



BS 6093 : 1981

UDC 693.224 + 699.868 + 691.58

Code of practice for

Design of joints and jointing in building construction

Code de bonne pratique pour la conception des joints et du jointolement dans la construction des bâtiments

Richtlinie für die Konstruktion von Verbindungen und Dichtfugen im Bauwesen

British Standards Institution

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Foreword

This code of practice has been prepared under the direction of the Basic Data and Performance Criteria for Civil Engineering and Building Structures Standards Committee. It arises from the need to give guidance on the design of joints and jointing in order to improve performance in building practice and to reduce the incidence of technical failure. Sound building construction depends on proper joints being formed between building components. Over recent years a greater degree of sophistication has emerged in the design of buildings, resulting from increased technical knowledge, with the result that modern techniques of building construction are now so different from the traditional ones that the design of joints and jointing, in particular, needs to be re-thought from first principles.

Joints and jointing mechanisms are no longer simple constructions and their design necessitates a full understanding of the constraints and environmental conditions in which they have to function.

With the advent of component design associated with dimensional coordination in building, the correct functioning of the joint takes on a greater significance in the overall performance of a building structure. This is particularly relevant to air and water penetration. The consequences of jointing failures are often such as to render buildings unservicable and to necessitate extremely costly remedial repair works.

With the ever increasing importance now being attached to the performance of joints and to the need to specify clearly

each type of joint and the standard of workmanship that should be achieved on site, a logical design process is of fundamental importance. This code therefore describes the design processes and mechanisms of a broad range of basic jointing methods in the belief that if the designer is guided along these lines he is better equipped to solve problems for his specific designs. Great emphasis is placed upon the need to design for each particular situation in which a joint has to function. The principal factors that the designer has to consider are listed in table 2, which is based on ISO 3447. Guidance on the use of sealants for joints is given in BS 6213*.

Considerably greater knowledge is needed about the performance of materials, building components and jointing solutions, and it is strongly recommended that designers test the joint designs if they have doubts about the design concepts, particularly where the consequences of failures would be costly. Testing, or at the least the interpretation of test results, needs to take particular account of the effects of accuracy and movements, which it may not be practical to simulate completely under test conditions.

In addition to this code, the following standards are relevant to joints and jointing: BS 4011, BS 5606, BS 6213*, DD 22 and DD 51.

This code of practice represents a standard of good practice and therefore takes the form of recommendations.

Compliance with it does not confer immunity from relevant statutory and legal requirements.

*In course of preparation.

British Standard Code of practice for

Design of joints and jointing in building construction

1. Scope

This British Standard gives recommendations for the design of joints and the use of jointing products in building construction. Following an analysis of joint functions and of the performance of the parts to be joined, joints are classified on the basis of the movements and inaccuracies they have to accommodate. Mechanisms by which joints operate are identified and recommendations are made on the use of sealants and gaskets. Examples are given of joints for structures, cladding, openings in walls, partitions, roofs, floors and services passing through building elements.

The code does not present guidance in the form of a catalogue of proven joint designs, because the extent to which a design is appropriate to a particular use depends on circumstances specific to the building, e.g. its exposure, desired performance, durability and costs. The code therefore draws attention to matters that need consideration and provides a framework (table 1) within which to consider them. It remains the designer's task to develop solutions appropriate to particular uses.

The code does not cover:

- (a) rigidly connected joints, such as those formed by welding or gluing;
- (b) joints within components normally made in a factory, such as those round opening lights in windows;
- (c) the load-bearing functions of structural joints;
- (d) glazing (see CP 152);
- (e) joints in service pipes and ducts and their connections to appliances (see the code of practice relevant to the particular service);
- (f) methods of test for joints or for jointing products.

NOTE. All figures in this standard showing detailed joint designs should be treated as illustrating the principles in a recognizable context and not as working drawings of proven and universally applicable joints. A reminder of this is given for each figure to which it applies.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this British Standard, the definitions given in BS 2900 and BS 4643 apply, together with the following.

3.1 Joint design

3.1.1 induced deviation. Dimensional deviation caused by work done.

NOTE. The operations of setting out, manufacture, assembly and erection give rise to this type of deviation.

3.1.2 inherent deviation. Dimensional deviation caused by an inherent material property.

NOTE. Changes in temperature, humidity, stress etc. give rise to this type of deviation.

3.1.3 interchangeability. Ability of a component to be used and joined satisfactorily with a variety of other components.

3.1.4 joint clearance. Distance between the joint faces of adjacent building components, i.e. the distance considered in the calculation of a work size in order to achieve fit.

3.1.5 joint geometry. Disposition of all the parts that contribute to the functions of the joint.

3.1.6 joint profile. That part of a component profile designed to relate to a joint.

3.1.7 movement accommodation factor (MAF) of a sealant. Maximum movement which a sealant is capable of tolerating throughout its working life, expressed as a percentage of the minimum joint width.

