

STANDARD INDUSTRI PEMBINAAN

(CONSTRUCTION INDUSTRY STANDARD)

CIS 21: 2018

**READY-MIXED CONCRETE: PRODUCTION, CONFORMITY,
TRANSPORTATION AND DELIVERY CRITERIA FOR
PRODUCERS**

Description: Ready-mixed concrete, ready-mix concrete plant, computerised batching plant, producers production control, conformity assessment, production, delivery, product certification

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**READY-MIXED CONCRETE: PRODUCTION,
CONFORMITY, TRANSPORTATION AND DELIVERY
CRITERIA FOR PRODUCERS**

Ready-Mixed Concrete: Production, Conformity, Transportation and Delivery Criteria for Producers

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COMMITTEE REPRESENTATION

The Construction Industry Standard (CIS) was developed and reviewed by the Construction Industry Development Board Malaysia with the assistance of the Technical Committee on Ready-mixed Concrete, which comprises representatives from the following organisations:

American Concrete Institute (KL Chapter)
Association of Consulting Engineers Malaysia
Cement & Concrete Association Malaysia
Concrete Society Malaysia
Construction Research Institute of Malaysia
Industrial Concrete Product Sdn. Bhd.
Institution of Engineers Malaysia
Iqramxpert Sdn. Bhd.
Jabatan Kerja Raya Malaysia
Master Builders Association Malaysia
National Ready-mixed Concrete Association Malaysia
Persatuan Konkrit Malaysia
SIRIM QAS International Sdn. Bhd.
Suntiga Concrete Sdn. Bhd.

PREFACE

Construction Industry Standard 21 (hereinafter referred as CIS 21) is a standard focused on ready-mixed concrete and serves as a basis for ready-mixed concrete producers in ensuring their ready-mixed concrete plant, production and production control, transportation and delivery are independently certified by a certification body recognised by CIDB.

The ready-mixed concrete in this CIS 21 is developed in reference to MS EN 206, MS 523-2 and MS 523-3. It is revised to reflect the changes and advances made in the industry. Industry players will find several new additions that will facilitate better understanding in the various components related to ready-mixed concrete. These revisions are detailed in the following pages.

It is hoped that this standard will be of good practical use for all involved. This CIS supersedes CIS 21:2016.

Compliance with this document does not in itself confer immunity from legal obligations.

READY-MIXED CONCRETE: PRODUCTION, CONFORMITY, TRANSPORTATION AND DELIVERY CRITERIA FOR PRODUCERS

SECTION 1: GENERAL

1.1 Introduction

MS EN 206:2016, which replaced MS 523:Part 1:2005, is a full adoption of EN 206: 2013. It provides a platform to further upgrade and enhance the quality of ready-mixed concrete to a higher level through production control and conformity approach by providing a mechanism for the product to be independently certified by a recognised certification body. MS EN 206 places greater responsibility to the producer, who shall be responsible for the conformity of ready-mixed concrete according to the concrete specification.

MS EN 206 is supported by two complimentary Malaysian Standards; i) MS 523-2 - the method of specifying and guidance for the specifier, and ii) MS 523-3 - a specification for constituent materials and concrete.

MS EN 206 covers both site-mixed concrete and ready-mixed concrete. The quality of site-mixed concrete is very much dependent on the contractor and the project supervisor while ready-mixed concrete, on the producer. However, to date, there is no specific Malaysian Standard for ready-mixed concrete that addresses and assists Malaysian producers to readily understand and adopt MS EN 206.

Thus, CIS 21 was developed to provide a clear direction for ready-mixed concrete producers in complying with the requirements of MS EN 206. Additional requirements are included in this CIS, which takes into consideration the knowledge and experience gained by the Malaysian concrete industry.

In general, Annex C of MS EN 206, have provisions for assessment, surveillance and certification for concrete, and they are applicable for ready-mixed concrete.

CIS 21, which is specifically titled as “Ready-mixed Concrete: Production, Conformity, Transportation And Delivery Criteria For The Producers” is dedicated to ready-mixed concrete only. It is to be used for product certification with new and redefined terms that are highlighted in 1.2 (new and defined terms). Additional requirements are provided in 1.3, which supplements the provision in MS EN 206.

While CIS 21 is aligned with MS EN 206, MS 523-2 and MS 523-3, additional references are also included (see 1.3 Normative References). The following main items were introduced or revised when preparing this revised CIS:

- a. Subheadings “Batching plant” (see 2.3.1), “Silos and stockpiles” (see 2.3.2), “Concrete mixer” (see 2.3.3) and “Testing” (see 2.3.4); Table 1 and Table 2.
- b. New heading “Production” (see Section 3), subheading “Production process” (see 3.1) and Appendix B, subheading “Production control system manual” (see 3.2.1) and repositioning “Production control procedures” to 3.2.2 and new heading “Initial and identity testing” (see Section 4).

- c. Producers are to decide whether to use individual concrete or concrete family concept, subheading “Sampling and testing” (see 5.1.1), subheading “Criteria for individual results” (see 5.1.2), subheading “Criteria for mean results” (see 5.1.3) and example of formats (Appendix C and Appendix D) for record of concrete compressive conformity computation are introduced (see 5.1.4).
- d. Additional requirements for a recognised certification body, routine surveillance and testing by producer at its own laboratory are highlighted in Section 7. Certification. Information on “plant profile”, see 9.2.1 iii and Appendix E.

1.1.1 New and redefined terms

Several existing terms of MS EN 206 are redefined¹ and new² definitions have been established in this CIS 21. These terms are also based on other information available from other sources.

These terms may assist the producers better, in order to comply with applicable requirements of CIS 21 and MS EN 206, which are as follows:

- i. Ready-mixed concrete (redefined, see 1.4.1 (i))
- ii. Ready-mixed concrete plant (new, see 1.4.1 (ii))
- iii. Production control (new, see 1.4.1 (vi))
- iv. Production control system (new, see 1.4.1 (vii))
- v. Wet batching (new, see 1.4.1 (viii))
- vi. Dry batching (new, see 1.4.1 (ix))
- vii. Plant mixer (new, see 1.4.1 (x))
- viii. Initial production (new, see 1.4.1 (xii))
- ix. Continuous production (new, see 1.4.1 (xiii))
- x. Initial assessment (new, see 1.4.1 (xiv))
- xi. Product certification (new, 1.4 (xix))

NOTE:

- 1 These terms are already in use and have been defined in MS EN 206.
- 2 These terms are already in use in MS EN 206 but not distinctly defined.

