Unit 15: Design and Build Highways

Unit code:	D/504/4364
QCF level:	6
Credit value:	15

Aim

This unit gives learners an understanding of the methods used in financing, designing, constructing and maintaining highway engineering projects. The unit will also develop the necessary skills to provide robust and sustainable solutions for highway engineering projects.

Unit abstract

This unit introduces learners to the funding and procurement mechanisms which govern the commissioning, delivery and ongoing maintenance of highway engineering projects.

Learners will cover the statutory and financial regulations and the range of contracts available. Learners will also cover the range of delivery models available for highway engineering projects.

This unit will give learners an understanding of the engineering theory relating to highway works. Learners will also cover the range of available design solutions, statutory and regulatory requirements and appraisal methods. The unit will also provide learners with the skills required to implement design solutions.

This unit will provide learners with an understanding of the construction techniques available to deliver highway engineering projects. Learners will cover the available methods to interpret design solutions and determine the available resources required to successfully deliver the project.

This unit provides learners with an understanding of the required techniques to manage and maintain the highway project following completion. Learners will cover the range of inspection, maintenance and intervention techniques used to sustain the project.

Learning outcomes

On successful completion of this unit a learner will:

1 Understand procurement mechanisms for highway engineering

2 Be able to design complex highway projects

3 Understand construction techniques used in complex highway projects

4 Be able to manage a highway asset.

Unit content

1 Understand procurement mechanisms for highway engineering

Procurement mechanisms: commissioning works; supply chain management; contract types (term maintenance), managing agent, frameworks, Private Finance Initiative (PFI);quality/price arrangements; fixed price; lean construction (Egan, Latham)

Funds: PFI; Local Transport Plan; developer or private; central government

Financial requirements: European Union Procurement Regulations; Public Authority Standing Orders

Financial control procedures: payments; performance/non-performance measures; retentions

2 Be able to design complex highway projects

Sustainable design solution: lifecycle plans; maintenance plan; specific customer-related requirements; client's requirements (participation in design, design, value engineering, risk management); contacts and communication protocols; appraisal of options; statutory, regulatory requirements (Construction (Design and Management) Regulations (2007)); Environmental Management Systems; National Design Guides (Manual for Streets, Design Manual for Roads and Bridges, Local Authority Design Guides, Sustainable Urban Drainage systems); computer aided design techniques (AutoCAD, MX; Design Modelling Tools); Site Waste Management

Legislation and approved codes of practice: current legislation relevant to the home country; UK legislation to include the Health and Safety at Work etc Act (1974), the Construction (Design and Management) Regulations (2007), approved codes of practice and guidance notes, the Management of Health and Safety at Work Regulations (1999)

Construction methods: supervision of contract works; materials testing; client, stakeholder feedback; Environmental Impact Assessment; safety audits

3 Understand construction techniques used in complex highway projects

Project information: specification, client requirements, scope of the construction works; constraints and requirements, ground conditions, water disposal, soil classification

Techniques: construction planning and sequencing; critical path networks; health and safety management; temporary works; emergency works; principles of lean construction; geotechnics; environmental protection; site planning and management; construction theory; principles of highway construction (earthworks, drainage, pavements, services); principles of highway structures construction

Highway schemes: types of highways (trunk roads, motorways, connecting spurs, minor roads, access roads); requirements for specific vehicles; infrastructure (bridges, flyovers, ramps, lighting, drainage, water dispersal)

Resources: labour; roles and responsibilities; plant and equipment; materials; supply chain management; project management; financial control of sub-contractors

Buildability of project: appraisal; constraints; stakeholder input; analysis; synthesis and testing processes; design iterations; cost planning; adaptability; flexibility; value for money; calculations; drawings; specifications; late amendments; changes and variations

Evaluation of project outcomes: sustainability; cost control; compensation events

4 **Be able to manage a highway asset**

Status: surveys*;* levels of service; perceived condition; analysis of data; level of performance gap; demand aspirations; liability

Types of highway conditions surveys: SCANNER; CVI/DVI; performance and non-performance (safety, accessibility); inspection regimes

Maintenance plan: lifecycle planning; decision making; identification of risks; whole-life costing; service delivery; resilience planning (winter and severe weather arrangements); cyclic maintenance; Highways Asset Management Plan (HAMP); Transport Asset Management Plan; Service Standards

Effectiveness: ongoing monitoring and review; physical works; performance measurement; benchmarking; Customer Management Systems

Learning outcomes and assessment criteria

Learning outcomes On successful completion of this unit a learner will:	**Assessment criteria for pass** The learner can:
LO1 Understand procurement mechanisms for highway engineering	1.1 Critically appraise the procurement mechanisms used in a specific highway project 1.2 Critically evaluate the financial control procedures used to commission a specific highway project
LO2 Be able to design complex highway projects	2.1 Create a sustainable design solution for a given highway project 2.2 Create a Health and Safety plan for a given highway project 2.3 Critically evaluate the effectiveness of selected construction methods for a given highway project
LO3 Understand construction techniques used in complex highway projects	3.1 Interpret project information as design outcomes for a specific highway project 3.2 Design a highway scheme for a specific project 3.3 Appraise the buildability of a specific highway project 3.4 Critically evaluate the project outcomes
LO4 Be able to manage a highway asset	4.1 Critically appraise the status of a specific highway asset 4.2 Create a viable maintenance plan for the specific highway asset 4.3 Justify the effectiveness of the maintenance plan