3.2 Jointing materials

3.2.1 seal. Physical barrier that is notionally impenetrable and is in contact with the components forming the joint.

NOTE. The term does not presuppose the use of any particular material or mechanism, but implies effectiveness in sealing against whatever agent is relevant, such as water, air, fire or sound.

3.2.2 sealant. Material that, when applied to a joint in an unformed state, seals it by adhering to appropriate surfaces within the joint.

3.2.3 elastic sealant. Sealant that after application exhibits predominantly elastic behaviour, i.e. the stresses induced in the sealant as a result of joint movement are almost proportional to the strain.

3.2.4 plastic sealant. Sealant that after application retains predominantly plastic properties, i.e. the stresses induced in the sealant as a result of joint movement are rapidly relieved.

3.2.5 elastoplastic sealant. Sealant having predominantly elastic properties but exhibiting some plastic properties when stressed for other than short periods.

3.2.6 plastoeelastic sealant. Sealant having predominantly plastic properties with some elastic recovery when stressed for short periods.

3.2.7 sealing strip. Preformed adhesive material that constitutes a seal when compressed between appropriate joint surfaces.

3.2.8 back-up material. Material inserted in a joint to limit the depth of sealant applied and that defines the back profile of the sealant.

3.2.9 baffle. Strip of flexible material inserted into a two-stage joint to prevent the passage of rain.

Documents

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3.2.10 bond breaker. Film or thin strip material applied to the back of a joint to prevent sealant adhesion.

3.2.11 gasket. Flexible, generally elastic, preformed material that constitutes a seal when compressed.

3.2.12 joint filler. Compressible non-adhesive material used to fill movement joints during their construction. It may act as a back-up material.

4. Design

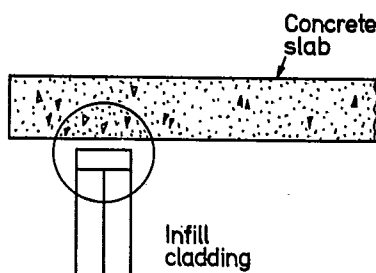
4.1 Analysis

4.1.1 General. Since joints are breaks in the physical continuity of construction, they are potential breaks in the continuity of performance. Unnecessary use of joints should therefore be avoided.

The designer should first decide what the joint has to do to maintain building performance.

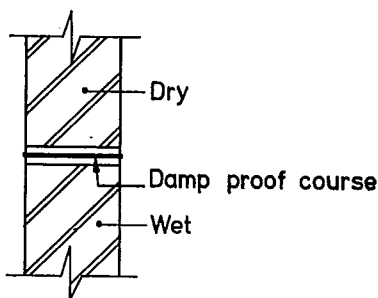
4.1.2 The necessity for and purposes of joints. Designers should consider whether and why joints are necessary: it may be possible to avoid or reduce the need for them. Some unavoidable circumstances may, however, determine that joints are necessary and in consequence determine the locations, the pattern of distribution and some of the functional needs of the joints.

4.1.3 Practical constraints. From circumstances inherent in materials and methods of work the need for site joints arises as follows.



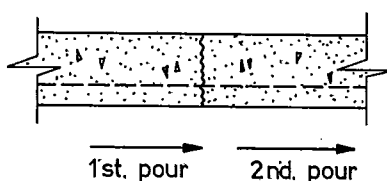
Section through vertical and horizontal elements

(a) Differing functions needed of contiguous parts that can be met only by the use of different materials



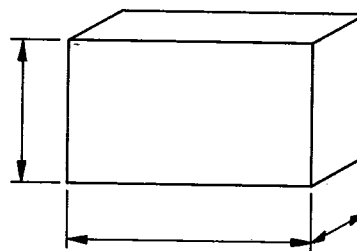
Section through wall

(b) Change of conditions necessitating separation by a barrier



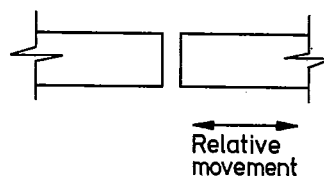
Section through concrete

(c) Limitations imposed by methods of working, for example formation of day-work joints in in situ concrete construction



Feasible limits of size for component

(d) Limitations of size and weight imposed by manufacture, handling of all stages, storage, transport and assembly



Plan at a joint subject to movement

(e) Limitations imposed in service by inherent properties of materials

4.2 Design decisions. Once the need for joints is established, their location and frequency are determined from design decisions and are influenced by:

- (a) general planning decisions about storey height, relationships between solids and voids (for example windows and walls), room sizes, floor spans, etc.;
- (b) values chosen from the range of co-ordinating sizes;
- (c) the desire to locate joints away from areas of high stress in service;
- (d) the desire to avoid complex joint intersections;
- (e) the desire to facilitate fit, for example:
 - (1) by increasing the number of joints;
 - (2) by avoiding components having to be fitted within preformed openings;
 - (3) by preforming internal and external corners;
- (f) the desire to minimize the extent of jointing for reasons of, for example, hygiene, cost or performance;
- (g) the desire to obtain a particular appearance of scale, proportion, pattern, symmetry or other attributes (such as false joints).

