Alteration and Repair of Brickwork

Structual Guide
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BRICK DEVELOPMENT ASSOCIATION

The Brick Development Association

The Brick Development Association is the national authority on clay bricks and pavers.

The membership accounts for almost 99% of the bricks produced in the UK; the BDA members are commitment to manufacturing products of outstanding quality and developing one of the nation's most productive and sustainable supply chains.

The BDA Guides and Technical Guides are continually updated to take account of the latest materials, systems and products developed in the clay brick and paver sector.

We are grateful to our various team of experts, contributors, staff as well as our membership whose support, we are eternally grateful for.

Keith Aldis

Chief Executive Officer
Brick Development Association

Scope of Document

This is an initial guidance document for the general public and members of the construction profession.

Brickwork alteration and repair can involve a number of solutions, so this document is not intended to be a comprehensive guide, but rather a summary of the key issues and a signpost to further information, if required.

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UK Brick Manufacturers

Bulmer
www.bulmerbrickandtile.co.uk
Sudbury (7)

Forterra
www.forterra.co.uk
Accrington (1), Claughton Manor (13), Cradley (14), Desford (16), Howley Park (24), Kirton (27), Measham (31), Whittlesey (47), Wilnecote (49)

H.G.Matthews
www.hgmatthews.com
Bellingdon (23)

Ibstock
www.ibstockbrick.co.uk
Aldridge & Atlas (2,3), Ashdown (4), Cattybrook (9), Chailey (10), Chesterton (12), Dorket Head (17), Ellistown (18), Eclipse (19), Laybrook (28), Lodge Lane (29), Parkhouse (34), Ravenhead (36), South Holmwood (39), Swanage (41), Throckley (42), Union (44)

Ketley
www.ketley-brick.co.uk
Brierley Hill (25)

Matclad
www.matclad.co.uk
Wrecham (30)

Michelmersh
www.mbhplc.co.uk
Michelmersh (32), Blockleys (6), Charnwood (11), Carlton (8), Freshfield (21)

Northcot
www.northcotbrick.co.uk
Blockley (33)

Raeburn
www.raeburnbrick.co.uk
Blantyne (35)

Sussex Handmade Brick
www.sussexhandmadebrick.co.uk
Sussex Handmade Brick (40)

W.H Collier
www.whcollier.co.uk
Marks Tey (48)

Wienerberger
www.wienerberger.co.uk
Denton (15), Ewhurst (20), Hartlebury (22), Kingsbury (26), Sandown (37), Smeed Dean (38), Todhills (43), Waresley (45), Warnham (46)

York Handmade
www.yorkhandmade.co.uk
Alne (50)

Contents

Introduction

Much old brickwork, where it has been properly detailed and soundly built, will need virtually no maintenance over long periods of its life. It is inevitable however, that the rehabilitation and restoration of older properties will often involve repairs to or adaptations of brickwork. Around 20% of the UK housing stock is more than 100 years old and the vast majority of this old stock is constructed from bricks. Achieving the 2050 Net Zero carbon target will require an unprecedented refurbishment of the existing housing stock so a thorough understanding of the alteration and repair of brickwork is important.

If such work is to be carried out without adversely affecting the architectural character or stability, then it is necessary for architects, engineers, and builders to have a sympathetic understanding of the qualities which make much old brickwork so attractive, to know the reasons why deterioration takes place and to have some knowledge of what can and cannot be attempted in its maintenance, repair, and alteration.

For repair or alteration, it is essential that the work should be considered in the proper sequence. The first step must be to assess by means of a detailed survey whether the structure is stable and to identify defects; the reasons for any defects found must then be established. The main causes of defects will be found to arise from foundations, overloading, and the presence of unwanted water.

Finally, when the problems have been analysed, decisions must be taken on the appropriate remedial measures needed. Only after these stages have been considered, can attention be given to the finished appearance of the brickwork.

Shrewsbury Flaxmill Maltings - Built 1797. Historic England.

Surveying Existing Brickwork

Survey

It is essential to make a detailed survey of a building before attempting to carry out any work on it. Where extensive repairs are likely to be required, the importance of carrying out this survey thoroughly cannot be too strongly emphasised. Only with detailed knowledge of its form, structure and history is it possible to determine with any degree of certainty what is happening to the building and why; or indeed what can be done to it in the way of repair, alterations and additions. The survey is best carried out in two parts.

1. Preparation of drawings

An accurate and detailed survey of the building must be prepared. Historically this would have been a complex process but drones and 3D laser surveys have made the process much quicker and more accurate. The finished model or drawings should show the construction, both original and as existing, additions and possible subtractions (e.g., partitions), structural and non-structural members and elements, and internal and external finishes. These drawings must be based on accurate information. The drawings will be found invaluable for the second part.

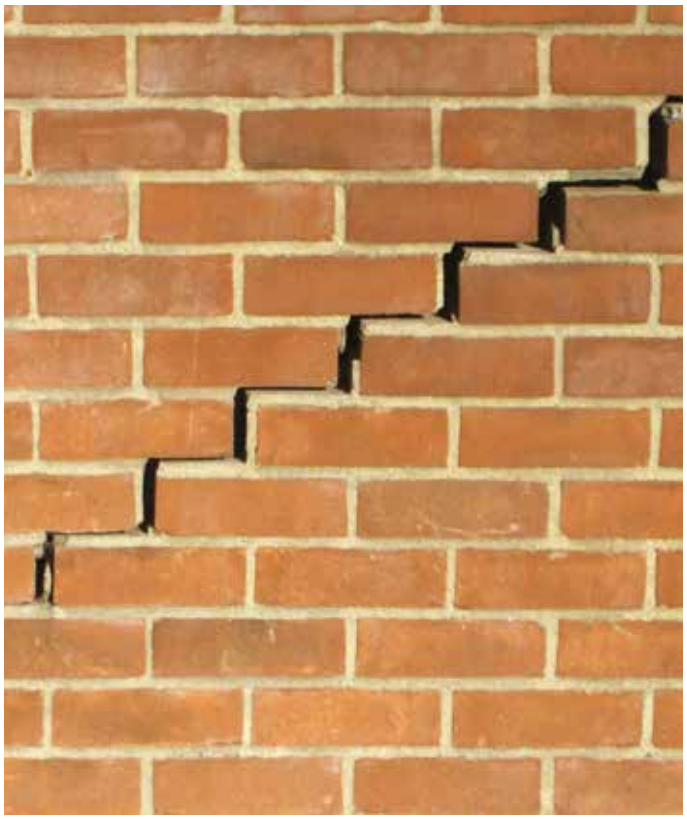
2. Structural and dilapidations survey

The structural and dilapidations survey is an inspection to locate signs of distress in the structure, dampness, vegetation growth and the general condition of the building and its surroundings. This part of the survey should include, if necessary, the application of 'tell-tales' where relative movement of parts of the structure has taken place or might be taking place. 'Tell-tales' in the form of pins rather than strips are preferable as their relative position can be accurately measured to monitor movements.

Establishing Priorities

The survey of the building and its condition should be accompanied by an assessment of the priorities of action required. Clearly, if structural collapse seems to be imminent, then urgent consideration must first be given to what action is needed to prevent it, either through temporary propping or other appropriate means. It should be followed by the eradication of any dry rot found, coupled with measures to eliminate the conditions which gave rise to it. Permanent repairs to failures in the structure will then follow.

The subject of failures in walls has been dealt with at length in a number of publications. The repair section is, therefore, a summary of the types of failure which are commonly found and detail for how such failures can be remedied.



Alteration of Brickwork

Major Structural Alterations

When an old building is rehabilitated, it often also must be adapted for a new use. This will usually require structural alterations, the new use may require walls and floors to carry greater loads than those for which they were built. This will need to be balanced against ensuring that the character and style of the building are not adversely affected.

