



University of Global Village (UGV), Barishal

STAADPro (Steel Frame Design)

Content of Laboratory Course



Prepared By

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Program: B.Sc. in CE



BASIC COURSE INFORMATION

Course Title	STAADPro (Steel Frame Design)
Course Code	CE 0732-4108
Credits	01
CIE Marks	30
SEE Marks	20
Exam Hours	2 hours (Semester Final Exam)
Level	6 th Semester



STAADPro (Steel Frame Design)

COURSE CODE: CE 0732-4108

CREDIT:01

TOTAL MARKS:50

CIE MARKS: 30

SEE MARKS: 20

Semester End Exam Hours 2

Course Learning Outcomes (CLOs): After completing this course successfully, the students will be able to-

- CLO 1** **Understand** concepts of Structural Design of steel members (flange, web, purlin, rafter, etc.
- CLO 2** **Analyze** various structural components of steel frame structures.
- CLO 3** **Develop** intellectual communication skills through working in groups in performing in different load assigning (dead, live, earthquake, wind etc.) and various Serviceability limit Check.
- CLO 4** **Generate** the detailing of various structural components of steel frames and trusses.

SL	Content of Course	Hrs	CLOs
1	Modeling of Structure and Material Assigning	10	CLO1
2	Dead, live, Earthquake and wind load assigning	20	CLO3
3	Load combinations assign, Member Meshing and Steel Joint Design (Moment Releasing Techniques)	20	CLO2, CLO4
4	Analysis and Checking	5	CLO1, CLO3
5	Serviceability Check (Deflection and lateral displacement)	10	CLO1
6	Cost-Effective Design of Building, Reinforcement Detailing of Structure, Details Discussion on AISC-2010/BNBC	10	CLO3
7	Lab Test, Viva, Quiz, Overall Assessment, Skill Development Test (Competency)	10	CLO1

Text Book:

1. Design of Concrete Structures by Arthur H. Nilson, David Darwin, Charles W. Dolan (Mc Graw Hill) – 13th edition.
2. Design of Concrete Structures by Arthur H. Nilson – 7th edition.
3. Design of Reinforced Concrete by Jack C. McCormac, Russell H. Brown – 9th edition
4. The American Society of Civil Engineers, code-7-05
5. User's Guide Staadpro® 2016
6. Staadpro S User's Manual
7. Gazetted-BNBC-2020-Enhanced-file-published-by-Dr.-Khan-Mahmud-Amanat-Follow-Design-Integrity-for-Civil-Engg-info.

ASSESSMENT PATTERN

CIE- Continuous Internal Evaluation (30 Marks)

SEE- Semester End Examination (20 Marks)

SEE- Semester End Examination (40 Marks) (should be converted in actual marks (20))

Bloom's Category	Tests
Remember	05
Understand	07
Apply	08
Analyze	07
Evaluate	08
Create	05

CIE- Continuous Internal Evaluation (100 Marks) (should be converted in actual marks (30))

Bloom's Category Marks (out of 100)	Lab Final (30)	Lab Report (10)	Continuous lab performance (30)	Presentation & Viva (10)	External Participation in Curricular/ Final Project Exhibition (10)
Remember/ Imitation	05		05	02	Attendance 10
Understand/ manipulation	05	05	05	03	
Apply/ Precision	05		05		
Analyze/ Articulation	05		05		
Evaluate/ Naturalisation	05	05	05		
Create	05		05	05	

Course plan specifying content, CLOs, teaching learning and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Assessment Strategy	Corresponding CLOs
1	Basic introduction about Staadpro software	Lecture, discussion, Experiment	Quiz, Lab Test	CLO1
2	Modeling of Structure	Oral Presentation, Project Exhibition	Lab Report Assessment, viva	CLO3
3-4	Material Assigning I	Presentation, Field visit	Skill Development Test	CLO2, CLO4
5	Material Assigning II	Lecture, discussion, Experiment, Demonstration	Quiz, Lab Test	CLO1, CLO3
6	Dead and live load assign	Oral Presentation, Project Exhibition	Lab Report Assessment, viva	CLO1
7-8	Earthquake and wind load assign	Presentation, Field visit	Skill Development Test	CLO3
9	Load combinations assign	Lecture, discussion, Experiment	Quiz, Lab Test	CLO2, CLO4

Course plan specifying content, CLOs, teaching learning and assessment strategy mapped with CLOs

Week	Topic	Teaching-Learning Strategy	Assessment Strategy	Corresponding CLOs
10-11	Steel Joint Design (Moment Releasing Techniques)	Lecture, discussion, Experiment	Quiz, Lab Test	CLO1
12	Analysis and Checking	Oral Presentation, Project Exhibition	Lab Report Assessment, viva	CLO3
13	Serviceability Check (Deflection)	Presentation, Field visit	Skill Development Test	CLO2, CLO4
14	Serviceability Check (Lateral displacement)	Lecture, discussion, Experiment, Demonstration	Quiz, Lab Test	CLO1, CLO3
15	Cost-Effective Design of frame, Details Discussion on BNBC-2020/AISC-2010	Oral Presentation, Project Exhibition	Lab Report Assessment, viva	CLO1
16	Reinforcement Detailing of Structure (steel Column, beam, connection, purlin, rafter, truss)	Presentation, Field visit	Skill Development Test	CLO3
17	Lab Test, Viva, Quiz, Overall Assessment, Skill Development Test (Competency)	Lecture, discussion, Experiment	Quiz, Lab Test	CLO2, CLO4



Basic introduction about Staadpro software

Week 1

Pages 8-29

Introduction to STAAD.Pro

STAAD.Pro stands for "**Structural Analysis and Design Program**". It is a software widely used by civil engineers to analyze and design various structures like buildings, bridges, towers, and industrial facilities.

Definition

Steel Structure: A steel structure is a metal structure which is made of **structural steel** components connected to each other to carry loads and provide rigidity.

Structural Steel: It is steel construction material which fabricated with a specific shape and chemical composition to suit a project's applicable specifications.

RCC Structure: Reinforced Cement Concrete (RCC) is a composite building material consisting of structural concrete reinforced with a reinforcing material like steel. The most common reinforcement used is steel, due to its complimentary properties and it is called steel reinforced cement concrete or simply Reinforced Cement Concrete.

Advantage & Disadvantage (Steel Structure)

Advantage:

- Reliability
- Industrial Behavior
- Lesser Construction Time / Greater Erection Speed
- High Strength And Light Weight Nature
- Uniformity, Durability And Performance
- Elasticity
- Ductility And Warning Before Failure
- Additions To Existing Structures
- Possible Reuse
- Scrap Value
- Water-Tight And Air-Tight Constructions
- Long Span Construction
- Temporary Construction

Advantage & Disadvantage (Steel Structure)

Disadvantage:

- High Maintenance Costs And More Corrosion
- Fireproofing Costs
- Susceptibility To Buckling
- Higher Initial Cost / Less Availability
- Aesthetics

Advantage & Disadvantage (RCC Structure)

Advantage:

- Strength
- Durability (Up to 100 years)
- Economy
- Convenience
- Availability
- Mouldability
- Fire Resistance
- Permeability
- Seismic resistance

Advantage & Disadvantage (RCC Structure)

Disadvantage:

- RCC sections are heavier
- Consume more space
- Requires lots of formwork, centering and shuttering to be fixed
- Takes time to gain its full strength
- Needs too much maintenance during its construction

Types of Steel Structure

Main structural types:

- ❖ Frame structures: Beams and columns
- ❖ Grids structures: latticed structure or dome
- ❖ Prestressed structures
- ❖ Truss structures: Bar or truss members
- ❖ Arch structure

Frame structures: Beams and columns

The Steel Structure Frame Building is composed of steel beams and steel columns.



Grids structures: latticed structure or dome



Prestressed structures

Prestressed Steel Structures are those in which, during manufacture, assembly, or exploitation, deliberate stresses are produced of precise magnitude, direction, and period of duration.



Truss structures: Bar or truss members

A truss is one of the simplest and most widely used structural members. It is a straight bar that is designed to take only axial forces, and therefore deforms only along its axial direction.



Arch structure

An arch is a vertical curved structure that spans an elevated space and may or may not support the weight above it.



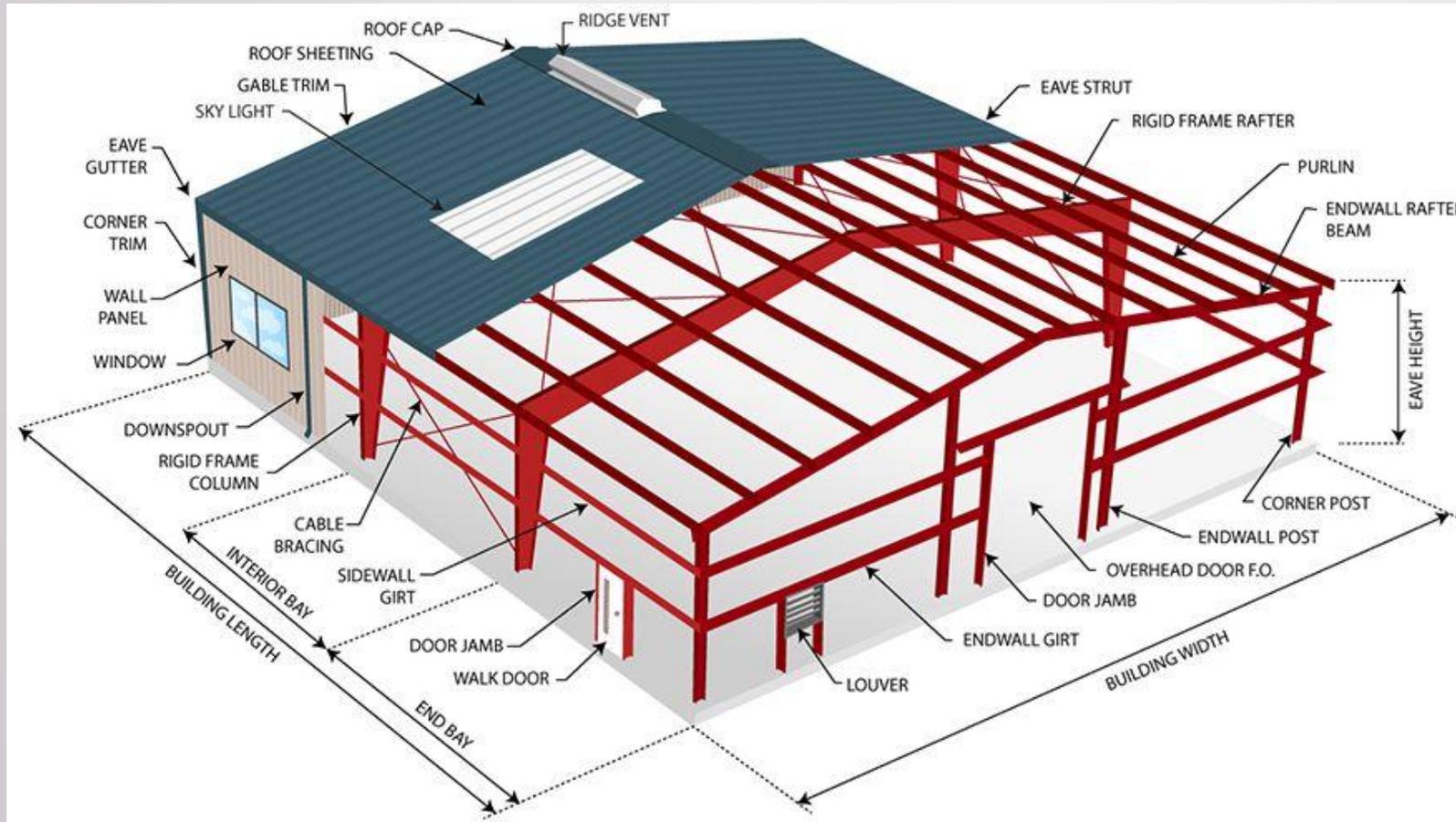
Component of Steel Structure

- Column
- Beam
- Rafter
- Sheet
- Deck Sheet
- Shear Stud
- Purlin
- Girt
- Bracing
- Anchor Bolt
- Royal Bolt

