INSTITUTE OF CONCRETE TECHNOLOGY

CONCRETE TECHNOLOGY & CONSTRUCTION

Stage 2

GENERAL PRINCIPLES

Learning Objectives Revision 4 (2026)

Introduction to the course: The course provides an introduction to the aims, objectives, and content of the course, helping the course participant to understand the methods of teaching and learning, and to help plan career progression and further training following successful completion of the course.

2.01 Health and safety	
2.01.01	Identify the risks to health and safety within the concrete construction industry.
2.01.02	Identify and state sources of danger in the operation of concreting plant and equipment and identify precautions to be taken to ensure safe working.
2.02 Sustainability	
2.02.01	Know definitions for 'sustainability', 'life cycle analysis', 'embodied energy' and 'embodied carbon dioxide' associated with concrete supply.
2.02.02	Understand the positive and negative environmental contributions of Portland cement manufacture.
2.02.03	Be able to list the alternative fuels that may be used in Portland cement manufacture.
2.03 Portland cements and additions	
2.03.01	Be able to list the common types of cements and combinations, be able to describe their manufacture and understand typical applications for each.
2.03.02	Know the four main chemical compounds in Portland cements and understand their effects on the properties of concrete.
2.03.03	Understand how Standards identify the different types of common cement, in respect to their compositions and strength classifications.
2.03.04	Know definitions for the terms 'hydraulic binder', 'minor additional constituents', 'additives', 'filler' and 'auto control' in relation to Portland cements.
2.03.05	Be able to describe the production, properties and use of fly ash (pulverized-fuel ash), ground granulated blastfurnace slag, silica fume, metakaolin and natural pozzolanas in concrete.
2.03.06	For each of the materials listed in 02.03.05, be able to describe their effects on the properties of concrete in the fresh and hardened states.
2.03.07	Identify the main Standard tests for cement, typical limiting values and the significance of the test result for concrete.
2.04 Non-Portland cements	
2.04.01	Be able to list the common types of non-Portland cements, high alumina cement (HAC), Alkali-activated materials (AAM) and calcium sulfoaluminate cement (CSA) and know their principal raw materials.
2.04.02	Understand how these cements work and the precautions to be taken in their use.
2.04.03	Be able to compare the properties of Portland and non-Portland cements.
2.04.04	Be able to describe suitable applications for non-Portland cements.

2.05 Natural, secondary and manufactured aggregates	
2.05.01	Know definitions for and be able to describe the sources of primary, secondary and manufactured aggregates and be able to list common types of each.
2.05.02	Be able to list the main operations in the extraction and processing of aggregates.
2.05.03	Understand how the source and production of an aggregate influence its physical properties.
2.05.04	Understand the limitations of using recycled aggregates.
2.05.05	Understand the requirements for the satisfactory storage of aggregates.
2.05.06	Understand the Standard tests for aggregates and their limiting values.
2.05.07	Be able to list the main impurities associated with aggregates for concrete, be able to describe their likely effects on the concrete and know their limiting values.
2.05.08	Be able to prepare a combined grading curve from two or more aggregate gradings.
2.05.09	Understand how changes in aggregate properties can influence the properties of fresh and hardened concrete.
2.05.10	Identify magnitude of changes in aggregate quantities likely to cause significant changes in the concrete.
2.06 Lightweight and heavy-weight aggregates	
2.06.01	Be able to name and recognise types of lightweight and heavy-weight aggregate.
2.06.02	Understand the origins of lightweight and heavy-weight aggregate.
2.06.03	Understand the reasons for using lightweight and heavy-weight aggregates in concrete and be able to describe typical applications.
2.06.04	Be able to compare characteristics of lightweight and heavy-weight aggregates affecting their storage, batching and mixing.
2.06.05	Understand the properties of lightweight aggregates and outline their production methods.
2.06.06	Be able to state the approximate relative densities of the main types of heavy-weight aggregates.
2.07 Admixtures	
2.07.01	Know definitions for and the classification of types of admixtures.
2.07.02	Understand the role of common types of admixtures and when they would be used.
2.07.03	Understand the requirements for the correct storage and dispensing of admixtures.
2.07.04	Understand how concrete admixtures can contribute to sustainability.
2.08 Mixing water	
2.08.01	Understand the need for the chemical and physical testing of non-potable mixing water for concrete.
2.08.02	Understand why seawater is unsuitable for mixing water for reinforced concrete.
2.09 Mix design	
2.09.01	Know definitions for the terms ‘characteristic strength’, ‘design margin’ and ‘target mean strength’ and understand how they are related.
2.09.02	Understand the factors affecting mix design and be able to make modifications to a design for particular conditions of construction and use.
2.09.03	Understand the principles for designing a concrete for a given strength class of concrete using a recognised method.
2.09.04	Understand the principles for designing 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 AAR.
2.09.05	Be able to design a trial mix of concrete given sufficient data.
2.09.06	Be able to calculate batch weights given size of mixer, density of fresh concrete and mix proportions by weight, expressed either as ratios or quantities per unit volume.
2.09.07	Understand the preparation of a laboratory trial mix, the assessment of the concrete and any necessary adjustment.
2.09.08	Be able to calculate quantities of materials for full-scale mixes from trial mix data, from materials properties and specified proportions or quantities.

