

BRITISH STANDARD CODE OF PRACTICE
CP 297 : 1972

**PRECAST CONCRETE
CLADDING**
(NON-LOADBEARING)

THIS CODE OF PRACTICE has been prepared by a committee convened by the Codes of Practice Committee for Building. It was published under the authority of the Executive Board on 21 July, 1972.

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This Code of Practice makes reference to the following British Standards:

- BS 648. Schedule of weights of building materials.
- BS 743. Materials for damp proof courses.
- BS 849. Plain sheet zinc roofing.
- BS 970. Wrought steels in the form of blooms, billets, bars and forgings. Part 4. Stainless, heat resisting and valve steels.
- BS 1217. Cast stone.
- BS 1400. Copper alloy ingots and copper and copper alloys castings.
- BS 1449. Steel plate, sheet and strip. Part 4. Stainless and heat resisting plate, sheet and strip.
- BS 1453. Filler rods and wires for gas welding.
- BS 1470. Wrought aluminium and aluminium alloys. Plate sheet and strip.
- BS 1881. Methods of testing concrete.
- BS 2787. Glossary of terms for concrete and reinforced concrete.
- BS 2870. Rolled copper and copper alloys. Sheet, strip and foil.
- BS 2872. Copper and copper alloys. Forging stock and forgings.
- BS 2873. Copper and copper alloys. Wire.
- BS 2874. Copper and copper alloys. Rods and sections (other than forging stock).
- BS 2875. Copper and copper alloys. Plate.
- BS 2901. Filler rods and wires for gas-shielded arc welding.
- BS 2926. Chromium-nickel austenitic and chromium steel electrodes for manual metal-arc welding.
- BS 3019. General recommendations for manual inert-gas tungsten-arc welding. Part 2. Austenitic stainless and heat-resisting steels.

- BS 3826. Silicone-based water repellents for masonry.
 CP 3. Code of basic data for the design of buildings.
 Chap. V. Loading.
 Part 1. Dead and imposed loads.
 Part 2. Wind loads.
- CP 116. The structural use of precast concrete. Part 2.
 Metric units.
- CP 121.201. Masonry walls ashlarred with natural stone or
 with cast stone.
- CP 153. Windows and rooflights. Part 1. Cleaning and
 safety.
- CP 231. Painting of buildings.
- CP 298. Natural stone cladding (non-loadbearing).
- PD 6440. Accuracy in building. Part 2. Metric units.
- PD 6445. Recommendations for the co-ordination of
 dimensions in building: Tolerances and joints.
 The derivation of building component manu-
 facturing sizes from co-ordinating sizes.
- DD Recommendations for the co-ordination of
 dimensions in building. Tolerances and fits for
 building. The calculation of work sizes. Joint
 clearances for building components. (In course
 of preparation.)

*British Standard Codes of Practice are revised, when necessary,
 by the issue either of amendment slips or of revised editions.
 It is important that users ascertain that they are in possession
 of the latest amendments or editions.*

The following BSI references relate to the work on this Code of Practice:
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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.

BRITISH STANDARD CODE OF PRACTICE CP 297
PRECAST CONCRETE CLADDING
(NON-LOADBEARING)

FOREWORD

Materials in the form of thin slabs of modest dimensions have been used for centuries as a decorative facing to backgrounds of stone and brickwork. With the advent of the framed structure where the loads are carried by the frame and not by the external walling, the materials or combination of materials used to cover the structural framework are now generally referred to as the cladding. Many cladding units are now made of concrete.

The construction of buildings of increasing size and height coupled with increasing speeds of erection has produced a number of design and structural problems related to cladding which did not previously exist.

Cladding, in the forms described in 1.1, 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. Movements due to temperature and other factors have also to be taken into account.

The purpose of this Code is to describe the provisions necessary for cladding to perform its function satisfactorily for the reasonable life of the building.

As part of BSI's programme of metrication, this Code is expressed in metric terms.

For further information on the values given in SI units, reference should be made to BS 3763, 'The International System of units (SI)'.

NOTE. $1 \text{ N/mm}^2 = 1 \text{ MN/m}^2$.

1. GENERAL

1.1 SCOPE

This Code of Practice deals with the design and use of precast concrete cladding in the form of:

- (1) an applied facing held to a solid background by mechanical means such as metal fixings,
- (2) units supported by the structural frame of the building, and
- (3) permanent formwork held mechanically to a background of in-situ concrete.

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

cladding units by metal framing.

The provisions contained in this Code relate only to the best known conventional practices at the time of publication and are based on current cladding techniques.

NOTE. The titles of the British Standards referred to in this Code of Practice are listed on pages 2 and 3.

1.2 DEFINITIONS

For the purposes of this Code the definitions in BS 2787 and BS 2874 apply, with the following modifications and additions:

Baffle. A flexible preformed section designed to be fitted in grooves between the adjacent units to minimize direct entry of rain into an open joint.

Cladding. The external non-load-bearing covering to the frame of a building or structure.

Composite unit. A cladding unit having a facing of materials other than concrete.

