

# Ian Black Consulting Ltd



**Consulting Structural & Civil Engineers**

## CONCRETE FRAME SPECIFICATION Issue 1.0

**1.0 INTRODUCTION**

This document is to act as a guide in the construction of concrete frame structures.

All matters covered in this report are enforced in every day practice on site. A copy of this report is to be kept on all sites employing the methods of construction noted.

All site personnel must be familiar with this document and enforce it fully.

**2.0 OVERVIEW**

Every effort is made to produce consistent drawings. Any errors must be reported.

The Main Contractor and his sub contractors (here after referred to as MC/SC) must plan ahead to ensure all details shown on drawings be implemented as drawn. Ian Black Consulting (IBC) and (or) their representatives carry out routine inspections to check that the construction is generally in accordance with the drawings. This should however not be in lieu of checking by MC/SC which are responsible for ensuring compliance with the drawings. To that end clear lines of responsibility must be established by McAleer & Rushe with all sub contractors to ensure checking procedures are in place, conducted regularly, recorded, signed off as checked and double checked by suitably qualified individuals.

**3.0 CONTINUITY REINFORCEMENT**

As a rule we required 50 times the bar diameter laps, for slabs, columns and walls.

Pour lines should be positioned at third points between supports.

**4.0 COVER**

Adequate cover to reinforcement is required to produce durable structures with adequate fire resistance and strength. Any areas failing to meet the required cover must be broken out carefully with suitable equipment and recast.

Kwikastrip or equal if used by prior agreement **must** be set at the correct level. If not it must be removed if too high, or the decking could be dropped if it too low. Any such changes to main slab level must be checked with the Design Team prior to casting.

Kwikastrip is usually used to replace tradition bars in areas where additional reinforcement is not shown on the engineers drawing. Ends or corners of walls are not ideal locations for its use.

The Kwikastrip unit is to be cast into the face of the wall. After the formwork is struck, the lid is removed to reveal the connection legs/starter bars inside the casing. These legs are bent out by the contractor using the **manufacturer's specified tool**, in preparation for lapping the main reinforcement of the subsequent pour.

**5.0 COLUMN REINFORCEMENT**

Columns, walls, slabs and landings all must have the minimum cover stated on the drawing. Consideration must be given to rebar where section size change and bars be correctly orientated. Also where bars are bent into the slab, they should be set at mid slab level and not under any circumstances to be cut, even at junction with upstand/beam rebar. **Prefabrication of beam cages may not always be possible.**

**6.0 SPALLING/DAMAGE**

Areas noted as damaged or cracked must be repaired as noted in item 7. Stripping of concrete elements should be carried out in accordance with specification.

**7.0 HONEYCOMBING**

Any areas stripped and found to exhibit honeycombing must be carefully broken back to sound concrete and filled with suitable material to the engineer's specification. This work should only be carried out by suitably qualified specialists and we will require work carried out by other operatives to be remedied by specialists with suitable expertise. Honey combing is completely avoidable, a result of not complying with concrete specification and leads to significant strength loss and is therefore not acceptable.

**8.0 WORKMANSHIP**

Workmanship must be to the highest standard, strictly adhering to BS 8666. Reinforcement to be clean and free from corrosive pitting, loose mill-scale, loose rust, ice, oil, and other substances which may adversely affect the reinforcement, concrete or bond between the two. Structural welded joints will not be permitted.

**9.0 KICKERLESS CONSTRUCTION**

Unless shown otherwise form horizontal construction joints at base of walls and columns without kickers, using one of the methods described in BCA Publication 47.023 “Kickerless construction”. The Contractor must satisfy himself as to the suitability of the chosen method.

**10.0 REINFORCEMENT SPACERS**

All spacers should be installed as per the manufactures guidance, and in strict adherence to BS 7973-2: 2001. A copy of BS 7973-1:2001 and BS 7973-2:2001 to be kept on site for reference. Particular care to be taken when using line spacers.

