Unit 32: Highway Construction and Maintenance in Civil Engineering

Delivery guidance

This unit is an optional unit that forms part of the 'Civil Engineering' pathway of the Pearson BTEC International Level 3 Diploma and Extended Diploma in Civil Engineering. This unit focuses on highway construction and maintenance, with three distinct learning aims covering planning and preparation, design and maintenance.

Approaching the unit

Methodology for the planning and delivery of this unit could include:

- engaging the local authority 'Highways Engineering Department' into the development of assignments for the design elements of the assessment
- arranging a site visit for learners to view highway maintenance techniques
- engaging with a highway design consultancy or a main contractor to design the road infrastructure for the initial planning stages of the development, along with associated highway drainage
- arranging for a guest speaker, such as a civil engineer who specialises in highway design.

Learners are to look at: the processes that are involved in planning, preparing and designing a road; earthworks, how these are developed and the ways highways can be drained; and different forms of construction, e.g. a concrete road or an asphalt/tarmacadam road construction. Linking this design element to a construction development would give an engaging method of integrating civil engineering into construction activities.

The planning and design of the road should form the basis of a new construction, so that all aspects of the planning within the unit content can be considered. Delivery methods can include guest speakers from local highways and planning departments. This would give a 'hands-on' approach for learners, including detailed and informative discussions with highway and planning professionals. Tutors may wish to engage with local authorities when delivering this unit, and this relationship may give the centre good resources on highway design. The unit also covers how planning of such highways is undertaken, and how authorities maintain infrastructure.

Gaining access to the standard design details for road construction is essential, in order to demonstrate applicable local and national standards. It is important to be selective and use those that suitably match the unit content and local practice for highway design and construction.

Issue 1 – June 2020 © Pearson Education Limited 2020

Delivery of learning aims

Learning aim A

Learning aim A covers the planning and preparation stages of a highway design. Placing this into the context of a new highway construction would give a useful greenfield approach to the planning of such an infrastructure. Aspects such as the acquisition of land, the route that the new highway will take, how it will be funded, and its design in terms of line and level, all need to be considered. Reference to any local planning issues or concerns raised by a community for a new highway development could be used as a discussion point related to land acquisition.

Learning aim A2 examines earthwork construction for new highways, including site clearance, cut and fill, embankment construction and the control of line and level. Tutors could invite a civil engineering contractor who specialises in road construction to visit the centre, as they would help to support learners' understanding of learning aim A2, especially regarding the earthwork associated with the construction of a new road, the balance of cut and fill, and how efficiencies are driven through good design.

Learning aim B

Learning aim B covers the production of plans for a new highway, with B1 covering the actual construction of a highway and the different methods of construction. There are two methods of pavement construction that must be covered: flexible and rigid. Small group work with two teams producing a design for the construction of a new road, along with a presentation to a client, would give an ideal opportunity to engage and share learner knowledge. This could be achieved as a micro project with learners conducting research into their methods, the plant and equipment required, and the specifications of materials used for each type of construction.

Learning aim B2 focuses on the drainage installation that is required to ensure that surface water is removed effectively from roads and highways. The standard highway design details (listed in the 'Resources' section) give clear illustrations of the installation of road drainage. It also gives detailed cross-sections of road pavements, so falls can be demonstrated to learners. The connection of road drainage to the associated discharge points needs to be explored in learning aim B3. Local roads could be used as an example to demonstrate this.

Learning aim B4 then covers quality control, which focuses on the testing of materials as they are laid in situ. It is important to highlight that tests differ between flexible and rigid pavement constructions.

Learning aim C

Learning aim C covers the maintenance of highways. The local 'Highways Engineering Department' could support the delivery by providing suitable guest speakers. Tutors could prepare a set of questions based around the assessment criteria for this unit, focusing on the different methods of repair and what maintenance is required. Similarly, gaining access to a highway maintenance contractor would give not only employer engagement, but also useful resources in terms of visual materials relating to the methods of repair. These are listed in learning aim C2 and cover a range of repair methods.

Issue 1 – June 2020 © Pearson Education Limited 2020

Assessment model

Learning aim	Key content areas	Recommended assessment approach
A Undertake the planning and preparation works required for highway construction	**A1** Introduction to planning a new highway **A2** Earthwork construction for new highways	A set of proposals for a new highway based on a given scenario, including information about preparatory activities, design of earthworks, pavement details and drainage.
B Undertake the production of plans for highway construction	**B1** Forms and methods of highway construction **B2** Drainage of highways **B3** Drainage of land and subsoils **B4** Quality control	
C Examine maintenance procedures for highways	**C1** Introduction to highway maintenance **C2** Highway maintenance processes	*A report that investigates and evaluates the need for highway maintenance and approaches that can be taken to rectify defects.

