


### **Quality of In-situ Reinforced Concrete Works at an Early Age**

As the design and construction of reinforced concrete structures become more complex, usually involving the use of fast-track construction method and different concrete grades for vertical and horizontal structural elements, it is necessary to exercise earlier and closer quality supervision and control of in-situ reinforced concrete works during construction. This practice note sets out the requirements to ascertain earlier the quality of in-situ reinforced concrete works for superstructure, and an alert system for registered structural engineers (RSE) and registered contractors (RC) to take early follow-up action if any irregularities are identified.

2. Guidance on quality supervision of building works is given in Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers (PNAP) APP-158. In relation to in-situ reinforced concrete works, Appendix A of PNAP APP-158 has listed the works items required for quality supervision, including the need to verify the quality of concrete; the placing, compaction and curing of concrete; the concrete condition after striking of formwork; and the in-situ concrete strength by, for example, concrete coring tests or rebound hammer tests (RHT).
3. Under item 6 of section 17(1) of the Buildings Ordinance, a condition will be imposed, when giving the first approval of superstructure plans involving the use of different concrete grades in the structure, that RHT should be carried out to structural concrete elements with higher concrete grade at an early concrete age. Details of the required RHT are given in Appendix A. For other ongoing development projects, RSE/RC should advise their clients to consider implementing the above enhanced quality supervision and control system.
4. A similar practice note has been issued to RC.

  
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### **Quality of In-situ Reinforced Concrete Works by Rebound Hammer Tests at an Early Concrete Age**

Where a structure is designed with the use of different concrete grades, rebound hammer tests (RHT) should be carried out to in-situ reinforced concrete elements with higher concrete grade between the seventh and tenth day<sup>1</sup> after they are cast and in accordance with BS EN 12504-2:2021 on “Testing concrete in structures – Part 2: Non-destructive testing – Determination of rebound number”.

#### **Qualified Supervision**

2. Under item 6 of section 17(1) of the Buildings Ordinance, a condition will usually be imposed, when giving approval of superstructure plans, that qualified supervision should be provided by the registered structural engineer (RSE) and the registered contractor (RC) for the reinforced concrete works.
3. To ascertain earlier the quality of concrete, RSE should determine the structural concrete elements to be subject to RHT and the necessary testing frequency according to the minimum requirements given in table below. A technically competent person (TCP) of grade T3 under RSE’s stream should witness at least 10% of the RHT conducted by RC.
4. All RHT should be carried out by a TCP of grade T1 or above under RC’s stream who should be adequately trained in the use of rebound hammers<sup>2</sup>. RHT results should be properly recorded in a standard form in accordance with the Annex. RC should keep all RHT records on site for inspection by RSE’s TCP.

#### **Requirements on RHT**

5. Structural concrete elements that require the carrying out of RHT between the seventh and tenth day after they are cast, and the corresponding testing frequency are given in the table below:

<b>Structural Concrete Element subject to RHT<sup>@</sup></b>	<b>Minimum Testing Frequency</b>
1. Vertical elements <sup>#</sup> of higher concrete grade than the immediate supports at the base provided by pile cap/footing/raft foundation/transfer plate/transfer beam	50%

/2. ...

<sup>1</sup> If RHT cannot be conducted between the seventh and tenth day due to, for example, public holiday, RHT should be carried out on the following working day.

<sup>2</sup> The RC may employ a laboratory accredited under the Hong Kong Laboratory Accreditation Scheme to carry out RHT.

2. Vertical elements of higher concrete grade than adjoining beams/slabs at the top	10%
3. Transfer beams	50%
4. Beams of higher concrete grade than adjoining beams/slabs on the same floor	10%

@ : RSE should randomly select elements for the carrying out of RHT by RC.

# : If vertical elements are with kickers, RHT should be conducted to the kickers in addition to the vertical elements.

### Alert Level for Follow-up Actions

6. In the absence of an engineering assessment, the following empirical guideline may be taken as the alert level and necessary follow-up actions to be taken by RSE and RC.

Concrete	RHT readings	Follow-up Actions
Concrete with the use of pulverized-fuel ash or ground granulated blastfurnace slag	< 55% of the minimum characteristic strength of concrete	(a) Examine the following records with the purpose of identifying any irregularities: <ul style="list-style-type: none"> <li>(i) approved plans;</li> <li>(ii) concrete order and delivery records;</li> <li>(iii) concreting method and curing method; and</li> <li>(iv) site supervision records.</li> </ul> (b) Take measures to ascertain the quality of the in-situ concrete as early as practicable by, for example, additional RHT or concrete coring tests.           (c) Enhance the site supervision and monitoring of the whole process of concreting works, in particular to similar structural elements to be cast on other floors.
Concrete without the use of pulverized-fuel ash or ground granulated blastfurnace slag	< 65% of the minimum characteristic strength of concrete	

/(d) ...

		(d) Keep the quality verification under review and if found necessary, report to the Buildings Department and suspend the concrete works until the necessary follow-up works have been completed.
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**Alternative to RHT**

7. As an alternative to RHT, the quality of in-situ concrete at early age may be assessed by the maturity method on the seventh day after they are cast in accordance with clause 11.7.5.4 of the Code of Practice for Structural Use of Concrete 2013. The number of measuring points and the alert level for follow-up actions should follow the same for RHT specified in paragraphs 5 and 6 above.

(3/2022)

### Record of Rebound Hammer Tests under BS EN 12504-2:2021

BD Ref.: \_\_\_\_\_

Date of test: \_\_\_\_\_

R<sub>1</sub> = \_\_\_\_\_ R<sub>2</sub> = \_\_\_\_\_

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Hammer No.: \_\_\_\_\_ Range from anvil ( \_\_\_\_\_ )

Floor	Member Mark*	Size		Date Cast.	Readings as taken#												Median Value	Concrete strength		Remarks	
		Measured	Approved		Equi.	Req.															

\*: In accordance with plans approved by the Building Authority      #: In accordance with clause 7.2 of BS EN 12504-2:2021

The rebound hammer tests were **carried out** by me and in accordance with BS EN 12504-2:2021.

Full name of RC's TCP T3/T1: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

The readings of the rebound hammer tests were **recorded** by me and in accordance with BS EN 12504-2:2021.

Full name of RC's TCP T3/T1: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_

The rebound hammer tests were **witnessed** by me. (if appropriate)

Full name of RSE's TCP T3: \_\_\_\_\_

Date: \_\_\_\_\_ Signature: \_\_\_\_\_