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Birla Institute of Technology & Science, Pilani
Hyderabad Campus

**ACADEMIC GRADUATE STUDIES AND RESEARCH DIVISION**
**SECOND SEMESTER 2023-2024**
Course Handout (Part -II)

Date: 12.08.2023

In addition to part I (General Handout for all courses appended to the timetable) this portion gives further specific details regarding the course.

*Course No. :* CE G562
*Course Title:* Advanced Concrete Technology
*Instructor-in-charge:* Prof. Arkamitra Kar

**Scope and objectives of the course:**

- Comprehensive scientific insight into concrete ingredients and their influence on hydration kinetics.
- Analysis of chemical compositions of different raw materials involved in cement manufacture and their influences on the mechanical and deformation characteristics of structural concrete.
- Necessity and development of sustainable alternatives for portland cement concrete.

**Expected Course Outcomes:**

At the end of this course, the students will develop an ability to:

- Apply the knowledge in modern construction practices.
- Evaluate fresh and hardened properties of concrete based on composition and ambience.
- Investigate and provide engineering solutions for the degradation of concrete in different exposure conditions.
- Design mix proportions for different combinations of portland cement and also of alternative binders through the use of industrial wastes.

Student Learning Outcomes (SLOs) assessed in this course – **(a), (b), (c), (e), (f), (g), (h), (j),** and **(k).**

**Textbook(s):**

**Text Book (TB)**

1. Mehta, P. K., and Monteiro, P. J. M., "Concrete: Microstructure, Properties, and Materials", 4th Ed., 2013, McGraw-Hill Education, USA.
2. Neville, A.M, "Concrete Technology", 2010, Addison Wesley Longman Limited, Harlow, UK.

**Reference Books (RB)**


1. Taylor, H. F. W., "Cement Chemistry", 2nd Ed., 1997, Thomas Telford Publishing, London, UK.
2. Mindess, S., Young, J. F., and Darwin, D., "Concrete", Second Ed., 2002, Pearson Education, New Jersey, USA.
3. Malhotra, V. M., and Carino, N. J., "Handbook on Nondestructive Testing of Concrete", Second Ed., 2004, CRC Press, ASTM International, PA, USA.
4. Provis, J. L., and van Deventer, J. S. J., "Geopolymers: Structures, Processing, Properties and Industrial Applications", 2009, 1st Ed., Woodhead Publishing, Cambridge, UK.
5. ASTM Standards, ACI Codes, IS Codes as necessary, and as referred in TB and RB.
6. Kett, I., "Engineered Concrete: Mix Design and Test Methods", 2nd Ed. 2010, CRC Press, T & F, FL, USA.
7. Newman, J. and Choo, B.S., "Advanced Concrete Technology", Vol. 1 - 4, 2003, Butterworth – Heinemann (ELSEVIER), MA, USA.


**Lecture wise Course Plan**

| CO | Lec. No. | Topics Covered | Learning Objectives | Reference to TB, RB | SLO* |
|---|---|---|---|---|---|
| 1 | 1-7 | Components of Concrete: Chemical Properties of Cement & Cementitious paste | Study the constituents, history, advantages, limitations and applications of cement; Study the raw materials, manufacturing processes, composition and types of portland cement; Study the hydration reactions, C-S-H models, heat of hydration and relevant experiments on cement paste and mortar; Study the microstructure of cementitious paste and microanalysis techniques and compute relevant volume stoichiometries. Enumerate the differences between classical and modern approaches. | Ch 1 – 4 (TB 1), Ch 6 (TB 1), Ch 1, 3, 4, 5, 7 (RB 1); Ch 1 – 4 (RB 2) | **(a), (k)** |
| 2 | 8 | Components of Concrete: Properties of Aggregates | Study the sources and mineralogical composition of aggregates; Study the techniques to determine aggregate properties. Study the concepts of high-performance concrete using different types of aggregates. | Ch 7 (TB 1) | **(a)** |
| | 9 –10 | Chemistry of Admixtures: Mineral | Study supplementary cementitious materials (SCM) and pozzolans (Artificial and natural); Study their influences on the volume stoichiometry of hydration reactions through numerical problems; study the differences between pozzolanic and hydraulic SCM; Study the influence of SCMs on fresh and hardened properties of blended concrete and how to apply them in different field conditions. | Ch 8 (TB 1), Ch 9 (RB 1) | **(a), (c), (g)** |