1.1.2 Additional requirements

Additional requirements have been included in CIS 21, in comparison to MS EN 206. These are as follows:

- i. Types of batching plants (see 1.2)
- ii. Legal requirement for the producer (see 2.1)
- iii. Technical personnel (see 2.2)
- iv. Certification by CIDB-recognised certification body (see 7 (i))
- v. Certificate (see 7 (vi))
- vi. Identification of ready-mixed concrete plant and signage (see Section 8)
- vii. Quality management requirements (see Section 9)

1.2 Scope

The scope of this CIS 21 is for ready-mixed concrete produced by any ready-mixed concrete plants (i.e. plants may be located on the construction site or off-site) producing concrete for structural and non-structural use, including those used in casting of precast concrete products. This CIS 21 covers two types of batching plants³ which are:

- Type 1 - Wet batching plant⁴ (W)
- Type 2 - Dry batching plant⁵ (D)

NOTE:

- 3 A typical schematic diagram of wet and dry batching plant is as in Appendix A.
- 4 In wet batching, the primary mixing of the concrete is performed in a plant mixer, and the secondary mixing is done in the truck mixer for maintaining the concrete in homogenous state before the concrete is discharged from the truck mixer.
- 5 In dry batching, the primary mixing of the concrete is performed in a truck mixer, and the secondary mixing is done in the truck mixer for maintaining the concrete in homogenous state before the concrete is discharged from the truck mixer.

This publication includes receiving of incoming materials, production and production control, conformity control and conformity criteria, transportation of concrete to the point of delivery, and delivery. It provides the basis for producers to obtain independent certification for compliance to CIS 21 for ready-mixed concrete produced, transported to the point of delivery, delivered under a documented production control system and production control procedures.

The ready-mixed concrete shall comply with applicable specified requirements of MS EN 206, MS 523-2 and MS 523-3.

1.3 Normative References

The following normative references are used for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the normative references (including amendments) applies.

- i. MS EN 206, Concrete - Specification, performance, production and conformity (Third revision)
- ii. MS 523-2, Concrete - Part 2: Method of specifying and guidance for the specifier (Third revision)
- iii. MS 523-3, Concrete - Part 3: Specification for constituent materials and concrete (Third revision)
- iv. MS 26-1-1, Testing of Concrete - Part 1: Fresh Concrete - Section 1: Sampling (Second revision)
- v. MS EN 12390-1, Testing hardened concrete - Part 1: Shape, dimensions and other requirements for specimens and moulds (Second revision)
- vi. MS EN 12390-2, Testing hardened concrete - Part 2: Making and curing specimens for strength tests
- vii. MS EN 12390-3, Testing hardened concrete - Part 3: Compressive strength of test specimens
- viii. MS EN 12620, Aggregates for concrete (Second revision)
- ix. ISO 9001: Quality Management System - Requirements
- x. ISO IEC 17025: General requirements for the competence of testing and calibration laboratories
- xi. ISO IEC 17065: Conformity assessment - Requirements for bodies certifying products, processes and services

1.4 Definitions and Abbreviations

1.4.1 Definition

Generally, the definitions in MS EN 206, MS 523-2 and MS 523-3 apply. In this CIS 21, the applicable definitions are as follows:

- i. **Ready-mixed concrete**
Concrete manufactured in any ready-mixed concrete plant situated at any location for delivery in a fresh state.
- ii. **Ready-mixed concrete plant**
The buildings, structures and batching facilities, including but not limited to the testing, silos, mixers, aggregate storage facilities for the production control, batching, production, and supply of ready-mixed concrete.
- iii. **Producer**
Person or body producing fresh concrete.
- iv. **Specifier**
Person or body establishing the specification for fresh and hardened concrete.
- v. **User**
Person or body using fresh concrete in the execution of a construction or a component.
- vi. **Production control**
Production control comprises all relevant measures necessary to maintain the properties of concrete in conformity to specified requirements.
- vii. **Production control system**
A documented production control manual, which defines the responsibility, authority and the interrelation of all personnel who manage, perform and verify work affecting quality of the concrete and contains documented procedures and instructions for production control.
- viii. **Wet batching**
The constituent materials are batch directly into a plant mixer.
- ix. **Dry batching**
The constituent materials are batch directly in a truck mixer.
- x. **Plant mixer**
Concrete mixer installed at the ready-mixed concrete plant that is capable of mixing a homogeneous concrete.
- xi. **Truck mixer**
Concrete mixer mounted on a self-propelled chassis capable of mixing and delivering a homogeneous concrete.
- xii. **Initial production**
Covers production until at least 35 test results are available.
- xiii. **Continuous production**
When at least 35 test results are obtained over a period not exceeding 12 months.

- xiv. **Initial assessment**
An initial inspection of the ready-mixed concrete plant and its production control for the purpose of determining whether the prerequisites, in terms of staff and equipment for orderly production and for the corresponding production control system and conformity to this CIS 21, appear to be adequate and suitable.
- xv. **Initial test**
Test to check before the production begins on how the new concrete shall be composed in order to meet all the specified requirements in the fresh and hardened states.
- xvi. **Conformity test**
Test performed by the producer to assess conformity of the concrete.
- xvii. **Spot test**
Test conducted by the certification body in parallel to those of the producer's.
- xviii. **Identity test**
Test to determine whether selected batches or loads come from a conforming population.
- xix. **Product certification**
Product certification is an attestation by an independent certification body that the producer has passed the initial assessment and has complied with specified requirements.
- xx. **Certification body**
Agency that is accredited as a product certification body by Standards Malaysia or certification bodies that are compliant with ISO/IEC 17065.

1.4.2 Abbreviations

The abbreviations used in this publication are as follows:

- i. **CIDB**
Construction Industry Development Board Malaysia
- ii. **CIS 21**
Construction Industry Standard 21
- iii. **MS**
Malaysian Standard
- iv. **SAMM**
Skim Akreditasi Makmal Malaysia (Malaysian Laboratory Accreditation Scheme)
- v. **RMC**
Ready-mixed Concrete
- vi. **CB**
Certification Body

- vii. **ISO**
International Organization for Standardization

- viii. **PPS**
PPS (Perakuan Pematuhan Standard) or Certificate of Standard Compliance issued by CIDB for product that comply with standard(s) specified by CIDB for regulatory purposes under Schedule IV of CIDB Act 520 (Amendment 2011)

SECTION 2: GENERAL REQUIREMENTS

The following requirements shall comply and conform with CIS 21.

2.1 Legal

The producer shall be a legally incorporated company operating in Malaysia, and the company shall be the owner of the ready-mixed concrete plant and shall be fully responsible for the quality of the concrete produced and supplied to the casting site.

2.2 Technical Personnel

The producer shall engage a quality control manager and competent batching plant operator as follows:

- i. A Quality Control Manager (however named) with recognized:
 - a) Degree in Engineering or Science; or
 - b) Diploma in Engineering or Science with at least 3 years experience in the concrete industry; or
 - c) Certificate in Engineering or Science with at least 5 years experience in the concrete industry; or
 - d) Other appropriate and suitable certificate, as assessed and determined by a certification body.

