BRITISH STANDARD

BS 8000-2.2: 1990

# Workmanship on building sites —

## Part 2: Code of practice for concrete work —

## Section 2.2 Sitework with in situ and precast concrete

Confirmed January 2010

## CAWS E10, E20, E30, E40, E50

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Council for Building and Civil Engineering (B/-) to Technical Committee B/146, upon which the following bodies were represented:

Building Employers' Confederation
Chartered Institute of Building
Consumer Policy Committee of BSI
Department of the Environment (Building Research Establishment)
Department of the Environment (Property Services Agency)
Federation of Associations of Specialists and Sub-Contractors
Institute of Clerks of Works of Great Britain Inc.
Institution of Civil Engineers
Institution of Structural Engineers
National Building Specification Ltd.
National Council of Building Materials Producers
National House Building Council
Royal Institute of British Architects
Royal Institution of Chartered Surveyors
Society of Chief Architects of Local Authorities

This British Standard, having been prepared under the direction of the Council for Building and Civil Engineering, was published under the authority of the Board of BSI and comes into effect on 30 November 1990



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# Contents

# Foreword

This Section of BS 8000 has been prepared under the direction of the Council for Building and Civil Engineering. It makes recommendations and gives guidance on basic workmanship for conventional types of building work.

The recommendations given are not necessarily comprehensive; particular project documents, e.g. project specifications, may need to cover particular recommendations not dealt with by this code of practice.

This code of practice is unique in that unlike other British Standards, it draws together recommendations given in other codes of practice.

The purpose of this code of practice is to encourage good workmanship by providing the following:

a) the most frequently required recommendations on workmanship for building work in a readily available and convenient form to those working on site;

b) assistance in the efficient preparation and administration of contracts;

c) recommendations on how designers' requirements for workmanship may be satisfactorily realized;

d) definitions of good practice on building sites for supervision and for training purposes; this guidance is not to supplant the normal training in craft skills;

e) a reference for quality of workmanship on building sites.

It is recognized that the design, procurement and project information should be conducive to good workmanship on site.

During the preparation of this code of practice the Building Industry's Co-ordinating Committee for Project Information (CCPI), produced a Common Arrangement of Work Sections (CAWS) for building work. This code of practice has generally been arranged in accordance with the Common Arrangement so that it can be used easily with project specifications and bills of quantities using this arrangement. Other major documents are being restructured in accordance with the Common Arrangement.

NOTE The CCPI was sponsored by the Association of Consulting Engineers, the Building Employers' Confederation, the Royal Institution of Chartered Surveyors and the Royal Institute of British Architects.

When complete BS 8000 will comprise the following Parts.

— *Part 1: Code of practice for excavation and filling;*

— *Part 2: Code of practice for concrete work;*

— *Part 3: Code of practice for masonry;*

— *Part 4: Code of practice for waterproofing;*

— *Part 5: Code of practice for carpentry, joinery and general fixings;*

— *Part 6: Code of practice for roof, slate, tile covering and cladding;*

— *Part 7: Code of practice for glazing;*

— *Part 8: Code of practice for plasterboard partitions and dry linings;*

— *Part 9: Code of practice for cement/sand floor screeds and concrete floor toppings;*

— *Part 10: Code of practice for plastering and rendering;*

— *Part 11: Code of practice for wall and floor tiling;*

— *Part 12: Code of practice for decorative wallcoverings and painting;*

— *Part 13: Code of practice for above ground drainage and sanitary appliances;*

— *Part 14: Code of practice for below ground drainage;*

— *Part 15: Code of practice for hot and cold water services (domestic scale).*

Technical Committees CSB/39, Structural use of concrete, and CAB/4, Concrete, have also participated in the preparation of this Section of BS 8000 and the content is based on and consistent with that of BS 8110. However, BS 8110 covers the subject matter more comprehensively and includes design, materials and other related aspects in addition to workmanship on site.

The text of this Section of BS 8000 includes commentaries. These commentaries are separately identified and are intended to be for guidance only and do not form part of the recommendations. They refer, unless otherwise stated, to the clause which immediately precedes each commentary.

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 16, 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.

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# Subsection 1. General

## 1.1 Scope

This Section of BS 8000 gives recommendations on basic workmanship on building sites and covers those tasks which are frequently carried out in relation to sitework with in situ and precast concrete.

This Section does not cover concrete work carried out for civil engineering and other specialist applications for which reference should be made to BS 8110-1.

NOTE This code of practice includes supplementary elements in the form of commentaries to assist in its use and understanding. Compliance with the commentaries is not necessary in order to be able to claim conformity with the standard.

## 1.2 References

### 1.2.1 Normative references

This Section of BS 8000 incorporates, by reference, provisions from specific editions of other publications. These normative references are cited at the appropriate points in the text and the publications are listed on the inside back cover. Subsequent amendments to, or revisions of, any of these publications apply to this Section of BS 8000 only when incorporated in it by amendment or revision.

### 1.2.2 Informative references

This Section of BS 8000 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 the inside back cover, but reference should be made to the latest editions.

## 1.3 Definitions

For the purposes of this Section of BS 8000, the definitions given in BS 6100-1.3.1:1987, BS 6100-1.3.3:1987 and BS 6100-6.2:1986 apply.

