Title:	Civil Engineering Design
Level:	3
Credit value:	10
GLH	60
Unique Reference Number:	**K/651/0578**
Sector Subject Area:	5.2 Building and Construction
Aim:	The aim of this unit is to provide learners with the skills and knowledge to be able to design a single storey built asset and external environment. Learners will review designs, evaluate them against the given brief and relevant legislation and regulations and assess the potential impact of the built asset on the environment.
Assessment Type:	Technical report, presentation and professional discussion.
Assessment Guidance:	Assessment of this unit will be through the completion of a mandatory technical report drawing together key artefacts from each unit presented holistically, reflecting workplace requirements. Applying the skills and knowledge developed in this unit, learners will create designs to support the construction of a civil engineering asset. Learners will identify the relevant aspects of the completed assessment to include within the technical report to meet a set brief.

Learning outcomes
The learner will:

1. Know civil engineering design and build concepts.

Delivery content:

The aim of this learning outcome is to provide the learners with knowledge of the stages involved in the civil engineering design process and relevant regulations and legislations that can inform and impact design solutions.

The learner must:

- explain the **stages** involved in the civil engineering design process.
- describe the **factors that influence** the civil engineering design decisions.
- outline the different **construction specifications** that are used in a civil engineering project.

- identify relevant **regulations and legislations** that can inform and impact design solutions.

2. Understand the importance of 'buildability' and 'sustainability' in civil engineering environments.

Delivery content:

The aim of this learning outcome is to provide the learners with knowledge of buildability and sustainability and how they can benefit civil engineering design and build projects.

The learner must:

- define the terms **'buildability'** and **'sustainability'**.
- explain how 'buildability' **impacts the construction** of the built asset.
- explain the **principles of buildability**.
- **factors** that affect the buildability of building design.
- summarise the **challenges of sustainable construction**.
- explain the **principles of sustainable construction**.
- identify the **benefits of sustainable construction**.

3. Be able to use design and build concepts to meet a civil engineering brief.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to use design and build concepts to meet the requirements of a civil engineering brief. Learners will apply their knowledge to designing a single storey structure and external environment.

The learner must:

- explore the **requirements for a substructure** for a civil engineering construction project.
- explore the **requirements for a superstructure** for a civil engineering construction project.
- **design** foundations, drainage installation and utilities provision for given ground conditions to meet a civil engineering brief.
- **design** a frame and retaining structure to meet a civil engineering brief.
- **produce plans for an external environment** surrounding a built asset.
- assess the impact of the built asset on the environment.

4.	Be able to review engineering design concepts to ensure it meets regulatory and client requirements.

Delivery content:

The aim of this learning outcome is to provide the learners with the skills and knowledge to evaluate their completed drawings and specifications against the given brief and relevant regulations, legislation and industry standards.

The learner must:

- **evaluate** the completed drawings and specifications against the given civil engineering brief.
- **review the completed design** (drawings and specifications) against relevant regulations and legislations and note any areas that may not be compliant.

Scope of Training

The Scope of Training identifies areas that must be covered during the delivery of this unit. This is the minimum that is expected but tutors are expected to include other areas, knowledge of which will benefit their learners, based on location, types of work available and from the tutors own professional experience.

Stages	Preparation and brief Concept design, information modelling Developed design Technical design
Factors that influence	Safety Functionality Sustainability Cost-effectiveness Client requirements, including contracts and specifications Site constraints and information Planning constraints Statutory constraints Environmental constraints Quality assurance requirements Social constraints Project and budget constraints
Construction specifications	Prescriptive – provides details on types of materials and installations needed to complete a project. May also describe how to measure installations to ensure they meet required quality and standards. Performance – describes the operational requirements. These should describe what is needed for the final product and how it should function once completed. Proprietary – often used if only one specific product can be used for an installation.

