

Code of practice for

Design and installation of natural stone cladding and lining

Committees responsible for this British Standard

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- British Adhesives and Sealants Association
- Building Employers' Confederation
- Department of the Environment (Building Research Establishment)
- English Heritage
- Federation of Civil Engineering Contractors
- Institute of Clerks of Works of Great Britain Incorporated
- Institution of Civil Engineers
- Natural Slate Quarries Association
- Stone Federation

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Foreword

This British Standard has been prepared under the direction of the Technical Sector Board for Building and Civil Engineering. It is a new edition of BS 8298:1989 which is withdrawn.

Stone in the form of thin slabs of modest dimensions has been used for centuries as a decorative facing to backgrounds of stone and brickwork. With framed structures, where the loads are carried by the frame and not by the external walling, the materials or combinations of materials used to cover the structural framework are referred to as cladding.

Cladding in the form described in this standard, requires care to ensure permanent fixing and to prevent or control the ingress of water. Adequate precautions have also to be taken to provide for permanent and temporary movements of the structure due to shrinkage and elastic deformation under load. Movement due to temperature and other factors has also to be taken into account.

This standard describes the provisions necessary for the cladding to perform its function satisfactorily. It gives the minimum standards required and the materials and methods most frequently used for stonework including stone faced precast concrete units.

The recommendations for fixing stonework where used as an internal wall lining and in shopfront work have been modified. The use of thermal insulation behind external cladding has also been included.

Cladding supported or held in position by metal framing or by bolts secured to stones by adhesion and bolted to a metal frame has not been included. The same general principles as for traditional stone cladding will apply to this alternative method, with particular attention paid to the need for articulation and isolation of dissimilar metals.

Assessed capability. Users of this British Standard are advised to consider the desirability of quality system assessment and registration against the appropriate Part of BS 5750 by a third party certification body.

Enquiries as to the availability of third party certification schemes are forwarded by BSI to the Association of Certification Bodies. If a third party certification scheme does not already exist, users should consider approaching an appropriate body from the list of Association members.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 40, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Section 1. General

1.1 Scope

This British Standard gives recommendations for the design, installation and maintenance of mechanically fixed facing units of natural stone as a cladding and lining:

- a) held to a structural background by metal fixings;
- b) to precast concrete units (i.e. stone faced concrete cladding units).

Loadbearing cladding or cladding held only by adhesion is not included, nor is any type of cladding supported or held in position around the perimeter of stones or series of stones by metal framing. Recommendations concerning traditional stone masonry including ashlar are given in BS 5390.

Movement of the structure may occur due to one or more reasons and recommendations are included to accommodate such dimensional changes (see 3.13). As it is virtually impossible to provide for this movement if the attachment of the stone cladding to the structure is too rigid, the use of stone cladding as permanent formwork to in situ concrete is not included (but see 3.8.5).

This code does not include the testing of materials and components except in cases where there is a relevant British Standard.

NOTE Unless the requirements differ, the term cladding refers to both cladding and lining. The general principles for cladding also apply to soffits and sloping surfaces (see 3.10.6).

1.2 References

1.2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on pages 39 and 40. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

1.2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on page 40, but reference should be made to the latest editions.

1.3 Definitions

For the purposes of this British Standard the definitions given in BS 6100 apply. Terms which are particularly relevant are reproduced below together with others not in BS 6100.

1.3.1

back-up material

material placed in a joint cavity behind the sealant to control the depth of sealant without inhibiting joint movement

1.3.2

bimetallic corrosion

corrosion caused by contact between dissimilar metals in the presence of an electrolyte, such as water

1.3.3

cavity barrier

construction provided to close a concealed space against penetration of smoke or flame, or provided to restrict the movement of smoke or flame within such a space

1.3.4

cladding

external vertical or near vertical non-loadbearing covering to a structure

1.3.5

fascia

long and relatively narrow vertical surface at eaves or corners or over a shop front

1.3.6 Finishes to stone faces

1.3.6.1

axed

finish obtained by using an axe or a bush hammer

1.3.6.2

dolly pointed surface

semi-rough finish on a plain face of granite

1.3.6.3

filled

finish where natural voids in stone are filled with cements, shellac or other material

NOTE It is also called a waxed or stopped finish.

