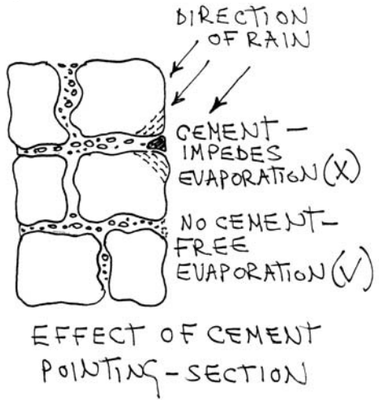
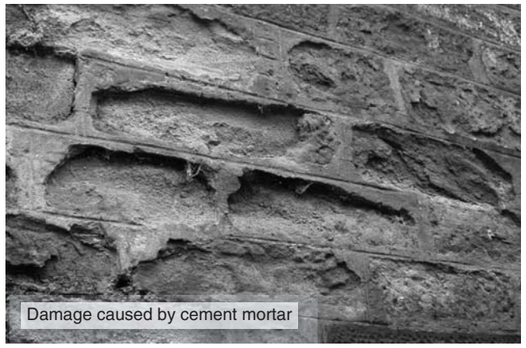
inside the wall and fungal decay can develop in the internal timbers of the building. All of this is caused by dense cement mortar blocking the free evaporation of moisture from the wall because the wall cannot breathe in the way it was designed to do.



EFFECT OF CEMENT POINTING – SECTION


Damage caused by cement mortar

Cement mortar facing and pointing can make a wall less thermally efficient than one built with lime mortar only because water can be trapped rather than evaporating away. Water is an efficient conductor of heat so prolonged wetting of mass walls covered in cement mortar will reduce the thermal efficiency of the building.

A brief word about clay bricks is necessary. Many chimneys, and some traditional buildings, are built from soft, and porous, clay bricks. These structures absorb and evaporate moisture so they will react adversely to the application of cement mortar facing and pointing. When clay bricks are pointed with cement mortar, sometimes the face of individual bricks bursts off, or 'spalls'. It is mistakenly assumed that the brick is too soft but the brick structure had probably performed perfectly well for decades, and longer, until it was pointed or faced in cement mortar.

The advice in this document also applies to free-standing garden walls as well as the walls of buildings.

REPAIR STRATEGIES

There are basic principles that the property owner can apply to ensure defects are correctly diagnosed so that repairs are properly specified and then carried out.

Look closely at the building to see what is wrong. Is it incorrectly bedded blocks that have delaminated? Is water washing down the wall and causing the clay in the stone to expand and contract leading to contour scaling? Is there failure of cement mortar that has been applied as pointing material or to face up the wall? The cause of the defects must be identified before appropriate repairs can be specified. Do not carry out repairs without understanding why the defects have occurred in the first place.

Consider carefully what needs to be done. Ask whether the defects are cosmetic, structural or are allowing water into the building. Depending on the nature of the defect, different treatments might be required. For example, if cement mortar has been smeared over the joints, and has started to become loose, can the cement mortar just be removed and the masonry or the lime mortar underneath left alone? Quite often, the loss of sandstone does not lead to either structural or weather proofing problems so little remedial work is required. If the original lime mortar is in sound condition wholesale re-pointing might not be necessary. Consider why the work being specified is necessary and what purpose it will serve.

Ask your adviser what they regard as the source of the problem and how their recommended course of action will then resolve it. Advice such as the stone is 'spalling' or is 'soft' is not a proper diagnosis of the defects. Your adviser should be able to identify incorrectly- bedded blocks, damage caused by localised water run-off, assess whether re-pointing is necessary and so on and explain why the problems have occurred and what can be done about them.

It is important to note that anyone commissioning, supervising, or carrying out building work, must be aware of the responsibility they have for health and safety.

CONCLUSION

It must be emphasised that this Advice Note is not intended to be a substitute for advice from a competent professional or a contractor. Nevertheless, you should now understand a little about what sandstone is, what the differences between traditional sandstone walls and modern cavity walls are and how they were designed to keep water out of the building. In particular, you should now be aware that cement mortar is often the cause of decay in sandstone walls and that it is not an appropriate material for their repair.

If cement mortar is applied to a sandstone building you should be aware that there will almost certainly be further problems in the future in the form of erosion of the sandstone surface and cement mortar falling off the face of the building. That is the main message of this Advice Note.

FURTHER INFORMATION

The Conservation Officer in the Planning and Transport Service can help clarify the points discussed in this Advice Note but cannot act as an agent for private individuals or companies. The Conservation Officer can be contacted on 01307 473507 during normal office hours.