Major alterations to the structure, such as the removal of load bearing walls, may lead to the redistribution of loading on other walls so it is important that the design is completed by a competent person. The removal of internal cross walls may lead to the instability of the external walls to which they were tied. A check must therefore be made to ensure that the structure is strong enough to bear the changes, or that it can be suitably strengthened.

If the wall is internal, reconstruction is probably the simplest solution, but if this is not acceptable, piers or a new loadbearing brick wall built alongside the existing one, or the transference of the excess load onto an independent structural frame, may have to be considered.

It should be borne in mind that this process will involve new foundations, which in turn may affect existing foundations. Also, the effects of such measures on the interior appearance of the building must always be carefully considered. External brick walls may present greater problems.

It is sometimes possible to strengthen existing brickwork with a new independent inner leaf, or piers, but where this is not possible careful reconstruction may be inevitable. In such cases, the existing bricks can be salvaged for reuse, but it is important that they are rebuilt in a similar location to ensure that the brick durability is suitable.

Alsop Fields, Cartwright Pickard Architects Ltd.

Alsop Fields, Sheffield. Mixed use development.

Thermal upgrades with bronze aluminium cladding.

Alteration of Brickwork

Openings

Increases in the width of existing openings or the formation of new openings will also call for careful thought to be given to the effects on the adjoining structure. Since the tendency will be to concentrate loading on smaller areas of the wall, some form of strengthening may be necessary.

A particular instance is in the formation of openings through party walls, where horizontal conversion of terrace houses is undertaken. Party walls in older properties are often poorly constructed and are subject to damage from differential settlement and other causes. Where the opening will be near a wall junction or chimney breast, the lintel over the new opening should be lengthened to form a tie into the cross walls or chimney breast to give stability, but the provision of a similar tie in the threshold of the new opening may also be needed.

Careful assessment is needed prior to removal

A new opening formed in an existing wall

Chimney Breasts and Stacks

The removal of chimney breasts to increase the area of available floor space is sometimes suggested but should only be considered if it is acceptable structurally. Often the heavy mass of brickwork is providing structural stability to the building, and its removal may weaken the structure.

The removal of chimney stacks at or below roof level is also frequently advocated. Due to the exposed position, brickwork at this level is usually in worse condition than elsewhere, perhaps even needing complete reconstruction. However, the removal of chimney stacks can have a big impact on the appearance, particularly for terrace houses.

The capping of flues and the sealing up of fireplaces has also been common practice. If ventilation of the flue is not sufficient, it can be harmful due to condensation within the flue. Where capping has been completed, ventilation of some form (Air brick) should be utilised, preferably at high level in the chimney breast above the sealed-up fireplace, and near the top of the chimney stack. If the stacks are prominent decorative elements in the design, air bricks may be unacceptable, or impracticable, and alternatives such as capping with ridge tiles can be considered.

Appearance of Brickwork

Demolition and Extensions

If demolition of later extensions to a building is required, it should be carried out with care. The effects on the remaining structure must be assessed, ensuring that its stability will not be impaired, and the materials of the parts to be removed should be carefully examined to see whether they would be suitable for re-use in the repair and restoration of the remaining parts.

The effects of extensions on the existing structure should also be carefully assessed. Including whether or how they are to be tied into the existing brickwork, what effect they will have on sub-soil conditions and foundations, and whether they will set up any direct or indirect stresses in the existing building. The use of wall starters is suggested to bond any new extension, this will help to adequately bond the structures existing forces to the new build by transferring and sharing the loads between the two structures.

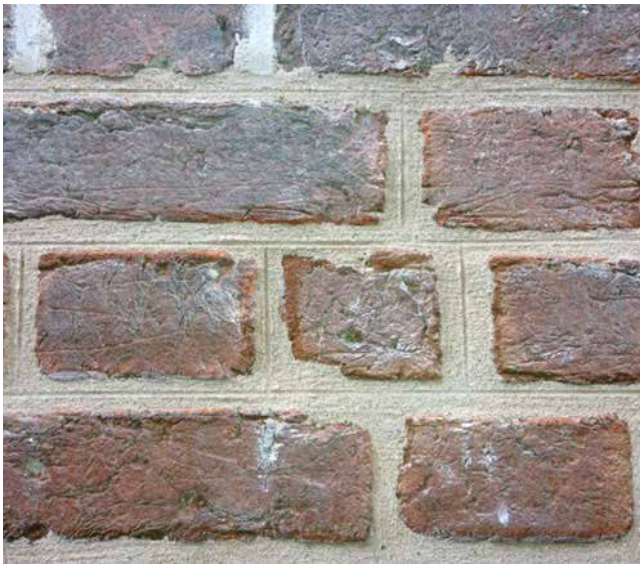
Pointing

Pointing

The importance of the treatment of the joints in old brickwork cannot be over-emphasised. Frequently a fine old brick wall which is otherwise in good condition is defaced by poor quality pointing, which is of the wrong material, the wrong colour and applied without regard for the need to match the original brickwork.

If the original finish to the joints still exists, and it is hard and sound, then nothing need be done to it except possibly to clean it down. If the original finish is in poor condition, soft and irregular, or if there is later pointing which is failing, then repointing will be necessary.

Tuck Pointing



Jointed Flush Pointing

Weather Struck Jointing

Appearance of Brickwork

Types of Joint

The finish given to joints has varied greatly with the development of bricks as a structural and decorative material. It is not possible here to do more than summarise the principal types which may be met.

(a) Flat or flush joints

These are formed by pressing the mortar flat into the joint with the back of the trowel while building. Common on older brickwork, but not the most robust profile.

(b) Flat joints jointed

These are sometimes called jointed joints and are formed by drawing an iron tool called a jointer, or the edge of a trowel along the centre of a flat joint, using a straight edge, to give an increased appearance of uniformity to the work.

(c) Bucket handle joints

These are formed with a shallow, curved depression and can be smooth or rubbed to create a textured finish. The compression creates a robust weather tightness.

(d) Weather struck and cut joints

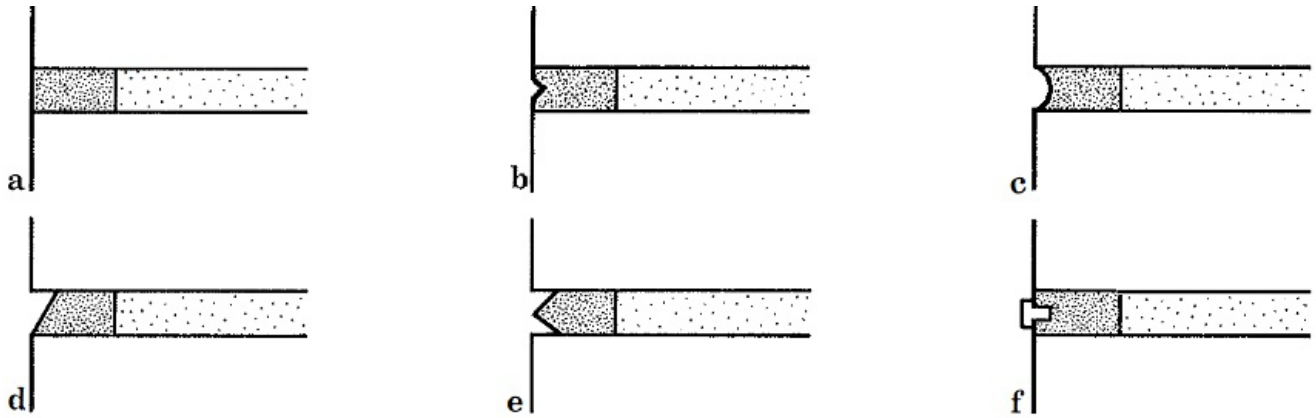
This is usually formed with the face sloping slightly inwards from the bottom of the bed joints to prevent water lodging on the lower edge of the joints. In much old work, it will be found as 'overhand struck jointing' in which the slope of the joint is reversed.