Assessment guidance

There are two distinct areas of assessment, including a written report and a set of highway design proposals. To set up the assessment for the highway proposal for learning aims A and B, learners will need to be given a design scenario that covers the following criteria:

- an area of land that the proposed road will route through, along with a location map
- the topographical survey of the route
- aerial photographs or access to the proposed site in order to view features that will need to be considered
- drainage discharge details
- environmental concerns voiced by the community
- client's proposed specification.

This scenario can be amended and extended as soon as learners begin their design route and specification for the proposed highway. Learners need to produce a full set of proposals that cover the aspects of each of the following:

- earthworks
- line and level
- land acquisition
- funding
- planned route.

Issue 1 – June 2020 © Pearson Education Limited 2020

Learners will need to produce drawings for the scenario in support of their proposals. Here, links to other units may prove useful, such as *Unit 7: Graphical Detailing* and any surveying and setting out units in the specification.

The second suggested assessment method for learning aim C is a formal report. This should introduce the types of highway maintenance used to repair defects in flexible and rigid pavements. Tutors could give a series of images of highways with defects and ask learners to propose solutions for each repair. Learners can achieve a distinction grade by evaluating the repair in terms of its quality and life span.

Issue 1 – June 2020 © Pearson Education Limited 2020

Getting started

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

Unit 32: Highway Construction and Maintenance in Civil Engineering

Introduction

This is a specialist unit dealing with highway infrastructure and its installation and maintenance. Engaging employers such as local authorities and highway contractors is essential in supporting you with the delivery, not only in terms of resources but also first-hand experience.

The key to the learners' proposals is the setting up of the scenario. This should contain sufficient detail so that learners can cover all aspects of the assessment criteria and contain some drawings of the location. Learners can present their evidence using a verbal and slide presentation, which could be recorded and used as the evidence for the 'comprehensive' descriptor used in the distinction criteria. Since learners have to explain, this is an ideal method of gathering evidence for the assessment criteria.

Learning aim A – Undertake the planning and preparation works required for highway construction

Learning aim A1

- Give learners a detailed scenario. Learners are to get into small groups and open a large-scale location map. They then have to plan their route. You should act as the voice of the surrounding community and give comments when appropriate.
- Learners use tracing paper to plan the route of the highway against the criteria within the scenario. At the end of the period of planning, learners are to present their route with a justification as to why its direction is appropriate by stating valid reasons.
- Once the route is established (as a group decision), the next stage involves some resource planning. The second part of this mini task is to make decisions with justification regarding the following questions:
  How will the new road be funded: public or private?
  What traffic volumes will it be able to carry?
  How can the environmental impact be reduced?
  How will the public be consulted about the changes?
  What type of highway should be constructed?
- You should ensure that learners discuss among themselves, so that they outline all of the considerations that need to be met as part of the assessment evidence.

Learning aim A2

- The next stage is to move onto the construction planning. Learners should obtain a longitudinal profile of the road design against the existing levels so that they can plan to balance the cut and fill volumes. This will need your intervention regarding design levels and ground levels. A link to a resource has been given (see 'Resources' section) that details mass haul cut and fill planning. This needs to be applied to the topography of the location and the design levels of the roadway.
- You could introduce a variable to make the task more challenging, e.g. weak ground that needs to be stabilised and drained before highway construction works can commence.

Issue 1 – June 2020 © Pearson Education Limited 2020

Learning aim B – Undertake the production of plans for highway construction

Learning aim B is concerned with the production of plans for highway construction. It includes the design of drainage for land and subsoils, which needs to be indicated on plans so this part of the substructure can be accommodated in the construction of the highway.

Learning aims B1, B2 & B3

- Ask learners to get into small groups. Allocate half of the groups with 'rigid' pavements and the other half of the groups with 'flexible' pavements. Learners then research the construction methods that are suitable and materials specifications for highways with a range of traffic requirements.
- Summarise the learners' research work and facilitate a debate, getting learners to justify which one to use for the given scenario.
- Have learners produce a cross-section detail with a specification for their justified choice, along with the associated drainage requirements at road kerb positions. This can include road gullies, associated drainage and discharge ditches and outfalls.
- Use videos to demonstrate the two different methods of construction (links to suitable videos have been given in the 'Resources' section).
- Investigate published standard details for highway design of drainage, which is covered in B2. A number of these are available to download on local authority and government highways websites to assist with this method.
- Learners investigate land drainage types for the disposal of collected water – methods and procedures (to include soakaways, sustainable urban drainage systems, watercourses, catch pits and associated calculations).
- Demonstrate to learners typical drainage arrangements for highways (including manholes) and soakaway designs, and give typical cross-section details.
- Arrange for a guest speaker from the Highways Department to visit the centre and give advice about the construction details for flexible and rigid pavement, including a class discussion of the typical details. These could include the build-up of the different layers in a flexible pavement, from the sub-base, base layer and wearing course. Examples of how they instigate repairs would also engage learners with this aspect of highway maintenance.
- You could also arrange for a highways contractor to visit the centre and give a case study for a design and build highway project, e.g. an access road or a privately funded highway.
- Presentation of the learner's proposals is a matter of choice. Learners could use small group work activities to deliver an aspect against their design proposals. However, care should be taken with any observation records for the presentation so that all individuals meet the assessment criteria for the unit.

