

Quality Control and Supervision of Precast Concrete Construction

Introduction

The use of precast concrete is common in private building developments in Hong Kong. To ensure that the precast concrete elements are of good quality, proper supervision and adequate quality control (QC) should be provided during the production, erection and inspection of the precast concrete elements. This practice note sets out the requirements on quality assurance (QA), qualified supervision and quality audit for key precast concrete elements produced in the precasting factory. The requirements stipulated in this practice note do not apply to minor elements such as non-structural precast concrete blocks, architectural features and planters.

Duties of the Authorized Person (AP), Registered Structural Engineer (RSE) and Registered Contractor (RC)

2. AP, RSE and RC have the responsibilities under the Buildings Ordinance (BO) to ensure that the precast concrete works comply with the provisions and standards of the BO and the approved plans. In accordance with section 4(3)(a) of the BO and regulation 37 of the Building (Administration) Regulations (B(A)R), *periodic* supervision should be provided by the AP and RSE for the carrying out of the precast concrete works, whereas the RC should provide *continuous* supervision as required under section 9(5)(a) and 9(6)(a) of the BO and regulation 41 of the B(A)R for the carrying out of such works.

3. Reference should be made to the recommendations and guidelines given in the Code of Practice for Precast Concrete Construction 2016 (Precast Concrete Code) on the design, construction and QC of precast concrete works.

Quality Assurance

4. The following conditions/requirements will be imposed when giving approval of plans:

- (a) Under item 6 of section 17(1) of the BO, precast concrete elements should be manufactured by a factory with ISO 9001 QA certification; and
- (b) Under regulation 10 of the B(A)R, a copy of the Quality Assurance Scheme (QAS) of the manufacturer should be submitted at least 14 days before the commencement of the production works in the precasting factory. The RSE should provide a written confirmation that the submitted QAS has adequate provisions in ensuring the quality of the precast concrete elements in compliance with the provisions of the BO and the approved plans.

5. The QAS should cover the following items:
- (a) QC tests of materials;
 - (b) Calibration of laboratory equipment for QC tests;
 - (c) Efficiency and proper operation of equipment at the casting yard;
 - (d) Production process;
 - (e) Testing procedures and requirements;
 - (f) Frequency and extent of inspection by in-house staff and independent parties¹; and
 - (g) Frequency and extent of audit check by in-house staff and independent parties.

Qualified Supervision

6. The following conditions/requirements will be imposed when giving approval of plans:

- (a) Under item 6 in section 17(1) of the BO, qualified supervision should be provided by the RSE and RC for the fabrication, erection and examination of precast concrete elements;
- (b) Under regulation 10 of the B(A)R, a Precast Concrete Supervision Plan² should be submitted at least 14 days before the commencement of the production works in the precasting factory. The required qualified supervision should cover paragraphs 6(c) to (e) below;
- (c) The RSE should assign a quality control supervisor (QCS) to supervise the precast concrete production works in the precasting factory in accordance with the requirements for in-situ reinforced concrete works stipulated in the PNAP APP-158. The RSE should determine the necessary frequency of the QCS's supervision, which should be no less than once a week. The minimum qualifications and experience of the QCS should be the same as grade T3 technically competent person (TCP) under the RSE's stream, as stipulated in the Code of Practice for Site Supervision 2009 (2021 Edition) (Supervision Code);

/(d). ...

¹ "Independent parties" refer to parties not under the direct employment of the precasting factory (i.e. either a certification body under the Hong Kong Certification Body Accreditation Scheme of the Hong Kong Accreditation Service (HKAS) or an inspection body under HKAS's Hong Kong Inspection Body Accreditation Scheme).

² The Precast Concrete Supervision Plan should contain the names, qualifications, identification, inspection frequency, confirmation of appointment and contact information of the quality control supervisor and quality control co-ordinator assigned by the RSE and RC under paragraphs 6(c) and 6(d) respectively.

