8 TRANSPORTATION AND PLACING OF CONCRETE

8.1 GENERAL

8.1.1 Scope of Work

1 This part deals with the transportation, placing and compaction of concrete.

2 Related Parts are as follows:

This Section

Part 1..... General
Part 7,..... Concrete Plants
Part 9,..... Formwork
Part 15,..... Hot Weather Concreting
Part 16,..... Miscellaneous

8.1.2 References

ACI 304, ...Guide for Measuring, Mixing, Transporting, and Placing Concrete

ASTM C94,.....Specification for ready-mixed concrete

BS 8500, ...Concrete, Complementary British Standard to BS EN 206.

EN 206, ...Concrete. Specification, performance, production and conformity

EN 1992-1-1.....Eurocode 2: Design of concrete structures. General rules and rules for buildings

8.1.3 Submittals

1 Should the Contractor propose to use concrete pumps for the transportation and placing of concrete, he shall submit details of the equipment and operating techniques he proposes to use for the approval of the Engineer.

2 A method statement shall be submitted for approval for major concrete placements, which shall address

(a) the planned rate of placing
(b) number of batching plants
(c) number of trucks
(d) number and positioning of pumps
(e) pour sequence
(f) quality control measures
(g) spare equipment
(h) any other factors that might affect the placing of concrete.

3 The method statement should be submitted at least three days in advance of the planned pour. If required by the Engineer or any other concerned party a prepour planning meeting may be arranged with representatives from the ready-mix supplier, Contractor and Engineer.

4 The Contractor shall submit to the Engineer for approval details of his proposed operations and standby equipment.

8.2 TRANSPORTATION

8.2.1 General

1 Transportation delivery and handling shall be in accordance with the requirements of BS 8500 and EN 206.

2 Concrete shall be conveyed from the mixer to its place in the Works as rapidly as possible by methods which will prevent segregation or drying out and ensure that the concrete is of the required workability at the point and time of placing.

3 Should segregation occur in the concrete then the materials shall be remixed to the satisfaction of the Engineer or discarded. Furthermore the cause of the segregation shall be determined and further occurrences prevented.

4 The Contractor shall ensure that the time between placing of different lifts or layers of concrete is short enough to prevent the formation of cold joints. The Contractor shall ensure that there is a back up plant that can be used in the event of a breakdown, and that adequate provision has been made for the number of delivery trucks.

5 The concrete shall be transported to the site in an approved type of truck mixer or agitator truck which apart from the cab and chassis shall be painted white and kept clean at all times. The discharge chute and other dirty areas shall be washed down after delivery to prevent spillage on the roads.

6 If a truck mixer or a truck body with an agitator is used for central-mixed concrete, limit the volume of concrete charged into the truck to 80% of the drum or truck volume as per ASTM C94 and NRMCA requirements. if shrink mixing is approved by the engineer limit the volume of concrete charged into the truck to 63% of the drum volume.

7 All trucks shall be rotated 30 revolutions at mixing speed before discharging concrete to assure uniformity.

8 The insides of concrete mix trucks shall be inspected periodically, and any build up of concrete removed that may impair the efficiency of the mixing action. All trucks shall be NRMCA certified or any equivalent certification

9 Discharge of the concrete shall be completed within 90 min, or before the drum has revolved 300 revolutions, whichever comes first, after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. These limitations are permitted to be waived by the purchaser if the concrete is of such slump or slump flow after the 90 min time or 300-revolution limit has been reached that it can be placed, without the addition of water, to the batch. In hot weather, or under conditions contributing to quick stiffening of the concrete, a time less than 90 min is permitted to be specified by the Engineer

8.2.2 Pumped Concrete

1 Access for the pump shall be checked prior to the pour. If access cannot be assured, the Contractor shall not continue with concreting operations.

2 If approval is obtained for pumped concrete, the Contractor shall ensure that shock is not transferred from the pipeline to the formwork and previously laid concrete.

