Level 3 Technicals in Constructing the Built Environment 6720-556

art of 6720-37

November 2017 Version 1.1

Guide to the examination

Version and Date	Change Detail	Section
June 2019 v1.1	Amendment to number of resit opportunities	.. Details of the exam

Who is this document for?

This document has been produced for centres who offer **City & Guilds Level 3 Technicals in Constructing the Built Environment.** It gives all of the essential details of the qualification's external assessment (exam) arrangements and has been produced to support the preparation of candidates to take the exam/s.

The document comprises four sections:

1. **Details of the exam**. This section gives details of the structure, length and timing of the exam.
2. **Content assessed by the exam.** This section gives a summary of the content that will be covered in each exam and information of how marks are allocated to the content.
3. **Guidance.** This section gives guidance on the language of the exam, the types of questions included and examples of these, and links to further resources to support teaching and exam preparation.
4. **Further information.** This section lists other sources of information about this qualification and City & Guilds Technical Qualifications.

1. Details of the exam

External assessment

City & Guilds Technical qualifications have been developed to meet national policy changes designed to raise the rigour and robustness of vocational qualifications. These changes are being made to ensure our qualifications can meet the needs of employers and Higher Education. One of these changes is for the qualifications to have an increased emphasis on external assessment. This is why you will see an external exam in each of our Technical qualifications.

An external assessment is an assessment that is set and/or marked by the awarding organisation (ie externally). All City and Guilds Technical qualifications include an externally set and marked exam. This must be taken at the same time by all candidates who are registered on a particular qualification. We produce an exam timetable each year. This specifies the date and time of the exam so you can plan your delivery, revision and room bookings/PC allocation in plenty of time.

The purpose of this exam is to provide assurance that all candidates achieving the qualification have gained sufficient knowledge and understanding from their programme of study and that they can independently recall and draw their knowledge and understanding together in an integrated way. Whilst this may not be new to you, it is essential that your learners are well prepared and that they have time to revise, reflect and prepare for these exams. We have produced a Teaching, Learning, and Assessment guide that is you should refer to alongside the present document *(Teaching, Learning and Assessment Guide).* If a learner does not pass the exam at their first attempt, there is only one opportunity to resit the exam, so preparation is essential.

Exam requirements of this qualification

- **Constructing the Built Environment** – Theory Exam (3 hours)

The exam is graded and a candidate must achieve at least a Pass grade in order to be awarded the qualification. (In addition to the exam, a synoptic assignment must also be completed and passed). You can find full details of the synoptic assignment in the *Qualification Handbook* and the *Synoptic Assessment Guide – p*lease see the link to the qualification page at the end of this document.

When does the exam take place?

The exam is offered on two fixed dates in March or June. The exact dates will be published at the start of the academic year in the *Assessments and Exam Timetable* *http://www.cityandguilds.com/delivering-our-qualifications/exams-and-admin*.

At the start of the programme of study, in order to effectively plan teaching and exam preparation, centres should know when the exam will be taking place and allocate teaching time accordingly. Section 2 of this document gives a summary of the content that needs to be covered in order to prepare learners for the exam and full details of this are given in the Qualification Handbook.

Form of exam

The exam for this qualification can be taken on paper (6720-556).

Can candidates resit the exam?

Candidates who have failed an exam or wish to retake it in an attempt to improve their grade, can do so **twice**. The third and final retake opportunity applies to Level 3 only. The best result will count towards the final qualification. If the candidate fails the exam three times then they will fail the qualification.

How the exam is structured

Each exam has a total of 90 marks and is made up of:

- approximately 17-19 short answer questions
- 1 extended response question.

Short answer questions are used to confirm **breadth of knowledge and understanding**.

The extended response question is to allow candidates to demonstrate **higher level and integrated understanding** through written discussion, analysis and evaluation. This question also ensures the exam can differentiate between those learners who are 'just able' and those who are higher achieving.

More details about and examples of question types are given in Section 3 of this document.

Assessment Objectives

The exams are based on the following set of assessment objectives (AOs). These are designed to allow the candidate's responses to be assessed across the following three categories of performance:

- **Recollection** of knowledge.
- **Understanding** of concepts, theories and processes.
- **Integrated application** of knowledge and understanding.

