

AMRUTVAHINI COLLEGE OF ENGINEERING, SANGAMNER
Department of Civil Engineering
Honors in Architecture and Town Planning (18 Credits)

Year	Semester	Course Code	Course Name	Credits
Second Year	Sem III	R25-CE-HOC-201	Sustainable Materials and Green Buildings	3
	Sem IV	R25-CE-HOC-202	Building Materials and Composites	3
Third Year	Sem V	R25-CE-HOC-301	Modern Indian Architecture	3
	Sem VI	R25-CE-HOC-302	Introduction to Urban Planning	3
Final Year	Sem VII	R25-CE-HOC-401	Finishing Materials and Systems for Building Applications	3
	Sem VIII	R25-CE-HOC-402	Housing Policy & Planning	3

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Dr. S. B. Kandekar
BoS Chairman

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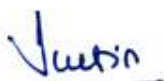


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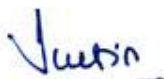
Program:	S.Y. B.Tech. (Civil Engineering)				Semester:		III	
Course:	Sustainable Materials and Green Buildings				Course Code:		R25-CE-HOC-201	
Teaching Scheme (hrs. / week)				Examination Scheme				
Lecture	Practical	Tutorial	Credit	CCE	ESE	TW	PR	OR
03	-	-	03	40	60	-	-	-
Course Description and Relevance: Sustainable Materials and Green Buildings focuses on eco-friendly construction practices using renewable, non-toxic, and recycled materials like bamboo, recycled steel, and low-VOC paints. It optimizes energy, water, and waste efficiency throughout a building’s lifecycle. Its relevance lies in reducing carbon emissions, conserving resources, lowering operational costs, and creating healthier indoor environments to combat global climate change.								
Prerequisite: Construction materials, SDGs								
Bridge Content: -								
Course Objectives: 1. To understand life cycle energy, lower carbon footprint through alternative cements, and evaluate building ecological impacts. 2. To teach resource-efficient concrete mix design using alternative materials and thermal performance optimization. 3. Evaluate masonry kiln performance and non-toxic interior materials to improve indoor air quality and sustainability. 4. To optimize building energy efficiency, achieve net-zero targets, and mitigate urban heat islands using climate-responsive strategies. 5. To master renewable energy integration, energy code compliance, and green building certification frameworks.								
Course Outcomes: After learning the course, students will be able to								
CO	Course Outcome						Bloom’s Level	
CO1	evaluate building ecological footprints and implement low-carbon cement strategies for sustainable construction.						2,3	
CO2	implement low-carbon concrete mixes, recycled aggregates, and thermal-efficient materials in sustainable construction.						2,3	
CO3	select low-emission bricks, paints, and adhesives that optimize indoor air quality and structural sustainability.						2,3	
CO4	apply genetic algorithms for energy optimization and design urban microclimates through strategic greening.						2,3,4	
CO5	design energy-efficient buildings compliant with ECBC, OTTV limits, and green rating standards.						2,3,4	
Course Content								
Unit 1	Title: Life Cycle Energy and Sustainable Cementitious					Week	CO1	