The importance of using appropriate materials in traditional buildings is discussed in sections 7.3.2.4 and 7.3.2.5 of British Standard 7913:1998 - 'The Principles of the Conservation of Historic Buildings'.

Historic Scotland publishes a Technical Advice Note titled 'Preparation and Use of Lime Mortars'. Copies of 'Preparation and Use of Lime Mortars' can be purchased from:

Historic Scotland, Technical Conservation,
Research and Education Group,
Longmore House, Salisbury Place,
EDINBURGH, EH9 1SH.

Tel: (0131) 668 8638, Fax: (0131) 668 8669.
Website: http://www.historic-scotland.gov.uk

Training courses for property owners, contractors and building professionals are run by:

The Scottish Lime Centre Trust, Rocks Road,
CHARLESTOWN, Fife, KY11 3EN.

Tel: (01383) 872722, Fax: (01383) 872744
Website: http://www.scotlime.org

GLOSSARY

Aggregate: The material added to cement or lime to make mortar.

Ashlar: A type of wall built from blocks with very thin joints. Usually the face of the block is smooth.

Bedding plane: Individual layers of sediment in a block of sandstone.

Binder: Material used to bind the aggregate together in order to make mortar.

Bossing: Separating of the surface layer from the main area of the wall.

Cant: (usually 'built on cant') A term used to describe a block that is incorrectly bedded.

Contour scaling: The detaching of thin layers of sandstone from individual blocks. 'Contour scales' run at right angles to the bedding planes and should not be confused with the different phenomenon of 'delamination'.

Delamination: Often mistakenly referred to as 'scaling'. Delamination is the separation of the bedding planes from one another.

Facing Up: Applying patches of cement mortar over sandstone.

Joints: The point where individual blocks are joined together. Horizontal joints are often referred to as the 'bed joints' - vertical joints are called the 'perpends'

Needle gun: A compressed air tool that is used for de-scaling sandstone. Very aggressive and requires formal approval from Angus Council on listed buildings and buildings in conservation areas. The use of a needle gun is not recommended.

Pointing: Filling mortar joints with mortar. Usually describes replacing defective/missing areas of mortar.

Pointing Key: A standard pointing trowel is fine for general building work but a special pointing 'key' that varies in width, depending on the width of the joint is required for traditional building repairs.

Pore Structure: The size and number of pores in a block of sandstone. The porosity is measured by individual pore size and as a percentage of the overall volume of the material.

Quoins: Pronounced 'coins' - The blocks at the corners of a wall.

Rybats: Pronounced 'rye - bats' - The blocks that form the margins of an opening, particularly windows. Also referred to as 'inband and outband' and 'long and short work'. The long vertical stones sometimes used to form margins to openings are not called rybats but 'jamb stones'

Slaistering: Where mortar is smeared over the face of the wall. It is a bad technique on ashlar walls and on walls built from regularly sized blocks with regularly sized joints but is traditionally used on rubble walls. Sometimes termed 'harl pointing'

Spalling: Often used incorrectly to describe contour scaling, delaminating or general powdering of the masonry surface. True spalling is usually caused by water freezing while in the wall which then causes small areas of masonry to burst off. Spalling is uncommon on local sandstone because they tend to be very dense but common on clay brick walls and chimneys if the bricks are porous.

Stugging: The finish on a sandstone block that looks like a series of small indentations. This is one of the commonest types of surface finishes on sandstone walls in Angus.

Angus Council

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ADVICE NOTE 30

REPAIR TO SANDSTONE WALLS

For further information and advice contact:

Planning & Transport
Angus Council
County Buildings
Market Street
Forfar
DD8 3LG

Telephone 01307 461460

INTRODUCTION

This is an Advice Note for the guidance of property owners when commissioning repairs to traditional sandstone buildings. It is not intended to be a substitute for independent professional advice or as a comprehensive guide. However, there are basic principles that apply to most situations, the most important of which is to avoid the use of cement mortar on sandstone buildings.

A little background information on construction types is helpful so that the reader can understand why cement mortar is not appropriate for sandstone walls. The Advice Note starts with an explanation of wall types before moving on to discuss appropriate, and inappropriate, repairs.

There is a list of sources of further information at the end of the Advice Note and a technical glossary.

WHAT IS SANDSTONE?

Sandstone is a sedimentary rock created by the depositing of layers of minerals over a long period of time. The layers were then compacted together resulting in the solid material that is referred to as sandstone. A good way to visualise a block of sandstone is as a thick book that has been laid on its back.