# Subsection 2. Materials, handling and preparation

Caution. When cement is mixed with water, alkali is released. Take precautions to avoid dry cement entering the eyes, mouth and nose when mixing concrete. Prevent skin contact with wet cement or concrete by wearing suitable protective clothing. If cement or concrete enters the eye, immediately wash it out thoroughly with clean water and seek medical treatment without delay. Wash wet concrete off the skin immediately.

It is important to observe all aspects of safety on site. For general guidance on safety with concrete construction see "A guide for small contractors. Site safety and concrete construction" issued by the Health and Safety Executive [1].

For particular health and safety measures to be observed when handling cement and concrete see Construction Industry Advisory Committee: "Hazard information sheet I Cement" [2].

## 2.1 Checking

### 2.1.1 General

Before discharge, check delivery tickets and certificates against the specification and examine marks and labels and condition of the material and components. If not satisfied refer to the supplier immediately.

For materials used for site mixed concrete, make reference to BS 8000-2.1. Check materials and components before installation or use and do not install or use materials that have been damaged or that have become defective whilst stored on site.

### 2.1.2 Ready-mixed concrete

**2.1.2.1** *Delivery.* Check ready-mixed concrete delivery tickets and certificates against the specification. If necessary refer to the supplier immediately. In particular check:

a) name or number of the ready-mixed concrete depot;

b) serial number of the ticket;

c) date;

d) truck number;

e) name of the purchaser;

f) name or location of the site;

g) grade of concrete or mix description;

h) specified workability;

i) minimum cement content, if specified;

j) type of cement;

k) limiting proportions of ground granulated blastfurnance slag (ggbs) or pulverized fuel ash (pfa), if specified;

l) maximum free water/cement ratio, if specified;

m) nominal maximum size of aggregate;

n) type or name of admixtures, if included;

o) quantity of concrete;

p) time of loading or of introducing water if later than loading time;

q) any other items that have been specified.

In cold and hot weather check the temperature of the concrete which should be not less than 5 °C nor more than 30 °C unless otherwise specified.

**2.1.2.2** *Records.* Keep a record of:

a) the time of completion of the discharge of the concrete;

b) the location within the construction where the concrete has been placed;

c) extra water, if any, added to the concrete.

COMMENTARY. *No water, other than the amount required to produce the specified workability should be added to the truck mixer drum before discharge, unless there are instructions to do so.*

### 2.1.3 Steel reinforcement

Check that reinforcement is the correct steel grade and that the bending dimensions are correct.

### 2.1.4 Precast components

Check precast components as described in **5.1**.

## 2.2 Handling and site storage

### 2.2.1 Reinforcement

a) Avoid rough handling, shock loading and dropping from a height.

b) Keep clean by sheeting overall if necessary.

c) Store reinforcements off the ground on supports close enough together to prevent permanent deformation.

d) Do not permit rust to such an extent that the effective cross-sectional area of the reinforcement is reduced to below the permissible negative tolerance. If necessary loosely cover the steel to exclude the rain; but allow good circulation of air all round the steel.

e) Store different sizes separately from each other and ensure that they are clearly labelled.

COMMENTARY. *Dirt or grease prevents a proper bond with the concrete; any badly misshapen bars should not be re-shaped on site without the permission and supervision of the specifying authority.*

*Unless rust is so heavy as to reduce the effective cross-sectional area of the reinforcement to below the permitted negative tolerance, it is not deleterious. Loose rust is removed by normal handling and any rust left adhering to the reinforcement does not reduce the bond (see CIRIA Report 91 [3]).*

*Each bay should be marked clearly to show the size of the bars, to avoid the need to judge by eye.*

#### 2.2.2 Precast components

Handle and store precast components as described in **5.2**.

#### 2.2.3 Storing accessories

Store all accessories such as tying wire, joint sealants, water bars, spacers, release agents etc., in conditions and temperatures such that they do not deteriorate, become damaged or become soiled or contaminated. Follow the manufacturer's sitework instructions.

#### 2.2.4 Distribution of materials

When materials and components are distributed to the work position ensure that:

a) neither construction nor scaffolding is overloaded;

b) protective measures are maintained to prevent deterioration.

#### 2.2.5 Transporting concrete on site

For the handling and transporting of concrete on site see **5.2** of BS 8000-2.1:1990.

## 2.3 Preparation of work

#### 2.3.1 Setting out building

Set out relative to securely marked or pegged reference lines and datum levels using serviceable equipment appropriate to the circumstances.

#### 2.3.2 Temperature records

Install a maximum and minimum thermometer in a position on site which is constantly shaded from the sun and not affected by the warmth from buildings or sheds. Maintain the following records:

a) daily maximum and minimum temperatures;

b) daily temperatures at the start and finish of normal site working hours.

Keep the records on site and available for inspection.

# Subsection 3. In situ concrete

## 3.1 General

### 3.1.1 Weather conditions

NOTE For information on mixing and transporting concrete on site see BS 8000-2.1. For curing of concrete in hot and cold weather see **3.2.3.3** and **3.2.3.4**.

**3.1.1.1** *Hot weather.* Take precautions to ensure that the temperature of the concrete is not higher than 30 °C at the time of placing.

**3.1.1.2** *Cold weather*

a) Take precautions to ensure that the temperature of the concrete does not fall below 5 °C at any time during placing and compacting.

b) Place the concrete quickly.

c) Do not place concrete against frozen or ice and snow covered surfaces.

