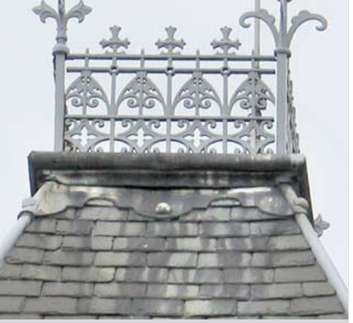
INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

Roofing Leadwork

HISTORIC SCOTLAND



Characteristics of lead

Lead is one of the most durable metals that is used in building, historically showing that it can perform satisfactorily for up to a few hundred years. It is a soft, heavy, metal which is extremely resilient and malleable. These characteristics make it ideal for widespread external use in construction, especially where it is necessary to keep out rainwater at the complex junctions between building details that would otherwise prove difficult to be kept weather-tight. In addition to performing an exceptional range of functional requirements, its malleable qualities have also made it possible to readily work the material into architectural features such as scalloped detailing, raised bosses and ball finial decorations.

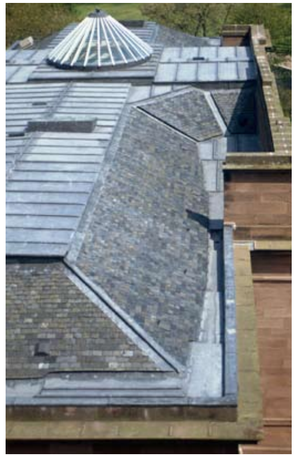
Freshly cut lead has a bluish white colour but this converts to a dull grey hue when exposed to the air. As this happens a natural resistance to corrosion is produced. In some circumstances the initial whitish finish may be unacceptable, and this can be avoided by the external application of patination oil. But, there is a need to carry out the patination quickly, as uneven smearing and discolouration may otherwise occur. In general terms, the thicker the sheet, the more durable the material will be.

The great ability of lead to be easily cut and worked can also be its disadvantage. Because it can expand and contract significantly, lead work detailing needs to allow for the material to move as weather conditions change. If, eventually, it fails, given its low melting point, lead roofing can be stripped off, melted down, readily reformed and circulated for reuse as new sheet.

Applications and use

With different thicknesses and weights (Codes) being used for different functions, the thicker and heaver sheets will last longer. They are also best suited to areas where there is a need to ensure that rainwater is properly channelled off the building and disposed. Lead is likely to be found in traditional building construction at a variety of locations including:

- Access hatch covers
- Apron flashings
- Bay windows
- Chimney flashings
- Cover flashings
- Dormer flashings
- Flat roofs
- Gable flashings
- Lining parapet gutters
- Parapet wall capping
- Rainwater downpipes
- Rainwater outlets
- Roof hips
- Roof lights
- Roof piercings
- Roof ridges
- Secret gutters
- Valley gutters
- Vertical cladding
- Weathering to cornices



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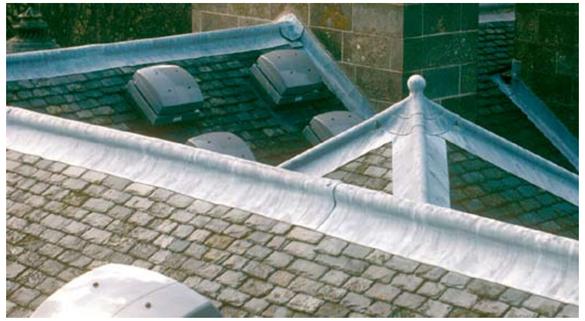

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Types of sheet lead

Sheet lead can be manufactured by three methods-

- Sand casting
- Machine casting
- Milling (rolled)

By pouring molten lead across a prepared bed of sand and spreading it out by hand to the required thickness, a distinctly rough appearance was created on the finished sheet. Sand cast sheets of lead were manufactured by the Romans to create water storage tanks and pipes but, in medieval times, many church and cathedral roofs were covered with lead made in a similar manner. A number of specialist firms can still carry out the process of sand casting.
The manufacture of machine made cast lead sheets has a much more modern pedigree, with the technique being invented during the 1950's and first introduced into the country during the 1980's. The sheet is produced by rotating a cool metal drum in a bath of molten lead. This solidifies onto the cooled surface of the drum, and is subsequently peeled from it in a continuous sheet. Different thicknesses are created by varying the speed at which the drum rotates, the depth by which it penetrates into the molten lead, and the temperature difference between the drum and the molten material. As a result of the process, the finished sheet has a relatively smooth surface where it has previously been in contact with the drum.

