HOKLAS Supplementary Criteria No. 19

Construction Materials Test Category – Accreditation of Diagnostic Tests on Concrete

0 Introduction

(a) This document serves to clarify and supplement the requirements of ISO/IEC 17025:2017 and HKAS Policy Document No. 1 for accreditation of laboratories performing diagnostic tests on concrete under the test category of 'Construction Materials'. It shall be read in conjunction with the current issue of ISO/IEC 17025:2017 and other relevant criteria documents. The following sections set out specific technical criteria for the diagnostic tests on concrete which include, but not limited to, the following methods:

- Carbonation test
- Covermeter survey
- Half-cell potential measurement
- Infrared thermography
- Resistivity measurement
- Surface hardness measurement
- Surface penetration radar survey
- Ultrasonic pulse velocity measurement

(b) In addition to the requirements stipulated in this document, an accredited laboratory shall comply with all specific requirements of the relevant test standards.

1 Scope

(No additional explanation)

2 Normative references

(No additional explanation)

3 Terms and definitions

(No additional explanation)

4 General requirements

(No additional explanation)

5 Structural requirements

(No additional explanation)

6 Resource requirements

6.1 General

(No additional explanation)

6.2 Personnel

6.2.1 An approved signatory for diagnostic tests on concrete (except infrared thermography and surface penetration radar survey) shall have the necessary competence to ensure that the test is performed in accordance with the test method and HKAS requirements are met. In this regard, each nominee for an approved signatory shall satisfy one of the following qualification and experience requirements (Option 1, 2 or 3):-

Option 1: Possess at least a Higher Diploma in Science or Engineering issued by the Vocational Training Council, or an equivalent qualification, with at least four years of relevant and accountable experience.

Option 2: Complete a learning programme[1] recognised under Hong Kong Qualifications Framework and at least four years of relevant and accountable experience.

Option 3: Has at least eight years of directly relevant technical and managerial experience.

[1] Acceptable learning programme shall include the following Unit of Competency (UoC): 105767L5, 105867L5, 105868L5, 105960L5, 105755L5 and 105842L4.

6.2.2 For infrared thermography, an approved signatory shall either have:

(i) a valid certificate of Level 2 (or equivalent) Thermography issued by a recognised organisation operating under international standards, or an accredited personnel certification body operating personnel certification system in accordance with international standard (e.g. BS EN ISO 9712 or equivalent), plus at least four years of technical and managerial experience on laboratory testing in which two years are directly related to infrared thermography,

(ii) attended and passed a training course provided by a recognised tertiary institution plus at least four years of technical and managerial experience on laboratory testing in which two years are directly related to infrared thermography,

(iii) obtained at least a Higher Diploma in Science or Engineering issued by a recognised technical institute or an equivalent qualification in a relevant discipline, with at least six years of directly technical and managerial experience on infrared thermography, or

(iv) completed a learning programme[2] recognised under Hong Kong Qualifications Framework plus at least six years of directly technical and managerial experience on infrared thermography.

Note: An outline of a typical training course for the purpose of 6.2.2(ii) is shown in Appendix A.

6.2.3 For surface penetration radar survey, an approved signatory shall either have:

(i) attended and passed a training course provided by a recognised tertiary institution plus at least four years of technical and managerial experience on laboratory testing in which two years are related to surface penetration radar survey,

[2] Acceptable learning programme shall include the following Unit of Competency (UoC): 105767L5, 105867L5, 105868L5, 105960L5, 105755L5 and 105833L5.

(ii) obtained at least a Higher Diploma in Science or Engineering issued by a recognised technical institute or an equivalent qualification in a relevant discipline, with at least six years of directly technical and managerial experience on surface penetration radar, or

(iii) completed a learning programme[2] recognised under Hong Kong Qualifications Framework plus at least six years of directly technical and managerial experience on surface penetration radar.

Note: An outline of a typical training course for the purpose of 6.2.3(i) is shown in Appendix B.

6.2.4 Testing operators shall normally be supervised by a qualified supervisor having the necessary qualifications, experience and technical knowledge not less than that of the testing operator.

6.2.5 Testing operators for infrared thermography shall have the necessary qualifications, experience and technical knowledge. A testing operator shall either have:

(i) a valid certificate of Level 1 (or equivalent) Thermography issued by a recognised organisation operating under international standards, or an accredited personnel certification body operating personnel certification system in accordance with international standard (e.g. BS EN ISO 9712 or equivalent), plus at least one year of on-the-job experience on infrared thermography, or

(ii) attended and passed a training course provided by a recognised tertiary institution plus at least one year of on-the-job experience on infrared thermography.

Note: An outline of a typical training course for the purpose of 6.2.5(ii) is shown in Appendix C.

[2] Acceptable learning programme shall include the following Unit of Competency (UoC): 105767L5, 105867L5, 105868L5, 105960L5, 105755L5 and 105833L5.