In full, the assessment objectives covered by the exam for this qualification are:

Assessment objective ***The candidate..***	**Mark allocation (approx %)**
AO1 **Recalls knowledge** from across the breadth of the qualification	34%
AO2 **Demonstrates understanding** of concepts, theories and processes from a range of learning outcomes.	46%
AO4 **Applies knowledge, understanding and skills** from across the breadth of the qualification in an integrated and holistic way to achieve specified purposes.	20%

Booking and taking the exam

All assessments for City & Guilds Technical Exams must be booked through Walled Garden. There is a deadline for booking exams, synoptic assessments and any other centre marked assessments, please refer to the time line to check these dates.

The exam must be taken under the supervision of an invigilator who is responsible for ensuring that it is conducted under controlled conditions. Full details of the conditions under which the exam must be taken can be found in the Joint Council for Qualifications (JCQ) document, *Instructions for Conducting Examinations (ICE)*.

Special consideration

Candidates who are unable to sit the exam owing to temporary injury, illness or other indisposition at the scheduled time may qualify for special consideration. This is a post-examination adjustment that can, in certain circumstances, be made to a candidate's final grade. The Joint Council for Qualifications' guide to the special consideration process can be found at www.jcq.org.uk .

To make a request for special consideration, please contact: policy@cityandguilds.com

Access arrangements

Access arrangements are arrangements that allow candidates with particular requirements, disabilities or temporary illness to take assessments, where appropriate, using their normal way of working. The Joint Council for Qualifications document, *Access Arrangements and Reasonable Adjustments* gives full details and can be downloaded here.

For further information and to apply for access arrangements please see:

Access arrangements - When and how applications need to be made to City & Guilds

Applying for access arrangements on the Walled Garden

2. Content assessed by the exam

The exam assesses:

- **Unit 308: Structural Mechanics (CE)**
- **Unit 309: Civil engineering technology (CE)**
- **Unit 311: Graphical communication**
- **Unit 320: Further mathematics for the built environment**

Each exam assesses a sample of the content of these units. This means that a single exam will **not** cover 100% of the unit content. The full range of content will be assessed over a number of examination series. Details of the coverage of a particular exam paper will **not** be released in advance of the exam itself. Centres should **not** make assumptions about what will be assessed by a particular exam based on what has been covered on previous occasions. In order to be fully prepared for the exam, learners **must** be ready to answer questions on **any** of the content outlined below.

The table below provides an overview of how the qualification's Learning Outcomes are covered by each exam and the number of **marks** available per Learning Outcome (ie **not** the number of *questions* per Learning Outcome). In preparing candidates for the exam, we recommend that centres take note of the number of marks allocated to Learning Outcomes and to assign teaching and preparation time accordingly.

In preparing candidates for the exam, centres should refer to the Qualification Handbook which gives full details of each Learning Outcome.

The following is a summary of only that qualification content which is assessed by the exam and **not** a summary of the full content of the qualification.

Unit	Learning outcome	Topics	Number of marks per section
308 Structural Mechanics (CE)	LO1 Determine shear force values, bending moments and deflections for simple structures	1.1 Calculations of reactions, shear force and bending moment values for various positions on a beam 1.2 Drawing of shear force diagrams for various loading conditions 1.3 Production of bending moment diagrams for various loading conditions 1.4 Calculation of mid-span deflections for simply supported beams	6

	LO2 Design simple beams and columns	2.1 Calculations of first and second moments of area of different sections 2.2 Design of rectangular beam sections using the General Theory of Bending 2.3 Determination of safe load/section size for axially-loaded columns 2.4 Determination of stress values for eccentrically-loaded columns	14
	LO3 Calculate factors of safety and pressures acting on retaining walls	3.1 Forces and pressures acting on retaining walls 3.2 Determination of factors of safety against sliding and overturning	
	LO4 Determine forces acting in statically determinate frames for various loading conditions	4.1 Determination of magnitude and type of force acting in frames using graphical techniques 4.2 Calculation of magnitude and type of force acting in frames by resolution of forces	
309 Civil engineering technology (CE)	LO1 Recognise the methods used to carry out deep excavations and control groundwater on site	1.1 Temporary and permanent support methods for deep excavations 1.2 Temporary and permanent methods of controlling groundwater	20
	LO2 Recognise the methods and techniques used in the construction of substructure and external works activities	2.1 Plant and equipment used in substructure and external work construction 2.2 Substructure and external works activities	
	LO3 Recognise the methods and techniques used in superstructure activities	3.1 Plant equipment used in superstructure 3.2 Forms of superstructure	

