Session 1

Overview of Structural Analysis and Design

Approach:

- Give an introduction to Structural Engineering.
- Define Structure and explain the structure types.
- Explain the basic definitions related to the structural engineering.

Shear force and Bending Moment

Approach:

- Help the students to recollect the formulas to calculate the shear force and bending moment for various support and load conditions.

Introduction

Approach:

- Intro to REI and Bentley.
- Intro to STAAD.Pro V8i.
- Explain the GUI
- Global coordinate system Vs Local coordinate system
  - Intro to Beta angle
- Introduction to STAAD.editor
  - Model program in STAAD.editor to create joints

Session 2

Creating a New Project & Units

Approach:

- Explain the start-up dialogue box.
  - Structure Types
  - How to create a new folder in My Computer and call it in STAAD.Pro.
- Intro for Units in STAAD.Pro and give an idea about the unit combinations.
- Intro to various model generation methods
  - Editor
  - GUI
  - Structure wizard
Model Generation (nodes and members)

Approach:

- Explain a simple plane frame model with all the necessary dimensions.
- Motivate the students to find the coordinates of the joints / nodes.
- Explain the steps to create the same model in STAAD.Pro.
  - Create the joints in STAAD.Pro.
  - Connect the joints by using members.
- Explain the steps to create the same model by using Snap node / beam.
  - Intro to various types of grids (linear, radial and irregular)

Select Menu

Approach:

- Explain the various tools used to select the components of the model (nodes and beams)

Session: 3

Translational Repeat

Approach:

- Give the details about the project like dimensions, number of floors, etc.
- Explain the advantage of using Translational Repeat instead of creating the nodes and joining those by members.
- Explain the tool with the following options
  - Direction
  - # of steps
  - Default step spacing
  - Link Step
  - Open base
  - Renumber
  - Explain the application of generation flags (after completing the property and loading commands demonstrate the option once again)
• Give the guidelines to complete the project.

**Concepts to be covered:**

• Need of grouping the members in floor wise by using member id (Renumber) and Generation flags.

**Examples / Application:**

• Structure with equally spaced elements.
• Structure with unequally spaced elements.

**Circular Repeat**

**Approach:**

• Explain a project which is in circular shape (as shown in the image) in the plan view with all the necessary dimensions.
• Explain the tool with the following options.
  o Axis of rotation
  o Pass through point
  o Angle
  o # of steps

**Concepts to be covered:**

• Right hand rule to find the direction of rotation.

**Examples / Application:**

• Structure which has octagonal shape in the plan view.

**Move**

**Approach:**

• After completing the above projects, ask the participants to change the top floor height or any one room span.
• Explain the steps how we can achieve it with the help of move tool and cover the Move – Origin, Move – Joint and Move – Member tools with the following options.
  o Input methods (Nodes and axis values)
  o Retain Connection

Rotate

![Diagram of Block 'A' and Block 'B'](image)

3 - 3

**Approach:**

• Explain the project which has one more block with project # 3 - 1.
• Explain the difficulties to get the coordinate values to create the Block B.
• Explain the rotate command.
• Explain the steps to complete the project.

**Concepts to be covered:**

• Assigning a wind load which is not parallel to the building sides.

Mirror

![Diagram of Block 'A', Block 'B', and Block 'C'](image)

3 - 4

**Approach:**

• Add one more block to the previous project as like as the image 3 - 4.
- Explain mirror command with the following options.
  - Mirror plane
  - Plane position

_Conscepts to be covered:_

- Mirror plane, Member orientation (beta angle)

**Insert Node**

![Image of transmission tower](image)

3 - 5

**Approach:**

- Draw the side view of a transmission tower as shown in the image and assign the necessary dimensions.
- Ask the students to get the coordinates of each and every joint.
- Explain the Insert Node tool and justify how it helps to reduce the time taken to complete this project. Cover the following options.
  - Add new point
  - Add mid-point
  - Add 'n' points.
- Create the two inclined members and divide by means of Insert Node.
**Concepts to be covered:**

- Number of nodes Vs number of segments

**Add Beam**

**Approach:**

- Explain the tool 'Add Beam from Point to Point'.
- Use the tool to draw the brace members of the transmission tower.
- Explain Add beam Between Mid-points, Add beam By perpendicular intersection and Curved Beam.
- In the project # 3 - 2 replace the straight beams into curved beams.

