

SPECIFICATION FOR MATERIALS AND WORKMANSHIP FOR REINFORCED CONCRETE WORK

1. GENERAL

All materials, workmanship and tests (where required) shall comply with the appropriate current British Standard, the Building Regulations and be in accordance with the drawings and this specification all to the satisfaction of the Engineer.

The contractor shall provide a programme and a schedule of information requirements before commencing on site. Should the Contractor wish to vary his programme and consequently his schedule of information requirements then reasonable notice shall be given to the Engineer

All materials shall be stored so as to be adequately protected and kept free from contamination from all sources.

2. CEMENTS

Ordinary Portland Cement shall comply with British Standard BS EN 197 (latest revision including amendments), and sulphate resisting cement shall comply with British Standard BS 4027.

All cement shall be obtained from an approved source. Certificates of manufacturer's tests on the cement are to be forwarded to the Engineer and cement is not to be used before it has been accepted by the Engineer. Appropriate methods to minimise the risk of Alkali Silica reaction shall be taken as described in other parts of this specification.

The contractor shall store cement in a manner approved by the Engineer and such approved arrangements shall be maintained for the duration of the contract.

3. AGGREGATES

The fine and coarse aggregates shall comply with the requirements of British Standard BS EN 12620 (latest revision including amendments). The grading of fine aggregates shall be limited to Grading Zones 1-3 unless otherwise specified. The shell content of the fine aggregate included as calcium carbonate as determined by the method in BS EN 933-7 (latest revision including amendments) shall not exceed 30%. Coarse aggregates shall be clean and free from shell, sand, clay, quarry refuse, dust and other impurities. Grading of coarse aggregates shall be within the limits of Table 1 of BS EN 12620 (latest revision including amendments), unless otherwise specified and their flakiness index shall not exceed 35%.

Aggregates shall not contain harmful impurities such as iron pyrites, coal, mica shale or similar laminated materials. Aggregates shall not contain flaky or elongated particles and rock or gravel likely to suffer from the action of frost shall not be used. Aggregates shall be obtained from one approved source capable of maintaining adequate supplies of consistently graded material throughout the contract. Aggregates for exposed concrete shall be free from all impurities likely to cause discolouration and shall be of consistent colour throughout the work.

The physical properties of the aggregates are to be such that the drying shrinkage of the concrete manufactured from them and tested in accordance with BS 1881 shall not exceed:

1. 0.04% for all exposed concrete work and superstructure.
2. 0.08% for foundations and other works not liable to rapid drying.

Aggregates from marine or estuarine sources shall be used only with the prior approval of the Architect. In the event of approval being given, the chloride content of the fine and coarse aggregates shall be such that the total chloride ion content does not exceed 0.32% by mass of cement in the mix.

The Contractor should also note the special clauses referring to Alkali Silica reaction given in other parts of this specification.

4. WATER

Water used for mixing and curing shall be clean and free from harmful matter, shall be obtained from the mains and shall comply with the requirements of BS EN 1008 (latest revision including amendments).

5. ADMIXTURES

The use of admixtures shall not be permitted without the express approval of the Architect.

6. POLYTHENE

Under all slabs, directly above ground, a specialist designed gas/waterproof membrane shall be provided, with laps as specified by the specialist. The product used will carry an appropriate British Board of Agreement (BBA) Certificate.

All gas and waterproofing membranes will need to be designed, installed and tested by the relevant specialist in accordance with the required codes of practice such as BS 8485-2015.

7. DE-BONDING COMPOUND

An approved proprietary de-bonding compound shall be used as shown on the drawings. It shall consist of 66% of 200 per bitumen blended hot and 14% light creosote oil and when cold brought to the consistency of paint by the addition of 20% solvent naphtha or other approved compound which shall not retard or in any other way affect the setting of the concrete. The average bond stress on 7 day pull out tests shall not exceed 0.14 N/mm².

8. REINFORCEMENT

Mild steel bars shall comply with British Standard BS 4449 (latest revision including amendments).

High Tensile steel bars shall be Grade B500 deformed bars complying with BS 4449 (latest revision including amendments).

Steel fabric reinforcement shall comply with BS 4483 (latest revision including amendments).

Reinforcement shall be obtained from a fabricator operating a quality assurance system approved by the UK Certification Authority for Reinforcing Steels or another approved scheme. The Contractor shall supply the Engineer with a certificate stating the source of the reinforcement, the process of manufacture and a test sheet giving the results of mechanical tests. If required, results of chemical analyses shall also be supplied.

All reinforcement incorporated into the works shall be free from mill scale. Any deleterious material and any loose rust shall be removed before use.

9. SPACES AND CHAIRS

Spacers at maximum centres of 1m shall be used to maintain the cover to all steel and shall be dense cement mortar unless other materials are approved by the Engineer.