- Connection Bolt
- Base Plate
- Joint Plate
- Checkered Plate
- Gutter
- Ridge Cap
- Gable Trim
- Bottom Flash
- Corner Cap
- Downpipe
- Insulation
- Screw

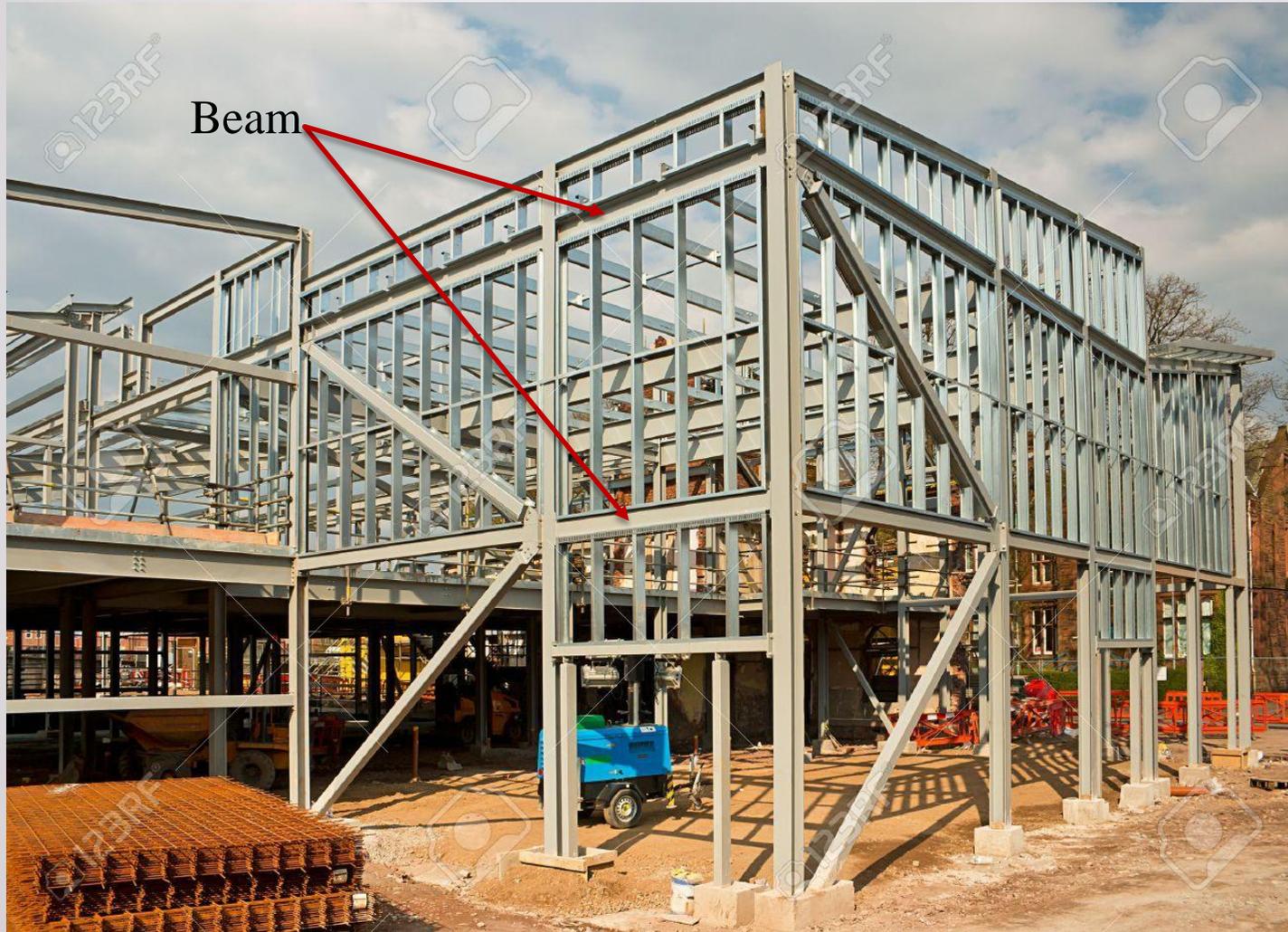
Column

A steel column is a vertical structure member used in construction to provide essential support. They may carry loads in compression or they may transfer loads from things like beams, ceilings, floor slabs or roof slabs to floors or foundations. Steel columns may also carry bending moments near cross-section axes.



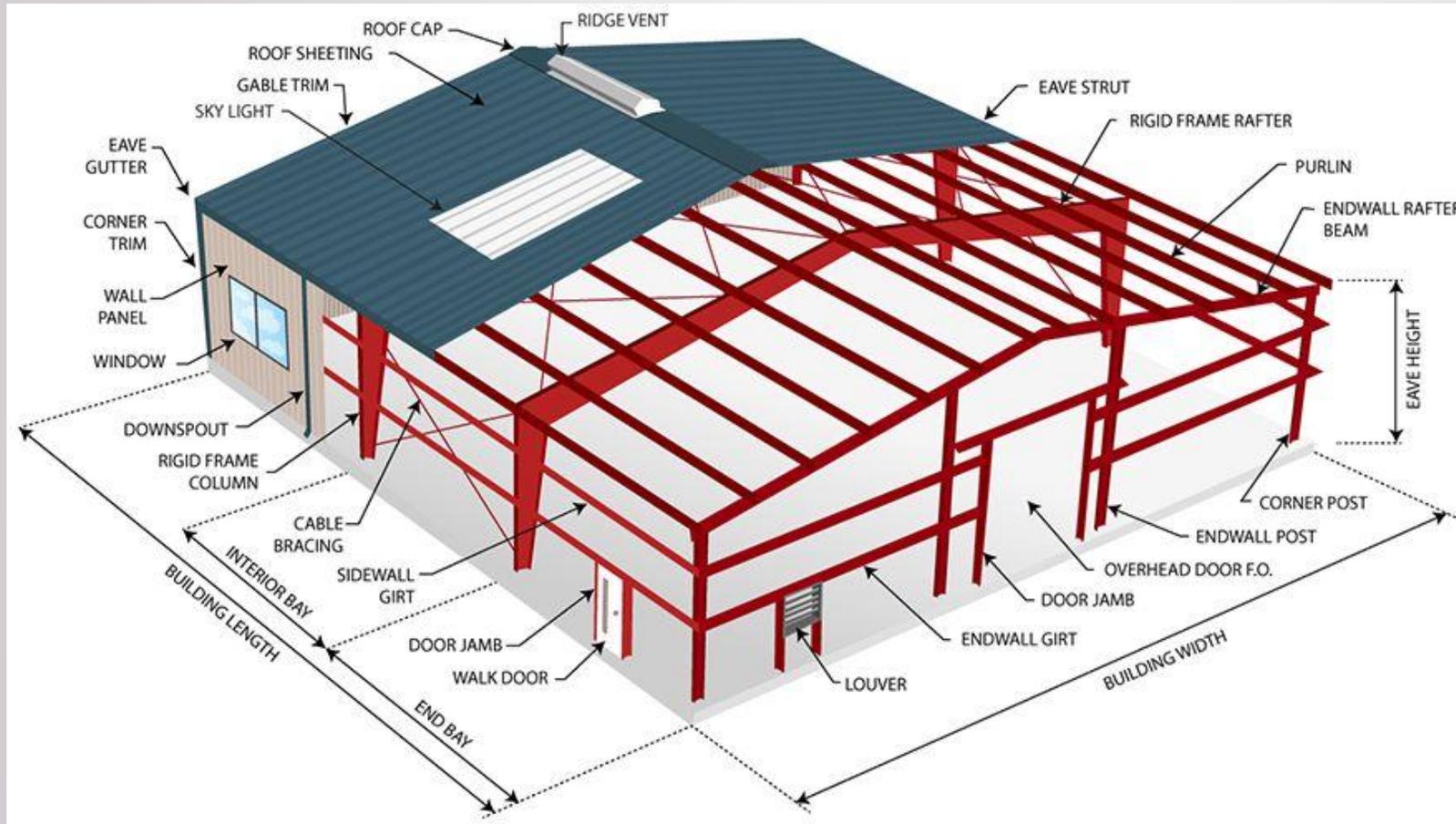
Beam

Horizontal structural member design primarily to resist moment.