**Concepts to be covered:**

- Gamma angle with right hand rule.

**Assignment:**

- Create a suitable structure for the given plan (the trainer should give a plan)
- Create a 3D transmission tower

**Session 4**

**Connect Beams Along**

**Approach:**

- Explain a project where we want to connect two adjacent structures.
- Explain the tool.
- Create a roof truss for a building and connect it to the structure.

**Concepts to be covered:**

- Multiple Structures in STAAD.Pro older versions and STAAD.Pro V8i.
Stretch Selected Members

**Approach:**

- Explain the situation where we required cantilever beams (eg: balconies).
- Explain how to create the cantilever beams by using 'Through a distance' option.
- Explain the remaining option and how we can get the same result as like as ‘Connect Beams Along’.

Intersect Selected Members

**Approach:**

- Explain a structure where two members are intersected (eg: Bridge structure as like as above image, Braces in steel transmission tower, etc)
- Explain the steps for how to highlight and intersect.
Concepts to be covered:

- Intro to Steel connection design.

**Merge Selected Members**

Approach:

- Explain the above project where it has a meeting hall in the top floor.
- Ask the students to give the steps to create the structure.
  - Translational repeat
  - Delete the unwanted columns
- Explain why we need to merge the beams.
- Explain the steps to merge the beams.

**Renumber**

Approach:

- Explain Renumber – Nodes and Renumber – Members with the following option.
  - Sort Criteria

Concepts to be covered:

- Need of renumbering in report setup.

**Split Beam and Break Beams at Selected Nodes**

Approach:

- Explain why we need these tools by using image 4 – 3.
- Compare these commands with Insert Node.
Run Structure Wizard

Approach:

- Create a space from Run Structure Wizard and compare the time taken with translational repeat.
- Create a complicated structure which has frame structure and roof truss by using Run Structure Wizard.
- Create Stadium roof and a simple tower.

Concepts to be covered:

- Advantage of having library models.

Assignment:

- Create the given structure.

Session 5

Support Specification

Approach:

- Define all the support types.
- Explain the steps to create the support types in STAAD.Pro.
- Explain all the 4 options used to assign the support to the nodes.

Concepts to be covered:

- 6 degrees of freedom.
- Need of inclined support.

Member Property Specification

Approach:

- Introduction to prismatic property.
- Explain the parameters of standard cross sections for column and beam.
- Explain the steps to create the same with prismatic properties.
- Explain the parameters required to create a taper I section.
- Give an intro for the steel table.
- Explain the steps to assign the member property to the members.
Concepts to be covered:
- In normal conditions, for a beam $Y_d > Z_d$. Why?
- Define: Area of cross section, Shear area, Torsional constant, Moment of inertia.

Member Offset
Approach:
- How can we find the start / end point of a member?
- Explain the directions to offset.
- Explain the tool with a plane frame.
- Give the guidelines and motivate the students to do it for a space frame.

Concepts to be covered:
- Effective span length.
- Effect of Member Offset in analysis and design.

Examples / Application:
- Bridge structure.

Material Specification
Approach:
- Intro to material table.
- Default values of material constants in STAAD.Pro.
- The steps to create a new material.
- Explain the steps to assign the material to the members.
- Explain ‘Set New Member Attributes’ tool.

Concepts to be covered:
- Define: Young’s modulus, Poisson’s ratio, Density, Shear Modulus and Co-efficient of thermal expansion.
- Relationship between Young’s modulus, Poisson’s ratio and Shear modulus.

Examples / Application:
- A structure with multiple materials.

Group Specification
Approach:
- Define: Group
- Explain the steps to create a group.
- Explain the methods to associate the selected members to the group.
By using the group assign supports and material properties.

**Concepts to be covered:**

- Usage of groups in member selection for support, member specification, loads and report setup.

**Examples / Application:**

- Create a structure and assign groups for Columns, Beams and Braces.