1.3.6.4

flame textured

rough textured finish obtained by passing a flame over the surface

1.3.6.5

honed

finish having a dull polish or a matt surface

1.3.6.6**polished**

surface finish having a high gloss

1.3.6.7**riven**

surface finish produced by splitting along the cleavage planes

1.3.6.8**rubbed**

smooth finish obtained by rubbing stone with an abrasive

1.3.6.9**tooled**

dressed surface finish showing tool marks

1.3.7 Fixings**1.3.7.1****cladding fixing**

device to support or tie back cladding units

1.3.7.2**face fixing**

cladding fixing through face of stone which combines the function of a loadbearing and/or restraint fixing

1.3.7.3**loadbearing cladding fixing**

cladding fixing that transfers the self weight of one or more cladding units to a structure

1.3.7.4**restraint fixing**

cladding fixing that ties back cladding units to a backing or to another restrained unit

NOTE The term “tying back fixing” is deprecated.

1.3.8 Joints**1.3.8.1****compression joint**

joint designed specifically to accommodate partial closure resulting from vertical shortening of the structure relative to the cladding

1.3.8.2**dry butt joint**

joint in which units abut each other without any jointing material

1.3.8.3**filled joint**

joint that makes use of a jointing product to fill the gap between adjacent parts

1.3.8.4**movement joint**

joint that permits movement between adjacent parts

1.3.9**lining**

dry covering to any internal building surface

1.3.10**pilaster**

pier or part of a column, attached to a wall

1.3.11**sealant**

unformed flexible material applied in joints to prevent the passage of moisture, wind, dust, etc.

1.3.12**soffit**

exposed horizontal or sloping undersurface of any form of construction works

1.3.13**stallriser**

the upright part of a shop front between the pavement and window sill

1.3.14**stone faced concrete cladding unit**

a cladding unit having a facing of natural stone, used as a permanent decoration to concrete, with or without a bond breaking agent

1.4 Exchange of information and time schedules**1.4.1 General**

At the preliminary design stage the stone(s) selected may still be unquarried, and possibly in a foreign country. Consideration should therefore be given to the availability and suitability of the stone(s) and the time for their preparation and delivery to site, especially when large quantities of stone will be required. Information is needed to enable the work to be scheduled satisfactorily, for an accurate price to be obtained, to minimize supply and production difficulties and to ensure safe and practical site fixing. The points that should be considered are given in 1.4.2, 1.4.3 and 1.4.4.

1.4.2 Initial feasibility planning

The information required at the feasibility planning stage includes the following items:

- a) the total areas to be clad and their locations on or in the buildings;

- b) the aesthetic and/or visual effect required, in terms of colour jointing pattern, surface finish, durability, etc. in order to “short list” suitable stones;
- c) the limitation in face size and thickness of possible stones and their availability from a quarry and/or works;
- d) the function of the cladding and the height, location and type of structure to which it is to be fixed;
- e) the natural variations in colour, tone and markings that can occur in the selected stone(s);
- f) the approximate time between placing the order and commencing on site.

NOTE This time may be significant for contracts with large quantities of stone and/or when the supply of stone is from a foreign quarry.

