

SQA Advanced Unit Specification

General information

Unit title: Architectural CADT: Structural Design and Detailing
(SCQF level 8)

Unit code: HR7D 48

Superclass: TD

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Unit purpose

This Unit is designed to provide learners with advanced knowledge and skills to enable them to develop a systematic approach to the analysis, design and detailing of structural elements, using sophisticated computer-aided design software packages.

Outcomes

On successful completion of the Unit the learner will be able to:

- 1 Analyse and design a structural steel element using computer-aided design software in response to a given brief.
- 2 Analyse and design a structural timber element using computer-aided design software in response to a given brief.
- 3 Analyse and design a structural masonry element using computer-aided design software in response to a given brief.
- 4 Analyse and design a structural concrete element using computer-aided design software in response to a given brief.

Credit points and level

2 SQA Advanced Credits at SCQF level 8: (16 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

Access to this Unit is at the discretion of the centre. However, it would be beneficial for learners to have a basic knowledge and understanding of construction and mathematics. This may be demonstrated by possession of the SQA Advanced Units:

HR70 47 *Architectural CADT: Construction Detailing*

HR71 47 *Architectural CADT: Building Technologies*

It is recommended that learners also possess a knowledge and understanding of CAD. This may be demonstrated by the possession of the SQA Advanced Unit HR6P 47 *Architectural CADT: Principles and Practice* or equivalent SCQF level of study.

Core Skills

Opportunities to develop aspects of Core Skills are highlighted in the support notes for this Unit specification.

There is no automatic certification of Core Skills or Core Skill components in this Unit.

Context for delivery

If this Unit is delivered as part of a Group Award, it is recommended that it should be taught and assessed within the subject area of the Group Award to which it contributes.

Equality and inclusion

This Unit specification has been designed to ensure that there are no unnecessary barriers to learning or assessment. The individual needs of learners should be taken into account when planning learning experiences, selecting assessment methods or considering alternative evidence.

Further advice can be found on our website www.sqa.org.uk/assessmentarrangements.

SQA Advanced Unit specification: statement of standards

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Acceptable performance in this Unit will be the satisfactory achievement of the standards set out in this part of the Unit specification. All sections of the statement of standards are mandatory and cannot be altered without reference to SQA.

Outcome 1

Analyse and design a structural steel element using computer-aided design software in response to a given brief.

Knowledge and/or skills

- ◆ actions upon structural steel elements:
 - compression on structural elements
 - tension on structural elements
 - deflection on structural elements
 - shear stress on structural elements
- ◆ loads acting on structural steel elements
- ◆ constraining structural steel elements
- ◆ factor of safety
- ◆ mathematical formulae
- ◆ computer-aided analysis
- ◆ computer-aided design software

Outcome 2

Analyse and design a structural timber element using computer-aided design software in response to a given brief.

Knowledge and/or skills

- ◆ actions acting upon structural timber elements:
 - compression on structural elements
 - tension on structural elements
 - deflection on structural elements
 - shear stress on structural elements
- ◆ loads acting on structural timber elements
- ◆ constraining structural timber elements
- ◆ factor of safety
- ◆ mathematical formulae
- ◆ computer-aided analysis
- ◆ computer-aided design software

Outcome 3

Analyse and design a structural masonry element using computer-aided design software in response to a given brief.

Knowledge and/or skills

- ◆ actions acting upon structural masonry elements:
 - compression on structural masonry elements
 - tension on structural masonry elements
 - deflection on structural masonry elements
 - shear stress on structural masonry elements
- ◆ loads acting on structural masonry elements
- ◆ constraining structural masonry elements
- ◆ factor of safety
- ◆ mathematical formulae
- ◆ computer-aided analysis
- ◆ computer-aided design software

Outcome 4

Analyse and design a structural concrete element using computer-aided design software in response to a given brief.

