TECHNICAL INFORMATION A18

DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

All building materials are subject to movement in use. This is in response to various stimuli – temperature changes, moisture content, variation or deformation under load of either the material itself or the adjacent materials.

If movement is not allowed to take place in a controlled manner, internal stresses will be set up and cracking and sometimes distortion is likely to occur. In order to avoid this, movement must be anticipated by the designer.

Movement has occurred since buildings were first constructed. Large brick structures were built from about the late 14th and early 15th centuries, using very thick construction and lime sand mortars. This form of construction continued for many years.

The Victorians really exploited the structural capabilities of brickwork and these structures are able to accommodate movement without the use of movement joints. (**Figure 1**).

- Modelling of facades and detailing to the elevations created shadows and limited movement from fluctuating temperature changes.
- Very thick construction is slower in responding to temperature changes.
- The mass of the brickwork restrained movement
- Lime: sand mortar was used which has the ability to absorb the expansion and contraction of the brick.

This compares very differently with the half brick skin of brickwork with stronger cement mortars now in use. Brickwork is now a relatively thin veneer/cladding to most modern buildings.

Figure 1

CONTENTS

DESIGN CONSIDERATIONS

Brickwork, like concrete, is good in compression and, unless reinforced, poor in tension. Most failures occur when the brick contracts however some movement failures may occur when the brickwork is restrained and is not allowed to expand. In all new construction, movement joints (MJ) accommodate both expansion and contraction and must be built in as work proceeds.

Mortars – cement / sand

Consideration should be given to reducing the centres between joints with increasing mortar strengths (see table in BS EN 1996-2 and PD 6697) since higher cement contents will limit movement capability and increase the tendency to crack.

Generally recommended joint spacing is for a designation (iii) mortar, or class M4 equivalent.

Reduced spacing for parapet, freestanding and retaining walls and capping courses already take this factor into account as stronger mixes are generally used in these situations, as well as being subject to greater temperature variation and less restraint.

Mortars – lime / sand

It is often suggested that the use of lime-sand mortars enables movement joints to be omitted. Whilst the spacing may be increased slightly by using a natural hydraulic lime mortar, it is not advisable to omit movement joints altogether in current thin wall/high load forms of construction.

Using more traditional bonding patterns and thicker wall construction may make it possible to omit movement joints but careful consideration must be given to both these elements. Advice would need to be sought from the lime mortar manufacturers as currently there is no published Standard or code of practice to base recommendations upon.

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

DESIGN CONSIDERATIONS (CONTINUED)

Cavity Insulation

There have been many changes in construction over the last 40-50 years, certainly within the past few decades the use of cavity insulation has become a common part of cavity construction. Insulation is required to provide the thermal insulation value of external walls, it can however affect the movement characteristics of brickwork.

With partially open cavities, the external leaf remains at a more uniform temperature. Heat from the external leaf dissipates into the cavity and gradually cools off. The whole cavity construction remains in a more even state of equilibrium. (**Figure 2**).

With a fully insulated cavity, the ability of the cavity to act as a heat sink is reduced and the external leaf is subjected to a greater range of temperature changes and with it additional expansion and contraction. This is particularly true with full-fill insulation. Insulating existing cavities increases the potential for movement. (**Figure 3**).

South, south west and south east facing walls are also more susceptible to temperature changes and not forgetting that the rear face of a north facing parapet may react as a south facing wall. (**Figure 4**).

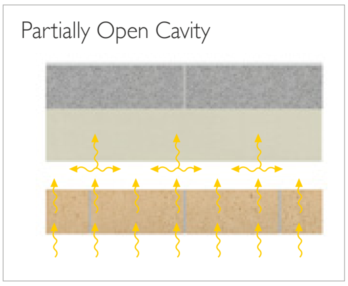

Figure 2

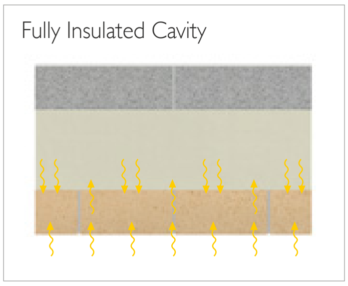

Figure 3

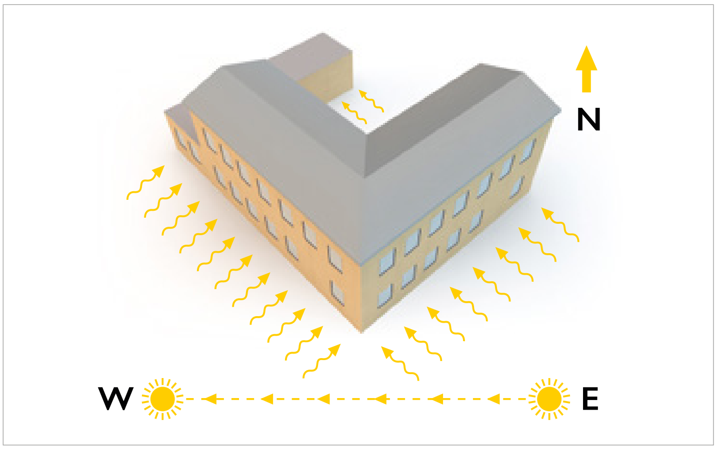

Figure 4

BUILDING & MATERIAL TOLERANCES

Brickwork and other building materials move at different rates and must be considered for individual applications as shown in **Figure 5**.

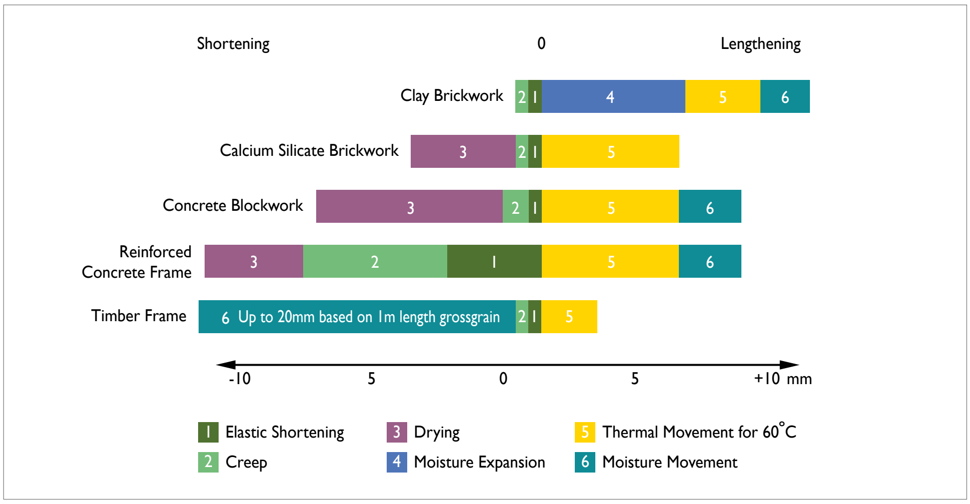

Figure 5

CAUSES OF MOVEMENT

Movement in building structures may be the result of:

- Temperature changes
- Moisture content variation
- Chemical action
- Deflection under loads
- Ground movement / settlement

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Ibstock Brick

DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

Thermal Expansion and Contraction

Clay brick has an unrestrained horizontal thermal expansion of approximately 1.2mm in a 10m length of wall for a temperature rise of 20°C (the surface temperature rise of a brick) but the actual movement of brickwork is difficult to predict due to the anticipated unrestrained expansion being reduced by internal friction and the difference in temperature across the thickness of the wall.

