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MODEL CLAUSES FOR CIVIL ENGINEERING WORKS

SECTION 83 STRUCTURAL CONCRETE REPAIRS

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SECTION 83

STRUCTURAL CONCRETE REPAIRS

Design, materials and workmanship generally

83.001 Unless otherwise detailed on the Contract Drawings, repairs to structural concrete shall be designed and carried out by the Contractor.

Repairs to structural concrete shall be designed in accordance with BS 5400: Parts 4, 5, and 10 or BS 8110-1:1997 as applicable to structure type and materials, and shall satisfy the load capacity, serviceability limits, durability and life expectancy requirements specified in Section 23: Structural Repair Survey.

Where the design of repairs to structural concrete is to be carried out by the Contractor, proposals for the repair shall be submitted in accordance with Section 23: Structural Repair Survey.

If required in Appendix 83/1, designs shall be subject to Technical Approval in accordance with NR/SP/CIV/003.

Materials and workmanship for concrete repair work shall be in accordance with the requirements of Section 80: Structural Concrete unless modified by this Section.

Repairs to structural concrete and the method of carrying out the repairs shall not adversely affect the performance of the structure by introducing local stiffening or adversely affecting the load path through the structure.

Deterioration and defects to be identified

83.002 In accordance with Section 23 Structural Repair Survey, the factual report shall detail the apparent deterioration of elements of the structure and identify defects that may be pertinent to the performance or durability of the structure. The deterioration to be detailed and the defects to be identified shall include, but not be limited to, the following:

- (i) cracks (including orientation, shape, size, depth, and any evidence suggesting whether this is new or long standing cracks), or whether reinforcement is exposed,
- (ii) spalling (including shape, size, depth, and any evidence suggesting whether these are new or long standing spalling), or whether reinforcement is exposed,
- (iii) “drumminess”: when struck with a suitable hammer, areas which sound “drummy” shall be identified,

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- (iv) insufficient cover to reinforcement: i.e. less than specified in BS 5400: Part 4 for the exposure and grade of concrete (including orientation, length, measured cover, and size of bars),
- (v) water seepage or retention (including the rate of seepage or the degree of retention, the source of the water, and any evidence suggesting whether this is new or long standing water seepage), leachate or rust staining, and whether the area is wet, damp, dry or subject to wetting and drying,
- (vi) exposure of reinforcement (including the orientation, shape, size and depth of the bars, and any evidence suggesting whether this is new or long standing exposure), and the nature and degree of corrosion to the reinforcement,
- (vii) honeycombing or other surface defects including shape and size,
- (viii) signs of loss of strength such as in situ crushing or as indicated by simple non-destructive tests.

All defects shall be logged and their locations identified on dimensioned sketches, to show the extent, and degree of deterioration of the structure. Photographs, in accordance with Section 23: Structural Repair Survey, shall be included for each defect, but shall not be used as a substitute for dimensioned sketches.

Tests: general **83.003** The choice of techniques for non-destructive testing of concrete shall be based on the guidelines and recommendations of BS 1881: Part 201 1986.

Where coring is proposed, the existence and location of reinforcement shall be verified by non-destructive testing prior to coring. Where necessary, calibration of the results of indirect tests shall be carried out through comparison with the direct tests.

Tests for carbonation **83.004** Details of the tests proposed to identify and quantify the extent of carbonation of concrete shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

The Contractor's proposed testing regime shall include the in situ determination of the depth of carbonation using a phenolphthalein indicator on a freshly fractured surface or on a sample of surface dust obtained from continuous percussion drilling operations.

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Tests for chloride attack

- 83.005** Details of the tests proposed to identify and quantify the extent of chloride attack shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

Wherever practical, the tests shall determine the variation in the chloride ion concentration profile with depth to assess whether the presence of chloride ions is due to intrinsic or ingressed chlorides.

In situ measurement of the chloride ion content of the concrete in accordance with Building Research Establishment Information Paper IP 21/86 shall only be used with the approval of the Employer's Representative.

Measurement of the chloride ion content of the concrete shall be carried out in accordance with Building Research Establishment Information Paper IP 21/86.