3 During placing concrete by pumping the end hose must never reach into the concrete. All measures shall be taken to avoid blockage of the delivery hose system. The Compaction of concrete shall be carried out as per standard practice procedures.

4 Grout shall be pumped through the concrete pump to provide initial lubrication. The initial discharge of any pumped concrete shall not be incorporated in the permanent works.

5 Where concrete is conveyed by chuting or pumping the plant shall be of a size and design to ensure continuous flow in the chute or pipe. The slope of the chute or the pressure of the pump shall allow the concrete to flow without the use of any water additional to that approved by the Engineer to produce the required consistency and without segregation of the ingredients. The delivery end of the chute or pipe shall be thoroughly flushed with water before and after each working period and kept clean. The water used for this purpose shall be discharged outside and away from any permanent works.

8.2.3 Records

1 Within 24 h of delivery, the Contractor shall provide the Engineer with delivery notes giving the information required under Paragraph 7.4.1.5 of this Section.

8.3 PLACING CONCRETE

8.3.1 General

1 The Contractor shall obtain the approval of the Engineer to his proposed arrangements before beginning concreting.

2 All placing and compacting of concrete shall be carried out under the direct supervision of a competent member of the Contractor's staff with a minimum of five years of experience in concreting works, and in a manner to produce a watertight concrete of maximum density and strength.

3 For night concreting operations, the Contractor shall arrange adequate suitable lighting.

4 The Contractor shall provide safe secure access for all personnel on concreting operations.

5 Where the thickness of the concrete section exceeds 600 mm the Contractor shall adopt special precautions, to be approved by the Engineer, to avoid thermal cracking due to external and core temperature differentials.

6 Concrete shall not be placed in adverse weather conditions such as dust storms or heavy rain.

8.3.2 Preparation

1 No concrete shall be placed until the Engineer has inspected and approved in writing the surfaces upon which the concrete is to be placed, the formwork, and reinforcing steel. The Contractor shall give the Engineer at least 24 hours notice to enable this inspection to be carried out. If concrete is not placed within 24 hours of approval being given, approval shall be obtained again before concreting. An inspection shall be made immediately prior to concreting to check the cleanliness of the forms.

2 Wood forms, unless lined, shall be oiled or wetted with water in advance of placing concrete so that joints will tighten and prevent seepage of cement grout from the mix.

3 The reinforcement shall be sprayed with a small amount of water prior to starting the pour. Reinforcement shall be secured in position, inspected, and accepted by the Engineer before placing the concrete.

4 All inserts, anchor bolts, sleeves and other embedded items shall be accurately located, using templates where appropriate, and held securely to prevent displacement during the placing of the concrete. Aluminium items shall be completely covered and protected when embedded in the concrete.

5 Except where shown on the drawings, no fixtures shall be attached to the concrete by shot fixing or drilling without acceptance by the Engineer. Notwithstanding any such authorisation, the Contractor shall be responsible for all damage so caused to the concrete and make good at his own expense.

6 Water shall be removed from excavations before concrete is deposited. Any flow of water shall be diverted through proper side drains and shall be removed without washing over freshly deposited concrete. All dewatering works shall be continued as long as required. Hardened concrete, debris, and foreign materials shall be removed from interior of forms and from inner surfaces of mixing and conveying equipment.

7 Runways or other means accepted by the Engineer shall be provided for wheeled equipment to convey the concrete to the points of deposit. Equipment used to deposit concrete shall not be wheeled over reinforcement nor shall runways be supported on reinforcement.

8 Before depositing new concrete on or against concrete that has set, existing surfaces shall be thoroughly roughened and cleaned of laitance, foreign matter and loose particles. Forms shall be re-tightened and existing surfaces slushed with a grout coat of mortar consisting of cement and fine aggregate in the same proportion in the mix, but not leaner than one (1) part cement to two (2) parts fine aggregate, after the existing surface has been moistened. New concrete shall be placed before the grout has attained initial set. Horizontal construction joints shall be given a brush coat of grout consisting of cement and fine aggregate in the same proportion as concrete to be placed, followed by approximately 75mm of concrete of regular mix, except that the proportion of coarse aggregate shall be reduced 50%.