In ribbed slabs the position of reinforcing bars in the ribs shall be maintained by the use of purpose made spaces occupying the full width of the rib.

Top steel reinforcement in slabs shall be positively supported in position with steel chairs at no more than 1m centres in each direction.

The Contractor shall allow in his reinforcement rates for the provision of all necessary chairs and spacers.

10. BENDING OF REINFORCEMENT

All bars shall be bent cold to the true form, as shown on the drawings and bending schedules, by the gradual uniform application of force. Heating will not be allowed.

Unless described otherwise, bending dimensions shall conform to BS 8666 (latest revision including amendments).

The Engineer shall supply to the Contractor all Bar Bending Schedules who shall check them and satisfy himself as to their accuracy before ordering or placing any reinforcement.

High Tensile reinforcement in position, irrespective of whether or not it is partly embedded in hardened concrete, shall not be bent without the Engineers permission.

No allowance will be made in the Bending Schedules for tying wire and rolling margins, and cutting and bending tolerances. All areas of mesh shall be taken off the contract drawings as required.

The Contractor shall be responsible for providing on site such skilled bar benders, bending machines, etc., as are necessary to ensure that minor variations to reinforcement can be made when necessary without incurring avoidable delays and expense.

11. FIXING OF REINFORCEMENT

All bars shall be maintained in the proper position, as shown on the drawings and temporarily fixed as necessary by means of 16 S.W.G. annealed steel wire, to prevent displacement before and during the process of concreting. All stirrups and links shall be tight to the bars which they embrace. All ends of binding wire must be bent back well clear of the formwork. Successive layers of reinforcement in beams and slabs shall be supported by means of steel spacer bars and stools.

The cover of concrete to the reinforcement shall be as described on the drawings and shall be maintained by means of distance pieces of cement mortar or other approved materials. Pieces of steel, blocks of wood etc, shall not be used against formwork for this purpose.

The spacers and supports shall be so arranged that the following tolerances of concrete cover will not be exceeded:

-0 +5mm

All bars left exposed for future work shall be suitably protected against exposure and corrosion, to the approval of the Architect.

Fabric reinforcement shall be supported in a manner similar to normal reinforcement.

No welding of reinforcement will be permitted unless the Architects prior permission is obtained and the requirements of the Architect and the regulations of the Local Authority shall be strictly complied with.

The fixing of all reinforcement shall be checked by the main Contractor's supervisor. Adequate notice shall be given to the Architect before pouring concrete.

During concreting a competent steel fixer shall be in attendance to adjust and correct the positions of any reinforcement which may be displaced.

12. LAPS OF FABRIC REINFORCEMENT

Unless otherwise indicated, steel fabric shall be lapped at least 300mm at the ends and sides of the mesh. Where congestion of fabric is likely to occur laps shall be of the overhang lap type. In slabs with top and bottom fabric reinforcement, laps in the two layers shall be staggered.

13. FORMWORK

a) General

All formwork shall be specialist design to ensure it is of sufficient strength, rigidity and tightness as required to support and maintain the concrete in its correct position and to withstand the worst combination of self weight reinforcement weight wet concrete weight, concrete pressure, construction and wind loads, together with all incidental dynamic effects caused by placing, vibrating and compacting the concrete. All joints shall be flush and close enough to prevent leakage of grout. Foam sealing strips shall be used as necessary to ensure joint tightness.

Formwork shall be set with an upward camber as follows:

Beams and slabs over 4.5m span: 1:600
All cantilevers: 1:300

Vertical struts to formwork to all upper beams, floor etc., shall be placed directly over those to the storey immediately below, and the lowest vertical strut shall bear on work of sufficient strength to carry the load, or on plates of sufficient size to distribute the load satisfactorily to the ground.

b) Preparation of Formwork

Before each use the formwork shall be carefully examined and any that has been damaged or defaced shall be discarded and shall be replaced with new material.

An approved release agent shall be used and shall not come into contact with reinforcement and shall not be allowed to collect in the bottom of the formwork.

Immediately prior to placing concrete the inside of the formwork shall be thoroughly cleaned out.

c) Striking of Formwork

Formwork shall be dismantled and removed from the cast concrete without sock, disturbance or damage. Unless the Contractor produces evidence to show that the concrete is of sufficient strength to permit earlier striking e.g. by reference to CIRIA reports, the minimum striking times shall be as follows:

Minimum period before striking formwork (concrete made with Ordinary or sulphate resisting Portland cement).			
Type of formwork	Minimum period before striking		
	Surface temperature of concrete		
	16°C and above	7°C	(any temperature between 0°C and 25°C)
Vertical formwork to columns, walls and large beams	12h	18h	$300/(t+10)$ h
Soffit formwork to slabs	4 days	6 days	$100/(t+10)$ days
Soffit formwork to beams and props to slabs	10 days	15 days	$250/(t+10)$ days
Props to beams	14 days	21 days	$360/(t+10)$ days

The above times shall be increased by half a day for each day on which the concrete is between 20°C and 7°C and one day for each day on which the concrete temperature is below 2°C.