COMMENTARY. *With freezing conditions day and night, it may be necessary to provide continuous heating to either the concrete or the building. If it is possible to ensure the concrete temperature is 10 °C when placed, and it is then insulated, it is probably unnecessary to heat either the concrete or the building.*

### 3.1.2 Accuracy

Follow the recommendations given in BS 5606:1990 so that the accuracy of construction does not impair the safety or durability of the structure, subsequent operations or the appearance and function of the structure.

## 3.2 Placing and curing

### 3.2.1 Preparation for concreting

**3.2.1.1** *Cleanliness*

a) Clear all rubbish, debris and free water from all surfaces on to which concrete is to be poured.

b) Additionally, in the case of formwork, remove waste nails, wire clippings, screws, etc.

c) Remove all loose scale and loose rust from the structural steel to be encased.

COMMENTARY. *Pieces of wire, nails, rust etc. are likely to cause staining of the concrete and of the formwork faces.*

**3.2.1.2** *General inspection.* When carrying out a general inspection check the following.

a) Confirm the availability of:

1) materials, including ready-mixed concrete;

2) labour;

3) plant and equipment;

4) power and water supply;

5) standby equipment and spares.

b) Confirm that setting out has been checked.

c) Confirm that earlier permanent work has been inspected.

d) If appropriate obtain the weather forecast.

e) Check adequacy of access to points of discharge and access platforms.

f) Confirm readiness of the batching plant.

g) Check the communications system.

h) Confirm compliance with safety regulations.

i) Confirm arrangements for transporting, placing, compacting, finishing, curing and testing.

**3.2.1.3** *Earth surfaces.* When concreting against earth surfaces check:

a) stability of earth slopes;

b) safety of earth faces when the construction plant is in operation;

c) arrangements for removal of water.

**3.2.1.4** *Other surfaces.* When concreting against other surfaces check the following.

a) Falsework for conformity with the design, stability and bracing, rigidity and precamber.

b) Formwork for:

1) conformity of dimensions to within allowable tolerances;

2) strength and rigidity;

3) correct use and number of ties;

4) provision of the surface to comply with the specification including the application of a release agent;

5) tightness and sealing of joints;

6) final clean-up before concreting;

7) arrangements for removal.

**3.2.1.5** *Joints, inserts and openings.* For joints, inserts and openings check:

a) construction of joints, dowels, water bars and sliding layers;

b) inserts and box-outs for accuracy and security;

c) fixing of stop-ends;

d) arrangements for forming kickers;

e) preparation of hardened surfaces.

**3.2.1.6** *Reinforcement.* For reinforcement check:

a) size, type, markings, location and cover are correct;

b) anchorages and laps are correct;

c) that it is rigidly secured;

d) surface condition;

e) use of spacers including type and size.

COMMENTARY. *The aim of the pre-concreting checks is to ensure that the concreting proceeds without delay or defects. Further information is available from the Concrete Society Report "Concrete on site — a check list" [4].*

**3.2.1.7** *Sampling and testing of concrete.* When it is required to sample and test concrete for compliance with specifications, ensure the appropriate procedures are followed, using equipment in good working order, and:

a) complete certificates of sampling, specimen making, curing and testing to confirm compliance with the specification;

b) transport concrete cubes to the test laboratory ensuring that they are kept moist, are not damaged and spend the minimum time in transit.

COMMENTARY. *The procedures for sampling, specimen making, curing and testing as given in BS 1881 are very detailed and involve the use of well-maintained standard equipment confirmed at regular intervals to comply with the appropriate standard.*

*Cubes should be stored and tested for strength at a laboratory accredited for the test by the National Measurement Accreditation Service (NAMAS).*

*Specimens need to be stored under controlled temperature and moisture conditions. This will require a site hut, suitably heated in the winter, and a temperature controlled water tank.*

*Deviations from standard requirements can affect results significantly and may lead to errors in judgement concerning the quality of the concrete. Supervision of personnel trained in the procedures is essential. The use of a laboratory accredited for site sampling and specimen making is recommended.*

**3.2.1.8** *Items to cast in.* Fix these securely to prevent displacement. Seal any openings and open pipe ends to prevent the unwanted entry of concrete.

**3.2.1.9** *Protection from traffic.* Use suitable stools, walkways and barrow runs to protect reinforcement or concrete that has not hardened.

**3.2.1.10** *Hardcore/blinding.* Where concrete is specified to be laid in direct contact with hardcore and/or loose blinding, wet the surface immediately before placing the concrete.

**3.2.1.11** *Work below ground*

a) Before pouring strip footings, bases and slabs against the faces of excavations, check that the faces are stable and accurate. If they are not, seek instructions.

b) Place concrete in such a manner that the sides of the excavation are not displaced.

c) If the concrete face is to be formed against the excavation, ensure that the cover to the reinforcement is not less than 75 mm.

### 3.2.2 Placing

**3.2.2.1** *Placing concrete*

a) Place concrete in one continuous operation between and up to the construction joints or other limiting features (see **3.3**).

b) Discharge concrete through the reinforcement or other obstructions with care so as to avoid dispersal, segregation or loss of ingredients.

c) Where reinforcement is congested use chutes or trunking to direct the concrete into position.

d) If, for any reason, concrete placing has to be stopped for any period such that the concrete will not remain plastic, obtain instructions and form a proper, additional construction joint.

**3.2.2.2** *Displacement when placing concrete.* Ensure no displacement or damage to damp proof membranes, reinforcement, formwork, or embedded fittings takes place whilst placing.

