SQA Advanced Unit Specification

General information for centres

Unit title: Structural Analysis A: Statically Determinate Structures

Unit code: HR6E 47

Unit purpose: This Unit seeks to allow the candidate to apply the principles of structural analysis to solve problems related to a variety of Civil Engineering Structures.

On completion of the Unit the candidate should be able to:

1 Apply the principles of stress and strain to composite structures.
2 Apply the theory of simple bending and shear stress determination to the analysis of statically determinate beams.
3 Apply Euler's theory of simple buckling to axially loaded columns.
4 Evaluate combined stresses in structural members and gravity walls and the stability of such walls.

Credit points and level: 1 SQA Credit at SCQF level 7: (8 SCQF credit points at SCQF level 7*)

**SCQF credit points are used to allocate credit to qualifications in the Scottish Credit and Qualifications Framework (SCQF). Each qualification in the Framework is allocated a number of SCQF credit points at an SCQF level. There are 12 SCQF levels, ranging from National 1 to Doctorates.*

Recommended prior knowledge and skills: Access to this Unit is at the discretion of the centre but it would be beneficial if the candidate possesses the Basic Structures Unit or a basic understanding and knowledge of the analysis of statically determinate beams and the concepts of stress and strain applied to structural elements. This may be evidenced by completion of the Structural Mechanics Unit or equivalent prior knowledge.

Core Skills: There are opportunities to develop the Core Skills of Numeracy and Problem Solving in this Unit, although there is no automatic certification of Core Skills or Core Skills components.

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.

Assessment: It is possible to assess candidates either on an individual Outcome basis, a combination of Outcomes 2 and 3 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 conditions. A single assessment covering all outcomes should not exceed 2 hours in duration. It should be noted that candidates must achieve all the minimum evidence specified for each Outcome in order to pass this Unit.

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. Candidates should not know in advance the items on which they will be assessed and different items should be sampled on each assessment occasion

An exemplar instrument of assessment and marking guidelines has been produced to provide examples of the type of evidence required to demonstrate achievement of the aims of this Unit and to indicate the national standard of achievement at SCQF level 7.

SQA Advanced Unit specification: statement of standards

Unit title: Structural Analysis A: Statically Determinate Structures

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The sections of the Unit stating the Outcomes, knowledge and/or skills, and evidence requirements are mandatory.

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. Candidates 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

Apply the principles of stress and strain to composite structures

Knowledge and/or skills

- The relationship between stress and strain within the elastic limit is applied to composite members
- The ratio between the direct stresses in structural composite members is evaluated
- The total load and the individual material loads carried by structural composite members are determined
- Changes in length of structural composite members under applied load are determined

Evidence Requirements

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

- determine the axial load(s) that can be applied to the composite member and individual materials based on limiting stress values
- determine the change in length of a composite member under applied axial load

Evidence for the knowledge and/or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **two out of four** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to both items, this must be provided by manual calculations and by computer techniques.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed conditions and as such candidates should be not allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions

Outcome 2

Apply the theory of simple bending and shear stress determination to the analysis of statically determinate beams

Knowledge and/or skills

- Apply the general expression for simple bending to solving problems related to statically determinate beams
- Calculate the second moment of area for standard geometrical shapes
- Sketch the bending stress distribution diagram, indicating significant values, for beams subject to lateral load
- Determine the shear stress in beams subject to vertical load
- Compare calculated bending and shear against limiting values given in relative design codes

Evidence Requirements

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

- calculate the maximum bending stress in a beam subject to standard loading conditions and compare the value obtained with permissible bending stress values
- calculate the shear stress in a beam subject to standard loading condition using the equations relative to the specific material and compare the value obtained with permissible shear stress values
- determine the maximum load that may be applied to a statically determine beam subject to standard loading conditions given limiting bending and/or shear stress values

Evidence for the knowledge and/or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all three items, this must be provided by manual calculations and by the computer techniques.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed conditions and as such candidates should be not allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions

Outcome 3

Apply Euler's theory of simple buckling to axially loaded columns

Knowledge and/or skills

- Euler critical load and buckling stress for axially loaded columns are evaluated using standard formulae
- Limitations of the Euler formulae applied to axially loaded columns are explained

Evidence Requirements

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

- apply standard formulae to evaluate the critical load and buckling stress of axially loaded columns under standard end restraint condition

Evidence for the knowledge and/or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **one out of two** the knowledge and/or skills items should

be sampled. Candidates must provide a satisfactory response to the item, this must be provided by manual calculations and by the computer techniques.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed conditions and as such candidates should be not allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions**.**

Outcome 4

Evaluate combined stresses in structural members and gravity walls and the stability of such walls

Knowledge and/or skills

- The terms stability moment, overturning moment are applied to gravity walls.
- The "middle third rule" is used to check the nature of the combined stresses in structural members and gravity walls.
- Direct and bending stresses are evaluated in structural elements and under gravity walls.
- The distribution of stress under gravity walls can be sketched and significant values determined.
- The stability of gravity walls can be checked for stability and sliding.

Evidence Requirements

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

- determine the magnitude of the direct and bending stress of structural members subject to eccentric loading conditions
- apply the "middle-third " rule and hence sketch the combined stress distribution diagram, indicating significant values, for structural members and gravity walls under applied load
- check the stability of gravity walls against stability and overturning

Evidence for the knowledge and /or skills for this Outcome will be provided on a sample basis. In any assessment of this Outcome a minimum of **three out of five** knowledge and/or skills items should be sampled. Candidates must provide a satisfactory response to all three items, this must be provided by manual calculations and by the computer techniques.

Evidence should be generated through assessment undertaken in controlled, supervised conditions. Assessment should be conducted under closed conditions and as such candidates should be not allowed to bring textbooks, handouts or notes to the assessment.

Assessment guidelines

Questions used to elicit candidate evidence should take the form of an appropriate balance of short answer, restricted response and structured questions.

Administrative Information

Unit code: HR6E 47

Unit title: Structural Analysis A: Statically Determine Structures

Superclass category: TM

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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.

SQA Advanced Unit specification: support notes

Unit title: Structural Analysis A: Statically Determinate Structures

This part of the Unit specification is offered as guidance. The support notes 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

The Unit has been written in order to allow candidates to develop knowledge and understanding skills in the application of the principles of structural mechanics in the following areas:

1 Assessing stresses in axially loaded structural members formed from two materials and checking values against permissible limits.
2 Assessing the maximum stresses in structural beams subject to vertical loading and checking values against permissible limits.
3 Assessing the critical load and buckling stress in columns subject to axial load using the standard Euler formulae and explaining the limitations of Euler theory.
4 Determining the combined direct and bending effects on a range of structural members.

This Unit at SCQF level 7 is a mandatory unit within 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. Sustainability should include reference to criteria affecting sustainability, impact of not implementing sustainability on the environment and the legislation promoting sustainability.

In designing this unit the unit writers have identified the range of topics they would expect to be covered by lecturers. The writers have also given recommendations as to how much time should be spent on each outcome. This has been done to help lecturers decide what depth of treatment should be given to the topics attached to each of the outcomes.

1 Apply the principles of stress and strain to composite structures (10 hours)

- the relationship between stress and strain within the elastic limit and implications of the relationship in composite member made from two materials
- the application of Hooke's law to composite members
- the use of the structural steelwork section tables
- the modular ratio and permissible (limiting) stress values
- calculation exercises both manual and using computer techniques involving: short reinforced concrete columns; concrete filled structural hollow sections; encased structural steel columns and flitched timber truss sections

2 Apply the theory of simple bending and shear stress determination to the analysis of statically determinate beams (11 hours)

- meaning of the terms and symbols used in the general expression of simple bending
- standard formulae for calculating maximum bending moment and maximum shear force in statically determinate beams to include simply supported and cantilevered beams
- determination of the maximum bending moment and shear force in beams subject to differing values of point load
- determination of the second moment of area of symmetrical beam shapes including rectangles, "I- beams" and circular sections
- the use of the structural steelwork section tables
- the parallel axis theorem for irregular shapes
- the forms of the shear stress formula adopted by the structural steelwork and timber design codes
- calculation exercises both manual and using computer techniques