- ii. A competent batching plant operator with:
 - a) A minimum secondary education of Sijil Pelajaran Malaysia (SPM) with at least 2 years experience in concrete industry and at least 1 year experience in operating a batching plant; or
 - b) Other appropriate and suitable certificate as assessed and determined by the certification body or certificate issued by other training providers recognised by CIDB.

2.3 Batching Plant, Silos, Stockpiles, Mixer, Testing

2.3.1 Batching plant

The ready-mixed concrete shall be produced at the producer's batching facility and the batching process shall be controlled using a computerised system. Computerised batching records shall also be generated for each batch of concrete produced.

A documented batching instruction giving details of the types and quantity of constituents shall be available at the place of batching of the concrete. For 1m³ or more of concrete, the tolerance of batching constituent shall not exceed the values given in Table 1:

Table 1. Tolerance for the batching process of constituent⁶

Constituent	Tolerance ⁷
Cement Water Total aggregates Additions and fibres used at > 5 % by mass of cement	±3 % of required quantity
Admixture, and fibres used at < 5 % by mass of cement	±5 % of required quantity

NOTE:

6 This table is adopted from Table 27 Clause 9.7 of MS EN 206:2016.

7 The tolerance is the difference between the target value and the measured value.

The batching equipment shall be such that under practical condition of operation, the tolerance, as highlighted in Table 1, is obtained and maintained, and shall conform to requirements in Table 2.

Table 2. Requirement for batching equipment⁸

Where batching by mass		
Load in % of the full scale	Minimum load ⁹ to 20% Full scale	20% Full scale to maximum load ⁹
Maximum permissible error in % of the load	±2 %	± 1 %
Where batching by volume		
Measured volume	< 30l	≥ 30l
Maximum permissible error in % of the volume	±3%	±2 %

NOTE:

8 This table is adopted from Table 26 Clause 9.6.2.2 of MS EN 206:2016.

9 Minimum load and maximum load are provided by the manufacturer of the equipment.

2.3.2 Silos and stockpiles

Silos shall be constructed from such materials and in such manner that are known to produce a weatherproof container, permitting free flow and efficient discharge of their contents. Each silo shall be fitted with an independent or shared filter, cleaned at regular intervals, as defined in the producer's production control manual, or any other method of dust control, which is sufficient to allow the delivery as to maintain the correct pressure.

Adequate stockpile facilities shall be provided to ensure that aggregates are stored on clean surface in separate stockpiles or bunkers.

Silos and storage compartment shall be clearly marked in order to avoid errors in use of constituent materials.

Facilities shall be provided to enable representative samples to be taken, e.g. from stockpiles, silos and bins.

The producer shall take precautions to ensure that bagged cement does not become damp either from the weather or from the ground. The store shall be managed so that the cement is used in the same order as it is delivered. Cement that has been adversely affected by damp or other causes shall not be used.

2.3.3 Concrete mixer

The concrete mixer¹⁰ shall be capable of achieving a uniform distribution of the constituent materials, and a uniform consistence of the concrete within the mixing time and the mixing capacity.

NOTE:

10 For dry mix batching, the speed of truck mixer should not be less than fifteen (15) revolution per minute (RPM) and each truckload of concrete should be mixed for seventy (70) revolutions after the addition of water.

2.3.4 Testing

Trained and competent personnel shall conduct all conformity testing, and the equipment used shall be properly calibrated and maintained. The testing shall be conducted in accordance with requirements of relevant test methods.

2.4 Constituent Material and Concrete

2.4.1 Constituent materials

The constituent materials shall comply with the applicable requirements in MS EN 206 and MS 523-3. Where applicable and where an appropriate Malaysian Standards is available, the constituent materials and testing methods shall comply and be tested in accordance with the Malaysian Standard.

2.4.2 Concrete

i. Concrete code and compositions

The producer shall give a coding for each composition of concrete, which is produced at its ready-mixed concrete plant(s). The coding shall be at the sole discretion of the producer and shall be able to identify the individual concrete composition without confusion. For designated and standard prescribed concrete, it shall follow the designation and composition as specified in MS 523-3.

ii. Chloride content

When determining conformity of chloride content in accordance with MS EN 206:2016 Clause 9.9, the method for determining the chloride content of constituent materials shall be in accordance with Table 5 in MS 523-3:2017.

iii. Resistance to alkali-silica reactions

The risk of damaging alkali-silica reaction (if and where applicable) shall be minimised in accordance with the guidance set out in Annex C of MS 523-3:2017 except;

- a) For prescribed concrete
- b) Where the specifier has specified provisions for resisting alkali-silica reaction

For cases that are exceptions, the specifier is responsible for ensuring that the concrete is not subjected to damaging alkali-silica reaction, but they may have, by specification, placed this requirement on the producer (MS 523-2:2017, B8.1)

SECTION 3: PRODUCTION

3.1 Production Process

The production process shall include the receiving of materials, material storage, weight batching of concrete mix composition, mixing of concrete, sampling and testing, transportation and delivery of fresh concrete to the casting site. A typical of process flow is as in Appendix B.

3.2 Production Control

3.2.1 Production control system manual

The producer shall have an authorised production control system manual (however named), which addresses the applicable requirements and procedures of Clause 9 of MS EN 206: 2016 and Clause 13 of MS 523-3:2017 and where the production control differs from these requirements, they shall be documented.

The responsibility, authority and the interaction of all personnel who manage, perform and verify work affecting the quality of the concrete shall be defined in the production control manual.

The production control system shall be reviewed, at least every two years, by the management of the producer to ensure the suitability and effectiveness of the system.

All relevant data from the production control be recorded and shall be retained for at least three years unless legal obligation requires a longer period.

The production control system shall be supported and complied with quality management requirements in Section 9.

3.2.2 Production control procedures

The producer shall establish and maintain procedures for production control. These shall include:

- i. Procedure to ensure correct delivery, storage, use of constituent materials and control of materials.
- ii. A documented batching procedure/instruction (see Clause 9.7 and Table 27 under MS EN 206:2016).
- iii. Procedure for equipment inspection and testing to ensure they are calibrated and in good working condition and they conform to the specified requirements.
- iv. Procedure for a planned maintenance of batching plant, equipment and transport facilities so that the properties and quality of concrete are not adversely affected (see Table 28, MS EN 206:2016).
- v. Procedure to control the quality of concrete (see Table 29, MS EN 206:2016).
- vi. Procedure for conducting initial test (see Annex A on MS EN 206:2016),
- vii. Procedure for conducting concrete conformity assessment (see Clause 8 of MS EN 206:2016).
- viii. Procedure for production, transport to the point of delivery and delivery.
- ix. Procedure on outsourcing of truck mixers, agitators or trucks, where applicable. In this case the producer shall take full responsibility for the quality and delivery of the concrete and the training of the drivers.

