Concrete Technology Course (CTC) – Detailed Learning Outcomes

BLOCK	MODULE	MAJOR TOPICS IN EACH MODULE	LEARNING OUTCOMES FROM EACH MODULE
Block 1: Course Introduction	**Module 1:** Concrete Technology Course (CTC) Introduction	1. About Cement, Concrete & Aggregates Australia (CCAA) 2. CCAA Concrete Technology Course	
	Module 2: Our Work Environment	1. Managing Health and Safety 2. Managing Risks in the Workplace 3. Implications for Me and My Team 4. Our Environmental Responsibilities 5. Environmental Risks in the Concrete Industry	At the completion of this module you will be able to: • Identify the key PPE requirements for working with concrete – at the concrete plant or on-site • Understand what safety precautions are necessary when working with concrete • Explain the key factors addressed in typical Environmental Protections Acts • Identify precautions that can be taken at a concrete plant in each area of environmental importance
	Module 3: Concrete Sustainability / Green Star	1. Challenges for the Concrete Industry 2. Sustainability Benefits from Concrete Use 3. Competitor Materials 4. Meeting the Challenges 5. Green Star 6. Life Cycle Assessment	At the completion of this module you will be able to: • Discuss the competing considerations relating to 'concrete sustainability' – including both the positive and negative aspects of concrete from an environmental perspective • Understand some of the changes being made or considered in concrete technology to reduce environmental impacts • Understand methods of producing 'green cements/concretes' – approaches being taken and applications to date • Discuss some approaches being used to reduce the environmental impact of concrete and their applicability

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Block 2: Concrete Materials	**Module 4a:** Cementitious Materials (*Portland and Blended Cements*)	1. History of Cement 2. Manufacture of Portland Cement 3. The Cement Manufacturing Process 4. Environmental Aspects of Cement Manufacture 5. Chemistry of Portland Cement 6. Reportable Properties and Materials 7. Types of Cement 8. Other Cements 9. The Hydration and Setting of Portland Cement 10. Hydration Characteristics of Portland Cement 11. The Hardening of Cement 12. Impacts on Concrete Performance 13. Special Properties of Cement 14. Storage Sampling and Testing of Cement	At the completion of this module you will be able to: • Describe the general use of 'cements' in ancient times. • Describe the manufacturing processes involved in making Portland cement. • Comment on the environmental issues associated with cement manufacture • Describe in general terms, the mineralogy and chemistry of Portland cement • Define the types of cement and the important characteristics of each type. • Describe the different stages in the cement hydration reaction • Understand the reasons certain concrete properties are affected by various cement characteristics • Describe in general terms, the nature of ASR and sulfate attack on concrete • Describe the important requirements for the proper storage of cement
	Module 4b: Cementitious Materials (*Introduction to Supplementary Cementitious Materials*)	1. How SCMs Work 2. Reasons for Use of SCMs 3. Properties of Concrete 4. Impact on Chemical Admixtures 5. Australian Standards for SCMs 6. Testing	At the completion of this module you will be able to: • Describe the typical SCM-types used in Australia. • Explain how SCM's work in concrete. • Describe the benefits of using SCM's in both the plastic and hardened states of concrete. • Explain the specific advantages to plastic and hardened state concrete properties from using the various SCM's. • Nominate the relevant Australian Standard series specific to SCM's.

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Block 2: Concrete Materials	**Module 5:** Fly Ash	1. Benefits 2. Concerns 3. The Material 4. Standards Requirements 5. Production 6. Properties 7. Use of Fly Ash 8. Transporting and Handling Fly Ash 9. How Does Fly Ash Work in Concrete 10. Use with Chemical Admixtures 11. Properties of Fly Ash Concrete 12. Curing 13. Formwork Stripping Times 14. High Volume Fly Ash Concrete 15. Testing Fly Ash	At the completion of this module you will be able to: • Describe the way in which fly ash is formed • Explain the benefits of using fly ash in concrete in both the plastic and hardened states • Explain how fly ash reacts and how this leads to improved concrete performance • List the concrete durability improvements derived from using fly ash • Describe the relative handling characteristics of fly ash (compared to cement) and how it should be stored and transported • Describe the concept of Proven and Unproven Sources • Discuss the environmental benefits from using fly ash
	Module 6: Slag	1. Benefits 2. Concerns 3. The Materials 4. Standards Requirements 5. Production 6. Properties 7. Transport and Handling of GGBFS 8. Use of GGBFS 9. Blast Furnace Slag Cement 10. How Does GGBFS Work? 11. Properties of Slag Concrete 12. Curing / Strength Development 13. GGBFS Replacement Ration 14. Testing	At the completion of this module you will be able to: • Describe the process in which slag is formed • Explain the difference between GBFS and GGBFS • Explain the benefits of using GGBFS in concrete in both the plastic and hardened states • Explain how GGBFS reacts and how this leads to improved concrete performance • List the concrete durability improvements derived from using GGBFS • Describe the relative handling characteristics of GGBFS (compared to cement) and how it should be stored and transported • Describe the concept of Proven and Unproven Sources • Discuss the environmental benefits from using GGBFS