Sandstones vary in their mineral composition and in their physical characteristics. Sandstones quarried in Angus tend to be rich in clay-based minerals. Cement mortar can accelerate the rate at which they decay

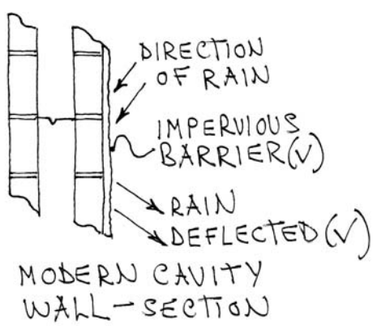
Another variable characteristic of sandstones is their density. All sandstones contain a network of pores, the amount, size and distribution of which varies from one type to the next. Most local sandstones have very little pore space so they rely on the joints to allow moisture to evaporate from their surfaces.

WALL CONSTRUCTION AND WEATHERPROOFING

Up until around the beginning of the 20th century, most walls were built using a technique called mass wall construction. Mass walls are solid throughout their depth and have an average thickness of around 550 millimetres, or 22 inches.

A mass wall is designed to absorb rainwater, hold it within the outer part of the wall, and then release it to the atmosphere as vapour after the rain stops. Most local sandstones have very little pore space so most of the evaporation is through the mortar joints. Bear this in mind in the section on mortar types.

Modern, cavity walls consist of an inner and an outer wall with a gap in between them. The two walls are held together with metal fixings known as 'ties' This type of wall is now used almost universally in modern house construction.



A cavity wall is designed to keep water out by presenting an impervious barrier to the weather. It is for that reason dense bricks and renders are used on the outside face of the building so that water cannot get into the interior of the building. As a safeguard, the ties on cavity walls have a detail known as a 'drip' in the middle to prevent any water that gets past the outer wall from travelling across the cavity.

Mass walls can be described as flexible and absorbent. Cavity walls tend to be inflexible and impervious. Neither of these comments should be regarded as adverse; they just describe how the two wall types behave. These differences can also be used to distinguish lime mortars from cement mortars, the next topic of discussion.

MORTARS

Mortar consists of two components - aggregate which is made up of sand particles, and a material to bind the aggregate together. Lime as a binder for mortars has been in use for thousands of years and was in general use until the beginning of the 20th century. The aggregate for lime mortars should generally be in a range of sizes and should be sharp and angular. Ordinary Builder's Sand is unlikely to be suitable as the aggregate for adding to lime in order to make mortar.

More can be discovered about the chemical and physical properties of lime from the literature listed below. For the purposes of this discussion it is sufficient to mention how lime mortar handles moisture.

A mass wall absorbs water, holds the water within the wall, and then releases it back to the atmosphere. The small size and number of pore spaces in local sandstones means they rely on the mortar joints to allow the free passage of moisture to the atmosphere. Lime mortar is ideal for this purpose and in the case of a mass wall it is essential. Anything that prevents the joints from breathing leads to the characteristic powdering and breakdown of local sandstone. One of the main causes of decay is cement mortar for reasons we shall discuss next.

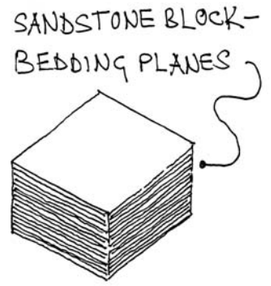
Before doing so it is worth mentioning the inherent flexibility of lime mortars. Mass walls expand and contract in response to temperature changes, ground movement and changes in moisture content. Lime mortar is a flexible material that can accommodate expansion and contraction without cracking. Walls built from cement mortar usually need expansion joints to accommodate movement.

Cement mortar sets rapidly to create a dense, impervious material. This is ideal for cavity walls that rely on physically keeping out the rain. In a mass wall, where the mortar joints are crucial as evaporation routes, the use of dense cement mortar is not advisable. Cement mortar is also less flexible than lime mortar so it cracks if subjected to excessive movement. The physical properties of cement mortar allow water to enter through these cracks where it is trapped and is then unable to evaporate easily.