1.4.3 At tender stage

1.4.3.1 Design and performance specification

Wherever possible, the following information should be provided at the tender stage:

- a) the building site limitations regarding access, restrictions, the time of deliveries, storage, handling, and distribution facilities;
- b) any limitation on the sequence and duration of site fixing, or an invitation to present recommendations;
- c) sufficiently explicit drawings to show the basic construction requirements, stone thicknesses, jointing (including movement joints) and any special stones or labours;
- d) the building tolerance(s) allowed in the structure, affecting the design width of cavity or overall stone dimensions;
- e) the type(s) of stone and finishes, and any demands on matching or selection, or limits on acceptable natural variations;
- f) the type of pointing;
- g) the type of (mastic) sealant;
- h) details of any insulation within cavities and the method to maintain the minimum clear cavity (see 3.2);
- i) the fixing system to be used, or an invitation to present design recommendations;
- j) any requirements for the routine or special testing of components, before or after erection, or for sample areas or mock-up panels;
- k) the criteria for the acceptance or rejection of individual stones and fixings.

1.4.3.2 Facilities and materials required on site

To prevent misunderstanding, particularly at the tender stage, it should be made clear whether the following will be provided and by whom:

- a) tower, or mobile crane, or forklift for offloading, distributing and raising suitably packed stone adjacent to fixing areas at each level, and elevation;
- b) if no crane, sufficiently big hoist(s) to take packed stone, and forklift/pallet truck to place in and take out on to scaffold, or structural slab at each level and elevation;
- c) forklift/pallet truck, and level access for the lateral movement of packed stone on to scaffold at each level and elevation, where hoist cannot be positioned adjacent to working areas;
- d) safe storage areas, with firm level access, when stone cannot be directly offloaded and placed adjacent to working areas;
- e) boarded working scaffold, in not more than 2.0 m lifts with one board between nearest upright and face of cladding, and allowing unimpeded lateral distribution of stone by sack, barrow or bogie;
- f) props for temporary support of, for example, fascias and soffits;
- g) adaptation of scaffold for headtrees or step-up brackets;
- h) loading platforms at each level, in number and spacing appropriate to site and performance requirements;
- i) supply of ordinary Portland cement, and clean grit sand for bedding; and grouting fixings;
- j) supply of any special coloured mix for bedding and pointing;
- k) datum lines and levels at each level, and regularly across elevations;
- l) 110 V electrical, and water, supply to within 30 m of working areas at each level;
- m) space for the provision of site accommodation/lock up store, and installation of 240 V supply;
- n) provision of messing, toilet, medical, and other welfare facilities;
- o) protection of fixed stone from any likely physical damage or staining;
- p) removal of debris, packing cases, etc. from agreed collecting areas.

1.4.4 Order stage

To enable the installation of stone cladding to be completed within the scheduled time, at the time an order is placed the parties concerned should either be in possession of the following information, or it should be agreed when it will be available:

- a) the fixing programme, and sequence, by elevation and levels;
- b) a full set of the latest design drawings from the architect and/or structural engineer giving all data relevant to the stone cladding;
- c) arrangements for taking site dimensions, if these are necessary;
- d) the time for the preparation of working drawings (in fixing sequence when many are involved);
- e) the time for the architect to check and return working drawings, either approved, or for amendment;
- f) the time between approval of working drawings and first delivery of stone to site;
- g) the minimum notice for any changes to the fixing programme, and opportunity to assess cost or extension implications;

Section 2. Materials and components

2.1 Cladding stones

2.1.1 General

The stones which are used for cladding fall mainly into four groups:

- a) granites;
- b) marbles and hard limestones;
- c) slates and quartzites;
- d) limestones and sandstones.

Whilst there is no specified line drawn between hard limestone and limestone, it is generally accepted that the former will take a polish. A further rough division is that hard limestone has a porosity of less than 5 % whilst limestones have a porosity greater than 5 %.

NOTE The porosity of natural stone excludes vents or similar features e.g. in travertines.

The maximum dry weight of cladding stones ranges from 2 500 kg/m³ for limestone to 2 750 kg/m³ for granite. Therefore, for general guidance purposes only, a figure of 3 000 kg/m³ can be used to calculate the maximum likely load to be carried, which will also allow for cladding stones having a + 3 mm tolerance as given in 4.2.2.2. Maximum masses per square metre are given in Table 1.