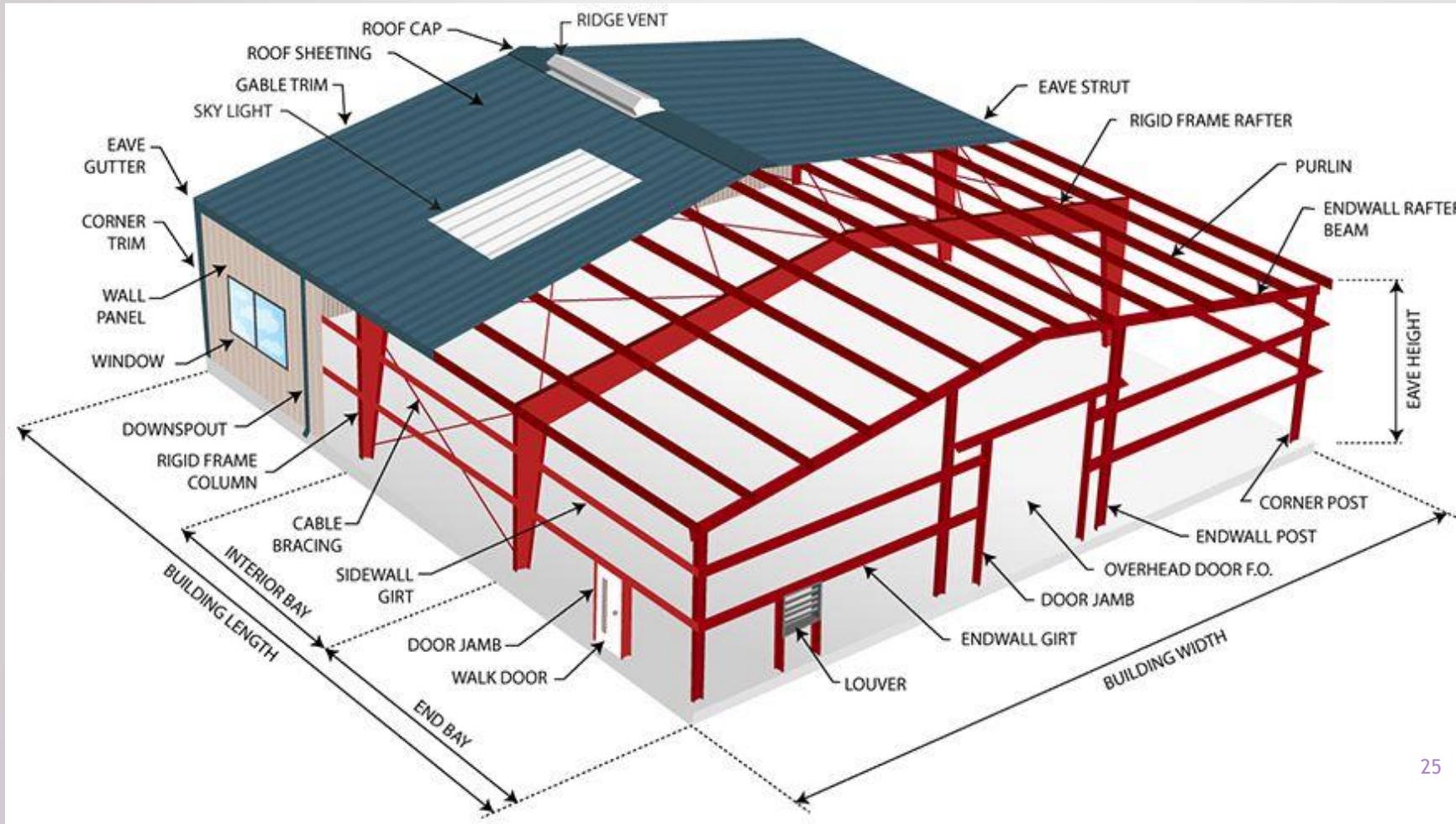
Rafter

Like as beam used at pitched roof.



Sheet

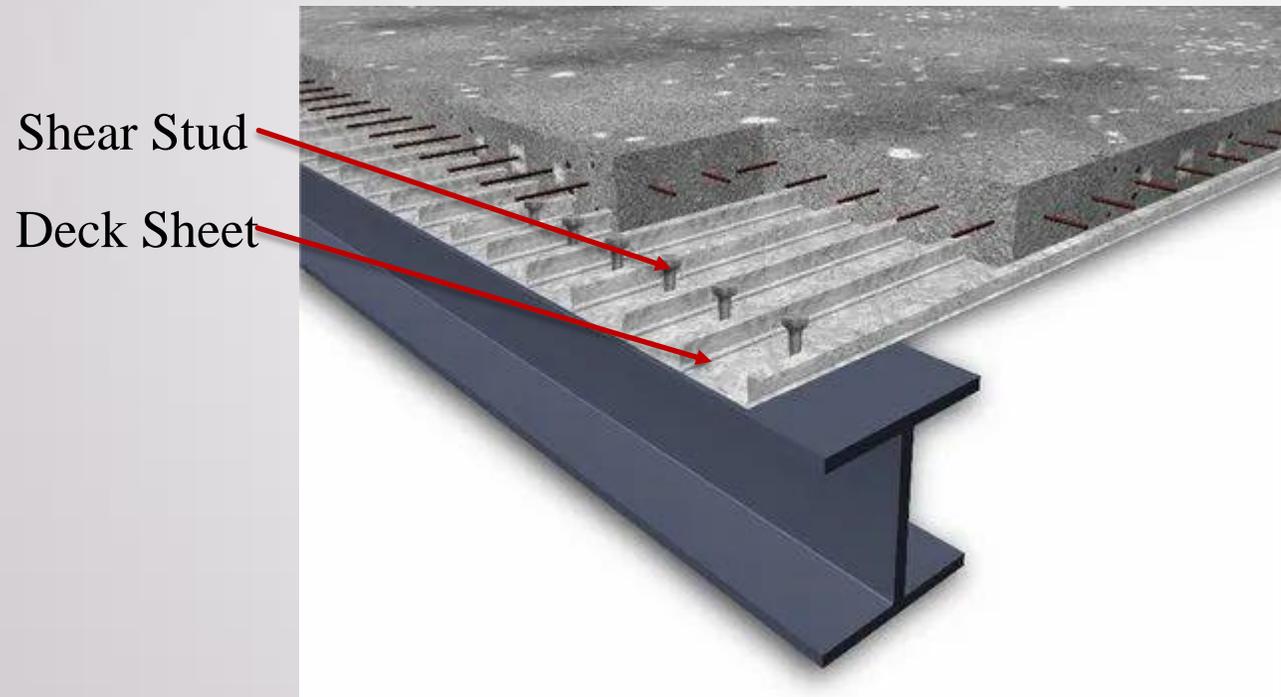
Top covering of a steel structure.



Deck Sheet & Shear Stud

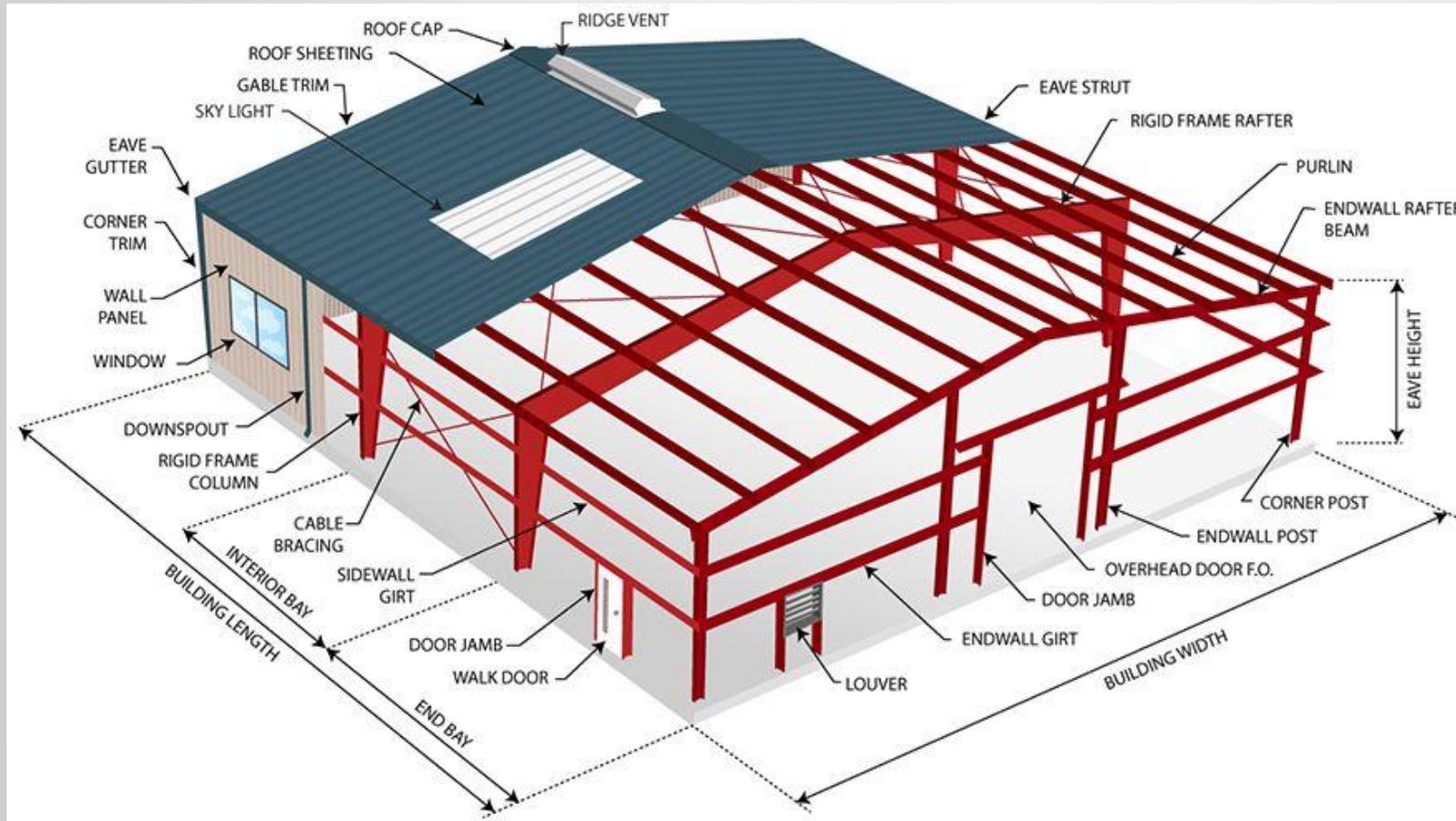
Deck sheet used at multistoried building floor.

Shear studs are used to secure framed buildings by creating a shear connection between steel and concrete.



