

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 1: The materials used in civil engineering

Suggested Teaching Time: 6 hours

Learning Outcome: Know the materials used in civil engineering

Topic	Suggested Teaching	Suggested Resources
<p>The materials used in civil engineering (AC 1.1)</p>	<ul style="list-style-type: none"> The learners should be exposed to a wide variety of the buildings, structures and roads that are created by civil engineering procedures. This could be done using photographs, video, CD and DVD material and, best of all, site visits. The learners should be encouraged to identify the materials used for civil engineering (such as metals, timber, concrete, polymers, bricks and blocks) and to relate the materials to the purposes for which they are used. The centre should develop a 'materials library' with a range of different types of concrete (dense, normal, lightweight, no-fines) and various timbers, metals, polymers and bricks, with the focus clearly on their use in civil engineering rather than in construction. Class discussions should be used to relate material properties to the different ways in which they are used and the potential advantages and disadvantages of using such materials. 	<p>Books</p> <p>Viridi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites</p> <p>www.bre.co.uk</p> <p>www.defra.gov.uk</p> <p>www.buildingdesign.co.uk</p> <p>Other</p> <p>Materials library</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 2: The manufacture of civil engineering materials from naturally-occurring raw ingredients

Suggested Teaching Time: 6 hours

Learning Outcome: Know the materials used in civil engineering

Topic	Suggested Teaching	Suggested Resources
<p>The manufacture of civil engineering materials from naturally-occurring raw ingredients</p> <p>(AC 1.2)</p>	<ul style="list-style-type: none"> Learners should be provided with an opportunity to visit establishments such as brickworks, cement works, concrete batching plants and metal manufacturing and processing plants, wherever possible. The learners should collect information and make notes while on the visits and should write a commentary afterwards. Exact details of the process used are less important than an understanding of the raw materials used, where the raw materials were sourced, how they were extracted or harvested, and the energy used in the various manufacturing processes. Where the above is difficult because of lack of access or time, the same learning can be delivered by use of videos, CDs, DVDs and the Internet, but there is always benefit to the learners from seeing things in the real world with their own eyes, and having things explained to them, and their questions answered, by experienced professionals who do it as a full-time job. This would be a good point at which to introduce the concept of 'embedded energy' and a whole-class, tutor-led discussion of the factors that affect this, and how the manufacture of different materials affects the amount of embedded energy, will be invaluable both here and in other cognate units. 	<p>Books</p> <p>Virdi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites</p> <p>www.bre.co.uk</p> <p>www.defra.gov.uk</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 3: Describe the tests performed on civil engineering materials

Suggested Teaching Time: 8 hours

Learning Outcome: Know the materials used in civil engineering

Topic	Suggested Teaching	Suggested Resources
<p>Describe the tests performed on civil engineering materials (AC 1.3)</p>	<ul style="list-style-type: none"> • Although the requirement is only to 'describe' the tests, it is nevertheless important to realise that learners will benefit from actually doing the test themselves, where the centre has access to the equipment needed to test for different types of strength, and both moisture content and workability. Centres should at least have access to concrete cubes, compression testing machines, tensometers, moisture meters for timber and aggregates, and slump cones. Visits to testing centres will help address a lot of the content. • Where the above is difficult because of lack of access or time, the same learning can be delivered by use of videos, CDs, DVDs and the Internet, but there is always benefit to the learners from doing things themselves or seeing the tests performed with their own eyes, and having things explained to them, and their questions answered, by those who do such things for a living. • Another way of covering this topic is for the class to be divided into small groups, and for each group to investigate a specific form of testing and produce a presentation to the rest of the class. A question and answer session could follow each presentation and the tutor should develop this into a whole class-discussion of the importance of the test results and the way in which the test results are used to design and specify materials correctly. 	<p>Books</p> <p>Virdi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Mamlouk, J.P., Zaniewski, J.P., <i>Materials for Civil and Construction Engineers</i> 4th Global Edition (Pearson Education Limited) ISBN: 1292060514</p> <p>Websites</p> <p>www.bre.co.uk</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p> <p>www.concrete.org.uk</p> <p>www.esg.co.uk</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 4: Physical properties of civil engineering materials

