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Weatherproof joints in large panel systems: 1 Identification and typical defects

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This paper examines the basic types of weatherproof joints found in large panel system buildings, and their typical modes of failure. It includes a list of the types of cladding and joints associated with the principal large panel systems. This publication is one of a series being prepared as part of BRE's pogramme of investigation of large panel system dwellings to assist engineers in local authorities and elsewhere in appraisal, maintenance and repair.

INTRODUCTION

The purpose of weatherproof joints in large panel systems is to prevent the ingress of water and air and to accommodate movements in the components between which they form the seal. In general, these joints are of four basic types, the details of which vary according to the system and its components. There may be more than one type of joint in a building and individual joints may combine features from more than one type, especially where they have been repaired.

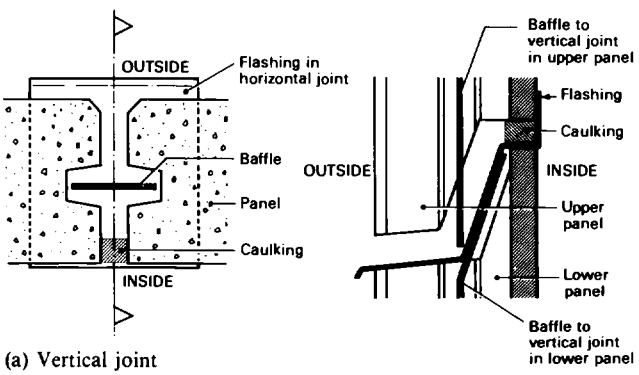
BASIC TYPES OF JOINT

The two-stage, or open-drained, joint

As the name implies, this type of joint has separate features to prevent the penetration of air and of water. In vertical joints (Figure 1(a)), water penetration is prevented by a baffle, typically of neoprene, butyl rubber, PVC or metal. As there is no positive seal at the edges of the baffle, there is no air pressure differential across it that would tend to drive water further into the joint. In horizontal joints (Figure 1(b)) water penetration is prevented by an upstand in the joint profile. Both vertical and horizontal joints are sealed against air penetration by strips of foam or other caulking, positioned at the rear of the joint. At the intersection of vertical and horizontal joints, baffles are overlapped so that water is directed towards the outside. To facilitate drainage, a separate flashing may be incorporated at the intersection of vertical and horizontal joints.

The single-stage, or face-sealed, joint

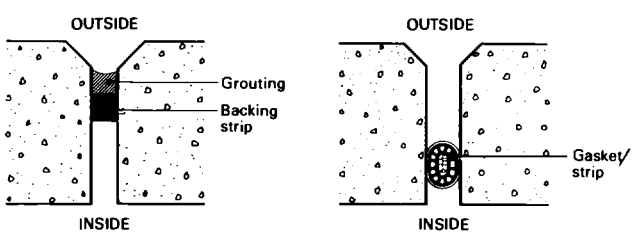
In this type of joint the penetration of both air and water is prevented by a single seal. The seal can be provided by a grouting of mastic or mortar (Figure 2(a)), a compressed foam strip or a flexible gasket (Figure 2(b)). Different forms of gasket are shown in Figure 3. In most cases, horizontal and vertical joints of this type are alike. Both mastic and



(a) Vertical joint (type 1 in Table 1)

(b) Horizontal joint (types 1 and 6 in Table 1)

Figure 1 Open-drained joints



(a) Mastic or mortar grouting with backing strip (joint types 2 and 7 in Table 1)

(b) Gasket or compressed foam strip (joint type 3 in Table 1)

Figure 2 Faced-sealed vertical joints

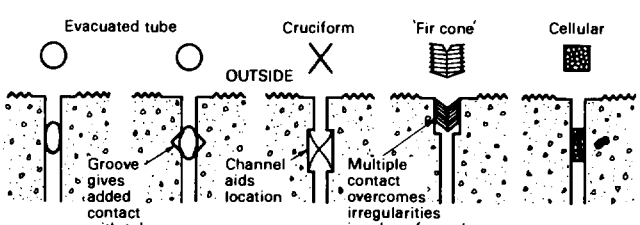


Figure 3 Basic forms of gaskets

mortar grouting rely upon adhesion to maintain the seal whereas gaskets and strips are installed in a compressed state and maintain the seal by their elasticity. To ensure correct positioning, grouting is usually applied against a former

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Table 1 Claddings and weatherproof joints in the principal large panel systems

