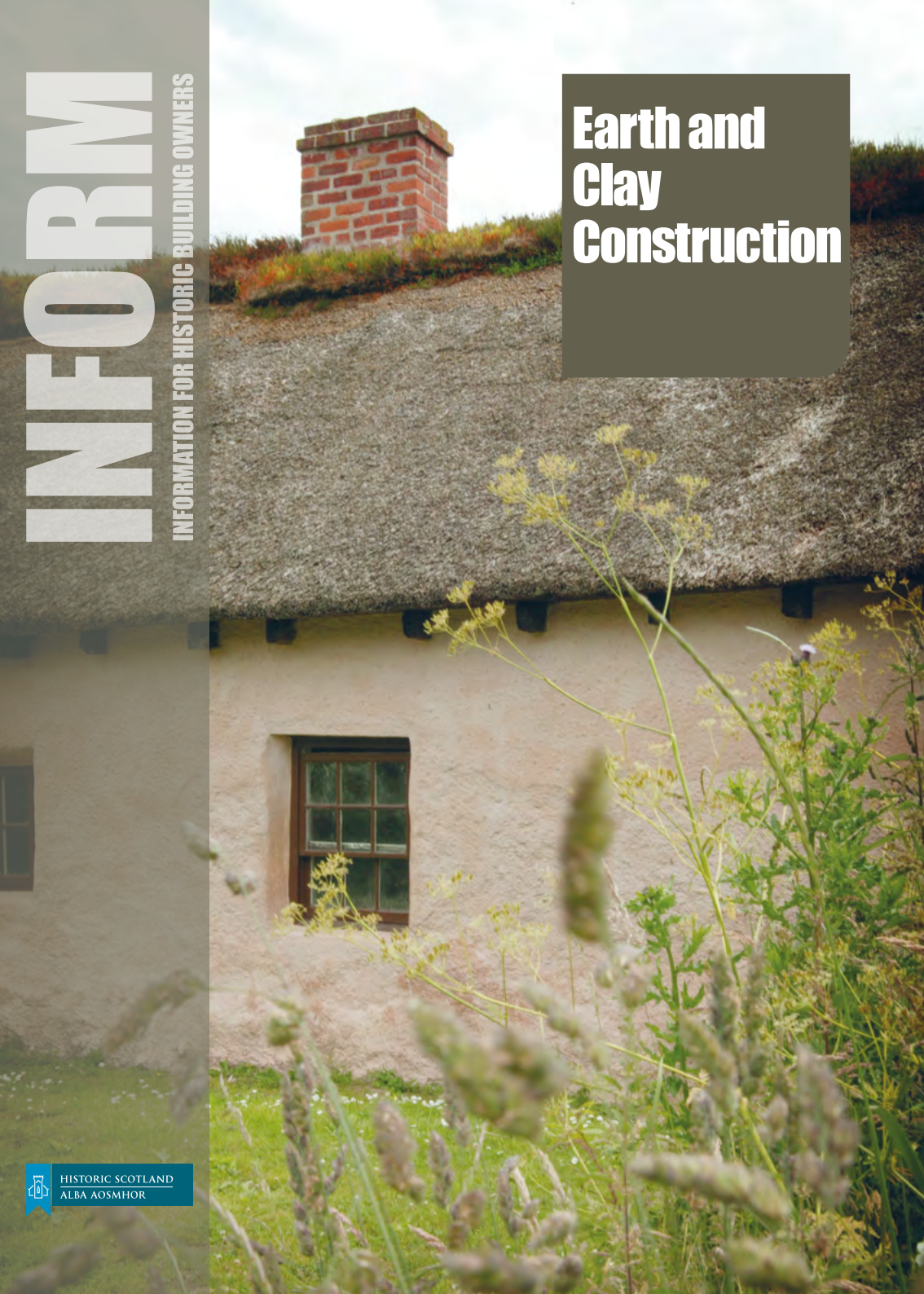
INFORM

INFORMATION FOR HISTORIC BUILDING OWNERS

Earth and Clay Construction



HISTORIC SCOTLAND
ALBA AOSMHOR

Introduction

This INFORM provides guidance on recognising common forms of earth and clay construction and their repair and maintenance. The use of clay and earth as a bedding mortar for masonry is covered in a separate INFORM *Clay Mortars for Masonry Buildings.*

The use of clay and earth based materials to construct walls was once a common practice in Scottish traditional building. Whilst the use of stone and brick generally superseded the use of these materials from the mid 19th century, there are significant concentrations of surviving examples in parts of the country such as Perthshire, Angus and the South West of Scotland. Vernacular techniques such as mudwall, claywall and clay and bool construction can all still be found in surviving structures.

