**INSTITUTE OF CONCRETE TECHNOLOGY**
**CONCRETE TECHNOLOGY & CONSTRUCTION**

**Stage 3**
**PRACTICAL APPLICATIONS**

**Learning objectives Revision 2 (2017)**

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| **3.00.00** | **Introduction to the course**<br>3.00.01 Outline the aims, objectives and content of the course.<br>3.00.02 State methods of teaching and learning to be used on the course.<br>3.00.03 Plan for career progression and further training following successful completion of the course. |
| **3.01.00** | **Health and safety**<br>3.01.01 Prepare an assessment of the risks to health & safety for a given situation in any sector of concrete construction.<br>3.01.02 Prepare a method statement for an activity in the concrete manufacturing or supply sector, making reference to appropriate regulations. |
| **3.02.00** | **Sustainability**<br>3.02.01 Describe ways by which concrete can reduce atmospheric carbon dioxide.<br>3.02.02 Explain how responsible sourcing is relevant to the concrete industry.<br>3.02.03 Describe the impacts and contributions of aggregate extraction to biodiversity.<br>3.02.04 Define life cycle analysis as applied to concrete construction.<br>3.02.05 Describe environmental management systems. |
| **3.03.00** | **Hydration of Portland cement**<br>3.03.01 Describe the principal chemical and physical processes of the hydration of Portland cement (CEM I) and blends of CEM I with fly ash, ground granulated blastfurnace slag, condensed silica fume, metakaolin and limestone powder.<br>3.03.02 Describe the composition and structure of the principal products of the processes described in in 3.03.01 |
| **3.04.00** | **Shrinkage-compensating cement**<br>3.04.01 Describe the mechanisms of shrinkage-compensating or expansive cements.<br>3.04.02 Describe applications of shrinkage-compensating or expansive cements.<br>3.04.03 Describe design measures necessary in the use of shrinkage-compensating or expansive cements. |
| **3.05.00** | **Recycled and secondary aggregates**<br>3.05.01 Describe a classification system for recycled aggregates for use in concrete.<br>3.05.02 Describe the use of recycled aggregates in concrete.<br>3.05.03 Describe the main types and sources of secondary aggregates for use in concrete. |

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| **3.06.00** | **Reinforcement and prestressing**<br>3.06.01 Read bar schedule and check fixed reinforcement against schedule.<br>3.06.02 Read simple reinforcement detail and check reinforcement against detail.<br>3.06.03 Describe the implications of deficient and excessive cover for structural and serviceability considerations.<br>3.06.04 Identify the satisfactory depth of cover to reinforcement in common situations.<br>3.06.05 List satisfactory means of maintaining cover to reinforcement.<br>3.06.06 State and give reasons for precautions to be taken when re-bending or straightening reinforcement.<br>3.06.07 Explain differences between pre-tensioning and post-tensioning and describe the advantages and limitations of each.<br>3.06.08 List the safety precautions to be taken when prestressing. |
| **3.07.00** | **Alternative reinforcing materials and corrosion-resistant reinforcement**<br>3.07.01 Identify suitable non-ferrous materials for reinforcement of concrete and compare their properties with conventional reinforcement.<br>3.07.02 Identify suitable applications for the use of non-ferrous reinforcement.<br>3.07.03 Describe how the properties of non-ferrous reinforcement affect design of reinforced concrete elements.<br>3.07.04 Compare the properties of stainless steel reinforcement with conventional carbon steel.<br>3.07.05 Identify suitable applications for the use of stainless steel reinforcement.<br>3.07.06 Describe limitations on the use of galvanised and epoxy-coated steel reinforcement in concrete. |
| **3.08.00** | **Fibre-reinforced concrete**<br>3.08.01 Describe the properties of steel, glass, natural and micro- and macro-synthetic fibres for use in concrete.<br>3.08.02 Describe and explain how different fibre types modify the properties of fresh and hardened concrete.<br>3.08.03 Explain how fibres are incorporated into concrete.<br>3.08.04 Describe a typical application of the resulting fibre-reinforced concrete. |
| **3.09.00** | **Durability**<br>3.09.01 Identify the main mechanisms of deterioration of concrete and its reinforcement.<br>3.09.02 Describe carbonation-induced corrosion of reinforcement and identify the main factors influencing it.<br>3.09.03 Identify elements of structures where carbonation-induced corrosion of reinforcement should to be considered in design.<br>3.09.04 Describe chloride-induced corrosion of reinforcement and identify the main factors influencing it.<br>3.09.05 Identify elements of structures where chloride-induced corrosion of reinforcement needs to be considered in design.<br>3.09.06 Describe freeze/thaw damage of concrete and the methods that can be used to protect concrete against freeze/thaw damage.<br>3.09.07 Identify elements of structures where freeze/thaw damage needs to be considered in design.<br>3.09.08 Describe the main types of chemical attack on concrete.<br>3.09.09 Describe the measures that can be taken to protect concrete against chemical attack.<br>3.09.10 Identify elements of structures where chemical attack needs to be considered in design.<br>3.09.11 Describe the mechanisms affecting mechanical attrition. |

