INFORM

STRUCTURAL CRACKS

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Fig. 1: A typical crack in a traditional stone wall.

STRUCTURAL CRACKS

This INFORM guide offers an introduction on how to recognise and diagnose various types of structural cracks that can be found in traditionally constructed buildings and what might be causing them. Understanding the variety of cracks which can appear can also help assist in determining where there is either no need for concern, or where a more serious problem is emerging which may require professional guidance and support to resolve.

Why cracks happen

The fabric of traditionally constructed buildings is always moving; in most cases, the extent of this movement is small and has little effect. These buildings are built in a way which can tolerate slight structural movements and expansions or contractions in building fabric, e.g. due to thermal movement or as buildings settle following construction (Fig. 1). For example, timber lintels were widely used to allow absorption of slight movement following construction; stone might have fractured.

Sometimes, cracks will appear on masonry walls. Whilst the majority of them are generally superficial, it is important to recognise that they are an indicator of a possible problem and not the problem itself. In some cases, their presence may indicate a problem emerging within the structure of a building or the ground on which it is built. Water disposal has a big part to play in this; most foundations are satisfactory but will be degraded by excess water and loss of mortar in the footings. When conducting routine inspection and maintenance of a traditional building, it is, therefore, necessary to understand the types of cracks which can emerge within masonry and why they happen.

Cracks are effectively a mechanism for releasing stress which has built up within a structure and they will naturally exploit inherent weaknesses in a building's design or construction. This is sometimes seen in cracks running from the corners of window and door openings, and in fractures in associated lintels above these openings.

Structural cracks can be caused by a variety of problems, which can include broken drains and rainwater goods, waterpipes and the consequent loss of bearing capability of the ground, decayed internal structural timber, subsidence or shrinkage within soil, tree roots, unstable walls adjacent to a building and washed out or damaged foundations.

Size of cracks

The width of a crack is generally used as the primary indicator of its severity. Cracks can be categorised into five groupings:

Fig. 2: A hairline crack on a rendered wall.

Fig. 3: A thin crack on a window cill.

1. Negligible (Fig. 2). It can be generally assumed that hairline cracks with a dimension of less than a millimetre in width are of little concern, apart from the visual effects. Redecoration may be all that is required.
2. Slight (Fig. 3). Over a period of time, if the structural movement has stopped, stabilised cracks that are between 1mm and 5mm in width can normally be dealt with through filling the open voids and carrying out redecoration on the interior and repointing the affected area on the exterior of the building.
3. Moderate (Fig. 4). Extending in a range of between 5mm and 15mm in width, moderate cracks will generally require some construction work to remedy. The related circumstances could also require the involvement of a professional to establish the cause of the cracks and to help identify the associated remedial work that needs to be carried out. In this width range, associated problems are also likely to emerge requiring localised replacement of fractured building fabric such as window sills, door lintels, etc. Work may also be required to remedy any associated concerns regarding the weather tightness of the building. This may have been compromised through disturbance to roof coverings or rainwater goods as a result of structural movement.

Fig 4: A medium sized crack on a stone wall. This will need remedial work.

4. Severe (Fig. 5). Cracks extending in width up to 25mm usually indicate that extensive structural repair works will be required. Cracks of this dimension can also be accompanied by a variety of lesser cracks and may involve the

Fig. 5: A severe crack, requiring professional advice and stabilisation.

Fig. 6: Very severe structural movement, requiring temporary support work.

replacement of affected sections of the building. Professional advice should always be sought on the cause of the failures and the extent of remedial work required. The installation of interim temporary support scaffolding or propping may be necessary until the remedial works are carried out.

5. Very severe (Fig. 6). Cracks in excess of 25mm in width will generally indicate very severe structural damage. This will normally require major repair works that could well involve the partial or complete rebuilding of the affected area. Structural underpinning may also be necessary due to the danger of associated collapse and instability. Obtaining early professional advice will be essential in addressing the associated issues. The installation of interim temporary support work will most likely be necessary until the remedial works are carried out.

The shape of cracks

In addition to considering the dimension of cracks, their shape and profile can give a strong indication as to what has caused them to occur.

Fine hairline cracks running across the face of a wall could indicate that a degree of shrinkage or settlement has occurred in the fabric (Fig. 7). As most pre-1919 buildings use lime mortar, the structure can readily accommodate such fine defects without undue concern. Indeed, hairline cracks may be seasonally driven, appearing and disappearing dependent on the prevailing conditions. Modern cement-based renders are more prone to cracking as they have less flexibility than lime-based wall coverings.