3 Apply Euler's theory of simple buckling to axially loaded columns (4 hours)

- definition of "short" and "slender" columns
- axial load carrying capacity of columns in terms of Euler critical load $P_e = \pi^2 EI/L^2$
- the effect of differing end restraint conditions on the Euler critical load
- the limitations of Euler formulae
- the principles behind practical buckling criteria: buckling stress compared against yield stress; section shape factors and slenderness ratio
- calculation exercises both manual and using computer techniques

4 Evaluate combined stresses in structural members and gravity walls and the stability of such walls (15 hours)

- development of formulae for eccentrically loaded elements based on direct and bending stress in combination
- determination of the second moment of area of symmetrical shapes including rectangles, "I- beams" and circular sections
- the use of the structural steelwork section tables to obtain the second moment of area, elastic modulus and area properties of standard shapes
- calculation exercises involving eccentrically loaded structural elements
- development of the "middle-third" rule
- extension of combined formulae for eccentrically loaded elements to mass gravity walls
- pressure distribution behind gravity wall calculated and the position and magnitude of the overturning force determined
- stability and overturning forces linked to sliding stability
- overturning and stability moments calculated about the toe of the section
- net force and net moment calculated and "middle-third" rule applied
- sketching, indicating significant values, the bearing pressure under gravity walls
- calculation exercises both manual and using computer techniques

Guidance on the delivery and assessment of this Unit

This Unit has links with the following unit/s Structural Mechanics and Structural Analysis B: Statically Determinate and Indeterminate Structures and it is recommended that it be delivered before Structural Analysis B: Statically Determinate and Indeterminate Structures and after Structural Mechanics.

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

It is recommended that evidence for learning outcomes is achieved through well-planned course work, assignments and projects. Assessment may be formative and summative and both may feature as part of the process. Although assessments must be focused on the individual achievement of each candidate, group work may contribute to the assessment. Integrative assignments and project work will help to link this unit with other related units.

The volume of evidence required for each assessment should take into account the overall number of assessments being contemplated within this unit and the design of the overall teaching programme.

In designing the assessment instrument/s, opportunities should be taken to generate appropriate evidence to contribute to the assessment of Core Skills units.

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

Opportunities for developing Core Skills

The following grid provides a general guide to opportunities for the development of Core Skills in this Unit. Opportunities for the development of Core Skills at the output level are more fully identified in the Core Skills Signposting Guide.

Core Skill	Outcome 1	Outcome 2	Outcome 3	Outcome 4	Outcome 5
1 Communication					
Reading					
Writing					
Oral					
2 Numeracy					
Using Number	3	3	3	3	
Using Graphical Information					
3 IT					
Using Information Technology					
4 Problem Solving					
Critical Thinking	3	3			
Planning and Organising					
Reviewing and Evaluating					
5 Working with Others					

Open learning

Given that appropriate materials exist this Unit could be delivered by distance learning, which may incorporate some degree of on-line support. However, with regard to assessment, planning would be required by the centre concerned to ensure the sufficiency and authenticity of candidate evidence. Arrangements would be required to be put in place to ensure that assessment/s were conducted under controlled, supervised conditions.

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.

General information for candidates

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The Unit has been written in order to allow candidates to develop knowledge and understanding skills in the application of the principles of structural mechanics in the following areas:

1 Assessing stresses in axially loaded structural members formed from two materials and checking values against permissible limits.
2 Assessing the maximum stresses in structural beams subject to lateral loading and checking values against permissible limits.
3 Using standard formula to calculate the Euler critical load on axially loaded columns and explaining the limitations the Euler formulae.
4 Determining the combined direct and bending effects on a range of structural members.

As an aid to the understanding the skills requirement of this unit the candidate should have prior knowledge of:

- stress and strain
- loading diagrams
- shear force and bending moment diagrams

Assessment will generally involve calculation exercises, both manual and using computer techniques, and the production of stress distribution diagrams