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| **3.10.00** | **Fire resistance**<br>3.10.01 Identify the main properties of concrete affecting its performance in fire.<br>3.10.02 Describe the effects of fire on concrete and its reinforcement.<br>3.10.03 Describe methods of use of concrete to protect steel from fire.<br>3.10.04 Compare the effects of fire on both lightweight aggregate concrete and high strength concrete with its effect on normal concrete. |
| **3.11.00** | **Cracking in concrete**<br>3.11.01 Distinguish between structural and non-structural cracks in concrete.<br>3.11.02 Explain reasons for limitation of crack width in reinforced concrete structures and state typical limits for different applications.<br>3.11.03 Describe factors affecting crack widths in reinforced concrete and outline how crack width can be controlled by design and by construction methods.<br>3.11.04 Identify the main types of non-structural cracks in concrete and describe the causes, features and implications of each. |
| **3.12.00** | **Creep and drying shrinkage**<br>3.12.01 Describe the mechanism of creep of concrete and identify the main factors influencing it.<br>3.12.02 Identify situations where creep of concrete is an important consideration.<br>3.12.03 Describe the mechanism of drying shrinkage of concrete and identify the main factors influencing it.<br>3.12.04 Identify applications where drying shrinkage of concrete is an important consideration.<br>3.12.05 Describe measures that can be taken to minimise drying shrinkage of concrete. |
| **3.13.00** | **Mix design**<br>3.13.01 Explain the relevance in mix design of normal distribution of concrete strength.<br>3.13.02 Explain why the mean and standard deviation of a set of results may differ from target or assumed values. |
| **3.14.00** | **Quality control and quality assurance**<br>3.14.01 Define the terms 'mean', 'standard deviation', 'coefficient of variation', 'running means of *n* results' and, given a number of results, calculate each of these values using formulae and graphical methods.<br>3.14.02 Describe typical requirements for factory production control.<br>3.14.03 Demonstrate ability to carry out the following statistical analyses of test results, *t* test and *f* test, given sufficient information.<br>3.14.04 Distinguish between 'repeatability' and 'reproducibility' as used in testing.<br>3.14.05 Describe, explain, compare and operate systems of quality control of concrete such as Shewhart Charts and Cusum, including necessary calculations.<br>3.14.06 Describe the operation of approved quality assurance schemes for concrete production. |
| **3.15.00** | **Testing, inspection and assessment**<br>3.15.01 Describe alternative methods for estimating in situ strength of concrete including early-age strength.<br>3.15.02 State reasons for core testing of concrete structures and explain the differences between estimated in situ strength and potential strength and explain where each might be required.<br>3.15.03 Describe the standard procedure for drilling, examining, preparing and compression testing of cores, and estimating strength.<br>3.15.04 Describe the correction factors for calculation of strength from drilled cores and identify their limitations. |