2.10 Fresh concrete	
2.10.01	Know definitions for the 'rheology of concrete' with respect to consistence, compactability and flow characteristics.
2.10.02	Be able to list the major factors which influence consistence and surface finish characteristics and their effects.
2.10.03	Understand the causes and effects of segregation, bleeding and plastic cracking and explain how the effects can be reduced.
2.10.04	Know definitions for the terms 'false set' and 'flash set' and understand possible causes.
2.11 Hardened concrete - behaviour under load	
2.11.01	Know definitions for the terms 'stress', 'strain', 'modulus of elasticity' and 'creep' in relation to concrete.
2.11.02	Understand the difference between compressive strength, tensile strength and flexural strength and be able to state the relative performance of concrete in each.
2.12 Hardened concrete - dimensional changes	
2.12.01	Know definitions for the terms 'autogenous shrinkage', 'drying shrinkage' and 'moisture and thermal movements' in relation to concrete.
2.12.02	Understand the main factors affecting dimensional changes and be able to state their effects and counter measures.
2.13 Hardened concrete - durability	
2.13.01	Understand the durability of concrete and be able to identify the major causes of deterioration.
2.13.02	Understand the important factors affecting the resistance of concrete to abrasion, fire, frost and chemical attack.
2.13.03	Be able to identify sources of chlorides and understand their effect on the durability of reinforced concrete and the precautions that should be taken in chloride environments.
2.13.04	Know the process of carbonation and understand its effect on the durability of reinforced concrete and the precautions that should be taken to resist this effect to ensure good durability.
2.13.05	Know the deleterious effects on concrete that can occur in sulfate bearing ground and acidic ground, and the precautions which should be taken to resist these effects to ensure good durability.
2.13.06	Know the mechanisms of Alkali Aggregate Reaction (AAR) and steps that can be taken to minimise the effect of it in concrete.
2.14 Steel for reinforcing	
2.14.01	Identify different types of steel reinforcement by visual inspection or description.
2.14.02	Know a definition for the 'yield stress' of steel.
2.14.03	Be able to compare important properties of different types of reinforcement.
2.14.04	Understand the uses and appearance of different types of reinforcement.
2.14.05	Understand sizes of reinforcement bars available.
2.14.06	Understand suitable methods of storing reinforcement bars on site.
2.14.07	Be able to identify the condition of reinforcement by visual inspection or from description and understand whether it is fit for use.
2.14.08	Understand methods of dealing with reinforcement in an unsatisfactory condition.
2.14.09	Be able to describe methods of bending reinforcement bars.
2.14.10	Understand shapes of bent bars in common use.
2.14.11	Understand the application of steel fabric and typical fixing details.
2.14.12	Understand methods of fixing and locating reinforcement
2.14.13	Understand the purpose of special reinforcements such as loops and rings.
2.15 Reinforced concrete	
2.15.01	Know definitions for and understand 'compression', 'tension', 'shear' and 'bending' as applied to reinforced concrete beams, slabs and columns under load.
2.15.02	Understand and be able to compare the behaviour of plain and reinforced concrete under load.

