CENTRE FOR RURAL TECHNOLOGY

Ph.D Course Work

Semester	Paper Code	Course Title	Credits	Total
Core Courses				
I	17CRTR0101 17CRTR0102 17CRTR0103 17APRR0101	Supplementary Cementitious Material Advanced Concrete Technology Recent Advances in Construction Materials Research Methodology	4 4 4 4	24
II	17CRTR0204 17CRTR02SX	Quantitative Techniques Specific course to be prescribed by the Doctoral Committee	4 4	
	Seminar (3) Term paper/Topical Research			
III Semester onwards	Research Credits a)Project planning including literature collection, finalization of objectives and methodology b) Field/ Lab Studies, Data collection, compilation of results, statistical analysis, results and final conclusion.		4 32	
End of Program	Synopsis and thesis submission, final viva		6	

List of courses that are candidate centric (17CRTR02SX)

17CRTR02S1	Alkali-Activated Cements and Concretes
17CRTR02S2	High Performance Concrete

17CRTR0101 SUPPLEMENTARY CEMENTITIOUS MATERIAL Credits: 4

Learning Objectives:

The main objective of this course is to make the scholar aware of the various cementitious materials used as alternate for cement, and its role in concrete offering the strength and durability to the concrete

Learning Outcomes:

At the end of the course the scholar familiar in the types of cementitious materials available and selection of cementitious materials based on its effect will be used as alternate for cement

UNIT I THE ROLE OF SUPPLEMENTARY CEMENTING MATERIALS ON SUSTAINABLE DEVELOPMENT

Introduction - Embodied Energy -Greenhouse Gas Emissions and Global Warming- Contribution of Cement on CO_2 Emissions-Concrete Production - Reducing Energy and Emissions - Supplementary Cementing Materials and Sustainability - Durability Enhancement by Application of Supplementary-Cementing Materials - Operational Energy.

UNIT II SILICA FUME

Introduction-Physical, Chemical and Mineralogical Properties-Hydration Reactions and Pozzolanic Activity - Effects of Silica Fume on the Mechanical Properties of Hardened Concrete- Effect of Silica Fume on Durability of Concrete-Effect on Volume Changes of Concrete-Application of Silica Fume in Mortars and Concretes.

UNIT III FLY ASHAND GRANULATED BLAST FURNACE SLAG

Fly Ash- Introduction- classification of fly ash -Physical, Chemical, and Mineralogical Properties of Fly Ash -The Fly Ash Hydration Reactions-Factors Affecting Pozzolanic Reactivity of Fly Ashes - Effects of Fly Ash on the Properties of Fresh Concrete- Effect of Fly Ash on Workability, Water Requirement, and Bleeding of Fresh Concrete - Effect on the Mechanical Properties of Hardened Concrete- Effect of fly ash on Durability of Concrete - Application of Fly Ash in Concrete.

Granulated Blast Furnace Slag- Introduction -Physical, Chemical, and Mineralogical Properties - Effects of Slag on the Properties of Fresh Concrete- Effects of Slag on the Mechanical Properties of Hardened Concrete -Application of Slag in Concrete.

UNIT IV METAKAOLIN AND RICE HUSK ASH

Metakaolin-Introduction –Production - Physical, Chemical, and Mineralogical Properties - Effects of Metakaolin on the Properties of Fresh Concrete - Effects of Metakaolin on the Mechanical Properties of Hardened Concrete - Effect of Metakaolin on Durability of Concrete - Effect of Metakaolin on Carbonation of Mortars and Concretes.

Rice Husk Ash- Introduction –Production- Usage of Rice Husk -Factors Influencing the Use of Rice Husk - Rice Husk Ash Production and Optimization - Physical and Chemical Properties of RHA -Effects of Rice Husk Ash on the Properties of Fresh Concrete- Effects of Rice Husk Ash on the Mechanical and durability Properties of Hardened Concrete - Microstructure, Porosity and Permeability Mortars and Concretes Containing Rice Husk Ash.