6.2.6 Testing operators for surface penetration radar survey shall have the necessary qualifications, experience and technical knowledge. A testing operator shall have attended and passed a training course provided by a recognised tertiary institution plus at least one year of on-the-job experience on surface penetration radar survey.

Note: An outline of a typical training course for the purpose of 6.2.6 is shown in Appendix D.

6.2.7 Each laboratory shall evaluate the technical competence of its testing operators for infrared thermography and surface penetration radar survey and keeps a separate list of qualified operators for infrared thermography and surface penetration radar survey who are authorised to perform the test(s) and sign the worksheets. Record of assessing the competence of the qualified operator(s) shall be kept and ready for examination during each HKAS assessment or upon request by HKAS.

6.2.8 The management shall structure its laboratory and provide sufficient manpower to ensure effective supervision. The detailed supervisory responsibility of each supervisory staff member shall be documented.

6.2.9 Supervisors have the responsibility to ensure that the operation has been properly conducted. Also, the supervisor shall ensure that the staff members under his or her supervision are working under suitable conditions which allow them to discharge their duties properly and not subject to undue pressure which may compromise the quality of their work, e.g. unreasonable deadlines, long working hours and unbearable working environments.

6.2.10 Adequacy of supervision will be emphasised in HKAS assessments and the laboratory will be required to justify their supervision arrangement and to demonstrate that supervisory staff members have been allowed sufficient time in their work schedule to carry out their supervisory duties.

6.2.11 Supervision is of particular importance for work performed on-site remote from the laboratory. The laboratory shall implement a system where HOKLAS approved signatories or other suitably qualified supervisors will conduct frequent unannounced on-site visits to check the work of on-site staff. Records of such checks and findings shall be kept

6.3 Facilities and environmental conditions

(No additional explanation)

6.4 Equipment

(No additional explanation)

6.5 Metrological traceability

6.5.1 General requirements on equipment calibrations are given in HOKLAS SC-02. Specific requirements on equipment calibration/verification intervals for various diagnostic tests on concrete are given in Appendix E of this document. These requirements shall be complied with unless overridden by more stringent testing specifications.

6.5.2 Where a laboratory has the necessary reference standard or reference material, suitably controlled environment and competent staff, it may perform in-house calibration/verification for its working equipment. Documented internal calibration/verification procedures shall be ready for examination during each HKAS assessment visit. HKAS Executive may require the laboratory to provide the calibration/verification procedures in the briefing notes to the assessment team.

6.6 Externally provided products and services

(No additional explanation)

7 Process requirements

7.1 Review of requests, tenders and contracts

(No additional explanation)

7.2 Selection, verification and validation methods

(No additional explanation)

7.3 Sampling

(No additional explanation)

7.4 Handling of test or calibration items

7.4.1 Items to be tested shall be identified throughout the test and records of identification of each test item shall be kept. Such identification shall also include the sampling location of a specific item where applicable.

7.4.2 For all diagnostic tests on concrete, high resolution and clear digital photography records shall be taken and kept. These may be in the form

of photographs or videos such that the location and identification of the tested areas are recorded. The digital photographs and videos shall include information on the project name, the test locations and the dates when they are taken. Where the location of the test is important, global positioning system (GPS) records or other records which allow accurate identification of the test sites shall also be kept.

7.4.3 For infrared thermography, automatic means shall be utilized to record essential test information, including test date and time, and thermograms with appropriate temperature bar. Printed hardcopies or properly controlled and protected computer records containing the above information and the corresponding test results shall be kept. The high resolution and clear digital photography records for the test areas shall be taken and put alongside the corresponding thermograms in the test reports. The laboratory shall have procedures to protect and back-up records stored electronically and to prevent unauthorised access to or amendment of these records.

7.4.4 For surface penetration radar survey, automatic means shall be utilized to record essential test information, including test date and time, and radargrams. Printed hardcopies or properly controlled and protected computer records containing the above information and the corresponding test results shall be kept. The high resolution and clear digital photography records for the test areas shall be taken and put alongside the corresponding radargrams in the test reports. The laboratory shall have procedures to protect and back-up records stored electronically and to prevent unauthorised access to or amendment of these records.

7.5 Technical records

(No additional explanation)

7.6 Evaluation of measurement uncertainty

(No additional explanation)

7.7 Ensuring the validity of results

7.7.1 An applicant or accredited laboratory shall conform with the proficiency testing requirements as stipulated in HOKLAS SC-33.

7.7.2 ‘Diagnostic tests on concrete’ is considered as a test area for the purpose of determining the proficiency testing activities required by HOKLAS SC-33.