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Block 2: Concrete Materials	**Module 7:** Amorphous Silicas	1. Benefits 2. Concerns 3. The Materials 4. Standards Requirements 5. Production 6. Properties 7. Use 8. Handling Amorphous Silica 9. Health and Safety 10. Amorphous Silica Reactions 11. Properties of Concrete Containing Amorphous Silica 12. Durability 13. Curing 14. Use of Chemical Admixtures 15. Testing	At the completion of this module you will be able to: • Distinguish between the various sources of amorphous silica materials. • Describe the different physical forms in which silica fume might be supplied to the concrete market. • Describe the benefits of using amorphous silicas and possible concerns. • Describe important aspects of the handling and storage of amorphous silicas • Discuss how amorphous silicas react in a concrete mix, and the nature of their effects on the plastic and hardened states of concrete. • Discuss the key ways in which silica fume affects compressive strength and durability performance of concrete. • Describe any limitations or effects resulting from the use of amorphous silicas on concrete admixture use and performance.

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Block 2: Concrete Materials	**Module 8:** Concrete Aggregates	1. Classification of Aggregates 2. Density 3. Specification of Aggregates 4. Water Absorption 5. Dimensional Aggregate Properties 6. Particle Shape and Texture 7. Hardness 8. Strength 9. Durability 10. Alkali Aggregate Reaction (AAR) 11. Other Deleterious Substances 12. Slag Aggregate 13. Typical Sources of Aggregate 14. Influence on Concrete Properties 15. Testing Aggregate	At the completion of this module you will be able to: • Understand the importance of the role aggregates play in concrete performance • Be able to explain the specific impacts that aggregates can have on plastic and hardened concrete performance • Understand the different sizes of aggregate materials and how they are prepared. • Describe the key properties of aggregate materials, how they affect concrete performance and how they are measured. • Understand the importance of aggregate grading – for both the individual materials and of the combined grading when they are combined in a concrete mix • Understand the need for aggregates to have good durability performance and how this relates to concrete performance. • Understand what 'manufactured sand' is and how it is tested. • Understand in general terms, the wide variety of geological materials that are available – including those that are acceptable as concrete aggregates and those that are unsuitable. • Understand how aggregates affect Alkali Aggregate Reaction/ Alkali Silica Reaction (AAR / ASR) and what testing is available to determine potential aggregate reactivity. • Describe the Australian Standards used to specify aggregate characteristics and performance and the relevant test methods.
	Module 9: Water and Concrete	1. Water Quality Issues 2. Water Quality Criteria 3. Effect of Major Impurities in Mixing Water 4. Limits on Impurities 5. Implications of Water Quality 6. The Role/s of Water in Concrete	At the completion of this module you will be able to: • List the two ways in which AS 1379 *Specification and Supply of Concrete* deems water to be acceptable for concrete • Understand the reason for limits on chlorides in mixing water • State the effect of salt(s) on concrete strength and setting time • Explain how to check water for suitability in concrete if laboratory water analysis is not available • Understand some of the direct effects that water has on the most basic elements of concrete performance.