- (d) The RC should assign a quality control co-ordinator (QCC) to provide continuous supervision of the precast concrete production works in the precasting factory. The minimum qualifications and experience of the QCC should be the same as grade T1 TCP under the RC's stream, as stipulated in the Supervision Code; and
- (e) The names and qualifications of the QCS and QCC assigned by the RSE and RC respectively should be recorded in their respective inspection log books. The details of precast concrete production, inspection, auditing and testing should be recorded in the log books by the QCS and QCC. The log books should be kept in the precasting factory, a copy of which should be kept at the building site office and, when required, produced to officers of the Buildings Department (BD) for inspection.

Quality Audit

7. The RSE and the authorized signatory (AS) of the RC should visit the precasting factory in person to inspect the first batch of the precast concrete production³ (the first visit) and subsequently carry out quality audit checks to the precasting factory at least once every month. The quality audit checks should comprise inspections at the factory in person at quarterly intervals while the monthly quality audit checks in between the first visit and quarterly quality audit checks (i.e. in the 2nd, 3rd, 5th, 6th months, and so on) may be carried out either by visiting the precasting factory in person or by videotelephony⁴. Under regulation 10 of the B(A)R, a requirement will be imposed, when giving approval of plans, that a copy of the RSE's quality audit reports of the precasting factory and a copy of the AS's quality audit reports of the precasting factory duly endorsed by the RSE and AS respectively should be submitted to BD within 14 days after completion of the quality audit checks⁵ for record purpose. The quality audit reports by the RSE and AS should respectively cover the qualified supervision by the QCS and QCC. Minimum requirements of the quality audit checks are detailed in Appendix A.

8. Quality audit checks conducted by the RSE and/or AS using videotelephony should comply with the following requirements:

- (a) The inspection by the RSE and AS should be conducted with the assistance of QCS and QCC respectively in the precasting factory;
- (b) The level of supervision by videotelephony should not be inferior to that carried out personally at the precasting factory. In addition, all supervision items covered in the videos taken should be recorded contemporaneously in the quality audit reports of the RSE and AS, and

/should ...

³ The purpose of the first visit to the factory is to verify that the QAS and QA/QC procedures are duly followed and the production line is functioning properly. The inspection of the first batch of the precast concrete production should cover items specified in clauses 3.1 to 3.14 and 4.1 of the Precast Concrete Code.

⁴ Videotelephony means two-way simultaneous communication with both audio and video in real time through telephone or computer network connection. The video should be recorded in colour with resolution of not less than 480p in a non-rewritable DVD-ROM.

⁵ Including the first visit and each subsequent quality audit check.

should be submitted to BD together with the DVD-ROM discs as required in paragraph 8(c) below; and

- (c) The RSE and AS should submit the quality audit reports with the non-rewritable DVD-ROM discs of the videos to BD within 14 days after completion of the quality audit checks by videotelephony. They should certify on each disc with a permanent marker signifying that they personally used videotelephony for compliance with the approval conditions.

Alternative Arrangement for Quality Audit Checks at Precasting Factory

9. As an alternative to the requirement for the RSE's monthly quality audit checks at the precasting factory under paragraph 7 above, the RSE may consider to carry out the first visit to the precasting factory in person, then conduct on-site quality audit checks after the precast concrete elements are delivered to the building site. In such a situation, the RSE is required to submit one-month prior written notification to the Building Authority (BA) for the adoption of this alternative arrangement. The RSE should, in addition to the submission of quality audit report within 14 days of the first visit, submit quality audit reports of the precast concrete elements delivered to the building site to BD within 14 days after completion of the on-site quality audit checks. The quality audit reports should cover the qualified supervision by the QCS. Minimum requirements of the on-site quality audit checks by the RSE are detailed in Appendix B.

Flow Chart and Standard Form of Supervision Plan

10. A flow chart showing the quality audits provided by the RSE and AS is at Appendix C. A standard form of supervision plan together with a list of typical items for quality supervision of precast concrete works and a sample of the inspection record are provided in Appendix D for reference.

