

**Graduate School of Professional Engineering Studies
Department of Civil, Structural and Environmental Engineering,
Trinity College Dublin**

Advanced Concrete Courses in 2011/12

Two courses are offered to external candidates in separate advanced concrete modules over two semesters. The modules are part of the MSc taught Master (Level 9) course and can be taken in isolation by candidates with an appropriate qualification in engineering or cognate discipline. The course lecturers, Prof Ravindra Dhir, Dr Sara Pavia and Dr Roger West, are very experienced in both concrete technology research and practice and in delivering high level academic courses. The lectures will be delivered in block over 9 weeks, with three lectures in one day in any one week. For details of fees, application form and timetables, contact **Dr Roger West**, course co-ordinator, at rwest@tcd.ie or at **01-8961832**. Special reduced fees apply for the unwaged.

The course assessment will be by examination and through a number of coursework assignments involving research, presentations and reports which will contribute 15% to the final mark for these subjects. Successful candidates will receive a document signifying their achievement and a certificate of attendance will be issued for CPD purposes.

Semester 1: Week beginning 26 September until week ending 25 November 2011

Advanced Concrete Technology

This course introduces concrete materials, properties, processes, products and testing in practice.

Topics:

1. Constituent materials (Dr Pavia, 4 lectures)

- 1.1 Portland cement: Constitution and specification, chemical composition, properties, international standards.
- 1.2 Natural and manufactured aggregates.
- 1.3 Admixtures

2. Hydration, setting and hardening of Portland cement (Dr Pavia, 4 lectures)

- 2.1 Chemical processes
- 2.2 Physical changes and their impact on mechanical properties and concrete making stages.

3. Early age properties of concrete (Dr West, 3 lectures)

- 3.1 Workability: including slump loss, segregation and bleeding
- 3.2 Rheology: Flow characteristics and testing
- 3.3 Production: Compaction and placing
- 3.4 Curing: including water, thermal and accelerated curing and maturity

4. Hardened properties of concrete (Prof Dhir, 4 lectures)

- 4.1 Mechanical: Compressive stress-strain curves, strength development with age, stiffness development, Poisson's ratio implications, impact strength,

4.2 Physical: Autogenous and drying shrinkage, creep, thermal movement, pore structure, porosity, permeability, evaporation, absorption, diffusion

5. Processes and products (Dr West, 5 lectures)

5.1 Processes: drying and heat of hydration phenomena, non-structural cracking including causes and prevention of plastic settlement and shrinkage, crazing, thermal and long-term drying shrinkage cracking

5.2 Products: Self-compacting concrete, fibre-reinforced concrete, high performance concrete, rolled carpet reinforcement, sprayed concrete, lightweight concrete including LWAC and foamed concrete, rolled compacted concrete and cement bound materials

6. Testing concrete (Dr West, 3 lectures, Prof Dhir 1 lecture)

6.1 Fresh concrete testing

6.2 NDT: strength including cores and maturity

6.3 Durability testing: permeation (Absorption, permeability, diffusion), carbonation, chlorides, sulphates, crack measurement, corrosion activity

6.3 Full-scale load testing

6.4 Statistical Methods: Mean, standard deviation, coefficient of variation, regression analysis, variability, repeatability and reproducibility, significance testing

Semester 2: Week beginning 16 January until week ending 16 March 2012

Concrete Durability and Sustainability

This course covers principally durability and sustainability of concrete, in all of their facets relevant to advanced concrete technology.

Topics:

1. Additional Materials (Dr Pavia, 3 lectures)

1.1 Low energy cements: Waste materials with pozzolanic activity. Chemical processes. Physical changes and their impact on concrete properties and behaviour.

1.2 Recycled aggregates: Types, advantages, limitations and standardisation. Effect on concrete properties.

1.3 Bioconcrete: Hemp-lime concrete and other biomaterials.

2. Durability (Prof Dhir, 10 lectures)

2.1 Physical properties of concrete related to durability

2.2 Resistance to destructive agents: Corrosion, carbonation, chloride ingress, sulfate attack, acid attack, alkali silica reaction, pyrites, freeze-thaw damage.

2.3 Corrosion protection: Sacrificial anodes, cathodic protection, desalination

2.4 Design for durability and standards

2.5 Concrete durability specifications

3. Sustainability (Dr West, 5 lectures, Prof Dhir 2 lectures)

3.1 Concrete Constituents: low energy concrete, cement manufacture, cement additions, recycled aggregates

3.2 Carbon footprinting and embedded carbon

3.3 Life-cycle costing including durability, maintenance and re-use of concrete

3.4 Thermal Mass and passive heating

3.5 Off-site concrete construction

4. Case Studies (Guest speakers, 4 hours)

4.1 Guest Speakers from sustainable concrete projects

4.2 Student presentations on sustainable research topics