(e) Weather or V joints

These were much used by stonemasons, but are sometimes seen in brickwork; also, sometimes known as 'beaked' joints.

(f) Tuck pointing

This was used where an effect of fine accurate brickwork was required even though the base may have been rough and shoddy. It was generally used for old work and consisted of thin lines of pure white lime putty, set in grooves cut in the mortar of the brick joints; the latter was coloured to match the bricks, and finished flush.



Appearance of Brickwork

Specification of pointing

Pointing old brickwork is a skilled job, requiring knowledge of the materials used, experience, patience and a sympathetic approach to the work. The correct specification of the work is most important.

(a) Raking out

Old mortar in the joints must be raked out as far as possible, preferably to a depth of 15mm to give an adequate key for new pointing. However, care must be taken over this as the raking out must be square and not pointed, and it is easy to damage the arrises of the bricks if some of the old mortar is hard and still adhering strongly to them.

If the brickwork is already in a worn and irregular state, then it may be necessary to rake back more than 15mm so that the face of the new pointing can be kept slightly back from the face of the bricks, and thus prevent mortar from spreading over the bricks themselves. The mortar must be pressed well home into the joints to ensure maximum penetration, but at the same time always kept well within the confines of the joint.

Raking out mortar joints

Repointing with lime mortar

(b) Materials of mortar

The type of sand used in old mortar was very variable, but on the whole it tended to be sharper and contained more coarse particles than is generally the practice today. Bone ash, coal ash and crushed brick or tile was sometimes added to the sand, as colouring matter.

Up to the middle of the 19th century, mortar was generally based solely on lime and sand, and the naturally lighter, brighter colour this produced is difficult to match in modern materials.

The simplest course now is to use white cement, but this produces an exaggerated effect, and the use of light coloured, but not yellow, sand, lime and the minimum amount of cement consistent with the need to obtain reasonable strength and hardness gives a more satisfactory appearance. The mix to be used will depend on the type of bricks, the position of the brickwork and the season in which the work is being carried out but should be no stronger than the existing mortar and generally not stronger than 1:1:6.

Coloured mortars are sometimes found to have been used in old brickwork. For instance, in some 19th-century Gothic or Tudor Revival buildings black mortar, made with ash, was used for pointing to contrast with rather bright red bricks. It is important in repointing to match the original closely and this can be achieved by the use of proprietary colour additives in the mortar.

Appearance of Brickwork

(C) Choice of joint

The type of joint to be used will depend on:

(i) Whether the original joint finish survives or is known.

(ii) The present condition of the bricks, and

(iii) The skill available to carry out the work.

If these conditions are favourable, then the original joint finish should be followed; if they are unfavourable, then it will probably be best to use a keyed (recessed) joint, with a roughened finish. The depth of the recess will depend on the degree of irregularity of the bricks, and the capability of the bricklayer. A possible alternative is a weather (V or beaked) joint, which has much the same effect of keeping the mortar away from the surface of the bricks.

Matching the Brickwork

With so many types of brick and brickwork to be found in every part of the British Isles, matching can present difficulties. Often the bricks will have been made locally, perhaps out of material dug on the site of the building and will therefore be unique. In some areas, particular sources may have been popular with builders and architects at particular times: for instance, the so-called 'grey stocks', made in parts of Kent, which were favoured in the late 17th and early 18th centuries: the yellowish-white 'gaults' from East Anglia which were popular with architects in the south of England in the late 18th century; and the 'blue' headers which are a common feature of 18th and 19th century building in Sussex and parts of Kent and Hampshire.

Although it is still possible to find new bricks which provide a tolerable match for most of the commoner bricks used, it will almost certainly require time and patience to track them down. The original bricks used may also prove to be of slightly different dimensions to the more standardised modern bricks.

This may create problems in obtaining the correct bond and coursing for the new brickwork, and the success will be dependent of the workmanship of the bricklayer. The re-use of bricks from any demolitions which have to be carried out as part of the work, may provide a sufficient source. In fact, where demolition of original brickwork forms part of the work to a building, consideration should always be given to whether the bricks themselves can be salvaged.

Where the mortar is soft, the bricks will probably come apart cleanly and with arrises intact, but the bricks themselves must be in good condition to warrant such action. Where the bricks are sound, but dirty, or spoiled on the external face, it is often possible to turn them round and use the unexposed face in the reconstruction work. Care should be taken to ensure that bricks taken from an internal situation are suitable for re-use externally. If the original location is not known then it should be assumed that the bricks cannot be used in an exposed location.

Appearance of Brickwork

Advice on firms that may be able to help in providing or finding suitable replacements for old bricks may be obtained from the Brick Development Association, The Society for the Protection of Ancient Buildings and the British Brick Society. It will also be found useful to consult local sources, such as local conservation groups and history societies, as well as the conservation officer of the local district council.

Cleaning of Old Brickwork

The desirability of cleaning old brickwork should be considered very carefully before it is undertaken. In some cases, the beauty of the material comes from the depth and richness that age and weathering have given to its colour and to the texture of the surface. Sometimes the weathered and the darkened surface will conceal a multitude of old repairs, which would be unsightly if visible. In such instances, cleaning would be a mistake. Some brickwork, however, was clearly designed to achieve a particular architectural effect, which weathering and dirt may have diminished or spoilt. Here, cleaning can be used to restore the original intention. This is especially the case in urban areas, where a very great impact can be made by the removal of grime.

Several methods of cleaning the surface of old brickwork are available: 'wet' processes are satisfactory, provided that they are carried out on brickwork that is otherwise sound. If possible, only water and light brushing with a bristle (not wire) brush should be used; detergents or weak acid should not be added unless necessary. All points where water can enter the building must be fully sealed up, and there must be a drainage system that can cope with the surface run-off of water.

Dry processes, using an appropriate abrasive material applied with or without a very fine mist of water, require equally careful preparation, in the protection of window and door openings, and other elements not to be cleaned, but eliminate difficulties as regards disposal of waste water. The collection of the abrasive material after use can present problems, however, as it is extremely fine.

The choice of method will depend on the type of brick to be cleaned. While wet processes will not damage the surface of the bricks or joints, they can result in the brickwork becoming saturated, with possible risk of efflorescence. Dry methods are, in theory capable of the fine adjustment needed to remove only the skin of grime, and not the face of the bricks, in practice depend to a great extent on the skill of the operator and may damage the surface texture.

Appearance of Brickwork

Treatment of Ornamental Brickwork

Throughout the history of brickwork, the material has been used ornamentally, to enrich the structure. Plinths, band courses, cornices and other horizontal projections; pilasters, buttresses, piers and other vertical projections; sunk and raised panels, plain or enriched; pediments, architraves, mullions, labels; and surface decoration using coloured bricks. The repair of such work requires skilful handling.

The greatest difficulties are with gauged and rubbed brickwork. Soft bricks, cut to shape and 'rubbed' to a great degree of accuracy were often used for enrichments; they were formed with great precision and laid in lime putty beds with joints rarely exceeding 3mm. In such cases, it is easy to ruin the appearance of the brickwork by attempting to repoint the joints, and it is almost always better to leave the existing work alone. Repairs should only be carried out in the most pressing circumstances, for instance where structural collapse is threatened, or water penetration. In such cases, the rubbed work should be carefully dismantled and rebuilt using the original bricks with lime putty as a jointing medium. Such bricks are soft and raking out joints will damage the arrises, which is vital to the effect of the finished work.

It should be borne in mind that this process will involve new foundations, which in turn may affect existing foundations. Also, the effects of such measures on the interior appearance of the building must always be carefully considered. External brick walls may present greater problems.