Separate RSE

11. For precast concrete elements not affecting the stability of the parent structure, such as precast concrete façade or staircase, a separate RSE may be appointed to prepare the design and to supervise the production and erection of such precast concrete elements. In such situation, the specified Forms BA4 and BA5 notifying the appointment of a separate RSE and the scope of works for which he/she is responsible are required to be submitted together with the plans for approval. The project RSE should also notify the BA in writing that he/she is fully aware of the appointment of a separate RSE and the demarcation of responsibilities. Upon completion of the precast concrete construction works, the separate RSE so appointed is required to certify the satisfactory completion of the works in accordance with regulation 25(3) of the B(A)R.

12. The separate RSE's submission should be accompanied by an assessment report prepared by him/her giving an account of the effect of the proposed precast concrete works on the parent structure. The assessment report should be appended with a statement of the project RSE to confirm that he/she is fully aware of the connection details and their effects on the parent structure.

13. The separate RSE should be responsible for the supervision of the production and erection of the precast concrete elements, including the connection between the precast concrete elements and the parent structure, i.e. ties, anchor plates, cast-in embeds etc., except in the event where such associated works have been installed in the parent structure prior to his/her appointment. For such cases, the structural details and layout of the pre-installed parts should be given in the superstructure plans submitted for approval by the project RSE who should then be responsible for the supervision of the installation of such parts. The separate RSE should refer to the pre-installed connection details when designing the precast concrete elements and should co-ordinate with the project RSE for any necessary amendment if different connection details are to be used.

14. The separate RSE should ensure that the conditions and requirements of the QA, qualified supervision and quality audit as stipulated in paragraphs 4 to 9 above respectively are complied with. He/she should also be responsible for the submission of the documents required in paragraphs 4 to 9 above.

15. A similar practice note is issued to registered contractors.


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Building Authority

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Minimum Requirements of Quality Audit Checks at Precasting Factory by RSE and AS

The quality audit checks carried out by the RSE and the AS at the precasting factory should include the following works items:

Works Item		Scope
1	Formworks	<ul style="list-style-type: none"> • Smoothness, cleanliness and dimensions of steel mould • Application of mould releasing agents
2	Steel reinforcing bars	<ul style="list-style-type: none"> • Size, pattern, fixing and layout of the steel reinforcing bars • Spacers • Concrete covers • Material testing reports
3	Concrete	<ul style="list-style-type: none"> • Placing and compaction • Curing • Material testing reports
4	Finished products	<ul style="list-style-type: none"> • Concrete surface and defects • Sizes, dimensions and fabrication tolerances • Starter steel reinforcing bars
5	Inspection records	<ul style="list-style-type: none"> • Log book of QCS for audit check by RSE • Log book of QCC for audit check by AS
6	Others	<ul style="list-style-type: none"> • Any other items considered essential by the RSE/AS for the project

Minimum Requirements of RSE's Quality Audit Checks of Precast Concrete Elements delivered to Building Site

The quality audit checks on the precast concrete elements delivered to a building site carried out by the RSE as an alternative to the quality audit checks on precast concrete elements at the precasting factory as specified in Appendix A should comply with the requirements in paragraph 2 below.