4.3 Functional needs. Once the need for and location of a joint are established, the following functional needs are imposed upon it:

- (a) *for all joints:* a performance such that the whole assembly including the joints achieves the desired performance. In many cases, this implies continuity of the desired performances of the joined components during their life, taking maintenance into account;
- (b) *for many joints:* the accommodation of movement of joined parts after assembly (inherent deviations) and also of variability in size and position of joined parts (induced deviations).

4.4 Desired joint performance. When joint clearance is subject to variation its size should be specified by means of both upper and lower limits.

If the joint is likely to fail before the joined components, the consequences and ease of repair should be considered.

Where the performance of an element is known or specified, it should be treated as a target to be achieved by the joints within it. In practice, reduced performance may be inevitable due to differences between materials suitable for jointing products and for components.

The performance in service of a joint is greatly influenced both by the effects of induced and inherent deviations on joint clearance and by the durability of the jointing products.

The performance of joints subject to dimensional variation (see 4.3(b)) is critically dependent upon the achievement of suitable clearances. The upper and lower limits of clearance for satisfactory working should be identified. The practice of basing the design of these joints on a single value of clearance is to be deprecated. Procedures given in DD 22* with data from BS 5606 enable an estimate to be made of the probability that achieved clearance will lie within the desired limits. When the final selection has been made, the permissible limits of clearance for the chosen joint (together with the corresponding target dimensions and accuracy for the components and construction) should be specified as an essential part of the description of the joint.

The measures to be adopted for those clearances that prove to be outside the working limits should also be considered at the design stage. These may include the provision of stand-by joint designs. Other measures, such as sorting of components, may be appropriate depending on cost and on the importance of the joint.

Durability imposes a time limit upon the performance of all functions. Inadequate durability increases maintenance costs both for the joints and for the building as a whole.

Design should aim to:

- (a) reduce the exposure of the joint;
- (b) minimize damage to the fabric should the joint fail;
- (c) provide accessibility for repair or replacement;
- (d) establish the expected frequency of replacement (see also 8.4).

4.5 A rational approach to joint design. The process of joint design is too complex to formalize totally. Designers should be clear about what they expect joints to do, and should:

- (a) establish the conditions under which the joints are expected to perform;
- (b) consider how the techniques of seal, profile and geometry can best be employed;
- (c) consider how to deal with dimensional variations.

The basis for a systematic approach to joint design is illustrated in table 1.

4.6 Environmental factors. When the general needs for joints have been considered, environmental factors should be quantified.

The data for joints are the same as those needed for the components. Some values emerge from user requirements such as temperature or humidity. Other values derive from the natural environment such as wind pressure and rainfall. Designers should also consider the environment during construction.

4.7 Dimensional factors

4.7.1 General. Data about inherent and induced deviations in components and spaces are needed to determine the effects of these deviations on joint dimensions and to aid selection of appropriate joint mechanisms and materials.

The data needed are:

- (a) the mean and standard deviations for the sizes of components. If these are not available, permissible deviations should be specified by the building designer;
- (b) the predicted variability in the size of spaces as given in BS 5606 (or, when not given therein, the permissible deviations estimated by the building designer);
- (c) the predicted changes in sizes of components and spaces in service;
- (d) the number of joints in the assembly;
- (e) the distribution of the deviations listed in (a) to (c) among those joints.

4.7.2 Thermal and moisture variations (item 4.2 of table 2).

The greatest range of temperature is usually experienced on the external face of buildings but resulting dimensional changes may tend to be balanced by opposite movements due to changes in moisture content. Internally, both thermal and moisture movements may be less significant depending on the environment within the building.

Whereas the annual air temperature range in Great Britain is about 35 K (-5°C to 30°C), the actual temperature range to which materials are subjected due to radiation is greater and depends on the orientation of, and the incidence of radiation on, the surface, as well as on the colour and degree of protection (insulation or shading) of the surface. Surface temperatures can in extreme circumstances be as high as 80°C and as low as -20°C .

Thermal movement per unit length can be calculated from:

- (a) the temperature range;
- (b) the degree of exposure;
- (c) the response of materials to thermal change;
- (d) the colour of surfaces;
- (e) the restraint of movement.

Calculation methods are given in BRE Digests 227, 228 and 229†.

The capability of joints to accommodate movement determines the maximum interval between them, taking account of the way in which fixings may distribute movement.

While it may be sufficient for a designer to make allowance for movement for in-service conditions on the basis of thermal movement only (see appendix A for list of coefficients), the validity of this assumption should always be confirmed. Exceptions are sandstone and timber (across grain), where movement due to moisture may exceed that due to thermal change (see A.2). Movement due to moisture along the grain of timber is not significant.

