SQA Advanced Unit Specification

General information

Unit title: Reinforced Concrete Design and Detailing (SCQF level 8)

Unit code: HR6F 48

Superclass: TL

Publication date: August 2017

Source: Scottish Qualifications Authority

Version: 01

Unit purpose

This Unit is designed to provide the learner with a fundamental understanding of how to apply limit state design philosophy to the checking of reinforced concrete elements in accordance with recognised design standards. In addition knowledge of detailing typical slab, beam and column elements will be developed.

Outcomes

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

1 Check the suitability of reinforced concrete one-way spanning slabs.
2 Check the suitability of singly and doubly reinforced concrete beam sections.
3 Check the suitability of short, braced reinforced concrete columns and pad foundations.

Credit points and level

1 SQA Credit at SCQF level 8: (8 SCQF credit points at SCQF level 8)

Recommended entry to the Unit

It is recommended that the learner has completed:

HR3V 47 *Structural Mechanics*
HR6E 47 *Structural Analysis A*
HR6C 48 *Structural Analysis B*
HR50 47 *Civil Engineering Materials and Testing*

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.

The Assessment Support Pack (ASP) for this Unit provides assessment and marking guidelines that exemplify the national standard for achievement. It is a valid, reliable and practicable assessment. Centres wishing to develop their own assessments should refer to the ASP to ensure a comparable standard. A list of existing ASPs is available to download from SQA's website.

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.

Where evidence for Outcomes is assessed on a sample basis, the whole of the content listed in the Knowledge and/or Skills section must be taught and available for assessment. Learners should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion.

Outcome 1

Check the suitability of reinforced concrete one-way spanning slabs.

Outcome 2

Check the suitability of singly and doubly reinforced concrete beam sections.

Outcome 3

Check the suitability of short, braced reinforced concrete columns and pad foundations.

The following Knowledge and/or Skills and Evidence Requirements apply to Outcomes 1, 2 and 3.

Knowledge and/or Skills for Outcomes 1, 2 and 3

- Design load effects on statically determinate structures at the ultimate and serviceability limit states, due to given applied characteristic loads
- Suitability of given reinforced concrete sections in accordance with recognised Design Standards
- Typical reinforced concrete design and details
- Reinforcement details
- Bar bending schedules
- Computer software analysis

Evidence Requirements for Outcomes 1, 2 and 3

Learners will need to provide evidence to demonstrate their Knowledge and/or Skills across all Outcomes by showing that they can:

- select the correct partial safety factors for structural loading and evaluate the ultimate/serviceability design loads.
- check the suitability of reinforced concrete elements in accordance with current design standards.
- sketch reinforced concrete elements in accordance with current design practice.
- prepare a simple bar bending schedule in accordance with current standards.

It is possible to assess learners either on an individual Outcome basis, a combination of Outcomes or by a single holistic assessment combining all Outcomes. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled open-book conditions. A single assessment covering all Outcomes should not exceed three hours in duration. It should be noted that learners must achieve all the Evidence Requirements specified for Unit in order to pass this Unit and all the Knowledge and/or Skills points must be met. The Evidence Requirements and Knowledge and/or Skills may be sampled over the three Outcomes.

Questions used to elicit learner evidence should take the form of clearly defined reinforced concrete elements using sketches where appropriate. The structural elements may be specified individually as separate questions or may form part of a larger structure comprising several types of structural element.

SQA Advanced Unit Support Notes

Unit title: Reinforced Concrete 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 40 hours.

Guidance on the content and context for this Unit

This Unit has been written in order to allow learners to develop knowledge, understanding and skills in the following areas of reinforced concrete design:

- One-way spanning slabs
- Singly and doubly reinforced beams
- Short braced columns
- Axially loaded pad foundations

This Unit provides the learner with the basic knowledge and understanding to check the suitability of and determine required areas of reinforcement for, given reinforced concrete elements, to sketch typical reinforcing details and prepare bar bending schedules in accordance with recognised design standards.

This Unit is at SCQF level 8 and has been developed as part of the SQA Advanced Diploma in Civil Engineering.

Throughout the Unit emphasis will be placed where appropriate on the application of Health and Safety and Sustainability. Safe working practices should be looked at in accordance with current safety codes of practice and regulations as part of the design process. Sustainability should include reference to criteria affecting sustainability, impact of not implementing sustainability on the environment and the legislation promoting sustainability.

This is a structural design Unit where emphasis should be on the concrete section meeting the requirements of the design standards. Analysis should be limited to the design effects on statically determinate structures. However in a wider context, the majority of reinforced concrete structures are statically indeterminate hence, where appropriate, this Unit should be linked to *Structural Analysis B* to indicate how shear forces and bending moments may be calculated for such structures.

Various aids are available to assist the design process, not all calculations need be carried out by hand. This may be in the form of charts, tables, commercially available software or software developed in-house. An opportunity exists for cross competence with *Computer Applications for Civil Engineering* (HR4Y 48) to look more comprehensive at a reinforced concrete structure as a whole.

In designing this Unit the following topics have been identified which would be expected to be covered by lecturers.

Reinforced concrete, one-way spanning slabs: consideration of appropriate partial safety factors for serviceability and ultimate limit state conditions, analysis to determine design load effects for statically determinate slabs, cover/dimension requirements considering durability/fire, check for singly-reinforced section, shear resistance, determine required areas

of tension reinforcement, check deflection, minimum/maximum required percentage of reinforcement, maximum/minimum spacing, anchorage, lap length and curtailment.

