INSTITUTE OF CONCRETE TECHNOLOGY
CONCRETE TECHNOLOGY & CONSTRUCTION
Stage 3: PRACTICAL APPLICATIONS
Learning objectives

3.00.00 Introduction to the course
3.00.01 Outline the aims, objectives and content of the course.
3.00.02 State methods of teaching and learning to be used on the course.
3.00.03 Plan for career progression and further training following successful completion of the course.

3.01.00 Health and safety
3.01.01 Prepare an assessment of the risk to health for a given situation in any sector of concrete construction.
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 (with acknowledgement to BRE Global Ltd)
3.02.01 Describe ways by which concrete can reduce atmospheric carbon dioxide.
3.02.02 Explain how responsible sourcing is relevant to the concrete industry
3.02.03 Describe the impacts and contributions of aggregate extraction to biodiversity.
3.03.04 Define life cycle analysis as applied to concrete construction
3.03.05 Describe environmental management systems.

3.03.00 Shrinkage-compensating cement
3.03.01 Describe the mechanisms of shrinkage-compensating or expansive cements
3.03.02 Describe applications of shrinkage-compensating or expansive cements
3.03.03 Describe design measures necessary in the use of shrinkage-compensating or expansive cements.

3.04.00 Recycled and secondary aggregates
3.04.01 Describe a classification system for recycled aggregates for use in concrete.
3.04.02 Describe the use of recycled aggregates in concrete.
3.04.03 Describe the main types and sources of secondary aggregates for use in concrete.

3.05.00 Alternative reinforcing materials and corrosion-resistant reinforcement
3.05.01 Identify suitable non-ferrous materials for reinforcement of concrete and compare their properties with conventional reinforcement.
3.05.02 Identify suitable applications for the use of non-ferrous reinforcement.
3.05.03 Describe how the properties of non-ferrous reinforcement affect design of reinforced concrete elements.
3.05.04 Compare the properties of stainless steel reinforcement with conventional carbon steel.
3.05.05 Identify suitable applications for the use of stainless steel reinforcement.
3.05.06 Describe limitations on the use of galvanised steel reinforcement in concrete.
3.05.07 Describe limitations on the use of epoxy-coated steel reinforcement in concrete.
3.05.08 Describe the properties and applications of metal, glass, natural and synthetic fibres in concrete and distinguish between them.

3.06.00 Reinforcement and prestressing

3.06.01 Read simple reinforcement detail and check reinforcement against detail.
3.06.02 Describe the implications of deficient and excessive cover for structural and serviceability considerations.
3.06.03 Identify satisfactory amount of cover to reinforcement in common situations.
3.06.04 List satisfactory means of maintaining cover to reinforcement.
3.06.05 Read bar schedule and check fixed reinforcement against schedule.
3.06.06 State and give reasons for precautions to be taken when re-bending or straightening reinforcement.
3.06.07 Explain differences between pre-tensioning and post-tensioning and describe the advantages and limitations of each.
3.06.08 List the safety precautions to be taken when prestressing.

3.07.00 Durability
3.07.01 Identify the main mechanisms of deterioration of concrete and its reinforcement.
3.07.02 Describe carbonation-induced corrosion of reinforcement and identify the main factors influencing it.
3.07.03 Identify elements of structures where carbonation-induced corrosion of reinforcement needs to be considered in design.
3.07.04 Describe chloride-induced corrosion of reinforcement and identify the main factors influencing it.
3.07.05 Identify elements of structures where chloride-induced corrosion of reinforcement needs to be considered in design.
3.07.06 Describe freeze/thaw damage of concrete and the methods that can be used to protect concrete against freeze/thaw damage.
3.07.07 Identify elements of structures where freeze/thaw damage needs to be considered in design.
3.07.08 Describe the main types of chemical attack on concrete.
3.07.09 Describe the measures that can be taken to protect concrete against chemical attack.
3.07.10 Identify elements of structures where chemical attack needs to be considered in design.