	LO4 Apply health and safety considerations in civil engineering	4.1 Key health and safety legislation associated with civil engineering activities 4.2 Production of risk assessments	
311 Graphical communication	LO1 Use equipment and processes involved in manual drafting	1.1 Drawing office equipment 1.2 Development of drawing skills 1.3 Production of construction drawings	16
	LO2 Use equipment and processes involved in computer-aided drafting	2.1 Computer-aided design	
	LO3 Develop an awareness of Building Information Modelling (BIM)	3.1 Uses and purposes of BIM 3.2 Integration and application of BIM	
320 Further mathematics for the built environment	LO1 Understand the underpinning mathematical techniques of algebra and trigonometry	1.1 Transposition/evaluation of formulae Indices and transposition 1.2 Binomial theorem	16
	LO2 Use calculus to solve practical problems in civil engineering	2.1 Differential calculus 2.2 Integral calculus 2.3 Maxima and minima	
	LO3 Apply arithmetical techniques to determine the properties of sections in structural engineering	3.1 Centroids of regular/irregular sections 3.2 Second moments of area 3.3 Polar second moments of area	
	LO4 Apply statistical techniques to civil engineering problems	4.1 Measures of central tendency 4.2 Measures of dispersion 4.3 Sampling distributions	
		Total marks for sections:	72 marks

		Integration across units*:	18 marks
		Total marks for exam:	**90 Marks**

* *Integration across units.* These marks relate to Assessment Objective 4. These marks are awarded to differentiate between levels of performance by candidates taking the exam. The marks are given for how well a candidate has applied their knowledge, understanding and skills from across the units that make up the qualification in an integrated way to meet the requirements of the exam questions.

3. Guidance

Vocabulary of the exam: use of 'command' verbs

The exam questions are written using 'command' verbs. These are used to communicate to the candidate the type of answer required. Candidates should be familiarised with these as part of their exam preparation.

The following guidance has been produced on the main command verbs used in City & Guilds Technicals exams.

A more detailed version of this table, which also includes the command verbs used in the assignments is published in *City & Guilds Technical Qualifications Teaching, Learning and Assessment* guide.

Command verb	Explanation and guidance
Analyse	Study or examine a complex issue, subject, event, etc in detail to explain and interpret, elements, causes, characteristics etc
Calculate	Work out the answer to a problem using mathematical operations
Compare (…and contrast) (or ***describe*** the similarities/differences)	Consider and describe the similarities (and differences) between two or more features, systems, ideas, etc
Define	Give the meaning of, technical vocabulary, terms, etc.
Describe	Give a detailed written account of a system, feature, etc **(..the effect of…on…)** the impact, change that has resulted from a cause, event, etc **(..the process..)** give the steps, stages, etc
Differentiate between	Establish and relate the characteristic differences between two or more things, concepts, etc
Discuss	Talk/write about a topic in detail, considering the different issues, ideas, opinions related to it
Distinguish between	Recognise and describe the characteristic differences between two things, or make one thing seem different from another
Evaluate	Analyse and describe the success, quality, benefits, value, etc (of an end product, outcome, etc)
Explain	Make (a situation, idea, process, etc) clear or easier to understand by giving details **(..how..)** Give the stages or steps, etc in a process, including relationships, connections, etc between these and causes and effects.

Give example(s) illustrate/	Use examples or images to support, clarify or demonstrate, an explanation, argument, theory, etc
Give a rationale	Provide a reason/reasons/basis for actions, decisions, beliefs, etc
Identify	Recognise a feature, usually from a document, image, etc and state what it is
Justify	Give reasons for, make a case for, account for, etc decisions, actions, conclusions, etc, in order to demonstrate why they suitable for or correct or meet the particular circumstances, context
Label	Add names or descriptions, indicating their positions, on an image, drawing, diagram, etc
List	Give as many answers, examples, etc as the question indicates (candidates are not required to write in full sentences)
Name	Give the (technical) name of something
Propose	Present a plan, strategy, etc (for consideration, discussion, acceptance, action, etc).
Select	Choose the best, most suitable, etc, by making careful decisions
State	Give the answer, clearly and definitely
Summarise	Give a brief statement of the main points (of something)

Question types

The following explains, and gives examples of, types of questions used in City & Guilds Technical exams. In preparing candidates to take the exam, it is recommended that you familiarise them with the requirements of each question type so that they can be effective and make best use of the time available when sitting the exam.

