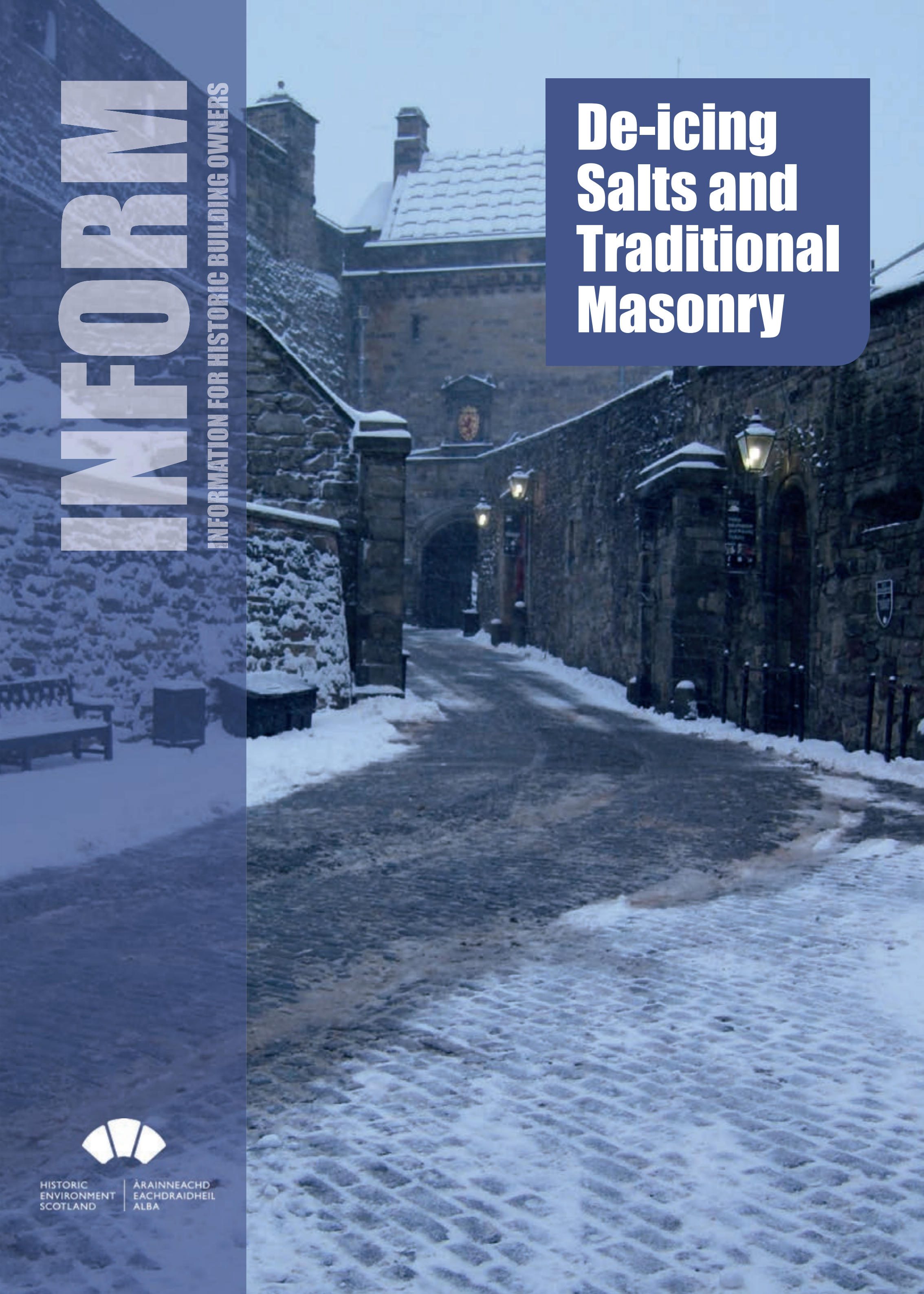

INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

# De-icing Salts and Traditional Masonry

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

## Introduction

During the winter months, as temperatures drop and ice builds up on the ground, we rely on salt and grit to remove ice from roads and pavements. De-icing is an important safety obligation, and an economic necessity to ensure businesses continue to operate during adverse weather conditions.

Despite its beneficial properties, the spreading of salt can also cause problems. Due to their high solubility, salts become mobile and can cause damage to buildings and the natural environment.

This INFORM guide provides a summary of de-icing salt types and practices, and describes the impacts of salts on natural building stone. This guide also recommends best practice for homeowners and managers of historic buildings to help limit the damage caused.