Knowledge and/or skills

- ◆ actions acting upon structural concrete elements:
 - compression on structural concrete elements
 - tension on structural concrete elements
 - deflection on structural concrete elements
 - shear stress on structural concrete elements
- ◆ loads acting on structural concrete elements
- ◆ constraining structural concrete elements
- ◆ factor of safety
- ◆ mathematical formulae
- ◆ computer-aided analysis
- ◆ computer-aided design software

Evidence Requirements for this Unit

Outcome 1

Learners will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ design a structural steel element for a given brief, using computer-aided design software
- ◆ from the design solutions reached, generate a hard-copy plot of the proposed structural steel element including a suitable connection detail
- ◆ analyse the effect of loading on a proposed structural element and produce a visual demonstration of the results

Evidence will be generated through assessment undertaken in controlled conditions. Evidence must contain any mathematical formulae used to calculate **one** of the actions and calculation of appropriate margins to establish factor of safety. Assessment will be conducted under open-book conditions, and as such, learners should be allowed to refer to relevant course material and mathematical formulae. This can be in the form of calculations or parameters input to a software application. The time allocation for the assessment is a maximum of three hours.

Outcome 2

Learners will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ design a structural timber element for a given brief, using computer-aided design software
- ◆ from the design solutions reached, generate a hard-copy plot of the proposed structural timber element and a suitable connection detail
- ◆ analyse the effect of loading on a proposed structural element and produce a visual demonstration of the results

Evidence will be generated through assessment undertaken in controlled conditions. Evidence must contain any mathematical formulae used to calculate **one** of the actions and calculation of appropriate margins to establish factor of safety. Assessment will be conducted under open-book conditions and as such learners should be allowed to refer to relevant course material and mathematical formulae. This can be in the form of calculations or parameters input to a software application. The time allocation for the assessment is a maximum of three hours.

Outcome 3

Learners will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ design a structural masonry element for a given brief, using computer-aided design software
- ◆ from the design solutions reached, generate a hard-copy plot of the proposed structural masonry element and a suitable connection detail
- ◆ analyse the effect of loading on a proposed structural element and produce a visual demonstration of the results

Evidence will be generated through assessment undertaken in controlled conditions. Evidence must contain any mathematical formulae used to calculate **one** of the actions and calculation of appropriate margins to establish factor of safety. Assessment will be conducted under open-book conditions and as such learners should be allowed to refer to relevant course material and mathematical formulae. This can be in the form of calculations or parameters input to a software application. The time allocation for the assessment is a maximum of three hours.

Outcome 4

Learners will need to provide evidence to demonstrate their knowledge and/or skills by showing that they can:

- ◆ design a structural concrete element for a given brief, using computer-aided design software
- ◆ from the design solutions reached, generate a hard-copy plot of the proposed structural concrete element and a suitable connection detail
- ◆ analyse the effect of loading on a proposed structural element and produce a visual demonstration of the results

Evidence will be generated through assessment undertaken in controlled conditions. Evidence must contain any mathematical formulae used to calculate **one** of the actions and

calculation of appropriate margins to establish factor of safety. Assessment will be conducted under open-book conditions and as such learners should be allowed to refer to relevant course material and mathematical formulae. This can be in the form of calculations or parameters input to a software application. The time allocation for the assessment is a maximum of three hours.

SQA Advanced Unit support notes

Unit title: Architectural CADT: Structural Design and Detailing
(SCQF level 8)

Unit support notes are offered as guidance and are not mandatory.

While the exact time allocated to this Unit is at the discretion of the centre, the notional design length is 80 hours.

Guidance on the content and context for this Unit

This Unit has been designed to enable learners to develop knowledge, understanding and skills in the analysis, design and detailing of structural elements using computer-aided design and analysis software.

This Unit is at SCQF level 8 and has been devised as an optional Unit within the SQA Advanced Diploma in Computer Aided Architectural Design and Technology Group Award. However, this does not preclude the use of the Unit in other awards where award designers feel this to be appropriate.

In designing this Unit, a range of topics have been identified that would be expected to be covered by lecturers. There are also recommendations as to how much time should be spent on each Outcome assessment. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the Outcomes. While it is not mandatory for centres to use this list of topics, it is recommended that they do so since any assessment exemplar pack for this Unit will be based on the knowledge and/or skills and list of topics in each of the Outcomes.