- An effective candidate will gauge the type and length of response required from the question and the number of marks available (which is given for each question on the exam paper).
- Short answer questions may not require candidates to write in complete sentences. Extended response questions will require a more developed response.
- Candidates should read the exam paper before attempting to answer the questions and should allocate time proportionate to the number of marks available for each question or section.

Question type:	Example question	Example question:
Short answer questions (restricted response) These are questions which require candidates to give a brief and concise written response. The number of marks available will correspond to the number of pieces of information/examples and the length of response required by the question.	Explain the importance of the Construction (Design and Management) Regulations (CDM) in relation to civil engineering projects. (6 marks)	A coherent explanation that considers the relevance and importance of the CDM regulations, as applied to civil engineering projects. Marks as shown below, up to a maximum of six marks. The aim of the CDM Regulations is to integrate health and safety into the planning, design and management of construction projects (1). It is intended to encourage everyone involved in a construction project to work together to (1); improve the planning, design and management of construction projects from the very start (1); Identify hazards early on, so they can be eliminated or reduced at the design phase (1) and the remaining risks can be properly managed during the construction phase (1); target effort where it can do the most good in terms of health and safety (1); discourage unnecessary bureaucracy throughout a

construction project, from the planning phase onwards (1).
The objective should be to reduce the potential risk of harm to those who have to construct, maintain or demolish the structure, as well as to those who will use it (1).
Competent people should be appointed at the right time to plan, design, manage and monitor health, safety and welfare (1), and to encourage teamwork that focuses on effective planning and management of risks, rather than paperwork. (1)

Extended response questions

Extended response questions are those that require the candidate to write a longer written response using sentences and paragraphs. These usually require candidates to discuss, explain, etc. a topic in some detail. The question is often based on a short case study, scenario or other prompt. The level of detail should be gauged from the question and the number of marks available.

Example question

A builder has been asked to construct an external patio area at the rear of a domestic property. The area selected for the patio comprises well-drained land that slopes up to a height of 3.5 m in an irregular manner. The intention is to cut back the ground to provide the space required for the patio, and to support the remaining ground with a cantilever retaining wall. The builder intends to consult a civil engineer for advice on the construction of the retaining wall and the preferred materials to use.

Discuss the information that the civil engineer must consider when providing the required advice. (12 marks)

Mark scheme

Active pressures, passive pressures, need for drainage (or not); cantilever retaining walls; possible modes of failure and how to prevent; materials such as mass concrete, reinforced concrete, masonry; first moments of area; centroids.

Band 1 (0 – 4 marks)

The learner identifies a limited amount of the issues to be considered by the civil engineer, but there is little in the way of description. The learner's response lacks detail and is not clearly linked to the scenario.

Example band 1 response

A civil engineer would need to consider the active pressures and passive pressures acting against the retaining walls. Although the land is well drained additional drainage in the form of weep holes should be provided. The material used for the retaining wall would be reinforced concrete. Masonry retaining walls would mean the requirement to employ bricklayers and would take longer to build. In order to complete structural factors of safety checks on the design of a retaining wall, a first moment of area calculation to determine the horizontal distance the weight of the retaining wall acts from the toe needs to be completed.

The wall will need to be designed for overturning and sliding. The factor of safety against overturning occurs about the toe. It is determined by the restoring moment divided by the overturning moment. It would be expected that once the final geometric shape of the wall has been designed that a series of drawings will need to be completed. These would include a site plan, section details and component drawings. Suitable scales should be adopted accordingly.

Band 2 (5 – 8 marks)

The learner identifies a wide range of the issues to be considered by the civil engineer and supports this with brief descriptions. The learner's response is detailed but incomplete and has clear links to the scenario in most cases.