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|---|---|---|---|---|---|
| | 11 | Chemistry of Admixtures: Chemical | Study the different types of chemical admixtures; Study their reaction mechanisms and effects of chemical admixtures on concrete characteristics; compare ancient construction practices with modern ones; determine the type of admixture for practical uses based on environmental, economic, and service requirements. | Ch 8 (TB 1) | **(a), (c)** |
| 3 | 12 - 16 | Characteriz-ation of concrete – powdered and solid | Study mineralogical, microstructural, elemental, and thermogravimetric techniques and working principles; analyze respective outputs. Evaluate the relative efficiency of modern techniques over classical ones based on accuracy of output. | Ch 8 (RB 1) | **(a), (b), (k)** |
| | 17 - 21 | Effect of concrete composition on Properties of Fresh Concrete | Study the effect of concrete composition and curing on workability, setting times, segregation, bleeding, and rheology of fresh concrete. Determine and recommend engineering solutions based on ambient conditions, while adhering to a professional and ethical code. | Ch 10 (TB 1) | **(a), (c), (g), (h)** |
| 4 | 22-26 | Effect of concrete composition on Properties of Hardened Concrete | Study the physical, chemical and engineering properties of hardened concrete; study the serviceability and deformation parameters; compute the correlation between micro- and specimen level properties; analyse the interfacial transition zone (ITZ) in concrete. | Ch 4, 13 (TB 1) | **(a)** |
| | 27-31 | Durability of concrete | Study the factors affecting durability of concrete – environmental, physical, and chemical. Study the durability test methods; investigate and analyze different models for service life prediction of concrete. | Ch 5 (TB 1) | **(a)** |
| | 32-34 | Techniques for Nondestructive Evaluations (NDE) of Concrete | Study the different NDE techniques for concrete – classical and modern; determine the suitability and applicability for each technique based on locational and economic constraints. | Ch 11 (TB 1), RB 3 | **(a), (c), (k)** |
| 5 | 35 - 37 | Special Concrete and Green Concrete | Design various mix proportions of raw materials for green concrete using additives like metakaolin, rice husk ash, sugarcane bagasse ash, microsilica, alccofines. Compare with the manufacturing process for portland cement; develop the groundwork for coming up with ethical guidelines to train field workers; concrete containing 3-D printed rebars. | Ch 12 (TB 1), Ch 11 (RB 1), RB 7 | **(b), (c), (f), (g), (h), (j)** |

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|---|---|---|---|---|---|
| | 38 - 42 | Concrete with Alkali Activated Binder | Study the modern developments in the field of concrete with alkali-activated fly ash and/or slag binders; study the chemistry of alkali-activated binders and compute the volume stoichimoteries; enumerate the differences between alkali – activated binders and blended cements; design optimum mix proportions based on locational and ethical restraints; analyze the potential for practical use of this binder over portland cement. | Ch 1 – 6 (RB 4) | **(b), (c), (e), (f), (g), (h), (j), (k)** |

***Student Learning Outcomes (SLOs):**

SLOs are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of mathematics, science and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
(d) an ability to function on multidisciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

**Evaluation Scheme**

| Ec. No. | Evaluation component | Duration | Weightage | Date, time | Nature of component |
|---|---|---|---|---|---|
| 1. | Midterm | 90 mins. | 25% | 09/10 - 2.00 - 3.30PM | OB |
| 2. | Seminar | - | 20% | | OB |
| 3. | Assignments (5) | - | 25% | | OB |
| 4. | Compre. Exam | 180 mins. | 30% | 16/12 FN | OB |

**Chamber Consultation Hour:** To be announced in the class.
**Notices:** All Notices concerning to the course will be displayed through the **CMS**.
**Make up policy:** Makeup will be given only to the genuine cases with prior permission.
**Academic Honesty and Integrity Policy**: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

**Instructor-in-charge**
**CE G562**