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	Materials	1-3	
A) Introduction, Embodied energy, Operational energy in Building and Life cycle energy. Ecological foot print, Bio-capacity and calculation of planet equivalent. B) Role of Material: Carbon from Cement, alternative cements and cementitious material, Alternative fuel for cements for reduction in carbon emission, Sustainability issues for concrete.			
Exemplars / Practical Applications and usage: Designing net-zero buildings using slag-based geo polymer concrete, high-performance thermal insulation, and life cycle assessments to minimize operational emissions.			
Assignments: Explain the distinction between embodied energy and operational energy in a building's lifecycle. How does a shift toward net-zero operational energy alter the relative significance of embodied carbon in construction materials?			
Unit 2	Title: Sustainable Materials, Low-Carbon Concrete, and Resource Conservation	Week 4-5	CO2
A) Role of quality, minimization of natural resource utilization, High volume fly ash concrete, geo-polymer concrete etc. concrete with alternative material for sustainability B) Reduction in water consumption in concrete, Recycled aggregate, Energy for grinding crushing of cement aggregate etc. and reduction. Operational energy in building role of materials and thermal conductivity			
Exemplars / Practical Applications and usage: Replacing cement with high-volume fly ash and recycled aggregates in structural design, paired with low thermal-conductivity wall assemblies to reduce processing energy and operational HVAC demands.			
Assignments: Discuss the mechanisms through which high-volume fly ash (HVFA) and recycled aggregates reduce virgin material consumption and processing energy in concrete manufacturing, and analyze how material thermal conductivity directly influences a building's overall operational energy consumption.			
Unit 3	Title: Sustainable Building Envelope Materials and Indoor Environmental Quality	Week 6-7	CO3
A) Clay Bricks, Types kilns, Comparative energy performance emission performance and financial performance, Indoor air quality B) Paints, adhesive and sealants for use in building, volatile organic content (VOC) emission issues and indoor air quality for sustainability and health hazard.			
Exemplars / Practical Applications and usage: Specifying low-VOC interior paints, non-toxic sealants, and zig-zag kiln clay bricks in residential designs to satisfy green rating standards (LEED/GRIHA) while reducing occupant health hazards and operational emissions.			
Assignments: Compare Hoffmann, Tunnel, and Zig-Zag kilns regarding thermal efficiency, specific energy			


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consumption, and carbon emissions. How does transitioning to modernized kiln designs improve localized air quality and building material sustainability?

Unit 4	Title: Net-Zero Buildings, Microclimate Optimization, and Evolutionary Design	Week 8-9	CO4
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- A) Operational energy reduction and net zero building, Optimization for design of building for energy efficiency and example of optimization through use of Evolutionary genetic algorithm
- B) Radiation budget, urban heat island; Surface water balance, Effects of trees and microclimatic modification through greening

Exemplars / Practical Applications and usage:

Using evolutionary genetic algorithms to optimize building orientation and window-to-wall ratios for minimum HVAC load, while designing urban green roofs and tree canopies to reduce local heat island effects.

Assignments:

Explain how evolutionary genetic algorithms optimize building envelopment parameters for energy efficiency, and discuss the thermodynamic mechanisms through which urban vegetation modifies microclimates to mitigate heat island effects.

Unit 5	Title: Energy Efficiency, Codes, and Green Rating Systems in Buildings	Week 10-12	CO5
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- A) Use of Building Integrated Photo Voltaic (BIPV) and other renewable energy in buildings, basic concepts and efficiency
- B) Energy codes ECBC requirement, Concepts of OTTV etc
- C) Green Performance rating, requirements of LEED, GRIHA etc

Exemplars / Practical Applications and usage:

Designing a commercial high-rise integrating facade solar panels (BIPV) to generate clean power, optimized insulation to satisfy OTTV/ECBC regulations, and target a LEED Gold or GRIHA rating.

Assignments:

Explain the methodology of calculating Overall Thermal Transfer Value (OTTV) for a building envelope. Explain the different criterias of LEED and GRIHA

Course Projects:

-

Textbooks:

Indian Building Congress, Practical Handbook on Energy Conservation in Buildings, 1 st ed. Nabhi Publication, 2008.

McQuiston, F.C., and Parker, J.D. Heating, Ventilating, and Air Conditioning, Analysis and Design, Fourth Ed. John Wiley & Sons, Inc, 1994.

Clarke, J.A., Energy Simulation in Building Design, Adam Hilger Ltd. 1985.