## How de-icing salts work

When the temperature drops below 0 °C ice starts to form and binds with the surface of roads, pavements, steps and entranceways. While ice can be removed mechanically, that is labour intensive. More commonly, salts are used to melt ice by lowering the freezing point of water and are used on road or pavement surfaces in the form of grit and salt. Although commonly referred to as *de-icing* compounds, salts are also used for *anti-icing,* to prevent the formation of ice on road and paved surfaces. Salt can be applied as a combination of concentrated brine and solid salt. Applying the salt in this way ensures faster melting rates, prevents further ice from accumulating and stops salt particles from bouncing away as they are spread onto the road surface.

## De-icing salt types

Salts are the most reliable, plentiful and affordable resource for de-icing roads and paths in Scotland. A variety of salt types are commercially available, the main ones being sodium chloride, calcium chloride and magnesium chloride.

**Sodium chloride** (common table salt) is the cheapest and most frequently used de-icing compound. It is usually available in the form of *rock salt* and is readily available from retailers and wholesalers. Many types have stone and grit fragments added to give the mixture an abrasive quality, providing extra traction on the ice surface. Sodium chloride is most effective at melting ice at temperatures above -7 °C, but can continue to melt ice as low as -21 °C. In Scotland, winter temperatures rarely drop this low.

**Calcium chloride** is a faster-acting salt that is extracted from naturally occurring salt water sources (brines), or from processing of other natural materials. It is a *hygroscopic* material which attracts moisture from its surroundings to form brine. The dissolution of calcium chloride in water is exothermic (produces heat on reaction) which further speeds up melting. Calcium chloride is effective at melting ice to temperatures lower than

-20 °C and can continue to melt ice to temperatures as low as -50 °C.

**Magnesium chloride** is another hygroscopic salt sourced from naturally occurring brines. As with calcium chloride, this salt gives off heat during reaction, although to a lesser degree. Magnesium chloride de-icer is effective at temperatures down to approximately -25 °C.

As sodium chloride is significantly cheaper than the other types it is much more commonly used by councils and road maintenance authorities as well as homeowners (Fig. 1). Magnesium chloride is sometimes used as a secondary salt when temperatures drop below -7 °C. This dual-salt approach was introduced in response to the extremely cold and prolonged winter of 2010-2011. Both calcium and magnesium chloride salts are available from specialist online retailers, but homeowners should check the descriptions to ensure they are buying the correct material for their requirements. These salts are significantly more expensive.


***Fig. 1** Sodium chloride is widely available for homeowner use at DIY stores.*

## De-icing salts in the environment

The spreading of de-icing compounds is one of the largest sources of salts to the urban and natural environment. The excessive use of de-icing salts can lead to wide-spread contamination due to the high solubility and mobility of salts in water. Salts can be easily spread to nearby areas through water run-off and vehicle splash, causing harm to the built and natural environment. While de-icing salts contribute to corrosion of vehicles, steel reinforced structures and cast iron, they can also cause damage to the masonry of buildings, boundary walls and other structures of natural stone.

## Effect of de-icing salts on masonry

Salts are a major decay agent of natural building stones, affecting their appearance and, with prolonged exposure, their structural integrity. De-icing salts are transported in solution into stone through capillary uptake (suction), and from the spray of salt solution from surface water. The salt solution occupies the pores (voids) within the stone. As water evaporates from the outer surface of the stone, salt crystals form beneath the surface. The severity of damage is affected by the following factors:

### Type of stone

Some stone types are more prone to salt damage than others. Resilience of building stone is influenced by the types of mineral grains that it contains, the composition of the material holding the grains together, and the amount, size, shape and distribution of pores between the grains. Sandstones were used historically across much of Scotland, and are generally slightly more resistant to salt damage than limestone. Sandstone with low strength and high porosity is typically less resistant to salt decay than high strength, low porosity sandstone. Sandstones containing distinct layering, such as the red sandstones used in parts of Glasgow, may be more vulnerable to salt decay due to salts preferentially crystallising parallel to these bedding planes (Fig. 2). Both sandstone and limestone are less resistant than granite and other igneous rocks, all of which have much lower porosity.

***Fig. 2*** *Preferential crystallisation of salt along certain bedding planes in red sandstone.*

**Environmental conditions**

Water causes direct damage to stone through mineral dissolution and freeze-thaw processes, and indirectly as a medium for salts, pollutants and biological growth. Temperature and humidity influence where and how much salt is deposited. The location of stone in a building can affect the likelihood of decay as this determines exposure to moisture and de-icing salts, as well as the processes of evaporation and salt crystallisation through drying out of masonry.

