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तैयार कांक्रीट—रीति संहिता
(दूसरा पुनरीक्षण)

Indian Standard

READY-MIXED CONCRETE—CODE OF PRACTICE
(*Second Revision*)

ICS 91.100.30

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BUREAU OF INDIAN STANDARDS
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FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Cement and Concrete Sectional Committee had been approved by the Civil Engineering Division Council.

This standard was first published in 1968. The first revision of the standard was brought out in 1976. In the first revision the major modifications included increase in the time limit for supply of ready-mixed concrete by half an hour in order to make the standard more practicable and permitting use of fly ash.

This second revision is being brought out to incorporate modifications found necessary based on the experience gained with the use of this standard and specially in the context of recent developments in this field in the country. The significant modifications included are as follows :

- a) Rationalization of definitions and addition of definitions for more terms.
- b) Requirements for materials brought in line with IS 456:2000 'Plain and reinforced concrete— Code of practice'.
- c) Minimum testing frequencies introduced for aggregates and water.
- d) Basis of supply modified to bring it in line with IS 456:2000 'Plain and reinforced concrete— Code of practice'.
- e) Transportation time made uniform to 2 h.
- f) Requirement of temperature of concrete deleted.
- g) Sampling procedure has been modified.
- h) Tolerance limits for workability have been modified.
- j) A clause on non-compliance has been included.
- k) A detailed clause on production and delivery including plant safety and maintenance and environmental considerations has been included.
- m) A detailed clause on quality control has been included.
- n) A detailed clause on order processing and training has been included.
- p) Detailed provisions on calibration and weighing equipment accuracy has been introduced as Annex E.

For effective implementation of the provisions of the standard, it may be desirable that the ready-mixed concrete plants operate their system under a third party certification scheme to ensure operation of a well structured system and to build confidence in the users of such concrete.

The composition of the Committee responsible for formulation of this standard is given at Annex H.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard***READY-MIXED CONCRETE — CODE OF PRACTICE***(Second Revision)***1 SCOPE**

This standard covers the requirements for the production and supply of ready-mixed concrete. It does not cover the placing, compaction, curing or protection of concrete after delivery.

2 REFERENCES

The standards given in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

3.0 For the purpose of this standard, the following definitions shall apply.

3.1 Agitator — Truck mounted equipment designed to agitate concrete during transportation to the site of delivery.

3.2 Batch — Quantity of concrete mixed in one cycle of operations of a batch mixer or the quantity of concrete conveyed ready-mixed in a vehicle or the quantity discharged during 1 min from a continuous mixer.

3.3 Characteristic Strength — The value of strength of concrete below which not more than 5 percent of the population of all possible strength measurements of the specified concrete are expected to fall.

3.4 Concrete — A mixture of aggregate, cement and water with or without admixtures and/or additions and including entrapped or entrained air, for all uses but excluding all mortars other than for use as floor or roof screeds.

3.5 Density of Fresh Concrete — Mass of a quantity of compacted fresh concrete divided by its volume, expressed in kg/m^3 in accordance with IS 1199.

3.6 Designed Mix — Mix for which the purchaser is responsible for specifying the required performance and the producer is responsible for selecting the mix proportions to produce the required performance.

3.7 Free Water-Cement Ratio — Ratio of the mass of free water (that is excluding the water absorbed by

the aggregate in a saturated surface dry condition) to the mass of cement including mineral additives as per 4.3 in a concrete mix.

3.8 Grade of Concrete — Numerical value of characteristic compressive strength of 150 mm cube of concrete at 28 days, designated by 'M' followed by this strength value in N/mm^2 characteristic compressive strength.

3.9 Minimum Cement Content — The minimum mass of cement including mineral additives as per 4.3 required by the purchaser to be present, in unit volume of specified mix (*see also* Note 2 under Table 5 of IS 456).

3.10 Prescribed Mix — Mix for which the purchaser specifies the proportions of the constituents and is responsible for ensuring that these proportions will produce a concrete with the performance required.

3.11 Producer — Person or authority entering a contract to supply ready-mixed concrete.

3.12 Purchaser — Person or authority entering a contract to buy ready-mixed concrete.

3.13 Ready-Mixed Concrete — Concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser's vehicles.

3.14 Truck-Mixer — A mixer generally mounted on a self-propelled chassis, capable of mixing the ingredients of concrete and of agitating the mixed concrete during transportation.

4 MATERIALS**4.1 Selection and Approval of Materials**

Materials used should satisfy the requirements for the safety, structural performance, durability and appearance of the finished structure, taking full account of the environment to which it will be subjected. The selection and use of materials shall be in accordance with IS 456. Materials used shall conform to the relevant Indian Standards applicable. Where materials are used which are not covered by the provisions of the relevant Indian Standard, there should be satisfactory data on their suitability and assurance of quality control. Records and details of performance of such materials should be maintained. Account should be taken of possible interactions and compatibility between

materials used. Also, prior permission of the purchaser shall be obtained before use of such materials.

4.2 Cement—Cement used for concrete shall be in accordance with the requirements of IS 456.

4.3 Mineral Admixtures—Use of mineral admixtures shall be permitted in accordance with the provisions of IS 456.

4.4 Aggregates—Aggregates used for concrete shall be in accordance with the requirements of IS 456. Unless otherwise agreed testing frequencies for aggregates shall be as given in Annex B.

4.5 Chemical Admixtures

4.5.1 Use of chemical admixtures shall be permitted in accordance with the provisions of IS 456.

4.5.2 It shall be the responsibility of the producer to establish compatibility and suitability of any admixture with the other ingredients of the mix and to determine the dosage required to give the desired effect.