Milled lead sheet is created by rolling a block of lead between cylindrical rollers. The rollers are brought progressively closer together until the required thickness of lead is obtained. Producing a consistent thickness of sheet with a fine smooth finish on both faces, the rolling technique was first started around the mid 18th century. Rolled milled sheet is the most common form of lead available today, and the related trade association offers excellent guidance and technical advice on how to use the material in a wide range of circumstances.

Range of defects and remedial work

Although lead resists corrosion well, it can be damaged or stained by alkalis from new cement, acids from some timbers (oak in particular) and the run-off from lichen, moss and algae surface growths. It is therefore best to try to avoid situations emerging where these circumstances can occur. Temporary protection may be necessary when working with cement or lime mortars in the vicinity of lead, an appropriate barrier may be necessary between it and the timber, and biological growths should be prevented from establishing themselves in the vicinity and building up on the surface.
Despite the excellent properties of the material a range of other physical defects may have to be dealt with including -

- Wind lift and distortion
- Surface ripples and creep
- Rips and tears
- Restricted thermal movement
- Topside and underside corrosion

The physical and visual effects of any of these defects should become obvious if a regime of routine inspection and maintenance is followed. Undertaking repairs requires an appropriate knowledge to assess and diagnose the cause of the defect before making recommendations, and carrying out the work.

This should consider the overall condition of the lead, how long it has been in place, whether there are any inherent design faults, and whether or not there is any interaction occurring between other nearby materials or growths.

Roofs should be generally inspected after any severe storm to determine whether or not strong winds may have lifted or distorted the lead work from its original position. This type of failure is usually caused by inappropriate, loose or inadequate fixings. This should be remedied when repair works are carried out in resetting the lead. To prevent lifting and distortion the free edge of all lead flashing should be appropriately clipped in place. The number of clips used will vary dependent upon the size of the piece of lead-work, its function, and the orientation of the building and its exposure. Clips are normally made from copper, stainless-steel or lead.

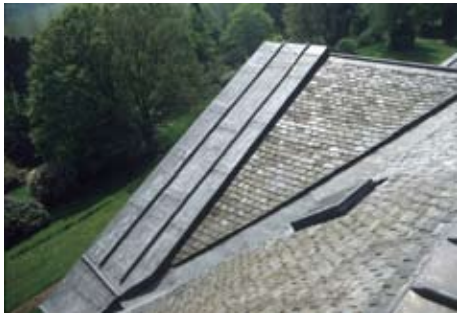
Large sheets of lead should be supported on a smooth decking with a suitable underlay positioned between the lead and the deck. The selected underlay should -

- Act as sound deafening
- Allow for thermal movement
- Not contain any material that is detrimental to the lead
- Provide a barrier against corrosion
- Provide an even support surface
- Reduce the risk of trapped moisture and condensation below the lead sheet

Inappropriate materials, such as bituminous roofing felt, laid in this position could "glue" the layers together during hot weather and cause the lead sheet to buckle and fracture. An appropriate building paper or polyester geotextile material is to be preferred.

Technical guidance

If an appropriate degree of thermal movement cannot take place due to the use of oversized sheets and overfixing, stresses can be set up which will lead to failure of the lead through distortion, buckling and cracking. Experience has shown that, depending upon their function, exposure and weight, there are recommended optimum sizes for different pieces of lead. This information is generally available to the construction industry and the detailed technical guidance should be followed when repair works have to be carried out. This will help ensure that the lead performs appropriately thereafter. In some circumstances the current guidance may involve changing the original detailing of the building to ensure that sufficient falls and drips are accommodated in addition to using the correct size of sheet when lining parapet gutters, or covering extents of flat roof work.



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Care needs to be exercised when nailing lead sheet in place to avoid creating any interaction with unsuitable metals. To prevent this, copper or stainless-steel nails are generally recommended to secure the sheets in place. Fixing screws should either be of brass or stainless steel. Where fixings have to be made through the lead sheet, these should be covered with lead "dots" to prevent water penetration.

Lead lined gutters, especially those behind parapet walls, can be particularly problematic to deal with. They are often split open by the cutting edges of loose slates that have slipped down the roof slope, or can be deformed as timber supports decay. This can lead to severe water penetration into the building, with erosion and decay of the saturated walling following if left unattended to.

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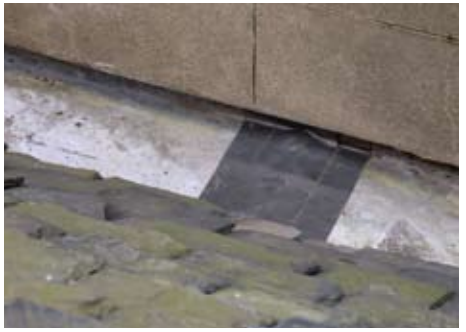

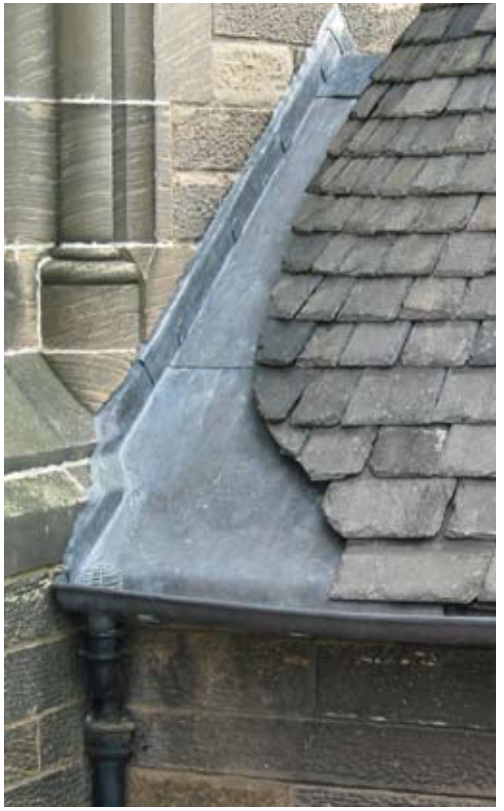

Whilst small cuts, rips and tears can be temporarily repaired by the application of bituminous backed foil, a more appropriate repair might be carried out by carefully welding small patches over the damaged area. Extreme care must be taken when any hot work is carried out to prevent the risk of fire occurring. Increasingly, across the industry, such on-site hot-working is being banned due to the risks involved. Consequently, it may only be possible to carry out such patchwork by carefully dismantling and removing the damaged piece of lead to undertake the welding off-site. As a fail-safe, parapet gutters should also be provided with an overflow outlet so that, should the rainwater outlet become blocked, pooled water can escape without flooding into the building interior.

With the increased impact of creating a well heated building interior there is an additional risk that warm moist air filtering into the roof structure could condense on the underside of any sheet lead roof coverings, particularly where large panels have been used. This, in turn can create corrosion resulting in white coloured runs or streaks, or white powder forming on the underside of the lead. To avoid this, a ventilated airspace needs to be created below the support decking material. It is also known that corrosion can be caused where lead comes in direct contact with oak timber, and this should be avoided by placing a suitable separating membrane between the two.

As proven by its long history of use, lead is an effective, reliable and indispensable material that has been successfully used in the care of traditional buildings. It does however require the skills and abilities of a craftsman trained and experienced in the art of lead working. Caution should be exercised if offered replacement materials, such as fibreglass or vinyl, when carrying out leadwork repairs. Appropriate advice should always be sought when any repair or replacement works are anticipated.

Useful contacts:

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Further reading

The Repair of Historic Buildings in Scotland Advice on principles and methods:
Historic Scotland, 1995
Lead Sheet Manual: Lead Sheet Association
BS 1178, Specification for milled lead sheet for building purposes:
British Standards Institution, 1982

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