2.15.03	Be able to make appropriate comparisons between the strengths of reinforcement and concrete and be able to compare the thermal expansions of steel and concrete.
2.15.04	Be able to state typical strength classes of concrete for reinforced concrete.
2.15.05	Understand and be able to give reasons for the disposition of reinforcement in concrete beams, slabs, cantilevers, columns and walls, its action in controlling cracking and how bond is developed within concrete.
2.15.06	Understand the causes and the effects on the durability of concrete of changes in the thickness of concrete cover, the quality of concrete and variations in exposure.
2.15.07	Understand the effects of surface geometry (i.e. plain or deformed bars) and the surface condition of steel on its performance as reinforcement.
2.15.08	Understand how the position of reinforcement is maintained during concreting.
2.16 Fibre-reinforced concrete	
2.16.01	Be able to list the various types of fibrous reinforcing materials and be able to state an application in concrete.
2.17 Testing fresh and hardened concrete	
2.17.01	Be able to compare consistence test methods and understand why two concretes of the same slump can have different degrees of compactability.
2.17.02	Be able to describe and compare test methods for the plastic properties of self-compacting concrete.
2.17.03	Understand the key mechanical and operational factors of compression testing machines and their effects on performance.
2.17.04	Understand the procedures for testing concrete cubes, cylinders and cores for saturated density and compressive strength, make calculations and be able to identify abnormal modes of failure.
2.17.05	Be able to describe the method of end preparation of cylinders and drilled cores for compressive strength testing.
2.17.06	Understand the necessary properties of materials for capping of cylinders or cores and suitable capping materials.
2.17.07	Understand the procedure for determining tensile splitting strength.
2.17.08	Understand the methods and purpose of common non-destructive tests for hardened concrete.
2.17.09	Be able to describe the testing of a structure using a rebound hammer and interpret the results accounting for the type of structure, the number of readings and their location, surface condition and the angle of test.
2.18 Quality control – statistical methods	
2.18.01	Be able to state the principles of quality control for the production of concrete.
2.18.02	Know definitions for the terms ‘mean’, ‘standard deviation’ and ‘coefficient of variation’ and, given a number of results, be able to calculate each of these values using formulae and graphical methods.
2.18.03	Understand the relevance in mix design of ‘normal distribution’ of concrete strength.
2.18.04	Understand why the mean and standard deviation of a set of results may differ from target or assumed values.
2.19 Specification	
2.19.01	Understand the role of Standards and Regulations in concrete specification.
2.19.02	Be able to identify and interpret specification clauses related to materials and mix design.
2.19.03	Understand the main parameters used for judging conformity for designated, designed, prescribed and standardized prescribed concretes.
2.19.04	Understand what is proprietary concrete and how it is specified.
2.19.05	Understand procedures for checking the conformity of a designed concrete and the range of possible actions in the event of non-conformity.
2.20 Storage, batching and mixing	
2.20.01	Be able to compare advantages and disadvantages of the main types of batching and mixing plants.
2.20.02	Be able to determine a suitable type and size of plant for a particular situation, given type of concrete and rate of production required, for common situations only.

2.20.03	Understand and be able to sketch storage and plant layout for batching and mixing, given details of output required, situation, ground conditions, access and facilities available for site-mixed, precast and ready-mixed concrete production.
2.20.04	Be able to calculate quantities of constituent materials, delivery rate and storage capacity given concreting programme, mix design data and materials availability, including allowances for loss.
2.20.05	Understand factors affecting uniformity of concrete and describe what action may be taken to minimize any problem.
2.21 Concrete production and supply	
2.21.01	Understand procedures for dealing with concrete in the event of changes to its consistence or cohesion during handling.
2.22 Production of concrete	
2.22.01	Be able to compare the basic advantages and economics of site-mixed and ready-mixed concrete.
2.22.02	Understand the capacities and total laden weights of typical ready-mixed concrete trucks.
2.22.03	Understand the normal contractual basis of supply of concrete and the method by which the quantity may be checked.
2.22.04	Understand the procedures to be agreed between purchaser and supplier in the provision of ready-mixed concrete.
2.22.05	Be able to list the essential items of information to be given in an order for ready-mixed concrete.
2.22.06	Understand the procedures for the preparation of a site for the receipt of ready-mixed concrete.
2.22.07	Understand the intentions and main requirements of a third-party accreditation quality assurance scheme.
2.22.08	Understand the main requirements for setting up and operation of mobile or portable concreting plant and equipment in common use.
2.22.09	Understand the procedures for cleaning concreting plant and equipment after use.
2.23 Precast concrete	
2.23.01	Understand the factors affecting the choice between precast and in situ concrete construction.
2.23.02	Understand the principal methods and main operations used in precast concrete manufacture and the applications and advantages of each method.
2.23.03	Understand the special requirements for aggregate storage, batching, mixing and handling equipment used in precast concrete production.
2.23.04	Understand the methods of mould making and the factors affecting dimensional accuracy.
2.23.05	Be able to name, list and recognise materials commonly used for moulds for standard precast concrete products.
2.23.06	Understand the common forms of moulds for standard precast concrete products and the correct mould from a product specification, selecting the material bearing in mind the number of casts, degree of accuracy required and the production technique.
2.23.07	Be able to list the main methods of compaction used for standard precast concrete products and the reasons for using each method.
2.23.08	Be able to list the main operations in manufacturing and curing processes for standard precast concrete products.
2.24 Formwork and falsework	
2.24.01	Understand the types of materials commonly used in construction of formwork and reasons for their use.
2.24.02	Understand the factors that affect the pressure of concrete on formwork and how the pressures are distributed.
2.24.03	Understand the satisfactory arrangements of formwork and falsework for concrete columns, suspended slabs, walls and beams, giving sizes, spacing and disposition of supports.
2.24.04	Be able to sketch arrangements of formwork to kickers, box-outs and stop ends.
2.24.05	Be able to compose pre-pour checklists for concrete columns, slabs, walls and beams.
2.24.06	Understand the types of release agent and their effects on striking and concrete finish.