Example band 2 response

A civil engineer would need to consider the active earth pressures acting against the retaining walls. This would be the density of the soil, water or other materials being retained. Although the land is well drained additional drainage in the form of weep holes should be provided. The retaining wall would also have pressures acting on its base, these are called passive earth pressures. The material used for the retaining wall would be reinforced concrete. Masonry retaining walls would mean the requirement to employ bricklayers and would take longer to build. Mass retaining walls are generally not considered to be economic over a height of 1.8 m. The shape of the retaining wall is proposed to be of a cantilever retaining wall type. They use much less concrete than gravity walls, but require more design and careful construction and are generally economical up to about 8m in height.

In order to complete structural factors of safety checks on the design of a retaining wall, a first moment of area calculation to determine the horizontal distance the weight of the retaining wall acts from the toe needs to be completed. For a trapezoidal vertical wall of height 3.5 m with top width 0.8m and bottom base of 2m the first moment of area calculation = (sum of the areas x centroids about the toes)/(sum of the two shapes areas).

The wall will need to be designed for overturning and sliding. The factor of safety against overturning occurs about the toe. It is determined by the restoring moment (weight of the wall per metre run multiplied by its centroidal distance to the toe) being divided by the overturning moment (which is the force acting horizontally to the wall multiplied by its centroidal distance to the toe). The factor of safety against sliding is calculated by multiplying the weight of the wall multiplied by the soils coefficient of friction divided by the horizontal force acting against the wall due to the retained material. Both factors of safety should be greater than 2.

It would be expected that once the final geometric shape of the wall has been designed that a series of drawings will need to be completed. These would include a site plan, section details and component drawings. Suitable scales should be adopted accordingly. Computer drawing software packages are now used in the modern construction design companies and this can vary from AutoCAD, Autodesk Revit or google sketch up in its simplest form.

Band 3 (9 – 12 marks)

The learner identifies a comprehensive range of issues to be considered by the civil engineer and supports this with in-depth descriptions. The learner's response is detailed and complete and has clear and accurate links to the scenario.

Example band 3 response

A civil engineer would need to consider the active earth pressures acting against the retaining walls. This would be the density of the soil, water or other materials being retained. Although the land is well drained, the density of the retained soil may be affected by its saturation during wet weather conditions and additional drainage in the form of weep holes of 75 mm diameter would need to be provided at 2m centres along the width of the wall. The retaining wall would also have pressures acting on its base, these are called passive earth pressures. These are a reaction of an equal and opposite forces to any imposed pressure thus giving stability by resisting movement. The material used for the retaining wall would be reinforced concrete. Within the constraints of the site this would be the easiest, quickest and most effective construction material for the wall to be constructed of. Masonry retaining walls would mean the requirement to employ bricklayers and would take longer to build. Mass retaining walls are generally not considered to be economic over a height of 1.8 m when constructed of brick or concrete and 1 m in the case of natural stonework. The shape of the retaining wall is proposed to be of a cantilever retaining wall type. Cantilevered walls consist of a relatively thin stem and a base slab. The base is also divided into two parts, the heel and toe. The heel is the part of the base under the backfill. The toe is the other part of the base. They use much less concrete than gravity walls, but require more design and careful construction and are generally economical up to about 8m in height.

In order to complete structural factors of safety checks on the design of a retaining wall, a first moment of area calculation to determine the horizontal distance the weight of the retaining wall acts from the toe needs to be completed. For a trapezoidal vertical wall of height 3.5 m with top width 0.8m and bottom base of 2m the first moment of area calculation = (sum of the areas x centroids about the toes)/(sum of the two shapes areas).

Area 1 = Vertical Rectangle = 0.8 x 3.5 = 2.8 m^2

Area 2 = Triangular shape at the toe = 1/2 (1.2 x 3.5) = 2.1m^2

Centroid 1 about toe = 1.2 + 0.4 = 1.6m

Centroid 2 about toe = 2/3 x 1.2 = 0.8m

The position of the centroid of gravity about the toe = $\frac{\text{Sum of moment areas about the toe of each shape}}{\text{Sum of the areas of each shape}}$

$= \frac{(2.8 \times 1.6) + (2.1 \times 0.8)}{}$ = 1.26 m from the toe

(2.8 + 2.1)

The wall will need to be designed for overturning and sliding. The factor of safety against overturning occurs about the toe. It is determined by the restoring moment (weight of the wall per metre run multiplied by its centroidal distance to the toe) being divided by the overturning moment (which is the force acting horizontally to the wall multiplied by its centroidal distance to the toe). The factor of safety against sliding is calculated by multiplying the weight of the wall multiplied by the soils coefficient of friction divided by the horizontal force acting against the wall due to the retained material. Both factors of safety should be greater than 2. If this is not achieved the geometric shape of the retaining wall would need to be amended or a change of material specified.