Tests for alkali-silica reaction

- 83.006** Details of the tests proposed to identify and quantify the extent of alkali-silica reaction shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

The Contractor's proposed testing regime shall include petrographic examination of 100 mm diameter, 150 mm long uncracked cores representative of the in situ condition, in accordance with the principles detailed in British Cement Association publication "The Diagnosis of Alkali Silica Reaction" and the Thomas Telford publication "Structural Effects of Alkali Silica Reaction".

Tests for delayed ettringite formation and thaumasite

- 83.007** Details of the tests proposed to identify and quantify the extent of delayed ettringite formation and thaumasite shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

The Contractor's proposed testing regime shall include petrographic examination of concrete sections in accordance with the principles detailed in British Cement Association publication "Sulphate Attack Arising from Delayed Ettringite Formation". Tests for the diagnosis of thaumasite shall also be included as set out in the DETR Thaumasite Expert Group publication "The thaumasite form of sulphate attack: risks, diagnosis, remedial works and guidance on new construction".

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Tests for compressive strength of concrete

83.008 Details of the tests proposed to determine the compressive strength of concrete shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

Unless otherwise specifically included in Appendix 83/2, the following tests shall be recommended for inclusion in the Contractor's proposed testing regime:

- (i) surface hardness tests in accordance with BS EN 12504 : Part 2,
- (ii) internal fracture tests in accordance with BS 1881: Part 207,
- (iii) pull-out tests in accordance with BS 1881: Part 207,
- (iv) pull-off tests in accordance with BS 1881: Part 207,
- (v) break-off tests in accordance with BS 1881: Part 207,
- (vi) penetration resistance in accordance with BS 1881: Part 207,
- (vii) taking and destructive testing of cores in accordance with BS EN 12504: Part 1. When carried out, the test report shall include all the information detailed in BS EN 12504: Part 1, clauses 8.2.1, 8.2.2, 8.3.1 and 8.3.2 as applicable. Where information is not known, the words "not known" shall be included against the relevant entry in the test report.

Tests for reinforcement corrosion

83.009 Details of the tests proposed to identify and quantify the extent of reinforcement corrosion and/or corrosion risk shall be submitted to the Employer's Representative: details shall include the elements to be tested and the number of samples to be tested.

The following tests shall be included in the Contractor's proposed testing regime:

- (i) resistivity measurements in accordance with BS 1881: Part 201 and the instructions for using the particular proprietary equipment used,
- (ii) half-cell potential measurements in accordance with Transport Research Laboratory (TRL) Application Guide AG9 and ASTM C876-91,

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- (iii) controlled exposure of the reinforcement; the details to be recorded shall include the location, extent and colour of the corrosion, whether the corrosion is general or concentrated in "pits", the original bar size and cover. Details of the extent of removal and detail of making good areas where reinforcement is exposed shall be included in the detailed method statement.

Where tests for chloride ingress and/or carbonation are carried out, an assessment of the corrosion risk shall be based on the results of such tests.

Tests for location of, and cover to existing reinforcement

- 83.010** Details of tests to determine the location of, and cover to existing reinforcement (including the elements to be tested, and the number of tests) shall be submitted for the agreement of the Employer's Representative.

Electromagnetic cover measurement in accordance with BS 1881: Part 204 shall be included in the Contractor's proposed testing regime.

Exposure of the reinforcement shall be included in the Contractor's proposed testing regime as a check on the accuracy of the electromagnetic cover measurement.

Where reinforcement is exposed, the details to be recorded shall include the location, extent and degree of corrosion, whether the corrosion is general or concentrated in "pits", original bar size and cover. Details of making good areas where reinforcement is exposed shall be submitted to the Employer's Representative for agreement.

Further tests

- 83.011** Where required the tests described in Appendix 83/4 shall be included in the Contractor's proposed testing regime.

Patch repairs generally

- 83.012** Repairs to spalled concrete or cracks caused by reinforcement corrosion shall be carried out by means of patch repairs in accordance, as far as is practical, with the principles shown on the Contract Drawings unless these are superseded by any of the specified requirements of this Section.

Where the cover to the reinforcement provided by reinstalling the patch repair to the dimensions of the original member would be less than that specified in BS 5400: Part 4 for the exposure and grade of concrete, increased protection shall be provided by one of the following methods: