

Civil Design for Substations and Power Utility Infrastructure

Target Audience

This course is designed for civil engineers, structural engineers, utility engineers, substation designers, EPC professionals, construction engineers, project managers, quality engineers, and infrastructure consultants involved in power transmission and distribution projects. It is also suitable for design reviewers, site engineers, maintenance personnel, and engineering graduates seeking practical knowledge of civil engineering requirements for substations and utility infrastructure.

Course Objective

The objective of this course is to provide participants with practical knowledge of civil engineering design principles, construction practices, and multidisciplinary coordination for substations and power utility infrastructure projects. Participants will learn to evaluate site investigations, interpret geotechnical data, coordinate civil and electrical requirements, review cable-trench and retaining-wall designs, assess construction quality, identify structural defects, implement repair and preventive maintenance strategies, and perform basic site coordination using Autodesk Civil 3D.

Course Outcome

Upon successful completion of this course, participants will be able to:

- Understand the civil engineering scope of substations and power utility infrastructure projects.
- Review survey data, geotechnical investigations, and design criteria for civil works.
- Coordinate civil and electrical design requirements during project development.
- Plan and review cable-trench systems for operational efficiency and future expansion.
- Analyze retaining-wall and compound-wall design requirements.
- Evaluate construction quality and identify common construction defects.
- Select appropriate repair techniques and preventive maintenance methods for civil infrastructure.
- Apply Autodesk Civil 3D for basic site layout and cable-trench coordination.
- Review engineering drawings and perform constructability assessments.

Course Outline

The course comprises **32 hours** of theory, practical discussions, drawing review exercises, real project case studies, and Autodesk Civil 3D demonstrations. It is divided into **10 comprehensive chapters**, with each chapter supported by practical exercises and technical discussions to reinforce learning and develop industry-ready skills.

Chapter 1. Civil Design Scope, Site Investigation and Design Inputs

Introduction

This chapter introduces the civil engineering scope of substation and power utility infrastructure projects, emphasizing site investigations, design inputs, and engineering criteria required for successful project execution.

Civil Engineering Scope

- Civil scope in substations
- Power utility infrastructure works
- Roles and responsibilities
- Project lifecycle overview

Site Investigation

- Topographic surveys
- Existing utilities
- Site levels
- Site constraints

Geotechnical Investigation

- Soil investigation
- Bearing capacity
- Groundwater conditions
- Geotechnical reporting

Design Inputs

- Design criteria
- Design loads
- Material selection
- Durability requirements

Chapter 2. Civil-Electrical Coordination and Constructability Review

Introduction

This chapter focuses on coordination between civil and electrical disciplines to improve constructability, reduce conflicts, and support efficient project execution.

Civil-Electrical Interface

- Foundation coordination
- Cable trenches
- Drainage systems
- Roads
- Earthing systems

Clash Detection

- Physical clashes
- Level conflicts
- Access requirements

Equipment Coordination

- Installation clearances
- Maintenance access
- Operational requirements

Constructability Review

- Construction sequence
- Interface checklist
- Hold points

Chapter 3. Cable-Trench Planning and Functional Requirements

Introduction

This chapter explains planning principles, functional requirements, and layout considerations for cable-trench systems within substations.

Cable-Trench Systems

- Types of cable trenches
- Functional requirements
- Applications

Trench Planning

- Route planning
- Cable capacity
- Cable segregation
- Future expansion

Layout Development

- Equipment connections
- Road crossings
- Trench layouts
- Cross-sections

Chapter 4. Structural Design of Precast and Prestressed Cable Trenches

Introduction

This chapter covers structural design principles for precast and prestressed cable-trench systems.

Structural Behaviour

- Load paths
- Structural behaviour
- Design considerations

Structural Analysis

- Soil pressure
- Surcharge loading
- Cover slab loads

Structural Design Checks

- Bending
- Shear
- Deflection
- Crack control

Precast and Prestressed Design

- Design principles
- Prestressing concepts
- Structural detailing

Construction Considerations

- Lifting
 - Transportation
 - Handling
 - Erection
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Chapter 5. Cable-Trench Joints, Drainage and Durability

Introduction

This chapter discusses detailing requirements that improve durability, serviceability, and long-term performance of cable-trench systems.

Joint Details

- Supports
- Bearings
- Inserts
- Service penetrations

Utility Crossings

- Road crossings
- Drain crossings
- Utility crossings

Drainage Design

- Trench slopes
- Low points
- Sumps
- Water outlets

Durability Measures

- Waterproofing
- Joint sealing
- Corrosion protection

Inspection Requirements

- Inspection access
 - Maintenance provisions
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Chapter 6. Retaining-Wall Design and Detailing

Introduction

This chapter presents engineering principles for selecting, designing, and detailing retaining-wall systems.

Retaining-Wall Systems

- Wall selection
- Applications
- Performance requirements

Design Inputs

- Soil properties
- Surcharge loads
- Groundwater conditions

Stability Analysis

- Sliding checks
- Overturning checks
- Bearing pressure checks

Structural Detailing

- Reinforcement detailing
- Structural detailing

Drainage Provisions

- Weep holes
 - Filters
 - Drainage arrangements
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Chapter 7. Compound Walls, Drawings and Quantity Take-Off

Introduction

This chapter explains boundary protection systems, engineering documentation, and preliminary quantity estimation.

Compound Wall Systems

- Compound walls
- Gates
- Fencing
- Security works

Foundation Requirements

- Foundations
- Operational clearances

Engineering Drawings

- General arrangement plans
- Sections
- Construction details

Quantity Take-Off

- Preliminary quantity estimation
- Material quantities

Drawing Review

- Constructability review
- Drawing review exercise

Chapter 8. Precast Production, Site Execution and Quality Control

Introduction

This chapter focuses on manufacturing, installation, inspection, and quality control of precast civil components.

Precast Production

- Production process
- Prestressing sequence

Concrete Production

- Mould preparation
- Reinforcement
- Concrete strength requirements

Site Installation

- Handling
- Stacking
- Transportation
- Erection

Quality Assurance

- Inspection plans
- Test plans
- Documentation

Construction Quality

- Line and level
- Concrete cover
- Tolerances
- Quality records

Chapter 9. Defect Assessment, Repairs and Preventive Maintenance

Introduction

This chapter explains systematic methods for evaluating civil defects and implementing effective repair and maintenance strategies.

Defect Identification

- Cracking
- Leakage
- Spalling
- Settlement

Root Cause Analysis

- Defect mechanisms
- Cause identification
- Performance assessment

Condition Assessment

- Visual inspection
- Defect mapping
- Condition evaluation

Repair Methods

- Repair selection
- Repair execution
- Acceptance criteria

Preventive Maintenance

- Maintenance planning
- Inspection schedules
- Asset preservation

Chapter 10. Safety and Integrated Project Exercise

Introduction

This chapter integrates the concepts covered throughout the course through practical coordination exercises and safety planning.

Safety Management

- Safety requirements
- Operational substations
- Electrical hazards

Safe Work Practices

- Permit-to-work
- Isolation procedures
- Excavation safety
- Lifting safety

Integrated Coordination

- Civil–electrical coordination exercise
- Construction sequence planning
- Quality control planning

Project Review

- Group presentation
- Technical review
- Action plan