Generally allowing a movement joint width of 1mm per metre plus 30% accommodates movement, 1mm per m for long term moisture expansion and the additional 30% to accommodate thermal expansion.

Moisture Movement

Fired bricks in use exhibit a small amount of reversible moisture movement which for design purposes is not very significant. They do, however, undergo irreversible long-term moisture expansion to a degree which varies with brick type and which needs to be provided for at the design stage. However, providing that bricks are not used immediately they leave the kiln the movement from this cause should also be accommodated by the joint spacing and width recommended.

Mortar Shrinkage

Cracking can occur if an over strong mortar is used. This is caused by the irreversible shrinkage of mortar which can be in the region of 0.04% to 0.10%. In the case of weaker mortars the shrinkage is less, due to the smaller quantities of cement present and is usually restrained (on the bed joints at least) by adhesion to the bricks. The mortar mix used should be determined by the load-bearing and durability requirements of the situation and should never be stronger than necessary.

Movement in other Materials

Different building materials move in different ways. To minimise problems, different materials should generally be separated from each other by movement joints.

Brickwork should not be set tight within a frame of another material. This is particularly critical when the frame is of concrete, as irreversible shrinkage and creep are likely to take place.

Single storey steel frames or frames of top floors of multi storey buildings must be allowed to expand without disrupting the adjacent brickwork.

Timber framed buildings tend to contract vertically due to the frame drying to its in-service moisture content. This necessitates a 12mm gap at the head of the brick cladding in two storey buildings and 18mm in three storey buildings with proportional provision at window and door openings. (**Figure 6**).

Clay and calcium silicate or concrete bricks should not be bonded together in single leaf, or solid wall constructon.

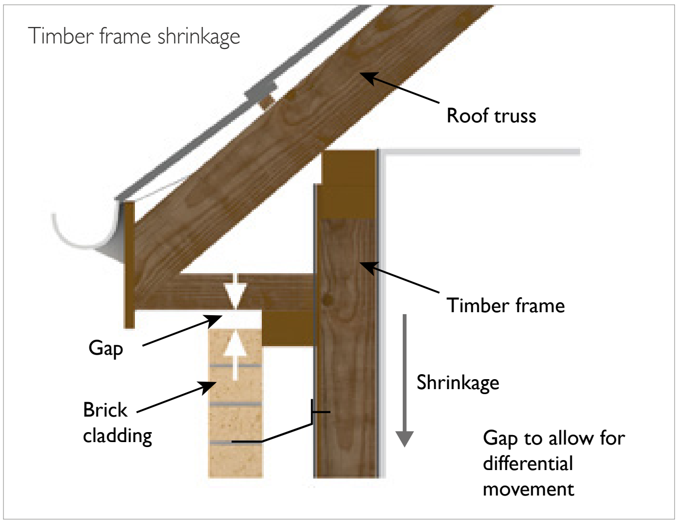

Figure 6

Movement due to Deflection/Displacement

Materials under load tend to deflect or distort. This is particularly true of beams and lintels. Such movement should not be allowed to place stress on the brickwork.

Wherever possible, brickwork should be supported on its own foundation. This is usually practical for buildings of up to two or three storeys. When brickwork is supported on lintels, beams or shelf angles, the maximum deflection of the bearing surface should be no greater than 1/500 of the span under full loading. A sliding type joint (slip plane) should be placed between the brickwork and lintel bearing surfaces.

Differential settlement between columns and brickwork should be accommodated by a movement joint and sliding anchors to allow vertical movement where required.

The unintentional loading of non-loadbearing brick walls due to the deflection of upper frame members should be avoided by the use of a movement joint.

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

GEOMETRY OF WALLS

Whether the cause of movement is in the building shell or due to ground movement, the geometry of the wall significantly affects the way in which the brickwork reacts to movement and the degree of damage caused. The design can potentially create planes of weakness where cracking could occur and the following are areas that should be looked at carefully.

Vertical Joint Spacing

Simple guidelines exist for the spacing of vertical joints to accommodate horizontal movement, the most common being 12 metres maximum for a half brick thick thick skin to cavity walling.

Current thinking in the light of modern construction techniques and higher insulation requirements for external walls is that the design spacing should be 10 metres.

12 metre centres is possible however it does stress the brickwork and will be dependant of door and window openings. (**Figure 7**). The 12m spacing will also require wider more obtrusive movement joints.

Distance from returns and angles should be approximately half of the above dimensions. (**Figure 8**)

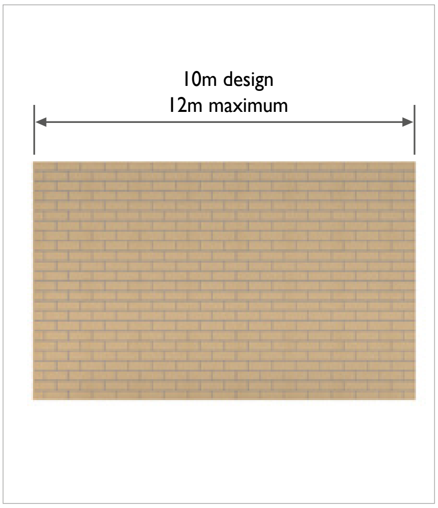

Figure 7

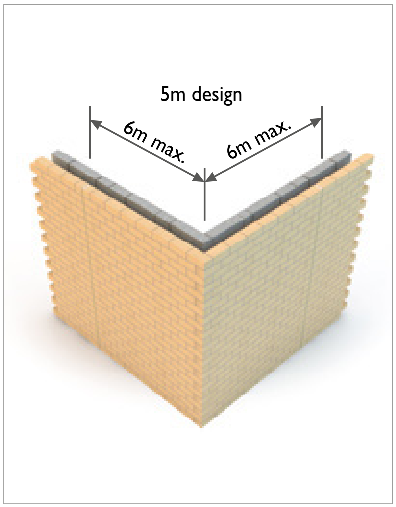

Figure 8

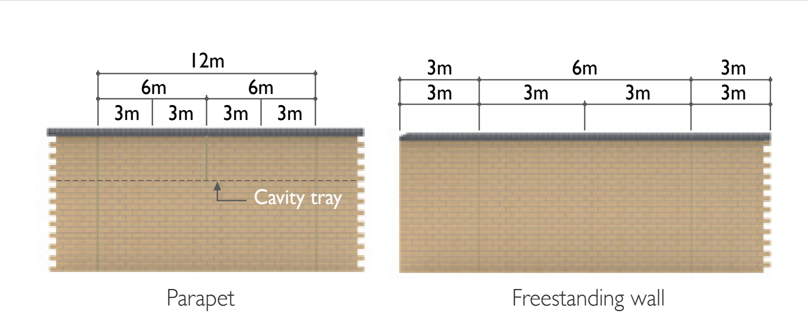

Figure 9

A similar provision should be made for freestanding and parapet walls, due to their greater exposure, less restraint and the stronger mortar mixes specified for these applications. Clay masonry copings and cappings on these walls require movement joints at 2.5 to 3 metres centres. (**Figure 9**).