It would be expected that once the final geometric shape of the wall has been designed that a series of drawings will need to be completed. These would include a site plan, section details and component drawings. Suitable scales should be adopted accordingly. Computer drawing software packages are now used in the modern construction design companies and this can vary from AutoCAD, Autodesk Revit or google sketch up in its simplest form. Potentially the production of 3D models of the proposed retaining wall could be produced which can give a modern view of the construction techniques adopted to meet the client's needs.

Examination technique

Candidates with a good understanding of the subject being assessed can often lose marks in exams because they lack experience or confidence in exams or awareness of how to maximise the time available to get the most out of the exam. Here is some suggested guidance for areas that could be covered in advance to help learners improve exam performance.

Before the exam

Although candidates cannot plan the answers they will give in advance, exams for Technical qualifications do follow a common structure and format. In advance of taking the exam, candidates should:

- be familiar with the structure of the exam (ie number and type of questions).
- be aware of the amount of time they have in total to complete the exam.
- have a plan, based on the exam start and finish time for how long to spend on each question/section of the exam.
- be aware of how many marks are available for each question, how much they should expect to write for each question and allow most time for those questions which have the most marks available.

At the start of the exam session

At the start of the exam, candidates:

- should carefully read through the instructions before answering any questions.
- may find it helpful, where possible, to mark or highlight key information such as command words and number of marks available on the question paper.
- identify questions which require an extended written answer and those questions where all or part of the question may be answered by giving bullets, lists etc rather than full sentences.

Answering the questions

Candidates do not have to answer exam questions in any particular order. They may find it helpful to consider, for example:

- tackling first those questions which they find easiest. This should help them get into the 'flow' of the exam and help confidence by building up marks quickly and at the start of the exam.
- tackling the extended answer question at an early stage of the exam to make sure they spend sufficient time on it and do not run out of time at the end of the exam.

Candidates should avoid wasting time by repeating the question either in full or in part in their answer.

Candidates should **always** attempt every question, even questions where they may be less confident about the answer they are giving. Candidates should be discouraged however, from spending too long on any answer they are less sure about and providing answers that are longer and give more detail than should be necessary in the hope of picking up marks. This may mean they have less time to answer questions that they are better prepared to answer.

Extended answer questions

Before writing out in full their answer to extended questions, candidates may find it helpful to identify the key requirements of the question and jot down a brief plan or outline of how they will

answer it. This will help clarify their thinking and make sure that they don't get 'bogged down' or provide too much detail for one part of the question at the expense of others.

Towards the end of the exam

Candidates should always set aside time at the end of the exam to read back through and review what they have written in order to make sure this is legible, makes sense and answers the question in full.

If a candidate finds they are running out of time to finish an answer towards the end of the exam, they should attempt to complete the answer in abbreviated or note form. Provided the content is clear and relevant, examiners will consider such answers and award marks where merited.

Further guidance on preparing candidates to take the exam is given in the City & Guilds publication, Technical Qualifications, Teaching, Learning and Assessment which can be downloaded free of charge from City & Guilds website.

4. Further information

For further information to support delivery and exam preparation for this qualification, centres should see:

City & Guilds

Qualification homepage: http://www.cityandguilds.com/qualifications-and-apprenticeships/construction/construction/6720-technicals-in-constructing-the-built-environment#tab=information which includes:

- Qualification handbook
- Synoptic Assignment
- Sample assessments

Technical Qualifications, Resources and Support: www.cityandguilds.com/techbac/technical qualifications/resources-and-support

Joint Council for Qualifications

Instructions for Conducting Examinations: http://www.jcq.org.uk/exams-office/ice---instructions-for-conducting-examinations