

Code of practice for cleaning and surface repair of buildings —

Part 2: Surface repair of natural stones, brick and terracotta

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The preparation of this British Standard was entrusted by Technical Committee B/209, General building codes, to Technical Subcommittee B/209/7, Cleaning and surface repair of buildings, upon which the following bodies were represented:

- Chartered Institute of Building
- Construction Confederation
- Department of the Environment, Transport and the Regions — Construction Directorate
- National Council of Building Material Producers
- National House-Building Council
- Royal Institute of British Architects
- Royal Institution of Chartered Surveyors

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- Brick Development Association
- British Ceramic Research Ltd.
- Concrete Society
- Council for Aluminium in Building
- Council for the Care of Churches
- Department of the Environment, Transport and the Regions — Represented by the Building Research Establishment
- Ecclesiastical Architects and Surveyors Association
- English Heritage
- Historic Scotland
- London Transport
- Mortar Producers Association Limited
- National Grp Construction and Engineering Federation
- Society for Protection of Ancient Buildings
- Stone Federation
- UK Steel Association

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Foreword

This British Standard has been prepared by Subcommittee B/209/7. Together with Part 1, it supersedes BS 6270-1:1982 and BS 6270-2:1985, which are withdrawn.

This part of BS 8221 gives guidance on surface repair of external facades of buildings. It has been prepared in parallel with BS 8221-1, which provides guidance on cleaning.

This code of practice covers repointing and types of mortar, repair of stone masonry, brickwork, terracotta and faience, use of surface coverings, external render repair, and use of consolidants on weathered stone and other porous building materials.

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

WARNING This British Standard calls for the use of materials that may be injurious to health or damaging to the environment if adequate precautions are not taken. The recommendations given in this standard refer only to technical suitability and do not absolve the user from legal obligations relating to health and safety.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 24, an inside back cover and a back cover.

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Introduction

This code of practice is intended to provide building owners, architects, surveyors, engineers and contractors general information concerning surface repairs of buildings.

This code of practice recommends investigative procedures for selecting a suitable repair process. It describes a range of repair and conservation procedures and some problems that may be encountered.

Before carrying out surface repairs, it is essential to ascertain any factors causing decay, such as open joints allowing water ingress, migrating salts from a backing wall, run-off from limestone, or a corroding metal tie/armature.

1 Scope

This British Standard provides recommendations for surface repair of natural stones, clay brick, calcium silicate brick, glazed and unglazed terracotta, and faience masonry in buildings. It covers repointing and selection of mortars, and provides guidance on treatment for protection of surfaces.

Surface repairs of concrete and structural repairs are not covered by this code of practice. For guidance on structural repairs, reference should be made to BS 5390 and BS 5628-1.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 12:1996, *Specification for Portland cement.*

BS 63-2:1987, *Road aggregates — Specification for single-sized aggregate for surface dressing.*

BS 187:1978, *Specification for calcium silicate (sand-lime and flint-lime) bricks.*

BS 812-103-1, *Testing aggregates — Method for determination of particle size distribution — Sieve tests.*

BS 882:1992, *Specification for aggregates from natural sources for concrete.*

BS 890:1995, *Specification for building limes.*

BS 1014:1975, *Specification for pigments for and Portland cement products.*

BS 1139 (all parts), *Metal scaffolding.*

BS 1178:1982, *Specification for milled lead sheet for building purposes.*

BS 1199 and 1200:1976, *Specifications for building sands from natural sources.*

BS 1217:1986, *Specification for cast stone.*

BS 2482:1981, *Specification for timber scaffold boards.*

BS 2873:1969, *Specification for copper and copper alloys — Wire.*

BS 3148:1980, *Methods of test for water for making concrete.*

BS 3892-1, *Pulverized-fuel ash — Specification for pulverized-fuel ash for use with Portland cement.*

BS 3921:1985, *Specification for clay bricks.*

BS 4551 (all parts), *Methods of testing mortars, screeds and plasters.*

BS 4721:1981, *Specification for ready-mixed building mortars.*

BS 4729:1990, *Specification for dimensions of bricks of special shapes and sizes.*

BS 4887-1:1986, *Mortar admixtures — Specification for air-entraining (plasticizing) admixtures.*

BS 5224:1995, *Specification for masonry cement.*

BS 5262:1991, *Code of practice for external renderings.*

BS 5390:1976, *Code of practice for stone masonry.*

BS 5628-1:1992, *Code of practice for use of masonry — Structural use of unreinforced masonry.*

BS 5628-3:1985, *Code of practice for use of masonry — Materials and components, design and workmanship.*

BS 5838-2:1980, *Specification for dry packaged cementitious mixes — Prepackaged mortar mixes.*