Although the maximum centres between movement joints in unreinforced walls as stated in EN 1996-2 is 12 metres, it should be noted that joint widths will be in excess of 16mm.

Additional ties will be necessary across the cavity either side of the movement joint.

Abrupt changes of Wall Thickness

- If two loading conditions are present, one on each thickness of wall, it is advisable for the two sections to be separated by a movement joint.
- If there is no differential load problem, the addition of bed joint reinforcement may minimise the risk of cracking.

Abrupt Changes in Height of Wall

- As two load conditions are present, the different heights of wall should be divided by a movement joint.
- The foundation design should be adequate for both load conditions, so that the wall will settle evenly. (**Figure 10**)

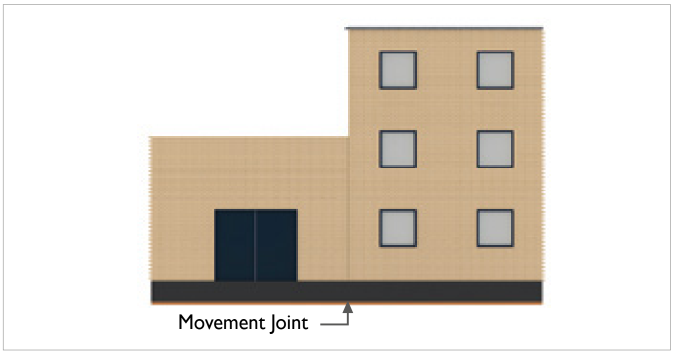

Figure 10

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

Points of Weakness Around Openings

Figure 11

Short Lengths

- In walls of 10m length or over the brickwork should be divided by movement joints including the condition where brickwork is continuous above and/or below window openings. (**Figure 11**).

Large Openings

- When large openings in low walls (or multiple openings above each other in high walls) occur a movement joint should be positioned near the plane of weakness, or alternatively bed joint reinforcement should be used. (**Figures 12 and 13**).

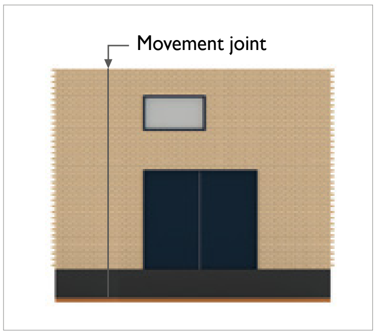

Figure 12

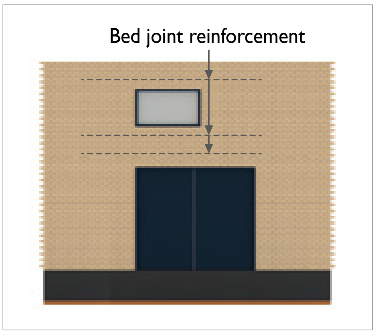

Figure 13

Changes in Direction Involving Short Return Walls

Return walls should be designed to have adequate stability to withstand the adjacent wall movement. Any return wall will be affected by the expansion forces in the brickwork in both adjoining walls. (**Figure 14 A**).

Where short returns are a design requirement, incorporate a movement joint. (**Figure 14 B**).

The movement at short returns is aggravated by the wall sliding on the DPC. Correct choice of DPC material is therefore important and advice should be sought from the manufacturer or the Ibstock Design Advisory Service.

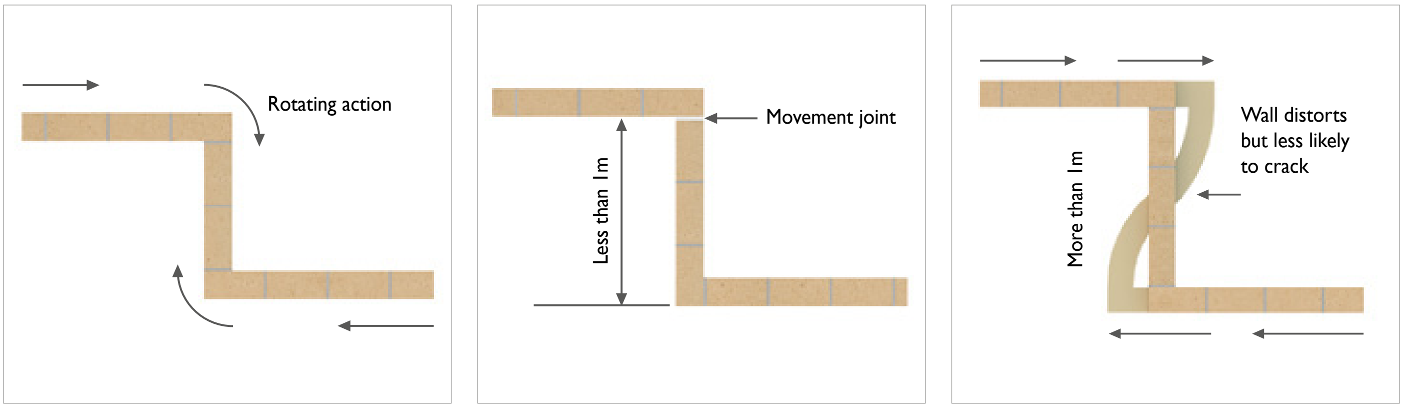

Figure 14 A B C

Ibstock Brick

DESIGN & SPECIFICATION CONSIDERATIONS
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ORIENTATION OF MOVEMENT JOINTS

Where the brickwork is stepped and short returns are involved, placement of movement joints must carefully consider what the joint is intended to achieve. With returns less than 1 metre cracking is possible in the positions shown in **Figure 15**.

Fig 16 indicates the preferred position where a movement joint acts in a sliding manner avoiding possible displacement of the adjacent return. It is also less visually obtrusive in this location than **Figure 17.** With the movement joint in this position no flat bar ties should be used across the MJ as movement would otherwise be restricted.

There is choice of movement joint positioning and that shown in **Figure 17** indicates a movement joint at the end of the longer brickwork length, but with the possibility of displacement of the short return.

An alternative arrangement using movement type joints is to place these some distance from the return – **Figure 18.**

Returns greater than 1m are generally able to accommodate movement without cracking.

The use of wall ties very close to returns can cause vertical cracks to develop because the inner and outer leaves, probably of different materials, are tied stiffly together.

This type of crack is particularly prevalent on gables with strong brick/mortar combinations and with the more rigid type of tie.