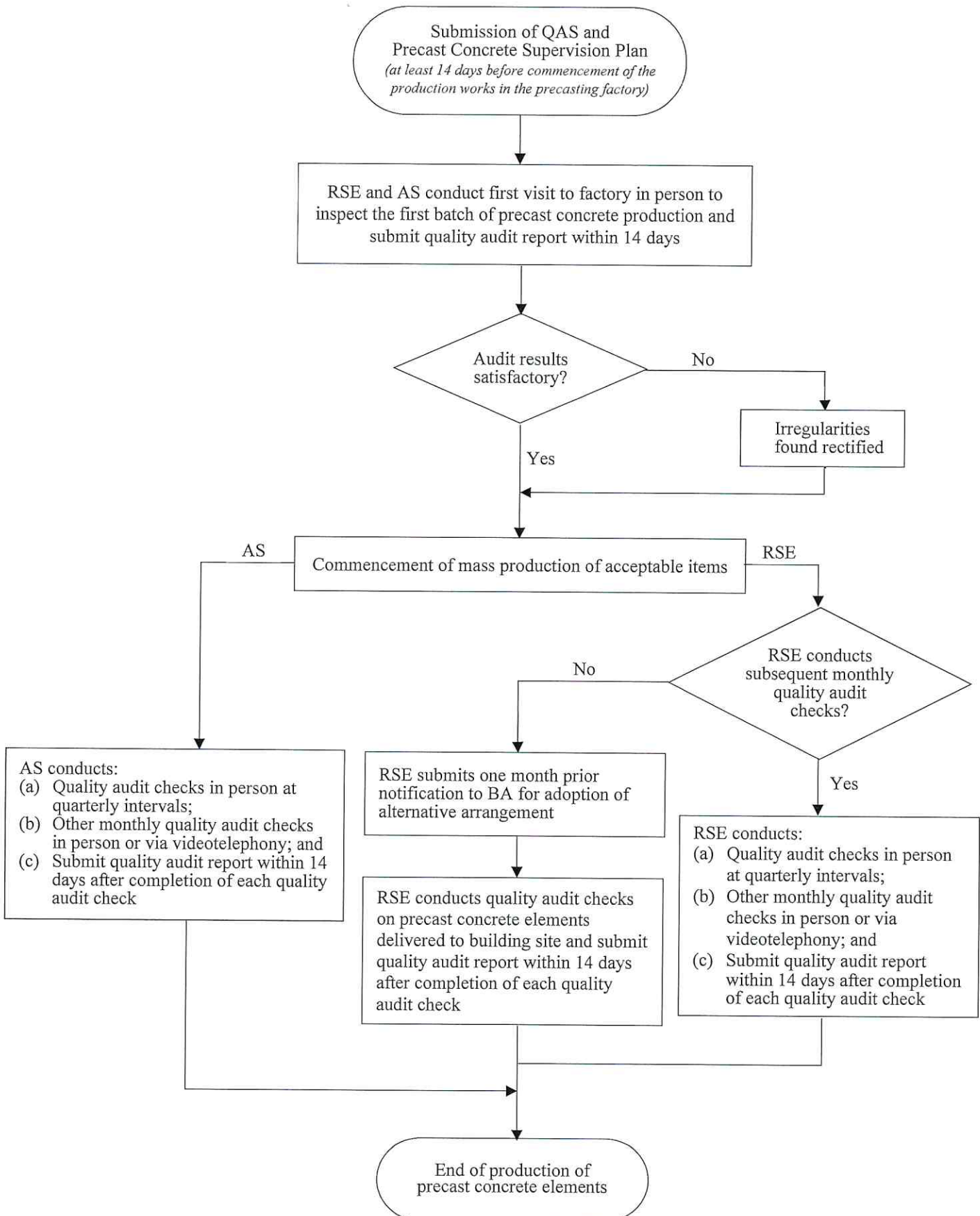
2. The rate of sampling for the quality audit checks should be at least 1% of the precast concrete elements with a minimum of one per every 20 batches¹ of delivery to the building site. The quality audit check for each sample of the precast concrete element should include the following works items:

Works Item		Scope
1	Steel reinforcing bars	<ul style="list-style-type: none"> Opening-up of the concrete surface at three locations, each with an area of 100mm x 300mm, to check the size, pattern and layout of the steel reinforcing bars; and the concrete covers Measurement of the concrete cover to steel reinforcing bars by covermeter at six locations, each with six readings taken in an area of 450mm x 450mm Material testing reports
2	Concrete	<ul style="list-style-type: none"> Concrete strength by non-destructive test (e.g. rebound hammer test) at three locations Material testing reports
3	Finished products	<ul style="list-style-type: none"> Concrete surface and defects Sizes, dimensions and fabrication tolerances Starter steel reinforcing bars
4	Inspection records	<ul style="list-style-type: none"> Log book of QCS for audit check by RSE
5	Others	<ul style="list-style-type: none"> Any other items considered essential by the RSE for the project

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¹ A batch means the same type of precast concrete elements such as precast façade, precast beams, precast columns and precast bearing walls delivered to the site on the same day.

