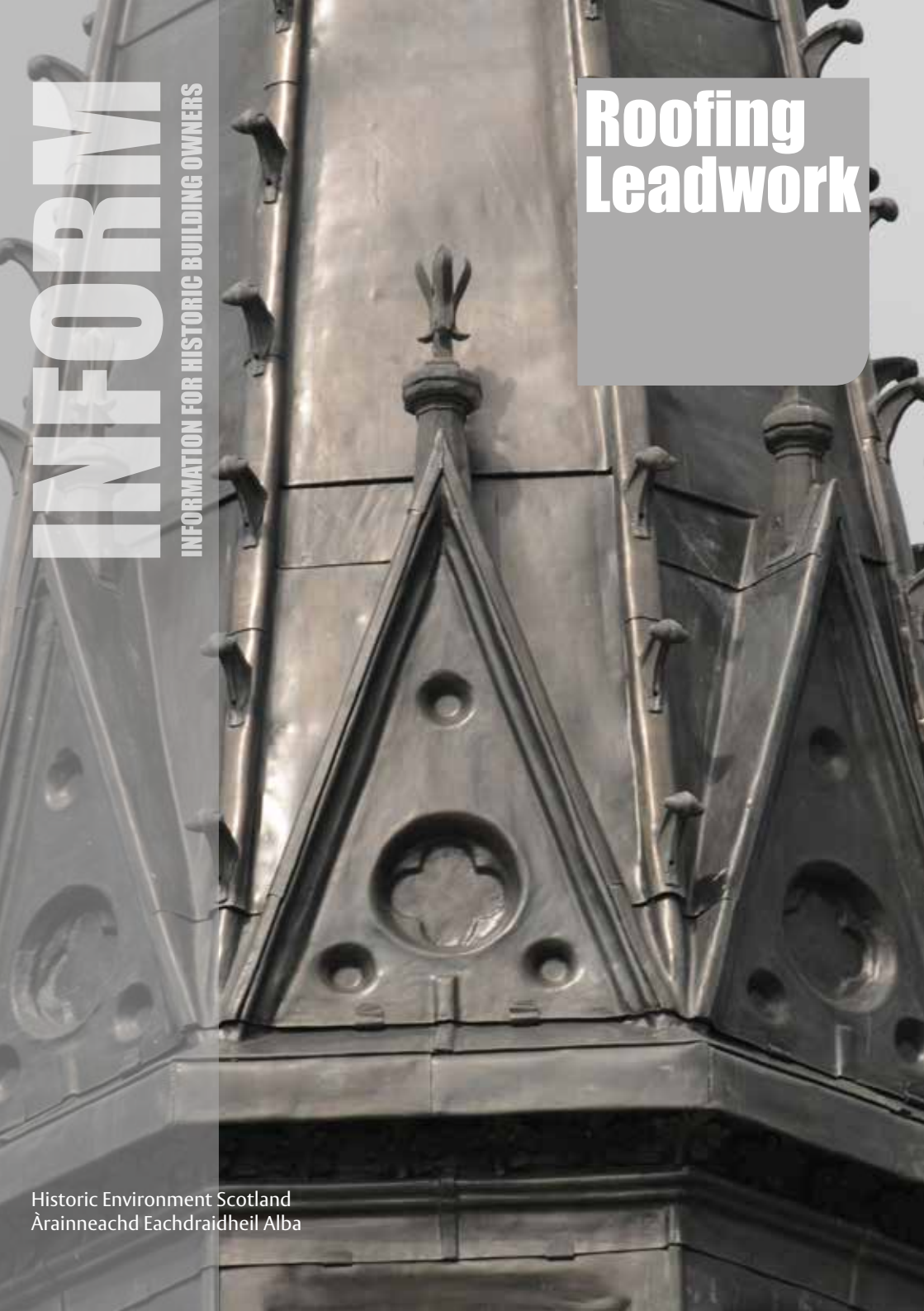
INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

Roofing Leadwork



Historic Environment Scotland
Àrainneachd Eachdraidheil Alba

Introduction

This INFORM provides guidance on the use of lead in traditional buildings and the correct repair and maintenance of leadwork. Lead is a material which is used in a number of places on historic and traditional buildings. It is found used as flashing around chimneys, roof ridges and detailing, valleys and on parapet gutters and as a roof covering for both pitched and flat roofs (Fig. 1). The specific material qualities of lead must be understood to allow correct repair and maintenance work to take place. Due to an increase in commodity prices in recent years the theft of lead has become an increasing problem and brief guidance on reducing the likelihood of this happening is also given.

Characteristics of lead

Lead is a durable and long lasting material, which if properly fitted and maintained can last for up to two hundred years or more. It is a soft, heavy, metal which is malleable yet extremely resilient. These characteristics make it ideal for widespread external use in construction, especially where it is necessary to keep out rainwater at the junctions between roof pitches (Fig. 2) and masonry (Fig. 3). Its malleable qualities also make it possible to readily work the material into architectural features such as scalloped detailing, raised bosses and ball finial decorations. Lead can be removed, melted down and re-formed into lead sheet, making it an easily recyclable and sustainable material.

The ability to easily cut and work lead can also cause problems, and it can expand and contract with changes in temperature. This means that lead work detailing needs to allow for the material to move slightly as weather conditions change. This is likely to involve arrangements of steps and other joints which need careful specification.

Fig. 1 *Lead is used extensively in this building as both a flat and pitched roof covering and to cover pediments and ridges.*

Fig. 2 *Lead is often used to protect areas of a roof where water is concentrated such as this valley gutter.*

Types of sheet lead

Sheet lead can be manufactured by three methods: sand casting, machine casting and milling (often referred to as rolled). Lead is classified in different codes indicating its weight in pounds per square foot. Generally higher codes of lead which are thicker and heavier will be more durable and are used for areas where there is a high flow of water over the leadwork.

Sand cast lead is manufactured by pouring molten lead across a prepared bed of sand and spreading it out by hand to the required thickness. This gives a distinctly rough appearance to the finished sheet. Sand cast sheets of lead were originally 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 (Fig. 4).

Fig. 3 *Lead is a durable material to use where a slate roof meets masonry such as at this skew cope.*

Fig. 4 *The manufacture of sand cast lead sheet.*

The manufacture of machine made cast lead sheets is a fairly modern innovation, with the technique being developed during the early 20th century. 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. 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 rolling technique was first used in the mid-18th century. 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. Rolled milled sheet is the most common form of lead available today (Fig. 5).

Fig. 5 *Milled lead sheet used to cover a flat roof.*

Defects and repairs in leadwork

Although lead resists corrosion well, it can be damaged or stained by alkalis from cement haunching and pointing, acids from some timbers (oak in particular) and the run-off from lichen, moss and algae. To avoid this, 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 timber, and biological growths should be prevented from establishing themselves close to or on the surface of lead.

Despite the excellent properties of the material, a range of other physical defects can lead to lead requiring repair. These can include wind lift (Fig. 6), surface movement, rips and tears, restricted thermal movement and corrosion on both the upper or underside of lead sheets. Defects of this sort will be identified if a programme of regular inspection of a building is undertaken. The cause of any defect should be established and rectified prior to any repair work to lead taking place. This should consider the overall condition of the lead, how long it has been in place, whether there are any inherent design faults and what building defects such as blocked rainwater disposal systems or other roof coverings may be causing damage to the leadwork.

Fig. 6 *Wind uplift on exposed leadwork can result in the lead coming off.*

Lead lined gutters, especially those behind parapet walls, can be particularly problematic to both inspect and repair. They are often split open by the edges of loose slates that have slipped down the roof slope, or can be deformed if their supporting timber decays. If left unattended, this can lead to severe water penetration into the building, with subsequent erosion and decay of the saturated masonry (Fig. 7). 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.

Fig. 7 *A blocked or leaking lead parapet gutter is causing saturation of the masonry below, seen here as the darker coloured stone and salt staining on the corner by the window.*

Roofs should be inspected after any extreme weather as strong winds can lift or distort leadwork from its original position, making it ineffective. This type of failure is usually caused by loose or inadequate fixings, and should be rectified when repair works are carried out. 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 and exposure of the building. Clips are normally made from copper, stainless-steel or lead.

All lead sheet should be supported on a timber decking with a fibrous underlay to separate the lead from the decking. This allows both thermal movement of the lead and condensation to disperse to give an even layer of support for the lead. In the past, some underlays have inadvertently glued the timber and the lead together, sometimes resulting in buckling and distortion of the 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 allow for thermal movement of the material, provide a barrier against corrosion whilst reducing the risk of trapped moisture and condensation below the lead sheet, and also provide an even support surface for the lead. 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 preferred.