*For many applications it may be found more convenient to use the Building Research Establishment (BRE) Report, Bonshor, R.B. and Eldridge, L.L., *Graphical aids for tolerance and fits*. HMSO, 1974.

†BRE Digests 227, 228 and 229, *Estimation of thermal and moisture movements and stresses*. HMSO, Part 1, July 1979; Part 2, August 1979; Part 3, September 1979.

Table 1. A rational approach to joint design

Design process

Guidance and data

Analysis

- (a) Consider the overall design concept for the building.
Establish the need for a joint (4.1)

Assimilation of requirements

- (b) Determine the joint location and frequency (4.2)

- (c) Determine the primary joint functions and note
secondary functions (4.3)

General list of joint functions, table 2

- (d) Identify the desired performance of components and
define performance objectives for the joint (4.4)

- (e) Quantify all environmental and dimensional factors
that affect joint performance (4.6 and 4.7)

General and site data, e.g. exposure

- (f) Consider the distribution of dimensional deviations in
the assembly and identify the joint type (4.8)

DD 22 and graphical aids
Previous experience

Generation of solutions

- (g) Select basic mechanisms (table 3)

Basic techniques: geometry, profile and seal
(clause 5)

- (h) Develop a solution (clause 7)

General jointing product data (clause 6)
Manufacturers' data
Codes of practice, specification and methods
of test
Details relevant to specific situations

- (j) Test if necessary

Pass

Fail

- (k) Accept the solution

NOTE. Examples of the use of this table for the development of specific solutions are given in appendix B.

Table 2. General list of joint functions, grouped under design aspects (based on ISO 3447)

1. Environmental factors**1.1 To control passage of**

- (a) insects and vermin;
- (b) plants, leaves, roots, seeds and pollen;
- (c) dust and inorganic particles;
- (d) heat;
- (e) sound;
- (f) light;
- (g) radiation;
- (h) air and other gases;
- (j) odours;
- (k) water, snow and ice;
- (l) water vapour.

1.2 To control condensation.**1.3 To control generation of**

- (a) sound;
- (b) odours.

2. Capacity to withstand stress (either during or after assembly)

To resist stress in one or more directions due to:

- (a) compression;
- (b) tension;
- (c) bending;
- (d) shear;
- (e) torsion;
- (f) vibrations (or any other type of stress which may induce fatigue);
- (g) impact;
- (h) abrasion (indicate, for each particular case, the type of wear);
- (j) shrinkage or expansion;
- (k) creep;
- (l) dilation or contraction due to temperature variations.

3. Safety

3.1 To control passage of fire, smoke, gases, radiation and radioactive materials.

3.2 To control sudden positive or negative pressures due to explosion or atmospheric factors.

3.3 To avoid generation of toxic gases and fumes in case of fire.

3.4 To avoid harbouring or proliferation of dangerous micro-organisms.

4. Accommodation of dimensional deviations

4.1 To accommodate variations in the sizes of the joint at assembly due to deviations in the sizes and positions of the joined components (induced deviations).

4.2 To accommodate continuing changes in the sizes of the joint due to thermal, moisture and structural movement, vibration and creep (inherent deviations).

5. Fixing of components

5.1 To support joined components in one or more directions.

5.2 To resist differential deformation of joined components.

5.3 To permit operation of movable components.

6. Appearance

6.1 To have acceptable appearance.

6.2 To avoid

- (a) promotion of plant growth;
- (b) discoloration due to biological, physical or chemical action;
- (c) all or part of the internal structure showing;
- (d) dust collection.

7. Economics

7.1 To have a known first cost.

7.2 To have a known depreciation.

7.3 To have known maintenance and/or replacement costs.

8. Durability

8.1 To have specified minimum life, taking into account cyclic factors.

8.2 To resist damage or unauthorized dismantling by man.

8.3 To resist abrasive action.

8.4 To resist action of

- (a) animals and insects;
- (b) plants and micro-organisms;
- (c) water, water vapour or aqueous solutions or suspensions;
- (d) polluted air;
- (e) light;
- (f) radiation (other than light);
- (g) freezing of water;
- (h) extremes of temperatures;
- (j) airborne or structure-borne vibrations, shock waves or high-intensity sound;
- (k) acids, alkalis, oils, fats and solvents.

9. Maintenance

9.1 To permit partial or complete dismantling and reassembly.

9.2 To permit replacement of decayed jointing products.

10. Ambient conditions

10.1 To perform desired functions over a specified range of

- (a) temperature;
- (b) atmospheric humidity;
- (c) air or liquid pressure differential;
- (d) joint clearance variation;
- (e) driving rain volume.