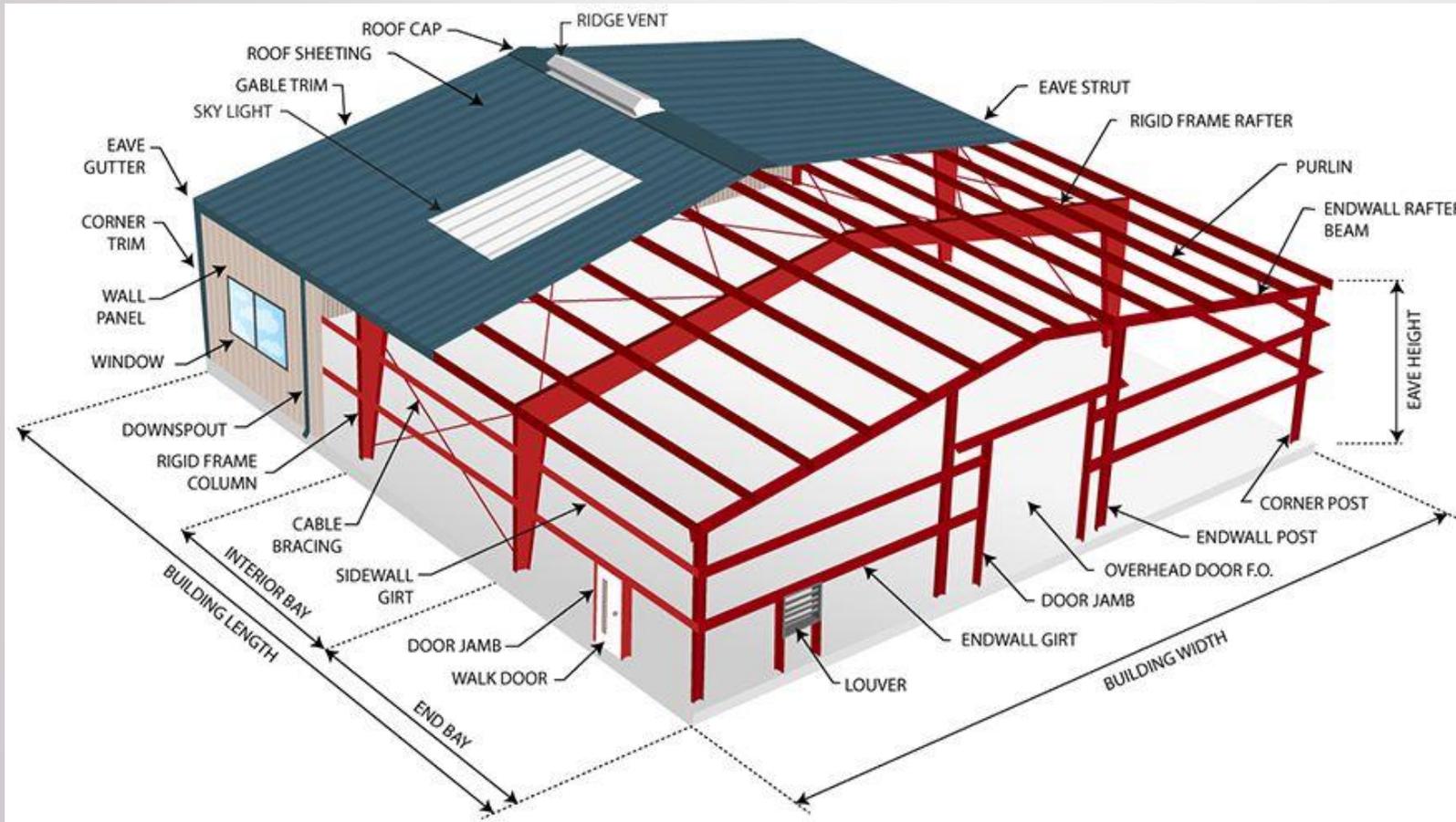
Purlin

Support roof sheet and transfer load to the rafter. It place at longitudinal direction of a building.



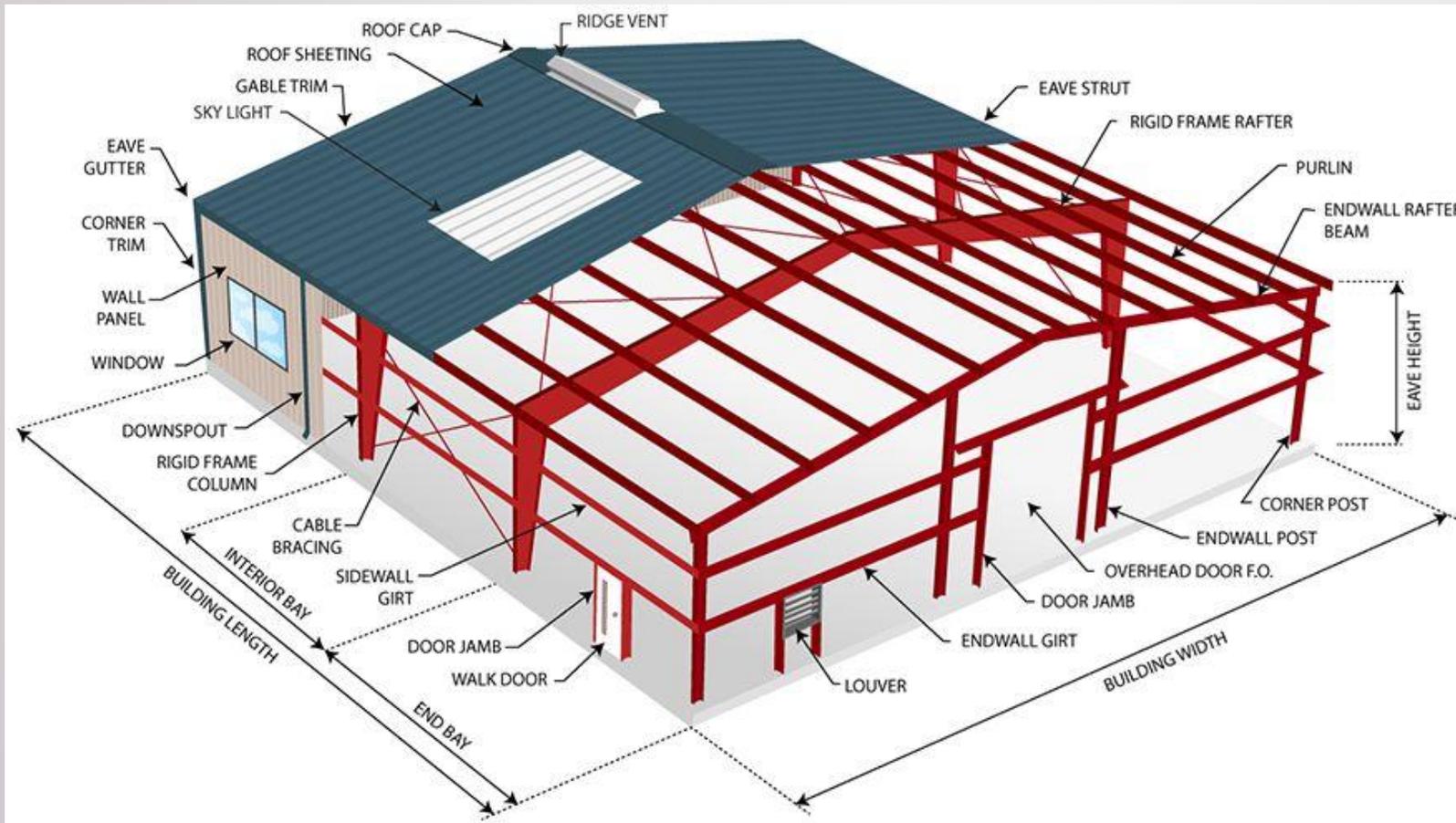
Girt

Same as purlin. Use to support side sheeting and transfer load to column.



Bracing

Steel bracing is generally used to increase the lateral load resistance of steel structures.