3.3 Exchange of Information

The producer shall have a format (however named) to record the information and request from the user for correct delivery of the fresh concrete, as applicable, in accordance with Clause 5 in MS 523-2:2017

SECTION 4: INITIAL AND IDENTITY TESTING

4.1 Initial Testing

In the case of using a new concrete composition, initial testing shall be performed to provide concrete that achieve the specified properties or intended performance with an adequate margin in accordance with Annex A of MS EN 206:2016.

The initial test shall establish a concrete composition that satisfies all specified requirements for fresh and hardened concrete. Where demonstrable, an adequate concrete composition, based on data from previous tests or long-term experience, this may be considered as an alternative to initial tests (ref: MS EN 206:2016, Clause A.1 (2)).

The results shall be recorded in a format established by the producer. The format (however designed) shall contain at least the following:

- i. Title of form: "Initial Test Report"
- ii. Project title
- iii. Concrete code (Producer's code)
- iv. Data of raw materials
- v. Results of test
- vi. Name of approving person
- vi. Others information as deemed necessary by the producer

4.2 Identity Testing

Where applicable;

- i. The specifier is responsible for organising any identity testing.
- ii. Identity testing for compressive strength shall be conducted according to Annex B, MS EN 206:2016.
- iii. Samples shall be taken from different batches or loads in accordance with MS EN 12350-1 and specimens prepared and cured in accordance with MS EN 12390-2.
- iv. The compressive strength of the specimens shall be determined in accordance with MS EN 12390-3. The test result shall be obtained from the average of two or more specimens made from one sample for testing at the same age. Where the range of the test value is more than 15% of the mean, the results shall be disregarded unless an investigation reveals an acceptable reason to justify disregarding an individual test value.
- v. Identity of concrete is assessed for each individual strength result and the average of n non-overlapping discrete results.
- vi. Concrete is deemed to come from a conforming population if both criteria in Table 3 (adopted from Table B.1, MS EN 206:2016) are satisfied for n results derived from strength tests on samples taken from the defined volume of concrete.

Table 3. Identity criteria for compressive strength

Number n of test results for compressive strength from the defined volume of concrete	Criterion 1	Criterion 2
	Mean of n results (f_{cm}) N/mm ²	Any individual test results (f_{ci}) N/mm ²
1	Not applicable	$\geq (f_{ck} - 4)$
2 to 4	$\geq (f_{ck} + 1)$	$\geq (f_{ck} - 4)$
5 - 6	$\geq (f_{ck} + 2)$	$\geq (f_{ck} - 4)$
f_{ck} , is the characteristic strength		

For the identity tests other than concrete compressive shall be conducted according to Annex C, MS 523-2:2017.

SECTION 5: CONFORMITY CONTROL AND CONFORMITY CRITERIA

The producer is responsible for the evaluation of conformity for specified requirements of the concrete. The conformity control and conformity criteria shall comply with Clause 8, MS EN 206:2016 and MS 523-3:2017.

The producer shall decide whether to use individual¹¹ concrete or concrete family¹² concept, in the conformity control and conformity, solely at its own choice taking into consideration of their capacity and capability.

NOTE:

- 11 This CIS is focused on individual concrete.
- 12 For guidance and information on concrete family concept, the producer or user of this CIS should refer CEN Report CR 13901¹³ and CEN/TR 16369¹⁴.
- 13 CEN Report CR 13901, the use of the concept of concrete families for the production and conformity control of concrete.
- 14 CEN/TR 16369, use of control charts in the production of concrete.

5.1 Conformity Control and Conformity Criteria for Compressive Strength

5.1.1 Sampling and testing

The sampling and testing plan shall be in accordance with Clause 8.2.1.2 of MS EN 206:2016.

Samples of concrete shall be carried out randomly and taken in accordance with MS 26-1-1:2009. The minimum rate of sampling and testing shall be in accordance with Table 4 (adopted from Table 17 of MS EN 206:2016), at the rate that gives the highest number of sample for initial or continuous production, as appropriate.

Conformity testing shall be based on samples taken at or before delivery. The place of sampling shall be chosen such that the relevant concrete properties and concrete composition do not change significantly between the place of sampling and the place of delivery. In dry batching, the samples shall be traceable to the truck mixer.

The samples shall be taken after any water or admixture are added to the concrete under the responsibility of the producer.

Table 4. Minimum rate of sampling for assessing conformity

Production	Minimum rate of sampling		
	First 50 m ³ of production	Subsequent to first 50 m ³ of production ¹⁵ , the highest rate given by :	
		Concrete with production control certification	Concrete without production control certification
Initial (until at least 35 test results are obtained)	3 samples	1 per 200m ³ or 1 per 3 production days ^d	1 per 150m ³ or 1 per production day ^d
Continuous ¹⁶ (when at least 35 test results are available)		1 per 400m ³ or 1 per 5 production days ^{17, 18} Or 1 per calendar month	

NOTE:

- 15 Sampling shall be distributed throughout the production and should not be more than 1 sample within each 25m³
- 16 Where the standard deviation of the last 15 or more test results exceeds the upper limit for S_n according to Table 5, the sampling rate shall be increased to that required for initial production for the next 35 test results.
- 17 Or if there are more than 5 production days within 7 consecutive calendar days, once per calendar week.
- 18 The definition of a 'production day, shall comply with Clause 3.1.8 of MS 523-3:2017.

The test results shall be obtained from an individual specimen or the average of the results when two or more specimens made from one sample are tested at the same age. Where two or more specimens are made from one sample and the range of the test values is more than 15% of the mean, then the results shall be disregarded unless an investigation reveals an acceptable reason to justify.

The minimum compressive strengths for applicable compressive strength class are as in Table 12 and Table 13 of MS EN 206:2016 and additional classes are found in Table 12 of MS 523-3:2017.

The characteristic compressive strength shall be tested at 28 days shall be of 150mm cubes_(fck,cube) or 150mm diameter by 300mm cylinders_(fck,cyl).

If conformity to the specified compressive strength class is determined using 100mm cubes, the minimum characteristic 100mm cube strength shall be that given for 150mm cubes in MS EN 206:2016, Table 12 and 13 (see Clause 12.2 MS 523-3-2017).

The specimens and moulds shall comply with MS EN 12390-1; specimens made and cured in accordance with MS EN 12390-2 and tested in accordance with MS EN 12390-3.

5.1.2 Criteria for individual results (refer to Clause 8.2.1.3.1 of MS EN 206:2016)

Conformity of concrete compressive strength is assessed on specimens tested at 28 days. Each individual test results, f_{ci} , shall satisfy:

$$f_{ci} \geq (f_{ck} - 4) \text{ N/mm}^2 \dots\dots\dots \text{Equation 1}$$

5.1.3 Criteria for mean results (refer to Clause 8.2.1.3.2 of MS EN 206:2016)

The achievement of the specified characteristic strength shall be assessed by one of the following methods.