**11.0 RELEASE AGENTS:** Type(s) which are suitable for use with the types of formwork, formed finishes and specified applied finishes. Use the same type and make throughout the entire area of any one finish. Apply evenly to form faces, from top downwards, and to horizontal surfaces last. Use the minimum amount necessary to obtain a clean release and prevent excessive local collection. Prevent release agent touching the reinforcement, hardened concrete, other materials not par of the form face, and permanent forms.

**12.0      FIXING**

Unless otherwise permitted, fix reinforcement in place before placing concrete. Comply generally with Concrete Society Report CS 101 'Spacers for reinforced concrete'. Unless otherwise specified tie using 16 swg annealed tying wire. Tack weld not to be used unless authorised by CA and manufacturer. Reinforcement should have no contact with nonferrous metals.

**13.0      CEMENTS**

The following abbreviations apply:

<b>PC42.5</b>	Portland Cement, Class 42.5 (in lieu of OPC).
<b>PC52.5</b>	Portland Cement, Class 52.5 (in lieu of RHPC).
<b>SRPC</b>	Sulfate Resisting Portland Cement.
<b>PBFC</b>	Portland Blast Furnace Cement.
<b>HSBC</b>	High Slag Blast Furnace Cement
<b>PPFAC</b>	Portland Pulverised-Fuel Ash Cement
<b>GGBS</b>	Ground Granulated Blast furnace Slag
<b>PFA</b>	Pulverised Fuel Ash

- Cements, GGBS and PFA must comply with the relevant British Standards. Portland cements must have cement certification meeting the requirements of the NACCB, Category 2 for product conformity.

**14.0      PLACING & COMPACTION**

Concrete must be fully compacted to remove all entrapped air. Amalgamation of consecutive batches of concrete should be carried out without damaging adjacent partly hardened concrete. Inspect fresh concrete where cracking is likely to occur, in the first few hours after pour, whilst concrete is still capable of being fluidized by the vibrator. Re-vibrate to eliminate cracks. **Concrete must not be poured at an ambient temperature below 5°C.** A Maximum/Minimum thermometer should be located on site for reference. This should be kept outside of accommodation and reflect site conditions.

**15.0 FINISHING**

Carry out finishing operations at optimum times in relation to the setting and hardening of the concrete. Wetting to assist working and sprinkling cement are prohibited. Tamped finish or trowelled finish to be used where stated.

**16.0 DESIGNED JOINTS IN IN-SITU CONCRETE**

Joints must be positioned accurately, being truly horizontal, vertical, or parallel with setting out lines of the building. Any modifications must be agreed before proceeding. Concrete in joints render them ineffective. Do not place concrete simultaneously on both sides of a joint.

**17.0** Concrete Mixes utilising GGBS must not be used in columns or flat slabs. They are permitted only in pile caps, ground beams, ground floor slabs (cast on ground), retaining walls and instances where permanent formworks to be used.

**18.0 CURING**

Prevent evaporation from surfaces of concrete throughout curing period. Maintain surface temperature of  $>5^{\circ}\text{C}$  during curing period. Records of location, time of casting and removal of formwork and coverings to be kept and maintained for inspection.

**19.0 TESTING AND CERTIFICATION**

Cube testing: One set of four per 30cu.m (not less than two sets per day)

Slump tests: Two per day.

**17.1 SAMPLING**

Two types of cube exist. Cubes from Conformity testing, and cubes from Identity testing. Conformity testing should be carried out by the supplier. Identity testing should be carried out by the Principle contractor.

### **17.1.2 SAMPLING RATE**

In the initial phase, 3 samples have to be taken from the first 50m<sup>3</sup> of production. Thereafter the minimum rate of sampling is 1 sample per 200m<sup>3</sup> or 2 samples per production week for concrete with production control certification or one sample per 150m<sup>3</sup> or one sample per production day without production control certification.