	Purpose of the specifications Standards and contracts	
Regulations and legislations, including policies, standards and codes of practice	Building Regulations Construction (Design and Management) Regulations 2015 Control of Substances Hazardous to Health Regulations (COSHH) 2002 Health and Safety (Consultation with Employees) Regulations 1996 Health and Safety at Work Act 1974 Common Safety Method (CSM) Construction Design and Management (CDM) Design Manual for Roads and Bridges (DMRB)	
Buildability	The ease with which a project can be built efficiently in terms of time, cost and quality	
Sustainability	Reducing the industry's impact on the environment	
Impacts the construction	Improve efficiency of overall building process	
Principles of buildability	Integration Construction knowledge Team skill Corporate objectives Available resource External factors	Program Construction methods Accessibility Specification Construction innovation Feedback
Factors	Standardisation Completion of design documents Clear specifications Labour skills Design to suit site conditions	
Challenges of sustainable construction	Net zero operational carbon Net zero embodied carbon Sustainable water cycle Sustainable connectivity and transport Biodiversity and sustainable land use Good health and wellbeing Sustainable communities and social value Sustainable life cycle cost	
Principles of sustainable construction	Sustainable design Durability Energy efficiency Waste reduction Indoor air quality	Including BREEAM assessment Applies to every part of building development; energy-efficient technology; energy-efficient materials; energy-efficient building methods and design; SAP calculations for energy efficiency Considering environmental impact of materials used; use low-impact materials; sustainable recycling of materials Bad air quality; inadequate construction including limited

		ventilation; key air pollutants; performance-based ventilation – maximum acceptable levels for nitrogen dioxide, carbon monoxide and total volatile organic compounds; passive stack ventilation
	Water conservation	Pressure reducing valves; leak detection tests and repairs where necessary; durable service pipes to minimise leakages, stall sub meter to record water use in different areas
	Sustainable building materials	Timber instead of steel; concrete reinforced with natural fibres; geo-textiles made from crops; straw bales; materials accredited as responsibly sourced
Benefits of sustainable construction	Reduce impact on environment Long term reputational and corporate social responsibility benefits Utilising new materials and new technologies in construction Lower operating costs Reducing waste and costs associated with this Lower fuel costs	
Requirements for a substructure	Including, but not limited to:	
	Foundations:	Basements Piled and ground beam Isolated pad Pad support on piles / pile cap
	Drainage systems:	Pipework Installation of deep sewers Culverts (concrete, reinforced) for water way containment / diversion
	Utilities:	Water discharge pipes Deep sewer installation Service tunnels Infrastructure developments Structured cable installation Cable trenches
Requirements for a superstructure	Including, but not limited to: **Structural frames**	
	Steel frames:	Universal beams / columns Column and beam connections Pad and column connections Wind-bracing Composite floor decks
	Concrete frames:	Beams Columns Column and beam connections Pad and column connections Reinforcement Floors Formwork requirements (beams, columns, floors)

	Composite construction: **Retaining walls**:	Integration of steel and concrete Alternative materials combinations Slip form curves Gabion baskets Earth-retaining structures Pre-cast concrete systems In-situ reinforced concrete Integral drainage to retaining structures Revetments
Design	Using findings from the requirements of the substructure and superstructure learners will produce: • Drawings • Specifications • Document control requirements Single storey structure(s), multipurpose building/	
Produce plans for an external environment	To support access (roadway, pedestrian) to the single storey structure and providing facilities including parking, loading/unloading, accessibility requirements. Document control requirements. To include drawings and technical information relevant to assessment brief, utilising engineering terminology and conventions.	
Evaluate	Consider the range of options for each aspect of the substructure and superstructure, giving advantages and disadvantages for each. Provide a detailed rationale to support their design and specification decisions utilising appropriate engineering terminology and conventions.	
Review the completed design	Areas of compliance and any non-compliances Any remedial work required to ensure design is fully compliant Against specifications and contracts	

Mapping to Civil Engineering Technician Standard ST0091

Learning Outcome	Knowledge Statements	Skills Statements	Behaviour Statements
1. Know civil engineering design and build concepts.	K2, K6, K7, K9		
2. Understand the importance of 'buildability' and 'sustainability' in civil engineering environments.	K2, K7		
3. Be able to use design and build concepts to meet a civil engineering brief.	K2, K7	S2, S3, S4, S5, S6, S7, S9, S10	B2
4. Be able to review engineering design concepts to ensure it meets regulatory and client requirements.	K1, K2, K3, K9	S2, S5	B4