BS 5973:1993, *Code of practice for access and working scaffolds and special scaffold structures in steel.*

BS 6037:1990, *Code of practice for permanently installed suspended access equipment.*

BS 6100 (all parts), *Glossary of building and civil engineering terms.*

BS 6213:1982, *Guide to selection of constructional sealants.*

BS 6431-17:1983, *Ceramic floor and wall tiles — Method for determination of crazing resistance — Glazed tiles.*

BS 6477:1992, *Specification for water repellents for masonry surfaces.*

BS 6649:1985, *Specification for clay and calcium silicate modular bricks.*

BS 6915:1988, *Specification for design and construction of fully supported lead sheet roof and wall coverings.*

BS 7913:1998, *Guide to the principles of the conservation of historic buildings.*

BS 8210:1986, *Guide to building maintenance management.*

DD ENV 459-1:1995, *Building lime — Definitions, specifications and conformity criteria*.

BS EN 10088-2:1995, *Stainless steels — Technical delivery condition for sheet, plate and strip for general purposes*.

BS EN 10088-3:1995, *Stainless steels — Technical delivery conditions for semi-finished products, bars, rods and sections for general purpose*.

BS EN ISO 3506-1:1998, *Mechanical properties of corrosion resistant stainless-steel fasteners — Bolts, screws and studs*.

BS EN ISO 3506-2:1998, *Mechanical properties of corrosion resistant stainless-steel fasteners — Nuts*.

PD 6472:1972, *Guide to specifying the quality of building mortars*.

Control of Pesticides Regulations, 1986.

The Lead Sheet Manual — A Guide to Good Building Practice.

3 Definitions

For the purposes of this British Standard, the terms and definitions in BS 6100 (some of which are repeated below for convenience) and the following apply.

3.1

armature

austenitic stainless steel, copper or copper based alloy rods, wires or mesh set within a mortar repair to secure it to the parent stone and reinforce its layers

3.2

brick slip

brick, either specially manufactured or cut, of the same height and length as a header or a stretcher, and usually with a thickness of between 20 mm and 50 mm

3.3

conservation

stabilizing and preventing or retarding further deterioration of masonry

3.4

crazing

fine, hair-line stress relief cracks caused by inability of a glazed surface and the underbody to accommodate thermal and moisture movement

NOTE Crazing is also known as poor glaze fit.

3.5

cramp

shaped piece of metal or slate, bedded into sinkings in stone units to tie them to each other or to their backing

3.6

Coade stone

proprietary off-white terracotta body produced from a kaolinitic clay, containing titanium dioxide, feldspar as flux and quartz as glass-forming agent, and a grog of powdered prefired clay

NOTE Coade stone was manufactured by the Coade family between 1769 and 1820.

3.7

dowel

short piece of material sunk or cast into adjacent hidden wall faces, to align or prevent movement of the faces

3.8

engobe

surface application by brush or spray of liquid clay, before firing, to provide an opaque, unglazed coloured finish on some forms of terracotta

3.9

faience

masonry, similar to terracotta, with one or more surfaces covered with a clear or coloured glaze

3.10

fired-clay unit

masonry unit formed from brick-earth, clay or shale, dried and burned

NOTE Fired-clay should not be confused with fireclay, which is used for making refractory bricks.

3.11

fireskin

thin, smooth, outer layer on unglazed terracotta, containing a high proportion of fines

NOTE In traditional firing processes, fireskin is vitrified to a greater degree than the body of clay beneath. Fireskin has a protective role and retention of it should be a priority in cleaning and repair works.

3.12

gauged brickwork

soft bricks cut to shape and abraded to the size required

3.13

glaze

mixed paste of fluxes and colouring ingredients that becomes a thin, vitreous, transparent or coloured surface finish of glassy, opaque or translucent consistency on firing

NOTE Glazes can be plain, mottled or textured and can range from high-gloss to egg-shell finish.

3.14**grog**

inert filler added to a clay mixture before firing to control shrinkage

3.15**grout**

flowing material that sets after application, used to fill fissures and cavities

3.16**hydraulic lime**

binder of limestone, clay, and calcium and magnesium carbonates, that sets and hardens by chemical interaction with water, both in water and in air

NOTE Hydraulic limes are classified as eminently, moderately or feebly hydraulic limes.

3.17**non-hydraulic lime**

binder consisting mainly of calcium hydroxide (high calcium lime) or magnesium carbonate (magnesian/dolomitic lime) that, when mixed with water, sets slowly by drying out and atmospheric carbonation

NOTE Non-hydraulic limes can be prepared and used as a putty or as a powder (hydrated lime).