Method A: Initial Production

For initial production, the mean strength of non-overlapping or overlapping groups of three consecutive results shall satisfy:

$$f_{cm} \geq (f_{ck} + 4) \text{ N/mm}^2 \dots\dots\dots \text{Equation 2}$$

Method B: Continuous Production

- Method B is an option when continuous production is established.
- Conformity assessment shall be made on test results taken during an assessment period that shall not exceed the period given by one of the following options depending on the rate of testing:
 - Option (i) - for plants with lower testing rates (number of test results for designed concrete less than 35 per three months), the assessment period shall comprise at least 15 results and not more than 35 consecutive results taken over a period not exceeding six months;
 - Option (ii) - for plants with higher testing rates (number of test results for designed concrete 35 or more per three months) the assessment period shall comprise at least 15 consecutive results and not exceeding three months.

The mean strength of non-overlapping or overlapping groups of consecutive test results obtained shall satisfy:

$$f_{cm} \geq (f_{ck} + 1.48 \sigma) \text{ N/mm}^2 \dots\dots\dots \text{Equation 3}$$

*The standard deviation (σ) in Equation 3 above shall be computed and checked against the requirement of clause 8.2.1.3.2 (8) of MS EN 206:2016.

To comply with * above, at the end of initial production, the standard deviation (σ) of the population shall be estimated from at least 35 consecutive test results taken over a period exceeding three months. When continuous production commences, this value of standard deviation shall be used to check the conformity over the first assessment period. At the end of the first and subsequent assessment periods, the standard deviation is checked to determine whether it has changed significantly using the limits given in Table 5 (Table is adopted from Table 19 of MS EN 206:2016). If it has not changed significantly, the current estimate of the standard deviation applies to the following assessment period. When there is a significant change in standard deviation, a new standard deviation is calculated from the most recent 35 consecutive results and applied to the following assessment period.

Table 5. Values for verification of standard deviation

Number of Test Results	Limits for S_n
15 to 19	$0.63 \sigma \leq S_n \leq 1.37 \sigma$
20 to 24	$0.68 \sigma \leq S_n \leq 1.31 \sigma$
25 to 29	$0.72 \sigma \leq S_n \leq 1.28 \sigma$
30 to 34	$0.74 \sigma \leq S_n \leq 1.26 \sigma$
35	$0.76 \sigma \leq S_n \leq 1.24 \sigma$

If the production of an individual concrete composition has been suspended more than 12 months, the producer shall adopt the criteria, sampling and testing plan and the criteria for initial production (see MS EN 206:2016, clause 8.2.1.1 (7)).

During continuous production, the producer may adopt the sampling and testing plan and the criteria for initial production (see MS EN 206:2016, clause 8.2.1.1 (8)).

Method C: Use of control charts

For this method, where applicable, please refer to MS EN 206:2016, Clause 8.2.1.3.2 (9) and (10).

5.1.4 Computation of compressive strength assessment

The compressive strength assessment shall be recorded properly and the assessment shall be carried out in continuity by the producer.

Examples of format of such computational records are in Appendix C (Initial production) and Appendix D (Continuous production).

5.2 Conformity Criteria for Properties Other Than Strength

For properties other than strength, the conformity control and conformity criteria shall be assessed against the requirement of Clause 8.2.3, MS EN 206:2016.

5.3 Action in the Case of Non-Conformity of the Product

Where the product has failed to comply with any conformity requirements, the producer shall investigate the consequent of non-conformity with respect to Clause 8.4, MS EN 206:2016 and take immediate action without delay.

SECTION 6: TRANSPORTATION AND DELIVERY OF CONCRETE

The transportation, delivery of concrete, truck operator and delivery ticket shall comply with the followings:

- i. The ready-mixed concrete shall be transported to the casting site in accordance with Clause 14.1, MS EN 206:2016
- ii. The truck operator shall be trained on handling the transport vehicle, discharging the concrete, cleaning of concrete spill and cleaning the vehicle.
- iii. The truck shall comply with the relevant law for its operation and shall be properly cleaned and maintained. The producer shall establish and maintain a list of trucks used in the transportation of the concrete.
- iv. At delivery, the producer shall provide the user with a delivery ticket (however named) for each load of concrete on which is printed, stamped or written with information, as in Clause 7.3 (1), MS EN 206:2016 and additional information, as applicable, as in 7.3 (2) and 7.3 (3) of MS EN 206:2016.
- v. The delivery ticket shall contain the plant identification as indicated in 8.1 and the PPS number in 8.2.
- vi. The producer shall ensure that each truckload of ready-mixed concrete does not exceed the designed capacity of the drum to avoid concrete spill onto public roads during transportation and/or where appropriate, to introduce additional measures to prevent such spill.
- vii. The ready-mixed concrete shall be delivered to the casting site within 2 hours after the time of loading where transported in truck mixers, or, within 1 hour after the time of loading where non-agitating equipment is used, unless a shorter time is specified or a longer time permitted by the specifier.
- viii. The identity of the truck mixer, agitator or the truck shall be traceable to the delivery ticket (see 6 (iv)). If a producer outsources the transportation to another party, the truck mixer, agitator or the truck shall be properly identified and labeled, and the producer shall take full responsibility of the concrete and the concrete quality.

SECTION 7: CERTIFICATION

The certification body, assessment, surveillance, certification, spot tests, accredited testing, certified and non-certified concrete shall comply with the followings:

- i. The producer shall make arrangement with independent third-party certification body (CB), recognised by CIDB for product certification to CIS 21.

The CB shall be either accredited under ISO IEC 17065 by the Department of Standard Malaysia for the ready-mixed concrete under the scope CIS 21 and MS EN 206, or the CB has obtained written approval from CIDB.

- ii. The certification body shall follow the provisions for assessment, surveillance and certification as stated in Annex C, MS EN 206:2016 and where additional procedures are incorporated in certification scheme, they shall be documented.
- iii. The initial assessment of production control shall at least check the provisions in Clause C.2.1 of MS EN 206:2016.

Routine surveillance on the certified ready mixed plant shall be performed at least twice a year, except where there is demonstrable justification for decreasing that frequency (see MS EN 206:2016, Clause C.2.2 (9)).

- iv. To provide confidence in the results of the production control, the certification body shall perform spots¹⁹ test in parallel to those of the producers.

NOTE:

19 Collection of sample for spot tests should be based on random sampling. The maximum amount of sample shall not exceed 30% of the delivery.

- v. All testing by the producer and the certification body for certification to CIS 21 shall be conducted at SAMM accredited laboratory.

Testing by the producers at its own laboratory is allowed, provided the lab is SAMM accredited for the testing scope. Handling of samples and issuing of test results shall comply strictly to the SAMM procedures and requirement of ISO IEC 17025.

