ACCREDITATION SCHEME FOR LABORATORIES

Technical Notes CE 002

Specific Requirements for Non-Destructive Testing for Concrete

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1. Introduction

1.1 This document provides guidelines for the accreditation of non-destructive testing (NDT) for concrete in structures and precast concrete components. It gives recommendations for staff requirements, laboratory practices and site control for field testing.

1.2 Non-destructive and other site testing for concrete may include, but is not limited to, use of the following techniques:

- Determination of rebound number
- Determination of ultrasonic pulse velocity
- Electromagnetic cover measurement
- Strain measurements
- Penetration resistance
- Initial surface absorption
- Half-cell potential measurements
- Resistivity measurements
- Depth of carbonation

1.3 Non-destructive tests for concrete shall be performed to national or international test standards whenever possible, but where it is necessary, in-house test methods may be used if appropriately documented and made available upon request. Specific requirements on equipment calibration/verification intervals for various non-destructive testing on concrete are given in Appendix A. This Technical Note only serves to supplement requirements of the respective standards.

1.4 This Technical Note should be read in conjunction with documents SAC 01 "Terms and Conditions for Accreditation", ISO/IEC 17025: "General Requirements for the Competence of Testing and Calibration Laboratories" and other CE-series Technical Notes published under SAC-SINGLAS.

2. Staff

2.1 It is recognised that the standard of performance of a non-destructive test depends on the capabilities of the staff responsible for and performing the testing. SAC-SINGLAS assessments of NDT therefore stress heavily on appraisal of staff.

2.2 Staff Structure

2.2.1 In general, a laboratory engaging in NDT should have staff classified into the following three categories:

(a) persons exercising technical control - those who are responsible for control of non-destructive tests

(b) persons who, under direction, can take responsibility for performance of routine tests

(c) assistants who perform routine technical and non-technical duties, working under close supervision

2.2.2 Persons exercising technical control shall have the competence, authority and time for effective control of non-destructive testing operations that they are responsible for. They are expected to have:

(a) sound knowledge of, and experience in the use of, applicable non-destructive testing techniques
(b) sound knowledge of properties of concrete and other relevant materials
(c) experience and ability to interpret data from relevant non-destructive tests
(d) experience in the use of relevant standards, and ability to prescribe suitable procedures based on established recommendations, in particular for testing on site
(e) ability to prepare routine and critical reports, where necessary
(f) ability to control quality of performance of non-destructive tests
(g) relevant tertiary qualification in Civil Engineering
(h) adequate training and experience in non-destructive testing for concrete

A person without tertiary qualification may be considered acceptable to exercise technical control if the other attributes listed above are satisfied, together with compensating practical experience.

2.2.3 Persons responsible for specific routine tests are expected to have:

(a) experience in performance of the applicable non-destructive test
(b) experience in the use of relevant standards, and ability to apply appropriate standards to the requirements of specific projects
(c) experience and ability in interpretation of data from non-destructive testing
(d) ability to maintain job records and prepare routine reports
(e) knowledge and experience which enable them to understand the reasons for and purposes of the operations for which they are responsible
(f) completed secondary education

A person without secondary education may be considered acceptable if the other attributes listed above are satisfied, together with compensating practical experience.

2.2.4 Assistants should have knowledge and experience commensurate with the duties that they are required to perform.

2.3 Approved Signatories

2.3.1 Practical tests are normally set for persons nominated for SAC-SINGLAS signatory approval either before or during an assessment.

2.3.2 When non-destructive testing is performed on site and on-the-spot reports are required, the officer in charge on site shall be an approved signatory of SAC-SINGLAS endorsed test reports.

3. Record System

3.1 The laboratory shall keep complete records of all work undertaken.

3.2 Adequate identification shall be given to structures and samples tested by including in the work records reference to drawing numbers, sketches, photographs, etc. such that traceability is maintained throughout the test and records are kept.

3.3 In situations where it is necessary for the operator to deviate from the standard requirements, a written or oral confirmation shall be obtained from the client prior to commencement of testing. However, where oral confirmation has been obtained from the client, the operator shall keep a full record of the discussions held. It is a requirement that such deviations are reported in the test report.

4. Laboratory Practices

4.1 Officers in technical control shall make sufficient periodic, but random, visits to work sites to ensure the quality of performance of NDT operators. Records of these visits shall be maintained in the laboratory records.

5. Requirements for Determination of Rebound Number (Recommended standard is BS EN 12504-2)

5.1 The laboratory shall possess a reference steel anvil supplied by the manufacturer of the equipment.

5.2 Rebound hammers shall be checked daily against the reference anvil before and after each day's testing. Records of these checks shall be kept.