Fixings

Loadbearing fixing. Any fixing designed to support the dead weight of one or more cladding units and to transfer this load directly to the structure.

Location fixing. A fixing whose sole purpose is to assist in the alignment of the cladding units.

Tying back fixing. Any fixing designed to tie cladding units to their backing or to one another.

Galvanic corrosion. Corrosion caused by contact between two dissimilar metals in the presence of an electrolyte.

Gasket. An elastic, flexible, preformed extrusion or moulding used to provide a seal between part of the structure and the cladding or between adjacent cladding units. Its primary purpose is to act as a barrier to wind and rain, and to function properly it is essential that it remains under compression at all times.

Joints

Compression joint. A joint designed specifically to accommodate partial closure resulting from shortening of the structure to which the cladding is attached.

Dry butt joint. A completed joint in which units abut each other without any jointing material.

Filled joint. A completed joint in which the space between adjacent units or between a unit and another part of the building is filled with jointing material.

Movement joint. A vertical or horizontal joint designed specifically to accommodate recurring cyclical movement of the structure or of the cladding, or both, without detriment to the cladding or affecting its performance.

Open joint. A completed joint taking the form of an intentional open gap between adjacent units or between a unit and the structure. A baffle strip may be located in vertical open joints.

Sealant. An adhesive material of a consistency suitable for application by means of a trowel, knife or gun, or as a preformed strip or tape, used for providing a seal between two units or between a unit and the structure. It is essential that the material be capable of accepting deviations and subsequent changes in the width of the gap it is intended to fill, but it should not be expected to be loadbearing.

2. MATERIALS

2.1 CLADDING

2.1.1 General. Cements, aggregates, water, admixtures and reinforcement should be in accordance with the requirements of CP 116, Part 2. When sea dredged aggregates are used, a proportion of shell fragments and salt may be present and the user should satisfy himself that these are not in such quantity as to induce a hazard into the concrete either structurally or aesthetically.

Shrinkable aggregates may be available, particularly in Scotland, where there are known deposits, and attention is drawn to BRS Digest 35* which examines the effect of such aggregates upon the drying shrinkage of concrete.

2.1.2 Concrete mixes. The concrete used for cladding should be in accordance with the requirements of Table 1 of CP 116, Part 2.

2.1.3 Surface finish. This Code does not describe the wide variety of finishes that can be given to self-faced and faced concrete, this being adequately covered by existing literature, for example, 'Precast concrete cladding'†.

2.1.3.1 Self-faced concrete. Finishes given to self-faced concrete are described in Clause 409 of CP 116, Part 2. Attention is also drawn to 'Recommendations for the production of high quality concrete surfaces'‡.

2.1.3.2 Faced concrete. The finishes commonly used for faced concrete are given in (1) to (5).

(1) ***Aggregate face.*** There are several methods used for producing exposed aggregate finishes. Users should satisfy themselves by reference to existing

* BRS Digest 35, 'Shrinkage of natural aggregates in concrete'.

† 'Precast concrete cladding', published by the Fountain Press.

‡ 'Recommendations for the production of high quality concrete surfaces', published by the Cement and Concrete Association.

work and by tests that the chosen aggregates and method will be satisfactory for the location and anticipated life of the building. Slight variations in the colour of natural aggregates are often unavoidable.

(2) *Cast stone*. Cast stone (also known as reconstructed stone and artificial stone) can be given a range of masonry and other tooled finishes and should comply with the requirements of BS 1217.

(3) *Mosaic*. Only mosaics that are known to be frost resistant should be used externally.

(4) *Tiles*. Tiles and brick slips used as a face to concrete should be frost resistant and be provided with well formed mechanical key grooves.

(5) *Stone facing veneer to precast concrete*. Any natural stone can be used as a facing for concrete cladding units provided that it has sufficient strength, in the relatively thin sections in which it may be used so as not to be damaged in the process of manufacturing the units. Any of the finishes applicable to the particular type of stone can be used (See CP 298).

2.2 FIXING MATERIALS

The various types of fixing material are given in 2.2.1 to 2.2.3.

2.2.1 Non-ferrous metals. It is recommended that the following materials should be used:

Tying back fixings: copper, phosphor bronze and silicon aluminium bronze*.

Loadbearing fixings: aluminium bronze, phosphor bronze, gunmetal (for cast in sockets only) and silicon aluminium bronze*.

The materials copper, phosphor bronze, aluminium bronze and gunmetal should conform to the requirements of the appropriate British Standards: BS 2870, BS 2872, BS 2873, BS 2874, BS 2875 and BS 1400.

* Silicon aluminium bronze is not, at present, covered by a British Standard and should comply with the following material composition and mechanical properties:

Aluminium	6.0 % to 7.0 %
Silicon	1.5 % to 2.4 %
Manganese	0.5 % maximum
Iron	1.0 % maximum
Nickel	0.25 % maximum
Tin	0.05 % maximum
Lead	0.05 % maximum
Zinc	0.2 % maximum
Copper	Remainder
0.2 % Proof stress	232 N/mm ²
Tensile strength	525 N/mm ²
Elongation (5.65√S ₀)	25 %

A wrought or continuously cast product should be used in preference to a sand casting. Freedom from porosity cannot be guaranteed in the latter.