**Loading - Selfweight**

**Approach:**

- Explain the manual calculation steps to find the self-weight of the given beam.
- Define: Primary load in STAAD.Pro.
- Explain the need of assigning proper load types for the primary load.
- Explain the steps in STAAD.Pro to calculate the same.
- Explain the reason why we need to change the density value of the concrete.
- Compare the result with manual calculation.

**Concepts to be covered:**

- Define Dead Load, Live Load, Wind Load, Seismic Load and Load Combinations as per IS Codes.
- Loads to be added in dead and live loads.

**Assignment:**

- Find the self-weight of the project created in the previous sessions.

**Session 6**

**Nodal Load**

**Approach:**

- Explain the situations where can we use the nodal / joint loads.
- Difference between force and moment loads.
- Explain the steps to add and assign the nodal loads in STAAD.Pro.

**Concepts to be covered:**

- Loads on a roof truss.
- Loads on a transmission tower.
- Intro to the equivalent wind load on joints.
- Define: Support displacement.

**Member Load**

**Approach:**
- Difference between Nodal and Member Loads.
- Explain the situations to use the various member loads.
- Difference between the various directions (X, GX and PX).
- Explain d1, d2 and d3.

**Concepts to be covered:**

- Eccentric loads.
- How to calculate / get the load values?

**Area Load**

**Approach:**

- Define: One way slab
- How to calculate the pressure load?
- Directions: usage of ‘Z’.
- Add an area load and compare the results with the manual calculation.

**Concepts to be covered:**

- One-way slab load distribution on beams.
- Unit weight of slab.

**Floor Load**

**Approach:**

- Define: Two way slab.
- Explain the ‘Range’ in X, Y and Z directions and Group.
- Assign the loads on a structure and compare the results with the manual calculation.
- Explain one way distribution and compare the results with Area load.
- Assign a floor load for a structure which has open to sky in middle.

**Concepts to be covered:**

- Two way slab load distribution.
  - Two way slab in square shape.
  - Two way slab in rectangular shape.

**Assignments:**

- Assign the Dead load and Live load for a residential building.

**Session 7**

**Wind Load**

**Approach:**

- Calculate the wind intensity as per the zone.
- How to generate the wind load?
- How to assign the wind load to the structure?
  - Directions and factor
  - Range
- Assign it to the structure and explain the results.
- Explain the exposure factor.
- Assign it to the selected joints and show the result.
- Explain how we can assign a wind load for a transmission tower (open structure).
- Assign the wind load which is not parallel to the sides of the structure.
- Assign the wind load to a structure which is in circular shape in plan view.

**Concepts to be covered:**
- How to calculate the wind intensity as per IS 875 Part III.
- Equivalent nodal loads for the wind load.
- Explain: Suction load

**Load Combination**

**Approach:**

- Explain the difference between Normal, ABS and SRSS.
- Explain the steps to create the load combinations in STAAD.Pro V8i.

**Concepts to be covered:**

- Various load combinations as per IS 456.

**Automatic Load Combination & Edit Auto Load Rules**

**Approach:**

- Load combination Vs Automatic load combination.
- Explain the need of customised load combinations.
- How to create a new automatic code.
- Use the same to create the load combination.

**Moving Load**

**Approach:**

- Intro to bridge design and vehicle load on the bridge.
- How to define the vehicle load.
- How to generate a moving load on a bridge structure.
  - One vehicle
  - Multiple vehicle at the same time
  - Two way traffic
- How to generate moving load on a curved structure.
  - As a curve in elevation view
**Concepts to be covered:**
- Vehicle loads as per IRC 6.

**Examples / Application:**
- Loads on a bridge.
- Loads on a flyover.

**Reference Load**

**Approach:**
- Create reference loads for dead load, live load and wind load.
- Create primary loads to represent the combination loads.

**Concepts to be covered:**
- Primary load Vs Reference load

**Repeat Load**

**Approach:**
- Load combination Vs Repeat load
- How to add the repeat load

**Assignment:**
- Assign the dead load, live load, wind load and load combinations for a commercial building as per the IS codes.
- Create a duplicate of the project and replace the primary loads with the reference loads.