4.5.3 Admixtures should be stored in a manner that prevents degradation of the product and consumed within the time period indicated by the admixture supplier. Any vessel containing an admixture in the plant or taken to site by the producer shall be clearly marked as to its content.

4.5.4 When offering or delivering a mix to a purchaser it should be indicated if such a mix contains an admixture or combination of admixtures or not. The admixtures may be identified generically and should be declared on the delivery ticket.

4.5.5 The amount of admixture added to a mix shall be recorded in the production record. In special circumstances, if necessary, additional dose of admixture may be added at project site to regain the workability of concrete with the mutual agreement between the producer and the purchaser.

4.6 Water

4.6.1 Water used shall be in accordance with the requirements of IS 456. Unless otherwise agreed, the testing frequencies for water shall be as given in Annex B.

4.6.2 The use of re-cycled water is encouraged as long as concrete of satisfactory performance can be produced and steps are taken to monitor the build up of chlorides in any recirculated water and that any subsequent adjustments to the mix design are made to ensure that any overall limit on chloride contents is satisfied. The addition of any recycled water shall be monitored and controlled to meet these requirements.

4.6.3 The total amount of water added to the mix shall be recorded in the production record. The water content

of concrete shall be regulated by controlling its workability or by measuring and adjusting the moisture contents of its constituent materials. The producer's production staff and truck-mixer drivers shall be made aware of the appropriate responses to variations in concrete consistence of a particular mix caused by normal variations in aggregate moisture content or grading.

5 GENERAL REQUIREMENTS

5.1 Basis of Supply

5.1.1 Ready-mixed concrete shall be supplied having the quality and in the quantity in accordance with the requirements agreed with the purchaser or his agent. Notwithstanding this, the concrete supplied shall generally comply with the requirements of IS 456.

5.1.2 All concrete will be supplied and invoiced in terms of cubic metres (full or part) of compacted fresh concrete. All proportioning is to be carried out by mass except water and admixture, which may be measured by volume.

5.2 Transport of Concrete

5.2.1 General

5.2.1.1 Ready-mixed concrete shall be transported from the mixer to the point of placing as rapidly as practicable by methods that will maintain the required workability and will prevent segregation, loss of any constituents or ingress of foreign matter or water. The concrete shall be placed as soon as possible after delivery, as close as is practicable to its final position to avoid rehandling or moving the concrete horizontally by vibration. If required by the purchaser the producer can utilize admixtures to slow down the rate of workability loss, however this does not remove the need for the purchaser to place the concrete as rapidly as possible. The purchaser should plan his arrangements so as to enable a full load of concrete to be discharged within 30 min of arrival on site.

5.2.1.2 Concrete shall be transported in a truck-mixer unless the purchaser agrees to the use of non-agitating vehicles. When non-agitating vehicles are used, the mixed concrete shall be protected from gain or loss of water.

5.2.2 Time in Transport

5.2.2.1 The general requirement is that concrete shall be discharged from the truck-mixer within 2 h of the time of loading. However, a longer period may be permitted if retarding admixtures are used or in cool humid weather or when chilled concrete is produced.

5.2.2.2 The time of loading shall start from adding the mixing water to the dry mix of cement and aggregate or of adding the cement to the wet aggregate whichever is applicable.

5.3 Ready-mixed concrete plant shall have test facilities at its premises to carry out routine tests as per the requirement of the standard.

6 SAMPLING AND TESTING OF READY-MIXED CONCRETE

6.1 Point and Time of Sampling

For the assessment of compliance of ready-mixed concrete, the point and time of sampling shall be at discharge from the producer's delivery vehicle or from the mixer to the site or when delivered into the purchaser's vehicle. It is critical that the sampling procedure and equipment used enables as representative a sample as possible to be taken of the quantity of concrete delivered (*see* Annex C).

The sampling may be carried out jointly by the purchaser and the supplier with its frequency mutually agreed upon. However, it will not absolve the supplier of his responsibility from supplying concrete as per the requirements given in this standard or otherwise agreed to where so permitted in the standard.

6.2 Workability

6.2.1 The test for acceptance is to be performed upon the producer's delivery vehicle discharge on site or upon discharge into the purchaser's vehicle. If discharge from the producers' vehicle is delayed on site due to lack of preparedness on behalf of the purchaser then the responsibility passes to the purchaser after a delay of more than 30 min.

The workability shall be within the following limits on the specified value as appropriate:

Slump	: ± 25 mm or $\pm 1/3$ of the specified value, whichever is less.
Compacting factor	: ± 0.03 , where the specified value is 0.90 or greater, ± 0.04 , where the specified value is less than 0.90 but more than 0.80, and ± 0.05 , where the specified value is 0.80 or less.

Flow table test may be specified for concrete, for very high workability (*see* IS 9103). Acceptance criteria for spread (flow) are to be established between the supplier and the purchaser.

6.3 Specified Strength

6.3.1 Compliance shall be assessed against the requirements of IS 456 or other agreed Indian Standard. The purchaser may perform his own sampling and testing or may enter in to an arrangement with the producer to provide his testing requirements.

6.3.2 Unless otherwise agreed between the parties involved, the minimum testing frequency to be applied by the producer in the absence of a recognized ready-mixed concrete industry method of production control, should be one sample for every 50 m³ of production or every 50 batches, whichever is the greater frequency. Three test specimens shall be made up for each sample for testing at 28 days (*see also* IS 456).

