

Unit 31: Highway Construction and Maintenance in Civil Engineering

NQF Level 3: BTEC National

Guided learning hours: 60

Unit abstract

The first major roads in Britain were built by the Romans, and little happened to them until the 18th century and the coming of the industrial revolution. Since then, Britain's highways have continued to develop, with traffic volumes continuing to grow and to place greater demands on the highway network.

Civil engineers are involved in the construction of new roads, the improvement of existing roads and highway maintenance.

Learners will explore and gain an understanding of what is involved in planning for a new road, of the construction methods and materials used to build roads, and of how highways are maintained.

Learners who study this unit will find it useful to study a civil engineering construction unit, and some prior knowledge of setting out techniques would also be useful.

Learning outcomes

On completion of this unit a learner should:

- 1 Know how a new road is planned
- 2 Be able to describe earthworks carried out in the construction of a new road
- 3 Understand the different types of pavement construction and the materials used
- 4 Understand the methods used to drain surface water from the surface of a road and how ground water can be controlled
- 5 Be able to describe and explain highway maintenance processes.

Unit content

1 Know how a new road is planned

Route location: assessment of traffic volumes; environmental impact and likely earthwork problems; choice of alignment; public consultation

Design of line and level: factors which affect vertical and horizontal alignment

Public consultation: procedures to consult public; public enquiries

Allocation of resources: funding of new roads (design, build, finance and operate – DBFO); private/public funding

Land acquisition: procedures to acquire land; potential problems

2 Be able to describe earthworks carried out in the construction of a new road

Site clearance: advance fencing contracts; grubbing out; stripping topsoil

Cut and fill: setting out for embankments/cuttings; plant used; mass haul curves; computer applications

Embankment construction: end product or method specification; suitable/unsuitable materials for fill; procedures and testing as work proceeds

Treatment of weak areas: replacement; stabilisation and drainage techniques

3 Understand the different types of pavement construction and the materials used

Forms of construction: flexible, rigid and composites; continuously reinforced concrete roadbase (CRCR) and flexible composite

Typical pavement: dimensioned cross-sections of road pavements

Construction methods: paving machines; slip form and fixed form pavers; manual and semi-manual methods of constructing elements; using site profiles and automatic paver guidance techniques; compaction procedures

Materials and quality control: composition of bituminous materials, concrete and cement bound materials (CBM); sampling of materials; temperature checks; analysis/testing of materials; checks on the finished road surface

4 Understand the methods used to drain surface water from the surface of a road and how ground water can be controlled

Types of drainage: differences and links between waste and surface water and subsoil

Surface water run off: camber; crossfall; longitudinal fall; crowned channels

Forms of surface water drainage: eg conventional kerb and gully, side filter drains, grips and ditches, combined kerb/main drain, gully spacing and construction

Pipelaying: connections to main drain; laying methods; support and protection; backfill

Manhole construction: purposes; materials used; typical cross-sections; construction

Forms of subsoil drainage: patterns used; types of pipes; typical cross-sections used

Disposal of collected water: soakaways; watercourses and drains via catchpits

5 Be able to describe and explain highway maintenance processes

Types of maintenance: structural, routine and winter maintenance

Pavement defects: typical structural defects in roads

Identification of defects: inspection and testing; typical results; application of maintenance standards; selection of remedial treatments from examination of collected and established data

Maintenance processes: patching; re-surfacing; re-construction; surface dressing; use of sealants; re-setting kerbs and flags; slurry sealing and re-treading

Grading grid

In order to pass this unit, the evidence that the learner presents for assessment needs to demonstrate that they can meet all of the learning outcomes for the unit. The criteria for a pass grade describe the level of achievement required to pass this unit.

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
<p>P1 identify and describe the activities that may be carried out in the planning of a new road</p> <p>P2 describe the site clearance and earthworks processes carried out prior to construction of the road pavement</p> <p>P3 describe commonly used forms of road pavement construction including the process used to construct one form</p> <p>P4 describe how surface water is collected from the paved surface of highways and piped to a suitable disposal point</p> <p>P5 identify and describe methods used for land and subsoil drainage</p>	<p>M1 explain methods of strengthening any weak areas prior to the construction of road pavement</p> <p>M2 explain the operating principles of pavers for laying flexible road carriages</p>	<p>D1 evaluate the testing requirements for materials used in pavement construction</p>

Grading criteria		
To achieve a pass grade the evidence must show that the learner is able to:	To achieve a merit grade the evidence must show that, in addition to the pass criteria, the learner is able to:	To achieve a distinction grade the evidence must show that, in addition to the pass and merit criteria, the learner is able to:
P6 describe structural, routine and winter maintenance.	M4 illustrate and explain typical structural defects and the methods used to identify and rectify them.	D2 evaluate given data from a structural survey of a pavement construction, making comparisons to warning levels of intervention and recommending appropriate remedial measures.