Fig. 7: A fine hairline crack on a rendered façade, possibly caused by normal seasonal expansion and compression of the building materials

Fig. 8: A stepped crack running diagonally.

Fig. 9: A vertical crack running through both, mortar joints and stones.

A diagonally running stepped crack, with the appearance likened to that of a stair when viewed edge on (Fig. 8), can indicate that structural settlement is happening. This could be due to upheaval at foundation level or some other form of slippage. Usually starting off as a hairline, this pattern of crack tents to follow the alignments of the horizontal beds and vertical joints in the built structure. If settlement continues, the crack can consequently grow in width and individual stones or bricks can become loose and dislodged. The advice of a professional should be sought at an early stage.

Vertical, or near vertical, cracks can also be a sign of serious structural problems (Fig. 9). If the cracks are wide at the top and tight at the bottom this can mean that one or both ends of the building foundation are dropping, or that the middle of the foundation is rising. Vertical cracks also usually mean that the stresses have been sufficiently severe to crack individual stones or bricks in the wall, making the broken pieces also unsafe. If the cracks are wider at the bottom and tighter at the top, then the opposite effects could be occurring.

Parallel sets of vertical or near vertical cracks can display variations of these symptoms which indicate complex foundational movements are taking place. Again, professional advice should be sought at an early stage in the discovery of this form of movement, and temporary support work may be required.

Retaining walls are often under additional pressure from the material held back. Excessive moisture held back by harder modern mortars can exacerbate the issues by making the earth less stable. In Figure 10, the pressure is showing by distorting the masonry outwards along the mortar beds. In this case, consideration should be given to removal of the render coat, repointing, and the provision of weep holes at the base of the wall.

In some buildings, it is common to see settlement of corners, particularly gable ends where leeching of mortar has occurred on the quoins. In addition, corners can settle if the foundations are wet and the surrounding soil has become softer or has been washed out (Fig 11).

Fig. 10: Cracks indicating outward pressure at the foot of the retaining wall, probably due to moisture retention behind the cement render.

Fig. 11: Cracks due to softer ground on a damp corner.

Monitoring cracks

As most cracks develop slowly, it is often good practice to set up a monitoring regime to check for further movement. Basic do-it-yourself methods of monitoring may be useful but are unlikely to be accurate enough to give detailed results when compared to the more professional options, which a structural engineer or surveyor will put in place. This can be achieved with proprietary "tell-tales" (Fig. 12) or the taking and recording of regular micrometer readings across the crack (Fig. 13).

Conclusion

Most cracks in traditional buildings are of the hairline variety, requiring only cosmetic redecoration treatments to remedy. However, any complexity in the shape, orientation and continuous movement indicates that the problem is progressive and may lead to failure. In such circumstances, a holistic approach to surveying and analysing the problem should be adopted so that all associated factors can be considered when determining the appropriate remedial action.

Fig. 12: A tell-tale installed over a crack.

Fig. 13: Using a micrometer to monitor a crack.

Further reading

Why Do Buildings Crack?, R. Sadgrove, BRE Press (2014).

Cracking and Building Movement - Book and CD ROM, P. Dickinson & N. Thomson, RICS (2004).

Has your house got cracks, T. J. Freeman, R. M. C. Driscoll & G. S. Littlejohn, ICE/BRE (2002).

Cracks Caused By Foundation Movement, BRE Press (1996).

Structural Movement: is it really a problem?, C. Richardson, The Building Conservation Directory (1996). www.buildingconservation.com

Further information

HES Technical advice
T: 0131 668 8951
E: technicalresearch@hes.scot

HES Casework and designations
T: 0131 668 8716
E: hmenquiries@hes.scot

HES Grants
T: 0131 668 8801
E: grants@hes.scot

THE ENGINE SHED
AN SEADA EINNSEIN
SCOTLAND'S BUILDING CONSERVATION CENTRE

THE ENGINE SHED

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

HISTORIC ENVIRONMENT SCOTLAND | ÀRAINNEACHD EACHDRAIDHEIL ALBA

Historic Environment Scotland
Scottish Charity No. SC045925

Principal author: Ingval Maxwell
First published: October 2008, revised: April 2020
Historic Environment Scotland, Longmore House
Salisbury Place, Edinburgh EH9 1SH Tel: 0131 668 8600