building work is being done nearby.

Palisade fences

Palisade fences typically have a low stone or rendered brick plinth surmounted by a palisade of wrought iron or mild steel shafts. The shafts penetrate flat wrought iron or mild steel rails and carry ornamental spearheads or tops of cast iron. The iron palisade is supported along its length by posts of cast or wrought iron or masonry.

A common conservation measure needed for palisade fences is to replace stays that may have been misguidedly removed to allow easier access for lawnmowers and the like. The stays are needed to brace the fence and ensure its lateral stability.

Corrosion in palisade fences

Crevice corrosion can occur where the shafts penetrate the rails and between the spearheads and the top rail. Careful filling and painting of these areas is required to eliminate crevices where corrosion may occur.

The traditional practice for setting the palisade fence on its plinth was to set the iron shafts in a leaded joint in the stone work by pouring molten lead into an oversize hole around the base of the shaft and tamping it down as it cooled. The lead insulates the iron from damp stone and because it is soft allows a certain amount of movement due to thermal expansion and contraction of the iron.

The problem with such fixings is that repeated thermal cycling creates a very small gap between the iron and the lead, allowing water entry and consequent crevice corrosion. Severe corrosion of the iron can result in rupturing of the masonry base as the rusted metal expands.

There are several methods of repair that can be adopted depending on the significance of the fence and its current condition. To repair under General Exemption remove the shafts, treat them for rust, and replace them according to traditional practice with molten lead.

Non-ferrous metals

Non-ferrous metals are more corrosion resistant than ferrous metals. Common non-ferrous metals used in building materials include lead, copper, zinc, brass, bronze, tin and aluminium.

Lead

Lead is a highly durable, soft, dense grey metal. Historically it has been used in building in sheet form as roofing, guttering, flashing, pipes and solder.

Lead is very resistant to corrosion developing a strong, insoluble lead sulphate patina that is silver-grey. Common causes of lead work failure include fatigue, creep, oversizing of lead sheets, corrosion caused by condensation, restriction of movement or the failure or lack of fixings.

Lead repairs, other than complete replacement of a high proportion of the element or fabric of the place, can be undertaken under General Exemption. Complete replacement of an element due to failure on a large scale is not covered by General Exemption.

Deterioration of lead from localised cracking or corrosion can be removed and a new section inserted by lead burning or melting. Solder should not be used to repair lead as it has a different thermal expansion. Where a ridge of lead has formed in a sheet it is not possible to drive the lead back into place. It needs to be cut out and a new patch added.

Condensation trapped on the underside of a lead covering can cause corrosion through a chemical reaction referred to as sugaring which can eventually break through from underneath.

Take care with lead repairs. The Lead Advisory Service Australia (www.lead.org.au) offers a free service to provide advice and support about any lead-related questions or concerns.

Copper

Copper is a very durable metal. It is strong, ductile and malleable, and resistant to corrosion. It can be stretched, beaten or drawn into sheet or wire form and is available in soft, half-hard or hard tempers. Copper is most commonly used in buildings for pipes, roofing and guttering.

Copper is one of the most corrosive-resistant metals and is not normally subject to galvanic corrosion but can be affected by acidic run-off from timber, lichen and bituminous surfaces.

When copper weathers it develops a protective, adherent patina that may change, aging from coppery red to a dark brown in the absence of pollutants or it may develop a green patina where the atmosphere is slightly corrosive. A highly polluted environment may change the patina to blue, brown or black.

Zinc

Zinc is a bluish-white, medium hard metal which is reasonably brittle and was used primarily for roofing and as a protective coating on steel (galvanising). Zinc initially has a bright surface finish that quickly develops a dark, matt grey patina.

Brass and bronze

Brass is copper alloyed with zinc and bronze is copper alloyed with tin. Brass was and continues to be used widely for architectural castings. Similarly, bronze was and continues to be widely used to cast sculpture, bells and other architectural elements.

The cleaning and repair of bronze sculpture requires the attention of a metals conservator and is not covered by General Exemption.

Tin

Tin is a silvery-white metal that is soft, ductile and malleable and was used historically for lanterns, candle shields, wall sconces and mirror frames. It was also used for roofing.

Aluminium

Aluminium is a lightweight white metal that has a high corrosion resistance and can be cast, formed and machined. It was first used as stamped metal ceiling sheets and is now found in a range of elements include roofing materials, rainwater goods, windows and doors, cladding, hardware and fittings.