10.2 To exclude from the joint if performance would be impaired:

- (a) insects;
- (b) plants;
- (c) micro-organisms;
- (d) water;
- (e) ice;
- (f) snow;
- (g) polluted air;
- (h) solid matter.

NOTE. Any one joint will have to satisfy a selection of functions only. This list cannot be comprehensive and the designer may have to identify additional functions applying in a specific situation.

Some materials respond to changes in moisture content following changes in weather conditions, and appropriate allowance has to be made taking into account the environment at the time of construction. Examples of such materials are concrete blockwork and timber.

Care should be taken about the moisture content of absorbent materials in storage and during the course of construction, in order to minimize subsequent movement.

In such environments as are found in swimming pools and certain industrial processes where high humidity occurs, the behaviour of moisture-sensitive materials should be given special consideration.

4.7.3 Drying shrinkage and thermal contraction. In addition to thermal and reversible movements, concrete is subject to shrinkage and thermal contraction.

Plastic shrinkage may occur during the first few hours after placing through the loss of water from the plastic concrete by evaporation or, sometimes, by absorption into adjacent materials. Plastic shrinkage is common in hot weather and in drying winds and can result in cracking. It can largely be avoided by slowing down the drying of the concrete.

Early thermal contraction can be significant in concrete over about 0.5 m thickness. It is due to the natural cooling that takes place when the heat of hydration passes its peak. The temperature rise can typically be about 20 K two days after placing. The designer should be aware of the effect of early thermal contraction and, where appropriate, should provide joints or planes of weakness to confine cracking to predetermined positions.

Drying shrinkage is a long term process and may continue over many months. Any movement is influenced by the size of section, the concrete mix, the amount of reinforcement and the environment. The designer should allow for the effects of drying shrinkage when detailing concrete blockwork.

Initial drying shrinkage of calcium silicate bricks is defined by BS 187; these bricks need to be protected against excessive moisture up to and during construction (see CP 121 : Part 1).

4.7.4 Expansion. Fired clay units exhibit reversible movements due to changes in moisture content. These are usually negligible but there is a permanent moisture expansion, the rate of which decreases with time and is dependent upon the type of clay and burning.

It is recommended that fired clay units be not used until at least two days after manufacture (see CP 121 : Part 1).

4.7.5 Effects of manufacture and assembly of components on joints. An individual component normally deviates both from its intended size and from its intended position in the building. Both kinds of deviation occur three-dimensionally. When two components are placed with a joint clearance between them these deviations affect the size and shape of the joint three-dimensionally. Designers have to design for the generality of such deviations, but a particular assembly when constructed contains deviations with particular values. If systematic account is taken of deviations (see table 1(f)) the majority

of joints can be expected to lie within the desired joint clearance limits.

When the width of a constructed joint exceeds the specified limits, consideration should first be given to the possibility of adjusting the position of the components in the assembly so as to distribute excess deviation among the joints in the assembly and optimize the joint clearances. Particular types of deviation in joint width may still need special action even when the width is within the desired limits at all points. For example:

- (a) *taper in elevation*: the depth to width ratio needed by a sealant may necessitate a change in depth at different parts of the joint's length;
- (b) *bow and twist*: these may produce misalignment between, for example, grooves and rebates on opposite joint faces, such that jointing products cannot be properly installed. Excessive bow or twist may necessitate substitution by a replacement component;
- (c) *misalignment of component faces*: like bow and twist, positional misalignment of components may produce unacceptable mismatch between grooves or rebates on opposite joint faces. Positional errors should be corrected until within limits such that the joint can be made, and can perform, satisfactorily. This is particularly important at joint intersections and cross-overs where continuity of seals with those in the intersecting joint is to be maintained;
- (d) *surface irregularities*: imperfections in joint faces should be corrected if joint performance would otherwise be impaired. In particular, protrusions on joint faces may produce local distortion of gaskets, and 'blowholes' may provide routes by which the jointing mechanism may be by-passed. Imperfections in surfaces adjoining the joint may make it difficult to achieve a well-defined edge to sealants.

When it is not practicable to rectify joints that have widths outside the specified limits, the appropriate one of the two 'stand-by' joint designs (for undersize and for oversize joints) should be adopted (see also 4.4).

4.8 Provision for dimensional deviations

4.8.1 General. The initial generation of solutions may be based upon four assumptions that can be made about the distribution of induced and inherent deviations (see clause 3). These are as follows.

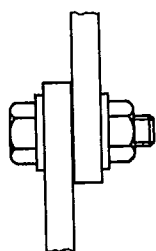
- Type 1. No allowance made for any deviations.
- Type 2. Allowance made for inherent and induced deviations.
- Type 3. Allowance made for inherent deviations only.
- Type 4. Allowance made for induced deviations only.

Examples of joints for which each assumption is usually made are given in figures 1 to 4.