Modelling of Structure

Week 2

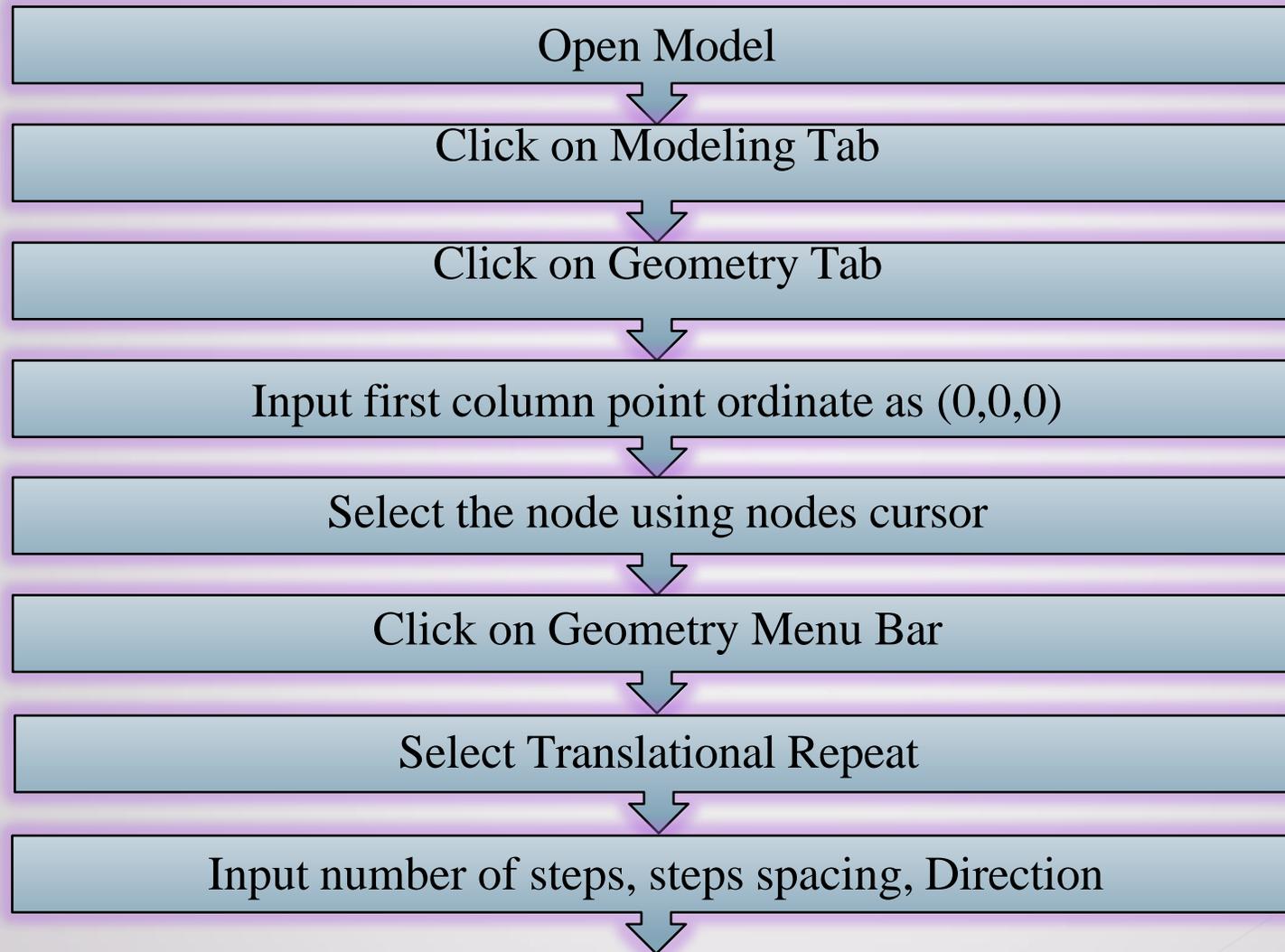
Pages 30-45

Modeling of Steel Structure in **STAAD Pro**

Opening a New Model



Drawing Geometry of a Structure



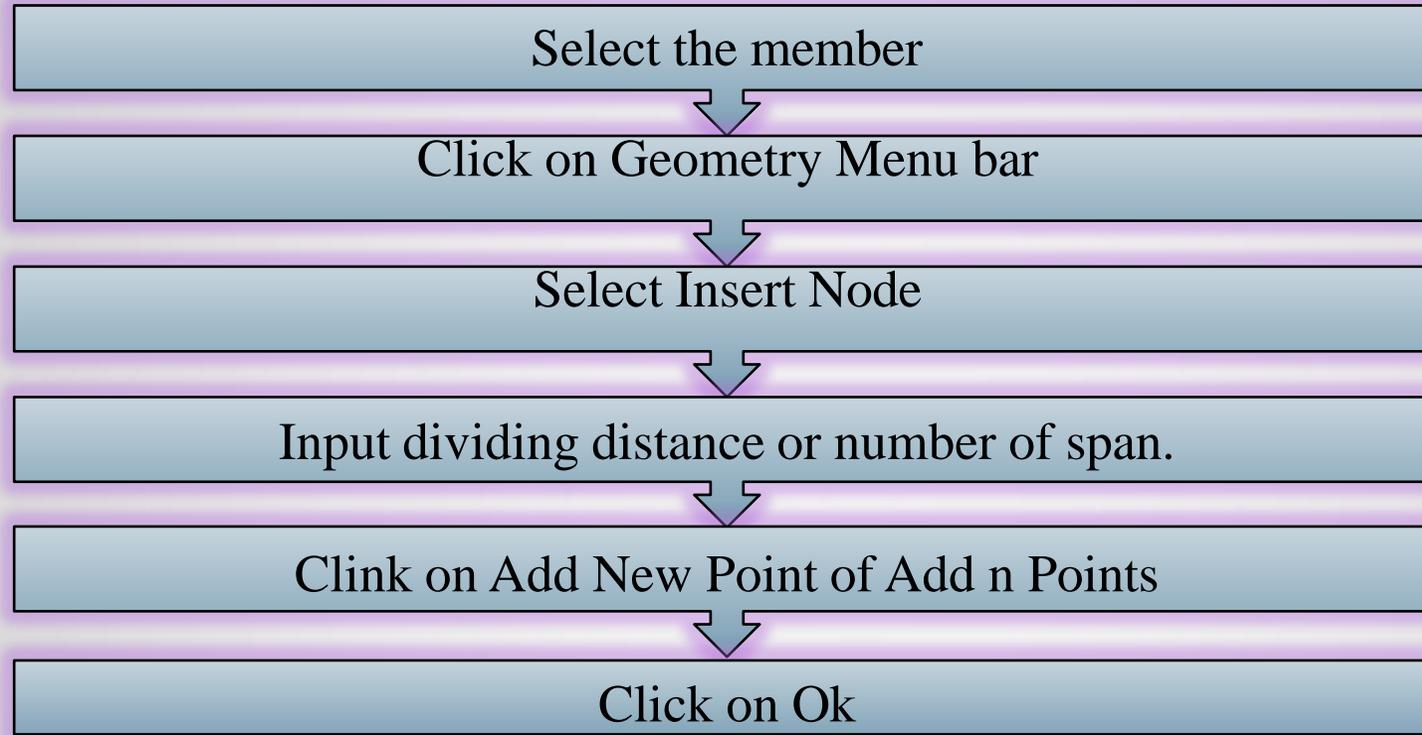
Continue...

Ok

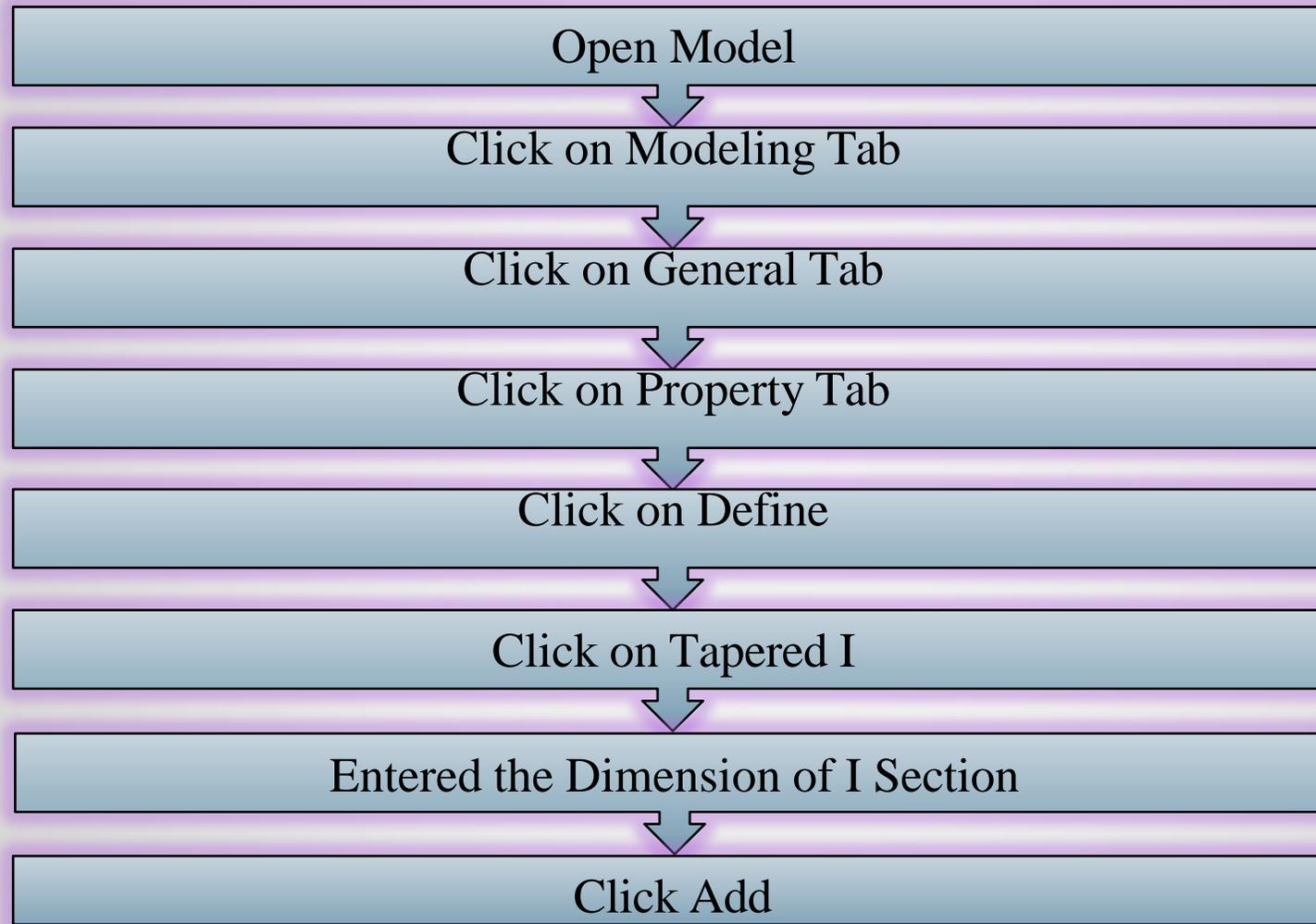


Draw column and beam following the previous procedure.

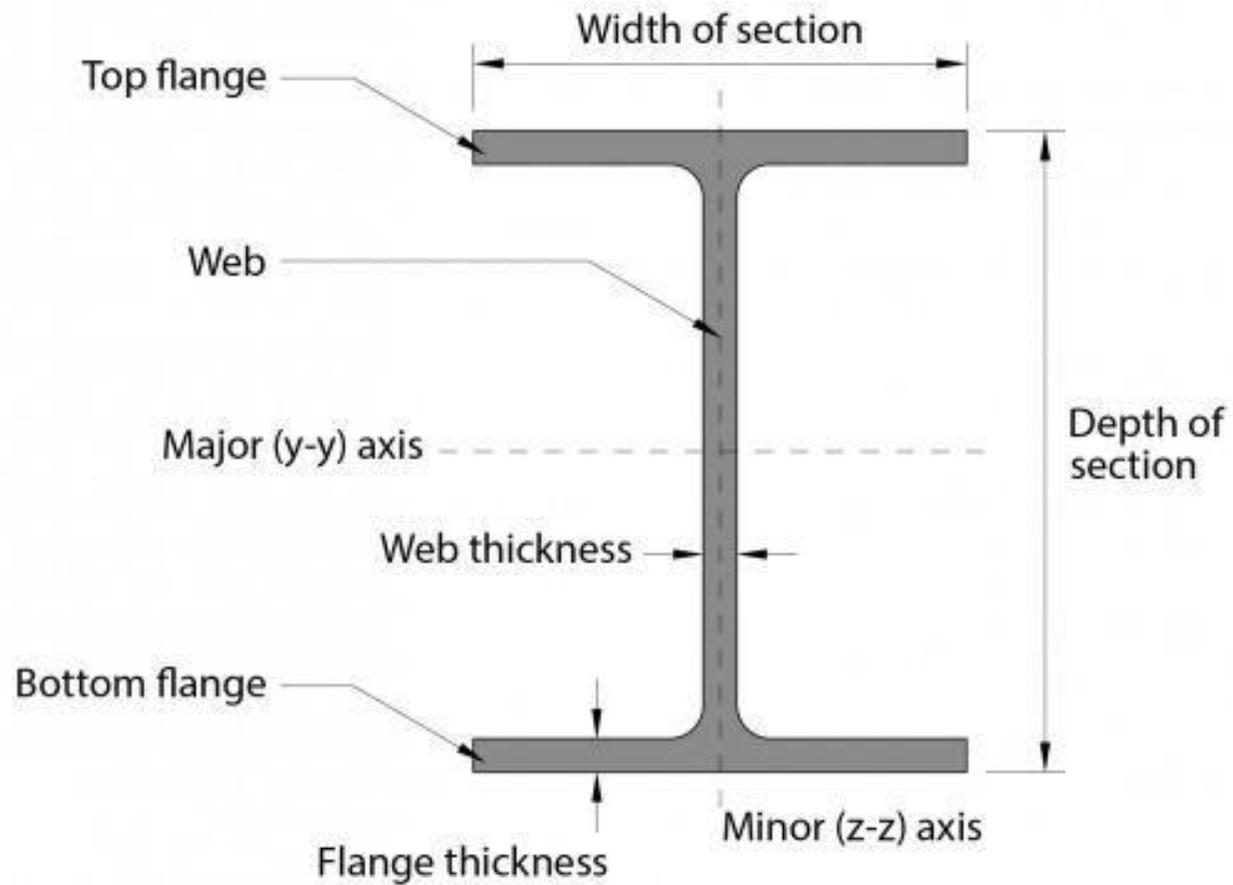
Dividing a Member



Creating Member Properties



Component of I Section



AutoRecovery On | Challenge 9.STD - STAAD.Pro CONNECT Edition [Academic License]

File Geometry View Select Specification Loading Analysis and Design Utilities

Analysis Commands Pre-Analysis Commands Post-Analysis Commands Miscellaneous Commands Load List Run Analysis Run Cloud Analysis Download Results Steel Concrete Aluminum

Workflow Analytical Modeling Physical Modeling Building Planner Piping Postprocessing Foundation Design Steel AutoDrafter Chinese Steel Design Connection Design Advanced Concrete Design Advanced Slab Design Earthquake

Challenge 9 - Whole Structure

Steel Design - Whole Structure

Current Code: AISC 360-16

- STAAD SPACE
- START JOB INFORMATION
- INPUT WIDTH 79
- UNIT METER KN
- JOINT COORDINATES
- MEMBER INCIDENCES
- SUPPORTS
- SPRING COMPRESSION
- DEFINE MATERIAL START
- MEMBER PROPERTY INDIAN
- CONSTANTS
- LOAD 1 LOADTYPE Dead TITLE Dead L
- LOAD 2 LOADTYPE Roof Live TITLE Live
- PERFORM ANALYSIS PRINT STATICS C
- PERFORM ANALYSIS
- FINISH

Highlight Assigned Geometry
 Toggle Assign

Select Parameters... Define Parameters... Commands...