Types of earth and clay construction

There are several types of earth construction found in Scotland, these include:

Mudwall: Formed of earth mixed with straw. This type of construction was built in "lifts", or courses, of between 15 and 55 cm depending on the material properties (Fig. 1). Mudwall is commonly known as cob in other parts of Britain.

Clay and bool: A variation of mudwall construction where rounded stones of a type unsuitable for other forms of building are set in courses between the earth material (Fig. 2).

Claywall: This involves the insertion of stones into a mudwall mixture formed between shuttering. The best stones were used on the outside face to present an impression of clay mortared masonry.

Turf: Occasionally referred to as sod, turf construction entails using earth blocks to form walls either on its own or alternating with stone. Turf is commonly laid in a herringbone pattern for added strength (Fig. 3).

Shuttered clay: A form of construction which utilises similar raw materials to mudwall, clay or earth mixed with straw, but in this case it is formed inside a shuttering of wood. In some cases brick was used to make a permanent face to hold in the clay or earth infill.

Other forms: Clay was widely used in combination with timber framing to form 'wattle and daub' and other kinds of thin walls. It was also used to make plasters and, mixed with straw, was used as deafening in timber floors.

Fig. 1 *Mudwall built up in short lifts, Dumfriesshire.*

Fig. 2 *Clay and bool construction.*

Fig. 3 *Turf was commonly laid in a herringbone pattern for added strength.*

Fig. 4 *Earth construction revealed following loss of the cement render.*

Identifying clay and earth construction

Most earth construction has been subsequently rendered, and identification is not always obvious. In some instances the use of such materials will be revealed where render has failed and become detached from a building (Fig. 4). Other features which can indicate the presence of earth construction are a rubble stone base course at the foot of a wall or a pronounced batter (slope) to the wall. Where earth based building materials are found it is important to correctly identify the construction type and the composition of the wall to properly plan repairs. Specialist material analysis and consultation may be necessary to aid this process.

Clay and earth materials

The composition of clay and earth materials varies considerably, largely reflecting local subsoil conditions. The subsoil composition includes differing ratios of clays and aggregates such as sands, gravels and silts. Clay based materials will generally be naturally plastic in character when moist, and free of organic matter, unless this is deliberately added. Turf materials will have organic matter, as they come from topsoil.

Additives normally take the form of chopped straw, although depending on the area of the country other plant types may be used (Fig. 5). Animal hair was sometimes added to clay and earth mixes for internal plasters.

Fig. 5 *Hand mixing of earth building material containing plant fibres.*

The addition of vegetable fibre or hair provides tensile strength to clay rich materials and reduces problems of shrinkage during drying. Dung and a wide range of other additives were also used to alter the working properties of earth materials. Should any material of this sort be found in an original mix it should be included in the repair material.

There are many regional and local variations in the earth and clays used in construction. It is important to ensure that any repair material used is compatible with the original fabric of the building. This should include any aggregates, fibrous re-enforcement such as straw or hair and the clay or earth which binds the whole together.

It is possible to analyse samples of clay and earth building materials to gauge the type of material used and anything which has been added to the mix.

During the original construction earth building materials would likely have been sourced close to the construction site. It may be possible to do this during repair work but all materials proposed for use should be analysed first to ensure suitability. Test panels may assist in confirming this. With the increase in popularity of sustainable building techniques, there are a number of suppliers who stock earth based building materials and where no local sources can be identified replacement materials may be sourced from them.

It is important to source materials that are appropriate for repairs to any earth built structure, and a number of facilities offer testing and analysis of original materials. The specification of repair materials may differ significantly from the original material in response to the technical requirements of individual structures, and specialist advice from consultants and contractors with experience of earth materials should be sought for anything other than a simple like-for-like repair.

Once an appropriate specification has been established, sourcing new materials can be challenging. Commercially available materials can be cost-effective and appropriate for many projects, but locally sourced, job-specific materials will usually be more compatible with the original fabric and may achieve a higher quality of conservation repair. Time should be allowed in a repairs programme for sourcing of such materials well in advance of the actual repairs.

Lime harling and plaster

To give protection to the finished structure, external elevations of clay and earth masonry were often finished using a thin lime harl or limewash. Where this exists it may be appropriate to reinstate the lime finish after repairs to the earth masonry have taken place (Fig. 6). Sufficient time should be allowed for the earth material to dry before the lime harling is applied. Cement harling should never be applied to a clay or earth building; where it is found it is usually appropriate during repair work to remove this and replace it with a lime based alternative. Cement based renders, being largely impermeable and inflexible, are liable to crack and allow moisture to penetrate behind the render but then prevent this moisture from evaporating. The long term effects of this can be a loss of cohesion of earth based materials and subsequent decay and damage.