System	Description of cladding	Type of joint*
Anglian Houses	Large precast concrete panels on gable walls and parts of main elevations; lightweight timber-framed infill panels on main elevations	1 2 4
Balency	Concrete wall panels; cast-in windows; various external finishes	2 4
Belfry	Houses — concrete panels with timber infill panels. Flats — concrete panels; exposed aggregate finish; cast-in windows	2 4 6
Bison	Concrete panels; exposed aggregate, mosaic or patterned finishes. On low-rise brick facings	1 4 6
Bryant	Concrete spandrel panels; mosaic, tile-hung, sprayed or trowelled finishes	2 4 5
Camus	Concrete panels; exposed aggregate, square tiling or mosaic finishes; cast-in windows and doors	2 3
Carlton	Concrete gable end panels; timber infill panels on main elevation	4
Cebus	Non-loadbearing facade panels; various external finishes	1 2 6
Conclad (Reema)	Concrete panels; exposed aggregate or fair-faced finishes	1 4
Cosmos	Concrete panels with ground beams; timber frames; plastic cladding	1 4 6
Fram Russell	Concrete panels; exposed aggregate, mosaic or tiled finishes; cast-in windows and doors	1 2 3 4 7
Gerrard 'Incon'	Concrete panels; mosaic, exposed aggregate, tile-hung finishes; ground floor — brick	4
GLE	Concrete panels; brick, exposed aggregate, clay, tile-hung or weatherboard finishes	1 4
Gregory	Concrete gable end and slab walls between storeys; brick cladding; timber infill panels elsewhere	4 5
Housing Development Construction	Concrete panels alternating with timber infill panels	1 3 4
Jesperson 12M	Concrete gable end walls; timber-framed or concrete infill panels to front and rear; various external finishes	1 4
Laing/BRS 'battery cast'	Concrete panels; various external finishes; cast-in windows	1 2
Larson & Nielson (TWA)	Concrete panels; various external finishes; cast-in windows and doors	1 3 6
Lecaplan	Concrete ground floor and walls; exposed aggregate finish; timber-framed curtain walling elsewhere	1 2 3 4 6
Sir Lindsay Parkinson ((HSSB)	Brick-faced concrete cavity wall units; some treated concrete; timber boarding	4 7
MFC (Moss & Sons)	Concrete panels; exposed aggregate, brick or painted finish on ground floor; tile hung, predecorated aluminium weatherboard or timber boarding elsewhere	2 4
Modus	Concrete panels with various finishes, brick or tile; timber infill secondary units; cedar boarding	1 4
PAC	Concrete panels; exposed aggregate finishes; curtain walling; mosaics	1
Reema	Concrete panels; variety of finishes; cast-in windows	1 2 4
SB2	Concrete panels; exposed aggregate, tiles or mosaic finishes	
Skarne (Crudens)	Non-loadbearing concrete panels; timber-framed curtain wall panels; brick cladding	1 4
Shepherd Spacemaker	Concrete panels; exposed aggregate, patterned concrete, brick, tile hung. On low rise, timber	1 4
Sundh	Non-loadbearing concrete panels; various external finishes; cast-in windows and doors	2
Tracoba	Non-loadbearing concrete panels; various external finishes; cast-in picture windows and doors. On low rise, timber infill panels	3 4 6
Wates	Glazed joinery units; concrete panels; storey-height window units; tiled and brick facings	1 2 4 7
XW (Selleck Nicholls Williams)	Brick; re-formed stone; timber infill panels; concrete with exposed aggregate; tile hung; weatherboarding	1 2 4
YDG (Yorkshire Dev Group) Mk1	Concrete panels; exposed aggregate finish; timber infill panels	1 4

* 1 Open-drained joint, vertical and horizontal (Figure 1)
2 Face-sealed with mastic (Figure 2(a))
3 Face-sealed with gasket (Figure 2(b))
4 'Traditional' joints, eg bricks, timber infill
5 Sealed with cover strip/capping piece (Figure 5)
6 Open-drained joint, horizontal only (Figure 1(b))
7 Grouted with mortar (Figure 2(a))

provided by a pre-positioned backing strip or by the joint profile. Weep pipes or weep holes are necessary in all single-stage horizontal joints to allow entrapped moisture to drain out.

The cover-strip joint

The cover-strip joint is a variation on the single-stage joint in which the seal is provided by a preformed section covering the gap between components. Cover strips of various materials and profiles are used (Figure 4). Figure 5(a) shows the joint in a timber cladding system sealed by a timber cover strip bedded in sealing compound. Figure 5(b) shows the joint between concrete cladding panels sealed with a cover strip of metal or durable plastic which has a spring clip that grips the sides of the joint. An advantage of cover-strip joints is that the seal is easily maintained and replaced.

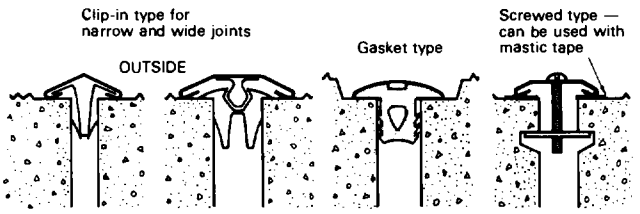
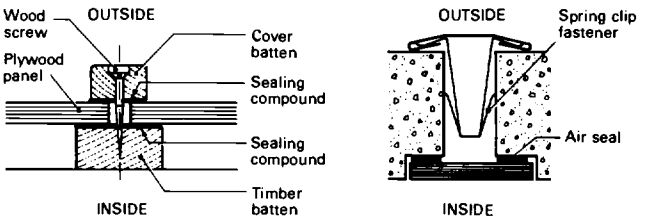


Figure 4 Basic details for cover strips for vertical joints only



(a) Timber cover strip (joint type 5 in Table 1)

(b) Metal cover strip (joint type 5 in Table 1)

Figure 5 Cover-strip vertical joints

Traditional joints

Many large panel systems include cladding materials and components that are more usually associated with 'traditional' housing. In addition to windows and doors, components such as infill panels of timber and brick are often used. The joints between these components, or between these components and concrete panels, will sometimes be of the types already described or they may be of types more commonly associated with traditional construction.