It is sometimes possible to strengthen existing brickwork with a new independent inner leaf or piers, but where this is not possible careful reconstruction may be inevitable. In such cases, the existing bricks can be salvaged for reuse, but it is important that they are rebuilt in a similar location to ensure that the brick durability is suitable.

Diaper pattern brickwork

Handmade bricks for restoration work

Repair of Brickwork

Foundation Failure

Foundation failure can come about because of overloading on the foundation structure, differential settlement, or movement of the ground, and produces the characteristic symptoms of leaning, bowing and cracking.

It is often claimed that vibration from heavy traffic causes structural damage, but if a road is properly constructed and the surface is well maintained, this should not be the case. Severe vibrations from heavy road-building equipment, pile driving and demolition work can occasionally cause settlement and fracturing.

The movement resulting from defective foundations gives rise to two main types of failure in brickwork. The walling may lean, or it may crack, or a combination of both may occur. The seriousness of these defects will be an important factor in assessing the amount and nature of the repair work to be undertaken. Other factors are the function of the wall (for example, whether it is load-bearing), whether it is restrained by cross walls, chimney stacks or buttresses, the number and disposition of window and door openings, and the extent to which it is tied in by floors and roofs.

Remedial Work

Although underpinning is commonly thought of as the proper remedy for defective foundations, careful consideration should always be given first to possible alternative remedies.

Failure from overloading

Where overloading is the cause of failure, it may be possible to redistribute the loading more evenly and to relieve the foundations of the excess load.

Differential Settlement

In the case of differential settlement, provided that it is not excessive, and has stopped, remedial measures will usually involve tying the two elements together in an acceptable way. However, where there has been horizontal as well as vertical movement, rebuilding may be required.

Where undermining of the foundations, or soil movement or consolidation is the cause, under-pinning in some form will probably be necessary. It should be used with great discretion this is because the introduction of new 'hard spots' in the foundations may generate fresh distress at the junction with older footings.

Differential settlement.

Repair of Brickwork

Leaning and Bulging Walls

Assessment of Distortion

The effect of marked leaning and bulging of walls will usually be more serious than cracking. It is important therefore, that the extent and degree of distortion should be accurately measured as, when this is related to the thickness of the wall, the overall and storey heights, and its general state of repair, it will provide a useful guide to what treatment will be required.

In general terms, slight distortions of up to say 25mm in a normal storey height would not need attention on structural grounds alone. If the wall is out of plumb by a greater amount than this, then it should be considered as suspect and an investigation carried out to ascertain whether it is still moving and why, the extent to which it is tied in vertically and horizontally and its dimensions and state of repair. The danger point for collapse is reached when the amount of lean in the full height of the wall exceeds one third of the thickness of the wall at the base; in such cases, reconstruction will almost certainly be the only solution.

Remedial Work

Remedial measures which may be considered if the distortion is deemed treatable measures to consider: to tie the wall back with metal rods or straps to the floor or roof members; or to support it externally with buttresses. These are both traditional methods that are are frequently used successfully.

If buttressing is used, it is essential to ensure that the thrust exerted by it; will, act against the lean of the wall; a buttress that is not well-founded and tied in, and settles away from the wall, will not be sufficient.

Bulging brickwork probably due to missing/failed wall ties.

Cracking

Assessment of Cracks

Where brickwork is cracked, a decision will first be needed on whether to repair it or not. The size of the cracks, the type of bricks and the degree of exposure of the wall must be considered in determining the appropriate course of action. For solid brickwork, the two major considerations are whether the cracks are unsightly and whether they would be likely to encourage rain penetration.

The approach to be adopted will be influenced by a number of factors.
(i) The width of the crack: this can vary from a barely visible hairline to a major fracture and will be an important factor in determining treatment. Cracks can be divided into three groups: fine - up to 1.5mm; medium - from 1.5mm to 10mm; and wide above 10mm.

Repair of Brickwork

Assessment of Cracks

(ii) Whether the crack passes (usually diagonally) through the brick joints, leaving the bricks undamaged, or passes through individual bricks as well as the joints (usually in a more or less straight line).

(iii) Whether it is an internal or external wall that has to be repaired.

(iv) In the repair of external walls, the nature of the brick should be considered. If it is dense, and non-porous, there may be a risk of water penetration by capillary action through fine cracks in the brickwork.

(v) The type of mortar used in the wall is also important. Weak lime mortar allows raking out and repointing, while stronger mortar will often make this difficult.

(vi) Whether the crack fluctuates in width with the season, eg through movements resulting from shrinkable clay subsoils or from the effects of the root systems of nearby trees.

Remedial Work

Cutting out and Rebuilding

(i) Fine cracks in dense non-porous brickwork where there is a likelihood of water penetration occurring.

(ii) Medium cracks in brickwork built in strong mortar where the crack follows the joint.

(iii) Medium cracks that pass through the bricks.

(iv) All wide cracks.

Raking Out and Filling

(i) Fine cracks in porous brickwork, although these are best left untreated.

(ii) Medium cracks that pass through the bricks built-in strong mortar where the crack follows the joint.

(iii) All types of cracking in internal walls, except where rebuilding is required in connection with stabilising the structure or for other reasons.

Repair Materials

Where the brickwork on either side of a crack has stopped moving, filling is best done with a mortar not stronger than the existing. Cracks that fluctuate with the season are better not repaired with mortar, but with a mastic that will accommodate movement.

Helifix - cut out bed joint either side of crack

Helifix - insert reinforcement bar

Helifix - inject the mortar and finish joint

Repair of Brickwork

Differential Settlement Cracks

Cracks due to differential settlement also present a special problem, because they result in one side of the fracture moving downwards relative to the other side. Thus one half of a brick that has fractured will usually be lower than the other half. The cracking is often accompanied by considerable distortion of the adjoining brickwork, and movement outwards or inwards. The faces therefore may not be in the same plane and rebuilding will thus be necessary.

As with cracks caused by other forms of foundation failure, remedial measures will often simply require the defective brickwork on either side of the crack to be cut out, and new brickwork inserted to stitch the crack together. Difficulties may occur in getting a satisfactory bond between new and existing brickwork because of the slipping effect of the settlement, and in internal walls recourse will have to be made to 'block' bonding to overcome this. In the case of external walls, this cannot usually be adopted however, special care will need to be taken to avoid emphasising the distortion and damage caused by the settlement by too obvious a repair. It may be necessary to cut out and replace brickwork on either side of the crack to a greater extent than in an internal wall.

Differential settlement moving bricks down and out of plane

Cracked chimney breast requiring stablisation

Cracks in chimneys

Chimney stacks are peculiarly vulnerable to cracking, as they are irregularly built up, and have quite large openings at each floor level; in addition, they are subjected to periods of localised intense heat. Fractures often occur above the fireplace openings due to the failure of arches or lintels, and in the exterior walls of stacks, where they can sometimes be extensive. Unless they are well tied in, they can lean and bow, and the terminal stacks can fail because of severe weather conditions and chemical action.

Remedial Work

Remedial action must start with stabilising the structure by cutting out cracks and stitching across. This will also eliminate fire hazards and the escape of smoke and flue gases into the house if the stack is in use. Defective fireplace arches or lintels must be replaced, and the flues lined if the use is going to be extensive, or anyway for most modern efficient appliances. Lining of old flues is achieved by the use of flexible flue liners; where there are many changes in direction, it will be necessary to cut holes into the flue at least at each floor level to guide the liner into position.

Repair of Brickwork

Cracks in Vaults

Brick vaults are encountered particularly in the cellars of 18th and 19th century buildings. Defects are usually confined to dampness and poor maintenance rather than structural faults, and little is usually required other than cleaning out and repointing the brickwork, except perhaps the removal of any old moisture-retentive finishes, such as limewash or distemper. Occasionally vaults can suffer if heavy traffic overhead has increased loadings above capacity. In such cases, rebuilding or filling-in or grouting are the only solutions.