Suggested Teaching Time: 8 hours

Learning Outcome: Understand how the physical properties of civil engineering materials affect their use

Topic	Suggested Teaching	Suggested Resources
Physical properties of civil engineering materials (AC 2.1)	<ul style="list-style-type: none"> • Small-group work should be used to introduce the topic, with each group researching each of the properties identified in the unit specification and producing a presentation to be made to the rest of the class. A question and answer session should follow each presentation and the tutor should develop this into a whole class-discussion of the importance of, and difference between, the properties. At this stage, the properties of individual materials are not as important as an understanding of the relevance of each property. • Wherever possible, learners should be given the opportunity to watch demonstrations of the properties of materials or, preferably, conduct such tests themselves, either individually or in small groups. This should be quantified as far as possible but precise values of say, strength, porosity or density are less important than an understanding of the relative properties and where each is to be considered when specifying materials. • When the physical properties have been described, and the tests that quantify their values for specific materials have been undertaken or observed, the tutor should lead a whole-class discussion on how each property might affect the way in which materials are used, in preparation for the next topic. 	<p>Books</p> <p>Virdi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites</p> <p>www.bre.co.uk</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p> <p>www.concrete.org.uk</p> <p>www.civilengineer.webinfolist.com</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 5: How the properties of civil engineering materials affect their use

Suggested Teaching Time: 10 hours

Learning Outcome: Understand how the physical properties of civil engineering materials affect their use

Topic	Suggested Teaching	Suggested Resources
<p>How the properties of civil engineering materials affect their use (AC 2.2)</p>	<ul style="list-style-type: none"> • Whole-class teaching should be used to introduce this topic. The tutor must stress throughout that the way materials are used depends primarily on their physical and chemical properties-in-use, with cost, sustainability and environmental impact also being taken into account. • The discussion should lead to a general consideration of how: <ul style="list-style-type: none"> ○ resistance to loads is affected by strength and elasticity ○ resistance to water is affected by porosity and water absorption ○ durability is affected by porosity, water absorption and density ○ ease of installation is affected by density (weight) and workability ○ dimensional stability is affected by thermal and moisture movement ○ costs are always important, but not necessarily the first consideration ○ sustainability and environmental impact affect everything • The discussion should be followed by a short formative assessment with a range of materials being specified for a range of situations. The learners must comment on whether the specification is appropriate, and why this is so in terms of the properties of the specified material and the environment in which they are to be used. Incorrect answers must be corrected by the learners after discussion and tutor feedback. 	<p>Books</p> <p>Virdi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Mamlouk, J.P., Zaniewski, J.P., <i>Materials for Civil and Construction Engineers</i> 4th Global Edition (Pearson Education Limited) ISBN: 1292060514</p> <p>Websites</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p> <p>www.concrete.org.uk</p> <p>www.civilengineer.webinfolist.com</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 6/1: Mechanisms by which civil engineering materials deteriorate and fail in use.

Suggested Teaching Time: 8 hours

Learning Outcome: Understand how civil engineering materials are protected from deterioration and failure in use

