Structural Design of Industrial Buildings

Training program

Description

The efficient structural design of industrial facilities requires engineers to understand the issues that can affect stability, safety, and serviceability. This course covers the structural design of industrial facilities in a systematic manner, starting with loads, load combinations, and different types of structural systems and framing concepts. The course then introduces roof-framing design including cantilever (Gerber) girders and open web steel joists. Participants will also study the detailed design of composite concrete-steel floor systems, focusing on vibration problems due to resonance, human comfort, and the need to control movement for sensitive equipment.

Overview

After participating in this course, you will be able to:

- Prevent serviceability failures that affect productivity
- Calculate design loads and combine them with anticipated loads
- Determine dynamic loading including crane, equipment, and seismic factors
- Provide durable, flat, low-maintenance concrete floors on grade
- Select economical structural systems that will provide longevity and scalability

Who Should Attend?

- Structural designers
- Owners & managers
- Facility owners
- Architectural engineers
- Plant engineers
- Building manufacturers
- Contractors
- Construction procurement personnel from oil companies and refineries, mining, chemicals processing, aluminum, pulp & paper

Course Outline:

- Structural Systems & Components
- Walls & Elevated Floors

- Design of Roof Framing
- Composite Floors with Concrete Deck Slab
- Composite Open Web Steel Joists & Trusses
- Stub-girder Floor Construction
- Steel & Composite Beams
- Structural Design for Walking
- Vibration Problems & Remedial Measures
- Crane Runways
- Design of Mill Buildings & Combined Columns

Welcome, Introduction, Workshop Preview, Learning Outcomes, and Assessment Method

Introduction

- What are industrial, general, and specialty manufacturing facilities
- How are they different from other types of structures such as warehouses and commercial, institutional, and municipal structures
- Most commonly used structural systems: gable frames, joists and joist girders, laced columns and trusses, stepped columns, conventional framing, and pre-engineered structural systems
- Design loads, governing codes, and minimum requirements
- Load combinations

Structural Systems and Components

- Structural systems
- Systems with cranes: heavy industrial facilities
- Systems without cranes: light industrial/manufacturing facilities

Walls

- Load bearing walls: dead and live loads, wind, and seismic loads
- Non-load bearing walls: interior and exterior walls
- Masonry walls: partition walls and fire walls
- Metal walls: design of girts, sag rods, and wind posts
- Structural insulated foam-timber panels (SIPs) as bearing wall and cladding
- Design of structural steel shear wall for lateral load resisting systems
- Design examples

Design of Roof Framing with Cantilever (Gerber) Girders and Open Web Steel Joists

- Roof framing layout
- Design considerations for the open web steel joists
- Design considerations for the Gerber girder system
- Transfer of loads to foundation trough columns and bracing system
- Structural stability considerations for columns
- Design example

Elevated Floors

- Types of floors used in industrial facilities
- Design of elevated floors for forklift truck traffic
- Design example

Composite Floors with Concrete Deck Slab on Steel Beams or Girders

- Deck slab systems in steel framed buildings
- Header shear stud for composite floor member design
- Loading considerations for shored and unshored composite floor system
- Effective slab width in composite beams
- Ultimate flexural capacity of composite beams at positive and negative moment regions

Composite Open Web Steel Joists and Trusses

- Floor layout
- Strength design consideration
- Serviceability design considerations
- Typical connection details
- Composite truss member trial section tables
- Floor design example

Stub-girder Floor Construction

- Stub and beam layout
- Structural modelling of stub-girder for preliminary manual analysis
- Structural modelling of stub-girder for computer analysis
- Stub-girder member flexural strength
- Stud shear connection design
- Shear capacity of stubs and stub stiffener details
- Design of weldments at stub-to-girder interface
- Stub-girder deflection check
- Shoring check for stub-girders
- Design example

Steel and Composite Beams with Web Openings

- Structural behaviour of reinforced versus un-reinforced web opening
- Overview of the design procedure
- Moment-shear interaction
- Equations for maximum moment capacity as well as shear capacity
- Guidelines for proportioning and detailing beams with web openings
- Deflection design approach for beams with web openings
- Design example

Steel Castellated (open-web expanded) Beams

- Configuration of castellated beam: fabrication
- Design considerations and procedure for moment, shear, and deflection
- Design example

Introduction to Floor Vibration Due to Human Activities

- Basic vibration terminology
- Floor vibration principles
- Acceptance criteria for human comfort
- Recommended criteria for structural design for walking and rhythmic excitation
- Natural frequencies of steel framed floor systems
- Deflection due to flexure, shear in beams and trusses, continuity effects
- Special considerations for open web steel joists and joist girders

Structural Design for Walking Excitation

- Recommended design criteria and estimation of the design parameters
- Application of the design criteria
- Design example for a foot bridge, typical interior and exterior bay in a commercial building and mezzanines level

Structural Design for Rhythmic Excitation

- Recommended design criteria and estimation of the design parameters
- Application of the design criteria
- Design example for a typical interior and exterior bay in a commercial building and mezzanines level

Structural Design for Sensitive Equipment

- Recommended design criteria and estimation of the design parameters
- Application of the design criteria
- Design example for a typical interior and exterior bay in a commercial building

Evaluation of Vibration Problems and Remedial Measures

- Evaluation of existing floor vibration
- Remedial measures
- Protection of sensitive equipment
- Cases studies

Crane Runways

- Overview of cranes and usage
- Forces imparted by cranes
- Load combinations involving cranes
- Types of crane runway systems, overhead, underhung, yard cranes, gantry cranes, and jibs
- Design of EOT crane runways
- Mono-symmetric versus symmetric crane girder in flexural strength
- Design example

Design of Mill Buildings and Combined Columns

- Design considerations
- K – factors and end restraints
- Column design: recommended procedure
- Bracing requirements
- Base fixity, rotational restraints, and support settlement
- Lateral drift and stiffness considerations
- Design of fixed column bases
- Design examples

Questions and Answers, Feedback on Achievement of Learning Outcomes

- Partial- and full-shear interaction
- Ultimate shear design
- Check for deflection in partial- and full-shear interaction; deflection due to concrete shrinkage
- Web opening in composite beams
- Design tables for composite beams with full-depth deck slab as well as with deck slab over permanent steel deck panels
- Design examples