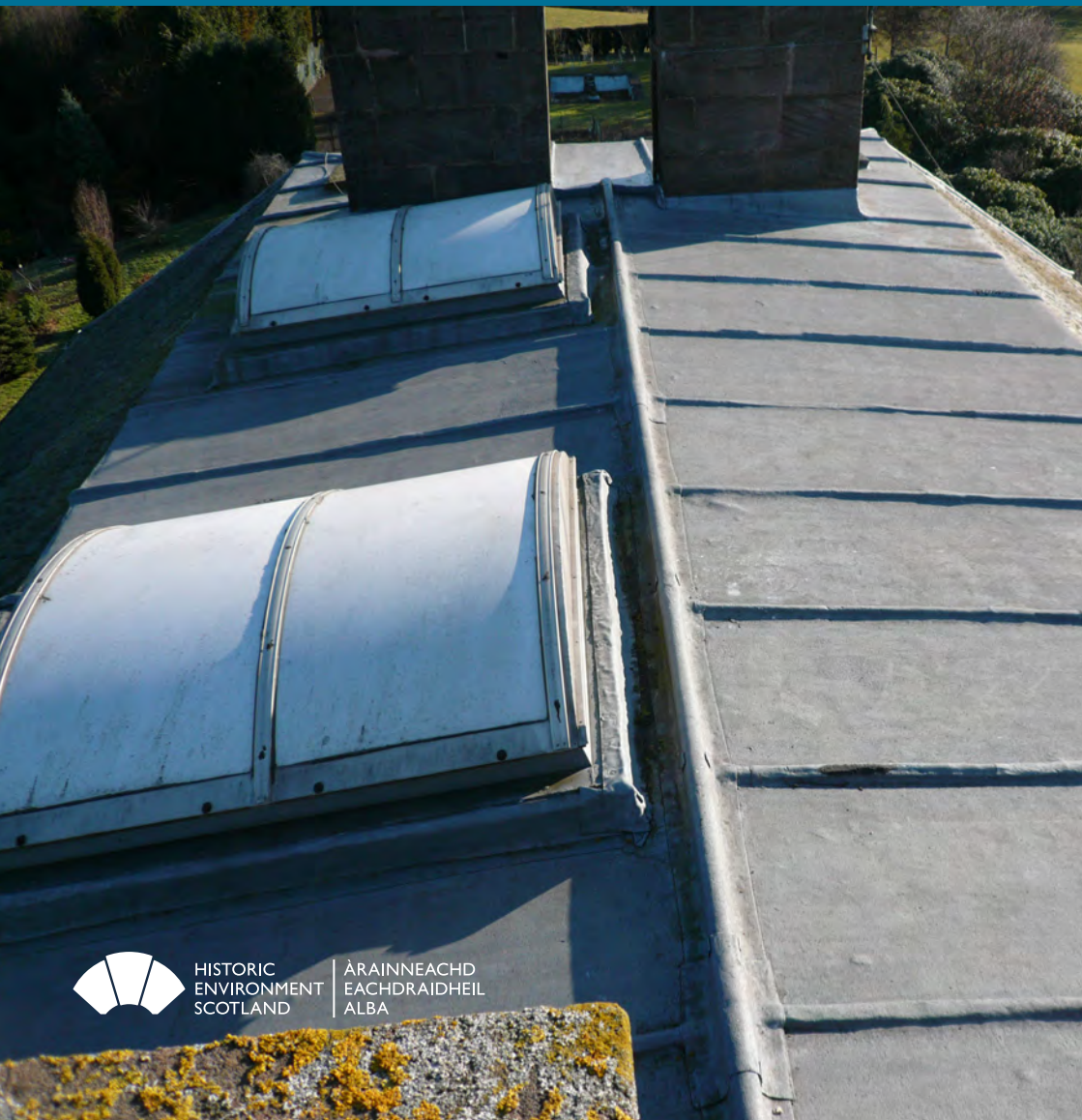
INFORM

ROOFING LEADWORK



HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Fig. 1: Lead is used for both roof coverings, and to cover pediments, ridges and roof valleys.

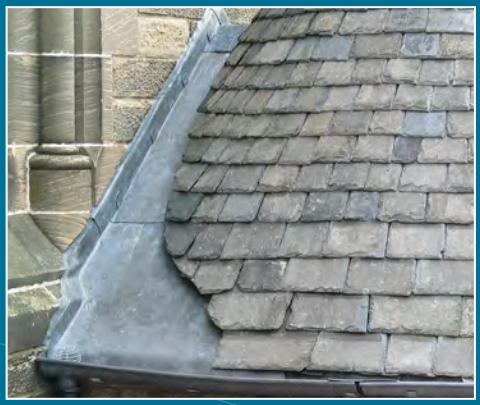


Fig. 2: Lead is a durable material to use where a slate roof meets masonry, such as this abutment.