Learning aim B4

- The use and application of quality control methods could be evidenced by asking learners to create a leaflet about onsite testing, to ensure that flexible and rigid pavements are constructed in accordance with applicable national standards and highways design standards. Images can be included in the leaflet to illustrate the different types of testing that need to be undertaken.

Learning aim C – Examine maintenance procedures for highways

Learning aim C focuses on the use and application of maintenance to ensure defects in highways are resolved, and the benefits and drawbacks of alternative approaches. The suggested assessment for this learning aim takes the form of a written report.

Learning aims C1 & C2

- Ask the guest speaker from the previous learning aim (the highways contractor) to give learners a demonstration of the methods that can be used to repair and maintain both flexible and rigid pavements.
- You can also invite a guest speaker from the local or regional authority to talk about the differences between seasonal maintenance of roads, e.g. summer versus winter, through routine and structural repairs. This should include how roads are surveyed for defects and the recording and commissioning processes involved.
- Give learners a series of visual images of defects. Then learners have to identify the defects and write a repair method statement, justifying their chosen repair method. You can use videos to demonstrate the repair methods that are used locally.
- Arrange for a site visit, where possible, so that learners can observe road planning work in the field and maintenance processes, such as laying a new surface. They can observe a top dressing being applied to maintain the road surfaces and lining in operation.
- This is a very short section within learning aim C, so a holistic approach to the maintenance of a highway should be adopted. This will allow the evidence to be based on a repair, with learners demonstrating a recommended technique, then justifying and evaluating that technique.

Issue 1 – June 2020 © Pearson Education Limited 2020

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

This unit links to the following units within the suite of qualifications:

- Unit 1: Construction Technology
- Unit 2: Construction Design
- Unit 7: Graphical Detailing.

Resources

In addition to the resources listed below, publishers are likely to produce Pearson-endorsed textbooks that support this unit of the BTEC International Level 3 Qualifications in Construction and Civil Engineering. Check the Pearson website (http://qualifications.pearson.com/endorsed-resources) for more information as titles achieve endorsement.

Textbooks

Fwa T – *The Handbook of Highway Engineering* (CRC, 2005) ISBN 9781420039504 – a guide to approaches to highway engineering across a range of international countries.

Garber N – *Traffic & Highway Engineering - SI Version* (Cengage Learning, 2009) ISBN 9780495438533 – covers local planning, draining, materials and road pavement types.

Hughes D – *Highways*, 5th Edition (ICE, 2016) ISBN 9780727759931 – a detailed textbook covering all aspects of highway engineering.

Pitman P – *External Works, Roads and Drainage: A Practical Guide* (Taylor and Francis, 2001) ISBN 9780419257608 – an excellent 'hands-on' approach textbook.

Videos

'Highway Concrete Machines At Work' – shows a rigid concrete paving being laid.

'Repairing Potholes Process – Velocity Patching' – shows pavement repair, using a unique spray method on a tarmacked road.

'Rad International Road Construction English' – road construction projects in the UAE.

Websites

Visit the Institute of Civil Engineers website – it is a professional body for civil engineering with information on professional development, career pathways, standards and other resources.

Visit the Institute of Highway Engineers website – the relevant professional body for highway engineering, including standards, professional development and other resources.

Visit the World Road Association – a forum that discusses all issues related to roads, including safety, maintenance and design.

Visit the World Highways website – an international website that addresses all aspects of highway design and maintenance.

Visit the United Nations Economic and Social Commission for Asia and the Pacific website and search 'ASIAN HIGHWAY CLASSIFICATION AND DESIGN STANDARDS' for a PDF explaining design standards for the 15 Asian Highways member countries.

Visit the United Nations Economic and Social Commission for Asia and the Pacific website for guidance on good design for roads and highways.

Visit Austroads.com, a good site for up-to-date practices for safe road design that is applicable for many regions and countries.

Search for 'UGPTI Earthwork and Mass Diagrams PDF', which gives an example of mass haul calculations for cut and fill.

For information on construction:

'Pavement Interactive' and 'The Constructor' – these websites give information on pavement types.

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.

Issue 1 – June 2020 © Pearson Education Limited 2020