Flow Chart for Quality Audits by RSE and AS



Precast Concrete Supervision Plan

To the Building Authority,

In accordance with the conditions of approval imposed in your letter of _____, we submit this supervision plan for the precast concrete production works for the development at (address of site) _____ on (Lot No.) _____.

2. We undertake that the supervision of the precast concrete production works will be carried out in accordance with this supervision plan, PNAP APP-143 and the Code of Practice for Precast Concrete Construction 2016 (Code). We also undertake that the management and execution of quality supervision of the works covered by this supervision plan will be carried out in the manner prescribed by the provisions of the Buildings Ordinance and Regulations.

3. The quality control supervisor (QCS) and quality control co-ordinator (QCC) assigned by the registered structural engineer (RSE) and the registered contractor (RC) respectively to supervise the above precast concrete production works are :

	Name in English [^]	Name in Chinese [^]	I.D. No. [^] / TCP No. ^{**}	Frequency of Quality Supervision
QCS [@]				Weekly
	Signature for confirmation of appointment under RSE's stream*: _____			
QCC [@]				Full time
	Signature for confirmation of appointment under RC's stream*: _____			

The contact information and CVs showing their relevant experience and academic qualifications are attached at the Annexes. If more than one supervisor/co-ordinator is proposed for a QCS/QCC post, the demarcation of their responsibility should be provided.

[^] In accordance with the Hong Kong Identity Card

^{**} CV is not required if TCP No. is provided

[@] The minimum qualifications and experience of the QCS and QCC should fulfill the requirements specified in paragraph 6 of PNAP APP-143

^{*} Signature of QCS/QCC for the confirmation of appointment under RSE's/RC's stream indicates that the QCS/QCC has read, understood and agreed with the notes on "Personal Data" of this supervision plan.

4. The quality supervision shall cover the items of works to be inspected at different stages as devised in Annex 1. The record of quality supervision in Annex 2 will be completed contemporaneously by the QCS/QCC with a copy of these documents to be kept on site for inspection by representatives of the Buildings Department.

Prepared by:

Signature	_____	Signature	_____
Name of RSE	_____	Name of AS	_____
Date	_____	RC	_____
		Date	_____

Enclosure : Annexes

Personal Data

Purposes of Collection

1. The personal data provided by means of this supervision plan will be used by the Buildings Department for the following purposes:

- (a) activities relating to this supervision plan;
- (b) activities relating to the above building works; and
- (c) facilitating communication between the Buildings Department and yourself.

2. It is obligatory for you to provide the information as required in the supervision plan. If you fail to provide the required data, delay may be caused in processing or even result in rejection of the submission.

Classes of Transferees

3. The personal data you provided by means of this supervision plan may be disclosed to other government departments, bureaux, organisations or any persons for the purposes mentioned in paragraph 1 above.

Access to Personal Data

4. You have the right of access and correction with respect to the personal data as provided under the Personal Data (Privacy) Ordinance. The Buildings Department has the right to charge a reasonable fee for the processing of any data access request. Request for personal data access and correction should be addressed to the New Buildings Division 2 of the Buildings Department.

(4/2022)

Items of Works for Quality Supervision of Precast Concrete Works

Items of precast concrete works required for quality supervision to be carried out by the QCS / QCC are given in the tables below for reference. The heads of the project management structure shall communicate with other streams to derive checklists of various works, determine appropriate inspection frequencies and individual items of works to suit the needs of individual project.