Welding should only be permitted where the necessary facilities, expert knowledge and skill are available. Filler alloys for welding should, where appropriate, comply with the requirements of BS 1453, Group C, for gas welding and BS 2901 for gas shielded arc welding.

2.2.2 Stainless steel. The types of stainless steel recommended for tying back and loadbearing fixings are as follows:

Fixings made from sheet and strip (BS 1449, Part 4)

302S17, 304S16, 316S16, 321S12, 347S17

Fixings made from plate (BS 1449, Part 4)

304S15, 316S16, 321S12, 347S17

or the high proof stress versions of these steels

Fixings made from bar (BS 970, Part 4)

302S25, 303S21, 304S15, 316S16, 321S12, 347S17

or the high proof stress version of 316S16.

For fixings involving welding, steels 302S17, 302S25 and 303S21 should not be used. Welding should be by metal arc, selecting filler materials in accordance with the requirements of BS 2926 or tungsten inert gas in accordance with BS 3019, Part 2, selecting filler materials in accordance with BS 2901, Part 2.

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

For fixings made by hot working involving prolonged heating, only steels 321S12 and 347S17 should be used, unless correct final heat treatment is applied to the fixings.

For fixings that are visible and must retain their original surface appearance, steel 316S16 should be chosen.

2.2.3 Ferrous or other materials. The use of ferrous metals and other materials is permitted where it can be shown that the performance characteristics of the fixings made from them are adequate in all respects for the conditions in which they are to be used.

2.3 JOINTING AND POINTING MATERIALS

2.3.1 Mortars. Materials for mortars and their storage should be in accordance with the requirements of CP 121.201. The types of mortar for different cladding are described in 3, 'Design considerations'.

2.3.2 Sealants. Types of sealant, their qualities, primers and back up materials are described in Table 1 and in 3.5.2.

2.3.3 Gaskets. Polychloropren  is the base for most of the extruded gaskets and foamed butyl, polyethylene and polyurethane for cellular gaskets.

Gaskets may be of various sections, but tubular, fir cone and cellular are the most satisfactory. Gaskets require to be durable and to take up movements and tolerances.

2.3.4 Baffles. Baffles are normally pre-formed sections of polychloroprene or similar material used in the joint between one unit and another or between one unit and another component.

2.4 DAMP PROOF COURSES, FLASHINGS AND MEMBRANES

2.4.1 Sheet material. Materials for damp proof courses are specified in BS 743 and where used should comply with the requirements of that standard. The same materials can often be used as flashings, as can aluminium complying with the requirements of BS 1470, Grade S1A, temper O, zinc complying with BS 849 and stainless steel complying with BS 1449, Part 4. Other materials may be suitable; the manufacturer should be asked to give written evidence of their performance.

2.4.2 Brush-applied materials. Solutions or emulsions based essentially on bitumen or coal tar pitches can be used for providing a damp resistant surface to a back-up wall, repelling small amounts of water which may penetrate the cladding. The material should be used to the manufacturer's instructions.

2.5 WATER REPELLENTS

Silicone-based water repellents should comply with the requirements of BS 3826.

Aluminium stearate waterproofers are incorporated into some Portland-type cements. The use of this type of cement imparts a degree of impermeability to the concrete, depending on mix design, and is especially recommended in the manufacture of cast stone.

Stearate waterproofers are also available as admixtures for mortars and the manufacturer's instructions for use should be followed.

3. DESIGN CONSIDERATIONS

3.1 PRINCIPLES OF DESIGN

In the case of medium or large and particularly high-rise projects involving the extensive use of cladding it is recommended that the structural engineer sets down the functional requirements governing the principles of its design, 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.

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 by the structural engineer and/or architect 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.

3.2 ENVIRONMENTAL FACTORS IN THE CHOICE OF FINISHES

3.2.1 General. The choice of finish for units will be affected by a combination of practical, economic and aesthetic factors.

3.2.2 Weathering and water run-off. Finishes vary considerably in their weathering characteristics and the designer should be aware of the likely changes in colour and texture of the cladding on exposure to the weather, so that these changes can be anticipated either in the design of the cladding or in the selection of the mix for the units. 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 rainwater, the degree of atmospheric pollution (see 3.2.3) and the effect of frost action (see 3.2.4).

Conspicuous disfigurement can be caused by uneven washing of cladding units by rain, particularly in association with glazed areas. Textured surfaces such as an exposed aggregate finish 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 (see BRS Digests 45 and 46*).

In whatever 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 over openings. The possibility of preferential run-off should be considered at the design stage.

3.2.3 Atmospheric pollution. Some concrete may disintegrate due to the action of sulphur compounds and sea salts present in the air and in rainwater, although concrete made with natural gravel or crushed igneous rock is least liable to be affected. The material should be inert in the atmosphere to which it will be

* BRS Digest 45, Design and appearance—1.
BRS Digest 46, Design and appearance—2.