Grouting Cracks in Thick Walls

Grouting is useful in the repair of cracks in very thick walls: pressure grouting may be possible where the wall is in good condition and the mortar is sound and hard and there is no risk that the high pressures involved will 'burst' the wall, but otherwise, as is more commonly the case, gravity grouting must be used.

The procedure for this is as follows;
(i) All cracks and open joints in both sides of the wall must be raked out and filled with a temporary medium such as clay or quick setting weak mortar. A small drainage hole must be left at the lower end of the cracks.

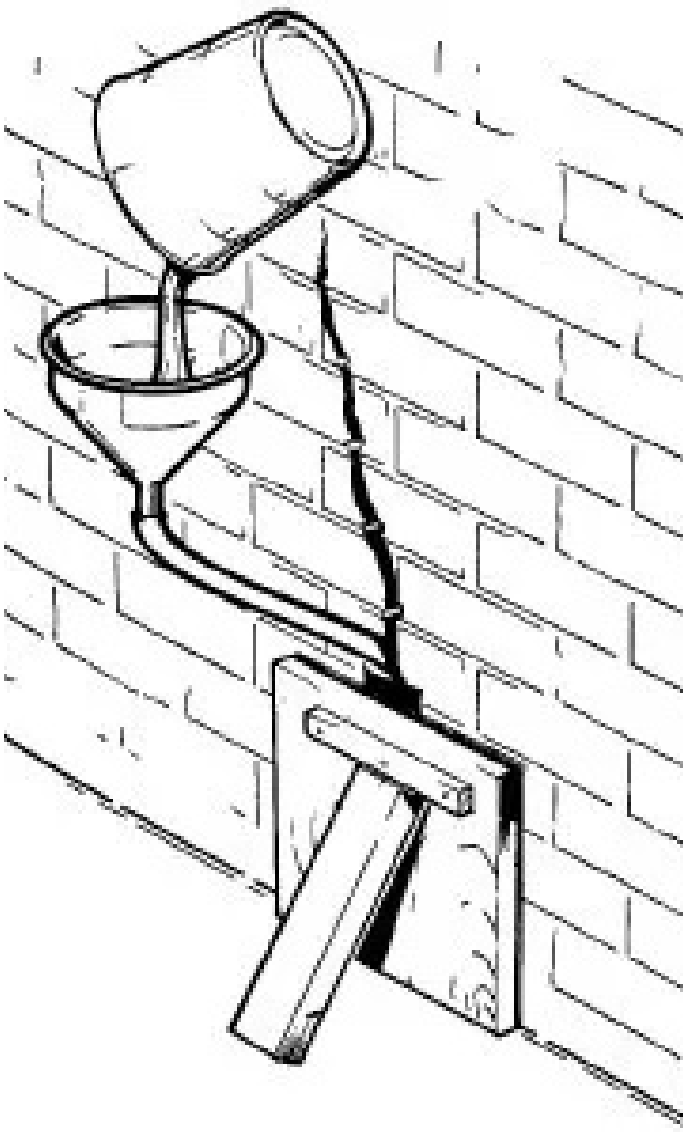
(ii) A satisfactory grouting apparatus can be built up using a large funnel or short length of metal piping with a length of 12mm flexible feed pipe and a nozzle leading from it, which is inserted into the cracks.

(iii) If the crack is a long one (over 1m), the grouting will have to be carried out in 'lifts', usually of not more than 1m at a time, to avoid undue pressure. Access and drainage holes will have to be left at each lift.

(iv) The whole crack is first flushed through with clean water to wet the brickwork for good adhesion and to check that there is no seepage from joints, etc.

(v) Grouting is then commenced, plugging the drainage hole as soon as grout starts to flow out of it. A mix of 1 ½ parts of water to ½ of cement and ½ of sand is generally satisfactory.

(vi) As soon as grouting has been completed and has set, the joints and cracks can be raked out and pointed up.



Grouting cracks in thick walls

Repair of Brickwork

Overloading

How to Assess the Causes of Overloading

Brickwork can present problems when considering design alterations after the initial construction of the walls have been completed. Overloading of structural brickwork can occur as a result. For example, additional storeys are sometimes found to have been added, superimposing a further load on all structural walls, and additional openings for windows, doors or shop fronts are often found to have been formed.

Under such added loading, the original brickwork may well show signs of distress. Leaning or bowing out from the vertical or crushing of softer elements such as plates and bonding timbers into a distorted form, are both indications of overloading, as is the crushing of actual bricks and joints. Bowing in the same direction will usually be visible on both sides of the wall, which will distinguish it from the more localised bulging due to the failure of the bond between the inner and outer skins of brickwork. Excess superimposed loads on floors or roofs can also affect structural brickwork causing similar symptoms of bowing or crushing.

Remedial Work

If movement is still taking place in the structure, it will be necessary to decide whether tying in or rebuilding the wall will be sufficient, or if the excessive loading on the damaged structure will have to be reduced in some way. The latter will involve either the elimination of later additions or alterations causing the distortion or, if this is not practicable, the strengthening of the original structure of the building so that it will carry the extra load or transfer the excess load from the damaged wall onto other walls better able to carry it. Only after this decision has been taken, and the necessary work carried out, will it be practicable to repair the damaged wall itself.

If it can be established beyond doubt that the wall is not still moving, and if it appears to be in otherwise sound condition, and other related factors being unlikely to alter the structural equilibrium, then it is much better to leave the brickwork alone, apart from superficial repairs such as pointing or cleaning.

Failure of Related Parts of a Building

Built-in Timber Members

The most common structural elements concerned in such failures are timber joists, bearers, plates, lintels, stud framing and bond timbers. These are frequently found embedded in or built into brickwork; they are always open to attack from insects and rot, and in some cases, because of the slenderness of the timbers used, are readily overloaded. Decay and failure of timber can have a considerable effect on the walls, drastically reducing or eliminating lateral support, causing distortion, fracturing and occasionally outright collapse.

Fine crack above timber lintel

Repair of Brickwork

Remedial Work

Remedial measures must always include the removal of the rotten timber, treatment to eliminate any rot or insect attack present, and the filling of cavities thus left, either with brick or concrete.

When cutting out rotted timbers, great care is needed to retain lateral support to the wall which will otherwise become unduly slender. This can be assured by removing timber over a short length at a time and filling the cavity before going on to the next section. Alternatively, shoring or bracing can be used. Where the built-in ends of structural members are involved, it will be necessary to cut away rotten ends, and to provide an alternative means of support.

Stabilisation is usually possible this way, without the need for extensive rebuilding, and repairs to the actual brickwork will usually involve either cutting out the fractured or damaged part and stitching across with new brickwork or simply filling and pointing if the damage is slight.

Built-in Iron and Steel Members

The corrosion of iron and steel members embedded in brickwork may well cause fracturing, distorting and loosening of the bricks immediately surrounding the built-in member. The corrosion of ties can also have a considerable effect on the walls.

Remedial Measures

Wherever possible corroded iron or steel should be removed from the wall and the cavities bricked up; if this is not possible the ends of the iron or steel member should be cleaned until they are free from rust and protected by zinc-rich paint or bitumen before the brickwork is rebuilt. Where ties have failed through corrosion and are considered necessary to the safety of the structure, they should be replaced by ties of stainless steel, non-ferrous metal or mild steel galvanised to PD 6697 and in each case, care should be taken to prevent future ingress of water.

Cracks Relating to Arches and Lintels

Assessment of Failure of Arches and Lintels

A type of failure occasionally met with arises from the lack of properly formed abutments to an arch causing it to thrust outwards and produce distortion, cracking or even collapse in the brickwork above it. The same type of problem can arise from the excessive deflection of a lintel over an opening.