ROOFING LEADWORK

Lead is a material which is used in a number of places on historic and traditional buildings. It is 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; 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 and masonry (Fig. 2). 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 (Fig. 3). Lead can be removed, melted down and reformed into lead sheet, making it an easily recyclable and sustainable material.

Types of sheet lead

Sheet lead can be manufactured by: sand casting, machine casting and milling (often referred to as rolled). Lead is classified in different codes, indicating its weight in pounds per

Fig. 3: A highly decorated lead spire on the roof of McManus Gallery & Museum, Dundee.

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. Several specialist firms can still carry out the process of sand casting (Fig. 4).

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. Milled sheet is the most common form of lead available today (Fig. 5).

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 the molten lead, and the temperature difference between the drum and the molten material.

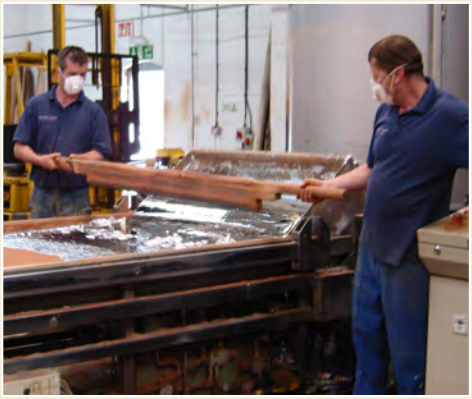


Fig. 4: The manufacture of sand cast lead sheet.

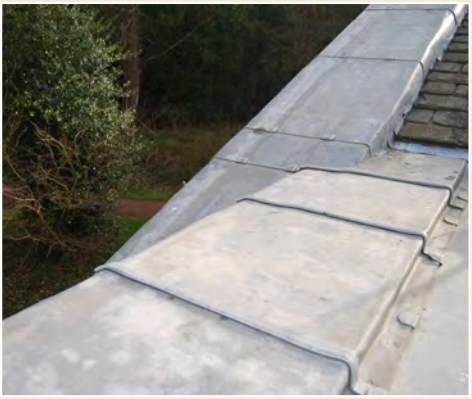


Fig. 5: Milled lead sheet used to cover a flat roof.

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. Where there is timber, an appropriate barrier may be necessary between the two materials. Biological growths should be prevented from establishing themselves close to or on the surface of lead.

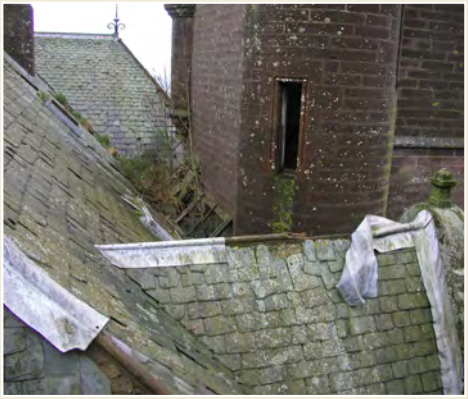


Fig. 6: Wind uplift on exposed leadwork can result in the lead coming off.

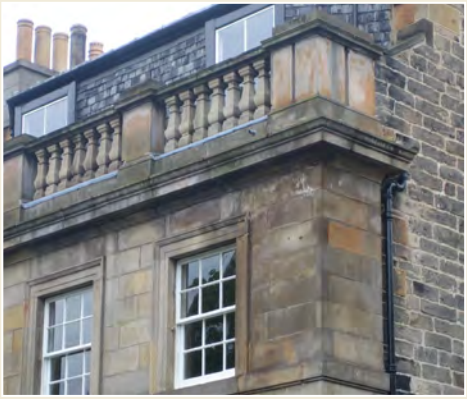


Fig. 7: A blocked lead parapet gutter is causing saturation of the masonry below.

Despite the excellent properties of the material, a range of other physical defects can lead to lead requiring repair. These can include wind uplift (Fig. 6), surface movement, rips and tears, restricted thermal movement and corrosion on both the upper and 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.

Lead lined gutters, especially those behind parapet walls, can be particularly problematic to 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, in the event of the rainwater outlet becoming blocked, pooled water can escape without flooding into the building interior.