**Salt type**

The type of salt will affect the extent and severity of damage due to the different crystallisation pressures exerted by different types of salts, i.e. the forces exerted against the interior of a stone when the salt crystallises in the pore space. Sodium chloride is the most common culprit, due to its widespread use. Calcium and magnesium chloride salts crystallise at lower humidities and are therefore less damaging to masonry, but are detrimental to concrete and cement structures.

**Salt decay**

Salt crystallisation can be identified by the build-up of white, powdery material on the stone surface *(efflorescence)*. This often appears as 'tide marks' (Fig. 3 and Fig. 4) on the surface of the stone. Deeper

***Fig. 3 and Fig. 4*** *Unsightly 'tide marks' showing movement of salt and moisture through the stone.*

***Fig. 5*** *Spalling of the stone surface caused by the crystallisation of salts within the pores of the stone.*

decay, where salt crystallises under the surface and within the pores of the stone (*subflorescence*), causes spalling or scaling of surface layers (Fig. 5), crumbling and breakdown (Fig. 6).

## Practical considerations

Although it is rarely possible to eliminate the use of de-icing salts, homeowners and property managers can take steps to limit the amount of salt used and therefore the potential damage to buildings:

**Plan ahead**

If cold weather or snow is expected, spreading salt before freezing conditions or snow will prevent accumulations of ice from forming. Evenly spreading salt and applying at the top of roads and paths will ensure that any generated brine will continue to melt ice as it flows downhill.

**Increase efficiency of de-icers**

The efficiency of snow and ice clearance can be increased by applying a mixture of brine and dry salt. The liquid brine starts melting surface snow and ice immediately, while the dry salt grains can

***Fig. 6*** *Granular disintegration on lower courses of stone due to salt crystallisation.*

***Fig. 7*** *De-icing salts should be used in moderation to minimise the risk of damage to stone structures.*

penetrate the ice, breaking the bond with the road surface. Salt grains or pellets have quicker ice penetration rates compared to flaked salt and are therefore more effective. A mixture of 70% solid salt and 30% brine is considered to be most effective.

**Protection of buildings**

For walkways in close proximity to stone buildings and vulnerable structures, it is recommended that de-icing salts are used judiciously or avoided where it is practical and safe to do so. Snow and ice can be removed mechanically, by shovelling or ploughing, and salt-free grit and sand mixtures can be used to provide grip. Where practical, affected paths around buildings might be temporarily closed if alternative routes are available or non-slip matting or other materials are laid on top. Alternatively, less damaging calcium and magnesium chloride salts ay be used in place of the more common sodium chloride. Salt spreaders, available from DIY stores, help give an even coverage of salt and thus minimise the amount used as can happen with hand spreading (Fig. 7). Excess salt should be swept up and re-stored.

## Repairing salt damaged masonry

Brushing salt crystals off the surface of dry masonry and removing it from the area prevents it from re-entering the stone. Where salts are not removed prior to repairs, it is likely that they will be drawn into the repair as moisture evaporates from the surface and this will reduce the lifespan of the mortar or new stone (Fig. 8). Where damage is limited to the surface of the stone, a mortar repair using an appropriately specified lime mortar or restoration mortar may suffice. Where salt damage has occurred, stone replacement may be required, and it may be appropriate to consider replacing the damaged stone with a more durable stone type, providing that this is compatible with the existing masonry. Stone with lower permeability is sometimes used to construct lower masonry courses as it will reduce the amount of moisture, and therefore salt, that can enter the structure.

***Fig. 8*** *Failure to remove salt from masonry prior to mortar repair can lead to efflorescence on the mortar surface.*

## Conclusion

Excessive use of de-icing salts can cause damage to the natural and built environment, including stone buildings and structures. Some stone types, particularly sandstone, are vulnerable to damage from salts. Pre-treatment of surfaces, mechanical removal of snow and ice; and providing alternative non-slip surfaces for pedestrians, can help minimise use of salts and reduce the potential damage to building stone. Where the use of de-icers cannot be avoided it is preferable to use those based on calcium and magnesium chloride salts. Where masonry is affected by salt damage, repairs should be carried out with compatible materials, and specialist treatment may be required.

## Contacts and further advice

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## Further reading


Historic Environment Scotland. *Inform: Lime and cement mortars in traditional buildings.* Edinburgh: Historic Environment Scotland, 2016.

Historic Scotland. *Inform: Cleaning Sandstone. Risks and consequences.* Edinburgh: Historic Scotland, 2007.

Historic Scotland. *Inform. Indent repairs to sandstone ashlar masonry.* Edinburgh: Historic Scotland, 2014.

Historic Scotland. *Inform: Masonry Decay. Dealing with the erosion of sandstone.* Edinburgh: Historic Scotland, 2005.


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 Engine Shed technical conservation website, address below. Alternatively, you can contact us via email for these or any other publication enquiries.


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