- vi. Certificate issued by the certification body shall contain at least the following information:

- a. Name and address of the producer
- b. Name and address of the ready-mixed concrete plant
- c. Identification of the Ready-Mixed Concrete Plant (see 8.1)
- d. Statement of compliance to MS EN 206, and this CIS
- e. Producer's Concrete Code
- f. Strength class, Max w/c ratio
- g. Minimum Cement content
- h. Consistence class
- i. Maximum aggregate size
- j. Source of aggregate
- k. Type of cement used and source of suppliers
- l. Source of water for concreting

Other relevant information may be included, subject to agreement between the producer and the certification body.

- vii. A concrete not specified in the certificate (see 7 (vi)) may be produced by the certificate holder and supply the concrete to a user, subject to a mutual agreement between the producer and the user, provided the specification addresses and comply with the applicable requirements of MS EN 206, MS 523-2 and MS 523 -3.

SECTION 8: IDENTIFICATION OF READY-MIXED CONCRETE PLANT AND SIGNAGE

8.1 Identification

The ready-mixed concrete plant shall be identified as follows:

@ - S-X-#

@ - name of company/abbreviation;

S - number corresponding to state as per list:

- 01 - Johor
- 02 - Kedah
- 03 - Kelantan
- 04 - Melaka
- 05 - Negeri Sembilan
- 06 - Pahang
- 07 - Pulau Pinang
- 08 - Perak
- 09 - Perlis
- 010 - Selangor
- 011 - Terengganu
- 012 - Sabah
- 013 - Sarawak
- 014 - Wilayah Persekutuan (Kuala Lumpur)
- 015 - Wilayah Persekutuan (Labuan)
- 016 - Wilayah Persekutuan (Putrajaya)

X - W (for wet batching) or D (for dry batching)

- plant serial number

Example: Company A has two (2) plants; one wet batching and one dry plant in the site in Johor. So the plant identities are:

Plant 1: A-01-W-1

Plant 2: A-01-D-2

8.2 Signage

The ready-mixed concrete plant shall have proper signage placed at the site. It shall contain at least the following information:

- Nama and address of plant
- Plant identity
- CIDB PPS number²⁰
- Name and certificate number of the certification body

NOTE:

²⁰ To obtain PPS, please refer to CIDB QPASS program (please refer CIDB website: www.cidb.gov.my).

SECTION 9: QUALITY MANAGEMENT REQUIREMENTS

The producer shall establish and maintain a quality management system that is capable of consistently meeting the requirements of CIS 21, in accordance with either Option A or Option B.

9.1 Option A²¹

The producer has fulfilled the requirement of CIS 21, if it has established and maintained a management system that is in accordance with the requirement of ISO 9001, and that is capable of supporting and demonstrating the consistent fulfillment of the ISO 9001 standards, and also fulfilled the requirement of Clause 12.2.

NOTE:

21 Option A does not require the producer management system to be certified to ISO 9001. However, if it is certified by a recognised Certification Body, the producer is deemed to have fulfilled the requirement of Option A provided it includes requirements of 9.2.

9.2 Option B

The quality management system shall comply with the quality system requirements, addressing the followings:

- General quality system documentation (see 9.2.1)
- Management and resources (see 9.2.2)
- Production control procedures (see 3.2.2)
- Calibration (see 9.2.3)
- Control of documents (see 9.2.4)
- Control of records (see 9.2.5)
- Internal audit (see 9.2.6)
- Management review (see 9.2.7)
- Corrective action (see 9.2.8)
- Preventive action (see 9.2.9)
- Complaints (see 9.2.10)

9.2.1 General quality system documentation

The producer shall have a quality manual in establishing, implementing and maintaining a management system related to ready-mixed concrete production, production control and conformity assessment including transportation and delivery.

The manual shall document the producer's quality policy and objectives, organisational structure and top management, policies and procedures and shall include, at least, the following:

- i. Description of producer's company organisation
- ii. Description of responsibilities of key personnel involved in production and production control
- iii. Ready-mixed concrete plant profiles

The plant profile shall contain the information, as highlighted in Appendix E.

The system's documentation shall be communicated to, understood by, available to, and implemented by the appropriate personnel.

9.2.2 Management and resources (Option B)

Top management shall provide evidence of its commitment to the development and implementation of the quality management system and continually improving its effectiveness by:

- i. Establishing and defining appropriate quality policy
- ii. Establishing quality objective
- iii. Communicating to the organisation the importance of meeting customer as well as statutory and regulatory requirements
- iv. Ensuring the availability of resources
- v. Conducting management reviews

The quality policy shall be appropriate and is communicated and understood within the organisation and is reviewed for continuing suitability to the purpose of the producer and shall include:

- i. Commitment to comply with requirements and continually improve the effectiveness of the quality management system
- ii. Framework for establishing and reviewing quality objectives

The responsibilities and authorities of key personnel are defined, documented and communicated within the organisation and interrelation between all personnel who manage, perform and verify work that affects quality shall be established and shall ensure the independence and authority to perform these tasks.

The producer shall determine the necessary competence for the key personnel; provide training, evaluate and maintain record.

9.2.3 Calibration (Option B)

The producer shall maintain a list of measuring equipment. All equipment used to monitor critical processes, testing and inspection shall be calibrated or verified at specific intervals, or prior to use, against measurement standards traceable to the International System of Units (SI units), where applicable, and the equipment shall be properly maintained.

9.2.4 Document control (Option B)

The producer shall establish and maintain procedures to control the documents (internal and external) that relates to production and production control, conformity, transportation and delivery of ready-mixed concrete that are required in MS EN 206 and CIS 21.

The procedures shall ensure that documents are:

- i. Authorised editions and are available at all locations
- ii. Periodically reviewed and, where necessary, revised to ensure continuing suitability and compliance with applicable requirements
- iii. Legible and readily identifiable
- iv. Prepared, approved and signed by authorised person and any change in the person shall be authorized
- v. Invalid or obsolete documents are promptly removed from all points of issue or use
- vi. Obsolete documents to be retained shall be suitably marked

9.2.5 Control of records (Option B)

The producer shall establish and maintain procedures to control record, which shall ensure that:

- i. Controls needed for the identification, storage, protection, retrieval, retention time and disposition of records are defined and the records are legible, readily identifiable and retrievable
- ii. All relevant data from the production shall be recorded (see Table 25, MS EN 206:2016) and records are retained for at least 3 years unless legal obligations require a longer period

9.2.6 Internal audit (Option B)

The producer shall establish procedures for internal audit, define the responsibilities and requirement for planning, conduct, reporting and maintaining the audit records.

Internal audit shall be conducted at least once a year to verify that it fulfills the requirements of MS EN 206, MS 523-2, MS 523-3 and this CIS and the quality management system is effectively implemented and maintained.