Throughout the Unit, emphasis should be on the correct design and selection of appropriate structural element to suit a given brief. The exercises and assessments should make use of the appropriate current standards and drawing conventions. Examples of these at the time of writing this Unit are:

Outcome 1

- ◆ BS 5950, Eurocode 3

Outcome 2

- ◆ BS 5268, Eurocode 5

Outcome 3

- ◆ BS 5628, Eurocode 6

Outcome 4

- ◆ BS 8110, Eurocode 2

The teaching should encourage the use of computer-aided analysis techniques wherever possible, such as spreadsheets, dedicated loading programs and finite element applications, while also making use of manual calculation techniques.

A list of topics for each Outcome is given below. Lecturers are advised to study this list so that they can get a clear indication of the recommended topics to be covered by learners in this Unit.

Outcomes 1–4 should introduce learners to:

- ◆ element selection:
 - user exercises investigating the factors affecting element selection, eg: span, load, factor of safety, support, space limitations
- ◆ constraints:
 - user exercises experimenting with the different constraints/connections available and demonstration of how the type used can alter the stress levels acting on the element
- ◆ properties and considerations of a structural material:
 - species of timber, natural characteristics, defects, grading
- ◆ loadings:
 - user exercises experimenting with uniformly distributed and point loads
- ◆ evaluation of permissible bending and shear stresses
- ◆ cost engineering:
 - user exercises experimenting with various section properties
 - explanation and user exercises specifying which of the satisfactory sections could be chosen
- ◆ engineered timber products:
 - user exercises investigating the advantages/disadvantages of engineered timber products, eg Glulam, Laminated Veneer Lumber
- ◆ reinforcement:
 - user exercises experimenting with horizontal and vertical reinforcement
- ◆ output:
 - user exercises creating animated/report formatted output of the loading effects on the element

Guidance on approaches to delivery of this Unit

This Unit is likely to form part of a Group Award designed to provide learners with the technical or professional knowledge and skills for employment within an architectural design/technology environment.

It is intended that this Unit be presented at all times using the specialist application CAD software available at the centre. Appropriate technical and support material should be available to the learner.

It is recommended that in the delivery of this Unit, learners be provided with the opportunity to gain as much 'hands-on' experience as possible. Each learner should have access to a PC with the CAD software installed.

The Unit may be taught through a series of lectures, practical exercises and design tutorials, which will logically, and sequentially progress knowledge and skills from the simple to the complex. At all times, a strong design base should underpin the learning and assessment.

Where available, evidence from the workplace can be incorporated to enhance the Outcomes, provided that this evidence is appropriate and authenticated as the learner's own work.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of assessment. The following are suggestions only. There may be other methods that would be more suitable to learners.

Centres are reminded that prior verification of centre-devised assessments would help to ensure that the national standard is being met. Where learners experience a range of assessment methods, this helps them to develop different skills that should be transferable to work or further and higher education.

All assessments for this Unit are undertaken as open-book in a controlled environment. All assessments could be stand-alone tasks or based on a single project.

Assessment guidelines

Outcome 1

The focus of the assessment could be on the selection of an appropriate structural element to suit a given brief. Learners could be provided with a design brief containing constraints such as but not limited to: a limit on the height of the element, resulting in different section mass properties being investigated or a limit on the overall weight of the element or similar.

Graphic evidence produced could be in the form of: a 2-dimensional CAD drawing of both the element and an appropriate connection detail using appropriate drawing standards and conventions. A 3-dimensional animation produced using FEA software, or a hard-copy drawing could be produced recording the effects of loading on the proposed element.

The assessment for this Outcome may be carried out as a separate assessment event. However, all the Unit assessments could be based around a single project. Assessment should be conducted under open conditions and as such learners should be allowed to refer to relevant course material and mathematical formulae.

It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Outcome 2

The focus of the assessment could be on the selection of an appropriate structural element to suit a given brief. Learners could be provided with a design brief containing constraints such as but not limited to: a limit on the height of the element, resulting in different section properties being investigated or a limit on the overall weight of the element or similar.

Graphic evidence produced could be in the form of: a 2-dimensional CAD drawing of both the element and an appropriate connection detail using appropriate drawing standards and conventions.

A 3-dimensional animation produced using FEA software, or a hard-copy drawing could be produced recording the effects of loading on the proposed element.

The assessment for this Outcome may be carried out as a separate assessment event. However, all the Unit assessments could be based around a single project. It should be an open-book assessment.