Remedial Work

When an arch abutment shows signs of failure it will normally be necessary to reconstruct both arch and abutment. Where the brickwork over a lintel has moved excessively it will be necessary to replace the lintel and rebuild the brickwork.

Rusting steel damaging surrounding brickwork

Repair of Brickwork

Failure in the Bonding or Tying-in of Brickwork

Failure of Facing Leaves

Some old brick walls which appear to be solidly built are deceptive; it was a common practice in the 19th century, where the bond required headers to tie the face back into the main body of the wall, to give the appearance of having achieved this by use of 'snapped' headers, or half bricks. The wall therefore, in fact consisted of two skins, an inner load-bearing one of perhaps 9 ins thickness and an outer one of facing bricks, which was only 4½ ins thick and was tied to the inner skin only very infrequently. In addition, the inner skin was frequently built of whatever bricks were available, and the bonding and coursing tended to be erratic.

As long as external conditions remain unaltered, such walling would not show signs of its weakness, but marked increases in vibration, poor maintenance or structural changes in the building can cause the outer skin to pull away from the inner skin. Symptoms are local bulging in the exterior face of the wall, often adjacent to window reveals, where a gap will open between the window frame and the brick reveal and arch soffit, or between window openings. Such distortions will not be apparent on the inside face of the wall. Often the failure is accompanied by the disintegration of the mortar.

Remedial Work

Remedial measures will be directed towards correcting the lack of bond between the brick skins. In severe cases, this may well mean that the affected parts of the wall will have to be taken down and rebuilt, but where only small areas of brickwork are involved – say up to 1 or 2 square metres – then it may well be possible to rebuild the area of loose facing brickwork only, obtaining a key to the inner skin by the use of metal ties which can be secured into the load-bearing part of the wall, or by cutting out cavities to allow the headers to be secured right back into the inner skin.

Junctions between Structural Walls

The junction between structural walls is another potential source of weakness in a brick building, being dependent for its strength on regular and sufficient bonding. Fracturing at such junctions is a defect commonly met within terrace houses, where the front and back walls are often found to be separated from the party walls. Examination often shows that the external walls have been rebuilt either wholly or partly and that in the rebuilding little attempt has been made to bond adequately into the original brickwork of the party walls. The cracking is usually due to the movement of the external walls and again it must be established whether they are still moving.

Remedial Work

If the crack seems old and no further movement appears to be taking place, then it will probably be enough to cut out the crack and to stitch across it with new brickwork, making sure that there is adequate bonding; the latter can be achieved by block bonding if bonding at every course is not possible. Additional strength can be provided by ties (non-ferrous metal or concrete) set into the brickwork horizontally in chases at about 1m intervals. Such treatment can usually be carried out as internal work; if there is still movement in the external walls however, then rebuilding to some extent may have to be considered.

Repair of Brickwork

Failure of Structural Ties

In many old buildings there are existing ties, rods or straps fixed back on the floor structure, taken through the wall and terminated on the exterior in an iron roundel or a cross made up of two lengths of flat iron. These are usually a clear indication of past trouble and a close inspection should be made of the walling they are restraining, as well as of the structure to which they are fixed. Cracks in the brickwork radiating out from or associated with the roundels or crosses or serious distortion of the floor structure may indicate that movement is still occurring and that further remedial measures will be required.

Cracking around a historic patress plate

Structural tie installation for retaining wall

Thermal and Moisture Movement

Movement in Walls

Brickwork has a tendency to move as its moisture content changes or the temperature rises or falls. Moisture movement is small and unlikely to cause problems in old brickwork. Thermal movement can be of a significant order, but with bricks set in soft lime mortars the movement tends to be absorbed in the joints and is unlikely to cause problems. Occasionally where bricks are set in relatively hard mortars, and the brickwork is able to expand – for instance along a dpc membrane – when the temperature drops and the brickwork contracts, because it is weak in tension there can be a tendency for cracks to form.

Remedial Work

If cracks caused by thermal movement are filled with a solid filler such as mortar, there is a strong likelihood that further progressive movement will take place. It may well therefore be necessary to form movement joints in the walls at not more than 12m centres and to fill them with a compressible filler. The positioning and design of such joints may need careful consideration to ensure that they do not adversely affect the architectural appearance of the brickwork.

Movement in adjacent members

Where brickwork is bonded to other structural members such as concrete roofs, shrinkage or thermal movement of the roof can apply considerable stresses to the brick walls. These stresses can cause cracking around the bearing of the roof.

Repair of Brickwork

Sulfate Attack

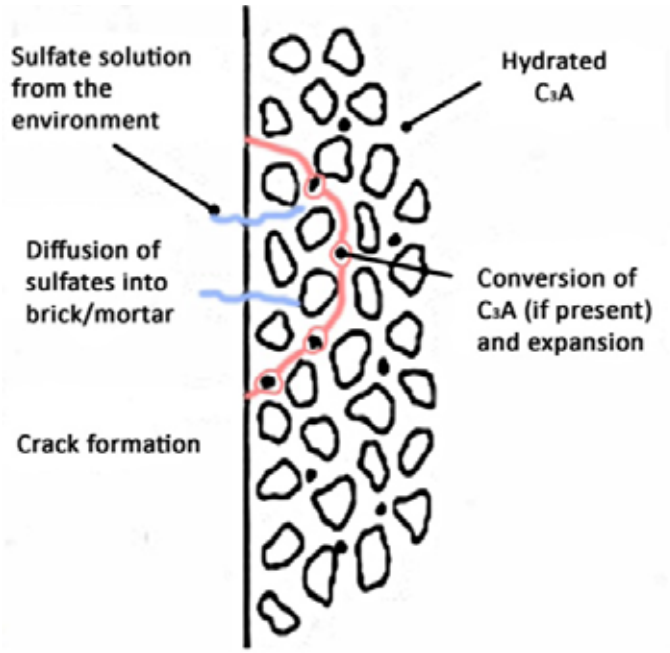
Where water is present (and only then) cement-based mortars can be vulnerable to attack by sulfates. Sulfates produce slow but steady expansion in the mortar, which can cause severe damage or failure to the brickwork. This attack is unusual, but most likely to occur when sulfates are transferred to the mortar joints by penetrating water. Sulfates can originate from a number of sources, including groundwater or from the bricks. Insufficiently dense mortar is more vulnerable to attack. The common situations are:

(i) In facing brickwork, the symptoms of expansion are firstly horizontal cracking visible at high level and in solid walls possibly lower down too; in long stretches of brickwork, some oversailing of the damp proof course usually occurs as well. As the attack proceeds, the mortar joints assume a whitish appearance, with narrow cracks in the middle. This is followed by spalling of the joint surface, with the mortar becoming friable and weak. Finally, the faces of the bricks may start to spall.

(ii) In unlined chimney stacks serving slow-burning appliances.

(iii) In rendering over brickwork with a high sulphur content where there will be extensive, mainly horizontal cracking of the rendering due to the expansion of the brickwork behind.

In both (i) and (ii) cracks tend to be of uniform thickness throughout their length, unlike cracks due to settlement, which tend to taper.



REMEDIAL MEASURES

Remedial Work

Recommended treatment for sulfate damage depends on the severity of the attack, but in all cases, the most important requirement is to remove sources of water.

Where only particularly vulnerable elements such as parapets have been affected, it may be sufficient to modify the detailing to prevent moisture from building up. In severe cases, however, it may be necessary to rebuild. The rebuilding may have to include the use of sulfate-resisting cement, flue linings and, if it is possible from the point of view of appearance, bricks of low sulphate (S2) content.

