Unit 23: Construction in Civil Engineering

Delivery guidance

This optional unit for the Diploma and Extended Diploma introduces learners to the large-scale construction projects that are undertaken by the civil engineering industry such as highways, railways, bridges, dams or skyscrapers.

Approaching the unit

There is opportunity for external speakers to provide contextualisation and add relevance to the learning. The use of visits and audio-visual resources will enable learners to understand the size, scope and complexity of civil engineering projects.

There are a wide range of approaches that you could adopt when delivering this unit that will provide opportunities to inspire and stimulate learners. Approaches could include lectures, discussions, presentations, site visits and investigations. You could use a range of case studies, project profiles and real-life civil engineering project details to add realism and contextualisation to the activities. A successful combination of these approaches will stimulate, motivate, educate and inspire learners.

Delivering the learning aims

Since this unit follows a logical sequence that is representative of many civil engineering projects, a linear delivery through each learning aim would give learners a broad introduction to how a civil engineering construction project develops through the various phases. This could be supported by following a construction project, potentially through site visits, to monitor its progression.

You could introduce learning aim A with a whole-class, tutor-led discussion on the basic principles related to earthworks, assessing any prior knowledge and understanding. You could then clarify any misunderstandings and misconceptions before setting learners a task to investigate the various methods used for excavation.

You could then divide the class into small groups to carry out investigations into the types of earthmoving, compaction and concreting equipment that are used on site. Each group could give a short presentation on the equipment that they have investigated.

During the various research tasks that learners will carry out (individually or in groups), the presentations or reports produced could be compiled into information files that can then be shared with the whole class after comment, amendment and editing by yourself.

Moving on to consider temporary works, dewatering and piling operations, activities could be introduced through site visits, with learners being set scenario-based problems to identify and suggest suitable solutions for given situations.

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To introduce learning aim B, you could first address the principles related to the design and construction of foundations and substructures for civil engineering projects. Where there is opportunity, learners would again benefit from site visits to gain deeper understanding of the different types of foundation that can be used. Learning could also be supported by visiting industry professionals to explain the principles related to the design of each foundation type. Site visits and case studies could also be used to provide insight into how drainage systems and utilities are accommodated within substructures, with learners completing scenario-based problem-solving activities to produce alternative proposals for substructures.

You could introduce learning aim C using whole-class, tutor-led discussions on the basic principles of structures while reinforcing principles covered in other units – such as *Unit 1: Construction Science* where structural members and failure modes are considered. Learners could complete investigations into the various methods that are used in the construction of steel and concrete frames.

Once learners have a good understanding of the structural members that are used in structural frames, you could use further whole-class, tutor-led discussion to introduce concepts of composite construction prior to setting learners scenario-based activities to develop designs for steel and/or concrete framed buildings.

You could then give learners opportunities to investigate retaining walls, including their effectiveness over the life cycle of a project. As with other topics, site visits or case studies could be used to give learners a deeper understanding of how and why certain solutions are used in given civil engineering projects.

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Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Understand the methods and techniques used to perform earthwork activities	**A1** Earthwork activities **A2** Earthmoving and compaction equipment **A3** Concreting equipment **A4** Temporary works **A5** Dewatering operations **A6** Piling operations	A written evaluation of the methods that could be used in a large-scale excavation for a given scenario
B Develop a substructure design for a civil engineering project	**B1** Foundations **B2** Design and drainage systems **B3** Utilities	A design for a civil engineering substructure, drainage system and utilities distribution for a given scenario
C Develop a superstructure design and specification for a civil engineering project	**C1** Structural frames **C2** Retaining walls	A design for a civil engineering superstructure and a retaining structure for a given scenario

Assessment guidance

The assessment of this unit will be in the form of three assignments, one for each learning aim. Each assignment will be in the form of a report, supported by drawings and diagrams as appropriate. There is flexibility in the forms of evidence that are acceptable, for example, presentations could be used, as long as the work submitted fulfils the necessary requirements of the assessment criteria and is individual to each learner.

Evidence for learning aim A is most likely to be in the form of an illustrated written report that will include drawings and diagrams to support the text. Learners should support their judgements by providing clear links to the requirements of the construction project they are considering, with reference to excavation methods, earthwork support and dewatering systems.

The evidence for learning aim B is also likely to be in the form of a report for the given project scenario. Learners will include their own designs for foundations, drainage work and utilities. They should include detailed and comprehensive drawings and diagrams that

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allow them to provide a reasoned evaluation of the suitability of their designs.

Finally, for learning aim C, learners should present a report that includes their own specification and design drawings for a given set of design parameters. The report should include both a specification for the superstructure frame and a specification and supporting drawings for a retaining structure. Learners should also evaluate their specifications against the given design parameters.