9 High strength grout for precision support of machine base and soleplates, including equipment subject to thermal movement, tanks, column baseplates, bridge seats, anchor bolts and dowels, etc., shall be a non-shrink, ready-to-use, fluid precision grout material, proportioned, premixed and packaged at the factory, delivered to the job site to be placed with only the addition of water, formwork, and curing shall be as specified.

8.3.3 Placing

1 Concrete shall be placed in its final position before initial set has commenced and shall not be subsequently disturbed. All concrete shall be placed within 15 min of mixing unless carried in purpose made agitators.

2 Concrete shall be carefully placed in horizontal layers which shall be kept at an even height throughout the work. The depth of layers and time between placement of layers shall be such that each layer can be properly merged into the preceding layer before initial set takes place, the depth of layer shall be determined from the type of plant the Contractor proposes to use.

3 Concrete shall be allowed to slide or flow down sloping surfaces directly into its final position from skips, down pipes or other placing machines or devices or, if this is not practical, it should be shovelled into position, care being taken to avoid separation of the constituent materials.

4 Concrete placed in horizontal slabs from barrows or other tipping vehicles shall be tipped into the face of the previously placed concrete.

5 Concrete dropped into place shall be dropped vertically. It shall not strike the formwork between the point of its discharge and its final place in the Work, and except by approval of the Engineer it shall not be dropped freely through a height greater than 1.5 m. Chutes and conveyor belts shall be also designed so that there is no segregation or loss of mortar and shall be provided with a vertical tapered down pipe, or other device, to ensure that concrete is discharged vertically into place.

6 Concrete shall not be placed in standing water in the formwork.

7 Concrete that has attained its initial set or has contained its water content for more than 1.5 hours or 300 drum revolutions, whichever comes first, shall not be deposited in the work.

8 Cold weather concreting shall be in accordance with EN 1992-1-1 or CIRIA Report 67 and ACI 306.

9 Hot weather concreting shall be in accordance with Part 15 of this section.

10 Special care shall be taken to protect new concrete from the harmful effects of drying winds.

11 During wet weather, the concrete shall be adequately protected as soon as it is in position.

12 No concreting shall be carried out during periods of continuous heavy rain unless it is completely covered during mixing, transporting and placing.

13 No concrete shall be carried out during dust storms.

14 Underwater placing of concrete is allowed only for unreinforced components, the placing being effected exclusively with stationary tremies or with a bottom-opening watertight boxes and shall be in accordance with the requirements of design or equivalent as accepted.

15 Underwater concrete is to be placed continuously without interruption. For water depths up to 1 m the concrete may be placed without tremie. In the case of water depths exceeding 1 m the concrete is to be placed in such a way that it does not fall freely through the water. The tremies must at all times dip sufficiently far into the freshly placed concrete to ensure that the concrete emerging from the tremie does not come into contact with the water.

16 All work connected with the placing of concrete under water shall be designed, directed and inspected with due regard to local circumstances and purposes. Work shall not proceed until all phases and methods to be used in the placing operations have been accepted by the Engineer.

17 Stops in concrete, at the end of a period of work, shall be made only at construction joint locations shown on the drawings and/or positions accepted. Where the positions of construction joints are not indicated on the drawings, these may be assumed, for estimating purposes, to occur at 5 metre intervals in foundations and retaining walls and at one-third to one-quarter of span in slabs and beams subject to a maximum spacing of approximately 9 metres.

18 At construction joint location the surface of the completed concrete shall be prepared by spraying, wire brushing or chipping so that it is free from all laitance, scum and loose material and shows a slightly roughened texture and tips of the coarse aggregate exposed. Before continuing concreting the exposed concrete face shall be thoroughly wetted.