3.08.00 Fire resistance
3.08.01 Identify the main properties of concrete affecting its performance in fire.
3.08.02 Describe the effects of fire on concrete and its reinforcement.
3.08.03 Describe methods of use of concrete to protect steel from fire.
3.08.04 Compare the effects of fire on light-weight aggregate concrete and high-strength concrete with the effect on normal concrete.

3.09.00 Cracking in concrete
3.09.01 Distinguish between structural and non-structural cracks in concrete.
3.09.02 Explain reasons for limitation of crack width in reinforced concrete structures and state typical limits for different applications.
3.09.03 Describe factors affecting crack widths in reinforced concrete and outline how crack width can be controlled by design and by construction methods.
3.09.04 Identify the main types of non-structural cracks in concrete and describe the causes, features and implications of each.

3.10.00 Hardened concrete – dimensional changes
3.10.01 Define the terms ‘stress’, ‘strain’, ‘modulus of elasticity’ and ‘creep’, ‘drying shrinkage’, ‘moisture movement’ and ‘thermal movement’ in relation to hardened concrete.
3.10.02 Identify the sequence and magnitude of strains due to the factors listed in 3.09.01.

3.11.00 Creep and drying shrinkage
3.11.01 Define creep of concrete and identify the main factors influencing it.
3.11.02 Identify situations where creep of concrete is an important consideration.
3.11.03 Describe the mechanism of drying shrinkage of concrete and identify the main factors influencing it.
3.11.04 Identify applications where drying shrinkage of concrete is an important consideration.
3.11.05 Describe measures that can be taken to minimise drying shrinkage of concrete.

3.12.00 Mix design

3.12.01 Design concretes of specified strength, of maximum water/cement ratio, minimum and maximum cement content, for conditions of exposure, air entrainment, sulfates in the ground or minimizing the risk of ASR.

3.12.02 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.

3.12.03 Explain the relevance in mix design of normal distribution of concrete strength.

3.12.04 Explain why the mean and standard deviation of a set of results may differ from target or assumed values.

3.13.00 Quality control and quality assurance

3.13.01 Describe typical requirements for factory production control.

3.13.02 Demonstrate ability to carry out the following statistical analyses of test results: standard deviation, *t* test, *f* test and coefficient of variation, given sufficient information.

3.13.03 Distinguish between 'repeatability' and 'reproducibility' as used in testing.

3.13.04 Describe the concept of concrete families.

3.13.05 Describe, explain, compare and operate systems of quality control of concrete such as Shewhart and Cusum, including necessary calculations.

3.13.06 Describe the operation of approved quality assurance schemes for concrete production.

3.14.00 Testing, inspection and assessment

3.14.01 Describe alternative methods for estimating in situ strength of concrete including early-age strength.

3.14.02 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.

3.14.03 Describe the standard procedure for drilling, examining, preparing and compression testing of cores, and estimating strength.

3.14.04 Describe the correction factors for calculation of strength from drilled cores and identify their limitations.

3.14.05 Compare the various methods of determining tensile strength.

3.14.06 Describe the ultrasonic pulse velocity test for concrete and explain how it can be applied in the assessment of concrete structures.

3.14.07 Describe the half-cell potential test for concrete and explain how it can be applied in the assessment of concrete structures.

3.14.08 Describe the procedure for the Initial Surface Absorption Test (ISAT), stating typical values.

3.14.09 Interpret results of the chemical analysis of hardened concrete

3.14.10 Prepare a report on a structure following investigation for carbonation, chlorides, visual defects or cover.

3.15.00 Formwork and falsework

3.15.01 Describe and state the function of formwork fixtures and fittings, sheathing materials and their effects on stripping and explain the economical use of all formwork materials.

3.15.02 Determine the pressure and working loads on propped and vertical formwork, given sufficient data, using approved graphs and formulae.

3.15.03 Sketch typical arrangements of travelling forms and state their applications.

3.15.04 Identify situations where permanent formwork is appropriate and explain the use of proprietary void formers.

3.16.00 Plant

3.16.01 Describe and explain the operation of automatically-controlled concrete production plants and autographic recording systems.