14. FORMWORK FINISHES - FORMED SURFACES

a) Exposed Concrete

Properly designed forms should be used with a hard smooth surface and all joints filled. The concrete surfaces should be smooth with true, clean arrases. Immediately after striking shutters all surface blemishes shall be filled with fresh specially prepared cement and fine aggregate paste. Every effort should be made to match the colour of the concrete. After the concrete has been properly cured, the faces should be rubbed down where necessary, to produce a smooth and even surface.

Surface Regularity of formed surfaces should be SR2 in accordance with BS 8204-2:2003 +A2;2011

The surface finishes of Formed surfaces should be Ordinary in accordance with BS EN 13670;2009

Exposed concrete surfaces to walls within the lift/stair core are to be as struck.

Exposed concrete columns are to be provided with chamfered corners to prevent cracking/chipping.

15. FORMWORK FINISHES - UNFORMED SURFACE FINISHES

- a) Concrete to be screeded.

The concrete shall be uniformly levelled and tamped to produce a plain, textured surface.

- b) Concrete which will not be covered with a screed.

The concrete shall be uniformly levelled and tamped to produce a plain, textured surface. When the moisture film has disappeared and the concrete has hardened sufficiently to prevent laitance from being worked to the surface.

Surface Regularity of unformed surfaces should be SR2 in accordance with BS 8204-2:2003 +A2;2011

The surface finishes of unformed surfaces should be Ordinary in accordance with BS EN 13670;2009

16. STRUCTURAL CONCRETE

- a) All concrete to conform to the requirements of BS8500 and BS EN 206-1 (latest edition) and all normative references including resistance to alkali silica reaction, sulphate resistance, chlorine content etc
- b) All details of the materials, proportions and preliminary test results shall be submitted to the Engineer for his approval prior to the use of the mix. A satisfactory method of control of water content must be employed.
- c) The Contractor must himself carry out the control requirements of BS EN 1992 and submit his results to the Engineer is requested.
- d) Concrete Work
 - i) Lean Mix/Concrete Blinding
Designate mix Gen-1
 - ii) Retaining Wall Base and Stem
Designate mix RC40 or C32/40
- e) Buried Concrete

All buried concrete to be in accordance with the recommendations of the site specific ground investigation report and as a minimum AC-1 DS-1

17. SITE TESTING OF CONCRETE

- a) The ready-mixed supplier must himself carry out all the control requirements of BS EN 1992 and submit his results to the Architect if requested. In addition, the Contractor is himself to take at least three number 150mm test cubes each day concrete is poured until ten sets of cubes have been made. There after three number cubes are to be made each week or every 50 m³ of concrete poured, which ever is the more frequent.
- b) Test cubes shall be made, cured, stored, transported and tested in accordance with Parts 3 and 115-120 of BS 1881. One cube from each set shall be tested at 7 days and one at 28 days. The tests shall be carried out in an approved laboratory and test report supplied to the Architect.
- c) Either a slump test or a compacting factor test shall be carried out each time test cubes are made or on any batch of concrete that the Architect shall so direct.

18. BATCHING

- a) Concrete shall be mixed in machines of adequate capacity and of a design approved by the Architect. Each mixing machine shall be washed thoroughly as often as is necessary to prevent the adhesion of partly set concrete. Mixing shall continue for a least two minutes until the concrete is uniform in consistency.
- b) Under special conditions the Architect may sanction hand mixing in which case a specially prescribed concrete mix shall be made on clean level watertight platform of sufficient area. The cement and fine aggregate shall be spread in thin layers and mixed dry until a uniform colour is attained. The coarse aggregate shall then be added and the mixture turned over until the concrete is of uniform consistency.

19. PLACING OF CONCRETE

Concrete shall be carried in purpose made agitators operating continuously or in truck mixers with continuously rotating drums. Concrete shall be placed in the works with no segregation and with the required workability. The concrete shall be compacted and in its final position within 2 hours of the introduction of cement to the aggregate. Furthermore any concrete which had developed an initial set before being placed shall be rejected.

Concrete when deposited shall have a temperature of not less than 5°C and not more than 30°C. Fresh concrete shall not be placed against insitu concrete that has been in position for more than 30 minutes unless a construction joint is formed.