Reinforced concrete beams: consideration of appropriate partial safety factors for serviceability and ultimate limit state conditions, analysis to determine design load effects for statically determinate beams, cover/dimension requirements considering durability/fire, identify singly or doubly reinforced section, shear resistance, determine required areas of tension and compression reinforcement, check deflection, minimum/maximum required percentage of reinforcement, maximum/minimum spacing, anchorage, lap length and curtailment.

Rectangular beams: shear reinforcement assuming vertical links.

Flanged beams: as for rectangular beams and in addition; determine effective flange width, check depth of neutral axis, and determine required area of transverse reinforcement.

Short, braced columns: consideration of appropriate partial safety factors for serviceability and ultimate limit state conditions, apply design load effects, cover/dimension requirements considering durability/fire, effective height, slenderness, provision of lateral stability, determine required areas of compression reinforcement, link reinforcement, check minimum/maximum required percentage of reinforcement, maximum/minimum spacing.

Axially loaded pad foundations: consideration of appropriate partial safety factors for serviceability and ultimate limit state conditions, analysis to determine design load effects, cover/dimension requirements considering durability/sub-soil bearing capacity, check for singly-reinforced section, shear resistance, determine required areas of tension reinforcement, minimum/maximum required percentage of reinforcement, maximum/minimum spacing, anchorage, lap length and curtailment.

Reinforced concrete detailing: prepare typical sketches of typical reinforcing details and bar bending schedules for each the element types considered.

Guidance on approaches to delivery of this Unit

The material in this Unit should be delivered in a manner which encourages learners to develop a working knowledge and familiarity of recognised design standards and the style in which they are written. The teaching should be based, wherever possible, on real design office situations incorporating commercially available, practical design aids such as computer software, design charts and design tables where appropriate in addition to the direct use of recognised design standards.

Learners should be encouraged to prepare calculations on formal ‘design calculation sheets’ in a manner similar to that found in practice. In addition they should be encouraged to use ‘flow charts’ to aid their understanding of design/checking procedures and which can be utilised in summative assessments.

Learners will usually work individually however, they should also be encouraged to work in small groups developing solutions to specific design problems; presenting and explaining the solutions to the remainder of their peer group.

It is recommended that Knowledge/Skills be developed by working through structured questions issued by the tutor or initiated by the learners themselves. Where possible some of the questions should be based on real-life structures which can be viewed locally and discussed prior to analysis and design by the learners.

Guidance on approaches to assessment of this Unit

Evidence can be generated using different types of instruments 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.

It is possible to assess learners either on an individual Outcome basis, a combination of Outcomes or by a single holistic assessment combining all Outcomes. The assessment paper/s should be composed of an appropriate balance of short answer, restricted response and structured questions. Assessment should be conducted under supervised, controlled open-book conditions. A single assessment covering all Outcomes should not exceed three hours in duration. It should be noted that learners must achieve all the Evidence Requirements specified for Unit in order to pass this Unit and all the Knowledge and/or Skills points must be met. The Evidence Requirements and Knowledge and/or Skills may be sampled over the three Outcomes.

Questions used to elicit learner evidence should take the form of clearly defined reinforced concrete elements using sketches where appropriate. The structural elements may be specified individually as separate questions or may form part of a larger structure comprising several types of structural element.

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

This Unit will provide opportunity for learners to develop their Core Skills in the areas of *Numeracy* and *Information and Communication Technology (ICT)* skills.

History of changes to Unit

Version	Description of change	Date

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: Reinforced Concrete 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 is designed to provide the learner with a fundamental understanding of how to apply limit state design philosophy to the checking of reinforced concrete elements in accordance with recognised design standards. In addition knowledge of detailing typical slab, beam and column elements together with axially loaded pad foundations will be developed.

Six Knowledge and/or Skills points will be developed:

- Design load effects on statically determinate structures at the ultimate and serviceability limit states, due to given applied characteristic loads.

  This will include the appropriate use of partial safety factors and the calculation of shear forces and bending moments for statically determinate elements.

- Suitability of given reinforced concrete sections in accordance with recognised Design Standards.

  The forms of reinforced concrete element considered will be one-way spanning slabs, singly and doubly reinforced beams, short braced columns and axially loaded pad foundations. These will be checked to meet the design requirements for shear, bending and deflection as appropriate.

- Typical reinforced concrete details

  At critical sections of a reinforced concrete structure values of shear force, bending moment and axial load, as appropriate will be given. This will allow areas of steel reinforcement to be calculated in accordance with current design standards.

- Reinforcement details

  Consideration will be given to maximum/minimum spacing, anchorage, lap length and curtailment of calculated areas of reinforcement allowing reinforced concrete elements to be sketched in accordance with current practice.

- Bar bending schedules.

  After the determining the reinforcement required for a structural element it must be detailed in such a manner that it can be easily fabricated to form a cage or mat. To assist in the process all reinforcement is cut and bent in accordance a standard practice and presented in the form of a standard schedule.

- Computer software analysis

  Not all calculations need be carried out by hand, various design aids are available to assist the design process. This may be in the form of commercially available software or software developed in-house covering all or some of the skills listed above.

Evidence that learners can satisfy the knowledge and skill elements of this Unit will be obtained by assessment in controlled open-book, supervised conditions. All of the Knowledge and/or Skills will be covered but will be sampled for individual Outcomes.

This Unit will provide opportunity for you to develop their Core Skills in the areas of *Numeracy* and *ICT* skills.