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| | 3.15.05 Compare the various methods of determining tensile strength.<br>3.15.06 Describe the ultrasonic pulse velocity test for concrete and explain how it can be applied in the assessment of concrete structures.<br>3.15.07 Describe the half-cell potential test for concrete and explain how it can be applied in the assessment of concrete structures.<br>3.15.08 Describe the procedure for the Initial Surface Absorption Test (ISAT), stating typical values.<br>3.15.09 Identify circumstances in which combined methods could be used.<br>3.15.10 Interpret results of the chemical analysis of hardened concrete.<br>3.15.11 Prepare a report on a structure following investigation for carbonation, chlorides, visual defects and cover. |
| **3.16.00** | **Formwork and falsework**<br>3.16.01 Describe and state the function of formwork facing materials and their effects on stripping and explain the economical use of all formwork materials.<br>3.16.02 Determine the pressure and working loads on propped and vertical formwork, given sufficient data, using accepted graphs and formulae.<br>3.16.03 Identify situations where permanent formwork is appropriate and explain the use of proprietary void formers. |
| **3.17.00** | **Plant**<br>3.17.01 Describe and explain the operation of automatically-controlled concrete production plants and autographic recording systems.<br>3.17.02 Compare methods of controlling water content and consistence during concrete production.<br>3.17.03 Compare the various types of plant used for transporting, placing, compacting and finishing concrete in terms of efficiency and reliability, interaction with other plant, overall costs and weather conditions.<br>3.17.04 Describe the main considerations in compacting and finishing lightweight, heavy-weight, low consistence and high consistence concretes. |
| **3.18.00** | **Planning, organisation, supervision and safe working practices**<br>3.18.01 Describe the roles of client, architect, consulting engineer, contractor, specialist sub-contractor, ready-mixed concrete supplier, precast concrete manufacturer and constituents supplier in the performance of a construction contract.<br>3.18.02 Devise an operational scheme detailing staff, equipment and timescale, given sufficient data and the following criteria where applicable: job specification, location of site, production method, materials and equipment, provision of services, testing facilities, labour and supervision requirements.<br>3.18.03 Outline a training programme for an operative in any sector of concrete production, construction and testing.<br>3.18.04 Plan the organisation, staffing and facilities for supervising the quality of in situ and precast concrete production.<br>3.18.05 Prepare an outline scheme for working on a construction site to enable concreting to take place in non-standard conditions. |
| **3.19.00** | **Curing**<br>3.19.01 Explain in simple terms the concepts of 'latent heat' and 'thermal capacity'.<br>3.19.02 Define maturity relating to concrete and estimate concrete strengths using this concept.<br>3.19.03 State typical requirements to avoid cracking of both low strength and high strength concrete. |

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| **3.20.00** | **Small precast products**<br>3.20.01 Prepare a suitable layout of facilities for the production of small concrete products.<br>3.20.02 Describe methods of producing concrete blocks, concrete kerbs, paving slabs and concrete pipes.<br>3.20.03 Interpret the Standards relevant to the quality control of precast concrete products and components.<br>3.20.04 Describe requirements and methods for sampling and testing small precast concrete units, applying appropriate Standards and codes of practice.<br>3.20.05 Detail the inspection procedures to be followed during and after production to meet the requirements of a quality assurance scheme. |
| **3.21.00** | **Large precast products**<br>3.21.01 Describe the main operations and principal methods used in precast concrete production.<br>3.21.02 Select and justify the selection of an appropriate technique for a particular precast concrete unit.<br>3.21.03 Prepare a suitable layout of facilities for the production of precast concrete products.<br>3.21.04 Select and justify the selection of a suitable mould in terms of materials and method of assembly.<br>3.21.05 Describe the various procedures for placing, compacting and curing precast concrete units.<br>3.21.06 Describe how different types of precast concrete units should be stored.<br>3.21.07 Describe the requirements and procedures for testing the main types of precast concrete units.<br>3.21.08 Detail the inspection procedures to be followed during and after production to meet the requirements of a quality assurance scheme. |
| **3.22.00** | **Sprayed concrete**<br>3.22.01 Define sprayed concrete and describe the wet and dry processes.<br>3.22.02 State and describe applications of sprayed concrete.<br>3.22.03 Describe the materials, mix proportions, plant and spraying procedure for each process of sprayed concrete.<br>3.22.04 Explain the inherent variability of sprayed concrete and the reasons for it.<br>3.22.05 Describe quality control and test procedures for sprayed concrete. |
| **3.23.00** | **Underwater concrete**<br>3.23.01 Describe the principal methods of concreting under water and identify where each may be used.<br>3.23.02 Identify formwork requirements and reinforcement configurations for underwater concreting.<br>3.23.03 State the properties of concrete required for underwater concreting.<br>3.23.04 Describe the materials and mix proportions for underwater concrete. |
| **3.24.00** | **Concrete piles and diaphragm walls**<br>3.24.01 Describe different types of piling operations.<br>3.24.02 Describe typical characteristics of concrete used in piling and diaphragm walls.<br>3.24.03 Describe the placing of concrete in open bore and cfa piles and diaphragm walls under bentonite. |
| **3.25.00** | **Grouts, grouting and grouted aggregate concrete**<br>3.25.01 Describe the principal applications for a cement grout.<br>3.25.02 State and describe the properties of cement grouts for particular applications.<br>3.25.03 State and describe the materials and methods used for grouting. |