3.16.02 Compare methods of controlling water content and consistence in concrete production.

3.16.03 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.

3.16.04 Select types and sizes and describe items of plant for economic placing of fresh concrete to suit particular requirements.

3.16.05 Describe the main considerations in compacting and finishing light-weight, heavy-weight, low consistence and high consistence concretes.

3.17.00 Planning, organisation, supervision and safe working practices

3.17.01 Describe the roles of client, architect, consulting engineer, contractor, specialist sub-contractor, ready-mixed concrete supplier, precast concrete manufacturer and materials supplier in the performance of a construction contract.

3.17.02 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.

3.17.03 Outline a training programme for an operative in any sector of concrete production, construction and testing.

3.17.04 Plan the organisation, staffing and facilities for supervising the quality of in situ and precast concrete.

3.17.05 Prepare an outline scheme for working on a construction site to enable concreting to take place in abnormal conditions.

3.18.00 Curing

3.18.01 Explain in simple terms the concepts of latent heat and thermal capacity

3.18.02 Define the maturity of concrete and estimate concrete strengths using this concept.

3.18.03 State typical requirements to avoid cracking in massive pours of both low strength and high strength concrete.

3.19.00 Small precast products

3.19.01 Prepare a suitable layout of facilities for the production of precast concrete products.

3.19.02 Describe the principal methods of concrete block production.

3.19.03 Describe methods of producing concrete kerbs and paving slabs.

3.19.04 Describe methods of producing concrete pipes

3.19.05 Interpret the standards relevant to the quality control of precast concrete products and components.

3.19.06 Describe the methods of sampling finished precast concrete products, applying appropriate standards and codes of practice.

3.19.07 Describe requirements and methods for testing small precast concrete units.

3.19.08 Detail the inspection procedures to be followed during and after production to meet the requirements of a quality assurance scheme.

3.20.00 Large precast products

3.20.01 Describe the main operations and principal methods used in precast concrete production.

3.20.02 Select and give justification for the selection of an appropriate technique for a particular precast concrete unit.

3.20.03 Prepare a suitable layout of facilities for the production of precast concrete products.

3.20.04 Select and give justification for the selection of a suitable mould in terms of materials and method of assembly.

3.20.05 Describe the various procedures for placing, compacting and curing precast concrete units.

3.20.06 Describe how different types of precast concrete units should be stored.

3.20.07 Describe the requirements and procedures for testing the main types of precast concrete units.

3.20.08 Detail the inspection procedures to be followed during and after production to meet the requirements of a quality assurance scheme.

3.21.00 Sprayed concrete

3.21.01 Define sprayed concrete and the wet and dry processes.

3.21.02 State and describe applications of sprayed concrete.

3.21.03 Describe the materials, mix proportions, plant and spraying procedure for each process of sprayed concrete.

3.21.04 Describe quality control and test procedures for sprayed concrete.

3.22.00 Underwater concrete

3.22.01 Describe the main methods of concreting under water and identify where each may be used.

3.22.02 Identify formwork requirements and reinforcement configurations for underwater concreting.

3.22.03 State the properties of concrete required for underwater concreting

3.22.04 Describe the materials and mix proportions for underwater concrete.

3.23.00 Concrete piles and diaphragm walls

3.23.01 Describe the different types of piling operations.
3.23.02 Describe typical characteristics of concrete used in piling and diaphragm walls.
3.23.03 Describe the placing of concrete in piles and diaphragm walls.

3.24.00 Grouts, grouting and grouted aggregate concrete

3.24.01 Describe the main applications for a cement grout.
3.24.02 State and describe the properties of a cement grout for a particular application.
3.24.03 State and describe the materials and methods used for grouting, including various specialist systems.