In order to get a relatively quicker idea of the quality of concrete, optional test on beams for modulus of rupture at 72 ± 2 h or at 7 days or compressive strength test at 7 days may be carried out in addition to 28 days compressive strength test. For this purpose the value should be arrived at based on actual testing. In all cases 28 days compressive strength shall alone be the criteria for acceptance or rejection of the concrete.

6.3.3 The purchaser shall inform the producer if his requirements for sampling and testing are higher than one sample every 50 m³ or 50 batches, whichever is the greater frequency.

6.4 Additional Compliance Criteria

Any additional compliance criteria shall be declared to the producer by the purchaser prior to supply and shall be mutually agreed upon in terms of definition, tolerance, frequency of assessment, method of test and significance of result.

6.5 Non-Compliance

The action to be taken in case of non-compliance shall be declared and mutually agreed upon.

7 INFORMATION TO BE SUPPLIED BY THE PURCHASER

7.1 The purchaser shall provide to the producer the details of the concrete mix or mixes required by him and all pertinent information on the use of the concrete and the specified requirements. Prior to supply taking place, it is recommended that a meeting is held between the purchaser and the producer. Its objective to clarify operational matters, such as notice to be given prior to delivery, delivery rate, the name of the purchaser's authorized representative who will coordinate deliveries, any requirements for additional services such as pumping, on site testing or training, etc.

7.2 Designed Mixes

Where the purchaser specifies a designed mix to be supplied it is essential that all relevant information is conveyed to the producer. In order to assist in this, the format given in Annex D may be completed and forwarded to the producer at the time of enquiry.

7.3 Prescribed Mixes

7.3.1 The concrete mix shall be specified by its constituent materials and the properties or quantities

of those constituents to produce a concrete with the required performance. The assessment of the mix proportions shall form an essential part of the compliance requirements. The purchaser shall provide the producer with all pertinent information on the use of the concrete and the specified requirements. In order to assist in this, the format given in Annex D may be followed with suitable modifications as applicable to prescribed mixes.

8 INFORMATION TO BE SUPPLIED BY THE PRODUCER

8.1 When requested, the producer shall provide the purchaser with the following information before any concrete is supplied:

- a) Nature and source of each constituent material,
- b) Source of supply of cement, and
- c) Proposed proportions or quantity of each constituent/m³ of fresh concrete.

8.2 When requested, the producer shall provide the purchaser the following information on admixtures:

- a) Generic type(s) of the main active constituent(s) in the admixture;
- b) Whether or not the admixture contains chlorides and if so, the chloride content of the admixture expressed as a percentage of chloride ion by mass of admixture;
- c) Whether or not the admixture leads to the entrainment of air when used at the adopted dosage;
- d) Where more than one admixture is used, confirmation of their compatibility; and
- e) Initial and final setting time of concrete when admixture is used at adopted dosage (tested as per IS 8142).

9 PRODUCTION AND DELIVERY

9.1 Plant and Equipment

9.1.1 Materials Storage and Handling

9.1.1.1 Cement

Separate storage for different types and grades of cement shall be provided. Containers may be used to store cements of different types provided these are emptied before loading a new cement. Bins or silos shall be weatherproof and permit free flow and efficient discharge of the cement. Each silo or compartment of a silo shall be completely separate and fitted with a filter or alternative method of dust control. Each filter or dust control system shall be of sufficient size to allow delivery of cement to be maintained at a specified pressure, and shall be properly maintained to prevent undue emission of cement dust and prevent interference with weighing accuracy by build up of pressure.

Cement shall be stored and stacked in bags and shall be kept free from the possibility of any dampness or moisture coming in contact with them and where cement can be stored and retrieved without undue damage to the bags. The bags are to be protected from becoming damp either from the ground or the weather. The cement is to be used in the order it is delivered (*see also* IS 4082).

In case, the cement remains in storage for more than 3 months, the cement shall be retested before use and shall be rejected if it fails to conform to any of the requirements given in the relevant Indian Standard.

9.1.1.2 Dry pulverized fuel ash and other mineral admixtures

Suitable separate arrangement for storage of pulverized fuel ash, silica fume, metakeolin, rice husk ash, ground granulated blast furnace slag such as for cement, shall be provided, in the plants utilizing these materials.

9.1.1.3 Aggregates (coarse and fine)

Stockpiles shall be free draining and arranged to avoid contamination and to prevent intermingling with adjacent material. Handling procedures for loading and unloading aggregates shall be such as to reduce segregation to a minimum. Provision shall be made for separate storage for each nominal size and type of aggregate and the method of loading of storage bins shall be such as to prevent intermingling of different sizes and types. Fine aggregates shall be stacked in a place where loss due to the effect of wind is minimum (*see also* IS 4082 and IS 456).

9.1.1.4 Water

An adequate supply shall be provided and when stored on the plant such storage facilities shall be designed to minimize the risks of contamination.

9.1.1.5 Chemical admixtures

Tanks or drums containing liquid admixtures shall be clearly labelled for identification purposes and stored in such a way to avoid damage, contamination or the effects of prolonged exposure to sunlight (if applicable). Agitation shall be provided for liquid admixtures, which are not stable solutions.