UNIT V NANO MATERIALS FOR CONCRETE

Introduction – classification of nano material for concrete. Applications of nano technology in concrete – nano particles for cement replacement-Nano SiO_2, Nano Al_2O_3, Nano Fe_2O_3, Nano clay,Nano ZnO_2, Nano TiO_2,Nano wires and CNT - effect of nano particles on workability - effect of nano particles on strength and durability of concrete.

REFERENCES:

1. Cement Replacement Materials- Properties, Durability, Sustainability by Ali Akbar Ramezanianpour,Springer Heidelberg,Year2014, ISBN 978-3-642-36720-5
2. Supplementary Cementing Materials in Concrete by Michael Thomas,CRC Press-Taylor & Francis Group. Year 2013,ISBN -13: 978-1-4665-7301-7
3. Supplementary Cementing Materials by Rafat Siddique and Mohammad Iqbal Khan, Springer Heidelberg, Year 2013, ISBN 978-3-642-17865-8
4. Waste Materials Used In Concrete Manufacturing by Satish Chandra,Noyes Publications, Year- 1997,ISBN: 0-8155-1393-3
5. Waste Materials and By-Products in Concrete by Rafat Siddique, Springer Heidelberg, Year2008ISBN: 978-3-540-74293-7

17CRTR0102 ADVANCED CONCRETE TECHNOLOGY Credits : 4

Learning Objectives:

The main objective of this course is to make the scholar aware of the various cementitious materials used as alternate for cement, and its role in concrete offering the strength and durability to the concrete

Learning Outcomes:

At the end of the course the scholar familiar in the types of cementitious materials available and selection of cementitious materials based on its effect will be used as alternate for cement

UNIT I FRESH AND HARDENED CONCRETE

Proportioning of concrete, operations involved in concrete production, Workability, Factors Affecting workability, Measurement of workability – Problem of Segregation and bleeding and Laitance. Properties of Hardened Concrete – Strength and durability, Factors affecting strength and durability.

UNIT II ADMIXTURES

Mineral admixtures- fly ash, silica fume, blast furnace slag, silica fume, metakaoline, Rice husk ash, quartz powder. Chemical admixtures, Plasticizers, Super plasticisers, Accelerators, Retarders, Air entraining admixtures, alkali aggregate expansion inhibiting admixtures, workability admixtures, corrosion inhibiting admixtures and bonding admixtures.

UNIT III CONCRETE MIX DESIGN

Principles and Methods, Statistical Quality control, Concrete Rheology, Maturity concept, Concrete mixes for different strength as per IS:456 – 2000, Factors causing variations, field control, statistical quality Control, quality measurement in concrete construction. Concrete mix design based on BIS method, ACI method, IRC 44 method and Road Note number 4 method.

UNIT IV MECHANICAL AND MICRO STRUCTURAL PROPERTIES OF HARDENED CONCRETE

Characteristic strength, compressive, tensile and flexure of concrete, tests on hardened concrete, modulus of elasticity, effect of w/c ratio and admixture on strength properties of concrete. Non-Destructive tests on concrete- Scanning Electron Microscope (SEM), Energy Dispersive X-ray Technique (EDAX), FTIR (Fourier Transform Infrared Spectrograph).

UNIT V DURABILITY OF CONCRETE

Flexural Strength Creep and shrinkage of concrete, significance, types of shrinkage and their control, factors affecting creep. Minimum & Maximum cement content, strength & Durability relationship, volume change in concrete, impact of w/c ratio on Durability, permeability, Exposure to different conditions, factors contributing to Cracks in concrete, Sulphate attack, Alkali aggregate reaction, chloride attack, corrosion of steel (chloride induced). Special types of concrete Light weight concrete, Self compacting concrete, Fibre reinforced composites, No fines concrete, High strength and High performance concrete, Shotcrete, polymer and Geo-polymer concrete, Bacterial concrete.

REFERENCES:

1. Gambhir, Concrete Technology, TataMcGraw- Hill, 3rd Edition, 2005.
2. M.S.Shetty, Concrete Technology, S.Chand and Company, new Delhi , 2012
3. A.M.Neveille, Propetties, and concrete, Longman publication's 4th Edition, 1995.
4. Orchard, Concrete Technology, Tata McGraw-Hill, 2002.