5.3 The test report shall include:

(a) the date and time of performance of test
(b) identification of Rebound Hammer
(c) the reference anvil readings before and after the day's testing
(d) identification of concrete structure/element and the location of test area(s)
(e) all details of concrete and conditions of test, or a statement if any of these details are not available
(f) surface conditions and preparation of test point(s)
(g) any deviation from the standard test method
(h) a declaration of the person technically responsible for the test, that it was carried out in accordance with the standard - except as noted in item (g)

6. Requirements for Determination of Ultrasonic Pulse Velocity (Recommended standard is BS EN 12504-4)

6.1 The laboratory shall be aware of the various factors that can influence pulse velocity, such as effects of moisture content, temperature of concrete, path length, shape, size and composition of specimen, and presence of reinforcing bars.

6.2 For on site measurements, the surface condition of each test point shall be noted. Where special preparation of the surface has been made, this shall be recorded and reported.

6.3 If a pulse is propagated through a composite material, the thickness of each layer and composition, where known, covering the entire path length shall be recorded and reported.

6.4 The test report shall include:

(a) date, time and place of the investigation
(b) identification of the concrete structures or test specimen and description of the concrete including mix composition (if known)
(c) age of the concrete at the time of test (if known)
(d) temperature of concrete at the time of test (other than ambient)
(e) type and make of apparatus used
(f) transducers arrangement and transmission method
(g) details of reinforcing steel or ducts in the vicinity
(h) surface conditions and preparation of test point(s)
(i) measured values of path length and calculated values of pulse velocity
(j) any deviation from the standard test method
(k) a declaration of the person technically responsible for the test, that it was carried out in accordance with the standard - except as noted in item (j)

7. Requirements for Electromagnetic Cover Measurement

7.1 Accreditation of electromagnetic cover measurements is offered only for the determination of cover, and does not include determination of bar diameters since this may be highly inaccurate under certain circumstances.

7.2 Cover measurement devices shall be initially, and thereafter every 6 months, calibrated by the laboratory in accordance to the standard being used. The calibrations shall extend over the full range of the equipment sensitivity.

7.3 For on site measurements, if the cover is made up of a composite material, the thickness of each layer and composition, where known, of the cover shall be recorded and reported.

7.4 The test report shall include:

(a) date, time and place of test
(b) description of the structure or component under investigation
(c) locations of test area
(d) make and type of covermeter used and date of last laboratory calibration
(e) measured values of indicated cover
(f) a declaration of the person technically responsible for the test, that it was carried out in accordance with the standard

8. Requirements for Strain Measurements

8.1 For ancillary instruments such as frequency meters, readouts, dial gauges, laboratory should refer to the recommended equipment calibration intervals in SAC-SINGLAS Technical Note: CE 001.

8.2 The test report shall include:

(a) date, time and place of each test
(b) description of the structure and the load history
(c) locations of gauges, including whether surface or embedded, with a dimensioned sketch
(d) details of concrete, including its condition at the time of investigation
(e) environmental conditions
(f) type of gauge
(g) method of attachment, including adhesive description
(h) gauge length, discrimination and details of calibration
(i) readings obtained and mean values, with appropriate measure of variation

9. Determination of Penetration Resistance

9.1 Unless the equipment is recalibrated by the manufacturer, it is recommended that the performance of the penetration probes be verified against a flat surface concrete block of a selected concrete. The verification shall be carried out at least once a year. When there is indication of malfunction or damage of the driving unit, verification shall be carried out to determine if repair is needed. After any repair, verification shall be carried out to check its performance.
(Note: This approach is NOT a calibration but only a comparative approach to demonstrate that the device continues to perform as previously)

9.2 The laboratory shall be aware of the limitations and problems that may arise in the use of the results of this technique in practice, e.g. effects of reinforcement bars, presence of cracks, edge distance, carbonation, surface condition, etc.

9.3 For on site measurements, if the penetration is carried out through a composite material, the thickness of each layer and their composition, where known, shall be recorded and reported.

9.4 For concrete more than three months old, the carbonation depth shall be recorded and reported.

9.5 The laboratory shall take all necessary safety and health requirements in accordance with the local regulations on safety and health.

9.6 The test report shall include:

(a) identification of the location and concrete member tested
(b) description of concrete mix composition including type of coarse aggregate

(c) description of surface finish
(d) date and time and place of testing
(e) driver unit identification number and energy level used in testing
(f) dimension of probes
(g) approximate thickness of member tested
(h) the exposed length of probes and the average exposed length in each test area (including the number of probes for the average)
(i) description of unusual conditions, including tests rejected for data analysis

10. Requirements for Half-Cell Potential Measurements

10.1 The apparatus shall be calibrated at least once a year, or when there is indication of malfunction or damage, the equipment shall be checked immediately and recalibrated if repairs have been carried out

10.2 The following information shall be recorded:

(a) preparation of surface
(b) condition of concrete surface
(c) nature of contact surface, e.g. curing compound, paint
(d) type of reinforcement, where known, e.g. mild steel, deformed bars, high tensile bars

10.3 For on site measurements, if the potential is measured through a composite material, the thickness of each layer and their composition, where known, shall be recorded and reported.