9.1.2 Batching Plants and Batching Equipment

Hoppers for weighing cement, mineral admixtures, aggregates and water and chemical admixture (if measured by mass) shall consist of suitable containers freely suspended from a scale or other suitable load-measuring device and equipped with a suitable discharging mechanism. The method of control of the loading mechanism shall be such that, as the quantity required in the weighing hopper is approached, the material may be added at a controllable rate and shut off precisely within the weighing tolerances specified

in Annex E. The weighing hoppers for cement, mineral admixtures aggregate shall be capable of receiving their rated load, without the weighed material coming into contact with the loading mechanism. Where the rated capacity of a batching plant mixing cycle is less than 2.0 m³, additional precautions shall be taken to ensure that the correct number of batches are loaded into the truck mixer. The weighing hoppers shall be constructed so as to discharge efficiently and prevent the build up of materials. A tare adjustment, up to 10 percent of the nominal capacity of the weigh scale, shall be provided on the weighing mechanism so that the scale can be adjusted to zero at least once each day. Dust seals shall be provided on cement hoppers between the loading mechanism and the weigh hopper, and shall be fitted so as to prevent the emission of cement dust and not to affect weighing accuracy. The hopper shall be vented to permit escape of air without emission of cement dust.

Vibrators or other attachments, where fitted, shall not affect the accuracy of weighing. There shall be sufficient protection to cement and aggregate weigh hoppers and weighing mechanisms to prevent interference with weighing accuracy by weather conditions or external build-up of materials.

Where chemical admixture dispensers are used, they shall be capable of measurement within the tolerances in Annex E and a calibrated container or weigh scales shall be provided to check the accuracy of measurement at least once a month.

Where a continuous mixer with ribbon loading is used, the batching procedure specified by the manufacturer of the plant shall be followed.

Each control on the batching console and weigh-dial or display shall be clearly labelled with its function and where concerned with the batching of materials, the material type.

When more than one type or grade of cement is being used, the weighing device and discharge screw or other parts of the transfer system shall be empty before changing from one type of cement to another.

When pulverized fuel ash and other mineral admixtures are batched through the cement weigh system, the weighing device and discharge screw or other parts of the transfer system shall be empty when the weighing system has returned to zero reading or completed the batch.

Where a backweigh system is utilized to weigh materials a system shall be in place so as to prevent materials being loaded during the process of weighing.

9.1.3 *Measurement of Materials*

Cement and mineral admixture materials shall be measured by mass in a hopper or compartment separate

from those used for other materials and on a scale of appropriate sensitivity, measurement being taken from a zero reading. Aggregates shall be measured by mass, allowance being made for the free moisture content of the aggregates. The added water shall be measured by volume or by mass. Any liquid chemical admixture (or paste) shall be measured by volume or by mass and any solid admixture by mass. When weighing materials, any build up in the hopper during the day must be tared out or allowed for in the batch weights. After measurement all materials shall be discharged into the mixer without loss.

The accuracy of the measuring equipment shall be within ± 2 percent of the quantity of cement and mineral admixtures being measured and within ± 3 percent of the quantity of aggregate, chemical admixture and water being measured. The plant operator shall be provided with a clear display of the quantities of materials to be batched for each mix and batch size and with information identifying the display to be selected for each designed and prescribed mix to be produced. Analogue scale displays for the weighing of cement, mineral admixtures, aggregates and water shall be readily discernable from the operating position. For digital readouts the numerals shall be readily discernable from the operating position.

Fully automatic production systems shall be fitted with control equipment to allow the correct operation of the plant to be monitored during weighing and batching. Automatic control systems on batching plants shall not commence batching until all hoppers have been emptied and/or tared and the scales zeroed unless such systems are designed to take account of build up in their programming.

All scales shall be tested and calibrated as per Annex E.

9.1.4 *Mixing*

9.1.4.1 *Washing out water*

Before loading concrete materials or mixed concrete into either a stationary mixer or truck mixer any water retained in the mixing drum for washing out purposes shall be completely discharged.

9.1.4.2 *Stationary or central mixers*

Stationary mixers shall not be loaded in excess of the manufacturer's rated capacity. The mixing time shall be measured from the time all the materials required for the batch, including water, are in the drum of the mixer. The mixing time shall not be less than that recommended by the manufacturer. Where a continuous mixing plant is used the complete mixing time shall be sufficient to ensure that the concrete is of the required uniformity.

9.1.4.3 Truck mixers

When a truck mixer is used for the partial or complete mixing of concrete, mixing shall be considered to commence from the moment when all the materials required for the batch, including water, are in the rotating drum of the mixer.

Truck mixers or agitators shall not be loaded in excess of the manufacturer's rated capacity. In order to produce a satisfactory mix, and where there is no data available to establish different period and speed of revolutions, mixing shall continue for not less than 60 revolutions of the truck mixer drum at a rate of not less than 7 revolutions/min. All completely truck mixed concrete shall be visually inspected for uniformity prior to leaving the plant.

When a truck mixer or agitator is used for transporting concrete which has been mixed before leaving the plant, the concrete shall be agitated during transit and re-mixed at the site for at least 2 min so that the concrete is of the required uniformity.

Where water is added to the concrete in the truck mixer through the truck mixer water meter and when such water is being accounted for in the total water within the mix, it shall be ensured that the truck mixer water meter is in operational condition and properly calibrated. Where a water meter is not available, water must be measured in a suitable container before being added to the truck mixer.

9.1.4.4 Condition of mixers

Stationary and truck mixers shall be maintained in an efficient and clean condition with no appreciable build up of hardened concrete or cement in the mixing drum, on the mixing blades, or on the loading hopper or discharge chutes. When, due to wear the height or depth of the mixing blades or paddles is less than two-thirds of the original, the blade or paddles shall be renewed or replaced.

9.1.5 Notwithstanding the requirements regarding mixing prescribed in the relevant clauses of this standard, it shall be ensured that stationary or central mixers and truck mixer shall be comply with performance criteria of mixing efficiency test as per IS 4634. Mixing efficiency test shall be performed at least once in a year.