17CRTR0103 RECENT ADVANCES IN CONSTRUCTION MATERIAL Credit:4

Learning Objectives:

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Learning Outcomes:

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UNIT I FIBRE REINFORCED CONCRETE

Foams and light weight materials -fibreinforced concrete - Types of fibres – workability - mechanical and physical properties of fibre reinforced concrete.

UNIT II INDUSTRIAL WASTE MATERIALS IN CONCRETE

Industrial waste materials in concrete - their influence on physical and mechanical properties and durability of concrete - Concrete at high temperature.

UNIT III CORROSION OF CONCRETE AND REINFORCING STEEL

High strength concrete - Changes in concrete with time - Corrosion of concrete in various environments - Corrosion of reinforcing steel - Electro-chemical process, measures of protection.

UNIT IV FERROCEMENT, FIBRES AND COMPOSITES

Ferro-cement - material and properties. Polymers - Fibers and composites. Fibre reinforced plastic in sandwich panels, modeling. Architectural use and aesthetics of composites. Adhesives and sealants.

UNIT V POLYMERS IN BUILDINGS

Structural elastomeric bearings and resilient seating. Moisture barriers, Polymer foams and polymers in building Physics, Polymer concrete composites, ceramics, fly ash quarry dust.

REFERENCES:

1. Shan Somayaji, Civil Engineering Materials, 2nd Edition, Prentice Hall Inc., 2001.
2. Mamlouk, M.S. and Zaniewski, J.P., Materials for Civil and Construction Engineers, Prentice Hall Inc., 1999.
3. Derucher, K. Korfiatis. G and Ezeldin S. Materials for Civil and Highway Engineers, 4th Edition, Prentice Hall Inc. 1999.
4. Aitkens, High Performance Concrete, McGraw-Hill, 1999

17APRR0101 RESEARCH METHODOLOGY Credits: 4

(Course offered by the Department of Applied Research, GRI)

17CRTR0204 QUANTITATIVE TECHNIQUES Credits: 4

Learning Objectives:

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Learning Outcomes:

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UNIT I STRAIN GAUGES AND APPLICATIONS

Types - Mechanical strain gauge, optical strain gauge, inductance and capacitance strain gauge – pneumatic strain gauges - strain rosettes. Strain gauge circuit - Measurement of static and dynamic strain using potentiometer and Wheatstone bridge circuits - Effect of transverse strains – strain recorders and load cells, calibration of testing machines, beam type load cell – proving ring – torque measurements Gauge construction, adhesive and mounting methods – gauge factor – environmental effects.

UNIT II THEORY OF PHOTOELASTICITY

Basic concepts, stress-optic law – isoclines and isochromatics – material fringe value – crack propagation study using fringes – components of photo elastic bench – dark field and white field arrangements of photo elastic bench – stress freezing techniques – hologram technique

UNIT III MODEL ANALYSIS

Structural similitude – structural and dimensional analysis – Buckingham pi theorem – Muller Breslau's principle – Direct and indirect analysis – Begg'sdeformeter – Eney'sdeformeter – Moment indicators – design of models for direct and indirect analysis

UNIT IV INSTRUMENTATION

Classification of transducers, capacitive, inductive, photo electri transducer – Seismic instruments – torque meter, LVDT, velocity transducer – Maxwell mesh current analysis for displacement measurement – Frequency measuring devices – angular motion measurement – Eddy current drag – vibration analyser, display and recording signals – Cathode ray oscillograph – Strip chart recorder , X-Y galvanometric type strip chart recorder – Digital acquisition systems

UNIT V MICROSTRUCTURAL ANALYSIS

Scanning Electron Microscope (SEM), Energy Dispersive X-ray Technique (EDAX), FTIR(Fourier Transform Infrared Spectrograph). Transmission Electron Microscopy (TEM).

REFERENCS:

1. Srinath L S et al, Experimental Stress Analysis, Tata McGraw-Hill Publising Co., Ltd., NewDelhi.1984
2. Dally J W and Riley W.F, Experimental stress Analysis, McGraw –Hill, International, New York, 1991.
3. Rangam C S et al., Instrumentation – Device and Systems, Tata McGraw – Hill Publishing Co.Ltd., New Delhi, 1983.
4. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi. 1996.