19 In the ground floor slab (where ground bearing), construction joints, crack inducer joints, contraction joints and expansion joints shall be incorporated into the work as appropriate. The spacing of construction joints, crack induced joints, contraction joints and expansion joints in water retaining structures shall be shown on the design drawings

20 Where the positions or type of joints are not indicated on the drawings in the ground floor slab, the slab shall be cast in strips not more than 4.0 metres wide, in alternating sequence, across the width of the building. A minimum of 3 days shall elapse between the casting of adjacent strips. Within each strip, crack induced joints shall be provided at not more than 5.0 metre spacing, and contraction joints shall be provided at not more than 15.0m spacing. Across the width of the building, construction joint shall be provided between adjacent strips with contraction joint at every 4th construction joint.

21 Wherever necessary and as required by the Engineer, waterstops of a type acceptable to the Engineer shall be embedded in the concrete. The waterstop should be made of a high quality material, which must retain its resilience through the service life of the structure for the double function of movement and sealing. The surface of waterstops should be carefully rounded to ensure tightness of the joint even under heavy water pressure. To ensure a good tightness with or without movement of the joints, the waterstop should be provided with anchor parts. The cross-section of the waterstops should be determined in accordance with the presumed maximum water pressure and joint movements. The complete works of fixed and welded connections must be carried out strictly in accordance with the manufacturer's instructions.

22 Engineer's acceptance shall be obtained by the Contractor, prior to start of work, on the casting sequence and the layout of joints.

23 Waterstops shall be carefully maintained in position prior to concreting on accurately profiled stop boards to create rigid conditions.

24 The type of waterbar to be used shall suit the joint and purpose according to water bar manufacturers recommendations

8.3.4 Compaction

1 Concrete shall be thoroughly compacted by vibration during the operation of placing and thoroughly worked around the reinforcement, around embedded fixtures and into corners or the formwork to form a solid mass free from voids.

2 When vibrators are used to compact the concrete, vibration shall be applied continuously during the placing of each batch of concrete until the expulsion of air has practically ceased and in a manner that does not promote segregation of the constituents of the concrete.

3 Immersion type vibrators shall be capable of producing not less than 10000 cycles per minute, and external vibrators not less than 3000 cycles per minute.

4 A sufficient number of vibrators in serviceable condition shall be on site to ensure that spare equipment is always available in the event of breakdown.

5 Immersion type vibrators shall be inserted into the uncompacted concrete vertically and at regular intervals. Where the uncompacted concrete is in a layer above freshly compacted concrete the vibrator shall penetrate vertically for about 100 mm into the previous layer. Vibrators shall not come into contact with the reinforcement or the formwork. They shall be drawn back slowly from the mass concrete so as to leave no voids. Internal type vibrators shall not be placed in the concrete in a random or haphazard manner nor shall concrete be moved from one part of the work to another by means of the vibrators.

6 Operators shall be trained in the use of vibrators. Foremen shall have a minimum of five years of experience in the supervision of placing concrete

7 Vibration of the concrete shall not be applied by way of the reinforcement.

8 Compaction shall commence as soon as there is sufficient concrete to immerse the vibrator and continue during the placing operations so that at no time shall there be a large volume of uncompacted concrete in the formwork.

9 The duration of vibration shall be limited to that required to produce satisfactory compaction without causing segregation. Vibration shall on no account be continued after water or excess grout has appeared on the surface.

10 During the placing of all reinforced concrete, a competent steel fixer and a competent carpenter shall be in attendance on each concreting gang. They shall ensure the reinforcement embedded fittings and forms are kept in position as work proceeds.

8.3.5 Continuity of Concrete Work

1 Whenever instructed by the Engineer, the Contractor shall carry out the work in such a manner that the placing of the concrete in any particular section of the structure shall be executed without any interruption whatsoever from the beginning to the end of the operation.

2 Casting of concrete shall not begin until a sufficient quantity of approved material is at hand to ensure continuity of operation, nor shall work begin until there is sufficient equipment in reserve in case of breakdown.

END OF PART