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Getting started

This provides you with a starting place for one way of delivering the unit, based around the recommended assessment approach in the specification.

Unit 23: Construction in Civil Engineering
Introduction You could introduce the unit by visiting an appropriate local civil engineering project so that learners can gain an understanding of the complexity of large-scale construction projects and be able to observe the nature of the activities that take place. This would include the plant and equipment that are used for excavation and construction, and the nature of different types of structure. The visit could be used as a stimulus for in-class discussion and be referred to throughout the delivery of unit.
Learning aim A – Understand the methods and techniques used to perform earthwork activities
Learning aim A1 ● You could introduce learning aim A by making reference to the visit to a construction site or using videos to introduce learners to the various earthwork activities that are used to reduce ground levels down to formation levels. ● You could discuss with learners the range of methods that are used for excavations before setting learners a group research activity to consider the advantages and disadvantages of trench and basement excavations. This could be followed by whole class activities using case studies of earthworks to consider the formation of cuttings and embankments, along with methods of supporting earthworks. You could use images and video resources to demonstrate examples to learners in order to reinforce learning. **Learning aim A2** ● Moving on, you could then ask learners to work in small groups to research the features of a different type of excavation or earth moving plant for each group. Each group could produce a presentation that explains the advantages and disadvantages of the equipment, making reference to their use, costs and time. The group could then deliver their presentations, to be followed by a group question and answer (Q&A) session to develop and reinforce points that are raised. ● A further activity could be to ask learners to produce their own research notes for the types of compaction plant that are used on civil engineering sites. These could be collated to produce a file of notes that learners could refer to when preparing for their assessments. **Learning aim A3** ● With an understanding of the equipment and plant used for excavating, earth moving and compacting, learners could be introduced to the types of equipment that are used to

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transport, place and compact in-situ concrete into formwork. Again, you could ask learners to work in pairs or small groups to research the features of a given type of concreting equipment. Groups could then come together to discuss the equipment they have been researching and compare the similarities and differences between them.

- Using appropriate videos or site visits, learners could be introduced to the types of equipment that are used for compaction. Following this, learners could investigate how each is used and produce a brief report that contains information about a range of plant.

Learning aim A4

- You could then introduce the concepts relating to temporary works. You could ask learners to work in small groups to investigate specific forms of temporary works such as sheet piling, trench boxes or diaphragm walling for given situations. The groups could first detail the features of temporary support systems before moving on to discuss the advantages and disadvantages of each. Groups could then present their findings to the wider group, which you could follow with discussing the relative merits of each.

Learning aim A5

- As a further activity, you could ask learners to work in pairs to investigate dewatering operations to limit the impact / effect of groundwater on excavation. Learners could produce short reports to explain the features of the types of equipment that are used for dewatering operations. You could then ask learners to consider the advantages and disadvantages of each type of equipment.

Learning aim A6

- Finally, you could introduce learners to piling operations. This could be achieved by small group activities with groups being tasked with investigating the types of piling operations that are used to support foundations, for retaining earth or to act as a permanent method of dewatering. Groups could then present their findings to the wider group, followed by a tutor-led discussion of the relative advantages and disadvantages of each method.

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Learning aim B – Develop a substructure design for a civil engineering project

Learning aim B1

You could introduce learning aim B through either a further site visit or by inviting a practising civil engineer to explain the principles relating to substructure design and construction. You could also introduce learners to the hazards and risks that are associated with civil engineering activities. This could be achieved by identifying potential hazards from video clips. You should also make sure learners are aware of relevant local health and safety legislation – this needs to be embedded into delivery throughout the unit.

You could use a whole class lecture to introduce learners to a range of types of foundation, including a brief outline of the design, construction and use of each type. Learners could then investigate the details of each type of construction, including drawings and diagrams for each. Learners should consider the applications for each type of foundation, along with the relative advantages and disadvantages of each.

Learning aim B2

This could be followed by small group activities to investigate the design of drainage systems as used in civil engineering projects. Learners could produce a report that considers the installation of deep sewers, pipe work and reinforced concrete culverts where these are necessary.

Learners could be given case studies to investigate and then produce designs for drainage systems that are appropriate for the given situations. These could be presented to the whole class, with discussions relating to the benefits associated with each taking place and any misconceptions being addressed.

Learning aim B3

With learners having a good understanding of the requirements for drainage, you could introduce other utilities, including water, electricity, gas and data services. This could initially be in the form of a group discussion.

You could then ask learners to carry out paired investigations into the techniques that are used for the installation of utilities with an emphasis on techniques used locally. The investigations should consider typical applications, with this supported by case studies and examples of installations.