Corrosion of Reinforcement

Corrosion of Iron and Steel Reinforcement

During the 19th century, wrought iron reinforcement was used in certain types of building, particularly industrial buildings in the Midlands. 1 in by ½ in wrought iron strips were laid in the bed joints of the brickwork. Where moisture has penetrated to the reinforcement, often due to inadequately maintained pointing and failure of rainwater goods allowing the walls to get saturated in places, the reinforcement then corrodes leading to horizontal separation at the mortar joints.

Repair of Brickwork

Remedial Work

Once the reinforcement has started to corrode it will tend to continue to degenerate even if the source of moisture is removed. It is therefore necessary to cut out the corroded iron and if necessary, replace it with stainless steel, before making good the mortar joint.

Failure of Bricks

Minor Problems

Bricks that are not allowed to become or remain saturated will last indefinitely. However, if the design details and workmanship are not to standard, then even the most durable (F2) bricks can have issues in any exposure condition. Rarely, bricks may have been made from clay containing impurities and/or may not have been fully fired. Spalling and erosion can occur in not very severe conditions and is noticeable because it happens only to the odd brick in an otherwise sound expanse of brickwork.

Remedial Work

Such bricks must be cut out and replaced with matching bricks. Failure of individual bricks often manifests itself when the pointing has deteriorated, and it may well be necessary to repoint at the same time as replacing the defective bricks.

Cut out damaged brick

Apply layer of mortar to cavity bed

Frost Failure

Where bricks are allowed to become and remain saturated in freezing conditions, extensive failure may take place. Under-fired and certain types of bricks with low frost resistance (F1) are more susceptible to frost attack. The water within the brick freezes, expands and pushes off the surface of the bricks.

It is usually a progressive action and can, in severe cases, lead to complete disintegration.

Apply mortar to three faces of brick and slide into place

Repair of Brickwork

Frost Failure After Repointing

In many cases where old brickwork has been repointed using a strong mortar over a weak mortar, the pointing constrains the brick leading to frost failures under relatively mild weather conditions. Where this is happening, the bricks crumble away leaving the mortar standing proud of the surface.

Remedial Action

Remove the source of moisture where possible and cut out and replace defective bricks. Where strong mortar has been used, this must be removed, and the brickwork repainted with a weak mortar.

Chemical Action

When bricks are subjected to saturated conditions, the movement of water through the bricks may cause migration of soluble salts. These may crystallize on the surface causing efflorescence, which will in due time usually weather off. In rare instances, salts originating from the brick, the mortar, or from run-off from materials such as limestone in a polluted atmosphere, may crystallize within the brick and cause the face to spall. Applied coatings can trap these salts at the brick surface.

Remedial Measures

Remove, where possible, the source of moisture and cut out and replace defective bricks.

Fire Damage

Where the rate of rise of temperature is very rapid, fire can cause bricks to spall, or in very intense heat, to vitrify; water coming into contact with hot brickwork in the course of firefighting can also cause spalling. Taken in isolation, fire should not generally affect the strength and stability of a brick wall unduly, but, of course, its effects on other structural elements built into the wall may well render it unstable.

Remedial Wore

Where individual bricks have spalled, they should be cut out and replaced. If structural damage has occurred, this should be considered as other structural problems.

Brickwork is generally resillient to fire damage

Repair of Brickwork

Bricks in Basements

Brickwork subjected continuously to excessively damp conditions such as in deep basements where there is no damp-proofing and little or no ventilation, often contains many individual bricks which have decayed. This can be due to any of the factors outlined above, but the most common causes of failure are the use of unsuitable bricks or mortar in positions where they could not be seen, and the action of soluble salts in both bricks and mortar.

Bricks in Basements

The damp conditions should be rectified before any real success can be achieved in the replacement of the damaged bricks. Where this is not possible, care should be taken to replace the brick with a brick that has a low soluble salt content (S2) and a sulfate resisting cement mortar.

Water penetration of Brickwork

Water penetration of Brickwork

Water Penetration of Brickwork

Penetration by water is one of the most common and potentially one of the most damaging failures that can occur in old buildings; it can damage brickwork by saturating it – to cause efflorescence on the surface of the brickwork; cause decay and washing out of mortar from the joints; to soak timbers built into it leading to dry and wet rot; to corrode iron and steel; to encourage frost damage and to stain the surface and provide ideal conditions for the growth of all kinds of vegetation.

Repairs must commence with stopping the penetration of water. Identification of the causes of penetration, and appropriate remedial measures, have been covered in detail by general guidance and it is not intended to go into them again here, except in those cases where brickwork is a direct factor in the failure. There are two situations where this applies:

Direct Penetration of Brickwork by Driving Rain and Groundwater

Direct penetration of brickwork by water can occur through the joints, through the bricks, between the mortar and the bricks, or a combination of all these. Generally, this is not an issue for cavity wall construction, but can be significant for solid walls, or walls with a very narrow cavity. The following sections provide guidance on solid walls.

Penetration of Brickwork built of Porous Bricks

Where the bricks within the brickwork are porous, the penetration will be from a combination of the above factors.

Repair of Brickwork

Remedial Work

(a) The external surface of the wall can be treated with a water repellent solution. Water repellents suitable for brickwork are colourless liquids or creams based on silicone resins which, by lining the pores of the masonry, inhibit capillary absorption, so that water does not sink into the surface, but stays in droplets and runs off. However, water vapour should still be able to move through the brickwork, to ensure that it is not trapped within the brick where it can cause issues with freeze/thaw deterioration. They should not appreciably change the appearance of brickwork. However, there are a number of conditions that must be remembered when considering this type of treatment:

(i) Water repellents may result in surface spalling of the brickwork if soluble salts are present, since they will prevent them from moving to the surface in the form of efflorescence, and it is therefore advisable in such cases to eliminate the efflorescence before treatment is applied.

(ii) The wall to be treated must be in a good condition structurally, since treatment with a water-repellent may increase the danger of penetration through cracks and defective joints. Dirty surfaces should be thoroughly cleaned of dirt, efflorescence, and organic growth.

(iii) The wall surface must be as dry as possible at the time of application since any moisture present in the walling after treatment will tend to evaporate towards the inside.

(iv) Ventilation within the building should be compatible with the treatment i.e., since water vapour cannot evaporate towards the outside, it is possible that this will permanently to saturate the wall, without additional ventilation.

If these conditions can be met, then the use of water repellents does provide a comparatively inexpensive way of reducing water penetration. It should be emphasised, however, that it is not a particularly durable form of treatment, and is estimated, if applied correctly, to be effective for approximately 10 years. There are many variables to the longevity of this type of remedial action and good design and careful planning are always preferred, typically maintenance should not be an issue with brickwork.

(b) The internal surface of the wall can be treated or faced with an independent skin. Treatment of the internal surface of the brickwork is frequently the most satisfactory procedure against penetrating damp. The rehabilitation of a building will often require most of the existing internal finishes (for example, plaster and floorboards) to be removed, and this will provide the necessary opportunity for treatment of the internal surfaces of damp walls. Before treatment, any damage to the brickwork must be made good. There are a number of different methods of waterproofing.

Masonry cream can reduce water penetration

Repair of Brickwork

There are a number of different methods of waterproofing. The simplest is to apply a waterproofing agent, such as one of the bituminous compounds, to the surface of the brickwork and then replaster over it. It is important to ensure that brickwork in areas normally concealed, eg within roof and floor spaces-is properly treated. If carefully executed, this will prove satisfactory in many cases, where the brickwork to be treated is not less than 8 to 9 inches thick and is intermittently porous.

Where severe and persistent dampness due to porosity is encountered, for instance in basements, then the formation of an inner lining to the wall is probably the only really satisfactory remedy.

In some cases, the construction of a brick or block inner skin incorporating waterproof tanking may be considered, especially if it is coupled with the need to provide additional structural stability. It should, however, be taken down to the foundation level.