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Block 2: Concrete Materials	**Module 10:** Admixtures	1. History 2. Types of Admixtures 3. Mechanisms for Admixture Reactions 4. Air Entraining Admixtures (Type AEA) 5. Set Controlling Admixtures 6. Water Reducing Admixtures 7. Other Admixtures 8. Hydration Control Admixtures (Type HCA) 9. Anti Washout Admixtures (Type AWA) 10. Permeability Reducing Agents 11. Internal Curing Admixtures 12. Antifreeze Admixtures 13. Foaming Admixtures 14. Guidance on Use of Admixtures 15. Checklist 16. Australian Standard AS 1478.1 17. Choosing an Admixture 18. Admixture Dose	At the completion of this module you will be able to: • Discuss the role that admixtures can play in improving concrete performance. • Elaborate on the various types of admixtures – where they are typically used, their primary role, advantages that they may confer on concrete performance, performance effects from their mis-use. • Understand which Australian Standards are used to specify admixture performance requirements and test admixtures. • Discuss the requirements for choosing an admixture or set of admixtures and assessing how they might be expected to perform. • Be aware of the potential for interaction between admixtures with potentially beneficial and detrimental effects.
	Module 11: Materials Testing (*Testing Cement and Materials*)	1. Test Equipment and Operator Training 2. Portland and Blended Cement 3. Concrete Testing 4. Supplementary Cementitious Materials 5. Fly Ash 6. Ground Granulated Iron Blast Furnace Slag (Slag) 7. Amorphous Silica	At the completion of this module you will be able to: • Discuss fundamental requirements for managing a laboratory to ensure test results are reliable and consistent. • Understand the key properties required to be tested for all cementitious materials. • Discuss key issues in each of the test methods used for cement and the SCM's. • Discuss the concept of Proven and Unproven Sources and their impact on testing frequencies. • Outline the requirements for test reports for the various cementitious materials.

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Block 3: Producing and Testing Concrete	**Module 12:** Specification and Supply	1. Specification of Concrete 2. Standard Strength Grades 3. Classes of Concrete 4. Accuracy and Calibration of Measuring Equipment in the Concrete Batch Plant 5. Tolerance on Batching 6. Mixing of Concrete 7. Delivery 8. Identification Certificate 9. Assessment of Concrete 10. Rejection of Concrete	At the completion of this module you will be able to: • Understand the differences between Normal Class and Special Class concrete. • Understand the key test types used in the specification of concrete and their Normal class limits. • Understand the calibration requirements for concrete plant weighing and metering systems. • Understand the batching accuracy requirements for pre-mixed concrete. • Understand the minimum requirements for mixing of concrete prior to delivery into forms. • Understand the allowable delivery timing of Normal Class concrete. • Understand the test methods specified for assessing the mixing of plastic concrete. • Understand the basis of assessment of specified concrete properties and actions to be taken on non-conforming product.

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Block 3: Producing and Testing Concrete	**Module 13:** Quality Assurance and Quality Control	1. Quality Assurance (QA) 2. Quality Control (QC) 3. Concrete Quality Control 4. Statistical Analysis 5. Statistical Concepts 6. Characteristic and Target Strength 7. Coefficient of Variation (CofV) 8. Sample Size for SD Calculation 9. Grouping of Plants 10. Production Interval 11. Compliance of Controlled Grade 12. Cusum Analysis	At the completion of this module you will be able to: • Explain the difference between QA and QC. • Identify the standards QA systems are based on. • Explain how the customer attitude affects QA. • Identify management steps does a typical process of continual improvement involve. • Identify stages of a QC process. • Identify some of the inherent variations in concrete that must be recognised in setting limits in QC. • Explain the difference between mean strength and characteristic strength. • Explain standard deviation. • List some things that can affect SD. • Explain how coefficient of variation is linked to standard deviation. • Explain what aspect of a Normal Distribution Curve of test results demonstrates good control. • Explain how the target strength calculated. • Explain what a controlled grade or associated grade of concrete is. • Explain what is considered an acceptable sample size for assessing a controlled grade of concrete.

