

Internationell svetskonstruktör, IWSD - Kursprogram

Designer engineering specialisation (M4, M5 och M6)

Module 4: DESIGN OF WELDED JOINTS / Utformning av svetsförband

4.1 Categories of welded joints/Olika kategorier av svetsförband, 4tim

Objective:

The students will understand the differences between functional weld categories and how the design requirements will depend on the categories

Scope:

Weld categories:

- primary load carrying joints;
- connecting joints;
- binding joints;
- accessory joints.

Expected result at comprehensive level:

Identify various classes of welded joints based on their function.

Explain the load-bearing requirement of various weld categories.

Explain the need to avoid the under- and over-size of the throat thickness.

Illustrate the role of joint preparation and weld penetration for load-carrying joints.

Identify joint categories from an engineering structure.

4.2 Design of welded joints with predominantly static loading/Utformning av svetsförband utsatta för statiska belastningar, 8 tim

Objective:

The students will understand how the throat thickness of weld will be defined in predominantly static loaded joints.

Scope:

Throat thickness

Elastic and plastic design

Deformation capacity

Stress components in a fillet weld

Correlation factor for weld strength

Design strength

As appropriate, a suitable design guidance document, e.g., EN 1993 Eurocode 3-part 1-8: Design of Steel Structures: Design of Joints, may be used.

Expected result at comprehensive level:

Explain the assumptions involved in the design of predominantly static loaded joints.

Identify relevant stress values from a type stress-time history for a structural component.

Calculate the design strength of end welds based on weld stress components.

Calculate the design strength of side welds based on weld stress components.

Calculate the strength reduction factor for long side welds or transverse stiffeners.

Calculate the needed throat thickness for a full strength primary load carrying weld.

Calculate the throat thickness for a binding welded joint.

4.3 Design of welded joints with predominantly fatigue loading/Utformning av svetsförband utsatta för utmattningsbelastningar, 10 tim

Objective:

The students will understand how the fatigue behaviour of welded joints and be able to perform relevant fatigue life calculations.

Scope:

Fatigue of welded joints:

- stress concentrations
- residual stresses
- initial defects

Constant and variable amplitude loading

Cumulative damage

FAT class

Overview of fatigue calculation methods in a relevant design guidance document, e.g., IIW Doc. XIII-1965-03/XV-1127-03 "Recommendations for fatigue design of welded joints and components"

Expected result at comprehensive level:

Explain the assumptions involved in the design of predominantly static loaded joints.
Identify relevant stress values from a type stress-time history for a structural component.
Calculate the design strength of end welds based on weld stress components.
Calculate the design strength of side welds based on weld stress components.
Calculate the strength reduction factor for long side welds or transverse stiffeners.
Calculate the needed throat thickness for a full strength primary load carrying weld.
Calculate the throat thickness for a binding welded joint.

4.4 Design against brittle fracture/Utformning av svetsförband utsatta för risk för sprödbrott, 3 tim

Objective:

The students will be acquainted with the brittle fracture analysis based on linear elastic fracture mechanics.

Scope:

Fracture toughness
Critical stress intensity
Critical crack size
Temperature and material toughness

Overview of calculation methods in a relevant design guidance document, e.g., EN 1993 Eurocode 3-part 1-10: Design of Steel Structures: Selection of materials for fracture toughness and through thickness properties

Expected result at comprehensive level:

Review theory of fracture mechanics and brittle fracture.
Explain relationship between material fracture toughness and temperature.
Review calculation procedures in a relevant design guidance document.
Compute critical crack size for structural element with typical material properties.
Compute stress intensity factor for a welded connection.

Module 5: DESIGN OF WELDED PLATE STRUCTURES / Utformning av svetsade plåtkonstruktioner

5.1 Plates and shells/Plattor och skal, 8 tim

Objective:

The students will have a basic understanding of plate buckling and design requirements to avoid buckling.

Scope:

Plate buckling
Modified slenderness
Effective width
Stiffeners
Buckling coefficient

Expected result at comprehensive level:

Explain the buckling of plate type structures and the buckling coefficient.
Illustrate the critical buckling stress vs. slenderness for plates.
Review the concept of cross section class and its relationship with relative slenderness.
Compute effective width for a slender flange under compression.
Illustrate an example of stiffener design based on standard equations.
As appropriate, a suitable design guidance document, e.g., EN 1993 Eurocode 3-part 1-5: Design of Steel Structures: Supplementary rules for planar plated structures without transverse loading, may be used.

5.2 Beam and column structures/Balkar och pelare, 8 tim

Objective:

The students will have a basic understanding of design methods for beam structures and beam / column structures to avoid buckling.

Scope:

Beam and column profiles
Cross section classes
Local and global stability

Plastic design
Longitudinal stiffeners
Design of slender webs
Shape factors for beam profiles

Expected result at comprehensive level:

Explain the combined effect of axial / bending loads.
Illustrate proper placement of longitudinal stiffeners for beams subject to bending.
Illustrate proper design methods for stiffening of wide flanges.
Review buckling of beam webs subject to shear loads.
Illustrate optimal design of beam elements for stiffness / bending resistance.
Compute bending resistance of a beam with slender or semi-compact webs.
As appropriate, a suitable design guidance document, e.g., EN 1993 Eurocode 3-part 1-5: Design of Steel Structures: Supplementary rules for planar plated structures without transverse loading, may be used.