When you are satisfied that learners have a secure understanding of substructure design, you could issue the second assignment that covers this learning aim.

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Learning aim C – Develop a superstructure design and specification for a civil engineering project

Learning aim C1

- Learning aim C could be introduced with either a visit from an external speaker, a site visit or through video. Learners should be given an opportunity to visualise the various methods of construction, including for structural frames, which come together to form the superstructure of a civil engineering project. This could lead to discussions about what forms a superstructure and how these come together in a project.

- You could then introduce learners to the principles that relate to the design of steel and concrete framed buildings. You could demonstrate to learners the techniques used for producing designs of steel and concrete framed buildings through drawings or animations.

- Learners could then be asked to investigate both concrete and steel frames, with small groups being given specific components to research. The research should include information about connections between elements and the advantages and disadvantages of each method they have researched. Learners could then present their research to the wider group, with theories being discussed and relative advantages and disadvantages considered. You could address any mistakes or misunderstandings.

- Learners could then be given a range of scenarios to produce designs for either steel or concrete frames; these could be designed by learners with accurate drawings being produced to explain the design proposals.

- You could then introduce learners to a range of composite construction methods, discussing how concrete and steel can be integrated into frameworks.

Learning aim C2

- With an understanding of frameworks, you could then discuss with the learners the methods of providing retaining walls. Learners could carry out independent research into a range of methods and then evaluate each method in terms of effectiveness over their planned life cycle: gabions, precast concrete systems, and in-situ reinforced concrete, integral drainage, and revetment works to sloping walls.

- Learners could then be given a task to design retaining structures for given scenarios and to justify their chosen solutions in each situation.

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Details of links to other BTEC units and qualifications, and to other relevant units/qualifications

This unit links to:

- Unit 1: Construction Technology
- Unit 2: Construction Design
- Unit 3: Construction Science
- Unit 4: Safe Working Practice
- Unit 6: Construction Mathematics
- Unit 7: Graphical Detailing
- Unit 10: Surveying in Construction
- Unit 13: Site Engineering for Construction
- Unit 31: Specialist Civil Engineering Techniques
- Unit 32: Highway Construction and Maintenance in Civil Engineering

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC International Qualifications in Construction and the Built Environment. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Chudley R and Greeno R, *Advanced Construction Technology*, Pearson Education Limited, 2006 ISBN 9780132019859 – covers site preparation work, plant and equipment, substructures, temporary works and safe working practices related to work on site.

Chudley R and Greeno R, *Building Construction Handbook* (Seventh Edition), Butterworth-Heinemann, 20 08 ISBN 9780750686228 – provides a broad introduction to elements of construction design, including diagrams and drawings of building elements.

Manley S, Charters M, Francis C, Topliss S and Doyle M, *Construction and the Built Environment,* Pearson Education Limited, 2008 ISBN 9780435499914 – includes reference to structures and the equipment used on construction sites.

Osbourn D and Greeno R, *Introduction to Building* (4th Edition), Pearson Education Limited, 2007 ISBN 9780582473034 – covers aspects of building processes and construction methods, including methods used for communicating information.

Smith P, Structural Design of Buildings, John Wiley & Sons, 2016, ISBN 9781118839416 - covers frameworks and retaining structures.

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Journals

Building Magazine (CMP)

Construction News (EMAP Publishing Limited)

International Journal of Structural Engineering (Indersceince)

Videos

YouTube:

"3 16 Concrete compaction" - Concrete compaction methods

"Construction podcast dewatering" - Dewatering techniques

"Excavation & Trenching Safety" - Hazards related to the construction of foundations and excavations

"SUPER SKYSCRAPERS "Building the Future" | Framework | PBS" - High-rise office block constructions

"Retaining Wall Types" - Types of retaining wall

"Excavations (1 of 6): Introduction" - one of a series of six videos related to excavations

"Excavations & Trenching" - Methods of supporting trenches

"Steel Frame construction 3D animation" - Steel portal construction

"Buildtrade steel construction process" - Structural steelwork animation

Websites

Visit the Chartered Institute of Building website

Visit the Global Construction Review website

Visit the Health and Safety Executive website and search "Structural stability during excavations" for the UK Health and Safety Executive guidance for excavations

Visit the Institute of Civil Engineers website

Visit the Thomas Telford website, this is the knowledge business of the Institution of Civil Engineers

Visit understandconstruction.com covers a wide range of topics including foundations, and both steel and concrete structures

Pearson is not responsible for the content of any external internet sites. It is essential for tutors to preview each website before using it in class so as to ensure that the URL is still accurate, relevant and appropriate. We suggest that tutors bookmark useful websites and consider enabling learners to access them through the school/college intranet.

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