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Block 3: Producing and Testing Concrete	**Module 14:** Concrete Properties	1. Plastic State Properties 2. Hardened Concrete Properties 3. Strength 4. Durability 5. Permeability, Sorptivity and Carbonation 6. AS 3600 Durability Provisions 7. Corrosion of Reinforcement 8. Supplementary Cementitious Materials (SCMs) 9. Chemical Attack 10. Volume Change 11. Drying Shrinkage 12. Creep 13. Thermal Movement 14. Abrasion Resistance 15. Freeze Thaw Resistance 16. Alkali Aggregate Reaction (AAR) 17. Properties of Prestressed and Post-tension concrete	At the completion of this module you will be able to: • Identify the common tests for measuring plastic properties of concrete • Identify the two major strength properties of concrete. • List 4 factors that affect the compressive strength of concrete. • List 3 factors that affect the workability of concrete as measured with the slump test. • Identify the affects that SCM's have on the concrete compressive strength • Identify the difference between workability and consistency of plastic concrete • Identify the key mix design ingredient that affects cohesiveness of concrete • Identify any relationship between flexural strength and compressive strength • Identify 3 aggregate types that can be used to create high density or heavyweight concrete • Explain the exposure classifications for concrete as listed in AS 3600. • Identify the most aggressive environment for concrete in AS3600. • List the two things that can destroy the passive layer the surrounds reinforcing steel and protects it. • Name two things that can be done to improve the sulphate resistance of concrete. • Identify two methods that can be used to reduce the drying shrinkage of. • Identify the key things that provide concrete with high abrasion resistance? • Identify two things that need to be done to prevent damage from Freeze Thaw • Identify two strategies in concrete mix design that will reduce the risk of damage to concrete from ASR.

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Block 3: Producing and Testing Concrete	**Module 15:** Testing Concrete	1. Properties Tested 2. Australian Standards 3. NATA 4. Sampling 5. Standard Tests 6. Repeatability and Reproducibility 7. Equipment 8. Consistency Tests 9. Strength Testing 10. Plastic Concrete Tests 11. Hardened Concrete Tests 12. Modulus of Elasticity (AS 1012 Part 17) 13. Volume of Permeable Voids (AS 1012.21) 14. Sulfate and Chloride (AS 1012.20) 15. Superworkable Concrete Testing	At the completion of this module you will be able to: • Explain the function of the organization called NATA. • Give some of the reasons for undertaking testing of concrete. • Explain the key aim of taking a sample of concrete. • Define the difference between a grab and a composite sample. • Explain when and how a sample of concrete should be taken on site. • Explain what the two most common tests done on concrete are and what their significance is. • Explain what the two common tests used to determine the tensile strength of concrete are. • Explain why standard conditions are adopted for assessment of concrete properties. • Explain what 600 microstrain drying shrinkage means. • Explain the method for performing a slump test. • Explain how concrete test cylinders are compacted. • Explain three methods that can be used for capping or creating plane ends on concrete test cylinders for compression testing. • Explain the terms repeatability and reproducibility. • Detail the five tests in AS 1012 for consistency of concrete. • Explain how a bleed test is carried out on concrete. • Explain how a setting time test is carried out on concrete. • Explain the tests for Slump Flow, T500 and J-Ring and what properties they measure.

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Block 3: Producing and Testing Concrete	**Module 16:** Non-Destructive Testing (NDT)	1. Equipment 2. Location and Number of Tests 3. Interpretation of Results 4. Basic Tools 5. Plan of Action 6. Strength Evaluation 7. Methods 8. Applications 9. Test Methods 10. Impact Echo 11. Reinforcement Electrical Potential 12. Ground Penetration Radar 13. Concrete Resistivity 14. Polarisation Resistance 15. Rebound Hammer 16. Ultrasonic Pulse Velocity 17. Covermeter 18. Other Tests 19. Digital Improvements 20. Core Testing 21. Interpretation	At the completion of this module you will be able to: • Give reasons why NDT may need to be used. • Explain the basic equipment that should be used prior to any sophisticated testing. • Explain the key methods that would be applicable to a strength investigation. • Explain the key methods that are applicable to assessing cracking and voids in concrete. • Explain the procedure for correct use of a rebound hammer. • Explain when a core testing program would be requested. • Explain the main factors that affect core test results. • Advise if it is possible to test cores that are not the standard diameter or L/D ratio. • Detail the steps to prepare cores for compression testing. • Advise when or if cores should be tested wet or dry. • Advise what happens if a core shows heavily uncompacted concrete or contains a reinforcing bar.