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| **3.26.00** | **Slipform and jumpform construction**<br>3.26.01 State and explain the principles of slipform and jumpform construction.<br>3.26.02 Compare and contrast slipform and jumpform construction, and compare with conventional formwork methods.<br>3.26.03 Describe typical applications for slipform and jumpform construction.<br>3.26.04 Describe and illustrate the principal components of a vertical slipform and jumpform assembly, showing how the formwork is supported and raised.<br>3.26.05 Describe slipform methods for the production of in situ kerbing and central barriers.<br>3.26.06 State and explain the properties required for concrete suitable for slipform construction.<br>3.26.07 Describe methods of supplying, placing, compacting, finishing and curing of concrete for slipform construction.<br>3.26.08 State common faults that can occur in slipform construction and describe remedial action. |
| **3.27.00** | **High strength concrete**<br>3.27.01 Define high strength concrete relative to normal strength concrete.<br>3.27.02 Describe the main characteristics and features of high strength concrete and identify typical applications.<br>3.27.03 Identify suitable materials for use in high strength concrete and describe typical mix designs.<br>3.27.04 Describe special considerations when testing high strength concrete. |
| **3.28.00** | **Self-compacting concrete**<br>3.28.01 Describe the main properties, advantages, limitations and suitable applications of self-compacting concrete.<br>3.28.02 Describe how the mix design of self-compacting concrete differs from that of conventional concrete.<br>3.28.03 Describe test methods for self-compacting concrete and explain how these can be used to measure filling ability, passing ability and segregation resistance of concrete. |
| **3.29.00** | **Concrete floors**<br>3.29.01 Describe procedures for the preparation, construction and finishing of concrete floor slabs.<br>3.29.02 Describe the properties of constituent materials and concrete suitable for high quality floor slabs and for abrasion-resistant floor slabs.<br>3.29.03 Describe a method of producing a concrete floor to a high flatness tolerance.<br>3.29.04 Describe a method of producing a non-slip concrete floor.<br>3.29.05 Describe a test method for the abrasion resistance of a concrete floor.<br>3.29.06 State the mix proportions and use for cementitious floor screeds, the possible causes of failure of screeds and the precautions that need to be taken to reduce failures.<br>3.29.07 Describe the various methods, materials and mix designs used in the application of levelling screeds and wearing screeds to concrete. |
| **3.30.00** | **Concrete roads and pavements**<br>3.30.01 Describe the principal methods of construction for concrete roads, including the sequence of operation of the plant used, for both fixed form and slipform construction.<br>3.30.02 Describe the types of material that can be stabilised to form cement-bound materials (CBM).<br>3.30.03 Distinguish between wet lean concrete, different categories of CBM and cement-stabilised soils.<br>3.30.04 Describe the differences between unreinforced, jointed reinforced and continuously-reinforced concrete pavements.<br>3.30.05 Sketch joints and joint assemblies for concrete roadwork.<br>3.30.06 Describe methods of achieving skid-resistance on concrete roads and pavements.<br>3.30.07 Describe methods of specifying, designing, producing, laying, compacting, curing and testing CBM, pavement quality (PQ) concrete and their constituent materials.<br>3.30.08 Name and describe acceptance tests for CBM and PQ concrete and their constituent materials. |

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| **3.31.00** | **Concrete repairs**<br>3.31.01 Describe common situations where repair of concrete may be necessary.<br>3.31.02 Describe the common features of concrete structures that may need remedial work.<br>3.31.03 Describe the need for regular inspections of concrete structures.<br>3.31.04 Describe the procedures for inspection of a concrete structure.<br>3.31.05 Identify required properties of concrete repair materials<br>3.31.06 Select the appropriate material type and repair method for common faults in concrete.<br>3.31.07 Describe concrete repair methods for replacement of cover to reinforcement.<br>3.31.08 Describe in situ test methods for concrete repairs.<br>3.31.09 Describe the principles of the theory and methods of the electrochemical process of chloride extraction, re-alkalization and cathodic protection.<br>3.31.10 List materials used for treatment of concrete surfaces pre and post repair, and describe the method of application for each. |
| | **END OF STAGE 3** |