**3.2.2.3** *Compacting concrete.* Compact the concrete, ensuring that:

a) it forms a solid uniform mass free from accidental voids;

b) it is packed tight around the reinforcement;

c) it fills all parts of all formwork or excavation;

d) there is no segregation of ingredients;

e) it is amalgamated with previous batches;

f) there is no damage to adjacent partly-hardened concrete;

g) the required finish will be achieved;

h) mechanical vibrators, if used, are the type appropriate to the circumstances and are operated by experienced operators.

COMMENTARY. *Inadequate compaction can seriously affect the quality of the concrete. The concrete may be assumed to be fully compacted when air bubbles cease to rise to the surface of the concrete in the vicinity of the poker vibrator. For advice on compacting concrete with vibrators see BCA Publication 45.108 "Placing and compacting concrete" [5].*

**3.2.2.4** *Deep sections.* For wall columns, beams etc:

a) place and compact concrete in layers, and ensure each layer extends over the length and width of the section;

b) place succeeding layers without delay and merge them, by compaction, with the layer below;

c) check for plastic settlement cracking and re-vibrate as necessary.

**3.2.2.5** *Surface finish.* Take particular care when placing concrete where a good surface finish is required and:

a) fill formwork at a steady rate to allow sufficient time for compaction, but avoid cold joints between succeeding layers;

b) do not permit the vibrator to touch any faces of the formwork;

c) vibrate thoroughly;

d) provide an unformed finish as specified (see **3.4.2**).

COMMENTARY. *When using vibrators inside formwork for fair face concrete, contact between the vibrator and formwork face can damage the surface, resulting in permanent marks in the concrete. Thorough vibrating assists in eliminating blow holes.*

**3.2.3 Curing (**see also **3.1.1).**

**3.2.3.1** *Curing measures.* Commence curing immediately after the finishing operations and maintain properly for at least the following periods:

a) concrete surfaces subjected to direct wear or abrasion: 7 days;

b) cure and insulate sections 300 mm or less in thickness when the average air temperature is 7 °C or less for 10 days;

c) other conditions: 4 days.

COMMENTARY. *The application of a 90 % efficient curing compound (as measured by the test method given in clause 1032 of the Department of Transport "Specification for Highway Works" [6]) is deemed to satisfy the requirements of this clause except for the recommendations to insulate concrete in cold weather.*

*By specification or agreement, more sophisticated curing requirements such as those in* **6.6.2** *of BS 8110-1:1985 may be used.*

*The purposes of curing and protection are to:*

*1) control the rate of loss of moisture;*

*2) control the temperature of the maturing concrete;*

*3) prevent plastic shrinkage cracking;*

*4) prevent damage.*

*The more severe the weather the more care that is required.*

*Lack of curing affects the durability and abrasion resistance of the concrete.*

**3.2.3.2** *Method of covering concrete.* Ensure that the method in any event:

a) is effective in preventing evaporation of water;

b) does not mark surfaces which will be visible in the completed work;

c) does not affect any bond required between the concrete and other construction or finishes;

d) provides adequate insulation in the covering in cold weather;

e) is well secured to prevent draughts and to prevent accidental removal by wind.

Do not walk on covered surfaces until curing is complete.

COMMENTARY. *Sprayed finishes can affect the bond between the concrete and other structural finishes.*

**3.2.3.3** *Hot weather.* During curing provide screens or covers to protect the concrete from the sun and winds that would cause over-rapid drying. Ensure the covers are fastened down at the edges to prevent wind funnelling.

Do not cover concrete with hessian and spray with water.

COMMENTARY. *There are always risks in using wet hessian to assist in curing concrete. The evaporation of water may cause irregular cooling in parts of the concrete, which may give rise to cracking, and spraying with cold water may aggravate this tendency; the hessian may not be kept properly damp throughout the period of curing unless it is most carefully supervised; it may also cause staining. For these reasons it is a practice best avoided. Impermeable sheeting such as polyethylene is preferred.*

**3.2.3.4** *Cold weather.* During curing do not spray with water or use wet covers in freezing weather.

Unless otherwise specified maintain the temperature of the concrete at not less than 5 °C for the periods given in Table 1 for ordinary Portland cement (OPC) and rapid-hardening Portland cement (RHPC).

**Table 1 — Recommended periods for maintaining temperature at 5 °C minimum**

| Concrete grade N/mm$^2$ | OPC | RHPC |
|---|---|---|
| 20 or less | 5 days | 3 days |
| 25 | 3 days | 2 days |
| 30 | 3 days | 2 days |
| 40 or more | 2 days | 1½ days |

Obtain instructions for other types of cement.

COMMENTARY. *The following is a summary of measures that might be taken for different degrees of severity of cold.*

*Temperature below* 5 °C *but not freezing*

a) *formwork should be kept in position for longer periods of time to compensate for slower strength gain, see* **4.1.1.1** *and* **4.1.3.1**;

*Slight freezing at night*

*In addition to a):*

b) *the top of the concrete should be covered with insulating material and the soffit of the slab when metal formwork is used;*

*Severe freezing day and night*

*In addition to a) and b):*

a) *all formwork should be insulated;*

b) *continuous heating should be provided to either the concrete or the building. However, if the temperature of the concrete is* 10 °C *when placed and it has been insulated immediately, it is probably unnecessary to heat the concrete or the building.*

## 3.3 Joints

### 3.3.1 Construction joints

**3.3.1.1** *Forming.* Form joints only where required and ensure that:

a) horizontal joints are level to show a straight line when the formwork is removed;

b) vertical joints are in a straight line with rigid stop ends in the formwork, designed to accommodate projecting reinforcement without temporary bending or displacement;

c) where projecting reinforcement penetrates the formwork, a seal is made around the bars with foam plastic strip and adhesive tape to prevent grout loss.

**3.3.1.2** *Preparing for next pour.* Prepare joints whilst concrete is still green, and:

a) remove all laitance;

b) expose coarse aggregate without disturbing it;

COMMENTARY. *The coarse aggregate is best exposed by light scabbling.*

c) remove all loose material from the formwork;

d) clean the concrete face and dampen it before placing fresh concrete against it and ensure any pools of water are removed.

**3.3.1.3** *Joints between bays in floors with concrete wearing surfaces*

a) Ensure that forms are square-edged, in good condition and fixed with the top edge true to line.

b) Compact the concrete thoroughly and pay particular attention to edges of slabs.

c) Place concrete in subsequent bays to form close butt joints with concrete already in place for the full depth of the slabs, and with no lipping at any point between the two bays.

### 3.3.2 Movement joints

**3.3.2.1** *Forming.* Form joints only as specified and:

a) do not permit concrete to enter any gaps or voids in the formwork or to render the movement joints ineffective;

b) do not permit concrete to impregnate or penetrate through any materials used as compressible joint fillers;

c) do not place concrete simultaneously on both sides of the joint.

**3.3.2.2** *Sheet joint fillers.* Fix compressible fillers accurately in position and ensure that the correct space is left for sealant by the use of temporary formers.

## 3.4 Work on concrete after placing

### 3.4.1 General

**3.4.1.1** *Timing.* Carry out all cutting and finishing operations when the concrete has achieved a degree of hardness most favourable to the work to be done.

**3.4.1.2** *Protection.* Prevent damage to the concrete as follows.

a) *Surfaces generally:* from rain, indentation and other physical damage.

b) *Surfaces to be exposed in the finished work:* from dirt, staining, grout runs and other disfiguring marks.

c) *Immature concrete:* from thermal shock, physical shock, overloading, movement and vibration.

d) *Pockets in concrete:* ensure that in freezing conditions precautions are taken to prevent water entering pockets formed in the concrete for holding down bolts etc. Either leave expanded polystyrene formers in position or cover openings with temporary covers of plywood, or similar material, fixed in position and sealed with bitumen or mortar.

COMMENTARY. *If water is trapped in a pocket and freezes, it is very likely to damage the concrete.*

**3.4.1.3** *Damage.* If concrete has been damaged seek instructions and agree suitable remedial measures if necessary.

### 3.4.2 Worked finishes

**3.4.2.1** *Work on fresh concrete*

a) Do not wet surfaces of concrete to assist surface working.

b) Do not sprinkle materials on surfaces to be worked unless specified.

**3.4.2.2** *Tamped finish.* Tamp the surface of a concrete slab with the edge of a board or beam to give an even texture of parallel ribs.

**3.4.2.3** *Brush finish.* After the surface has been levelled and the sheen has just disappeared draw a brush across the surface in parallel lines to produce an overall even texture, each sweep of the brush being made without interruption.

**3.4.2.4** *Floating and trowelling.* Float the surface to the required level. Use a trial area to determine the best time to commence trowelling.

COMMENTARY. *Floating and trowelling operations should be carried out by experienced operatives. Floating is the operation of levelling and trowelling is carried out to make the surface dense and hard wearing. If trowelling is started too soon a poor surface will result.*

**3.4.2.5** *Keying concrete floors.* Check the specification for the degree of keying required and ensure this is carried out.

**3.4.2.6** *Keying surfaces other than floors.* If not directed beforehand, agree the method of roughening surfaces of concrete to form a key for applied finishes, see also **3.4.2.5**.

COMMENTARY. *It is essential to avoid damage to the structure when mechanically roughening the concrete. Alternatively it may be thought desirable to propose the use of a retarding agent. The resulting skin of soft mortar may then be brushed away after the concrete has hardened.*

### 3.4.3 Cutting holes and chases

Obtain permission before cutting holes and chases in hardened concrete and seek instructions on the method of cutting to be used.

COMMENTARY. *Care is needed so that the structural capability is not impaired; it is important to avoid indiscriminate cutting and in particular to avoid damaging the reinforcement and fair face of the concrete.*

# Subsection 4. Formwork and reinforcement

## 4.1 Formwork

### 4.1.1 Construction

**4.1.1.1** *General.* Construct formwork so that it provides support until the concrete gains sufficient strength to support its own weight and any superimposed loads, and:

a) make all ties, props, scaffold fittings and construction tight and secure against vibration before and during concreting operations;

b) fix all props and struts vertically and where necessary brace them. Provide sole plates as necessary and seat sole plates firmly throughout their length;

c) seat all supports adequately and securely on their bearings;

d) fix stop ends securely;

e) align forms correctly and ensure they are level.

COMMENTARY. *For further guidance see "Formwork: Guide to good practice" issued by the Concrete Society/Institution of Structural Engineers [7].*

**4.1.1.2** *Precamber.* Construct formwork to soffits with any precamber necessary to allow for deflection of the formwork.

COMMENTARY. *If a precamber is specified this will be for the concrete itself. Any precamber to allow for deflection of formwork is in addition to this.*

**4.1.1.3** *Joints in formwork.* Construct joints in formwork and between formwork and completed work to prevent loss of grout. Use foamed plastics strip seals where necessary. Secure formwork tightly against adjacent concrete to prevent formation of lippings. Do not overstress the tie bolts.

**4.1.1.4** ***Inserts, holes, chases etc.***

a) Fix inserts, formers and boxing for holes, chases etc. securely in position so that they will not be displayed when concrete is poured. Seal where necessary to prevent leakage of grout.

b) Do not make alterations to size and location without approval.

**4.1.1.5** *Vertical faces below ground.* Cast faces of walls below ground against formwork or previously cast, backshuttered concrete. If in doubt about the need for formwork for other members seek advice, (see **3.2.1.11**).

COMMENTARY. *In general the vertical faces of strip foundations and pad footings are cast against the face of the excavation, unless the soil is especially unstable. There may be special problems with shrinkable or expansive clay subsoils and instructions should be sought in these circumstances.*

**4.1.1.6** *Propping.* Provide adequate propping to prevent excessive deflection or damage to the structure during construction.

Carry propping down through the structure to suitable and adequate bearings.

COMMENTARY. *If the load during construction is likely to exceed the capacity of the structure below, on which propping is to be supported, BS 5975 offers some guidance.*

### 4.1.2 Cleaning and treatment

Before each use of formwork carry out the following.

a) Clean the contact surfaces carefully and dry them before applying a release agent.

b) Ensure the release agent is appropriate to the surface to be coated. Use the same type and make of release agent throughout on similar formwork materials and do not mix different types.

c) Coat formwork surfaces evenly and thinly with release agent. Treat vertical surfaces before horizontal surfaces and wipe off any excess.

d) Prevent the release agent coating any part of the reinforcement, hardened concrete, permanent formwork or other materials not part of the formwork. Carefully remove any release agent that accidentally gets onto these surfaces.

### 4.1.3 Striking

**4.1.3.1** *Timing.* Remove the formwork only when the concrete has developed sufficient strength and ensure that:

a) the surface of the concrete is not damaged;

b) the structure is not overloaded in relation to the strength reached and there is no excessive deflection in structural members.

Prop as necessary after striking the formwork. See **4.1.1.6**.

COMMENTARY. *Care is needed to ensure the concrete structure has sufficient strength before the formwork is removed. This can be assessed either by means of test cubes prepared for the purpose or by reference to tables of minimum striking times published in CIRIA Report 67 [8] or in BS 8110-1. The temperature of the concrete during the curing period is a key factor in the use of tables.*

*The times given in Table 2 will normally ensure that adequate strength has developed and may be used unless otherwise specified or instructed.*

*The times given are for concrete made with ordinary Portland cement or sulphate-resisting Portland cement.*

**Table 2 — Striking times for formwork**

| Types of formwork | Minimum period before striking | |
|---|---|---|
| | Surface temperature of concrete 16 °C and above | Surface temperature of concrete 7 °C |
| Vertical formwork to columns, walls and large beams | 12 hours | 24 hours |
| Soffit formwork to slabs | 4 days | 6 days |
| Props to slabs | 10 days | 15 days |
| Soffit formwork to beams | 10 days | 15 days |
| Props to beams | 14 days | 21 days |

**4.1.3.2** *Making good after striking.* When surface excrescences, tie holes, blow holes etc. are required to be made good:

a) remove excrescences from the surface;

b) fill in tie holes with 1:3 cement and sand semi-dry mortar well rammed in and finished flush with the face of the concrete;

c) fill blow holes exceeding 5 mm across with 1:1$^{1}/_{2}$ cement and sand rubbed in;

d) take care on permanently exposed concrete surfaces and follow the recommendations given in BS 8110-1:1985;

e) if strength and durability cannot be assured, agree procedures for repair or replacement.

COMMENTARY. *The sand in the mortar should be fine aggregate of the concrete. This initial making good would precede any finishing of surfaces that may be required.*

## 4.2 Reinforcement

### 4.2.1 General

**4.2.1.1** *Types.* At time of fixing reinforcement check the type of steel is correct for its location, see **2.2.1**.

COMMENTARY. *Steel properties vary, and use of reinforcement of a lower quality could result in structural failure.*

**4.2.1.2** ***Cutting and bending***

a) Shear or saw reinforcement.

b) Bend reinforcement cold on a proper bending machine.

c) If reinforcement temperature is below 5 °C obtain instructions before bending.

d) Cut and bend bars in accordance with BS 4466:1989 unless otherwise instructed.

e) Do not rebend or straighten steel bars without instructions.

COMMENTARY. *Bending at too low or too high a temperature may affect the structural properties of the steel.*

**4.2.1.3** *Laps in reinforcement.* Lap bars only where it is specified or permitted.

**4.2.1.4** *Welding.* Do not weld or tack weld reinforcement unless it is specified or permission has been obtained.

### 4.2.2 Fixing and placing

**4.2.2.1** ***General***

a) Fix reinforcement together by ample use of tying wire or patent ties, or, if permitted, by welding.

b) Do not allow tying wire to intrude into the concrete cover.

c) Secure reinforcement in the correct positions using approved temporary or permanent chairs, spacers, etc., maintaining specified cover by means of cover spacers secured to prevent displacement.

d) Do not attempt to place reinforcement directly on formwork and raise it into its correct position as the concrete is being placed, see **4.2.2.3**.

e) Do not insert reinforcement into concrete already placed in position.