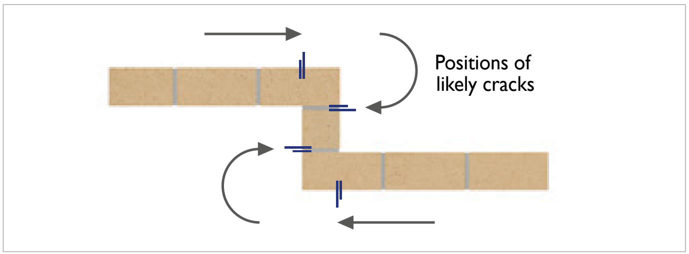

Figure 15

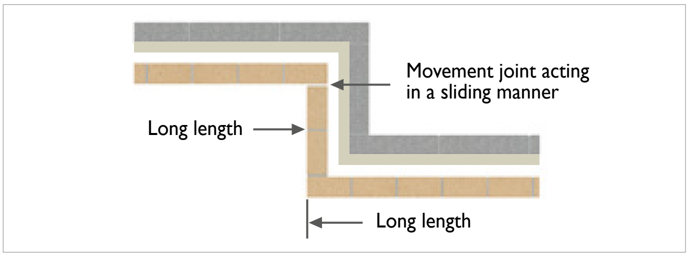

Figure 16

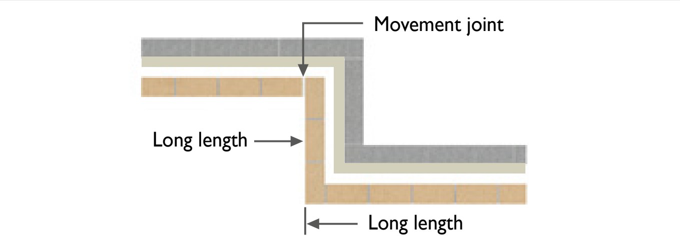

Figure 17

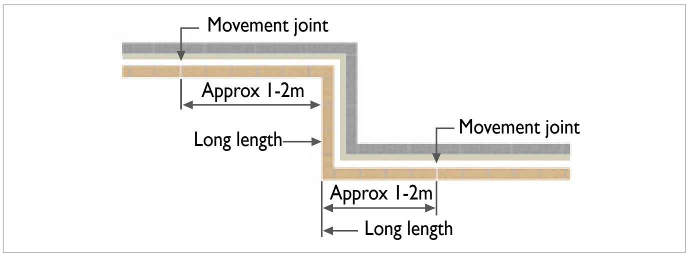

Figure 18

Horizontal Joint Spacing

Vertical movement is currently considered to be about the same as horizontal movement. However in multi storey framed buildings, the outer leaf of brickwork is usually supported at intervals of not more than every third storey or every 9 metres, which ever is the less. (**Figure 19**)

It is common practice to incorporate support at every second storey, thus providing the opportunity to locate movement joints of reduced thickness. (**Figure 20**)

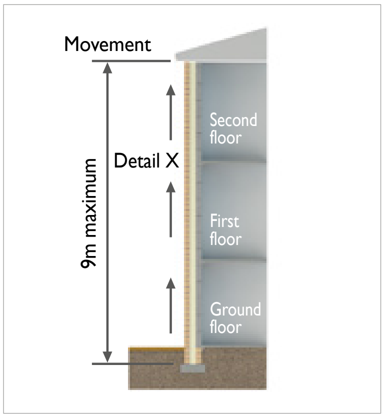

Figure 19

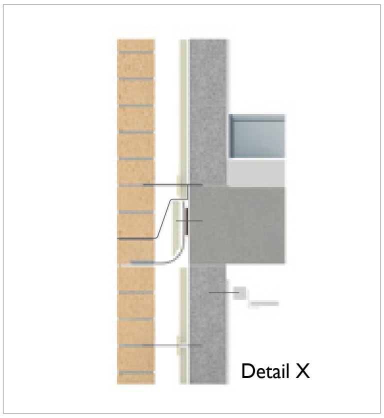

Figure 20

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

Curved Walling

It is sometimes thought unnecessary to provide for movement to curved brickwork. There is however an argument for controlling movement and the possible lateral displacement of the wall.

Vertical movement joint spacing should be at a frequency at least equal to that for straight walls, but a reduction to 7 or 8 metre maximum spacing is thought to be beneficial. Coping and capping courses should have movement joints at half these distances.

Measurements of curved walling in this respect are lengths (distance around the curved surface) and not chord lengths (straight distance between any 2 points on the curve). (**Figure 21**).

Serpentine walls seem to offer contrary evidence as examples exist of great length with pitch lengths of 5-7 metres with no movement provision, and no detrimental effects.

In spite of this evidence, it is prudent to incorporate some movement joint control. Movement joints should be placed that they do not interfere with the structural action of the section, preferably in full or multiples of full wavelengths and at the point of reverse curvature. (**Figure 22**).

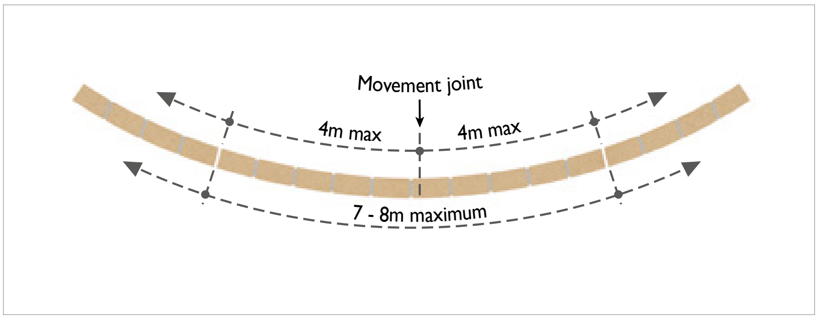

Figure 21

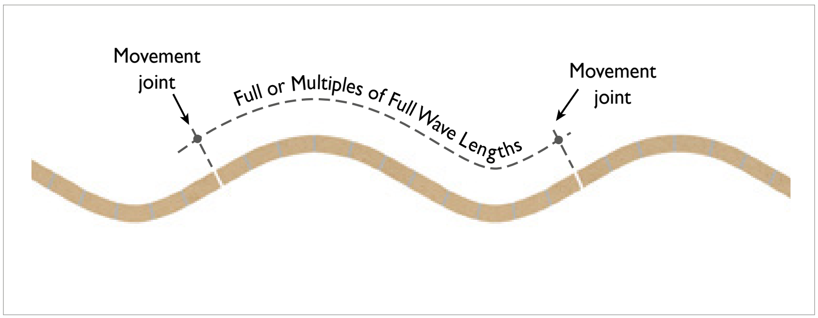

Figure 22

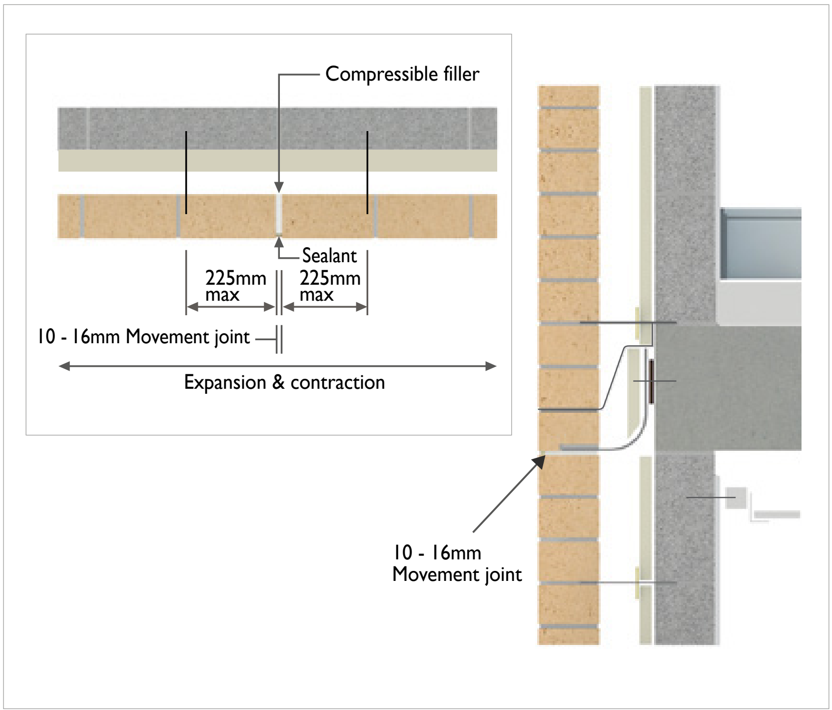

Figure 23

JOINT CONSTRUCTION

Vertical and Horizontal Movement Joints -

The basic joint is used where compressive and tensile stresses are expected. It is usually a butt joint between two stop ends of brickwork, or between brickwork and another material. The joint width is typically between 10mm and 16mm and is faced externally by a flexible sealant or gasket covering an easily compressible jont filler. (**Figure 23**)

Factors affecting the choice of sealant are:

- Dimension of joint
- Expected degree of movement of joint
- Required life of sealant
- Movement accommodation factor of sealant

Sliding Joint – Horizontal

This joint is located where shear stress only is expected. In its simplest form this joint can be a DPC laid on a hardened mortar bed and correctly formed as described in PD 6697.