9.2 Plant Safety and Maintenance

At all times, all guardrails and machinery guards shall be fixed securely in position and walkways kept clean and tidy with clear access. All plant and equipment shall be maintained in a clean and efficient working condition and regular, routine maintenance checks shall be carried out as detailed in Annex F. Check lists, including weekly, monthly and quarterly routines, shall be prepared to cover general storage, handling,

batching, mixing and transporting plant, as well as the routine maintenance recommended by manufacturers for specific items of equipment. The name and/or position of the person responsible for ensuring that the maintenance schedules are carried out shall be included on each checklist and a provision made for their signature.

The supplier shall provide suitable communication system between batching plants, transit mixers and the delivery site so as to ensure the compliance of service criteria agreed to with the purchaser/user.

9.3 Environmental Considerations

The design, management and operation of a ready-mixed concrete plant should be with due regard for the environment. The broad criteria given in 9.3.1 to 9.3.10 should be borne in mind when establishing a ready-mixed concrete plant (where in the following the term minimize is used it is understood to mean to reduce to the lowest realistic level using technologies which are proven, reasonable and economic).

9.3.1 External Appearance

The producer should endeavor to ensure that plant operations are landscaped and screened from the surrounding industrial, commercial, residential or rural community so that impact on the environment is minimized.

9.3.2 Plant, Office Buildings and Staff Facilities

The producer shall ensure that plant buildings are suitably maintained, kept clean and that all required records are appropriately kept.

9.3.3 Traffic Control and Cleanliness

The producer should ensure that traffic routes will be chosen to avoid sensitive areas where practicable and to minimize fuel consumption. Vehicles should be maintained in a clean condition and action should be taken to minimize the incidence of concrete spillage on public highways.

9.3.4 Site Safety

The producer shall provide working conditions which have regard to the health and safety of employees.

9.3.5 Air Pollution

The producer should utilize appropriate technology to prevent or minimize dust emissions in line with local or national regulations.

9.3.6 Noise And Vibration

The producer should take steps to ensure that plant and vehicle noise are minimized through plant design, the use of appropriate technology and the location of the plant.

9.3.7 Water Management

The producer should take action to improve effluent quality where necessary and reduce volumes of discharge. He should aim to minimize water usage and wastage and to meet national and local regulations concerning effluent discharges.

9.3.8 Fuel, Oil and Chemical Spillage

The producer should take appropriate measures to prevent pollution of surrounding surface and groundwaters from accidental effluent discharges and fuel, oil or chemical spillage.

9.3.9 Waste Management

The producer should introduce processes and working practices that minimize the production of waste. Where waste cannot be avoided, to provide environmentally sound treatment and disposal, or find markets for its use as a resource.

9.3.10 Training

The producer should undertake to train employees to be aware of the responsibility to the environment, he should give a high priority to site care and good housekeeping and to encourage participation in the local community.

9.4 Delivery Ticket

Immediately before discharging the concrete at the point of delivery, the producer or his representative shall provide the purchaser with a preprinted delivery ticket for each delivery of concrete on which is printed, stamped or written the minimum information detailed in Annex G. The delivery ticket will form the basis of invoicing.

10 QUALITY CONTROL

Quality control of ready-mixed concrete may be divided into three components, forward control, immediate control and retrospective control.

10.1 Forward Control

Forward control and consequent corrective action are essential aspects of quality control. Forward control includes the following.

10.1.1 Control of Purchased Material Quality

A control system shall be operated to provide assurance that all materials purchased for and used in the production of concrete conform to the Indian Standards agreed with the material supplier and the requirements of the producer's mix design methodology and quality control procedures. This may include visual checks, sampling and testing, certification from material suppliers and information from material suppliers.

10.1.2 Control of Materials Storage

Materials should be stored in such a way as to prevent the risk of contamination. The producer should utilize suitable transfer and feed systems. Aggregate storage areas should be free draining. Measures should be taken to prevent freezing or excessive solar heating of aggregates. Admixtures should be clearly identified and protected from sunlight (where applicable) and the risk of contamination.

10.1.3 Mix Design and Mix Design Modification

The producer shall maintain a record of all mix designs and modifications current on the plant.

10.1.4 Plant Maintenance

The producer shall be able to demonstrate that a documented plant maintenance procedure is in place. Regular plant inspections should be carried out with faults reported and rectified.

10.1.5 Transfer and Weighing Equipment

The producer shall be able to demonstrate that a documented calibration procedure is in place. Calibration records should contain details of any corrective action required, the date of the next calibration, confirmation that any required corrective action has taken place and the signature of the designated manager for that plant. The producer shall also maintain a daily production record for that plant, including details of which customers were supplied, which mixes were supplied and which delivery dockets were dispatched. There should be a record of what materials were used for that day's production including water and admixture. The use of electro-mechanical weighing and metering systems, that is, load cells, flow meters, magmeters, etc, is preferable over purely mechanical systems, that is, knife edge and lever systems.

10.1.6 Plant Mixers and Truck-Mixers

Plant mixers where present and truck-mixers used shall be in an operational condition and shall be purchased from a supplier of proven experience and quality. The producer should ensure that regular maintenance is performed as per requirements.

10.2 Immediate Control

Immediate control is concerned with instant action to control the quality of the concrete being produced or that of deliveries closely following. It includes the production control and product control.

10.2.1 Production Control

10.2.1.1 The production of concrete at each plant shall be systematically controlled. This is to ensure that all the concrete supplied shall be in accordance with these requirements and with the specification that has formed

the basis of the agreement between the producer and purchaser.