10.4 The test report shall include:

(a) type of cell used, including calibration details and KCl solution concentration for Ag/AgCl/KCl reference electrodes
(b) the estimated average temperature of the reference electrode during test
(c) the method for pre-wetting the concrete member and the method of attaching the voltmeter lead to the reinforcing steel.
(d) an equipotential contour map, showing the location of reinforcing steel contact, or a plot of the cumulative frequency distribution of the corrosion potentials, or both.
(e) the percentage of the total corrosion potentials that are more negative than -0.35 V or other suitable lower threshold
(f) the percentage of the total corrosion potentials that are less negative than -0.20 V or other suitable lower threshold

11. Determination of Carbonation Depth (Recommended standard – BS EN 14630)

11.1 The laboratory shall be aware that a suitable surface has to be provided by coring or breaking (chiseling) and testing immediately, ensuring that the surface is dust-free before the application of spray-on indicator compound.

11.2 The test report shall include:

(a) date and time of test
(b) name of person who carried out the test
(c) general weather conditions during in situ testing
(d) identification number and location of each sample and its exposure; eg sheltered from or exposed to rain, internal or external
(e) size and type of specimen used (i.e. in-situ, core or fragment)*
(f) the composition of the indicator solution used
(g) carbonation depth values
(h) a record of the carbonation profile
(i) reference to the standard used

*Note: BS EN 14630 recommends core specimen only

Appendix A

Specific requirements on equipment calibration/verification intervals

Type of equipment/chemicals	Period between successive calibration/verification	Recommended calibration/verification procedure, guidance documents and equipment requirements
Rebound Number		
(a) Rebound Hammer	Before and after each session of testing	Check against calibration anvil
(b) Calibration Anvil	3 years	Verify the hardness of calibration anvil as per manufacturer's instruction
Ultrasonic Pulse Velocity Measurement		
(a) Ultrasonic Pulse Signal Measuring Device	Before each test	Verify the ultrasonic pulse signal with a Reference Bar of known transit time
(b) Reference Bar	3 years	Calibrate by accredited calibration laboratory or by manufacturer
Electromagnetic Cover Measurement		
(a) Cover-meter	6 months	Calibrate in accordance to section 6 of BS 1881 Part 204
	Before each test	At least one point check using a reference block
Strain Measurements		
(a) Mechanical Gauges	Yearly	Calibrate by accredited calibration laboratory
(b) Invar Bar	Every 1000 readings or yearly (whichever represent more frequent use)	Check against a Reference Invar Bar kept solely for this purpose
(c) Electrical Displacement Transducer and input/output measuring devices	Yearly	Calibrate by accredited calibration laboratory

Type of equipment/chemicals	**Period between successive calibration/verification**	**Recommended calibration/verification procedure, guidance documents and equipment requirements**
Penetration Resistance		
(a) Driver Unit	Annually	Check by the manufacturer
Half-Cell Potential Measurements		
(a) Reference Electrode	As recommended by manufacturer	Calibrate by accredited calibration laboratory
(b) Voltmeter	Annually	Calibrate by accredited calibration laboratory
Depth of Carbonation		
(a) Phenolphthalein solution	Prepare solution before each test (maximum storage period: 6 months)	Prepare solution in accordance with section 3 of BS EN 14630

Appendix B

List of references :

BS publications

BS 1881 – 204	Recommendations on the use of electromagnetic cover meters
BS 1881 – 206	Recommendations for determinations of strain in concrete
BS 1881 – 207	Recommendations for the assessment of concrete strength by near-to-surface tests
BS 1881 – 208	Recommendations for the determination of initial surface absorption of concrete

BS EN publications

BS EN 12504 – 1	Cored specimens – Taking, examining and testing in compression
BS EN 12504 – 2	Determination of rebound number
BS EN 12504 – 3	Determination of pull-out force
BS EN 12504 – 4	Determination of ultrasonic pulse velocity
BS EN 14630	Determination of carbonation depth in hardened concrete by the phenolphthalein method

ASTM publications

ASTM C597	Standard test method for pulse velocity through concrete
ASTM C803	Standard test method for penetration resistance of hardened concrete
ASTM C805	Standard test method for rebound number of hardened concrete
ASTM C876	Standard test method for corrosion potentials of uncoated reinforcing steel in concrete

SS EN publications

SS EN 13791	Assessment of in-situ compressive strength in structures and precast concrete components
SS 592	Assessment of in-situ compressive strength in structures and precast concrete components – Complementary guidance to that given in SS EN 13791