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Block 3: Producing and Testing Concrete	**Module 17:** Concrete Mix Design	1. Preparation of Mix Design 2. Use of Mix Design Information 3. Presentation of Mix Design 4. Aim of Mix Design 5. Influences on a Mix Design 6. Basic Factors 7. The Process 8. Mix Design Input 9. Project Documents 10. Other Hardened Concrete Properties 11. Site Requirements 12. Mix Design Procedure 13. Developing First Trial Mix Proportions 14. Trial Testing Data 15. Yield Calculations	At the completion of this module you will be able to: • Explain the common method of presenting the components of a concrete mix design. • Explain the aims of a concrete mix design. • Identify the key factors that influence a mix design. • Identify the 6 common steps in mix design. • Explain what is meant by “Wet Density” of concrete. • Identify types of chemical admixtures that can be used to change the wet density of the concrete. • Explain what is meant by the “Yield” of concrete. • List the three basic factors that must be considered when doing a mix design. • List site requirements and placing factors that will influence a mix design. • List factors that can change the wet density of the concrete. • List the important things to check in a mix design when checking initial mix proportions. • Explain how to adjust an initial mix design when the batch weights of the concrete components exceed the trial mix wet density. • Carry out a trial mix design using the method proposed in this module.
Block 4: Placing and Finishing Practices	**Module 18:** Hot and Cold Weather Concrete	**Hot Weather Concreting** 1. Effect of Increased Temperature 2. Prevention of Plastic Cracking 3. Assessment of Drying Conditions 4. Temperature Limit 5. Contributions to Concrete Temperature 6. Controlling Concrete Temperature **Cold Weather Concreting** 1. Impact of Low Temperatures 2. Precautions in Cold Weather	At the completion of this module you will be able to: • Explain List the consequences of increasing temperature on concrete. • Explain the important factors that influence the surface drying of concrete and the likelihood of plastic cracking. • Identify three methods of reducing concrete temperature at placement. • List the effects of lower concrete temperatures on concrete properties. • Identify methods of offsetting the lower strength gain in concrete due to lower temperatures. • Explain how stripping of formwork and back-propping is affected by cold air temperatures.

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Block 4: Placing and Finishing Practices	**Module 19:** Compaction of Concrete	1. Objective of Compaction 2. Stages of Compaction 3. Effect on Hardened Concrete 4. Methods of Compaction 5. Other Forms of Compaction 6. Re-vibration	At the completion of this module you will be able to: • Explain what compaction means for concrete performance. • Name two methods of compacting concrete and indicate where you would use each. • List the two stages of compaction of concrete that are evident with immersion vibration. • Explain the difference between Entrained Air and Entrapped Air in concrete. • Explain when vibrating screeds are used and where poker vibrators also are used with them. • Explain the concern about over vibration and the steps in mix design that can correct any of these concerns.
	Module 20: Curing of Concrete	1. Requirements for Curing 2. Effect of Curing on Concrete Properties 3. Curing Methods 4. Heat Accelerated Curing 5. Curing Period 6. Air Curing 7. Selection of Method of Curing	At the completion of this module you will be able to: • Explain what is meant by the term curing. • Explain why curing is important • Describe the three basic methods of curing concrete. • Explain the term ponding and the precautions that need to be taken when using this method. • Explain the requirements for effective curing with polythene sheet. • Comment on the key types of liquid membrane-forming curing compounds ability to comply to AS 3799 • Explain the efficiency rating for a curing compound • Explain the two things required to enable cement to react properly in concrete • Explain the reasons for using heat accelerated curing for precast, prestressed concrete • Identify the key stages in a steam curing process • Explain how ‘maturity’ of concrete is determined

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Block 4: Placing and Finishing Practices	**Module 21:** Formwork and Finishes (*Implications and Considerations*)	1. Basic Formwork Principles 2. Choice of Materials for Formwork 3. Formwork for Precast Concrete 4. Design of Formwork 5. Preparation for Concreting 6. Formwork Stripping 7. Special Off Form Finishes in Concrete 8. Methods of Surface Treatment 9. Test panels 10. Requirements for Good Finishes 11. Formwork Standard 12. Concrete Materials 13. Mix Design 14. Batching 15. Delivery and Placement Time 16. Testing 17. Formwork detailing for Construction 18. Joints and Construction Process 19. Surface Finish Forms – Basic Needs 20. Release Agents 21. Concrete Placement 22. Curing 23. Evaluation of Surface Finishes 24. Defects	At the completion of this module you will be able to: • Identify which parts of formwork provide the temporary structural strength • Identify four reasons for choosing a specific material as formwork for a concrete element • Explain why formwork must be rigid and appropriately sealed • Explain method of choosing a release agent be used for special off form finish • Identify two things that place load on formwork for a suspended floor • Identify what changes the sideways pressure on the forms for a wall • Explain why formwork stripping times are related to ambient temperature • Explain why test panels are essential for special finishes. • Identify how many classes of concrete surface finish AS 3610.1 lists • Identify what classes of finish can have colour control specified • Identify the things that need to be watched with concrete materials to produce consistent off form concrete. • Explain if fast or slow placement of concrete in walls and columns give better off form surface finish • Explain the main cause of blowholes • Explain what is meant by hydration staining. • Explain what is meant by viewing distance for assessment of finishes