In the continuous phase, the requirement is on sample per 400 m<sup>3</sup> or one sample per production week for concrete with production control or one sample per 150m<sup>3</sup> or one sample per production day for concrete without production control specification.

Annex B: BS EN 206 suggests that where identity testing is to be performed, the particular volume of concrete shall be defined as follows.

- Single batch or load where there is doubt as to quality.
- Concrete supplied for each story of a building or group of beams/slabs or columns/walls of storey of a building or comparable parts of other structures.
- Concrete delivered to a site within one week, but not more than 400m<sup>3</sup>.

BS 5328 for compliance testing may be taken as guide to the maximum rate of identity testing:

<b>Critical Elements</b>	<b>1 sample per 2 trucks</b>
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*(Very high strength columns, masts cantilevers etc.)*

<b>Typical Elements</b>	<b>1 sample per 4 trucks</b>
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*(Beams, slabs, etc.)*

<b>Low risk elements</b>	<b>1 sample per 10 trucks</b>
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*(Rafts etc.)*

Cube making to be undertaken by a suitably qualified individual with documented training.

EN 12350-1: A COPY OF THIS STANDARD MUST BE KEPT ON SITE FOR REFERENCE AND STRICTLY ADHERED TO.

Training in the making of concrete cubes (to EN 12390-2) must be provided to those pouring the concrete into the moulds.

Test specimens shall be prepared and cured in accordance with EN 12390-2.

### **17.1.3 PROCEDURES**

If a filling frame is used, the amount of concrete used to fill the mould shall be such that a layer of concrete remains in the filling frame after compaction. The thickness of this layer shall be 10% to 20% of the height of the test specimen.

Specimens shall be compacted in a minimum of two layers, but no layer should be more than 100mm in thickness.

NOTE: Before filling, the inner surface of the mould should be covered with a thin film of non-reactive release material to prevent the concrete from adhering to the mould.

## **18.0 COMPACTION OF THE CONCRETE**

### **18.1.1 GENERAL**

The concrete shall be compacted immediately after placing in the moulds in such a way as to produce full compaction of the concrete with neither excessive segregation nor laitance. Each layer shall be compacted using one of the methods described below.

NOTE 1: Full compaction is achieved using mechanical vibration, when there is no further appearance of large air bubbles on the surface of the concrete and the surface becomes relatively smooth with a glazed appearance without excessive segregation.



NOTE 2: The number of strokes per layer required to produce full compaction by hand will depend upon the consistence of the concrete.

## **18.2 MECHANICAL VIBRATION**

### **18.2.1 COMPACTING WITH INTERNAL VIBRATOR**

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. Avoid over-vibration, which may cause loss of entrained air.

NOTE 1: Care should be taken not to damage the mould. The vibrator should be vertical and not allowed to touch the bottom or sides of the mould. The use of a filling frame is recommended.

NOTE 2: Laboratory tests have shown that great care is needed if loss of entrained air is to be avoided when using an internal vibrator.

### **18.2.2 COMPACTION WITH VIBRATING TABLE**

Apply the vibration for the minimum duration necessary to achieve full compaction of the concrete. The mould should preferably be attached to, or firmly held against the table. Avoid over-vibration, which may cause loss of entrained air.

### **18.3.1 HAND COMPACTION**

Compacting with compacting rod or bar. Distribute the strokes of the compacting rod, or bar, in a uniform manner over the cross section of the mould. Ensure that the compacting rod, or bar, does not forcibly strike the bottom of the mould when compacting the first layer, nor penetrate significantly any previous layer. Subject the concrete to at least 25 strokes per layer. In order to remove pockets of entrapped air, but not entrained air, after compaction of each layer tap the sides of the mould smartly with the mallet until large bubbles of air cease to appear on the surface and depressions left by the compacting rod or bar, are removed.

## **18.4 SURFACE LEVELING**

If a filling frame is used, remove it immediately after compaction is completed.