**Session 8**

**Analysis**

**Approach:**
- How to add the analysis command.
- Analysis sub-menu (print).
- Explain the output file.
- Explain Pre and Post Analysis tools.
- Explain the Post Processing mode.

**Concepts to be covered:**
- Intro to analysis and analysis types.

**Inactive / Delete Specification**

**Approach:**
- Explain the situation where we need the tools.
- Command sequences to use the commands.
- Limitations and factors of those tools.

Concepts to be covered:
- Difference between Inactive and Delete.

General Guidelines for Design
Approach:
- Explain the Dead, Live and Wind loads.
- Explain the load commands to be included in dead and live loads.
- Explain the procedure to calculate the load value for the same as per IS codes.

Column and Beam Design
Approach:
- Intro to various parameters involved in column and beam design.
- How to assign the country code and parameters to the members.
- Design a single beam.
  - Compare the output with the manual calculation.
- Explain the procedure to design the entire structure.
  - How to assign different properties for columns and beams.
  - Design the columns.
  - Design the beams.

Concepts to be covered:
- Design procedures in STAAD.Pro.
  - Column
  - Beam
    - Design for flexure
    - Design for shear
- Model (manual) calculation to design a beam

Assignment:
- Design a commercial building.

Session 9

RC Designer
Approach:
- Intro
  - Need of RC Designer
  - GUI of RC Designer
• Procedure to design
  o Beam
  o Column

Concepts to be covered:
• Beam Vs Physical beam

Session 10

Seismology
Approach:
• How to calculate base shear as per IS 1893:2002 (manual calculation)
• Seismic design procedure in STAAD.Pro
  o Compare the result with manual calculation

Concepts to be covered:
• Intro to Seismology
  o Plate tectonics theory
  o Earthquake fault types
  o Seismic Waves
  o Terminologies
  o Indian Standards
  o General principles for design

Response Spectrum Analysis
Approach:
• Design procedure in STAAD.Pro

Concepts to be covered:
• Intro to dynamic analysis
• Static analysis Vs Dynamic analysis

Assignment:
• Design a school building structure against seismic loads.

Session 11

Cylindrical and Reverse Cylindrical Coordinate System
Approach:
• Explain cylindrical and reverse cylindrical coordinate systems with suitable example
  o Cylindrical coordinate system
- Pipe line
  - Reverse cylindrical coordinate system
- Water tank
- Spirals
- Explain the Jtorig tool

**FEM Modelling**

*Approach:*

- How to create a slab in STAAD.Pro
  - By using Snap plate / Infill plates / Add plate and plate mesh
  - By using Surface mesh
  - By using Parametric modelling
    - How to add slab to wall connection
- How to create a staircase
  - Straight flight
  - ‘U’ shape
  - Spiral

**Concepts to be covered:**

- Into to FEM / FEA
- Parametric Modelling

**Session 12**

**Member Truss**

*Approach:*

- Need of Member truss command
- Effect in result
  - After the analysis show the difference in the result file (beam vs truss member)

**Concepts to be covered:**

- Define Brace Members

**Examples / Application:**

- Elevated water tank
- Transmission towers

**Run Structure Wizard**

*Approach:*

- Explain the ex:18 of the Structural workbook (printed on December 2010)
- Explain how can we get the dimensions of the model
• Explain the steps to create the model from Structure Wizard

**Plate Thickness**
*Approach:*

• Explain the steps to assign the plate thickness

**Plate Load**
*Approach:*

• Create the suitable model and explain the steps to assign the
  o Full pressure load
  o Partial pressure load
  o Concentrated load
  o Trapezoidal load
  o Hydrostatic load
  o Element joint Load

**Session 13**

**Water Tank Design**
*Approach:*

• How to create a water tank
  o Square / rectangular base
  o Circular base
• How to assign the suitable loads on a water tank
• Design procedure

*Concepts to be covered:*

• How to calculate the water tank dimensions
• How to calculate the load values acting on the water tank

**One Way Slab Design**
*Approach:*

• Loads to be assigned for the design
• Steps to be followed for the design

*Concepts to be covered:*

• Design procedure – assume as a beam

**Two Way Slab Design**
*Approach:*

• Loads to be assigned for the design
• Steps to be followed for the design
• Difference in loading to design a building when it has both members and elements.