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Block 5: Speciality Concrete Applications	**Module 22:** Industrial Floors and Pavements	1. Loads on Concrete Pavements 2. Load Carrying Capacity 3. Crack Control 4. Joints 5. Joint Layout 6. Joint Sealants 7. Slip Membranes 8. Construction Activities	At the completion of this module you will be able to: • Achieve basic understanding of concrete floor and pavement composition, as well as the role of each structural layer • Provide appropriate selection and basic detailing of major structural layers • Conduct concept planning/layout for different pavement designs, joint types and joint arrangements • Provide concept planning/layout for special areas such as road intersections • Comprehend the overall construction process, from construction sequence, reinforcement and dowel arrangement, formwork installation, concrete placement and finishing techniques, curing, sawn joints and joint sealing
	Module 23: Special Paving Finishes	1. Range of Finishes 2. Coloured Concrete 3. Colouring Options for Concrete 4. Patterned Paving 5. Patterned Concrete Defects 6. Exposed Aggregate Finishes 7. Polished Concrete 8. General Considerations	At the completion of this module you will be able to: • Achieve basic understanding of special concrete paving finishes • Conduct appropriate selection of materials for special paving finishes • Comprehend the techniques, along with basic sequence for each type of special paving finish • Provide a reasonable evaluation of special paving finishes, regarding their effects on structural performance of concrete pavement (e.g., mix design, reinforcement and joint arrangement)

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Block 5: Speciality Concrete Applications	**Module 24:** High Performance and Speciality Concrete	1. High Strength Concrete and High Durability Concrete 2. Special Mixes: a) Super-Workable Concrete b) Shotcrete / Sprayed Concrete c) Kerb Concrete Produced by Extrusion Technique d) Exposed Aggregate Concrete e) Stamped/Stencilled Concrete f) Honed and Polished Concrete g) No Fines Concrete h) Controlled Low Strength Fill i) Lightweight Concrete j) Heavyweight Concrete k) Very High Strength Concrete l) Underwater – Tremie Concrete m) Mass Concrete	At the completion of this module you will be able to: • Discuss the classification of different concrete types, in terms of their high and/or special performances in practice • Understand the basics of mix design and material selection • Understand the special testing methods needed to ensure the desired performance • Understand the basics of construction techniques and methods of placing and curing for each type of high/special performance concrete
	Module 25: Reinforced and Pre-Stressed Concrete with Pre- and Post-Tensioning	1. Reinforced concrete a. Introduction b. Structural design of reinforced concrete c. Reinforced concrete detailing guidelines 2. Pre-stressed concrete a. Basic concept and benefits of prestressing concrete b. Types of prestressing technique – pre-tensioning and post-tensioning c. Special considerations in the design of prestressed concrete d. Construction	At the completion of this module you will be able to: • Achieve a basic understanding of reinforcing concrete by steel and prestressing; • Understand the key factors that make steel and concrete compatible; • Understand the difference in process and relative advantages and uses of prestressed and post-tension structures. • Have a basic knowledge of detailing requirements for reinforced and prestressed structures • Have a basic knowledge of some key issues in the construction of reinforced and prestressed elements