Assignment Method

- Assign To Selected Beams
- Assign To View
- Use Cursor To Assign
- Assign To Edit List

Select Group/Deck

Assign Close Help

For Help, press F1 | Analytical Modeling Workflow | Load : 2: Live Load | Input Units : kN-m

27°C Cloudy | 18:43 19-08-2022

AutoRecovery Challenge 9.STD - STAAD.Pro CONNECT Edition [Academic License]

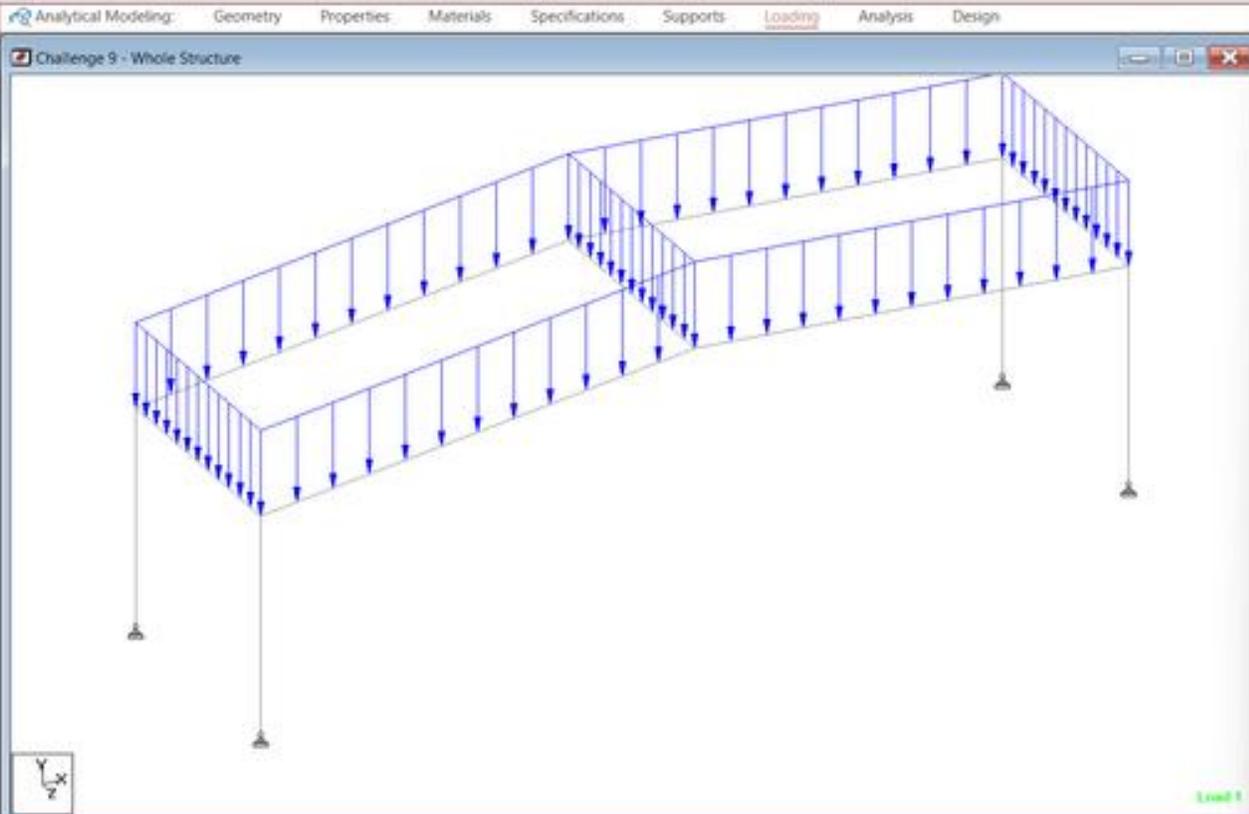
File Geometry View Select Specification **Loading** Analysis and Design Utilities

Primary Load Case Combination Load Case Reference Load Case Load Items Load Generator Primary Load Type Automatic Combinations Wind Snow Seismic Direct Analysis Vehicle Pushover Time History Modal Damping Load: 2: Live Load View Loading Diagram

Workflow

- Analytical Modeling
- Physical Modeling
- Building Planner
- Piping
- Postprocessing
- Foundation Design
- Steel AutoDrafter
- Chinese Steel Design
- Connection Design
- Advanced Concrete Desi...
- Advanced Slab Design
- Earthquake

Challenge 9 - Whole Structure



Load & Definition

- Definitions
- Load Cases Details
 - 1: Dead Load
 - 2: Live Load
- Load Envelopes

New... Add... Edit... Delete...

Toggle Load

Assignment Method

- Assign To Selected Entities
- Assign To View
- Use Cursor To Assign
- Assign To Edit List

3 5 8 To 10 13 14

Assign Close Help

For Help, press F1 | Analytical Modeling Workflow | Load : 2: Live Load | Input Units : kN-m

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AutoRecovery AutoRecovery Challenge 9.STD - STAAD.Pro CONNECT Edition [Academic License]

File Geometry View Select Specification **Loading** Analysis and Design Utilities

Primary Load Case Combination Load Case Reference Load Case Load Items Load Generator Primary Load Type Automatic Combinations

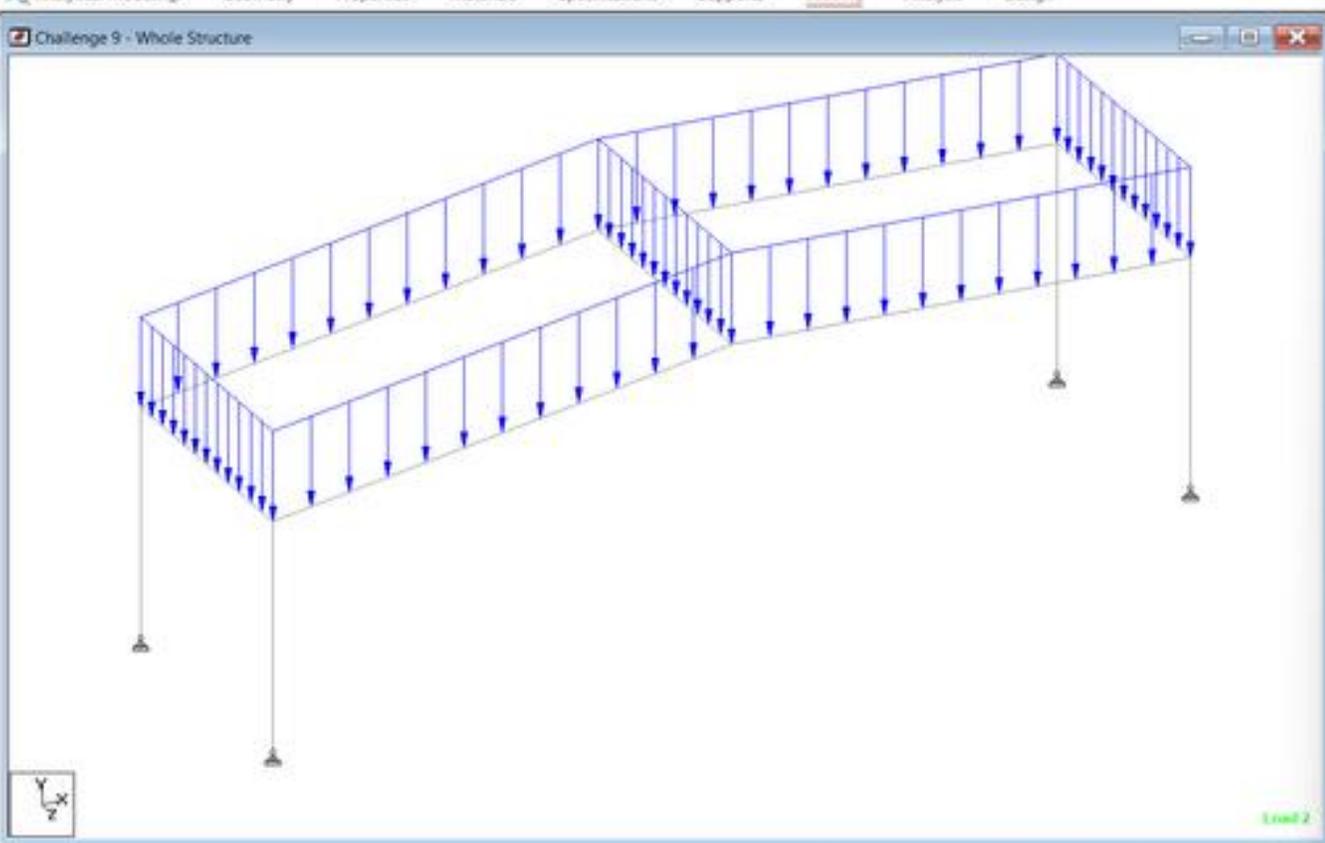
Wind Snow Seismic Direct Analysis Vehicle Pushover Time History Modal

Load: 2 Live Load View Loading Diagram

Workflow

- Analytical Modeling
- Physical Modeling
- Building Planner
- Piping
- Postprocessing
- Foundation Design
- Steel AutoDrafter
- Chinese Steel Design
- Connection Design
- Advanced Concrete Desi...
- Advanced Slab Design
- Earthquake

Challenge 9 - Whole Structure



Load & Definition

Definitions

Load Cases Details

- 1 Dead Load UNI GY -50 kNm
- 2 Live Load UNI GY -75 kNm

Load Envelopes

New... Add... Edit... Delete...

Toggle Load

Assignment Method

- Assign To Selected Entities
- Assign To View
- Use Cursor To Assign
- Assign To Edit List

3 5 8 To 10 13 14

Assign Close Help

For Help, press F1

Analytical Modeling Workflow Load: 2 Live Load Input Units: kN-m

27°C Cloudy

18:43 19-08-2022

AutoRecovery AutoRecovery Challenge 9.STD - STAAD.Pro CONNECT Edition [Academic License]

File Geometry **View** Select Specification Loading Analysis and Design Utilities

Label Settings Zoom Window Whole Structure Display Options Set Structure Colors Structural Tooltip Options Cascade Tile Horizontal Tile Vertical Structure Only Tables Windows 3D Rendering

Workflow Analytical Modeling Physical Modeling Building Planner Piping Postprocessing Foundation Design Steel AutoDrafter Chinese Steel Design Connection Design Advanced Concrete Desi... Advanced Slab Design Earthquake

Analytical Modeling: Geometry Properties Materials Specifications Supports **Loading** Analysis Design

Challenge 9 - Whole Structure

Load & Definition

Definitions

Load Cases Details

- 1: Dead Load
UNI GY -50 kN/m
- 2: Live Load
UNI GY -75 kN/m

Load Envelopes

New... Add... Edit... Delete...