2.24.07	Understand the factors which govern the minimum striking times for formwork and be able to state typical minimum striking times for concrete columns, suspended slabs, walls and beams.
2.24.08	Understand the satisfactory condition of formwork for re-use and procedures for maintenance and storing forms for re-use.
2.25 Transporting and placing	
2.25.01	Be able to describe the principal means of transporting and placing fresh concrete.
2.25.02	Be able to compare advantages and disadvantages of each type of equipment in 2.25.01, including the ranges of handling capacity.
2.25.03	Be able to select suitable type of equipment and method of placing fresh concrete for a particular situation given details of concrete, construction and access, for common situations only.
2.25.04	Understand how properties of concrete can be affected during handling, transporting and placing and be able to describe and justify suitable methods for typical and special situations, including re-tempering and on-site adjustments.
2.26 Compaction and finishing	
2.26.01	Understand the principal types of compaction equipment and recognise from visual inspection or description.
2.26.02	Be able to compare advantages and disadvantages of each type of equipment listed in 02.26.01.
2.26.03	Be able to select the correct vibrating equipment in a given situation and be able to describe its care and maintenance.
2.26.04	Understand the correct use of immersion, beam and clamp-on vibrators.
2.26.05	Understand the correct use of pneumatic or electric hammer for vibration of concrete.
2.26.06	Understand the effects of various types of vibration on the design and construction of formwork.
2.26.07	Understand the potential problems in compacting and finishing special concretes.
2.27 Concrete finishes	
2.27.01	Understand the factors to be considered in the production of a concrete required for a given type of finish.
2.27.02	Understand the factors necessary to produce direct and indirect surface finishes.
2.27.03	Understand the common types of integral decorative finish to concrete and methods of production.
2.27.04	Be able to identify the condition of moulds and erected formwork as suitable for achievement of high quality finish.
2.27.05	Understand the significance of release agents, striking times and curing on the appearance of concrete finishes.
2.27.06	Understand the factors affecting quality of finished surface of concrete and the effects of each.
2.27.07	Understand the concreting procedures for achieving a high quality finish.
2.27.08	Understand the occurrence of common defects in concrete surfaces and how to minimise them.
2.28 Curing	
2.28.01	Be able to list common methods of curing.
2.28.02	Understand the special requirements which should be taken when curing concrete in hot or cold weather.
2.28.03	Understand how a delay in curing may cause plastic cracking and be able to state remedies.
2.28.04	Understand the purpose of accelerated curing and established methods.
2.29 Ground slabs	
2.29.01	Be able to list the main operations in the construction of concrete ground slabs.
2.29.02	Understand the main methods of construction for concrete floor slabs and their finishes.
2.29.03	Understand the requirements for suitable materials for sub-grades and sub-bases.
2.29.04	Understand the reasons for providing underlay to ground slabs.
2.29.05	Understand the main factors to be considered in determining bay layout and flatness.
2.29.06	Be able to sketch and explain the standard joints used in floor slabs.
2.29.07	Understand the construction details for ground slabs at edges and joints.
2.29.08	Understand the main methods of finishing floor slabs, including power floating.

2.29.09	Understand the methods of curing floor slabs and concrete finishes and treatment to combat dusting on a concrete floor.
2.29.10	Understand the difference between a screed and a slab.
2.30 Joints	
2.30.01	Understand and be able to sketch details of joints in a concrete structure and understand the applications of each type of joint.
2.30.02	Understand the items requiring special care and attention in the formation of joints and likely effects of not taking care.
2.30.03	Understand the locations and methods of forming construction joints for a given structure.
2.30.04	Understand the satisfactory location of construction joints in walls, slabs, beams and columns.
2.30.05	Understand the use of compressible joint fillers, water stops and joint sealing compounds.
2.31 Management	
2.31.01	Be able to name the key management and supervisory positions on a construction contract, in a precast concrete works and in a ready-mixed concrete plant and understand the roles of these personnel.
2.31.02	Understand the roles of client, architect, consulting engineer, contractor, specialist sub-contractor, ready-mixed concrete suppliers, precast concrete manufacturer and materials supplier in the performance of a construction contract.
2.31.03	Be able to outline a training programme for a testing technician to such a level as ACI/ICT Concrete Field Testing Technician or ICT Stage 1 Concrete Practice.
END OF STAGE 2	

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