

Unit 3: Science & Materials

Unit code D/615/1389

Unit type Core

Unit level 4

Credit value 15

Introduction

Science and material performance are intrinsically linked through the need to create structures and spaces that perform in both mechanical operation and in providing human comfort.

This unit aims to support students to make material choices to achieve the desired outcomes of a brief. This is approached from the perspective of materials being fit for purpose; as defined by testing standards and properties, but also by consideration of the environmental impact and sustainability. Awareness of health & safety is considered alongside the need to meet legislative requirements.

The topics covered in this unit include: health & safety; storage and use of materials; handling, and problems associated with misuse and unprotected use; environmental and sustainable consideration in material choices; and human comfort performance parameters. Material choice is developed through the understanding of testing procedures to establish conformity to standards and define performance properties. The performance of materials to satisfy regulations and provide appropriate comfort levels is addressed through design and calculations.

Upon successful completion of this unit students will be able to make informed decisions regarding material choices; based on understanding the structural behaviour of materials established through recognised testing methods, sustainability, context of build, and health & safety. Students will also be able to perform the calculations necessary to establish anticipated performance of the materials in-use and therefore determine their compliance with regulations and suitability.

Learning Outcomes

By the end of this unit students will be able to:

1. Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site.
2. Discuss the environmental and sustainability factors which can impact on and influence the material choices for a construction project.
3. Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration.
4. Evaluate the performance of a given building in respect of its human comfort requirements.

Essential Content

LO1 **Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site**

Regulations and guidance:

Health & safety management regulations.

Design management regulations.

Provision and use of equipment regulations.

Control and management of hazardous materials through storage, movement and use.

Materials handling and installation:

Risk assessments and method statements (qualitative and quantitative).

Materials storage: moving materials safely; working in confined spaces; working at height.

Occupational health risks associated with materials: asbestos-related and respiratory disease; dermatitis and skin problems; musculoskeletal disorders; hand arm vibration.

Personal Protective Equipment (PPE).

LO2 **Discuss the environmental and sustainability factors which can impact and influence the material choices for a construction project**

Environmental considerations:

Lifecycle assessment.

Environmental profile methodology.

Environmental product declaration and certification.

Embodied energy.

Waste management: the economics and technologies of construction waste disposal.

Sustainability:

Resource availability and depletion: renewable and non-renewable materials.

Reuse and recycling of construction and demolition waste.

Waste and Resources Action Programme (WRAP).

Environmental assessment methods:

Building Research Establishment Environmental Assessment Method (BREEAM).

Leadership in Energy and Environmental Design (LEED).

Green Star.

Estdama, or other forms of environmental assessment.

Construction Industry Research Information Association.

LO3 Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration

Material testing:

Testing methods, interpreting test data.

Codes and standards.

Structural behaviours

Performance properties: strength, elasticity, toughness, hardness, creep, fatigue, porosity, brittleness, density, thermal conductivity, durability.

Inherent material properties.

Relationship between material properties, behaviour and use.

LO4 Evaluate the performance of a given building in respect of its human comfort requirements

Human comfort provision:

Indoor environmental quality: thermal, illumination, sound, ventilation.

Thermal losses and gains.

Passive and active design: design solutions, environmental benefit vs implementation cost.

Calculations of u-values, lux levels, acoustic and ventilation.

Learning Outcomes and Assessment Criteria

Pass	Merit	Distinction
<p>LO1 Review health and safety regulations and legislation associated with the storage, handling and use of materials on a construction site</p>		<p>LO1</p> <p>D1 Discuss how multiple regulations and legislation would apply to a given site activity, highlighting how to plan and manage for safe handling and use.</p>
<p>P1 Explain how regulations impact on the use, storage and handling of a selection of vocationally typical construction materials.</p>	<p>M1 Assess how risk assessments can be used to address significant hazards posed by selected materials or activities.</p>	
<p>LO2 Discuss the environmental and sustainability factors which impact on and influence the material choices for a construction project</p>		<p>LO2 LO3</p> <p>D2 Illustrate how the use of sustainable practices and considerations for material choice can improve the environmental rating of the completed building.</p>
<p>P2 Explain material environmental profiling and lifecycle assessment. Use a relevant material to exemplify your explanation.</p> <p>P3 Discuss the benefits of product declaration and environmental certification.</p>	<p>M2 Produce a waste management plan for a given project, taking into account a typical range of relevant waste materials.</p>	
<p>LO3 Present material choices for a given building using performance properties, experimental data, sustainability and environmental consideration</p>		
<p>P4 Present the results of relevant testing procedures to identify performance characteristics of selected construction materials.</p> <p>P5 Discuss the results in terms of the material properties and regulatory requirements, highlighting any unexpected results and why these may occur.</p> <p>P6 Select construction materials for a given building based upon their performance properties in use.</p>	<p>M3 Assess the effects of loading structural materials and compare the behaviours and performance of materials which could be used for the same function.</p>	

Pass	Merit	Distinction
<p>L04 Evaluate the performance of a given building in respect of its human comfort requirements.</p>		<p>L04</p> <p>D3 Evaluate how the use of passive or active strategies can minimise energy, materials, water, and land use.</p>
<p>P7 Define a material selection strategy with regard to human comfort requirements.</p> <p>P8 Identify materials for a selected area within a building and explain how these contribute to a balanced indoor environment.</p>	<p>M4 Perform calculations which relate to a selected area (lux levels, u-values, acoustic and ventilation).</p>	

Recommended Resources

Textbooks

- BLANC, A. (2014) *Internal components*. Abingdon: Routledge.
- BUXTON, P. (2015) *Metric handbook: Planning and design data*. Abingdon: Routledge.
- CASINI, M. (2016) *Smart buildings: Advanced materials and Nanotechnology to improve energy*. Duxford: Woodhead Publishing.
- THOMAS, R. (ed.) (2006) *Environmental design: An introduction for architects and engineers*. Third Edition edn. London: Taylor & Francis.
- CLAISSE, P, A. (2015) *Civil Engineering Materials*. Kidlington: Butterworth-Heinemann.
- DEAN, Y. (1996) *Materials Technology*. (Mitchells Building Series). Abingdon: Routledge.
- DORAN, D. and Cather, B. (2013) *Construction Materials Reference Book*. Abingdon, Routledge.
- EVERETT, A. (1994) *Materials*. (Mitchells Building Series). 5th Ed. Abingdon: Routledge.
- KATIB, J.M. (2009) *Sustainability of Construction Materials*. Abingdon: Woodhead Publishing Ltd.
- LYONS, A. (2014) *Materials for Architects and Builders*. 5th Ed. Abingdon: ROUTLEDGE.
- PACHECO-Torga, F. and JALALI, S. (2011) *Eco-Efficient Construction and Building Materials*. London: Springer.
- PACHECO-TORGA, F. et al. (2013) *Eco-efficient Construction and Building Materials, Life Cycle Assessment (LCA), Eco-Labeling and Case Studies*. London: Springer.

Links

This unit links to the following related units:

- Unit 2: Construction Technology*
- Unit 9: Principles of Heating Services Design & Installation*
- Unit 15: Principles of Refurbishment*
- Unit 16: Principles of Alternative Energy*
- Unit 35: Alternative Construction Methods*
- Unit 46: Advanced Materials*