CONCEPT

# Structural Steel Design: Member Buckling, Joints, Sway Stability and Plant Steelwork

15 – 26 February 2027
London - Central London four-star



# Structural Steel Design: Member Buckling, Joints, Sway Stability and Plant Steelwork

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## Introduction:

Structural steel design errors on process plants and buildings rarely show in the model: an unrestrained compression flange, a stanchion verified without second-order sway, a bolted splice that cannot be tightened on site or a piperack bent that sways under thermal piping thrust. This Core Concept course takes participants through steel grades, rolled and hollow profiles and limit state verification to ANSI/AISC 360 and Eurocode 3, member buckling, beam-columns, bolted and welded joints, bracing and 3D sway stability, then into piperacks, walkways, machinery supports, fabrication, erection, inspection, corrosion and fire protection. Participants produce a Steelwork Verification Report.

## Course Objectives:

- Select steel grades, rolled and hollow profiles and fracture toughness for members and joints in plant and building steelwork
- Verify ties, struts, stanchions, girders and beam-columns against flexural, torsional and lateral-torsional buckling using ANSI/AISC 360 and EN 1993-1-1 resistance equations
- Proportion bolted and welded joints, base plates and holding-down bolts and classify joint rotational stiffness to EN 1993-1-8
- Build and validate 3D stiffness models of braced and moment-resisting steelwork, including second-order sway, imperfections and notional horizontal forces
- Size steel piperacks, access walkways, skid and machinery supports and crane runway girders for operating, thermal, wind and seismic actions
- Review shop drawings, erection sequences, inspection records, protective coating systems and fire protection for completed steelwork

## Target Audience:

- Structural specialists who carry out steel member and joint calculations for process plant, utility and building projects
- EPC steelwork specialists who size piperacks, walkways and machinery supports
- Independent reviewers who verify steel calculation packages, stiffness models and connection sheets
- Steelwork inspectors and quality specialists who verify fabrication, bolting, welding and coating against shop drawings
- Site erection specialists responsible for temporary stability, lifting sequences and alignment of steelwork

## Course Outline:

### Day 1: Steel Grades, Rolled Profiles and Verification Basis

- Structural Steel Grades to EN 10025 and ASTM A992 and A36: Yield, Ductility and Weldability
- Fracture Toughness and Through-Thickness Property Selection to EN 1993-1-10
- Hot-Rolled I, H, Channel and Angle Profiles Versus EN 10210 and EN 10219 Hollow Sections
- Section Property Tables: Second Moment of Area, Radius of Gyration and Warping Constant
- Cross-Section Classification: Plastic, Compact, Semi-Compact and Slender Elements

### Day 2: Actions, Combinations and Limit State Verification

- Permanent, Imposed, Wind, Seismic, Thermal and Crane Actions on Steelwork
- LRFD and ASD Combinations in ANSI/AISC 360 Compared with Eurocode Partial Factors
- Resistance Factors and Partial Factors on Resistance in EN 1993-1-1
- Serviceability Criteria: Deflection, Sway and Floor Vibration Limits for Steelwork
- Combination Matrix Build in a Verification Spreadsheet

### Day 3: Ties, Struts, Stanchions and Flexural Buckling

- Tie Member Gross Yielding, Net Section Rupture and Shear Lag Factors
- Euler Critical Force, Effective Length Factor K and Slenderness Ratio
- Buckling Curves in EN 1993-1-1 and the AISC Compression Chapter
- Torsional and Flexural-Torsional Buckling of Angles, Tees and Cruciform Sections
- Built-Up and Laced Struts: Batten Spacing and Local Buckling Limits

### Day 4: Girders, Lateral-Torsional Buckling and Beam-Columns

- Laterally Restrained Girder Bending and Shear Resistance with Web Bearing and Crippling
- Lateral-Torsional Buckling: Unbraced Length, Moment Gradient Factor Cb and Critical Moment Mcr
- Restraint Provision: Compression Flange Bracing, Fly Braces and Torsional Restraints
- Beam-Column Interaction Equations in ANSI/AISC 360 and EN 1993-1-1 Compared
- Member Verification Spreadsheet for Combined Axial Force and Biaxial Bending