Venkatarama Reddy, B. V., and Jagadish, K., S. “Embodied energy of common and alternative building materials and technologies”. Energy and Buildings., 35, 129-137, 2003



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Chani, P. S., Najamuddin., and Kaushik, S.K. “Comparative Analysis of Embodied Energy Rates for Walling Elements in India”. Energy and Buildings., 84, 47- 50. 2003

Reference Books:

TERI-Griha’s Green Design practices (www.teriin.org/bcsd/griha/griha.htm)

Leadership in Energy and Environmental Design (www.usgbc.org/LEED)

Article on Residential Green Choice(www.austinenergy.com)

MOOCs Links and additional reading material:

- https://onlinecourses.nptel.ac.in/e-learning/preview/noc26_ce162

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	-	-	-	1	3	3	3
CO2	3	3	2	2	2	2	1	-	-	-	1	3	3	3
CO3	3	3	2	2	2	2	1	-	-	-	1	3	3	3
CO4	3	3	2	2	2	2	1	-	-	-	1	3	3	3
CO5	3	3	2	2	2	2	1	-	-	-	1	3	3	3
Avg.	3	3	2	2	2	2	1	-	-	-	1	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Assessment Pattern

a) Continuous Comprehensive Evaluation (CCE) – 40 Marks

The Continuous Comprehensive Evaluation shall be carried out by the Department based on the student's performance throughout the duration of the SWAYAM-NPTEL course.

- Performance in NPTEL Weekly Assignments: 30 Marks
- Course Progress and Participation (completion of video lectures, timely submission of weekly assignments, and periodic progress monitored by the Faculty Mentor): 10 Marks

b) End Semester Evaluation (ESE) – 60 Marks



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1. Students shall register for and appear in the SWAYAM-NPTEL Proctored Certification Examination.
2. The marks obtained in the NPTEL Proctored Examination shall be converted proportionally to 60 marks using the following formula:

$$\text{ESE Marks} = \left(\frac{\text{NPTEL Proctored Examination Score}}{100} \right) \times 60$$

3. Students who successfully obtain the NPTEL certificate shall have the converted score considered as the End Semester Evaluation (ESE) marks.
4. Students who fail to obtain the NPTEL certificate, fail to appear for the NPTEL certification examination, or fail the certification examination shall appear for the Institute End Semester Examination conducted by the College.
5. If a student appears for both the SWAYAM-NPTEL Certification Examination and the Institute End Semester Examination, the higher of the two ESE scores shall be considered for the award of the final grade.
6. The decision of the Department regarding verification of NPTEL scores and award of marks shall be final and binding.

BT Level	CCE						ESE
	CT1	CT2	Assignments	Course Project	Field Activity / Case Study	Quiz / presentation etc.	
K1	-	-	✓	-	-	-	✓
K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

- Advanced Concrete Technology
- Environmental Studies

Job Mapping:

Job opportunities that one can get after learning this course:

- Green Building / Sustainability Consultant
- Life Cycle Assessment (LCA) Specialist
- Green Building Advisor

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Program:	S. Y. B. Tech (Civil Engineering)			Semester:	IV		
Course:	Building Materials and Composites			Course Code:	R25-CE-HOC-202		
Teaching Scheme (Hrs. / week)			Credits (TH)	Examination Scheme			
Lecture	Practical	Tutorial		CCE	ESE	TW	PR
3	-	-	3	40	60	-	-

Course Description: This course provides a comprehensive overview of fundamental, alternative and modern building materials used in civil engineering and architectural construction. It covers the physical, chemical, mechanical and structural properties of conventional materials such as clay products, natural stones, timber, cement, concrete and metals. The course emphasizes sustainable and eco-friendly alternatives (such as fly-ash bricks, CEB/CSEB, and precast walling/roofing systems) alongside advanced materials including engineered wood, ceramics, smart glazing systems, bitumens, protective coatings, plastics, fiber composites and nanotechnology applications in modern civil infrastructure.

Course Relevance: Building materials form the fundamental core of civil engineering and structural design, making material knowledge essential for site execution and planning. Incorporating eco-friendly alternatives like fly-ash bricks and CSEB aligns academic training with sustainable green building practices. Understanding proper selection of bituminous waterproofing, protective coatings and corrosion-resistant metals ensures long-term structural durability. Ultimately, this curriculum prepares graduates for fast-track modular construction and contemporary engineering projects.