Remove the excess concrete above the upper edge of the mould using two steel trowels or floats, brought together with a sawing action and carefully level the surface.

## **19.0 MARKING**

The test specimens shall be marked clearly and indelibly, without damaging the specimen.

Records shall be kept to ensure the traceability of the specimen from sampling to testing.

## **20.0 CURING OF SPECIMENS**

Leave the test specimens in the mould for at least 16 hours, but not longer than 3 days, protect against shock, vibration and dehydration at a temperature of  $20^{\circ}\text{C} \pm 5^{\circ}\text{C}$  (or  $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$  in hot climates).

After removal from the mould, cure the test specimens until immediately before testing, in water at a temperature of  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$ , or in a chamber at  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$  and a relative humidity of  $\geq 95\%$ .

NOTE 1: In case of dispute, curing in water shall be the reference method.

NOTE 2: Maintenance and measurement of high humidity  $\geq 95\%$  at  $20^{\circ}\text{C} \pm 2^{\circ}\text{C}$  is not simple. Regular checks should be made that surfaces of specimens in the chamber are continuously wet.

## **21.0 TRANSPORT OF TEST SPECIMENS**

Avoid loss of moisture and deviations from the required temperature at all stages of transport, by, for example, packing the hardened test specimens in wet sand or wet sawdust or wet cloths, or sealed plastic bags containing water.

## **22.0 REPORT**

The report must include:

- (a) Identification of the test sample.
- (b) Date and time of making the specimen(s)
- (c) Details of storage of specimens prior to de-moulding, including duration and conditions;
- (d) Method of curing specimens after de-moulding, during transportation, (if appropriate), giving temperature range and duration of curing.
- (e) Any deviation from the standard method of making and curing the specimen(s);
- (f) A declaration by the person technically responsible that the specimens were prepared in accordance with this standard, except as noted in item e)

This report may include:

- (g) Temperature of the re-mixed concrete;
- (h) Method of compaction the concrete in the moulds and the number of strokes, in the case of hand compaction;
- (i) Condition of specimens(s) on receipt, for curing (if appropriate).

Compressive strength of the specimens shall be determined in accordance with EN 12390-3. The test result shall be obtained from the average of the results of two or more specimens made from one sample for testing at the same age.

**COMPLETE CORRELATED RECORDS** must be maintained for each Design and Prescribed mix including. Information to be in accordance with BS 5328-3, clauses 3.1 and 3.2.

**23.0 FAILURES:** If a concrete sample fails to achieve specified criteria or to pass specified tests, inform the CA immediately and submit:

- Confirmation of the validity of the test results, and/or
- Proposals for further tests to assess the strength of the concrete in the structure as set out in BS 6089, and/or
- Proposals for rectification.

## **24.0 FORMWORK**

**24.1.1** No Through formwork ties to be used in capping beams or other retaining structures unless agreed in writing with the engineer.

### **24.2.1 CAMBERS**

Specified cambers relate to the concrete immediately before formwork is struck. Make adequate allowance for deflection of formwork under weight of fresh concrete. Top surfaces of concrete must also be cambered to maintain the required structural depths and profiles.

After striking of formwork and removal of props check levels to determine extent of any residual camber and inform CA.

**24.2.2** Unless otherwise shown on drawings construct forms to achieve the following cambers:

- Slabs: % of span measured at centre: 0.2
- Beams: % of span measured at centre: 0.2
- Cantilever beams: % of cantilever measured at free end.

## **25.0 STRIKING**

**MINIMUM PERIODS:** The following periods (in days) for retaining formwork in position before striking apply to class 42.5 or sulphate resisting Portland Cement concrete with no cement replacement materials or admixtures.