For the design of fixings, the actual density and porosity of the particular stone should be ascertained and used.

Table 1 — Maximum masses per square metre of cladding stones

Stone	20 mm thick kg/m	40 mm thick kg/m	50 mm thick kg/m	75 mm thick kg/m
Granites, marbles, hard limestones, slates and quartzites	60	120	^a	^a
Limestones and sandstones	^a	^a	150	225
^a These stones are not normally used as cladding at these thicknesses (see Table 4).				

2.1.2 Finishes

Stone face finishes are generally as follows:

- a) *granite*: polished, honed, axed, dolly pointed, flame textured or tooled;
- b) *marble and hard limestone*: polished, eggshell or honed;
- c) *slate*: riven, flame textured, sawn or fine rubbed;
- d) *quartzite*: riven;
- e) *limestone and sandstone*: fine rubbed, tooled, sawn or riven.

2.2 Stone faced concrete cladding units

Any of the stones listed in 2.1.1 can be used as a facing to precast concrete units, provided the relatively thin stone used is sufficiently strong or well supported and of a size that will not be damaged during the manufacturing process. Once the concrete has hardened, the strength of the stone is of less significance.

The finishes given in 2.1.2 are all suitable for stone faced concrete cladding units.

2.3 Fixings

NOTE This standard refers to alloys readily available in the UK. This does not preclude the use of other alloys if their suitability can be demonstrated.

2.3.1 Stainless steel fixings

The grades of stainless steel used for restraint and load-bearing fixings should be as specified in the following British Standards;

- a) for fixings made from sheet strip and plate, BS 1449-2;
- b) for fixings made from rod and bar, BS 970-1.

The recommended grades and their uses are as follows.

- 1) 304 S15 and 304 S16. The most common grades used for the manufacture of fixings.
- 2) 304 S11. The reduction in carbon makes this grade suitable for hot working or welding since subsequent heat treatment may be unnecessary.
- 3) 316 S31. The additional molybdenum enhances the resistance to pitting corrosion of this grade, which makes it more appropriate in aggressive environments, e.g. by the coast.
- 4) 316 S11. The reduction in carbon content makes this grade more suitable for hot working or welding since subsequent heat treatment may be unnecessary.
- 5) 321 S31. Contains titanium which acts as a stabilizer and may permit the elimination of subsequent heat treatment.
- 6) 303 S31. Contains phosphorous and sulfur and is used when significant machining is involved. It is not suitable for welding or working on site.

Other austenitic stainless steels, especially those with carbon content greater than 0.06 %, should only be used if it has been clearly demonstrated that the fixings have not been sensitized to intergranular corrosion. This can be demonstrated by tests carried out in accordance with BS 5903 on specimens tested without further sensitization heat treatment.

Welding should only be permitted where the necessary facilities, expert knowledge, inspection and testing facilities and skills are available. Welding, hot working and heat treatment operations lead to scale formation and discoloration. In order to maintain the intrinsic corrosion resistance of the material, it is necessary to remove the scaling and discoloration by suitable cleaning methods. Such cleaning may not be essential for all fixings but if scale is not removed, premature rust staining of the surface is likely to occur, corrosive attack may commence more readily and a shorter serviceable life may result.

Rust staining of the surface can occur as a result of surface contamination, which can arise from particles of non-stainless steel tools used in the manufacture of the fixing component. Although such rusting is unsightly, it generally has no long term detrimental effects on the performance of the fixing.

2.3.2 Stainless steel bolts and nuts

Bolts and nuts should be manufactured from austenitic stainless steel as specified in BS 6105. The bolts and nuts will be identified as:

- A1 which generally equates to 303;
- A2 which generally equates to 304;
- A4 which generally equates to 316.

2.3.3 Copper and copper based alloy fixings

The grades of copper and copper alloy used for restraint and loadbearing fixings should be as follows.