Essential guidance for tutors

Delivery

Tutors delivering this unit have opportunities to use a wide range of techniques. Lectures, discussions, seminar presentations, site visits, supervised practicals, research using the internet and/or library resources and the use of personal and/or industrial experience are all suitable. Delivery should stimulate, motivate, educate and enthuse learners. Visiting expert speakers could add relevance of the subject, Learning outcomes 1, 2, 3 and 4 are linked and form a logical, consistent and progressive structure. Learning outcome 5 is not directly linked to the previous four learning outcomes and can be delivered independently. This suggests two broad areas of delivery.

A mixture of tutor-centred teaching and learner-centred investigation should be used to support delivery. Case study material can be used to allow learners to investigate aspects of planning and design. Calculations for surface water drainage should not be complex and charts and tables can be used.

A programme of site visits will add value to and will help learners to understand theoretical concepts and observe road construction in progress. For aspects such as route planning, visits to completed highways will help learners to understand the issues involved. It is useful, but not always necessary, to visit major highway projects.

Where possible, links should be forged with industry, and in particular the local highway authority. They may be able to provide the opportunity for a visit to a materials testing laboratory so learners could observe the testing of materials used in highway construction.

Group activities are permissible, but tutors will need to ensure that individual learners are provided with equal experiential and assessment opportunities.

Health, safety and welfare issues are paramount and should be strictly reinforced through close supervision of all workshops and activity areas, and risk assessments must be undertaken prior to practical activities. Centres are advised to read the *Delivery approach* section on page 24, and *Annexe G: Provision and Use of Work Equipment Regulations 1998 (PUWER)*.

Assessment

Evidence for this unit may be gathered from a variety of sources, including well-planned investigative assignments, case studies or reports of practical assignments.

There are many suitable forms of assessment that could be employed and tutors are encouraged to consider and adopt these where appropriate. Some examples of possible assessment approaches are suggested below. However, these are not intended to be prescriptive or restrictive, and are provided as an illustration of the alternative forms of assessment evidence that would be acceptable. General guidance on the design of suitable assignments is available on page 19 of this specification.

Some criteria can be assessed directly by the tutor during practical activities. If this approach is used suitable evidence would be observation records or witness statements. Guidance on the use of these is provided on the Edexcel website.

The structure of the unit suggests that the grading criteria may be fully addressed by using two assignments. The first of these would cover P1, P2, P3, M1, M2 and D1. The second would cover P4, P5 and M3, and the third would cover P6, M4 and D2.

To achieve a pass grade learners must meet the six pass criteria listed in the grading grid.

For P1, learners must identify and describe the activities that may be carried out in the planning of a new road. They need to include how traffic volumes are assessed (but do not need to assess them), route selection and potential constraints, environmental impact, land acquisition, funding and public consultation. Evidence could take the form of a presentation or a report.

For P2, learners must describe the site clearance and earthworks processes carried out prior to construction of the road pavement. Learners should be able to describe how line and level are controlled, but do not need to perform calculations or carry out practical work. They will use sketches or referenced diagrams from texts to illustrate description. Evidence could take the form of a presentation, a report or verbal questioning.

For P3, learners must describe commonly used forms of road pavement construction including the process used to construct one form. They should cover the different types that have been used historically and that are still in use, current methods being used and surface treatments used to improve skid resistance. It should include at least one form of rigid, flexible and tactile pavement construction. Learners also need to describe the process used to construct one pavement type. They will use sketches or referenced diagrams from texts to illustrate their description. Examples of suitable evidence approaches could be as for P2, but with the inclusion of appropriate drawings and other images.

For P4, learners must describe how surface water is collected from the paved surface of highways and piped to a suitable disposal point. They should also identify a suitable disposal point for surface water and describe how surface water can be collected and conveyed to this point. Learners will use sketches or referenced diagrams from texts to illustrate description. Examples of suitable evidence approaches could be as for P2 but with the inclusion of appropriate drawings and other images.

For P5, learners must identify and describe methods used for land and subsoil drainage. They must include a description of a typical example of land and subsoil drainage. Learners will use sketches or referenced diagrams from texts to illustrate description. Examples of suitable evidencing approaches could be as for P2 but with the inclusion of appropriate drawings and other images.

For P6, learners must describe structural, routine and winter maintenance. Structural could including defects, testing, inspection and remedial works. Routine could including sweeping, gully cleaning, road markings, signs, signals and lighting. Winter could including gritting and snow clearing. Examples of suitable evidence approaches could be as for P2 but with the inclusion of appropriate drawings and other images.

To achieve a merit grade learners must meet all of the pass grade criteria and the four merit grade criteria.

For M1, learners must explain methods of strengthening any weak areas prior to the construction of the road pavement. They should include the plant, materials and techniques used to strengthen weak areas. Examples of suitable evidence approaches could be as for P2 but with the inclusion of appropriate drawings and other images.

For M2, learners must explain the operating principles of pavers for laying flexible road carriageways. They could make reference to manufacturers' plant, but must not simply submit brochures. The key principles must be explained in a detailed report which could be supported by brochures.