**4.2.2.2** *Fabric reinforcement.* Fix welded fabric reinforcement as follows:

a) in the bottom of slabs with longitudinal bars underneath;

b) in the top of slabs with longitudinal bars uppermost, (see **4.2.2.1**).

**4.2.2.3** *Top steel reinforcement*

a) Unless otherwise permitted, firmly support top steel reinforcement in the position specified before concrete is placed, either by links or steel chairs.

b) In the case of ground bearing concrete slabs reinforced with a single layer in fabric set in the upper part of the slab, if permission is obtained, place the reinforcement in position on top of the first compacted layer of concrete and then place and compact the second layer of concrete.

COMMENTARY. *Table 3 gives a guide for spacing of chairs and spacers.*

**Table 3 — Recommended spacing for chairs and spacers**

| Structural element | Spacing |
|---|---|
| Slabs | 50 × size of bar or 1 000 mm maximum |
| Beams | 1 000 mm maximum |
| Columns | 3 sets per storey or 100 × size of main column bars maximum |

NOTE For comprehensive guidance on spacers, spacing and tying of reinforcement see Concrete Society Report CS 101 "Spacers for reinforced concrete" [9] which gives standard provisions for achieving cover encircling reinforcing steel.

**4.2.2.4** *Cleanliness.* At the time of placing reinforcement ensure that it is clean and free from mud, paint, retarders, loose rust, loose mill scale, snow, ice, grease or any other substances likely to affect the bond with the concrete, cleaning it if necessary before fixing. Maintain it in a clean condition and protect it from substances likely to weaken the bond with the concrete until the concrete is placed, see **2.2.1**.

COMMENTARY. *There is always some danger that mud and release agents may be deposited on reinforcing bars from the boots of operatives.*

**4.2.2.5** *Damage.* Prevent damage to and disfigurement of forms, form linings and adjacent work when placing and fixing reinforcement.

### 4.2.3 Prevention of rust stains

Prevent rust staining of surfaces of concrete which will be exposed in the finished work.

a) Prevent rust stained water coming in contact with formwork or completed concrete.

b) If projecting reinforcement, or reinforcement fixed in position in the formwork, will be left exposed for more than 10 days protect it from moisture.

COMMENTARY. *Projecting reinforcement may be given short term protection by coating with cement grout. If the reinforcement is likely to be exposed for a longer time it should be wrapped with weatherproof material such as polyethylene fixed securely with galvanized wire.*

# Subsection 5. Precast components

## 5.1 Checking

When a load arrives on site check the driver's ticket to confirm that the correct units have been supplied and also check the markings on the units.

Check for any units that have been damaged during delivery and reject any that are beyond reasonable repair.

## 5.2 Handling on site

### 5.2.1 General

a) When handling and storing units, support them in a manner which will not subject them to stress and deformation for which they are not designed. Ensure that lintels and other reinforced or prestressed items are the right way up.

b) Store units on a clean, firm base, clear of the ground, protected as necessary from the weather and from staining by splashing from rain or from the ground.

Where necessary use plastic stacking pads or timber battens between units to prevent direct contact. Wrap timber battens in polyethylene.

c) Avoid walking on, marking, soiling, chipping or breaking units.

COMMENTARY. *It is particularly important to avoid any staining or chipping of precast components which will be exposed in the completed building. Making good to concrete faces may be necessary but is always undesirable because of the difficulty of colour matching.*

*Components of any size may be subject to damage if they are not properly supported. All reinforced or prestressed units may crack if they are stressed in a way for which they have not been designed. Any damage is difficult to repair satisfactorily.*

### 5.2.2 Storage of fittings

Store all fittings in such a way that they do not deteriorate, become damaged or contaminated. Follow the manufacturer's sitework instructions.

### 5.2.3 Lifting

NOTE Attention is drawn to the need to ensure that all aspects of lifting and protection are strictly within legislation current at the time and that all lifting equipment is correctly tested and certified.

Before lifting the unit from the ground or truck, ensure that there are no obstructions, overhead wires or scaffolds in the way of the crane and crane jib which would prevent the unit from being properly landed. Ensure that the crane movement will not present a safety hazard.

Lower the unit gradually to its final position, avoid shock loading and avoid impacts on adjacent units which may knock them off their bearings.

### 5.2.4 Fixing

Fix units into a safe position before the crane hook is released. Fit the final fixing system as soon as is practicable.

## 5.3 Grouting

Limit access over units which are awaiting grouting. If access is essential, check with the designers that this is safe.

Grout strictly in accordance with the engineer's instructions and take test cubes if required. Grout only in conditions which are suitable.

Ensure that the ungrouted floor is capable of carrying the weight of casting machines or skips.

## 5.4 Screeds

When precast concrete floor units are required to be screeded with reinforced or unreinforced concrete screeds, see BS 8000-9:1989.

## 5.5 Protection

Provide protection in the manner required. Avoid protective systems which rub on units as they may be damaged in wind.

Ensure that drain holes are provided and are kept clear to release built up water.

Do not stack reinforcement, scaffold poles or place heavy equipment on to a floor without checking first that it is safe to do so.

COMMENTARY. *Architectural units may need to be protected until site work is completed. Units with central voids or deep pockets may fill with water and in winter may then freeze causing spalling of the concrete.*

## 5.6 Floors

### 5.6.1 General

a) Clear all rubbish and debris from bearing surfaces to ensure precast units have a firm seating.

b) Ensure that the clearance between units and earth or other fill below the floor is as specified. In the case of clay soil the minimum clearance is to be 150 mm.

c) Do not permit the ends of units to project into cavities in cavity walls.

d) Do not damage or displace damp-proof courses when setting units in position.

e) Ensure the bearing length of units is not less than that specified or given in the manufacturer's sitework instructions.

f) Do not overload the floor during construction.

g) Prop the floor until it is able to take superimposed loads.