Toggle Load

Assignment Method

- Assign To Selected Entities
- Assign To View
- Use Cursor To Assign
- Assign To Edit List

3 5 8 To 10 13 14

Assign Close Help

For Help, press F1 | Analytical Modeling Workflow | Load : 2: Live Load | Input Units : kN-m

27°C Cloudy | ENG IN | 18:43 19-08-2022

AutoRecovery Challenge 9.5TD - STAAD.Pro CONNECT Edition [Academic License]

File View Select **Results** Utilities Post Processing Tools

Load: 2: Live Load Design Parameters

View Loading Diagram

Deflection Displacement Utilization Ratio

FX FY FZ MX MY MZ

Beam Stress Plate Stress Solid Stress

Layouts

Mode: Mode Shape Relative Response

Time Steps

Layouts

Animation

Select Load Case

Structure Scale Annotate

Update Properties

Reports

Workflow

Postprocessing: Displacements **Reactions** Beam Results Plate Results Solid Results Dynamics Reports

Challenge 9 - Whole Structure

$X = -526.833 \text{ kN}$
 $Y = 1034.991 \text{ kN}$
 $Z = 0.000 \text{ kN}$
 $MX = \text{FREE}$
 $MY = \text{FREE}$
 $MZ = \text{FREE}$

$X = 526.833 \text{ kN}$
 $Y = 1034.991 \text{ kN}$
 $Z = 0.000 \text{ kN}$
 $MX = \text{FREE}$
 $MY = \text{FREE}$
 $MZ = \text{FREE}$

Challenge 9 - Support Reactions

Node	LC	Horizontal			Moment	
		Fx kN	Fy kN	Fz kN	Mx kip-in	My kip-in
1	1 Dead Load	351.222	689.994	-4.285	0.000	0.000
	2 Live Load	526.833	1034.991	-6.427	0.000	0.000
2	1 Dead Load	-351.222	689.994	-4.285	0.000	0.000
	2 Live Load	-526.833	1034.991	-6.427	0.000	0.000
7	1 Dead Load	351.222	689.994	-4.285	0.000	0.000
	2 Live Load	526.833	1034.991	-6.427	0.000	0.000
8	1 Dead Load	-351.222	689.994	-4.285	0.000	0.000
	2 Live Load	-526.833	1034.991	-6.427	0.000	0.000

Challenge 9 - Static Check Results

LC		Fx kN	Fy kN	Fz kN	Mx kip-in	My kip-in
1	Loads	0.000	-2759.977	0.000	61069.749	0.000
	Reactions	-0.000	2759.977	-0.000	-61069.749	-0.000
	Difference	-0.000	0.000	-0.000	-0.000	-0.000
2	Loads	0.000	-4139.965	0.000	91604.619	0.000
	Reactions	-0.000	4139.965	0.000	-91604.619	-0.000
	Difference	-0.000	0.000	0.000	-0.000	-0.000

Click on nodes to select (Ctrl+click to toggle selection)

Postprocessing Workflow Load: 2: Live Load Input Units: kN-m

27°C Cloudy

18:49 19-08-2022

AutoRecovery ON Challenge 9.5TD - STAAD.Pro CONNECT Edition [Academic License]

File View Select **Results** Utilities

Load: 2: Live Load Design Parameters Deflection Displacement Utilization Ratio FX MX Beam Stress FY MY Plate Stress FZ MZ Solid Stress

Mode: Mode Shape Relative Response Time Steps Layouts Animation Select Load Case Structure Scale Annotate Update Properties Reports

Workflow: Analytical Modeling Physical Modeling Building Planner Piping Postprocessing Foundation Design Steel AutoDrafter Chinese Steel Design Connection Design Advanced Concrete Design Advanced Slab Design Earthquake

Postprocessing: **Displacements** Reactions Beam Results Plate Results Solid Results Dynamics Reports

Challenge 9 - Whole Structure

Challenge 9 - Node Displacements

Node	L/C	Horizontal X in	Vertical Y in	Horizontal Z in	Resultant in	Ro rad
1	1 Dead Load	0.000	0.000	0.000	0.000	-0.041
2	2 Live Load	0.000	0.000	0.000	0.000	-0.061
2	1 Dead Load	0.000	0.000	0.000	0.000	-0.041
2	2 Live Load	0.000	0.000	0.000	0.000	-0.061
3	1 Dead Load	-40.618	-0.171	0.001	40.618	0.082
3	2 Live Load	-60.927	-0.257	0.001	60.927	0.123
4	1 Dead Load	40.618	-0.171	0.001	40.618	0.082
4	2 Live Load	60.927	-0.257	0.001	60.927	0.123
6	1 Dead Load	0.000	-409.389	0.000	409.389	0.103
6	2 Live Load	0.000	-614.083	0.000	614.083	0.155
7	1 Dead Load	0.000	0.000	0.000	0.000	0.041
7	2 Live Load	0.000	0.000	0.000	0.000	0.061

Challenge 9 - Beam Relative Displacement Detail

Beam	L/C	Dist m	x in	y in	z in	Resultant in
12	1 Dead Load	0.000	0.000	0.000	0.000	0.000
		1.250	-0.000	-9.811	1.890	9.991
		2.500	-0.000	-15.697	3.023	15.895
		3.750	-0.000	-13.735	2.645	13.967
		5.000	0.000	0.000	0.000	0.000
	2 Live Load	0.000	0.000	0.000	0.000	0.000
		1.250	-0.000	-14.716	2.834	14.966
		2.500	-0.000	-23.545	4.535	23.978
		3.750	-0.000	-20.602	3.968	20.981
		5.000	0.000	0.000	0.000	0.000
13	1 Dead Load	0.000	0.000	0.000	0.000	0.000
		2.512	-0.000	14.895	0.104	14.896
		5.025	-0.000	-31.031	0.430	-31.034
		7.537	-0.000	-53.709	0.542	-53.712

Click on nodes to select (Ctrl+click to toggle selection) | Postprocessing Workflow | Load : 2: Live Load | Input Units : kN-m

27°C Cloudy | ENG IN | 18:49 19-08-2022

AutoRecovery Challenge 9.STD - STAAD.Pro CONNECT Edition [Academic License]

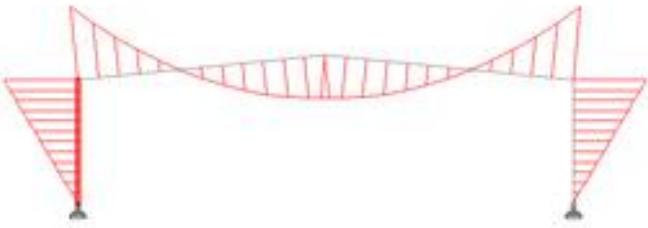
File View Select Results Utilities Post Processing Tools

Load: 2: Live Load Design Parameters Deflection Displacement Utilization Ratio FX FY FZ MX MY MZ Beam Stress Plate Stress Solid Stress Mode: Mode Shape Relative Response Time Steps Layouts Animation Select Load Case Structure Scale Annotate Update Properties Reports

Workflow Analytical Modeling Physical Modeling Building Planner Piping Postprocessing Foundation Design Steel AutoCrafter Chinese Steel Design Connection Design Advanced Concrete Design Advanced Slab Design Earthquake

Postprocessing: Displacements Reactions **Beam Results** Plate Results Solid Results Dynamics Reports

Challenge 9 - Whole Structure



Challenge 9 - Beam End Forces

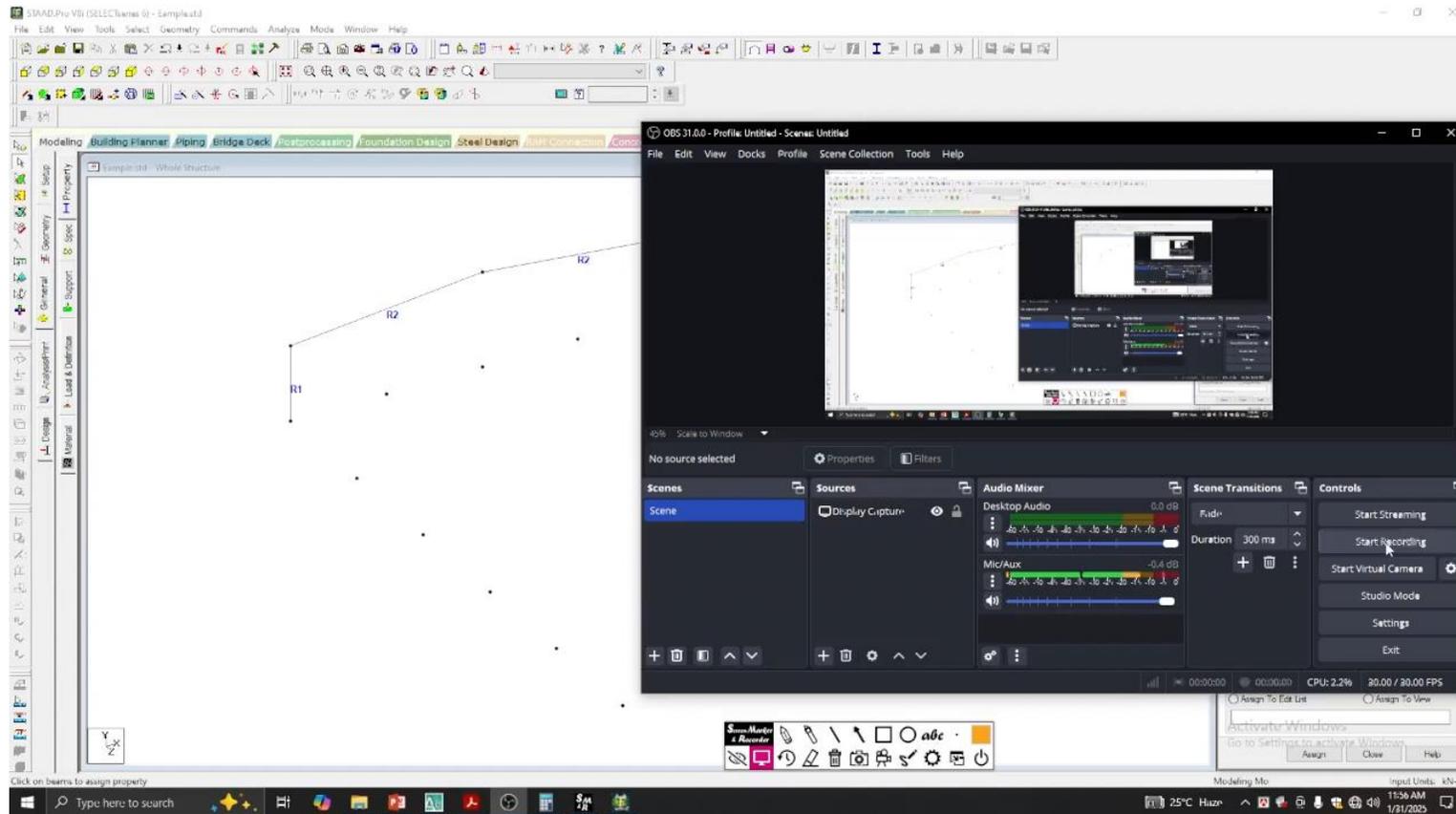
Beam	L/C	Node	Fx kN	Fy kN	Fz kN	Mx kip-in
1	1 Dead Load	1	689 994	-351 222	4 285	0 000
		3	-689 994	351 222	-4 285	0 000
2	Live Load	1	1034 991	-526 833	6 427	0 000
		3	-1034 991	526 833	-6 427	0 000
2	1 Dead Load	2	689 994	351 222	4 285	0 000
		4	-689 994	-351 222	-4 285	0 000
2	Live Load	2	1034 991	526 833	6 427	0 000
		4	-1034 991	-526 833	-6 427	0 000
3	1 Dead Load	3	405 698	527 242	0 108	-0 097
		6	-355 698	-27 242	-0 108	0 097
2	Live Load	3	608 547	790 863	0 161	-0 146
		6	-533 547	-40 863	-0 161	0 146
5	1 Dead Load	4	405 698	527 242	-0 108	0 097