Type and formwork	Average Mean Daily (Day and Night) minimum and maximum air temperatures during the period		
	16°C	7°C	3°C
Vertical formwork to columns, walls and beams	1/2	3/4	1
Soffit forms to slabs	4	6	8
Props to slabs and soffit forms to beams	10	15	20

Props to beams	14	21	28
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Alternative methods of determining minimum periods for retaining formwork in position may be submitted for approval. Accept responsibility for cost of checking proposals by CA and for any testing.

**25.1.1 RESPONSIBILITY:** Strike formwork without disturbing, damaging or overloading structure. Take care not to disturb props.

**25.1.2** Formwork Contractor to provide full details, drawing and calculations to justify the falsework design and back-dropping regime.

## **26.0 STRIPPING CONCRETE**

Defective concrete must be carefully stripped and removed without causing damage to any other unaffected element of the structure. Areas being amended should be suitably propped and supported. All repairs to be undertaken by a suitably qualified individual with documented training.

## **27.0 TOLERANCES**

See Section 7 National Structural Concrete Specification for Building Construction 3<sup>rd</sup> Edition.

## **28.0 BREAKING DOWN OF PILES**

Breaking down of concrete piles is an essential element of the construction process and due consideration should be afforded to it when planning piling works.

### **28.1 TRADITIONAL MECHANICAL METHODS**

Traditionally, hand held pneumatic breakers have been used to remove concrete over-pour, however this method has significant risks in particular hand arm vibration (HAVS), dust and noise. Either “Light” hand held, or “Heavy” plant mounted

breakers can be used, but there is increased health and safety issues regarding this method.

- Using this method, **piles should be allowed to cure for a minimum of 5 days** before excavation and trimming (for high cement replacement mixes curing period is extended).
- Pneumatic breakers should not be used to penetrate the pile vertically as this is likely to split the pile and shear the concrete below cut-off level. To prevent this, the tool should be worked from the perimeter of the pile towards the centre.
- Heavy impact breakers should not be used in cases where the pile is of small diameter, lightly reinforced, or where the pile is situated in soft ground.
- It should be noted that this type of breaking can increase the **risk of integrity failures**

There are several other viable alternatives to this method.

## **28.2 HYDRAULIC PILE BREAKERS**

Special design pile breakers are available in various sizes and capabilities. Nevertheless these systems are not appropriate for large diameter piles, most secant pile walls and diaphragm walls. This equipment is readily available from a range of suppliers. Suppliers and manufacturers are to be consulted about the limitations and capabilities of all plant and machinery before use.

## **28.3 INTEGRATED PILE BREAKING METHODS – PASSIVE**

This system relies on the installation of a bonding device to the pile at, or close to the level it is to be cut-off at. This method is suitable for larger diameter cast in place concrete piles, contiguous and secant wall piles, and diaphragm walls. When using such techniques, manufacturers notes and guidance on the use of the system must be strictly adhered to. The use of any such method should be reported to the design team a suitable period before works commence.

#### **28.4 INTEGRATED PILE BREAKING METHOD – ACTIVE**

This method incorporates an active pile breaking system within the pile that can be activated once the pile has cured, breaking the pile at cut off level. Manufacturers should be consulted for guidance and suitability for each type of pile and site.

#### **28.5 HYDRO-DEMOLITION METHODS**

This method is the least common in the UK, using high pressure water jets capable of removing concrete without damaging reinforcing bars. Exact method is dependant on manufacturer.

### **BIBLIOGRAPHY AND ASSOCIATED BRITISH STANDARDS**

BS EN 12350-1:2000

BS EN 206-1:2000

BS EN 12390-2

BS 6089

BS 5328

BS 8666

BS 1881-204

BS 8110: Part 1: 1997

Concrete Society Report CS 101

**Our ref: Concrete Spec/AH/SB**

Concrete Society Advice No. 34

Concrete Society: National Structural Concrete Specification for Building Construction  
3<sup>rd</sup> Edition

Federation of Piling Specialists: Breaking Down of Piles

Kwikastrip Installation Guidance.