The internal audit shall address all elements in quality management system, including the production control and shall be carried by trained and qualified personnel who are, wherever resources permit, independent of the activity to be audited.

The area of activity audited, the audit findings and corrective actions that arise from them shall be recorded.

Follow-up audit activities shall verify and record the implementation and effectiveness of the corrective action taken.

9.2.7 Management review

The producer's top management shall establish a procedure to review its quality management system, including the production control at planned intervals, in order to ensure its continuing suitability, adequacy and effectiveness and to introduce necessary changes and improvements.

The review shall take account of:

- i. Results of internal and external audits
- ii. Customer feedback
- iii. Complaints
- iv. Status of corrective and preventive action
- v. Recommendation for improvement

9.2.8 Corrective action (Option B)

The producer shall establish a policy and procedure and designate appropriate personnel for implementing corrective action whenever nonconformity is identified.

The producer shall establish a procedure for corrective action and the procedure shall define requirements for the following:

- i. Review of the nonconformity²²
- ii. Determine the root cause(s) of the problem
- iii. Evaluate the need to eliminate the problem and to prevent recurrence
- iv. Determine, select and implement the most suitable action(s)
- v. Record all actions taken
- vi. Review the results to ensure that the corrective actions taken have been effective

NOTE:

22 Auditing of the activity may be needed if the nonconformity identified cast doubts.

9.2.9 Preventive²³ action (Option B)

Preventive action shall be a proactive process to identify opportunities for improvement and to eliminate potential nonconformities from occurring.

The producer shall establish a procedure for preventive action and the procedure shall define requirements for the following:

- i. Identify potential nonconformities and their likely causes
- ii. Evaluate the need for action to prevent the occurrence of nonconformities
- iii. Determine and implementing the action needed
- iv. Record the results of actions taken
- v. Review the effectiveness of the preventive actions taken

NOTE:

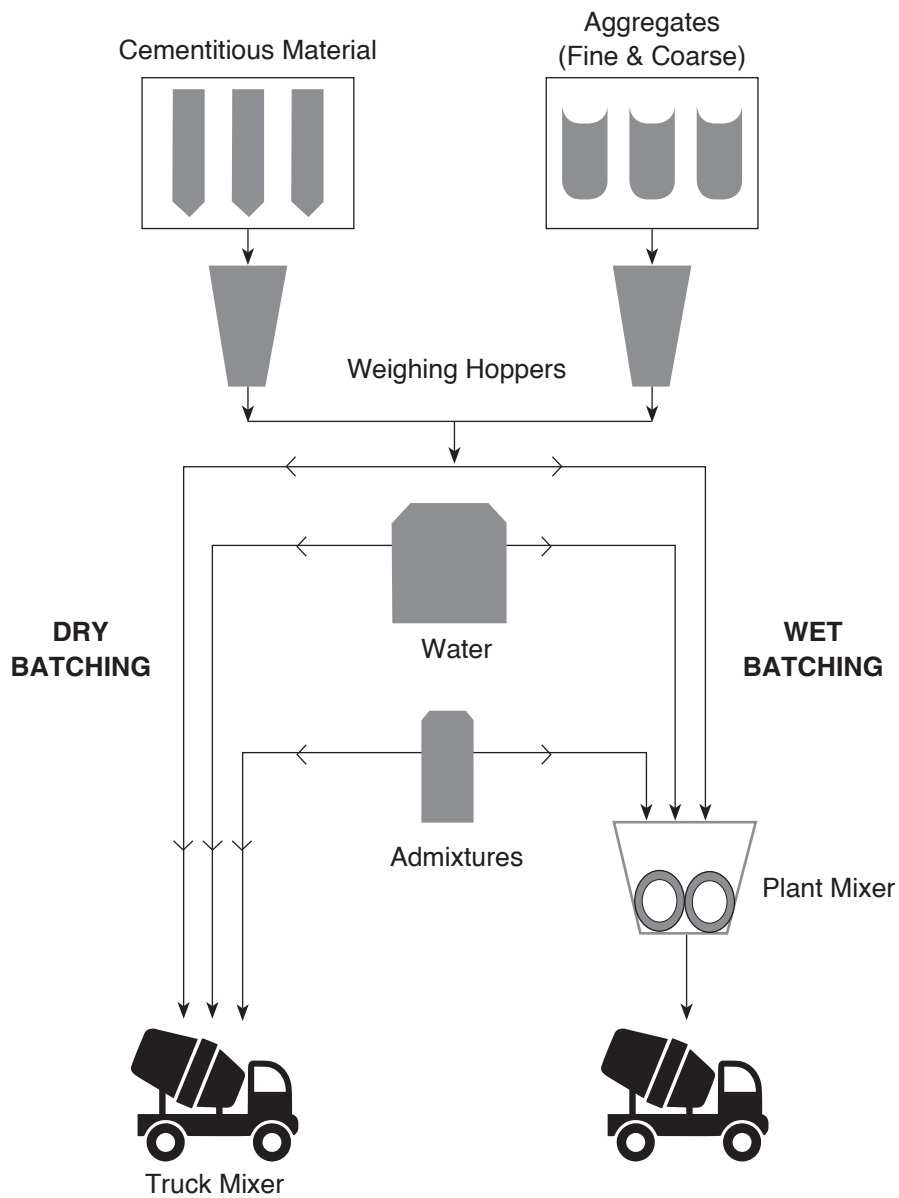
²³ The procedure for corrective and preventive actions do not necessarily have to be separate

9.2.10 Complaints

The producer shall have a documented procedure for receiving, evaluating, investigating, making decision, action taken and recording on complaints regarding ready-mixed concrete, batching plant and trucks.

APPENDIX A
(Informative)