10.2.1.2 Each load of mixed concrete shall be inspected before dispatch and prior to discharge. Alternatively systems may be incorporated into the plant or truck-mixer to allow the correlation of a particular parameter to concrete workability (thus removing the need to visually inspect at the plant) as long as the producer documents the validity of such a system in the form of a method statement or procedure.

10.2.1.3 The workability of the concrete shall be controlled on a continuous basis during production and any corrective action necessary taken.

10.2.1.4 For each load, written, printed or graphical records shall be made of the mass of the materials batched, the estimated slump, the total amount of water added to the load, the delivery ticket number for that load, and the time the concrete was loaded into the truck.

10.2.1.5 Regular routine inspections shall be carried out on the condition of plant and equipment including delivery vehicles.

10.2.1.6 No additional water, other than the amount required to produce the specified workability, shall be added to the truck mixer drum before discharge unless specifically requested and signed for by the purchaser.

10.2.2 Product Control

10.2.2.1 Concrete mixes shall be randomly sampled and tested for workability, and where appropriate, plastic density, temperature and air content. Where significant variations from target values are detected, corrective action shall be taken.

10.2.2.2 It is important to maintain the water cement ratio constant at its correct value. The amount of added water shall be adjusted to compensate for any observed variations in the moisture contents in the aggregates. Suitable adjustments should also be made in masses of the aggregates due to this variation (*see* IS 456). Any change in water content due to change in aggregate grading shall be taken care of by forward control by suitable modifications to mix design.

10.2.2.3 When the assessment of moisture content is carried out continuously using a suitable instrument a system shall be provided to indicate the necessary changes in added water for changes in moisture content.

10.3 Retrospective Control

Retrospective control is concerned with those factors that influence the control of concrete quality that can not be assessed at the time of production. Retrospective control may cover any property of materials or concrete, such as aggregate grading, slump, or air content, but is particularly associated with 28-day cube strength because by its very nature it is not a property which

can be measured ahead of, or at the time of, manufacture.

10.3.1 Mix Performance

The producer shall be responsible for ensuring that suitable control procedures are in place to ensure the following.

10.3.1.1 Designed mixes

A quality control system shall be operated to control the strength of designed mixes to the levels required in accordance with 3.4 and 3.8 and shall be based on random tests of mixes which form the major proportion of production. The system shall include continuous analysis of results from cube tests to compare actual with target values together with procedures for modifying mix proportions to correct for observed differences. Compressive strength testing shall be carried out using a machine that meets the requirements of IS 14858.

10.3.1.2 Prescribed mixes

Periodic and systematic checks shall be made to ensure that the cementitious material contents of prescribed mixes comply with their mix descriptions.

10.3.2 Stock Control of Materials

The producer shall operate a materials stock control procedure to enable verification of total quantities used and to confirm that only approved materials have been received.

10.3.3 Complaints

The producer shall have a procedure in place to enable the diagnosis and correction of faults identified from complaints.

11 ORDER PROCESSING

A competent person to interpret the specified requirements and relate these to mix design criteria shall systematically review specification and orders supplied by the purchaser. These shall be formally recorded together with any modification to the specification resulting from subsequent agreed documentation to ensure that the plant operator is given the correct instructions for batching and mixing.

When mixes or materials are offered as alternatives to requested mixes or where there is no specification supplied by the purchaser, orders whether received verbally or in writing, shall be agreed with the purchaser and the fact recorded. Alternatives to the mix description or compliance requirements in the purchaser's specification shall be clearly identified in the quotation.

12 TRAINING

12.1 All personnel concerned with production, delivery

and the function of the producer's quality system shall have received training appropriate to the duties they perform.

12.2 The testing of materials, proportioning of mixes and the production of concrete together with all its control testing shall be under the overall supervision of an experienced concrete technologist.

12.3 Operator who have received proper instructions on the equipment in use and who are able to comply with the required accuracy of batching shall produce concrete.

13 RECORDS

Records shall be maintained by the producer to provide confirmation of the quality and quantity of concrete produced. The records shall be retained for the purposes

of these requirements for a period of at least one year. They shall cover the following aspects:

- a) Production and delivery:
 - 1) Batching instructions,
 - 2) Batching records,
 - 3) Delivery tickets, and
 - 4) Equipment calibration and plant maintenance.
- b) Materials and production control:
 - 1) Concrete production and materials purchase, usage and stocks, and
 - 2) Certificates or test results for materials.
- c) Production quality control:
 - Control test results

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

<i>IS No.</i>	<i>Title</i>	<i>IS No.</i>	<i>Title</i>
383 : 1999	Coarse and fine aggregates from natural sources for concrete—Specification (<i>third revision</i>)	4634 : 1991	Methods for testing performance of batch-type concrete mixers (<i>first revision</i>)
456 : 2000	Plain and reinforced concrete—Code of practice (<i>fourth revision</i>)	8142 : 1976	Method of test for determining setting time of concrete by penetration resistance
1199 : 1959	Methods of sampling and analysis of concrete	9103 : 1999	Concrete admixtures—Specification (<i>first revision</i>)
4082 : 1996	Recommendations on stacking and storage of construction materials and components at site (<i>second revision</i>)	14858 : 2000	Compression testing machine used for testing of concrete and mortar—Requirements

ANNEX B

(Clauses 4.4 and 4.6.1)

MATERIALS TESTING REQUIREMENTS

B-1 AGGREGATES

Aggregates shall be tested at a minimum frequency indicated by the high or low test rates given below:

Minimum Test Frequencies

<i>Sl No.</i>	<i>Aggregate Property/ Parameter</i>	<i>Type of Aggregate</i>	<i>Assessment of Typical Properties and High Test Rate</i>	<i>Normal Monitoring and Low Test Rate</i>	<i>Requirement for Normal Monitoring and Low Test Rate</i>
(1)	(2)	(3)	(4)	(5)	(6)
i)	Grading	Sand/fine Coarse – singlesized – graded	Weekly Weekly	Monthly Monthly Monthly	Last 8 results conform to IS 383 or representative values
ii)	Particle Density Oven dry Saturated surface dry Apparent	All types	Weekly Weekly Weekly	3 monthly 3 monthly 3 monthly	Last 4 results ± 0.04
iii)	Absorption	All types	Weekly	3 monthly	Last 4 results ± 0.04 percent
iv)	Bulk Density Loose Compacted	All types All types	Monthly Monthly	6 monthly 6 monthly	Last 4 results $\pm 75\text{kg/m}^3$ $\pm 75\text{kg/m}^3$
v)	Fines (silt) Content	Sand Coarse	Weekly Monthly	Monthly 3 monthly	Last 10 results < 75 percent maximum allowed
vi)	Aggregate Impact Value	Coarse	As specified	As specified	—
vii)	10% Fines	Coarse	Yearly	Yearly	—
viii)	Flakiness	Coarse	2 Weekly	6 monthly	Last 3 results conform to standard
ix)	Chloride Content	All types	Weekly	6 monthly	Last 3 results <0.01 percent
x)	Aggregate Abrasion Value (Los Angeles Method)	Coarse	—	Yearly/ Source change	—
xi)	Soundness	Fine and Coarse	—	Yearly/ Source change	—
xii)	Potential Alkali Aggregate Reactivity Including Petrography	Fine and Coarse	—	5 yearly/ Source change	—
xiii)	Petrographic Description (General)	All types	—	5 yearly	—

B-1.1 The high or low test rates apply in accordance with the following conditions:

- a) High test rate
 - 1) To establish the typical characteristics of an aggregate, and
 - 2) When significant changes in properties occur outside the tolerances for low test rates given.
- b) Low test rate
 - 1) When the typical characteristics of the aggregate have been established, and
 - 2) When subsequent tests lie within the tolerances for low test rates given.

The results of all valid tests shall be plotted on calendar charts, tabulated or recorded in computerized systems. The results shall be compared with identified tolerances and corrective action taken when these are exceeded.

B-2 WATER

The minimum testing frequencies shall be as follows:

- a) *Mains Water*—Water samples are taken from all sources of supply and tested for pH, chloride ion content, sulfate content and any other parameters in accordance with IS 456. The initial test rate shall be weekly until six results are obtained. Three monthly samples shall then be taken and compared against the average of the original six. Significant deviation shall require further investigation.
- b) *Non mains Water*—A sample shall be taken annually for routine records however if the chloride ion content is above 0.01 percent then the interval of testing shall be reduced to 3 monthly.

ANNEX C

(Clause 6.1)

SAMPLING OF CONCRETE

After the truck-mixer has re-mixed its delivery on site allow at least the first one-third of a m³ of concrete to be discharged prior to taking any samples. Take at least 4 incremental samples from the remainder of the load

avoiding sampling the last cubic metre of concrete. Thoroughly re-mix this composite sample either on a mixing tray or in the sampling bucket and proceed with the required testing.

ANNEX D

(Clauses 7.2 and 7.3.1)

CONCRETE MIX INFORMATION TO BE SUPPLIED BY THE PURCHASER

RMC : _____

Contractor : _____

Site : _____

MIX CODE						
Grade (N/mm ²) (Characteristic strength)						
Minimum Cement Content (kg/m ³)						
Mineral Additives (Pulverized fuel ash/Slag/Others) (kg/m ³)						
Maximum Free Water -Cement Ratio						
Nominal Maximum Aggregate Size						
Cement Type and Grade (if preferred)						
Target Workability [Slump(mm)]						
Target Workability at Site						
Maximum Temperature of Concrete at the Time of Placing						
Class of Sulphate Resistance (if applicable)						
Exposure Condition (if applicable)						
Class of Finish (if applicable)						
Mix Application						
Method of Placing						
Any Other Requirements (Early strength workability retention, permeability testing, chloride content restriction, maximum cement content, etc)						
Concrete Testing (Frequency)						
Material's Testing (any non- routine requirements)						
Alternatives to be Offered: YES/NO						
Method of Curing to be Used by Contractor						
Quantity(m ³)						

NOTE— Additional proforma for further information may be used, such as for specific test rates to be achieved for concrete or raw materials, exact method statements of the contractors proposed site practice.