Prerequisite: The student should have completed two semesters of UG Engineering or Science program.

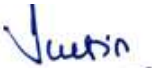
Bridge Content: Core concepts of stress, strain, elasticity, thermal conductivity, and density essential for evaluating material performance.

Course Objectives:

- Understanding of physical properties, manufacturing processes, and sustainability aspects of conventional masonry
- Understanding of structural timber, engineered wood, smart glazing, and ceramic materials for appropriate application in building envelopes and interiors.
- To know fundamentals of aggregate grading, cement hydration, concrete mix behavior, and standard quality testing methods.
- To impart foundational knowledge regarding precast structural elements, structural steel, non-ferrous alloys, and their corrosion prevention mechanisms.
- To enable students to evaluate bituminous damp-proofing, protective surface coatings, and advanced composite materials for enhanced structural durability.

Course Outcomes: After learning the course, students will be able to:

CO	Course Outcome	Bloom's Level
CO1	Compare the mechanical properties, manufacturing techniques, and sustainability parameters of conventional clay bricks against alternative walling units like Fly-ash, CSEB, and stone dust blocks.	3
CO2	Select appropriate timber species, engineered wood, smart glazing, and ceramic systems based on structural requirements and environmental exposure.	3


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CO3	Examine aggregate grading curves, cement hydration dynamics, and field test results to determine concrete mix workability and compressive strength.	3
CO4	Describe the structural functions, manufacturing methods, and corrosion prevention mechanisms of precast concrete elements, structural steel, and non-ferrous alloys.	2
CO5	Differentiate the performance of bituminous damp-proofing, protective surface coatings, and fiber-reinforced composite materials in harsh environmental conditions.	2,3

Course Contents

Unit 1	Masonry Materials and Sustainable alternatives	Weeks 1-2	CO1
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- A) Physical and mechanical properties of conventional clay products alongside sustainable, eco-friendly walling alternatives such as fly-ash bricks, Compressed Earth Blocks (CEB), and Compressed Stabilized Earth Blocks (CSEB).
- B) Classification, processing, and structural applications of natural stone, stone tiles, and stone dust blocks.

Exemplars / Practical Applications and usage:

- Utilizing Fly-ash bricks, CEB, and CSEB in place of traditional burnt-clay bricks
- Repurposing stone quarry waste into engineered stone dust blocks for cost-effective, high-strength masonry in foundation and boundary wall construction.
- Applying natural stone and precision-cut stone tiles for low-maintenance, weather-resistant exterior facades and heavy-duty flooring in public infrastructure.

Assignments:

- Compare conventional burnt clay bricks with eco-friendly alternatives (Fly-ash bricks, CEB, and CSEB) in terms of raw materials, manufacturing process, compressive strength, environmental impact, and cost-effectiveness.
- Explain the classification, characteristics, and selection criteria of natural building stones used in construction.

Unit 2	Timber, Engineered Wood, Ceramics and Glazing Systems	Week 2-3	CO2
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- A) Characteristics, defects, and seasoning of natural wood, as well as the manufacturing and structural uses of engineered wood products.
- B) Properties and applications of structural glass, modern glazing systems, thermal and acoustic insulation materials, ceramic tiles, and vitrified tiles.

Exemplars / Practical Applications and usage:

- Utilizing natural timber and engineered wood products
- Installing modern double or triple-glazed glass systems and thermal insulation materials to reduce HVAC energy consumption
- Applying ceramic and vitrified tiles with specific water absorption rates and slip resistance for hygienic, durable, and aesthetically appealing flooring

Assignments:

- Differentiate between natural timber and engineered wood, listing three distinct practical applications for each in modern building construction.



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- 2) Compare ceramic tiles and vitrified tiles based on their water absorption properties, durability and suitable installation areas.