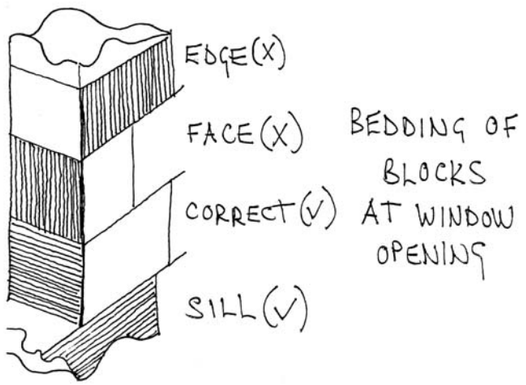
Cement mortar is a good material when used for the correct purpose but it was never meant for mass walls where moisture absorption and evaporation is an essential aspect of the technology. In effect, applying cement mortar to a mass wall is to use the material for a purpose for which it was not designed.

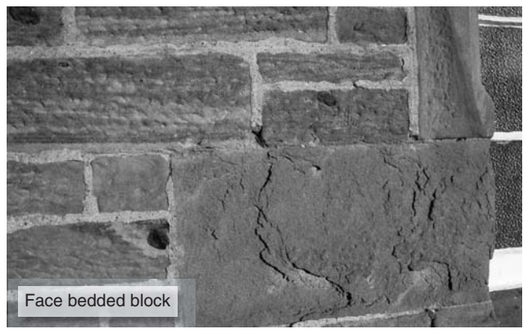
DEFECTS

A block of sandstone might be thought of as a book lying on its back - the layers of sediment can be likened to the individual pages in the book. Look at a sandstone wall - these layers, or bedding planes, are often clearly visible.



In construction, the bedding planes should usually run at a right angle to any load that is placed upon the block. Think of the book analogy and the reasons become clear. The load placed upon the 'book' presses the 'pages' together instead of causing them to buckle and split apart. Unfortunately, local sandstone blocks are often too shallow in depth to allow them to be 'correctly bedded'. It is common to see blocks laid incorrectly, either 'face bedded' or 'edge bedded', most often on deep blocks around openings and at the corners of buildings. Stonemasons refer to this as 'on cant' and it causes delaminating of the block as the individual layers separate from one another. Usually, a thin layer of stone detaches itself from the surface of the block of masonry.




Face bedded block

'Contour scaling' appears similar to delaminating masonry but it has different causes. It also takes the form of a thin layer detaching itself from the surface of the block. However, the layer runs at right angles to the bedding planes and it was probably caused by the action of water on the clay-based minerals in local sandstones. Polished ashlar walls are particularly prone to contour scaling because water tends to have less surface area from which to evaporate and the joints, which are crucial as evaporation routes, are very thin which restricts the rate of evaporation.

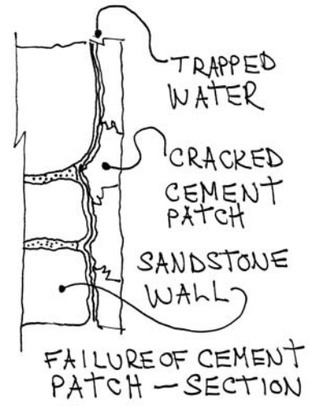
A common method of repairing delaminating and contour scaling masonry is to 'face up' the defective block with cement mortar. That is not advisable for several reasons:

The cement mortar does not replace the load-bearing material that has been lost. Structural failure requires structural repairs, not facing up in cement mortar.

The different rate of expansion and contraction between the cement mortar and the sandstone will eventually lead to the two materials separating, a phenomenon referred to as 'bossing' The use of adhesives is sometimes used to strengthen the bond but this often leads to the cement mortar patch pulling part of the sandstone off instead.

Water gets trapped behind the cement mortar and accelerates the rate at which the surrounding sandstone decays.

If pieces of cement mortar break loose they fall to the ground which causes a hazard to persons directly underneath the building.



Other defects include pieces of sandstone falling away from the underside of cornices, lintels and other blocks that project from the wall. Facing up in cement mortar is a common response but, for the reasons just described, it is not a proper repair.

It is also common to find cement mortar used for pointing on sandstone walls. As with cement mortar facing, its undesirable effects are only too evident. Its use leads to the same problems of failure of the cement mortar, trapping of water within the wall and further damage to the sandstone itself. Look at any sandstone wall where there is evidence of surface decay and it will become clear that many have been pointed with cement mortar.

The damage that cement mortar facing and pointing can cause is made much worse in areas that are subject to repeated washing with water. If the wall is faced or pointed with cement mortar, the rate of decay increases significantly. The clay minerals expand and contract repeatedly leading to increased delaminating of incorrectly-bedded blocks and contour scaling of blocks that are correctly bedded. When the temperature drops to freezing point any water trapped in the wall freezes and expands causing further damage, commonly around the area where the sandstone and the cement mortar meet. In walls where cement facing and pointing is extensive, water can build up