### Day 5: Week-One Guided Case: Portal Shed Member Verification

- Case Brief: Single-Storey Portal Workshop with Mezzanine Floor
- Combination Envelope and Governing Member Force Extraction
- Rafter and Stanchion Verification Including Haunch Zone Stability
- Mezzanine Girder and Floor Vibration Review Against Serviceability Criteria
- Peer Review of Member Verification Using a Steel Calculation Review Checklist

## Day 6: Bolted and Welded Joints, Base Plates and Holding-Down Bolts

- Bolt Categories, Preloaded Bolting to EN 14399 and Slip-Critical Joints
- Fillet and Full-Penetration Butt Weld Resistance and Eccentric Weld Groups
- Simple, Semi-Rigid and Rigid Joint Classification by the Component Method of EN 1993-1-8
- End Plate Moment Joints, Web Panel Shear and Stiffener Detailing
- Base Plates, Holding-Down Bolt Pull-Out, Shear Keys and Grout Details

## Day 7: Bracing, Sway Stability and 3D Stiffness Modelling

- Vertical and Plan Bracing Systems: Force Paths, Diaphragm Action and Brace Member Forces
- Second-Order P-Delta Effects, Amplification Factors and the Direct Analysis Method
- Initial Sway Imperfections, Notional Horizontal Forces and Stiffness Reduction
- 3D Modelling Software Practice: Member Releases, Offsets and Support Conditions
- Model Validation: Hand Calculations, Reaction Balance and Mode Shape Review

## Day 8: Plant Steelwork: Piperacks, Walkways and Machinery Supports

- Steel Piperack Bents: Operating, Friction, Anchor and Thermal Piping Actions
- Longitudinal Strutting, Expansion Bays and Piperack Bracing Arrangements
- Access Walkways, Stairs, Handrails and Open Grating Verification
- Skid and Support Steelwork for Exchangers, Vessels and Vibrating Machinery
- Crane Runway Girders and Fatigue Detail Categories to EN 1993-6 and EN 1993-1-9

## Day 9: Fabrication, Erection, Inspection, Corrosion and Fire Protection

- Execution Classes and Fabrication Tolerances Under EN 1090 and the ANSI/AISC 303 Code of Standard Practice
- Erection Sequence Planning, Temporary Bracing and Lifting Lug Verification
- Steelwork Inspection and Test Plan: Dimensional Surveys, Bolt Tightening Records and Weld Visual Reports
- Protective Coating Systems: Surface Preparation, Hot-Dip Galvanizing and Dry Film Thickness Readings
- Fire Resistance of Steel Members to EN 1993-1-2: Critical Temperature, Section Factor and Intumescent Coatings

## Day 10: Capstone: Process-Plant Steelwork Verification

- Capstone Brief: Piperack Bay with Heat Exchanger Platform and Access Stair
- 3D Stiffness Model Build and Combination Assignment for the Capstone Steelwork
- Member, Joint and Base Plate Verification with Serviceability Limits
- Fabrication, Erection and Protection Requirements Schedule for the Steelwork
- Steelwork Verification Report Presentation to a Technical Review Panel

## Skills You Will Gain:

- Steel Profile Selection
- Member Buckling Verification
- Lateral-Torsional Stability
- Bolted and Welded Joint Proportioning
- Second-Order Sway Modelling
- Stiffness Model Validation
- Steelwork Inspection Planning
- Corrosion and Fire Protection Specification

## Why Attend This Course:

- Return with a Steelwork Verification Report for a piperack bay, walkway platform and machinery support set
- Work to ANSI/AISC 360 and Eurocode 3 side by side, which suits projects where specifications change between clients
- Catch unrestrained flanges, flexible joints and missing notional forces before steelwork is released for fabrication
- Compare steelwork practice with specialists from oil and gas, petrochemical, power, water and commercial building projects

## Conclusion:

Steelwork performs when members, joints, sway stability, fabrication and protection are treated as one system. Week one covers steel grades, profiles, actions, limit state verification, ties, struts, girders, lateral-torsional buckling and beam-columns, closing with a guided portal shed case. Week two adds bolted and welded joints and base plates, bracing and second-order 3D modelling, piperacks, walkways, machinery supports and crane girders, then fabrication, erection, inspection, coatings and fire protection. Participants leave with a Steelwork Verification Report ready for their next project.