3.18**piecing-in**

cutting out a decayed or damaged section of masonry and inserting new

NOTE Piecing in is also known as indenting.

3.19**slip casting**

method of manufacture of thin solid slabs, hollow blocks, or tiles, in which a suspension of clay particles in water, of liquid, creamy consistency, is poured into plaster moulds and allowed to dry solid before releasing, drying and firing

3.20**surface repair**

renewal, by minor replacement, of damaged or heavily weathered masonry surfaces with similar or compatible material

3.21**terracotta**

fired clay, fine textured and unglazed, usually yellow to brownish-red

4 Considerations affecting surface repair decisions

4.1 General

COMMENTARY Most surface repairs are concerned with prevention of moisture ingress or repair/replacement of decayed or damaged elements. Work to improve the weather resistance of buildings may relate to repair of surface defects likely to have a long-term detrimental effect on the whole or part of the structure, replacement of defective fixings, or reinstatement of the surface of a building after structural repairs. Work to improve the appearance of buildings may include repairs of decayed or damaged mouldings, surface decoration or sculpture, badly stained areas, and areas that have been badly repaired in the past. Repair work has many criteria to consider, including method of repair, materials of construction, and the condition of these. Previous experience with a building or similar buildings may be useful but should not be assumed to apply fully.

Distinction should be made between what is necessary and what is desirable before carrying out surface repair work. If funds are limited or if the building is of architectural or historic value, only essential repairs should be carried out.

Ease of access for future work, relative costs of hiring/erecting scaffolding and the probable frequency of maintenance, should be considered at the planning stage of repairs. If significant numbers of masonry units are defective or likely to become so within a few years, it may be more economical in the long term to replace rather than repair them, and this should be decided on considerations of structural, weathering and aesthetic assessments and any conservation requirements of the building.

For work on historic buildings, advice should be obtained from professionals experienced in historic masonry repairs, to determine the extent and nature of the work required. When this has been established, formal consent should be obtained through a procedure established by the relevant legislation. Guidance on conservation of historic buildings is given in BS 7913.

Repair work on historic buildings should be carried out by skilled and experienced masonry repairers, under the direction of a supervisor(s) with a full working knowledge of the repair process.

4.2 Procedure for selecting and undertaking surface repair

4.2.1 Inspection and identification

A comprehensive survey should be carried out, by advisors with expertise in the particular type of masonry repair, before carrying out any work. The nature and condition of masonry materials and the causes of deterioration should be assessed before the extent and nature of appropriate repairs are decided.

Masonry facades should be inspected closely using the following procedure.

- a) Each material should be identified in sufficient detail to enable work to proceed without risk to the fabric of the building.
- b) The condition of the masonry and its joints and associated materials should be assessed and recorded, as well as the effects of previous repairs.
- c) Tests to identify stone types or causes of deterioration should be carried out where appropriate.

4.2.2 Documentation

Records should be kept of buildings and repair work, including:

- a) photographs of the building showing its condition and appearance before repair work is carried out; and/or
- b) non-destructive survey techniques (see annex A).

Drawings and work schedules should be used. If original drawings cannot be found, new ones should be prepared. The level of documentation should be appropriate to the nature and scale of the facades and the work proposed.

4.2.3 Trial area of repair work

Trial areas should be completed, where appropriate, to determine that proposed repairs are suitable for the masonry and its condition, and that acceptable standards can be achieved.

4.2.4 Specification

After an assessment has been carried out and documented, a detailed specification for the work should be prepared. Where applicable, the specifications for surface repair work should be integrated with the specification for cleaning the building.

NOTE Repair work to prevent water penetration may be required prior to cleaning.

4.2.5 Selection of a masonry repair contractor

The competency of the masonry repair contractor and the skilled operatives assigned to carry out proposed work should be established. It is important to establish that work supervisors have a full working knowledge of the repair processes.

4.2.6 Records

All work and treatment on masonry facades should be recorded as executed. Documents should be retained to provide background information prior to further assessments or work.

4.3 Use of scaffolding

Access to the facades of the building may be by fixed scaffolding or in some circumstances by permanently installed suspended access equipment. Guidance on fixed scaffolding is given in BS 5973, BS 1139-1 to -5 and BS 2482. Guidance on suspended access equipment is given in BS 6037.

NOTE Scaffold requirements can be extensive and complicated. Scaffolding is not considered in detail in this standard.

If repairs to masonry are to be undertaken, scaffolding should be appropriate to the repair work. Lifting tackle may be required and the scaffold may be used to support large weights. Particular attention should be paid to:

- a) tying-in to avoid or reduce damage to the faces of masonry units;
- b) avoiding physical damage during erection and striking;
- c) use of base plates to isolate stones or other surfaces from scaffold standards;
- d) avoiding rust staining of the building.