3.25.00 Slipform and jumpform construction

3.25.01 State and explain the principles of slipform and jumpform construction and compare with conventional formwork methods.
3.25.02 Compare and contrast slipform and jumpform construction.
3.25.03 State the main criteria in determining suitability of slipform and jumpform construction and describe typical applications.
3.25.04 Describe and illustrate the principal components of a vertical slipform assembly, showing how the formwork is supported and raised.
3.25.05 Describe slipform methods for the production of in situ kerbing and central barriers.
3.25.06 State and explain the properties required for concrete suitable for slipform construction.
3.25.07 Describe methods of supplying, placing, compacting, finishing and curing of concrete for slipform construction.
3.25.08 State common faults that can occur in slipform construction and describe remedial action.
3.25.09 Describe and illustrate the principal components of a vertical jumpform assembly and describe the construction sequence.

3.26.00 High strength concrete

3.26.01 Define high strength concrete
3.26.02 Describe the main characteristics and features of high strength concrete and identify typical applications.
3.26.03 Identify suitable materials for use in high strength concrete and describe typical mix designs.
3.26.04 Describe special considerations when testing high strength concrete.

3.27.00 Self-compacting concrete

3.27.01 Describe the main properties, advantages, limitations and suitable applications of self-compacting concrete.
3.27.02 Describe how the mix design of self-compacting concrete differs from that of conventional concrete.
3.27.03 Describe test methods for self-compacting concrete.

3.28.00 Concrete floors

3.28.01 Describe procedures for the preparation, construction and finishing of concrete industrial floor slabs.
3.28.02 Describe the properties of constituent materials and concrete suitable for high quality floor slabs and for abrasion-resistant floor slabs.
3.28.03 Describe a method of producing a concrete floor to a very tight flatness tolerance.
3.28.04 Describe a method of producing a non-slip concrete floor.
3.28.05 Describe the classification of abrasion resistance of concrete industrial floors and describe the test method.
3.28.06 State the mix proportions and use for floor screeds, the possible causes of failure of screeds and the precautions that need to be taken to reduce failures.
3.28.07 Describe sand/cement levelling screeds and their uses
3.28.08 Describe the various methods, materials and mix designs used in the application of levelling screeds and wearing screeds to concrete.

3.29.00 Concrete roads and ground slabs

3.29.01 Describe the main methods of construction for concrete roads, including the sequence of operation of the plant used, for both fixed form and slipform construction.
3.29.02 Describe the types of material that can be stabilised to form cement-bound materials.
3.29.03 Distinguish between wet lean concrete, different categories of CBM and cement-stabilised soils.
3.29.04 Describe the differences between unreinforced, jointed reinforced and continuously- reinforced concrete pavements.
3.29.05 Sketch joints and joint assemblies for concrete roadwork.
3.29.06 Describe methods of achieving skid-resistance on concrete roads and pavements.
3.29.07 Describe methods of specifying, designing, producing, laying, compacting, curing and testing CBM, pavement quality (PQ) concrete and their constituent materials.
3.29.08 Name and describe acceptance tests for CBM and PQ concrete and their constituent materials.

3.30.00 Vacuum process

3.30.01 Describe the vacuum process for concrete de-watering.
3.30.02 Describe applications for the vacuum dewatering process.
3.30.03 State advantages and disadvantages of vacuum process.
3.30.04 Discuss the effects of vacuum on concrete properties.

3.31.00 Concrete repairs

3.31.01 Describe common situations where repair of concrete may be necessary.
3.31.02 Describe the main features of concrete structures that may need remedial work.
3.31.03 Describe the need for regular inspections of concrete structures and identify applicable structures.
3.31.04 Describe the procedures for inspection of a concrete structure.
3.31.05 Identify required properties of concrete repair materials
3.31.06 Select the correct material type and repair method for given faults in concrete.
3.31.07 Identify suitable crack repair materials for different types of crack in concrete.
3.31.08 Describe crack repair methods.
3.31.09 Describe concrete repair methods for replacement of cover to reinforcement.
3.31.10 Describe test methods for concrete repair materials.
3.31.11 Describe the principles of the theory and methods of the electrochemical process of chloride extraction
3.31.12 Describe the principles of the theory and methods of the electrochemical process of re-alkalization
3.31.13 Describe the principles of the theory and methods of the electrochemical process of cathodic protection
3.31.14 List materials used for treatment of concrete surfaces and describe the method of application for each.