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 leadwork, 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, something resulting in buckling and distortion of the lead.

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 on their function, exposure and weight, there are recommended optimum sizes for different pieces of lead, guidance on which can be found in the Further Reading section. 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 (Fig. 8). 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

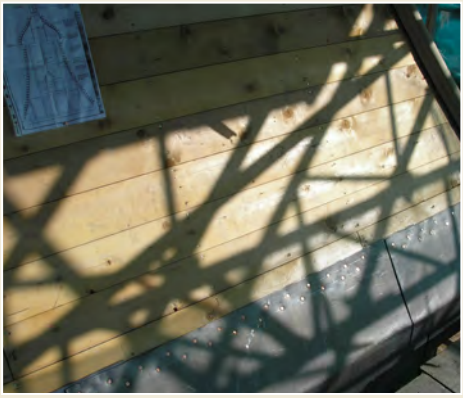


Fig. 8: Copper nails fixing the lead in place.

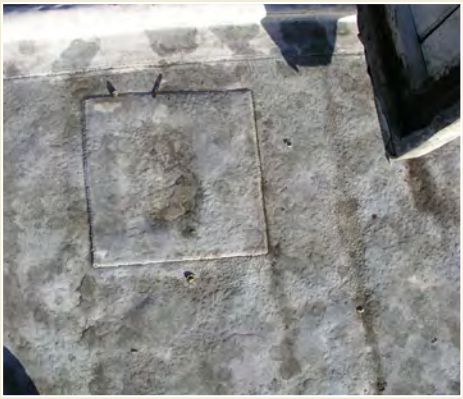


Fig. 9: A patch repair with a piece of lead welded in place.

foil, a more durable and long-lasting repair is to carefully weld small lead patches over the damaged area (Fig. 9). Materials such as vinyl and fibreglass are also sometimes offered as alternatives, however, are not technically as long lasting and they cannot mimic the aesthetic look of lead. As such, using these should only be considered in special circumstances. 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

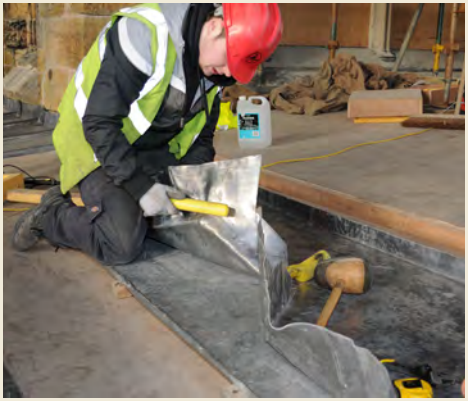


Fig. 10: Dressing in new lead sheet using traditional techniques and tools.

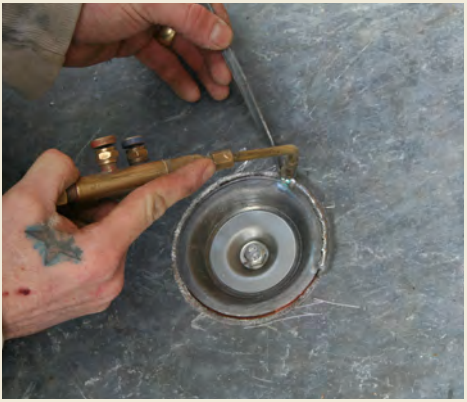


Fig. 11: The use of additional fixings can be an effective deterrant against lead theft.

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. 10). Hand dressing can be done on site.

Care should be taken when insulation is being installed in a roof space with 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. 11). More information about mitigation against lead theft such as protection and alternative repair materials can be found in Historic Environment Scotland's *Short Guide 2: 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.

Further Reading

SHORT GUIDE 2: Lead Theft: Guidance on Protecting Traditional Buildings, Historic Scotland (2015).

'Lead.', R. Curtis, in *Buildings Scotland,* M. Jenkins (ed), Historic Scotland (2010).

"Protecting Lead Roofs from Theft.", J. Livesey, Historic Churches (2010). https://www.buildingconservation.com/articles/lead-theft/lead-theft.htm

Roofs: Managing Change Guidance Notes, Historic Scotland (2010).

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

Further information

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The Engine Shed is Scotland's buildings conservation centre. Run by Historic Environment Scotland, it is a hub for everyone to engage with their built heritage. We offer training and education in traditional buildings, materials and skills. For more information, please see our website at www.historicenvironment.scot or email technicaleducation@hes.scot.

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