Assignment:
• Design a water tank for your town.
• Complete the column, Beam and Slab designs for a residential building.

Session 14

Staircase Design
Approach:
• Loads to be assigned for the design
• Design procedure

Concepts to be covered:
• Types of staircases
• Support types

Shear wall Design
Approach:
• How to create a surface by using ‘Add Surface’ tool
• How to assign the surface properties (thickness and material)
• How to assign the loads
• Design procedure

Concepts to be covered:
• Intro to Shear wall

Solid Modelling and Analysis
Approach:
• How to create the model
• Various loads to be assigned for the solid modelling
• Explain the analysis results

Concepts to be covered:
• Need of Solid modelling in STAAD.Pro

Assignment:
• Design a commercial building with shear wall.
Session 15

STAAD.Beava

Approach:
- Intro to STAAD.Beava.
- Procedure to create the model and analysis.

Concepts to be covered:
- Types of Bridges.
- Intro to Bridge deck design.
- Intro to IRC 6.
- Standard vehicle loads as per the code.

Assignment:
- Create vehicle loads as per IRC 6 on a bridge structure by using STAAD.Beava

Session 16

Member Cable Specification

Approach:
- Explain the terms initial tension and un-stretched length
- Explain the steps to convert a beam member into a cable member

Concepts to be covered:
- Beam Vs Cable member

Tension / Compression Specification

Approach:
- Explain the steps to assign it to the member.

Concepts to be covered:
- Need of specifying Tension / Compression properties.

Table Member Property

Approach:
- Explain the type specifications for various cross sections.

Concepts to be covered:
- Intro to Indian standard steel cross sections.
**Steel Design**

*Approach:*

- Explain the design parameters as per STAAD.Pro.
- Explain the design procedure with the following
  - Check code
  - Select and Select optimized
  - Takeoff

*Concepts to be covered:*

- Intro to steel design as per IS 800:2007.

*Assignment:*

- Design a steel frame structure as per IS 800:2007.

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**Session 17**

**Interactive Steel Design**

*Approach:*

- Explain the steel design procedure.

**Design of Overhead Transmission Line Tower**

*Approach:*

- How to create the model.
- Intro for the loads to be assigned for the design.
- Explain the analysis results.
- Design Procedure.

*Concepts to be covered:*

- Intro to IS 802

**Pushover Analysis**

*Approach:*

- Explain the various inputs to be given for the pushover analysis
- Design procedure

*Concepts to be covered:*

- Intro to non-linear analysis
- Intro to FEMA

*Assignment:*

- Design a steel frame structure against seismic loads (by using Pushover analysis).
Session 18

Isolated Foundation

*Approach:*

- How to design a single isolated foundation
  - Compare the design output with the manual design
- How to import the model from STAAD.Pro and do the design

*Concepts to be covered:*

- Intro to the foundation types
- Model manual calculation for an isolated footing design

Combined / Strip Foundation

*Approach:*

- Explain the procedure to design a combined / strip foundation in STAAD.Pro

Tool Kit

*Approach:*

- Intro to tool kit
- Design procedure to design an isolated foundation and a combined foundation

*Assignment:*

- Design the foundation for a building which has both the isolated and combined foundations.

Session 19

Mat Foundation

*Approach:*

- Explain the design procedure to design the mat foundation.

*Concepts to be covered:*

- Intro to mat foundation.
- Explain the advantages of mat foundation when compared to other types of shallow foundations.

Pile Cap Design

*Approach:*

- Design procedure to design the pile cap.

*Concepts to be covered:*


• Intro to pile and pile cap design.

Assignment:
• Design the mat foundation for a building structure.

Session 20
Import CAD Models
Approach:
• Explain Y up and Z up in STAAD.Pro
• Explain the steps to import a DXF file

Report Setup
Approach:
• How to generate the report as per the need

Concepts to be covered:
• Importance of Report generation

Plotting
Approach:
• How to make print out from STAAD.Pro
• How to export the model to AutoCAD / MS-word to take printouts.

Project:
• Help the students to do a final project.