Aluminium bronze and silicon aluminium bronze

BS 2872 CA 104 and CA 107

BS 2874 CA 103 and CA 104

Phosphor bronze

BS 1400 PB1

BS 2870 PB101 and PB102

BS 2873 PB102 and PB105

BS 2874 PB102

BS 2875 PB102

Copper

BS 2870 C101, C104 and C106

BS 2873 C101 and C106

BS 2874 C101 and C102

NOTE Fixings produced from copper are not suitable for carrying permanent loads.

Welding and brazing should only be permitted where the necessary facilities, expert knowledge and skill are available.

2.4 Materials for mortar

2.4.1 Cement

Cement should conform to the relevant British Standard:

Ordinary and rapid-hardening Portland cement	BS 12
Masonry cement	BS 5224

NOTE BS 5224 has been partially replaced by Sections 3.1, 3.4, 3.5, 3.6, 3.7 and 3.8 of Part 3 of BS 4550.

2.4.2 Lime

Limes should conform to BS 890.

2.4.3 Plaster

Plaster should be class A plaster of Paris as specified in BS 1191-1.

2.4.4 Sands

Sands from natural sources should conform to BS 1200.

2.4.5 Admixtures and pigments

2.4.5.1 General

Admixtures may affect the strength and adhesion of mortars and care should be exercised in their use.

2.4.5.2 Calcium chloride

Calcium chloride and admixtures containing calcium chloride should not be added to mortars.

2.4.5.3 Plasticizers

Mortar plasticizers should conform to BS 4887-1.

2.4.5.4 Pigments

Pigments should conform to BS 1014.

2.4.6 Water

Water should be mains water or other potable supply. If mains water is not available, the water should be clean and should not contain any material, either in solution or in suspension, in quantity sufficient to have a harmful effect on the mortar or on metals or to impair the durability of the construction.

In cases where water supplies may be of doubtful quality, the methods used for sampling and testing the water should be as described in BS 3148.

2.4.7 Ready-to-use mortars and ready-mixed lime : sand

Ready-mixed lime : sand for mortar and ready-to-use retarded cement : lime : sand and retarded cement : sand mortars should conform to BS 4721.

Dry-packaged cementitious mixes should conform to BS 5838-2.

2.5 Damp-proof courses, flashings, weatherings and cavity trays

Damp-proof courses, flashings, weathering and cavity trays should conform to the recommendations and relevant British Standards given in Table 2 and Table 3.

In general, only durable materials which do not stain light coloured stones should be used. Thus whilst bitumen based materials may be used for damp-proof courses, they would not be suitable for other purposes. Similarly copper should not be used for flashings or weatherings and is unlikely to be used as a damp-proof course. The initial white carbonate run-off from lead flashings which may stain the stones below, can be avoided by a smear coat of patination oil after fixing.

2.6 Sealants

Sealants should be one of the following types and where relevant should conform to its British Standard.

One-part polysulfide based sealants	BS 5215
Two-part polysulfide based sealants	BS 4254
One-part silicone-based sealants (type A)	BS 5889

Acrylic resin (solvent type)

One-part polyurethane

Two-part polysulfide (high modulus)

Two-part polyurethane

The expected service life of the sealants listed above may be limited to 20 years, but will depend upon environmental conditions and quality of application. See BS 6093 and BS 6213.

Some sealants can cause staining of stone and reference should be made to the sealant manufacturer to confirm their suitability and fitness for purpose.

NOTE Many sealants will require a primer.

2.7 Back-up materials

Back-up materials are commonly of polyethylene or polyurethane, but synthetic rubber types are available. They can be obtained in sheet, square, rectangular or circular section strips. All are intended to be installed in the joint under a degree of compression. The circular section is preferred, since it can be more easily inserted, is not subject to twisting displacement, and provides a suitable shape to the sealant.