Fig. 6 *This clay building has been lime harled to protect against the weather.*

Fig. 7 *Water ingress through the roof can cause significant damage.*

Fig. 8 *A clay gable with stone base course.*

Maintaining earth structures

For clay or earth structures, as with any building, water should be prevented from entering the fabric to avoid damage (Fig. 7). It is therefore important that the roof is kept in good condition and all rainwater goods are maintained free of blockages. Earth structures were almost always constructed on a plinth of stonework to minimise dampness rising from the ground and to protect the clay from splash back (Fig. 8); this should always be maintained when earth structures are being repaired.

Where this is not the case and it is considered that dampness from ground level is causing decay at the base of a wall, retrofitting a damp proof course should be avoided as it can act as a barrier and concentrate moisture in the base of the wall. The management of excess moisture around the wall, for example using a French drain, is more likely to be effective. Where earth construction has been coated in lime harling and/or limewash, such a finish should be maintained in line with guidance for these materials.

Likewise, internal finishes should be moisture permeable lime or clay plasters. Finally, it is important to ensure that the site on which an earth structure sits is kept well drained.

Pests such as mice and rats can present difficulties to earth structures although this is usually only the case where decay is already present and they are attracted by a food source.

Vegetation should be removed as it can quickly establish itself and cause damage. Likewise vegetation should be kept away from the immediate vicinity of such buildings as root systems can penetrate walls or destabilise the base course on which they are built.

Repairing earth buildings

Prior to any repairs being executed a detailed survey of the building and its surroundings should be carried out. This should take note of problems with ground drainage, defects in roof structure and roof drainage (gutters and downpipes), the nature and composition of external coatings, and the form and materials used in the construction. It should also be recognised where an original thatch roof has been replaced with a slate roof, perhaps giving less protection from rain.

If decay has occurred to the base course of the wall repairs should be carried out to ensure the earth wall does not deform. Re-bedding masonry with a clay or lime mortar is likely to be the most appropriate method of repairing damaged base courses. A further problem facing stone plinth courses is the gradual build-up of soil leading to external ground levels becoming higher than the masonry. This can have the effect of moisture penetrating into earth based materials by passing above the original stone base course. Where this has occurred ground levels should be lowered to below the level of the original base course and the base course repaired or repointed as appropriate.

Where sections of earth walling require to be replaced this should be carried out using materials and methods which match those used originally as far as possible. Earth block repairs can be a good solution in instances where it is not feasible to replicate the original techniques (Fig. 9). Patch repairs of earth structures using cement based renders is likely only to exacerbate problems by driving moisture into adjacent sections of the building.

Fig. 9 *Earth block repairs can be an appropriate solution where it is not possible to replicate original methods of construction.*

When repairs are being patched into an earth building, the existing work will normally be drier than the repair. This means that the dry wall is likely to suck moisture out of the new work or render and it is common practice to dampen down the wall onto which the repair will be bonding. Patched repairs can also be vulnerable to shrinkage when used in large areas. Therefore large areas of work should be done in vertical layers or 'lifts' (see Fig. 1). The aftercare of earth based building materials will depend on local conditions; in wet weather it will require to be protected from excessive rain until it has hardened. Conversely, in very dry conditions it may be necessary to cover the work with a tarpaulin or dampened hessian to prevent drying occurring too quickly.

Conclusion

Until relatively recently the use of earth and clay in construction was common practice in Scottish traditional construction. A significant number of historic and traditionally built structures still survive; however identification is not always obvious as most examples were subsequently rendered with lime harling or limewash. When maintained using the correct skills and materials such structures can prove durable and effective. To achieve this, it may be necessary to seek specialist material analysis and consultation.

Contacts and Further Reading

Historic Scotland Conservation (technical advice)
T: 0131 668 8668
E: hs.conservationgroup@scotland.gsi.gov.uk
W: www.historic-scotland.gov.uk/conservation

Earth Building UK (EBUK) (information, advice and contacts)
W: www.ebuk.uk.com

The Society for the Protection of Ancient Buildings (SPAB) (advice and information on older buildings)
W: www.spab.org.uk

Houben H. and Guillard H., 'Earth Construction: A Comprehensive Guide', Intermediate Technology (1994)

Morton T., 'Earth Masonry Design and Construction', BRE (2008)

Norton J., 'Building with Earth: A Handbook', Intermediate Technology (1986)

Practical Building Conservation Series: Earth, Brick and Terracotta, English Heritage (2014)

Walker B. and McGregor C., 'Earth Structures and Construction in Scotland', Historic Scotland (1996)

Walker B., 'Scottish Turf Construction', Historic Scotland (2006)

Historic 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 **hs.cgpublications@scotland.gsi.gov.uk** for these or any other publication enquiries.

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