Having made a provisional assumption about the design of the joint, the designer then needs to consider:

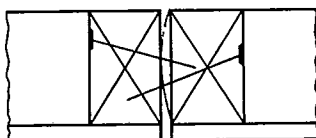
- (a) the significance and values of dimensional deviations to be accommodated;
- (b) the consequences of this assumption for joints elsewhere in that assembly.

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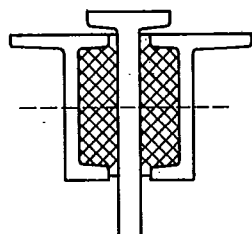
Section

(a) Plain bolted joint. Holes sized for bolt clearance only



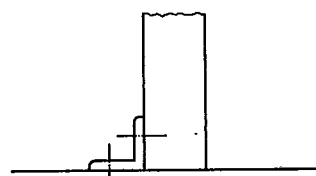
Plan

(b) Junction of timber panels skew nailed together. These will abut at 'high spots'



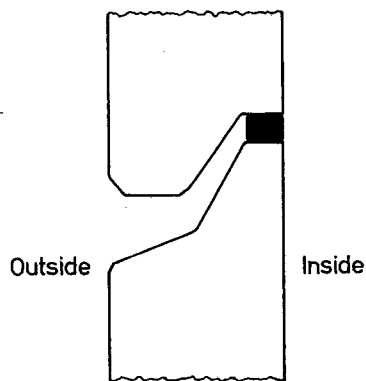
Plan

(c) Coupling bar between two steel window frames. Mechanical fixing allows negligible movement



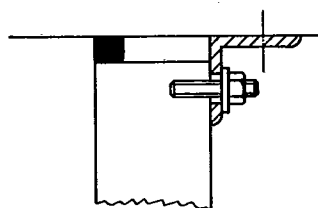
Section

(d) Base of partition panel fixed with non-adjustable cleat

Figure 1. Examples of type 1 joints (no allowance made for any deviations)

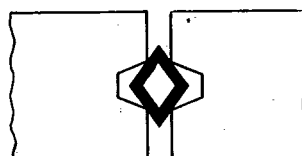
Section

(a) Horizontal joint between external wall panels (support remote from joint)



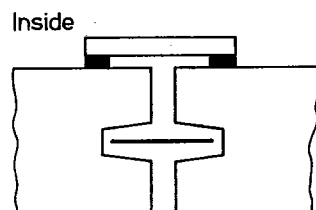
Section

(b) Joint at head of partition panel with restraining cleat designed to allow movement. Prefixing of cleat to soffit is a type 1 joint



Plan

(c) Joint between panels with gasket seal

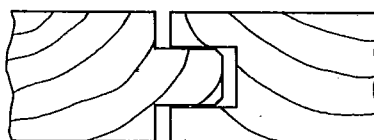


Outside

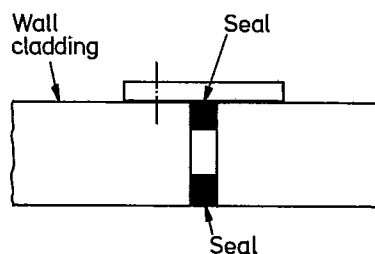
Plan

(d) Two-stage joint with rain baffle and air seal

Figure 2. Examples of type 2 joints (allowance made for inherent and induced deviations)

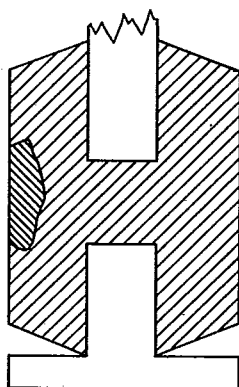


(a) Tongue jointed floor boarding, close butted initially. Joints subsequently subject to movement

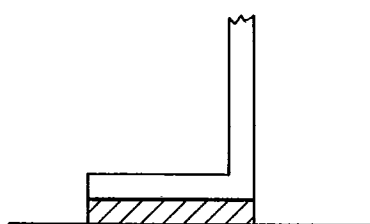


Plan

(b) Joint between wall panels. Joint clearance at assembly made with fixed (constant) width gauge or stop



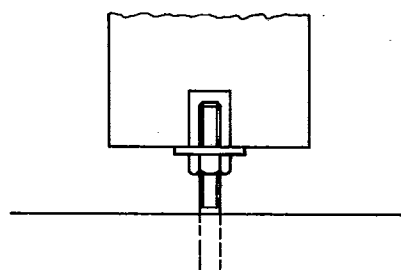
(c) 'Zipper' structural gasket in rubber/plastic



Section

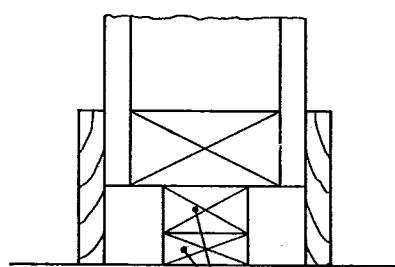
(d) Component on resilient packing (anti-vibration)