Where there is excessive dampness in old brickwork, the presence of old, porous plaster or lime wash finish may inhibit drying out, and the removal of this surface could bring about a significant improvement in the internal condition of the wall.

Basement floor and wall tanking membrane

Penetration of Brickwork built of Hard Non-porous Bricks

In brickwork containing hard non-porous bricks, any water penetration will arise from the jointing medium.

Remedial Measures

Repointing will usually prove to be sufficient to remedy the trouble, providing it is carefully carried out, to eliminate all possibility of capillary action. The choice of mortar is determined by the quality of the brick, but even with very dense non-absorbent brick, the mix should never be stronger than 1:1:6, cement:lime:sand.

Rising Damp

Rising damp is the name given to the saturation of bricks and joints by water drawn up by capillary action from the ground. It rarely rises more than 1.5m or so above ground level but can travel higher in certain circumstances.

The remedy is first to create conditions where rising damp is discouraged, and then to insert a damp-proof course if necessary. Changes in conditions adjoining the wall can materially affect rising damp, and this is the first aspect to consider. The immediate surroundings of the buildings should be examined to see whether the surrounding ground has risen above its original level, as this can result in the damp-proof course, if there is one, being bridged.

Repair of Brickwork

Even if there is no damp-proof course, such rises in ground level can greatly increase the risk of rising damp. Historically the base of brickwork walls were made thicker to reduce water penetration. A common solution to damp penetration was to introduce a rendered concrete plinth. Although it made the wall thicker, the concrete will also prevent evaporation from the brickwork, and therefore increase damp penetration.

Old cement rendered plinths can also act as a bridge for rising damp. In both cases, remedial action must start with the removal of the 'bridge' and replacement of a rotten timber on the ground floor or basement floor. Once the members are sufficiently replaced, where applicable, they should be accompanied by the insertion of a damp-proof course.

In many old properties, especially in urban areas, there will be basements constructed wholly or partly underground. Where they are not inhabited, such basements can act as efficient barriers to rising damp by providing sufficient area of wall to allow the water to evaporate before it appears at ground floor level.

Where no such barrier exists, it will be necessary to create one.

The Insertion of a Solid Damp Proof Course

The traditional method of inserting a slate DPC is by removing the courses of brickwork above and below the selected bed joint in short sections, then rebuilding to incorporate the DPC. This creates a positive barrier against rising damp but it can present practical problems. Alternatively, a rigid damp-proof material can cut in a bed joint within the brickwork with a specialist grinder. It is still dependent, however, on well-built brickwork, not too thick, and easily accessible from at least one side. Certain conditions, for example at chimneys, sometimes present particular difficulties.

In walls carrying normal domestic loads, it is wise to limit the length of the wall treated at one time to 500mm, and where the wall is more heavily loaded, to reduce this to 250mm. Some slight settlement must be expected as the cut advances (usually not more than 1.5mm), but this can be reduced to a minimum if the cut is packed with mortar and wedges.

Traditional slate DPC

Concrete plinth to be removed

Repair of Brickwork

In deciding which of the methods of controlling rising damp to adopt, the following should be considered; the length of life it is intended that the building should have; the complexity of the work and the condition of the walls; and the comparative costs of the systems. Generally speaking, if a life of say 25 years or more is envisaged, then a traditional damp-proof course should be considered first.

However, if the walls are thick, irregular, in long unbroken runs or there is doubt about their homogeneity, then the injection of a chemical damp-proof course would probably be more effective.

Dry Rot

The most damaging fungus associated with old buildings is dry rot. Although its effects on timber are well known, it should be remembered that the fruiting body sends out a network of grey branching strands (hyphae) sometimes as thick as a lead pencil, which conduct water, to enable the fungus in a damp situation to spread to neighbouring woodwork.

These strands spread across and through almost any material, including brickwork, and it is this characteristic that makes it imperative to ensure that the full extent of the fungus is traced and that all brickwork in the vicinity, as well as all timber, is treated.

Dry rot network

Treatment must start with the removal of the surface finish to expose the brickwork. All infected timber, such as plates, bond timbers, lintels, joists ends must then be cut out, and the brickwork left clear for treatment. Following this, the exposed brickwork should be treated with a fungicide.

Surface spraying is rarely sufficient to ensure that the fungus is killed, so it is recommended that the fungicide is channelled into every part of the infected brickwork, to saturate it thoroughly.

This work should be completed by a specialist and any health and safety precautions recommended by the manufacturers of the fungicide must be carefully observed.

Mosses and Algae

Although the growth of mosses and algae on brickwork is often considered to produce a pleasing appearance, it is usually an indication that moisture is present in considerable quantities and remedial measures to cure this will often result in the disappearance of vegetable growth. In cases where growth persists and is definitely harmful, for example where moss growth is blocking gutters or downpipes, or where algae are producing disfiguring stains on brickwork, an algicide or moss killer may be used to clear the remaining traces.

Although such growths are usually associated with buildings in rural areas, they can also prove to be a source of trouble in urban areas, particularly where buildings are in sheltered locations with little direct sunlight.

Repair of Brickwork

Plant Growth

While frequently looking attractive, plant growth on brickwork is usually harmful to the wall. Ivy is perhaps the best-known example of this: the wall is kept damp, joints are forced apart by the expanding root systems, and eventually bricks are dislodged. In general, most plant growth should be discouraged, although there are exceptions. Climbers which require trellis-work are in many cases acceptable, although they will require nails and hooks to be fixed into brickwork.

Where large growths of vegetation must be removed, special care must be taken to avoid damage to brickwork, which may well have been weakened by it. The growth should first be killed, and once the top growth is dead and brittle, it can then be removed methodically, attention being paid to any loose bricks to ensure that they are not wrenched away in the process.

Lichens, the rather leathery, plate-like growths of orange or grey often found on old roofs and walls, are usually harmless, and in many cases add considerably to the charm of old brickwork, forming an essential part of the patina associated with age and weathering.

Ivy growth on Brickwork

References and Further Reading

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Brick Development Products & Services

Brick Awards
The Brick Awards celebrate the best examples of clay brick in our built environment. Each year the awards attract over 350 entries from leading architects, housebuilders, developers and contractors; accross 17 hotly contested categories. It is FREE and simple to enter on our web site: www.brick.org.uk

Technical Publications
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The Fourth Eddition of 'Guide to Successful Brickwork' is available at all good book shops.

Brick Works Events
The BDA regularly runs courses and seminars for all those professionals involved with the design and construction of brick buildings. Please contact George Spreckley our Events & PR Manager on email: georgespreckley@brick.org.uk

Brick Bulletin
This widely acclaimed e-magazine features the latest developments in brick design and is recognised world wide as the foremost journal of contemporary brickwork. It is available free through the 'Brick Bulletin' tab our website: www.brick.org.uk.

Brickmakers Quality Charter
Clay brick makes a significant contribution to the UK's safe, healthy and sustainable built environment. The Brickmakers Quality Charter scheme promotes the responsible sourcing of clay brick, through credentialling and the flexibility businesses seek from an established and audited supply chain.

Training and Education
The BDA offers lectures and other educational services for Architects, Engineers, Developers as well as support for students and public interested in creating successful brickwork. We also provide technical input to events for practicing architects, engineers and organisations involved in continuing professional development.

Research and Testing
The BDA identifies specific areas where independent research and testing programmes are required to further the confident use of clay brick and to ensure quality.

Statistical and Marketing Information
The Brick Development Association is an independent body committed to providing authoriative information about the use of clay brick in construction.

We collate statistical information on brick production, UK deliveries, and related supply for imported products together with volume information including testing, research and development.

We provide free technical support on the use of clay brick, and encourage best practice in the use of brick in the built enviornment.

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