The size and code of lead sheet used and the correct fixing, whether pitched or flat, is crucial to its longevity. If an appropriate degree of thermal movement cannot take place due to the use of oversized sheets and over fixing, stresses can build 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, guidance on which is contained in the Further Reading section of this INFORM. 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.

Care needs to be exercised when fastening lead sheet into place to avoid creating any interaction with unsuitable metals which can cause bi-metallic corrosion. To prevent this, copper or stainless-steel nails are generally recommended to secure the sheets in place. If screw fixings are being used, they 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.

Whilst small cuts, rips and tears can be temporarily repaired by the application of bituminous backed foil (Fig. 8), a more durable and long lasting repair is to carefully weld small lead patches over the damaged area. Extreme care must be taken when any hot work is carried out to prevent the risk of fire, and a system of permits will be required.

While more time consuming than welding, the hand shaping or dressing of lead allows the traditional shape and appearance of the old work to be retained with new material, as well as removing the need for hot work (Fig. 9). Hand dressing can be done on site.

Fig. 8 *Temporary repairs such as this offer a measure of short term protection, but will not be as durable in the long term as those executed in lead.*

Fig. 9 *Fitting new lead sheet using traditional dressing techniques and tools.*

Care should be taken when insulation is being installed in a roof space with a lead covering. When such work occurs, there is a risk that the lead roof is made colder on the underside and warm moist air entering the space between the insulation and roof covering results in condensation and decay. 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 in the roof void below the support decking material.

Lead theft

There are a number of measures which can be taken to minimise the risk of lead theft from traditional buildings. This can include simple 'good housekeeping' measures such as ensuring ladders are not left where they can provide easy access to lead roofs. More significant interventions such as the use of physical barriers, alarms, sensor flood lighting and forensic marking can also reduce the chances of theft occurring. Additional fixings can also be used to secure lead in place making it harder to remove from a roof. Such fixings can be added to existing or new lead (Fig. 10).

Fig. 10 *The use of additional fixings can be an effective deterrent against lead theft.*

Conclusion

As proven by its long history of use, lead is a durable and integral material in traditional construction. It does however require the skills and abilities of a craftsperson trained and experienced in the art of lead working or 'lead dressing'. Caution should be exercised if offered replacement materials, such as fibreglass or vinyl, as none will provide the durability or finish of leadwork. Appropriate advice should always be sought when any repair or replacement works are anticipated.

Contacts and Further Reading

Historic Environment Scotland
Conservation
(technical advice)
Longmore House, Salisbury Place, Edinburgh, EH9 1SH
T: 0131 668 8683
E: technicaleducation@hes.scot
W: www.historic-scotland.gov.uk

Historic Environment Scotland
Heritage Management
(planning/listed building matters)
Longmore House, Salisbury Place, Edinburgh, EH9 1SH
T: 0131 668 8716
E: hmenquiries@hes.scot
W: www.historic-scotland.gov.uk

Lead Sheet Association
Unit 10 Archers Park, Branbridges Road, Tonbridge, Kent TN12 5HP
T: 01622 872432
W: www.leadsheet.co.uk

British Standard: BS EN 12588:2006. Lead and lead alloys: Rolled lead sheet for building purposes.

Curtis, R. 'Lead.' In *Building Scotland*, edited by M. Jenkins, 119-126. Edinburgh: Historic Scotland, 2010.

Historic Scotland. *Roofs: Managing Change Guidance Notes*. Edinburgh: Historic Scotland, 2010. Available online at www.historic-scotland.gov.uk/index/heritage/policy/managingchange.htm

Historic Scotland. *Short Guide 2: Lead Theft: Guidance on protecting Traditional Buildings*. Edinburgh: Historic Scotland, 2015.

Lead Sheet Association. Free information leaflets, available online at www.leadsheet.co.uk/free-information-sheets

Livesey, J. "Protecting Lead Roofs from Theft." *Historic Churches* (2010). Available online at www.buildingconservation.com/articles/leadtheft/lead-theft.htm

Historic Environment Scotland's INFORM Guide and Short Guide series contain further information on the conservation and maintenance of traditional buildings. These publications are free and available from our technical conservation website, address above. Alternatively, you can contact us on technicaleducation@hes.scot for these or any other publication enquiries.

Historic Environment Scotland
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Principal authors: Moses Jenkins and Ingval Maxwell

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Tel: 0131 668 8638 Fax: 0131 668 8669
W: www.historic-scotland.gov.uk E: technicaleducation@hes.scot

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