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Block 6: Concrete Performance Characteristics	**Module 26**: Durability *(Structural)*	1. Durability of Concrete Structures from Design and Manufacturing Process a) Structural Design and Mix Design b) Concrete Production and Curing c) Mass Transport 2. Dimensional and Positional Stability a) Formwork Movement – Foundation Movement b) Overloading c) Creep and Shrinkage-Swelling d) Thermal Movement e) Cracking Processes 3. Durability of Concrete Structures Under Environmental Impacts a) Moisture b) Raining – Flooding – (Short-Term) Immersion c) Alternate Wetting and Drying d) Frost Attack and Alternate Freezing-Thawing e) Climate Change and Extreme Weather Patterns 4. Durability of Concrete Structures under Chemical Impacts a) Sulfate Attack b) Corrosion of Reinforcing Steel (including Steel Fibre) and Prestressing Steel c) Alkali-Aggregate Reaction (AAR) d) Acid Attack 5. Durability of Concrete Structures under Physical Impacts a) Abrasion b) Erosion c) Physical Salt Attack (PSA) 6. Other Harmful Sources for Concrete Durability a) Biological Processes b) Fire c) Earthquake 7. Durability of Special Concretes a) Fibre-Reinforced Concrete (FRC) b) Polymer-Modified Concrete	At the completion of this module you will be able to: • Achieve initial knowledge regarding the assessment process of concrete durability • Analyse the causes and mechanisms of different degradation types in concrete structures • Propose suitable protection measures for different types of concrete deterioration • Provide suitable techniques to improve concrete durability from design stages

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Block 6: Concrete Performance Characteristics	**Module 27:** Trouble Shooting, Investigations and Failure Modes	1. Troubleshooting 2. Procedure 3. Testing 4. Concrete Strengths Below Standard 5. Cracking of Concrete 6. Types of Cracking a) Plastic Shrinkage Cracking b) Plastic Settlement Cracking c) Craze Cracking d) Drying Shrinkage Cracking e) Thermal Cracking f) AAR/ASR Cracking 7. Dusting Surfaces 8. Curling 9. Delamination of Slab Surfaces 10. Problems with Finishing Slabs 11. Rain Damage 12. Efflorescence 13. Uncompacted Concrete 14. Concrete Short Supply	At the completion of this module you will be able to: • Understand the processes and activities required to undertake an investigation into concrete problems, • Understand the resources required to undertake an investigation into concrete problems, and • Understand key contributors to a wide range of common concrete issues and possible mitigation methodologies.

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Block 6: Concrete Performance Characteristics	**Module 28:** Alternative Binders-Alkali Activated Materials	1. Major types and principles of alkali-activated materials (AAM's) 2. Important factors in mix design of alkali-activated materials (AAM's) 3. Properties of fresh and hardened alkali-activated materials (AAM's) 4. Durability of concrete made of alkali-activated materials (AAM's) 5. Current applications of alkali-activated materials (AAM's)	At the completion of this module you will be able to: • Understand the underlying reason to develop and major benefits of alternative binders • Classify alternative binders with respect to the fundamental chemical reactions and compositions • Familiarize with important design factors for each type of alternative binders • Obtain initial understanding over properties and related durability issues of concrete made of alternative binders • Recognize the current scope of application of alternative binders, as well as remaining issues to address to further develop and implement the materials

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Supplementary Information	**Module A:** Reporting and Report Writing – Technical Investigations	1. General Commercial Considerations 2. Technical Considerations 3. Report Structure	At the completion of this module you will be able to: • Understand who the potential stakeholders are when carrying out a technical investigation. • Understand the assessment of risks associated with a site issue investigation and report. • Understand the general steps in developing a report for a site issue. • Understand the commercial and legal impacts associated with a site issue report. • Understand the technical considerations and professional standards associated with developing a report. • Understand the detail elements that should be contained in a site issue investigation report.
	Module B: Laboratory Visit Notebook & Report Requirements	1. Laboratory Visit Expectations 2. Laboratory Visit Report 3. Finding a Laboratory to Visit	At the completion of this module you will have: • Visited a construction-materials testing laboratory. • Noted the scope of work carried out by the laboratory and the range and type of materials tested. • Understood the nature of the laboratory customer base. • Become aware of the type of accreditation held by the laboratory and the requirements of the accrediting body. • Noted the sample receipt process(es) and the management of samples. • Understood the laboratory structure in terms of the separation of testing types, numbers of staff involved and the operational nature of the laboratory. • Understood the training program and processes – for new and existing staff. • Understood the process for test data recording and quality assessment and treatment of 'doubtful data'. • Understood the nature of the Test Report process(es).