Unit 3	Concrete Materials	Weeks 4	CO3
Physical characteristics, grading, and testing of fine and coarse aggregates, alongside the chemical hydration, mix proportioning, fresh and hardened properties, and durability of cement and concrete.			
Exemplars / Practical Applications and usage: • High-Strength Structural Concrete Production • Quality Control & Field Testing • Custom Concrete Mixes for Harsh Environments			
Assignments: 1. State the significance of particle size distribution (grading) of fine and coarse aggregates in achieving optimal concrete workability and strength. 2. Explain the chemical hydration process of cement and describe two key field tests used to evaluate fresh concrete workability on site.			
Unit 4	Precast Building Systems and Metallic Materials	Week 5-6	CO4
A) Manufacturing, handling, and assembly of precast elements, including precast flooring, roofing, walling systems, Hollow Concrete Blocks (HBC) and Autoclaved Aerated Blocks (AAB). B) Metallurgical properties, mechanical behavior, corrosion protection and structural applications of ferrous and non-ferrous metals.			
Exemplars / Practical Applications and usage: • Rapid Modular Construction • Structural Steel and Rebar Frameworks • Corrosion-Resistant Architectural Elements			
Assignments: 1) List four advantages of using precast walling and flooring systems over conventional cast-in-situ concrete construction. 2) Differentiate between ferrous and non-ferrous metals based on their corrosion resistance and structural applications in buildings.			
Unit 5	Bitumen, Paints and Advanced Materials	Weeks 7-8	CO5
A) Characterization, testing, and application of bituminous materials for damp proofing, as well as the formulations and protective mechanisms of paints. B) Applications of modern plastics, fiber-reinforced composites, and nanotechnology innovations in building materials.			
Exemplars / Practical Applications and usage: • Substructure Damp-Proofing & Waterproofing • Surface Protection & Anti-Corrosive Coatings • High-Performance Composite Reinforcement			

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Assignments:

1. Explain the role of bituminous materials in damp-proofing foundations and basements, listing two essential testing methods used to evaluate bitumen quality.
2. What are fiber-reinforced polymer (FRP) composites? Mention two key advantages of using advanced composites over conventional materials for structural retrofitting.

Textbooks:

- 1) S.K. Duggal, Building Materials, New Age International Publishers
- 2) P.C. Varghese, Building Construction and Materials, PHI Learning Pvt. Ltd.
- 3) M.S. Shetty & A.K. Jain, Concrete Technology: Theory and Practice, S. Chand Publishing

Reference Books:

1. Krishan K. Chawla, Composite Materials: Science and Engineering, Springer

MOOCs Links and additional reading material:

1. https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ar10

Strength of CO-PO-PSO Mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	-	2	3	1	-	1	-	3	2	1
CO2	3	2	2	1	1	2	2	1	-	1	-	3	2	1
CO3	3	3	2	2	1	2	1	1	-	1	-	3	2	1
CO4	2	2	1	1	1	2	1	1	-	1	1	3	1	1
CO5	3	2	2	1	2	2	2	1	-	1	-	3	2	1
Avg	2.8	2.2	1.6	1.2	1.25	2	1.8	1	-	1	0.2	3	1.8	1

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Assessment Pattern

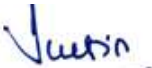
a) Continuous Comprehensive Evaluation (CCE) – 40 Marks

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- Performance in NPTEL Weekly Assignments: 30 Marks
- Course Progress and Participation (completion of video lectures, timely submission of weekly assignments, and periodic progress monitored by the Faculty Mentor): 10 Marks

b) End Semester Evaluation (ESE) – 60 Marks

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60 marks using the following formula:

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K2	-	-	✓	-	-	-	✓
K3	-	-	✓	-	-	-	✓
K4	-	-	✓	-	-	-	✓
K5	-	-	-	-	-	-	-
K6	-	-	-	-	-	-	-

This course serves as a prerequisite for / maps with the following future courses:

- 1) Advanced Structural Materials
- 2) Design of Reinforced Concrete Structures
- 3) Design of Steel Structures:

Job Mapping:

- Sustainable Construction Specialist
- Materials Procurement Officer
- Concrete Quality Control (QC) Engineer
- Waterproofing & Retrofitting Consultant

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