5.3 Design considerations for welding residual stresses and distortion / Utformning med hänsyn till svetsegenspänningar, svetsdeformationer, 9 tim

Objective:

The students will understand the theoretical background of residual stresses and distortion and can use simplified estimation methods.

Scope:

Welding induced residual stresses
Welding induced distortion
Classification of distortions
Weld sequence effects and residual stresses
Effect of residual stress on structural behaviour
Lamellar tearing

Expected result at comprehensive level:

Illustrate the formation of longitudinal and transverse welding residual stresses.
Explain the influence of constraint on residual stress formation.
Illustrate the difference between single and multipass welding on residual stress formation.
Compute approximate residual deformation due to welding.
Illustrate the influence of residual stresses on the ultimate strength of a structural member.
Explain possible influences of residual stress on lamellar tearing and fatigue.
Illustrate proper selection of weld order to minimise residual stresses.

Module 6: DESIGN FOR PURPOSE OF WELDED STRUCTURES / "Anpassad" utformning av svetsade konstruktioner

6.1 Introduction to design for purpose concepts for welded structures, 3 tim

Objective:

The students will be introduced to the basics of the "design for purpose" strategy for welded structures

Scope:

Alternate structure solutions
Assessment of weld importance in terms of loading
Definition of weld quality for different purposes

Expected result at comprehensive level:

Explain the roles and priority of welds within a structure.
Explain the importance of various structural solutions for fatigue and static strength of a welded joint.
Review of possible weld defect types and identify significance or lack of significance for strength.
Review alternatives for improving the fatigue strength of a structural detail.
Illustrate good and bad examples of weld specification.

6.2 Improved design of statically loaded joints, 2 tim

Objective:

The students will understand what are essential items concerning improved design of statically loaded joints

Scope:

Flow of forces in welded joints
Weld start / stop positions

Slot and plug welds
Deformation capacity of a weld

Expected result at comprehensive level:

Illustrate the effect of statically loaded welds on a flexible foundation.
Review deformation capacity for statically loaded welds and illustrate good and bad design examples.
Compute optimal geometry for a welded attachment.

6.3 Improved design of fatigue loaded joints, 8 tim

Objective:

The students will understand how the fatigue life will depend on the different parameters and how these parameters can be control in design and manufacturing phases of production

Scope:

Nominal stress
Structural stress
Weld defects
Notch stress
Welds starts / stops
Root defects

Expected result at comprehensive level:

Review principals for weld location for improved fatigue strength.
Illustrate importance of reducing the structural stress concentration.
Explain the importance of weld misalignment in fatigue design.
Explain the importance of weld toe shape for fatigue.
Review importance of weld start / stop positions.
Compute fatigue strength of cruciform joint based on IIW recommendations.

6.4 Post- weld treatment methods for welded structures, 4 tim

Objective:

The students will understand the theoretical background, advantages and disadvantages of post-weld treatment methods. They will be acquainted with the practical aspects for executing the methods and inspection requirements. Reference document should be IIW publication XIII-1815-00 "IIW recommendations on post-weld improvement of steel and aluminium structures".

Scope:

TIG dressing
Grinding
Needle peening
Hammer peening
Quality control
Fatigue strength improvement

Expected result at comprehensive level:

Review common methods for post-weld treatment for welded joints.
Explain procedures and quality control procedure associated with common treatment methods.
Explain benefits and limitations of the various methods in terms of fatigue strength.

6.5 Design considerations for manual and automated welding processes, 2,5 tim

Objective:

The students will understand the design requirements and challenges involved in automated welding processes

Scope:

Weld angle and position
Interference
Seam tracking
Joint selection

Expected result at comprehensive level:

Review examples of both good and bad design with respect to manufacturability.
Explain sources of interference during welding and how these can be avoided in design.
Explain design alternatives that are better suited for automated weld processes.

6.6 Numerical methods and fatigue design, 4 tim

Objective:

The students will be introduced to the use of numerical analyses methods in the fatigue design of welded structures

Scope:

Finite element analysis

Nominal stress approach

Structural stress approach

Notch stress approach

Linear elastic fracture mechanics

Overview of fatigue numerical methods in a relevant design guidance document, e.g., IIW Doc. XIII-1965-03/XV-1127-03 "Recommendations for fatigue design of welded joints and components"

Expected result at comprehensive level:

Explain principals of proper FE meshing for fatigue analysis based on structural stresses.

Explain principals of proper FE meshing for fatigue analysis based on local notch stresses.

Review simple tools for fracture mechanics crack growth simulations.

6.7 Laboratory testing, 1,5 tim

Objective:

The students will have a general background on the role of laboratory testing and its role in research, development and design

Scope:

Fatigue testing methods

Quasi-static testing methods

Evaluation of laboratory failures

Methods for data analysis

Expected result at comprehensive level:

Explain the background of design curves based on fatigue testing.

Review of relevant documents and standards for laboratory testing and data analysis. For example:

- IIW XIII-1516-93 Fatigue testing of welded components;
- IIW XIII-1871-01 Large scale testing of welded components;
- XIII-WG1-114-03 Best practice guide on statistical analysis of fatigue data.