4.4 Services

Before choosing a surface repair method, the water supply, drainage, and electricity supply should be examined to ensure they are satisfactory.

4.5 Weather conditions

Wet methods of surface repair (including repointing) should be suspended, or suitable protection provided, if there is risk of freezing of the building fabric.

In hot, dry or windy conditions, sheeting, boarding or similar should be provided to prevent rapid moisture evaporation from repaired surfaces.

5 Procedures associated with surface repair

5.1 Replacement materials

New replacement masonry units should match the old units. Physical characteristics, visual appearance, weathering performance, and method of preparation of new materials should match the old ones.

The lead-in time necessary for procurement of replacement materials should be determined and accounted for in the repair programme.

NOTE 1 Sometimes and for some materials, determining replacement materials may require scaffolding.

If a particular stone is not available, the best petrographic match should be used.

Inspection and testing of replacement stone should be carried out in accordance with BS 5390:1976. Samples of new stone should be compared with existing masonry.

NOTE 2 Replacement units for historic brickwork, terracotta, and faience are available, but sometimes may have to be specially made.

NOTE 3 Use of alternative replacement materials for historic building work is not usually recommended or necessary. In exceptional cases, poor stone in the original construction may justify replacement by a more durable stone that is otherwise compatible.



5.2 Taking down and rebuilding

If it is necessary to rebuild localized areas of historic masonry, these should be recorded before taking down. Records should include photographs, measurements, and levels, and details such as bed and perpendicular joint widths.

Temporarily removed masonry units should be numbered, coded to a survey drawing, and stored to prevent accidental damage or contamination.

5.3 Metal fixings

5.3.1 Corrosion

Corroded iron or steel cramps or dowels that have fractured surrounding masonry by expansion should be removed, if necessary, and:

- replaced with austenitic stainless steel fixings; or
- thoroughly cleaned on all surfaces and treated to prevent further corrosion.

NOTE Structural iron, steel frames and embedded ferrous metal fixings can sometimes be protected from further corrosion by cathodic protection.

5.3.2 Metal components in masonry

5.3.2.1 General

New masonry fixings (anchor bolts, armatures, cramps, dovetail slots, dowels, wall ties, or other reinforcement) should be of austenitic stainless steel or phosphor bronze. Masonry fixings attached to other fixings should be of the same metal or isolated to avoid bimetallic corrosion.

5.3.2.2 Stainless steel fixings

Stainless steel for restraint and load bearing fixings should conform to the following:

- BS EN 10088-2 for fixings made from sheet, plate and strip;
- BS EN 10088-3 for fixings made from bar and rod.

Austenitic stainless steel grades and uses should conform to Table 1.

5.3.2.3 Nuts and bolts

Nuts and bolts should be of austenitic stainless steel conforming to BS EN ISO 3506-1 and -2.

5.3.2.4 Copper wire

Copper for wire should conform to BS 2873:1969.

5.3.2.5 Fabrication

Welding and brazing should be carried out by skilled craftsmen with proper facilities. Procedures for testing welds should be agreed at the design and specification stage.

5.4 Removal of soluble salts

5.4.1 Identifying salt types and quantities

Tests should be performed to determine the level of potentially damaging soluble salts within masonry. Salt types and quantities should be determined at several locations on the masonry, at a range of depths.

NOTE This should be done by drilling the masonry.

5.4.2 Methods of removal

Soluble salts should be removed by one of the following methods:

- dry brushing with bristle brushes and collection of removed salts (a dry vacuum with soft brush attachments can also be used);
- saturation and poulticing with an inert absorbent medium (e.g. clay, paper pulp or cotton wool);
- treatment with a sacrificial render (which breaks down or is cut away after a period of months);
- application of acidic proprietary chemicals that combine with and neutralize inherent or deposited salts.

5.4.3 Verification of salt reducing measures

Tests should be performed after a programme of work to verify the level of soluble salts within masonry.

NOTE This should include drilling the masonry.

Table 1 — Austenitic stainless steel grades and uses

Grade ^a	Formerly known as	Application
1.4301	304 S15, 304 S16	General fixings
1.4303	303 S31	If significant machining is required (e.g. threaded ferrules, couplers or sockets) ^b
1.4306	304 S11	Hot working or welding
1.4401	316 S31, 316 S33	For enhanced resistance to pitting corrosion (e.g. for use on coastal sites)
1.4404	316 S11	Hot working or welding on coastal sites
1.4541	321 S31	Stabilized welding if subsequent heat treatment not required

^a The designation system used in BS EN 10088 is defined in BS EN 10027.

^b Not suitable for welding or working on site.