ANNEX E

(Clauses 9.1.2 and 9.1.3)

CALIBRATION AND WEIGHING EQUIPMENT ACCURACY

E-1 The following limits shall apply to all ready-mixed concrete plants:

- a) The accuracy, sensitivity and arrangement of the weighing devices shall be such as to enable the materials to be batched within the following tolerances:
- 1) Cement, mineral admixtures : Within ± 2 percent of the quantity of the constituent being measured
- 2) Aggregate, chemical admixtures and water : Within ± 3 percent of the quantity of the constituent being measured
- b) Analogue scales shall have scale increments not exceeding 5 kg for cement and mineral admixtures, 25 kg for aggregate and 2 kg for water.
- c) Preset controls shall be calibrated in increments not exceeding 5 kg for cement and mineral admixtures, 10 kg for aggregate and 2 kg for water.
- d) For continuous mixer plants calibration shall be in increments not exceeding 10kg/m³ for cement and mineral admixtures, 25kg/m³ for aggregates and 10 l/m³ for water.
- e) Digital readouts shall have a scale increment not exceeding 2 kg for cement and mineral admixtures, 10 kg for aggregate and 1 l for water.
- f) At the time of installation, or reconditioning, the accuracy of the indicated mass at any point on the scale shall be within 0.25 percent of the full scale reading.
- g) At any other time during operation the accuracy shall be within 0.50 percent of the full scale reading.

h) Chemical Admixture dispensers shall have scale increments not exceeding:

<i>Range of scale in kg/l</i>	<i>Scale increment in kg/l</i>
0.1 - 0.5	0.01
0.5 - 1.0	0.02
1.0 - 10.0	0.2
more than 10.0	0.4

j) All weighing and measuring equipment shall be tested and calibrated over its full working range at the following intervals:

- 1) Mechanical / knife edge systems : At least once every two months
- 2) Electrical / load cell systems : At least once every three months

Adequate and identified facilities shall be provided for the application of the test loads.

- k) In the case of batch weighing systems testing and calibration shall be based on the application test loads to the weigh hoppers.
- m) Checks on continuous weigh systems shall be based on comparison of preset quantities with those actually produced.
- n) To achieve the required accuracy of calibration, a minimum of 500 kg of stamped weights are required, except that for low capacity scales an acceptable limit on the total mass of calibration weights would be 20 percent of the scale capacity.
- p) When calibration of weighing equipment is carried out all personnel involved should be competent and fully trained, the procedures should be fully documented, and special attention should be paid to the health and safety aspects of the procedure.

ANNEX F

(Clause 9.2)

ROUTINE MAINTENANCE CHECKS FOR PLANT AND EQUIPMENT

F-1 STORAGE AND HANDLING EQUIPMENT

Weekly Routine:

- a) Check area under plant for spillage and trace source.
- b) Clean-up yard, checking that all drains and traps are clear.
- c) Maintain settlement pits, recyclers and wash down areas in efficient working order.
- d) Check all storage bins and doors for efficient operation.
- e) Check conveyors, boom scrapers and bucket elevators for free running and wear, and adjust as necessary.
- f) Routine checks and servicing on loading shovels.
- g) Routine checks and servicing on compressors.
- h) Report any defects.

F-2 BATCHING AND MIXING EQUIPMENT

Daily Routine:

- a) Adjust tare weights and clean weigh dials (if applicable).
- b) Ensure weighing hoppers empty properly.
- c) Washout central mixer drum or pan.

Weekly Routine:

- a) Maintain all hoppers and doors in clean and efficient working order.
- b) Check central mixer blades, paddles or arms for wear and tightness and adjust as necessary.
- c) Remove any cement or concrete build up in the mixer.
- d) Shack out cement silo filter sock (if applicable) and maintain in efficient working order.
- e) Check dust seals on cement hoppers for wear.
- f) Clean knife edges or load cells on weighing equipment.

- g) Check calibration of moisture meter if applicable.
- h) Check oil levels on air line lubricators.
- j) Drain water traps on air lines.
- k) Check rams and air lines for leaks.
- m) Check pipework for leaks and wear.
- n) Check wiring and electrical apparatus for correct operation and over heating.
- p) Routine greasing of bearings and gears.
- q) Routine checks and servicing on central mixers.
- r) Report any defects.

Monthly Routine:

- a) Check calibration of all weigh scales.
- b) Check calibration of water meter.
- c) Check calibration of admixture dispenser.

Quarterly Routine:

- a) Inspection and testing of all weigh scales over their complete operational range.
- b) Routine oil changes in gearboxes and oil baths.

F-3 TRANSPORTING EQUIPMENT—MIXER AND AGITATOR UNITS

Daily Routine:

Wash out truck mixer drum.

Monthly Routine:

- a) Check mixer unit for blade wear.
- b) Check operation of revolution counters, if fitted.
- c) Check calibration of truck mixer water meter.
- d) Report any defects.

NOTE— The producers shall be responsible for maintaining all vehicle chassis in accordance with the relevant laws, if ready-mixed concrete is to be transported on the public highways.

ANNEX G*(Clause 9.4)***DELIVERY TICKET INFORMATION**

G-1 The following information shall be included in the delivery ticket to accompany the load to the purchaser:

- 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 and location of site.
- g) Grade or mix description of the concrete.
- h) Specified target workability.
- j) Minimum cement content (if specified).
- k) Type of cement and grade (if specified).
- m) Maximum free water-cement ratio (if specified).
- n) Nominal maximum size of aggregate.
- p) Generic type or name of any chemical and mineral admixtures included.

- q) Quantity of concrete in m³.
- r) Time of loading.
- s) Signature of the plant operator.
- t) A statement warning the purchaser of the precautions needed to be taken when working with cement and wet concrete.

G-2 On site the following information will be added :

- a) Time of arrival on site.
- b) Time when discharge was completed.
- c) Any water/admixture added by the supplier to meet the specified workability.
- d) Any extra water/admixture added at the request of the purchaser of the concrete, or his representative, and his signature.
- e) Pouring location.
- f) Signature of the purchaser or his representative confirming discharge of the load.

ANNEX H

(Foreword)

COMMITTEE COMPOSITION

Cement and Concrete Sectional Committee, CED 2

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Central Soil and Materials Research Station, New Delhi	DIRECTOR
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Amendments Issued Since Publication

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