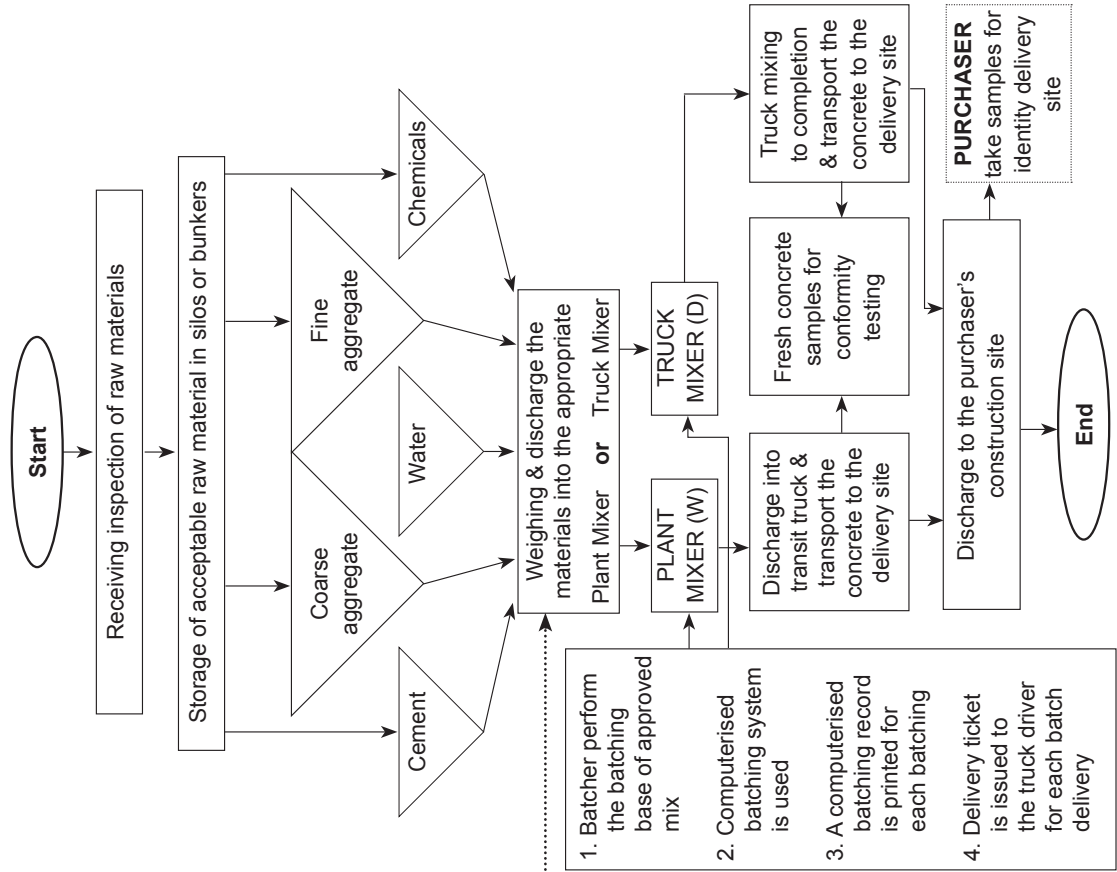
Figure 1 : A typical schematic diagram of wet and dry batching plant



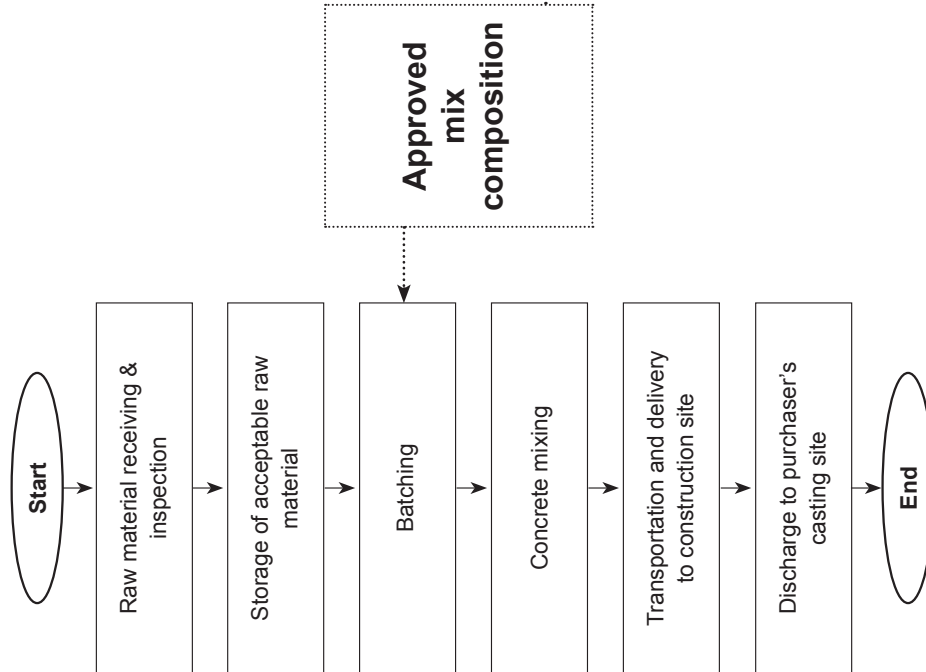
APPENDIX B
(Informative)

Typical flowchart of a ready-mixed concrete manufacturing and delivery process

General Schematic Flowchart of RMC Manufacturing and Delivery Process



Simplified Flowchart for Manufacturing and Delivery Process



APPENDIX C
(Informative)

Example of conformity assessment format for initial production stage

Form PCSM-0#-xxxx (Initial)

CONFORMITY ASSESSMENT OF CONCRETE COMPRESSIVE STRENGTH

Assessment Date:				RMC Plant Location			RMC Plant Identity		
Assessment Period:		FROM		Production Stage			Initial		
				Type of Concrete Mix/Code					
		UNTIL		Concrete Strength Class					
				Characteristic Strength (fck)					

No	Test Report Reference No.	Date	28 Days Compressive Strength				Range of Cube Results	% of Range Over Average Results	Acceptance of Test Results (range of test values <15% of the means)	Test Results fci N/mm ²	f _{cm} Mean of 3 Consecutive Test Results	fci ≥ fck - 4 ..Equation 1	fci ≥ fck + 4 ..Equation 2
			N/mm ²										
			1st	2nd	3rd	Ave.							
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Prepared by:

Checked by:

Approved by:

APPENDIX D
(Informative)

Example of conformity assessment format for continuous production stage

Form PCSM-0#-xxxx (continuous)

CONFORMITY ASSESSMENT OF CONCRETE COMPRESSIVE STRENGTH

Assessment Date:				RMC Plant Location		RMC Plant Identity	
Assessment Period:		FROM		Production Stage		Initial	
				Type of Concrete Mix/Code			
		UNTIL		Concrete Strength Class			
				Characteristic Strength (fck)			

No	Test Report Reference No.	Date	28 Days Compressive Strength				Range of Cube Results	% of Range Over Average Results	Acceptance of Test Results (range of test values <15% of the means)	Test Results fci N/mm ²	fci ≥ fck - 4 ..Equation 1	fcm ≥ fck + 1.48σ ..Equation 3
			N/mm ²									
			1st	2nd	3rd	Ave.						
1												
2												
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Mean fcm											
Std deviation, σ (from initial/new value)											

Prepared by:

Checked by:

Approved by:

APPENDIX E
(Informative)

Plant Profile

RMC Plant – Name & Address		
#	Particulars	Information
1	Address of Plant	
2	Type of Plant	
3	Plant Identity	
4	Plant Mixer Capacity	
5	Production Capacity	
6	Cement Storage Capacity	
7	Aggregate Storage Capacity	
8	No of Trucks	
9	Distribution Area	
10	Year of Manufacturing of RMC Plant	
11	Certified Concrete Code	

ACKNOWLEDGEMENT

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