Table 2 — Damp-proof courses

Material	Standard and grade	Minimum thickness mm	Other recommendations
Lead	BS 1178 Code no.3	1.32	Protect from contact with mortar and concrete by a coating of bituminous paint
Bitumen	BS 6398	As classified in BS 6398	
Polyethylene	BS 6515	0.46	

Table 3 — Flashings, weatherings and cavity trays

Material	Standard and grade	Thickness mm	Other recommendations
Aluminium alloy	BS 1470 grade 3103	0.6 to 0.9	Prefabricated items should be of H2 or H4 temper. Items worked on site, "O" condition.
Aluminium	BS 1470 grades 1050A, 1080A and 1200	0.6 to 0.9	Protect from mortar contact by bituminous compound.
Lead	BS 1178 Code nos 4 and 5	1.8 to 2.24	Lengths should not exceed 1.5 m

Section 3. Design

3.1 Introduction

3.1.1 General

Many materials used as non-loadbearing external vertical enclosures of buildings, have functional requirements similar to external stone cladding and reference should be made to BS 8200, which provides a systematic framework for the design of non-loadbearing external walls. The subjects included in BS 8200 are listed in Annex A.

In the case of projects involving the extensive use of cladding and fixings, it is recommended that the structural engineer sets down the functional requirements governing the principles of its design, its means of support and restraint and the maximum movement of the cladding for which allowance is to be made, together with the anticipated movement characteristics of the building frame, including calculations of the anticipated shortening and how this is to be accommodated in the cladding (see 3.13).

On such projects it is further recommended that a technical specification dealing with all aspects of the supply and/or fixing of the cladding should be prepared in consultation with a structural engineer and that this should include definitions of the nature of any special tests required to be carried out on the cladding in advance of the work.

Accuracy in the construction of the background structure is essential, otherwise the fixings designed for the job will not fit.

It is essential to provide a cavity between the cladding and the structure to cater for:

- a) accommodation of fixings, bolt heads and blockliners which could add up to 25 mm or more;
- b) permitted tolerances in sawing thicknesses, erection and structural face lines;
- c) insulation if required (see 3.2);
- d) discontinuity to minimize the transmission of rain water.

Lightning conductors should be detailed to obviate staining or damage to the cladding.

3.1.2 Cavities

A sufficiently wide clear cavity should be provided to allow free draining of any trapped moisture between the stone cladding and the background.

The width of the cavity should be designed to leave a clear gap not less than 10 mm wide after all construction tolerances have been accommodated.

It is essential that weep holes are provided at points where any entrapped moisture could accumulate, e.g. at cavity trays and at damp-proof course levels.

When a cavity wider than 100 mm is necessary a supplementary framework or special fixing should be provided to support the cladding.

3.1.3 Cavity barriers to resist spread of fire

It is essential to provide cavity barriers to prevent the spread of fire, both horizontally and vertically, in the cavity behind the units; and to reduce the effect of fire on fixings. Horizontal cavity barriers should be located at each storey to prevent the spread of fire from storey to storey. Vertical cavity barriers should abut compartment walls.

Particular care should be taken with the detailing of cavity barriers at fixings and at vertical joints between units in order to avoid gaps in the cavity barriers.

NOTE Experience has shown that serious fires can spread at these points.

Cavity barriers should be composed of non-combustible materials having at least 1/2 h fire resistance. They should be adequately fixed and supported to ensure that they remain effective for the life of the cladding.

Requirements concerning cavity barriers are contained in the Building Regulations [1].

3.2 Insulation behind cladding

In those situations where it is necessary to provide insulation behind the cladding, such insulation should be:

- a) non-combustible or limited combustibility as stated in the Building Regulations [1];
- b) non-absorbent;
- c) rot and vermin proof.

The insulation should be fixed in such a manner as to maintain a clear cavity behind the stone cladding (see 3.1.2).

NOTE Some insulating materials require a residual air gap for waterproofing purposes. Some stones may be adversely affected if they are not allowed to dry out.

3.3 Weathering and water run-off

Likely changes in colour and texture of the stone on exposure to the weather should be considered, so that these changes can be anticipated either in the design or in the selection of the material for the cladding. Possible changes in the colour of the jointing materials should also be taken into account.