Guidance

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

The learning outcomes associated with this unit are closely linked with:

Level 4	Level 5	Level 6
Level 4 NVQ in Built Environment Design Level 4 NVQ in Construction Contracting Operations Level 4 NVQ in Construction Site Management Level 4 NVQ in Site Inspection	Level 5 NVQ in Built Environment Design and Consultancy Level 5 NVQ in Construction Senior Management	Unit 4: Construction Design (T/504/4340) Unit 6: Civil Engineering Design (D/504/4347) Unit 7: Construction Management (H/504/4351) Unit 8: Construction Financial Management (K/504/4352) Unit 19: Managing Resources for Project Work (Y/504/4380) Unit 21: Project Management in Construction (A/504/4386)

Essential requirements

Learners need access to IT, library and internet resources, case study material and examples of actual projects in the various sectors of highway engineering.

Delivery

Case studies should be used extensively to develop a working knowledge and practice of the construction industry. The unit might usefully include the production of sketches and drawings (manually or using computer-aided design) to enhance the knowledge gained. Learners will usually work individually and should be encouraged to provide oral presentations to justify and discuss their work. Consideration must be given to sustainable methods of construction and environmental issues in the selection and use of materials.

Construction methods and practices must comply with health, safety and welfare legislation and practice. Particular attention should be given to the implications that the site investigation and solution design have for the safety of the project. The use of visiting speakers is encouraged given the specialist nature of this unit.

It is essential that a culture of health and safety is embedded in the unit to ensure that learners understand the importance and relevance of health and safety issues.

Assessment

In order to pass this unit learners must meet all the assessment criteria. A mixture of assessment types would be appropriate. There should be some practical-based assessment where learners are required to demonstrate the ability to create highway design solutions and the methodology of how the project is to be delivered and maintained.

Resources

Legislation

The Highways Act 1980 (Stationery Office Books, 1980) ISBN: 0105466802

Flood and Water Management Act 2010 ISBN: 978-0105429104

New Roads and Street Works Act 1991: A Code of Practice for Inspections (Stationery Office Books, 2002) ISBN: 0115525414

Traffic Management Act 2004 (Stationery Office Books, 2007) ISBN 978-0105418047

Health and Safety at Work etc. Act (1974)

EU Procurement Directive

Local Authority Standing Orders and Financial Regulations

Land Drainage Act 1991: Elizabeth II. Chapter 59 (Stationery Office Books, 1991) ISBN: 0105459910

Construction (Design and Management) Regulations 2007 (CDM)

Standards

Design Manual for Roads and Bridges	Downloadable from the Highways Agency website
Traffic Advisory Leaflets	Copies available from the Department for Transport website
Manual of Contract Documents for Highway Works	Copies available through The Stationery Office website

Code of Practice – CDM regulations

Traffic Signs Manual published by the Department for Transport as separate chapters:
Chapter 3 Regulatory Signs (2008) ISBN: 978-0115529252.
Chapter 4 Warning Signs (2007) ISBN: 978-0115524110
Chapter 5 Road Markings (2003) ISBN: 978-0115524790
Chapter 7 The Design of Traffic Signs (2003) ISBN: 978-0115517006
Chapter 8 Traffic Safety Measures and Signs for Road Works and Temporary Situations (1991) ISBN: 978-0115509377

Manual for Streets 2 (The Chartered Institution Of Highways and Transportation, 2010) ISBN: 978-0902933439

Code of Practice for Site Investigations' third edition (British Standard Institution, 1957) ASIN: B000XY1M6Y

Code of Practice for Earthworks, third edition (The Council for Codes of Practice/British Standard Institution, 1959) ASIN: B004W3VSC0

Textbooks

Ashworth A – *Civil Engineering Contractual Procedures* (Longman, 1998) ISBN: 978-0582251274

Ashworth A – *Contractual Procedures in the Construction Industry* (Prentice Hall, 2012) ISBN: 978-0273745600

Other publications

Construction Industry Board Report – *Towards a 30% Productivity Improvement in Construction* (ICE Publishing, 1996) ISBN: 978-0727725509

Construction Industry Board Report – *Construction Success* (Thomas Telford Ltd, 1997) ISBN: 978-0727725417

Construction Industry Board Report – *Partnering the Team* (Thomas Telford Ltd, 1997) ISBN: 978-0727725516

Periodicals

Highways	www.highwaysmagazine.co.uk
New Civil Engineering	www.nce.co.uk
Surveyor	Institute of Highway Engineers

Websites

www.ice.org.uk	Institution of Civil Engineers
www.theihe.org	Institute of Highway Engineers
www.ciht.org.uk	Chartered Institute of Highways and Transportation
www.highways.gov.uk/knowledge_compendium	Highways Agency