Concrete shall be compacted using mechanical vibrators in such a manner as to produce a dense homogenous mass with a good surface finish. Care shall be taken that the vibrators are not allowed to come into contact with, or displace, any reinforcement, timber inserts, shutter ties, fixings etc., embedded in the concrete. A sufficient number of vibrators in a serviceable condition shall be on site to ensure that spare equipment is always available in a breakdown.

20. BLINDING

Reinforced concrete shall not be placed directly onto or against an earth surface. These surfaces shall be blinded with a layer of 'Gen 1' mix concrete. Unless detailed otherwise blinding shall be a minimum thickness of 50mm placed to a true surface.

Blinding shall be placed in such a way and at such times as to ensure that the exposed surface of the ground does not deteriorate after excavation through exposure to weather, traffic or other reasons.

21. CONSTRUCTION JOINTS

Concrete shall be deposited continuously between pre-determined joints, either as shown on the drawings, or in the case of construction or day to day joints the positions of which have already been agreed with the Architect.

Construction joints are to be generally formed, with the approval of the Engineer, within the middle third of the span of the beams and slabs.

The joints shall be prepared so that the full cross section of the work is lightly roughened and is entirely clean and free from scum, loose particles and foreign matter, immediately prior to the recommencement of concreting.

Immediately prior to depositing new concrete, the surface shall be wetted. Care shall be taken to ensure that the water used for wetting is not allowed to collect in the formwork. Particular attention must be given to see that the concrete is thoroughly compacted around the joint and at the bottom of each lift.

Movement joints shall be formed in the positions and to the detail shown on the drawings.

Unless stated on the drawings, kickers for all columns shall be not less than 75 mm high. Kickers for wall shall be not less than 150 mm high. The formwork for all kickers must be centred and rigidly fixed in position prior to placing concrete. All kickers shall be cast monolithically with the slab.

Where brick/block walls abut vertical concrete faces, dovetail stainless steel slots of approved manufacture shall be cast in the concrete to receive adjustable bonding ties. Alternatively, either 37 x 1.5mm stainless steel ties, 'Brickforce', 'Bricktor', 'Expamet' or other approved stainless steel fabric reinforcement, not less than 22 gauge, 600mm long shall be cast into the concrete for building into the horizontal joints of walling and partitions at not more than 300mm centres to suit the courses.

All concrete surfaces which are honeycombed or defective shall have the defective concrete cut out to a depth of at least 25mm or until solid concrete is reached, with all edges being cut perpendicular to the surface. The area should then be thoroughly dampened with water and then thoroughly primed, together with any exposed reinforcement, by brushing in a grout obtained by mixing equal volumes of cement and styrene butadiene rubber latex all as per manufacturer's instructions. Mortar, consisting of cement, zone 2 sharp sand, SBR latex and water in proportions recommended by the manufacturer, should be applied whilst the priming grout is still wet. The patch should be well consolidated with a wood float in layers of maximum 25mm thickness.

22. CURING OF CONCRETE

Immediately after compaction and for a minimum of 7 days, concrete shall be protected against harmful weather effects including rain, rapid temperature changes, frost and from drying out. The method of curing shall prevent loss of moisture from the concrete.

The manner in which the Contractor proposes to carry this out shall be described for the different concrete elements and shall be approved by the Engineer before work commences on site.

Notwithstanding any approval given by the Engineer, he may, if he considers particular method of curing to unsuitable, order him to vary the method to ensure satisfactory curing of the concrete.

23. COLD WEATHER WORKING

When concrete is placed at air temperatures below 2°C, the following requirements shall be met:-

- i) The aggregates and water used in the mix shall be free from snow, and frost.
- ii) The surface temperature of the concrete at the time of placing shall be at least 5°C and shall not exceed 30°C.
- iii) The surface temperature of the concrete shall be maintained at not less than 5°C until the concrete reaches a strength of 5N/mm² as determined by tests on cubes that have been cured under identical conditions to the structural concrete, in a manner approved by the Engineer.
- iv) Before placing concrete, the formwork, reinforcement, pre-stressing steel and any surface with which the fresh concrete will be in contact shall be free from snow, ice and frost.
- v) Cement shall not be allowed to come into contact with water at a temperature greater than 60°C.

24. HOT WEATHER WORKING

During hot weather the Contractor shall ensure that the constituent materials of the concrete are sufficiently cool to prevent the concrete from stiffening in the interval between its discharge from the mixer and compaction in its final position.

Cement shall not be allowed to come into contact with water at a temperature greater than 60°C. The temperature of the concrete when deposited shall not exceed 30°C, nor should fresh concrete come into contact with hot dry surfaces. Where necessary all surfaces should be shaded from direct sunlight.

25. TOLERANCES

The standard of acceptances for tolerances shall be taken from the relevant Codes of Practice and National Structural Concrete Specification, 4th edition.