Proprietary resilient bearings can be used where rotational movements are involved as well as shear. Where compressive, tensile and shear stresses are likely, movement type joints should be used in preference to sliding type joints.

DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

Commencement and Termination of Joints

It is preferable that movement joints should commence at foundations and be continuous to roof/parapet level.

If cavity trays are broken by the movement joint then stop ends should be provided where appropriate. (**Figure 24**)

Where sloping sites require extensive brickwork below ground level, movement joints should be taken 600 to 1000mm below ground level. (**Figure 25**).

Movement joints should be continuous through the external leaf of brickwork and should therefore pass through copings and cappings of parapet and freestanding walls, without interruption.

Movement joints should therefore not be positioned aligned vertically with the reveal where a lintel passes through the MJ as this would negate the movement capability of the joint. The end bearings of the lintels and the brickwork directly above could be provided with a slip bearing but it is complicated to construct effectively and therefore not recommended.

Where reduced movement joint centres are provided to parapets (maximum 6 metre centres) , these should terminate on the slip plane cavity tray usually positioned at roof level. (**Figure 26**)

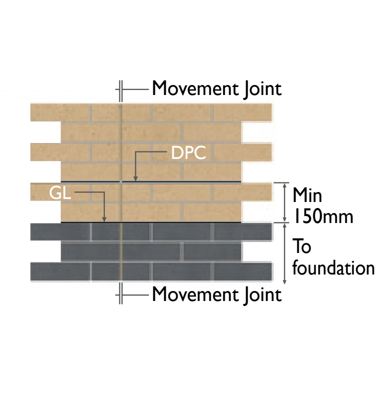

Figure 24

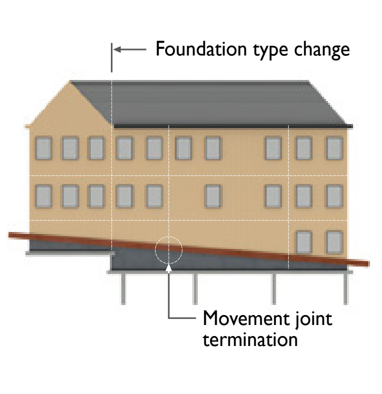

Figure 25

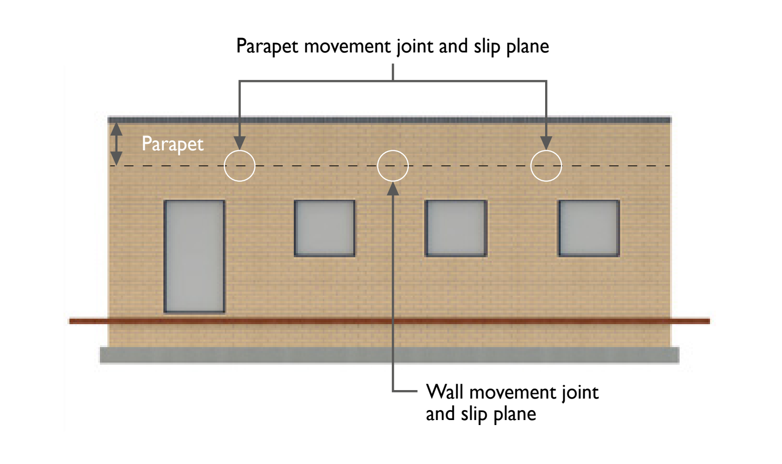

Figure 26

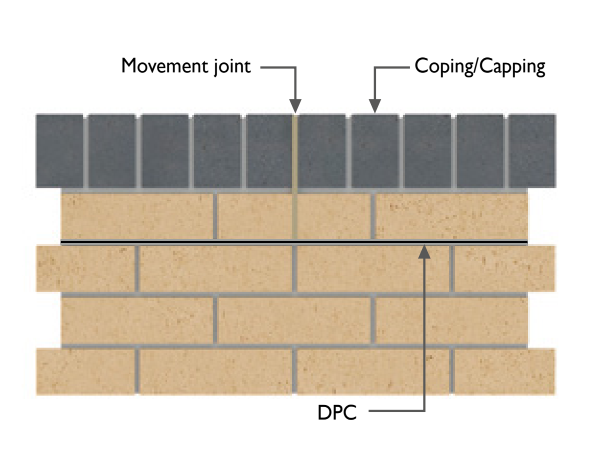

Figure 27

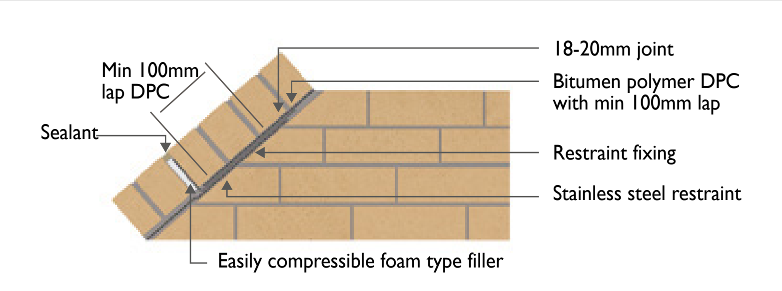

Figure 28

Likewise where additional movement joints are incorporated into coping and capping courses they should extend down to the DPC position. (**Figure 27**)

Where sloping brickwork incorporates coping or capping courses, movement joints will be necessary to control the tendency for the coping/cappings to slide down the slope. The number and frequency of such restraints will depend on the angle of inclination and the sliding weight being restrained. Some of these restraints will, by necessity, be located at movement joint positions. (**Figure 28**).

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DESIGN & SPECIFICATION CONSIDERATIONS
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Inner Leaf Joint Positions

Where in a cavity wall it is required to provide movement joints to the inner leaf, these wherever possible should be staggered with those in the outer leaf, particularly where materials with differing expansion coefficients are used.

This will reduce the amount of differential movement occurring at the movement joint position and maintain the integrity and proper functioning of the cavity ties and restraints. (**Figure 29**).