Figure 3. Examples of type 3 joints (allowance made for inherent deviations only)



Section

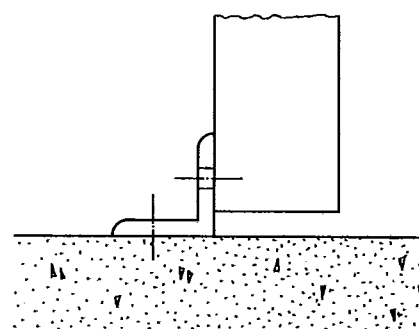
(a) Base of wall partition component with levelling device



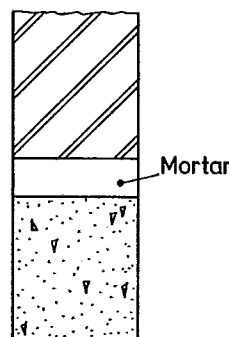
Folding wedges

Section

(b) Base of partitioning component with folding wedge packings



(c) Base of suspended panel fixed with adjustable cleat



Mortar

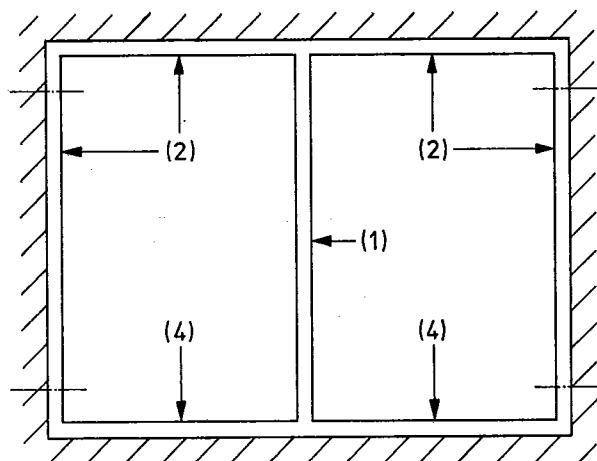
(d) Horizontal mortar joint

Figure 4. Examples of type 4 joints (allowance made for induced deviations only)

4.8.2 Interaction of the four joint types. An assembly usually contains more than one of the four joint types. The designer should assess the *distribution* of induced and inherent deviations throughout the assembly in order to choose the appropriate combination of joint types.

Figure 5 illustrates the interrelationship and effects of an assembly of two panels of walling erected in an existing opening.

Fixings may modify the distribution of inherent deviations in the assembly and this needs separate consideration. For example, central fixings cause inherent deviations to be shared between the end joints: fixings at one end concentrate all inherent deviations at the other end.



NOTE 1. *Joint at base: assumed type 4.* Panels are supported at the base. Induced deviations are taken into account:

- (a) to ensure verticality of jamb joints;
- (b) to distribute the total vertical clearance between head and base joints.

Inherent deviations are assumed not to occur. (A supporting joint without adjustability would be type 1.)

NOTE 2. *Joint at head: assumed type 2.* Allowance for induced deviation is shared with the joint at the base. Allowance is made for inherent deviation due to change in panel size (thermal and moisture movement) and change in size of the opening (thermal movement, deflection and creep).

NOTE 3. *Joint at jambs: assumed type 2.* Inherent and induced deviations are shared by these joints but not with the centre joint (1).

NOTE 4. *Joint at centre: assumed type 1.* This joint is butted and fixed on assembly and is subject to neither inherent nor induced deviations.

Figure 5. Assembly of panels showing joint types

Key to table 3

The diagrams do not represent specific materials.

Symbol	Key	Notes
EV EH	External walls: vertical joint External walls: horizontal joint	Column 1 of table 3 gives a code for each joint and column 6 gives a code for those joints at right angles that can be used with it.
R	Roofs	Column 1 reference code.
G P S	Geometry Profile Seal	The notations in column 2 of table 3 are in the sequence in which penetration is resisted.
O	Single seal	Column 3 of table 3 illustrates the jointing mechanism.
	Linked seal	
	Continuous seal	
	Bonding	
	Designed depth of penetration of the agency being resisted	
	Flashing	

Table 3. Illustrations of basic mechanisms

(a) Applied to vertical joints in external walls (functions considered: control of water and air penetration)