Topic	Suggested Teaching	Suggested Resources
<p>Mechanisms by which civil engineering materials deteriorate and fail in use. (AC 3.1)</p>	<ul style="list-style-type: none"> The tutor should open the topic with a presentation of the different ways in which materials can deteriorate and fail. A discussion should ensue on the common factor involved in most failure mechanisms and the tutor should lead the learners to an understanding of the important role played by water in most failure mechanisms and of UV radiation in others. Site visits could be made to highways and civil engineering structures with previously identified defects such as ice and frost attack, corrosion, fungal and insect attack, sulphate attack, fading and delamination of plastics by ultra-violet (UV) attack and efflorescence. Other defects should be noted even if they are not specified in the unit content. The tutor should draw the learners' attention to the source of the water that has (mainly) played a large part in the deterioration and the consequences of poor maintenance. Where the above is difficult because of lack of access or time, the same learning can be delivered by use of videos, CDs, DVDs and the Internet, but there is always benefit to the learners from seeing things in the real world with their own eyes, and having things explained to them, and their questions answered, by experienced civil engineering professionals. 	<p>Books</p> <p>Virdi, S., <i>Construction Science and Materials</i>, 1st Edition (Wiley-Blackwell, 2012) ISBN: 0470658886</p> <p>Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p> <p>www.concrete.org.uk</p> <p>www.civilengineer.webinfolist.com</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 6/2: Mechanisms by which civil engineering materials deteriorate and fail in use (continued)

Suggested Teaching Time: 6 hours

Learning Outcome: Understand how civil engineering materials are protected from deterioration and failure in use

Topic	Suggested Teaching	Suggested Resources
<p>Mechanisms by which civil engineering materials deteriorate and fail in use. (continued) (AC 3.1)</p>	<ul style="list-style-type: none"> • The class should be divided into small groups with each group being given an example of modes of failure specific to civil engineering works. Each group should work up their researches into a presentation (verbal plus images, posters, hand-outs or PowerPoint as appropriate) and make a presentation to the rest of the group. Each group should be prepared to answer questions and provide hard copies to inform the whole class. The modes of failure could include: <ul style="list-style-type: none"> ○ overloading causing plastic deformation to suspension cables ○ overloading causing sinking of foundations ○ corrosion of suspension cables and steel reinforcement to concrete ○ fatigue failure and stress corrosion in bridge structures ○ creep in concrete structures leading to reduced effective life ○ low-temperature embrittlement of steel 	<p>Books Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites www.howstuffworks.com www.concrete.org.uk www.civilengineer.webinfolist.com</p>

UNIT 443: MATERIALS FOR CIVIL ENGINEERING

Lesson 7: Methods used to protect civil engineering materials

Suggested Teaching Time: 8 hours

Learning Outcome: Understand how civil engineering materials are protected from deterioration and failure in use

Topic	Suggested Teaching	Suggested Resources
<p>Methods used to protect civil engineering materials (AC 3.2)</p>	<ul style="list-style-type: none"> • Whole-class teaching should be used, with the tutor revisiting the learning contained in Lesson 5, to emphasise that the first step is to specify materials that will not deteriorate in their environment. • This should be developed into a whole class-discussion of the methods used to exclude water, and in some cases, oxygen (including painting and coating techniques), and the use of creative design solutions to exclude water. The tutor should lead the class to an understanding that, if you know what causal mechanisms of deterioration are, and can exclude these from the material in question, deterioration cannot occur. • The class should be divided into small groups, with each group being given a different group of materials to research (cements and concretes, timbers, metals, plastics, bricks and blocks). Each group should research the methods used to provide protection, such as appropriate concrete mix design use of sulphur-resistant cement, preservation of timber, anti-corrosion measures, UV stabilisers in plastics, specification of low porosity engineering bricks or application of water repellent coatings. Each group should produce a presentation. The tutor should develop this into a whole class-discussion of the relative benefits of each method. 	<p>Books</p> <p>Mamlouk, J.P., Zaniewski, J.P., <i>Materials for Civil and Construction Engineers</i> 4th Global Edition (Pearson Education Limited) ISBN: 1292060514</p> <p>Taylor G.D., <i>Materials in Construction: An Introduction</i>, 3rd Edition (Routledge, 2013) ISBN: 0582368898</p> <p>Websites</p> <p>www.howstuffworks.com</p> <p>www.youtube.com</p> <p>www.concrete.org.uk</p> <p>www.civilengineer.webinfolist.com</p>