For M3, learners must produce details, supported by calculations from given data, for the spacing of road gullies and the sizing of a soakaway. The details are to be supported by calculations. These should be substantially correct, clearly set out and the correct units stated.

For M4, learners must illustrate and explain typical structural defects and the methods used to identify and rectify them. The methods and materials that might be used to rectify these defects must be explained in a presentation or report.

To achieve a distinction grade learners must meet all of the pass and merit grade criteria and the two distinction grade criteria.

For D1, learners must evaluate the testing requirements for materials used in pavement construction. The evaluation should be in terms of their importance and the consequence of incorporating materials out of specification. A report supported by calculations, graphs and testing data as appropriate is required.

For D2, learners must evaluate given data from a structural survey of a pavement construction, making comparisons to warning levels of intervention and recommending appropriate remedial measures. Reasons for selected method(s) should be given in a report supported by appropriate drawings and other images.

Links to National Occupational Standards, other BTEC units, other BTEC qualifications and other relevant units and qualifications

The learning outcomes in this unit are closely linked with, for example, *Unit 10: Surveying in Construction and Civil Engineering*, *Unit 12: Setting Out Processes in Construction and Civil Engineering* and *Unit 29: Construction in Civil Engineering* together with similar units at Higher National and degree level.

This unit may have links to the Edexcel Level 3 Technical and Professional NVQs for Construction and the Built Environment. Updated information on this, and a summary mapping of the unit to the CIC Occupational Standards, is available from Edexcel. See *Annexe D: National Occupational Standards/mapping with NVQs*.

The unit presents opportunities to gain Level 3 key skills in communication and information and communication technology. Opportunities for satisfying requirements for Wider Curriculum Mapping are summarised in *Annexe F: Wider curriculum mapping*.

The unit has links with 2005 CIC Occupational Standards at Level 3 (B21, B31, B32, B33, B63, D26 and E33).

Essential resources

Visits to highway construction sites will add to the learner's experience of construction techniques and methods. Learners can also gain from visits to completed highway projects where planning was an issue. If it is not possible for visits to be organised, video or DVD materials can be viewed by learners.

A visit to a materials testing laboratory will provide an insight into the properties of materials used in highway construction and reinforce theories of how they are tested and why, plus they will give evidence of typical results.

Copies of drawings of highway schemes will provide a valuable resource for helping learners to understand highway layout, earthworks and surface water disposal.

Learners will require access to copies of legislation, standards and design charts and tables.

Health, safety and welfare issues must be considered at all times and risk assessments should be undertaken for site visits and any practical work.

Indicative reading for learners**Textbooks**

Institution of Civil Engineers – *Highway Winter Maintenance: ICE Design and Practice Guide* (Thomas Telford, 2000) ISBN 0727729578

Kendrick P, Copson M, Beresford S and McCormick P – *Roadwork: Theory and Practice, 5th Edition* (Butterworth-Heinemann, 2004) ISBN 0750664703

O'Flaherty C – *Highways: The Location, Design, Construction and Maintenance of Road Pavements, 4th Edition* (Butterworth-Heinemann, 2002) ISBN 0750650907

Pitman P – *External Works, Roads and Drainage: A Practical Guide* (Spon Press, 2001) ISBN 0419257608

Watson J – *Highway Construction and Maintenance, 2nd Edition* (Longman, 1994) ISBN 0582234123

Other publications

Highway Design Guides (local authorities)

Website

www.standardsforhighways.co.uk

Highways Agency

Key skills

Achievement of key skills is not a requirement of this qualification but it is encouraged. Suggestions of opportunities for the generation of Level 3 key skill evidence are given here. Tutors should check that learners have produced all the evidence required by part B of the key skills specifications when assessing this evidence. Learners may need to develop additional evidence elsewhere to fully meet the requirements of the key skills specifications.

Communication Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> • identifying and describing activities that may be carried out in the planning of a new road • describing site clearance and earthwork processes • describing commonly used forms of pavement construction • explaining methods of strengthening weak areas and preparing a specification • explaining the operating principles of pavers • evaluating the testing requirements for materials used in pavement construction • describing how surface water is collected and piped to disposal points • identifying and describing land drainage and subsoil drainage • describing maintenance • explaining structural defects and methods used to rectify them. 	<p>C3.2 Read and synthesise information from at least two documents about the same subject.</p> <p>Each document must be a minimum of 1000 words long.</p> <p>C3.3 Write two different types of documents each one giving different information about complex subjects. One document must be at least 1000 words long.</p>

Information and communication technology Level 3	
When learners are:	They should be able to develop the following key skills evidence:
<ul style="list-style-type: none"> • describing site clearance and earthwork processes • describing commonly used forms of pavement construction • describing how surface water is collected and piped to disposal points • identifying and describing land drainage and subsoil drainage. 	ICT3.3 Present combined information such as text with image, text with number, image with number.