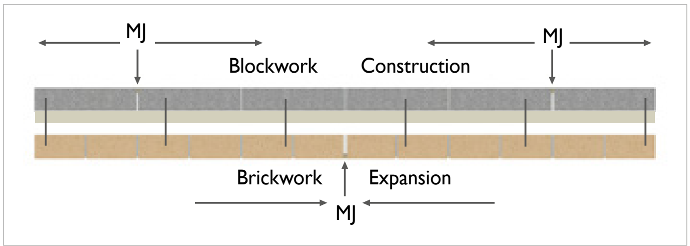

Figure 28

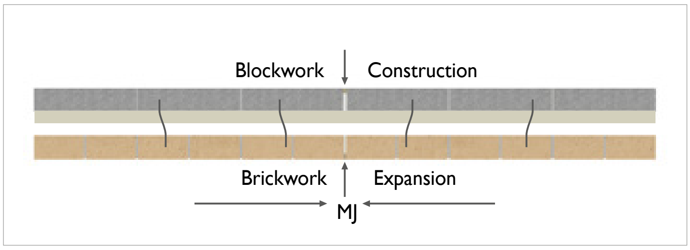

Figure 29

Joint Filler Materials

Movement joints in brickwork will comprise an open joint free of mortar or other bonding materials and will be provided with a separate filler material and an external sealant.

Filler materials should allow the brickwork to move freely without exerting any additional stresses to the brickwork. They should completely fill the joint space both when the brickwork is in an expansive state and the joint is under movement and also in the contraction state when the joint will open up. Partially filling with strip material, solid or circular or tube type, leaves a void within the thickness of the brickwork. This can become blocked by other matter such as mortar and may restrict the movement of the brickwork and proper functioning of the movement joint. (**Figure 30**).

Materials such as fibre-board, hemp and cork are not suitable for clay brickwork movement joints as they do not compress easily and may impart additional stresses to the brickwork. They do not always fully recover their original thickness following movement.

Flexible cellular polyethylene, cellular polyurethane or foam rubbers are the most satisfactory materials as they are easily compressed and recover fully under all temperature and climatic conditions. Typically the material for filling movement joints to accommodate expansion should be easily compressible to approximately 50% of its original thickness. A simple test to determine if the filler material is suitabe is that it should be easily compressible between finger and thumb and recoil back to it original thickness when released.

When specifying 'build in' filler materials consideration should be given to the possibility that subsequent contraction of the brickwork may leave the filler material loose in the joint and some means of additional tie or support for the filler material may be necessary. The filler strip material should be built in as the work proceeds excluding wet mortar from the movement joint.

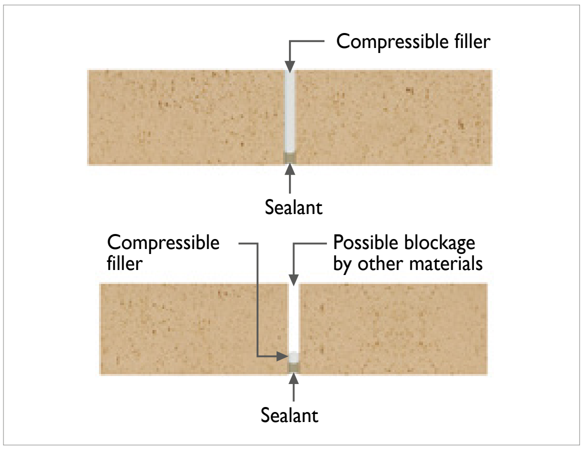

Figure 30

Joint Sealants

Sealants to movement joints must be chosen with great care. No sealant will last the life of the building and sealant filling is not the all purpose answer for inadequate allowance of building and material tolerances or badly designed joints. It is essential that the maximum movement in the brickwork does not exceed the permitted movement in the joint sealant. For performance details of the sealant types refer to the manufacturer's literature and recommendations.

Factors affecting the choice of sealants are:

- Width of joint
- Expected amount of movement of the joint
- The movement accommodation factor (MAF)
- The life expectancy of the sealant

For guidance to the types of joint sealant, their selection, correct application to joint function and design, refer to BS 6293 and BS 6093. The joint widths and depth of seal for movement joints is important, usually the depth should equal the width. Optimum performances in butt joints is obtained when the width to depth ratio of the sealant bead lies within the range recommended by the individual sealant manufacturers.

DESIGN & SPECIFICATION CONSIDERATIONS
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Joint Sealants continued

Movement accommodation factors (MAF) vary greatly between the various sealant types and must be considered against the amount of movement taking place and the designed or required width of the joint.

Before fillers and sealants are applied to porous surfaces, the joint may require preparation with a suitable primer to ensure adhesion and watertight finish of sealant. Consultation with the sealant manufacturer is recommended to obtain their advice. If an applied primer is to be specified it must not be applied to the visible face of the brickwork as it will cause staining dissimilar to the untreated brickwork.

Ideally the sealant should not bond to the compressible filler therefore a bond breaking tape will need to be inserted after the primer is used.

FIRE RESISTANCE OF MOVEMENT JOINTS

Should there be a need to fire-seal a movement joint, intumescent type fillers are available to suit most gap widths.

MOVEMENT JOINT WIDTHS

PD 6697 adopts a flexible approach to the question of joint width and frequency and recommends that for lightly restrained walls, as a general guide and to allow for the compressibility of the filler, the width of the joint in millimetres should be about 30% more than the numerical value of the distance between joints in metres. For example, movement joints at 12 m centres should be about 16 mm wide.

This allowance is intended to accommodate both thermal movement and long term irreversible moisture expansion and take some account of sealant performance.

Horizontal movement joint calculations tend to accommodate brickwork movement only. Vertical movement between shelf angle supports may require the accommodation of brickwork movement and structural displacements. (**Figure 31**)

In practice joint widths will need to take account of the Movement Accommodation Factor of the sealant to be used whose controlling influence will dictate the actual joint width in many cases. (See BS 6093).

All of the above assumes that the joint will be close to the mean temperature when the sealant is applied. It also assumes that the joint has not been used to absorb any out of tolerances in the adjacent construction. If the actual formed joint width is likely to differ from its determined width, an adjustment must be made to the calculations. For advice on calculating movement joint widths please contact the Ibstock Design Advisory Service.

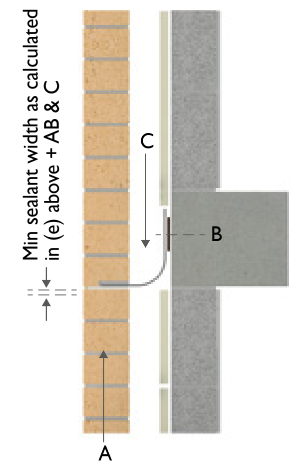

Figure 31

SMALL BUILDINGS

There are exceptions to every rule and small to medium buildings may fall into this category. Square or rectangular buildings where each wall is no greater than 10 metres in length may not need movement provision as a wall length of 10m will have equalling forces which do not need a central movement joint.

However, should a short return be incorporated such as an external chimney flue, staggered geometry and abrupt changes in height will affect the movement potential of the structure, as will the use of mixed materials and/or colours, and advice should be sought as to the necessity for and positioning of joints in these cases.

POLYCHROMATIC BRICKWORK & DISSIMILAR MATERIALS

Current research reveals significant differences in movement of individual brick types due to long term moisture expansion and temperature change. If combinations of materials or different brick colour types (polychromatic) are to be used, movement joints at a maximum 6 metre centres should be specified, with a distance of 3 metres from corners and changes in direction, to allow for different movement.