The changes in appearance of the facade of a building exposed to the weather are mainly influenced by the aspect and location of the building, the design of the cladding, particularly in relation to the run-off of rain-water, the degree of atmospheric pollution (see 3.4) and the effect of frost action (see 3.5).

Conspicuous disfigurement can be caused by uneven washing of cladding by rain, particularly where cladding is used in association with glazed areas. Textured surfaces help to distribute the flow of water more evenly and projections on the facade can be designed to throw the water clear. Care is needed, however, to ensure that the projections do not contribute to uneven washing.

Disfigurement of plinths can be caused by rising damp and rain water splashing from pavements and earth. This can be minimized by the use of suitable durable and possibly dark stones.

Whichever way the cladding is constructed and jointed, it should be anticipated that it will permit some rain penetration and/or condensation within the cavity between the cladding and the inner leaf or back-up wall. Such cavities should therefore have adequate provision for drainage and for damp-proofing. The possibility of rain running off and cleaning or staining the facade below should be considered at the design stage.

3.4 Atmospheric pollution

The rate at which units become dirty as a result of atmospheric pollution in any particular locality should be ascertained by examination of other buildings in the district, particularly noting the factors which have determined the degree of disfigurement.

3.5 Frost action

The stone to be used should not normally be affected by frost. Alternatively suitable measures should be taken to provide reasonable protection. With certain stones, including the softer limestones, the use of thin open joint construction is not recommended. With these stones, the use of lead flashings on cornice, string or other projecting courses is recommended in order to avoid saturation on horizontal surfaces and subsequent frost damage.

3.6 Efflorescence

Efflorescence is a white coating caused by the migration in solution of soluble salts present in some building materials to the surface, where they crystallize. It is not usually troublesome on cladding, unless the cladding is located against salt-bearing brickwork. It is recommended that the efflorescence be left to weather normally.

The risk of efflorescence is reduced if the cladding can be fixed when both it and the brickwork backing are dry. The migration of salts may be prevented by coating the brickwork with a water-proofing agent before cladding is fixed. It is advisable to provide a cavity between the cladding and the backing.

3.7 Staining

To avoid the possibility of the face of the cladding becoming stained by the corrosion of metals, non-staining materials such as stainless steel or silicon aluminium bronze should be used.

Certain timbers contain water soluble extractives which can discolour all types of stone. Similarly some exterior wood finishes are susceptible to chalking, which can also discolour stone. Advice on the selection of timber species and finishes should be sought from the relevant trade associations.

Plasticizers used in some sealants can cause staining of the stone and specifiers should refer to the sealant manufacturer to confirm their suitability and fitness for purpose.

NOTE Many sealants will require a primer.

3.8 Choice of stone

3.8.1 General

Stone is liable to variation in the bed. In some quarries, beds are sufficiently regular in character for selection to present no difficulty, the relative durability of stone from such quarries being fairly well known. In other quarries, however, the variations are such that the individual blocks from which the units are to be cut will need to be considered on their merits. In some beds, blocks of good or inferior quality can be distinguished by inspection; in others the differences are not readily apparent and expert opinion should be obtained.

In the choice of natural materials it is most advisable at a very early stage in the design to obtain a generous estimate of the total quantity likely to be required and to decide what is the largest unit size likely to be used. The designer should take all reasonable precautions to ensure that adequate quantities of the selected size of material approximating to the chosen sample in colour and texture can be delivered at a time to suit the building programme.

With any stone subject to natural variations in texture, colour, marking or quality, it is recommended that samples should be selected in order to establish the range of any such variation. This is particularly recommended in the case of any stone which has characteristic markings. The designer should satisfy himself that these are not structural weaknesses.

The seasoning of certain stones after quarrying or dressing is important and the designer should allow adequate time for seasoning all the stone required when arranging time schedules for building. Late changes in design which reduce this time should be avoided.