Traditional joints have been included in this paper because, when used in high-rise large panel system dwellings, they can be subjected to conditions of extreme exposure to driving rain.

Joints in individual systems

Each large panel system tends to have a standard structural form, but some incorporate variations in cladding which may affect the types of joint. A summary of the claddings and joint types used in the principal systems is given in Table 1. This list is not exhaustive and other combinations may exist.

JOINT DEFECTS

Ageing and movement caused by changes in temperature and moisture content are two of the most common causes of failure of weatherproof joints. Because of the size of the units in large panel systems, changes of joint width may be as much as 10 mm. This movement has to be accommodated by the joint if it is to remain weatherproof. Problems also arise as a result of differential movement between components constructed of materials having different thermal expansion coefficients. For example, where a long metal strip is used as a trim, the movement to be accommodated by the associated seal is reduced if the strip is fixed at intervals rather than only at the ends.

The weathertightness problems reported by owners of large panel system buildings show that it is not only system joints that have failed. The majority of leakage problems appear to be associated with 'traditional' components. The most common defects reported are described below. Problems associated with flat roofs, balconies and access ways will be dealt with in a later paper.

The two-stage, or open-drained, joint

The most common fault with these joints is the deterioration of the baffles, especially if they are of an early type for which butyl rubber was specified. Metal and metal-faced baffles tend to deteriorate at their ends and laps. Faults also occur at the intersection of vertical and horizontal joints. Here, instances have been reported of baffles lapped the wrong way so that water is directed into the buildings, and of flashings being omitted or damaged. Dimensional variations in manufacture and erection can result in joint widths outside a baffle's working range. Vertical baffles may become displaced if inadequately anchored at the top. Failure of air seals has given rise to draughts inside dwellings. In some cases, the upstand on horizontal joints has been insufficient to prevent the ingress of driving rain. Faults have also arisen from the wrong choice of remedial measure. A common defect is water entrapment where open-drained joints have been sealed with mastic without the inclusion of weep pipes.

The single-stage, or face-sealed, joint

Ageing is the most common fault with this type of joint, particularly where the seal is exposed to the elements. Under such conditions, seals tend to fail through a loss of adherence or elasticity. Premature failures have been reported where a narrow joint cannot take a mastic seal large enough to accommodate the movement, or where joints have been designed incorrectly. Joints between components of dissimilar materials may have to accommodate differential movement and adhere to dissimilar substrates. Where used in conditions outside their working range, gaskets, like baffles, may be over-compressed and lose elasticity, or the joint width may be too large for them to form an effective seal — cases have been reported of gaskets simply falling out of joints. Seals formed by mortar grouting may fail owing to weathering or shrinkage. Water may be entrapped in face-sealed or single-stage joints because weep pipes have been incorrectly designed or installed, or because they have been omitted. Cases have been reported where water plugging a weep pipe has been forced into the building by wind pressure.

Damaged panels

Problems have been caused by cracking of decorative surfaces, allowing water to enter a panel, where, if it collects, it can cause serious structural problems such as delamination of the panels. There have also been reports of the bowing or corrosion of panels distorting edge joints and destroying the integrity of seals. Damage to panels during construction, especially at edges and corners, can make the formation of a weatherproof seal virtually impossible.

Cast-in windows and doors

Many systems have cast-in wooden subframes for windows and doors which, by today's standards, have been inadequately treated with preservative during manufacture. With prolonged exposure the wood deteriorates and rots, allowing the ingress of water and air.

'Traditional' joints

Another common leakage problem on large panel system facades is leakage around window and door frames caused by inadequate flashings at heads and sills, inadequate water bars, failed mastic joints, deformed metal sub-sills and ill-fitting replacement units. The windows and doors themselves often leak because they have insufficient weathersealing. Inward opening French doors can be included in this category. Timber infill panels can shrink away from their frames, leaving an unprotected gap; or they may deteriorate and become porous. The cavities behind brick infill panels may be bridged by mortar droppings. Flashings at the top of panels may be damaged or missing. Junctions between infill panels and concrete components are prone to differential movement, and may be difficult to seal.

REMEDIAL MEASURES

Remedial measures should be appropriate to the type of joint in question. They are dealt with in *BRE Information Paper* IP9/86.

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