In particular, brickwork combined with cement based or natural stone products requires movement joints at a maximum 6 metres, to accord with the requirements for cement based or natural stone materials -movement joints may at times need to be maintained at 10 to 12 metre centres. In these situations the incorporation of bed-joint reinforcement may be considered to prevent cracking and disruption from differential movements. (**Figure 32**).

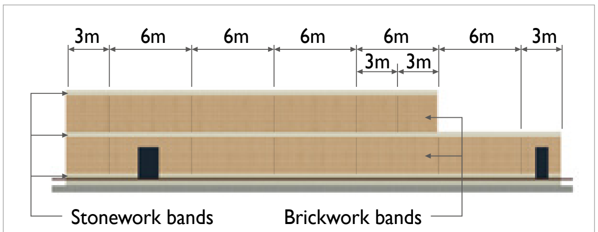

Figure 32

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

POLYCHROMATIC BRICKWORK & DISSIMILAR MATERIALS (CONTINUED)

Similarly, where differing products are bonded vertically (e.g. stone quoins) bed- joint reinforcement should be incorporated between the adjoining materials to avoid cracking at the brick/mortar/stone interface. (**Figure 33**).

Clay bricks and calcium silicate or concrete bricks should not be bonded together in single leaf or in other solid walls.

When different materials are built on top of each other it is often preferable to separate them from each other by way of a slip plane in the bed joint between them by using a DPC or similar membrane to allow the materials to expand and or contract at differing rates from each other.

The DPC/membrane should be laid on a flat, level, cured bed of mortar to prevent it bonding with the mortar.

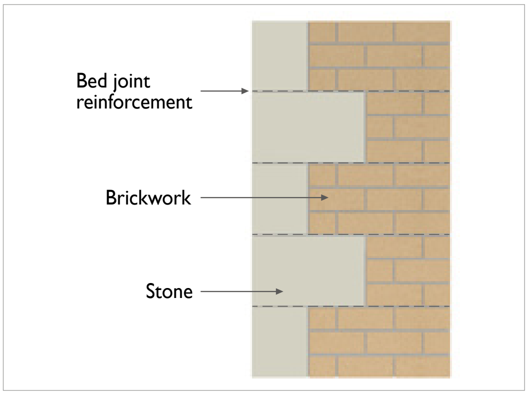

Figure 33

MAINTAINING STABILITY

The introduction of movement joints to a wall breaks the walls continuity and may thus reduce stability. Consideration must be given to this factor and additional support and/or stabilisation provided at either side of the joint.

PD 6697 requires that wall ties spaced not more than 300mm apart vertically should be provided within 225mm from the sides of all openings with un-bonded jambs. (**Figure 34**).

Movement joints are generally un-bonded and additional ties should be provided in accordance with the previous requirements.
(**Figure 35**). If a shear connection is required the ends of the brick leaves at either side of the joint may be connected by the use of flat bar ties having de-bonding sleeves. (**Figure 36**)

If the cavity wall ties are incorporated on either side of the MJ at maximum 300mm vertical centres then the flat bar ties can be omitted allowing the filler material to be built in in a continuous strip.

For use in clay brickwork the ties must be prepared by pulling them from the sleeves by an amount equal to the specified joint width to allow for expansion and contraction of the brick panels. Failure to do this may completely negate the sliding action intended. (**Figure 37**)

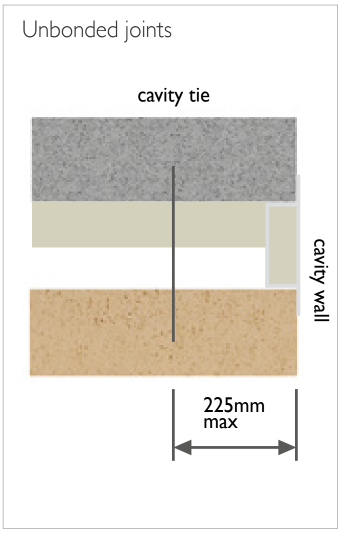

Figure 34

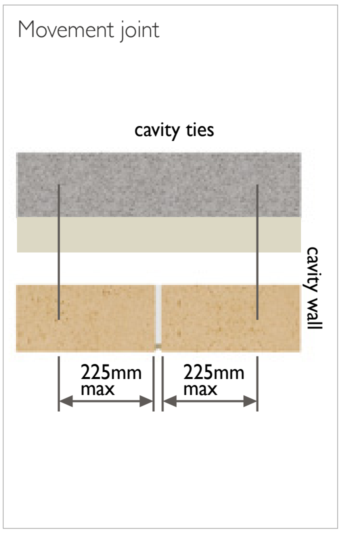

Figure 35

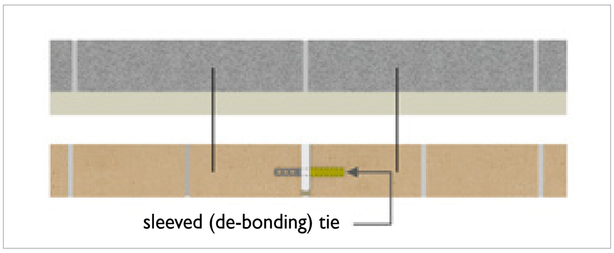

Figure 36

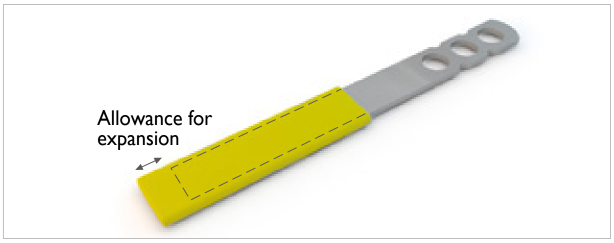

Figure 37

DESIGN & SPECIFICATION CONSIDERATIONS
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MAINTAINING STABILITY (CONTINUED)

A thickening in the form of piers at one or both sides of the movement joint will also provide additional stability and this is particularly suited to free standing boundary walling and parapets of solid wall construction. Alternatively the use of ties having de-bonding sleeves may be considered, prepared as described in the previous paragraph. (**Figure 38**)

The inclusion of stainless steel parapet posts for the vertical restraint of either parapets of cavity construction or spandrel panels may be considered.

Particular attention should be paid to stability at horizontal movement joint positions, where shelf angles and pistol shaped bricks are used and often incorporating a cavity tray. Cavity ties or other restraint devices should be located as near as possible to the joint without restricting the inclusion of adequate support systems and the proper functioning of cavity trays.

Where differential vertical movements have to be accommodated to the portion of brickwork adjacent to an inner leaf movement joint for instance, a sliding anchor restraint system should be provided. (**Figure 39**).

Where damp proof courses and cavity trays are continuous and pass through the movement joint, consideration must be given to the ability or otherwise of the DPC material to accommodate both the compressive and tensile forces to which it is subjected.

Those types most affected will be those with little or no flexibility.

Where large amounts of movement or large structural separation joints are to be accommodated a break in the DPC/ cavity tray is recommended. Stop ends, sealed to the DPC/ cavity tray in the usual manner, should be provided at either side of the movement joint. (**Figure 40**).