7.8 Reporting of results

(No additional explanation)

7.9 Complaints

(No additional explanation)

7.10 Nonconforming work

(No additional explanation)

7.11 Control of data and information management

(No additional explanation)

8 Management system requirements

(No additional explanation)

APPENDIX A

A typical training course on Infrared Thermography for Diagnostic Tests on Concrete (for the purpose of Clause 6.2.2(ii) above) shall span a duration of a minimum of 27 teaching hours, and shall comprise the following: -

A. Lecture

1. Infrared theory / radiosity
2. Heat transfer principles
3. Characteristics of infrared camera
4. Calibration and uniformity check of infrared camera
5. Thermal image analysis

B. Practical (not less than 9 hours)

1. Practical exercise on the use of infrared camera for building diagnosis
2. Computer aided data analysis of thermograms
3. Interpretation of test results

C. Assessments

1. Coursework
2. Practical assessment
3. Written assessment

APPENDIX B

A typical training course on Surface Penetration Radar for Diagnostic Tests on Concrete (for the purpose of Clause 6.2.3(i) above) shall span a duration of a minimum of 27 teaching hours, and shall comprise the following: -

A. Lecture

1. Theory of concrete radar
2. Characteristics of concrete radar equipment
3. Calibration and verification of concrete radar equipment

B. Practical (not less than 9 hours)

1. Detection of internal features of reinforced concrete structures
2. Computer aided data analysis of radargrams
3. Interpretation of test results

C. Assessments

1. Coursework
2. Practical assessment
3. Written assessment

APPENDIX C

A typical training course on Infrared Thermography for Diagnostic Tests on Concrete (for the purpose of Clause 6.2.5(ii) above) shall span a duration of a minimum of 15 teaching hours, and shall comprise the following: -

A. Lecture

1. Basic principle and theory of infrared thermography
2. Operation of infrared camera
3. Uniformity check of infrared camera (including sources of error)

B. Practical (not less than 6 hours)

1. Practical exercise on the use of infrared camera for building diagnosis
2. Uniformity check of infrared camera

C. Assessments

1. Coursework
2. Practical assessment
3. Written assessment

APPENDIX D

A typical training course on Surface Penetration Radar for Diagnostic Tests on Concrete (for the purpose of Clause 6.2.6 above) shall span a duration of a minimum of 15 teaching hours, and shall comprise the following: -

A. Lecture

1. Basic principle and theory of concrete radar
2. Operation of concrete radar equipment
3. Calibration and verification of concrete radar equipment

B. Practical (not less than 6 hours)

1. Detection of internal features of reinforced concrete structures
2. Calibration and verification of concrete radar equipment

C. Assessments

1. Coursework
2. Practical assessment
3. Written assessment

APPENDIX E

SPECIFIC CALIBRATION/VERIFICATION REQUIREMENTS

This appendix lists the specific calibration/verification requirements for equipment of diagnostic tests on concrete.

Type of equipment/chemicals	Recommended maximum period between successive calibration/verification	Recommended calibration/verification procedure or guidance documents and equipment requirements
Carbonation test		
Phenolphthalein solution	-	Before each test, prepare the solution in accordance with BS EN 14630 Section 3. (The maximum storage period is 6 months starting from the date of freshly made of the solution.)
Covermeter survey		
Covermeter	1 year	Calibrate in accordance with BS1881: Part 204 Section 6 Method C.
	Before each test	Check against a reference block in accordance with BS 1881: Part 204 Section 6 Method A.
Half-cell potential measurement		
Half cell	3 months	Check the half cell using the method described in the manufacturer's instructions.
Resistivity measurement		
Resistivity meter	Before each test	Calibrate the resistivity meter using a calibration kit provided by the manufacturer or equivalent.
Surface hardness measurement		
(a) Rebound hammer	Before each test	Check against a calibration envil.
(b) Calibration envil	3 years	Check the hardness and weight of the calibration envil.
Surface penetration radar		
Surface penetration radar measuring apparatus	1 year	Measure the transit time of the radar wave travelling from the antenna of the radar to a flat reflector in air through at least five distinct reference distances. The reference distances shall not be smaller than 300mm and the distance's increment shall not be less than 100mm. Plot the curve of

Type of equipment/chemicals	Recommended maximum period between successive calibration/verification	Recommended calibration/verification procedure or guidance documents and equipment requirements
		reference distances against radar travel time values to obtain the gradient which is equivalent to radar wave velocity in air. Definition of time zero's position in the radar waveform, as well as trigonometrical corrections regarding the relative positions of radar's transmitter, receiver and the flat reflector shall be considered. Compare the measured velocity in air with the theoretical value (i.e. 0.2998 m/ns). If the error is larger than 5%, or the value recommended by the manufacturer, whichever is less, a full check/repair of the radar is required.
	Before each test	Carry out on-site verification of the survey wheel/odometer according to the manufacturer's recommendation if the radar system is triggered by survey wheel/odometer. Record and report the verified value before each test.
	For each test	Carry out on-site estimation / verification of dielectric constant of the test area to estimate the representative radar wave velocity in accordance with the calibration procedures in Appendix C of HKCI: TM2 'Determination of Concrete Cover and Distribution of Steel Rebar by Surface Penetration Radar' or other appropriate methods.
Ultrasonic pulse velocity measurement		
(a) Ultrasonic pulse signal measuring apparatus	Before each test	Calibrate the ultrasonic pulse signal using a reference bar.
(b) Reference bar	3 years	Check the transit time of ultrasonic pulse through the reference bar.