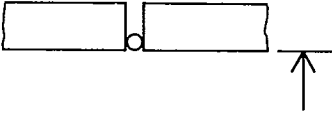
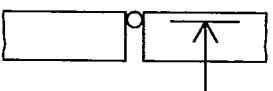
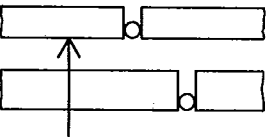
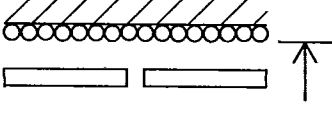
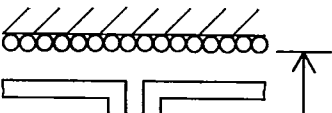
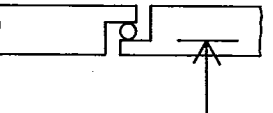
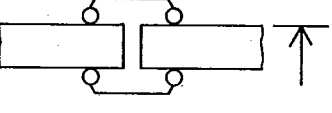
Reference code	Mechanism	Diagrams of principles	Application of principles	Comments	Use with
EV1	S		Sealant face joints	Single line of defence with greatest exposure. If movement is also to be accommodated, the demands on product performance are particularly great.	EH1
EV2	GS		Gasket joints	As EV1 but direct exposure is less.	EH2
EV3	SG		Mortar joints in cavity construction	Jointing primarily air seals	—
EV4	GS		Rain screen joints	Seal well protected and has low performance demand.	EH3
EV5	PGS		Rain screen joints	As EV4 but with additional protection to reduce side flow of water from face to cavity	EH3
EV6	PGS		Two-stage open drained joint in cladding	Seal primarily against air penetration with a baffle against water penetration	EH2
EV7	PGS		Rebated window joint	Seal well protected and advantageously stressed in shear when subject to movement	EH2
EV8	P		Profiled sheets	Labyrinth joint adequate for some situations. Can also be sealed.	—
EV9	SGS		Double-sealed as in H-clip joints, patent glazing or structural gaskets	Potentially highly effective joint. Needs cladding overlaps at horizontal joints or total continuity of seals.	EH4 EH5

Table 3. Illustration of basic mechanisms (*continued*)

(b) Applied to horizontal joints in external walls (functions considered: control of water and air penetration)

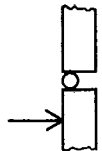
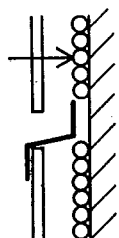
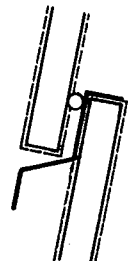
Reference code	Mechanism	Diagram of principles	Application of principles	Comments	Use with
EH1	S		Sealant face joints	Single line of defence	EV1
EH2	PGS		Gasket recessed joints in cladding	Potentially well protected. Combined flashing and seal	EV2 EV6 EV7
EH3	PGS		Rain screen joints	Drainage of cavity at horizontal joints to limit the volume retained in it	EV4 EV5
EH4	GS		Glazing joints water and air sealed	May be compared with EH2	EV9
EH5	SGS		Double sealed joints	Seals continuous at junctions. Void between seals may be used as a second line of defence against water penetration but drainage is necessary	EV9

Table 3. Illustrations of basic mechanisms (*concluded*)

(c) Applied to roofs (function considered: control of water penetration)

Reference code	Mechanism	Diagrams of principles	Application of principles	Comments
R1	S		Minor movement joints, for example, at screed bay joints in a felted roof	Interruption of bonding by a slip strip avoids concentration of strain in the membrane
R2	S		Medium movement joints, for example in multi-storey car parks. May accommodate larger movements if specialized components are used	This principle is used where R3 cannot be adopted. Unlike R1 it relies on a separate seal at the joint. The amount of movement permissible is determined by the design of the seal
R3	PG		Major movement joints, for example in asphalt roofs	The principle is to lift the joint above the vulnerable plane; effectiveness increases with upstand height
R4	GS		Tiled pitched roofs with an air seal provided by boarding or felt (formerly by 'torching')	Angle of pitch needs to be related to size and type of tile
R5	GS		Pitched roofs with, for example, rigid sheets having sealed laps	As angle of pitch diminishes, the contribution of 'geometry' decreases

5.2 General characteristics of joint geometry and joint profile. The contributions of joint geometry and joint profile to the performance of functions have been established in 5.1.

Geometry and profile affect the performance either directly or indirectly. In many joints, geometry and profile can be designed to extend the surfaces and enclose the gap, within both the joint and its surrounding construction. Their contribution to joint performance as a whole cannot be isolated and has to be considered in terms of general principles and attributes.

In order to consider joint geometry and profile, three methods of constructing the external envelope are described in 5.3 to 5.5:

(a) single skin with one-stage joints;

(b) single skin with two-stage joints;

(c) multi-layer.

5.3 Single skin construction with one-stage joints

5.3.1 General principles. One-stage joints depend entirely upon the effectiveness of the jointing products to seal against water and air penetration simultaneously. Jointing products have to maintain contact with joint faces and to remain cohesive in use. Continuing satisfactory performance depends mainly upon the durability of the jointing products; the life of many jointing products is less than that of buildings. Consideration should be given to protection of the joint, to the expected frequency of repair and to the consequences of periodic failure.

5.3.2 The needs of seals. Seals for one-stage joints are available in two forms: those that depend for the transmission of movement forces on (a) adhesion, such as