It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Outcome 3

The focus of the assessment could be on the design of an appropriate structural masonry element to suit a given brief. Learners could be provided with a design brief containing constraints such as but not limited to: a limit on the height of the element, resulting in different section properties being investigated or a limit on the overall weight of the element or similar.

Graphic evidence produced could be in the form of but not limited to a 2-dimensional CAD drawing of the element using appropriate drawing standards and conventions.

The assessment for this Outcome could be carried out as a separate assessment event. However, all the Unit assessments could be based around a single project. It should be an open-book assessment.

It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Outcome 4

The focus of the assessment could be on the design of an appropriate structural concrete element to suit a given brief. Learners could be provided with a design brief containing constraints such as but not limited to: a limit on the height of the element, resulting in different section properties being investigated or a limit on the overall weight of the element or similar.

Graphic evidence produced could be in the form of but not limited to a 2-dimensional CAD drawing of the element using appropriate drawing standards and conventions.

The assessment for this Outcome could be carried out as a separate assessment event. However, all the Unit assessments could be based around a single project. It should be an open-book assessment.

It is recommended that centres develop checklists to support the assessment requirements for each of the knowledge and/or skills items.

Opportunities for e-assessment

E-assessment may be appropriate for some assessments in this Unit. By e-assessment we mean assessment which is supported by Information and Communication Technology (ICT), such as e-testing or the use of e-portfolios or social software. Centres which wish to use e-assessment must ensure that the national standard is applied to all learner evidence and that conditions of assessment as specified in the Evidence Requirements are met, regardless of the mode of gathering evidence. The most up-to-date guidance on the use of e-assessment to support SQA's qualifications is available at www.sqa.org.uk/e-assessment.

Opportunities for developing Core and other essential skills

There may be opportunities to gather evidence towards Core Skills of *Numeracy*, *ICT*, *Problem Solving* and *Communication* at SCQF level 6 in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

The use of number/formulae to calculate parameters critical to the design, planning and specification, detail the stressing of material to arrive at safety tolerances, and the cost effectiveness of producing designs all give ample opportunities to develop the Core Skills of *Numeracy* and *ICT*. *Planning*, critical appraisal, review and evaluation are intrinsic to this process also, thus developing the Core Skill of *Problem Solving*.

History of changes

Version	Description of change	Date

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SQA acknowledges the valuable contribution that Scotland's colleges have made to the development of SQA Advanced qualifications.

FURTHER INFORMATION: Call SQA's Customer Contact Centre on 44 (0) 141 500 5030 or 0345 279 1000. Alternatively, complete our [Centre Feedback Form](#).

General information for learners

Unit title: Architectural CADT: Structural Design and Detailing
(SCQF level 8)

This section will help you decide whether this is the Unit for you by explaining what the Unit is about, what you should know or be able to do before you start, what you will need to do during the Unit and opportunities for further learning and employment.

This Unit has been designed to help you develop knowledge and skills that will enable you to analyse, design and evaluate various structural elements with diverse material properties. Using a variety of advanced techniques, you may design elements so as to be structurally sound, while investigating the cost effectiveness and any limiting factors, produce appropriate connection details to current conventions and standards, and demonstrate the effectiveness of your design using computer-aided design or finite element analysis (FEA) software packages.

The Unit may be taught with a series of lectures, practical exercises and design tutorials, which will logically and sequentially progress knowledge and skills from the simple to the complex. At all times, a strong design base will underpin your learning and assessment.

It is imperative that you develop your technical knowledge within this Unit so learning within the Unit builds upon other knowledge and skills. Existing CAD skills would be beneficial so that new tools and techniques can be used to develop and analyse structural elements using both computer-aided analysis software and manual calculations.

There are four formal assessment events, which may or may not be integrated. The greater element of assessment time and effort will be on the design and analysis of various structural elements. The evidence for all the practical assessment events is likely to be integrated into a single presentation, although other approaches are possible.

Assessments may be supervised and conducted under open-book conditions in which you will be allowed access to notes, textbooks and other material during the assessment. You will sit these assessments at prescribed points during the Unit at the discretion of the lecturer.

As you will be working consistently with numerical and graphical data within an IT-based platform, opportunities exist within this Unit for you to also develop Core Skills in *Communication, Information and Communication Technology (ICT), Problem Solving* and *Numeracy* to SCQF level 6.