COMMENTARY. *Depending upon the types of precast units, spans and other factors there will be differing requirements for temporary propping, structural screeds, joint reinforcement, etc. In all these matters it is essential that the specifier or manufacturer's sitework instructions are followed carefully.*

*Building materials may be stacked on the floor provided that:*

*1) materials are stacked as near as possible to floor supports;*

*2) materials are stacked on stout planks laid across the units;*

3) *the weight of materials does not exceed that given in the manufacturer's sitework instructions.*

**5.6.2 Beam and block floors**

Follow **5.6.1** a) to g) and:

a) space beams by placing one block in position between each end of adjoining beams;

b) do not place any block with a bearing width less than 10 mm;

c) after floor laying is complete, brush 1:6 cement and sand grout over the surface with a stiff broom and ensure all gaps are filled solid.

**5.6.3 Plank floors**

Follow **5.6.1** a) to g) and:

a) ensure the edges of adjoining units are in contact as far as inaccuracies in casting permit;

b) prevent structural damage;

c) prevent disfigurement of the faces and arrises exposed to view in finished work;

d) level and align the unit accurately;

e) prevent grout leakage at joints between planks and at junctions with formwork and finished work.

# Index

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# List of references (see 1.2)

## Normative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 4466:1989, *Specification for scheduling, dimensioning, bending and cutting of steel reinforcement for concrete.*
BS 5606:1990, *Guide to accuracy in building.*
BS 6100, *Glossary of building and civil engineering terms.*
BS 6100-1, *General and miscellaneous.*
BS 6100-1.3, *Parts of construction works.*
BS 6100-1.3.1:1987, *Walls and cladding.*
BS 6100-1.3.3:1987, *Floors and ceilings.*
BS 6100-6, *Concrete and plaster.*
BS 6100-6.2:1986, *Concrete.*
BS 8000, *Workmanship on building sites.*
BS 8000-2, *Code of practice for concrete work.*
BS 8000-2.1:1990, *Mixing and transporting concrete.*
BS 8000-9:1989, *Code of practice for cement/sand floor screeds and concrete floor toppings.*
BS 8110, *Structural use of concrete.*
BS 8110-1:1985, *Code of practice for design and construction.*

## Informative references

BSI standards publications

BRITISH STANDARDS INSTITUTION, London

BS 1881, *Testing concrete.*
BS 5975:1982, *Code of practice for falsework.*
BS 8000, *Workmanship on building sites.*
BS 8000-1:1989, *Code of practice for excavation and filling.*
BS 8000-3:1989, *Code of practice for masonry.*
BS 8000-4:1989, *Code of practice for waterproofing.*
BS 8000-5:1990, *Code of practice for carpentry, joinery and general fixings.*
BS 8000-6:1990, *Code of practice for roof, slate, tile covering and cladding.*
BS 8000-7, *Code of practice for glazing*[1)].
BS 8000-8:1989, *Code of practice for plasterboard partitions and dry linings.*
BS 8000-10:1989, *Code of practice for plastering and rendering.*
BS 8000-11, *Code of practice for wall and floor tiling.*
BS 8000-11.1:1989, *Ceramic tiles, terrazzo tiles and mosaics.*
BS 8000-11.2:1990, *Natural stone tiles.*

[1)] In preparation.

BS 8000-12:1989, *Code of practice for decorative wallcoverings and painting.*

BS 8000-13:1989, *Code of practice for above ground drainage and sanitary appliances.*

BS 8000-14:1989, *Code of practice for below ground drainage.*

BS 8000-15:1990, *Code of practice for hot and cold water services (domestic scale).*

Other references

[1] HEALTH AND SAFETY EXECUTIVE. *A guide for small contractors. Site safety and concrete construction.* London: HMSO, 1989.

[2] HEALTH AND SAFETY EXECUTIVE. *Hazard information sheet I Cement.* London: HMSO, 1985.

[3] CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION. *CIRIA Report 91: Early age thermal crack control in concrete.*[2] 1981.

[4] CONCRETE SOCIETY. *Concrete Society Report CS 023, Concrete on site — a check list.*[3] 1980

[5] BRITISH CEMENT ASSOCIATION. *BCA Publication 45.108: Placing and compacting concrete.*[4] 1980.

[6] DEPARTMENT OF TRANSPORT. *Specification for highway works.* London: HMSO, 1986

[7] CONCRETE SOCIETY/INSTITUTION OF STRUCTURAL ENGINEERS. *CS 026 or CS 030, formwork: Guide to good practice.*[3] 1986

[8] CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION. *CIRIA Report 67: Tables of minimum striking times for soffit and vertical formwork.*[2] 1977, reprinted 1985

[9] CONCRETE SOCIETY. *Concrete Society Report CS 101, Spacers for reinforced concrete.*[3] 1989

[2] Obtainable from the Construction Industry Research and Information Association, 6 Storey's Gate, London SW1P 3AU.

[3] Obtainable from the Concrete Society, Framewood Road, Wexham, Slough SL3 6PJ.

[4] Obtainable from the British Cement Association, Wexham Springs, Slough SL3 6PL.

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