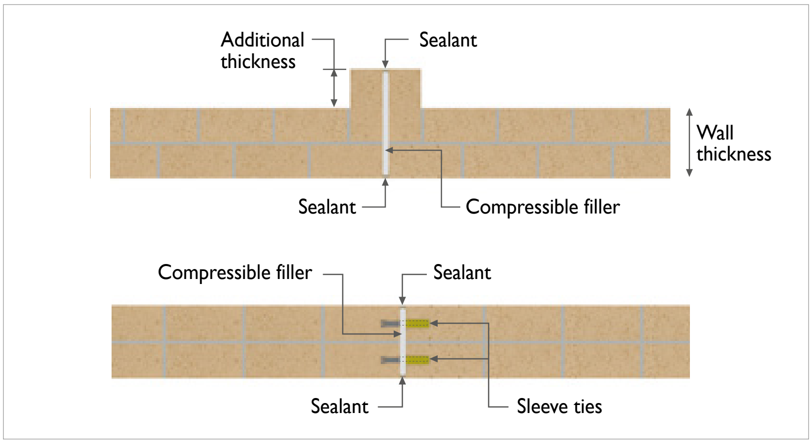

Figure 38

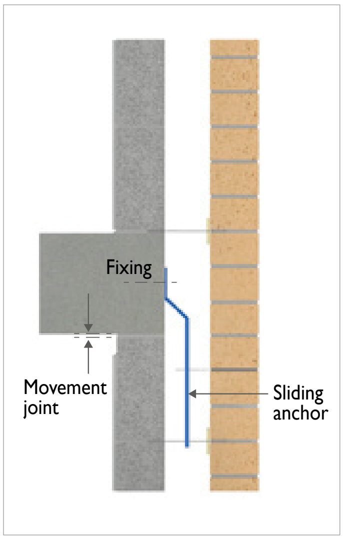

Figure 39

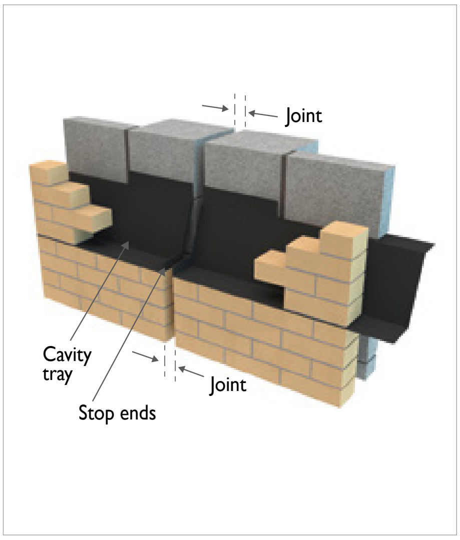

Figure 40

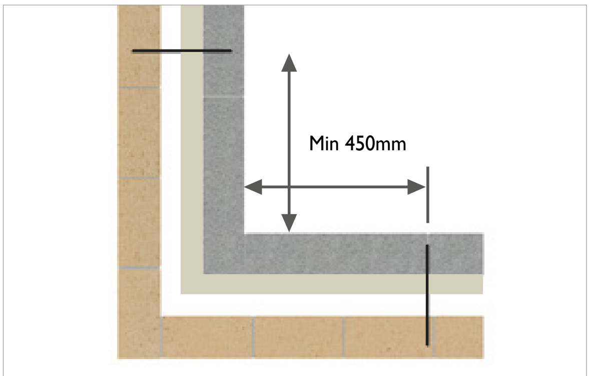

Figure 41

WALL TIES

All movements in the brickwork, no matter how small, will impart a twisting action into the cavity wall tie, particularly differential movements between inner and outer leaves (see Inner Leaf Joint Provisions).

Some designs of wall ties are better able to cope with movement than others and this can be a critical factor in the development of cracks in service. There are nowadays a proliferation of proprietary ties and their accommodation of movement may be a factor in the choice of type.

The stiffer types should not be used within 450mm of the internal corner of the masonry returns. (**Figure 41**).

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DESIGN & SPECIFICATION CONSIDERATIONS
DESIGNING FOR MOVEMENT

REINFORCEMENT TO BRICKWORK

The majority of brickwork is unreinforced, but there is an increasing interest in adding reinforcement not only to increase its efficiency and improve its general performance, but also to control cracking at points of high tensile stress.(**Figures 42 to 44**).

Give more freedom to spacing of movement joint

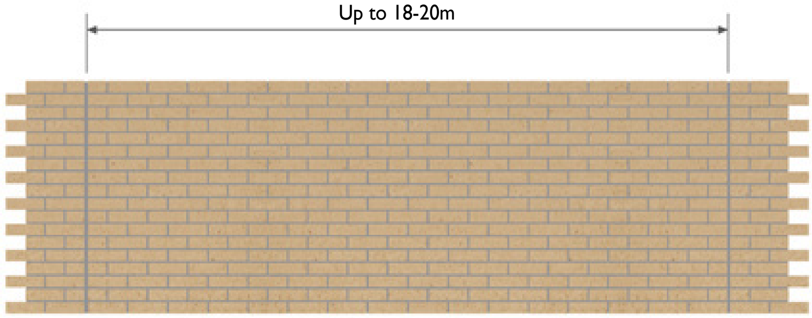

Figure 42

Stress concentrations around windows and doors

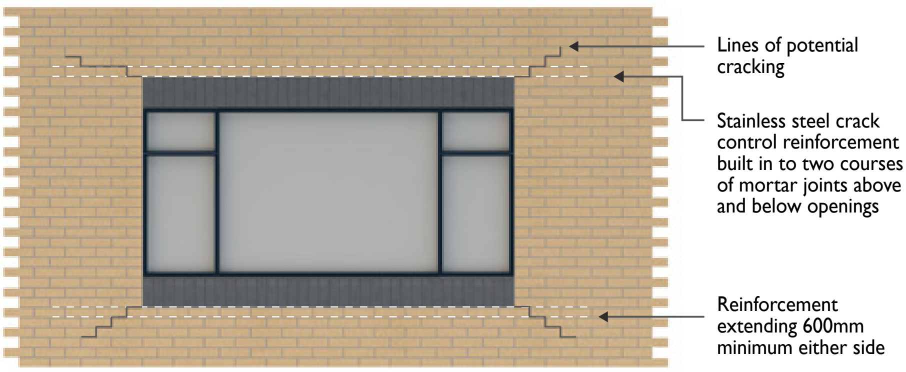

Figure 43

Brickwork, like concrete, is good in compression but poor in tension and the addition of reinforcement to the mortar bed joints will:

- Give more freedom in spacing of movement joints
- Reduce cracking due to the following causes:
  - Movement due to fluctuating temperatures
  - Flexural or tensile stresses resulting from loading
  - Stress concentrations around openings (windows and doors)
  - Differential movement between bonded materials
  - Differential settlements
  - Irregular elevations
  - Changes in wall thickness

Reinforcement is supplied in various widths, shapes and finishes suiting the applications but external walling suitable grades of austenitic stainless steel should always be specified.

Design Guides and technical and structural advice are available from manufacturers and suppliers, together with guidance on correct application of the material.

Irregular elevations

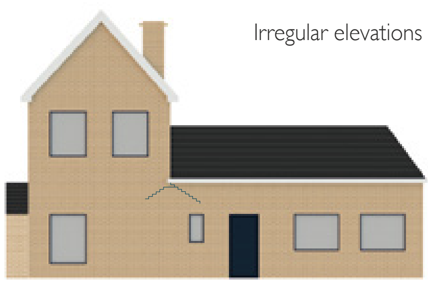

Figure 44

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