Item No.	Stage/Item	Description	Stream	
			RSE	RC
(a) Essential Construction Materials				
PC1	Quality of steel reinforcing bars	Check material delivery records and batch size; sampling and testing of steel reinforcing bars in accordance with the applicable version of CS2.	✓	✓
PC2	Quality of concrete/grout	Check material delivery records; sampling of concrete/grout and compression testing and statistics of concrete/grout test cubes in accordance with the applicable version of CS1.	✓	✓
(b) Production of Precast Concrete Elements				
PC3	Condition of moulds	Check the overall dimension, squareness of corners and edges, condition of side and base of mould, cleanliness, application of mould releasing agents and records of periodic full re-checking of moulds for dimensional tolerance compliance and regular maintenance.	✓#	✓#
PC4	Fixing of steel reinforcing bars	Check the sizes, location and amount of steel reinforcing bars and their fixing details including concrete cover and starter bars details and the workmanship in accordance with PNAP ADV-15.	✓	✓
PC5	Cast-in items	Check the location, layout and types of cast-in items including starter bars, dowels and connections, lifting inserts and window frames with fixing lugs, etc and their support, provision of finishes and fixing of recesses, sleeves and boxouts.	✓#	✓#
PC6	Placing, compaction and curing of concrete	Check the quality and workmanship of concrete works, proper sequence of works, concreting method and curing method are used.	✓#	✓#
PC7	Demoulding and initial handling	Check the concrete achieved sufficient strength prior to commence the demoulding process and initial handling	✓#	✓#

Item No.	Stage/Item	Description	Stream	
			RSE	RC
(c) Inspection and Testing of Finished Products				
PC8	Concrete condition	Check the quality of concrete after demoulding which includes size and shape of the products, location of cast-in items and construction joints, surfaces finishes, defects identified and associated repair works, etc.	✓#	✓#
PC9	Storage of finished products	Check the condition of storage area and stacking method	✓#	✓#
PC10	Special testing of finished products	Check watertightness (e.g. by water penetration test), the performance of tiled finishes (e.g. pull off test).	✓@	✓@
PC11	In-situ concrete strength	Check in-situ concrete strength (e.g. by concrete coring test or rebound hammer test).	✓	✓
PCn	Any other items considered essential for quality supervision of the precast concrete works		as appropriate	

Legend:

The quality supervision requirements are detailed in clauses 3.2 to 3.14 of the Code.

@ The special testing is detailed in clause 4.3 of the Code.

**Record of Quality Supervision Carried Out by
QCS under RSE Stream**

BD Ref.: BD 3/1234/22
Building Project: ABC Centre
Type of Works: Precast Concrete Works
Name of QCS⁽¹⁾: Mr LEE Tai-man
Frequency of Inspection: Weekly

Date Item No. ⁽²⁾	07/05/2022 (Wed)			
	Locations of the precast concrete elements (Product ID)	Inspection Findings		Photos (if any)
		Result (S ⁽³⁾ /NS ⁽⁴⁾ /NA ⁽⁵⁾)	Remedial / Remark	
PC1	-	NA	-	
PC2	Batch no. 10, delivered on 07/05/2022	S	-	
PC3	Zone A of 4/F (ABC-ZA-04-T1-004)	S	-	
PC4	Zone B of 2/F (ABC-ZB-02-T5-002)	S	-	
PC5	Zone C of 2/F (ABC-ZC-02-T1-002)	NS	Insufficient concrete cover	1-2
PC6	Zone A of 2/F (ABC-ZA-02-T5-002)	S		
PC7	Zone A of 2/F (ABC-ZA-02-T4-002)	S		
PC8	Zone A of 2/F (ABC-ZA-03-T2-002)	S		
PC9	Zone A of 2/F (ABC-ZA-03-T1-002)	S		
PC10	-	NA	-	
PC11	-	NA	-	
Signature				

Note ⁽¹⁾ : Full name of the QCS as provided in the supervision plan.

Note ⁽²⁾ : According to the checklists devised by the RSE and AS of the RC.

Note ⁽³⁾ : “S” denotes “Satisfactory”.

If a non-conformity is very minor in nature and has been rectified to the satisfaction of the QCS at the same inspection, it would be recorded as “satisfactory”.

Note ⁽⁴⁾ : “NS” denotes “Not Satisfactory”.

It should be recorded in the log book of QCS and where applicable, **Form B** in Appendix III of the Code of Practice for Site Supervision 2009 (2021 Edition).

Completion of **Form B** is **Required** for a non-conformity that (a) has material concern for safety; or (b) does not have material concern for safety but the works item/rectification works cannot be verified due to the areas have been covered up during inspection or re-inspection.

Note ⁽⁵⁾ : “NA” denotes “Not Applicable”.