Challenge 9 - Beam Force Detail

Beam	L/C	Dist m	Fx kN	Fy kN	Fz kN	Mx kip-in
1	1 Dead Load	0 000	689 994	-351 222	4 285	0 000
		1 250	689 994	-351 222	4 285	0 000
		2 500	689 994	-351 222	4 285	0 000
		3 750	689 994	-351 222	4 285	0 000
		5 000	689 994	-351 222	4 285	-0 000
2	Live Load	0 000	1034 991	-526 833	6 427	0 000
		1 250	1034 991	-526 833	6 427	0 000
		2 500	1034 991	-526 833	6 427	0 000
		3 750	1034 991	-526 833	6 427	0 000
		5 000	1034 991	-526 833	6 427	-0 000
2	1 Dead Load	0 000	689 994	351 222	4 285	0 000
		1 250	689 994	351 222	4 285	0 000
		2 500	689 994	351 222	4 285	0 000

For Help, press F1 | Postprocessing Workflow | Load : 2: Live Load | Input Units : kN-m

27°C Cloudy | ENG IN | 18:49 19-08-2022



Modelling of Structure (video)

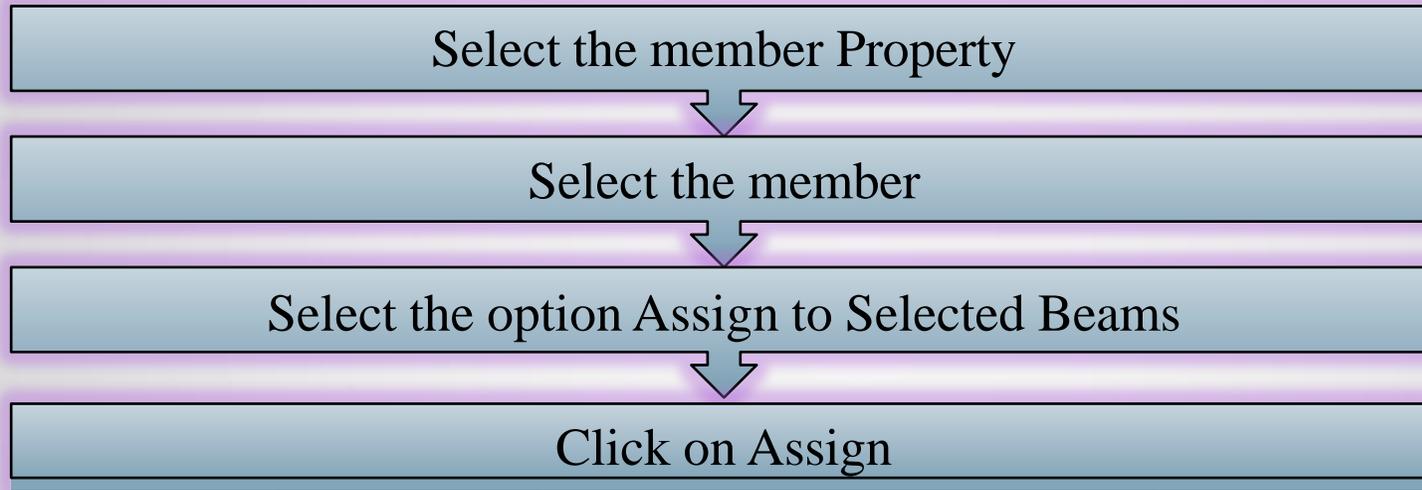


Materials Assigning I

Week 3-4

Pages 46-60

Assigning Member Properties



Royal Bolt



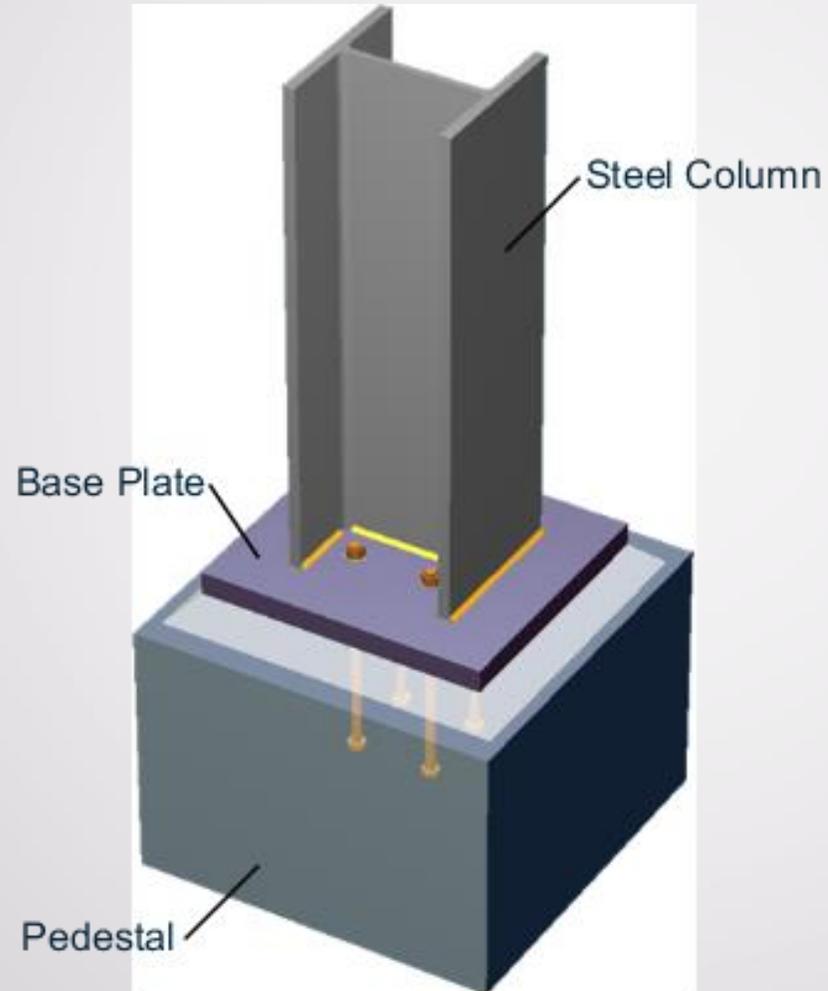
Connection Bolt

They are used to join steel structures.



Base Plate

A steel plate placed beneath a column to distribute applied loads to a concrete member.



Joint Plate



Checkered Plate

Flat hot rolled plate with raised checkered design to prevent slipping



Gutter

A gutter is a pipe or trough along the edge of a roof that carries rainwater away from a building.



Ridge Cap

Metal roofing ridge cap is the trim placed along the roof's ridge – the peak, where two roof slopes meet up.



Gable Trim

Gable trim is used to finish off the edge of roof. It's installed on the two high sides of the roof, not the low side of the roof that follows the pitch.



Bottom Flash



Corner Cap



Downpipe

A downpipe is a pipe carrying rainwater from a gutter to a sub-surface drainage system or ground level.



Insulation

It's designed to reflect heat radiation, but also comes combined with bulk insulation materials like rock wool batts, glass wool batts, loose fill cellulose etc.



Screw

A screw and a bolt are similar types of fastener typically made of metal and characterized by a helical ridge, called a male thread (external thread).





Materials Assigning II

Week 5

Pages 61-73

Sections of Steel Member

Two common types of steel sections are used in constructing a steel structure.

- Rolled Section
- Built-up Section

Rolled Section: The steel sections manufactured in rolling mills and used as structural members are known as rolled structural steel sections.

Built-up Section: Sections made by combining two or more hot rolled sections, joined together at intervals are called built-up sections. This joining is done with the help of direct welding, stay plates or lacing.

Rolled Sections

Two common types of rolled sections are used in constructing a steel structure.

- Hot Rolled Section
- Cold Rolled Section

Hot Rolled Section: Hot-rolled structural steel sections are widely used in the construction of steel structures. It is hoped that this standard will control the variation in dimensions, chemical composition and, hence, the strength of these sections..

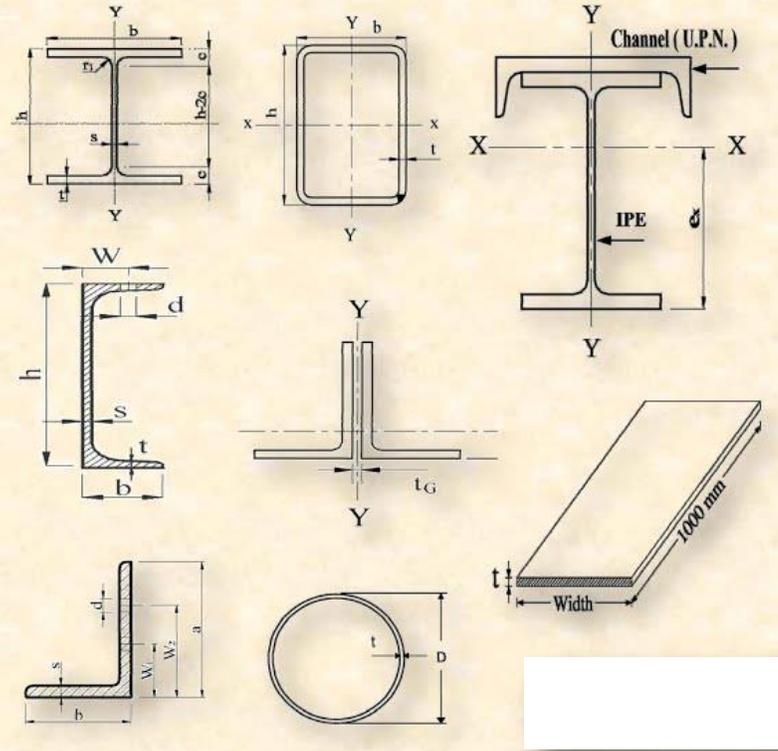
Cold Rolled Section: Cold rolled steel sections are usually smaller, stronger and with a better surface finish than similar products that are hot rolled, also the sections can be supplied with a pre-coated surface finish of paint or zinc.

Rolled Sections

(Hot Rolled) Section Shapes



(Tables)



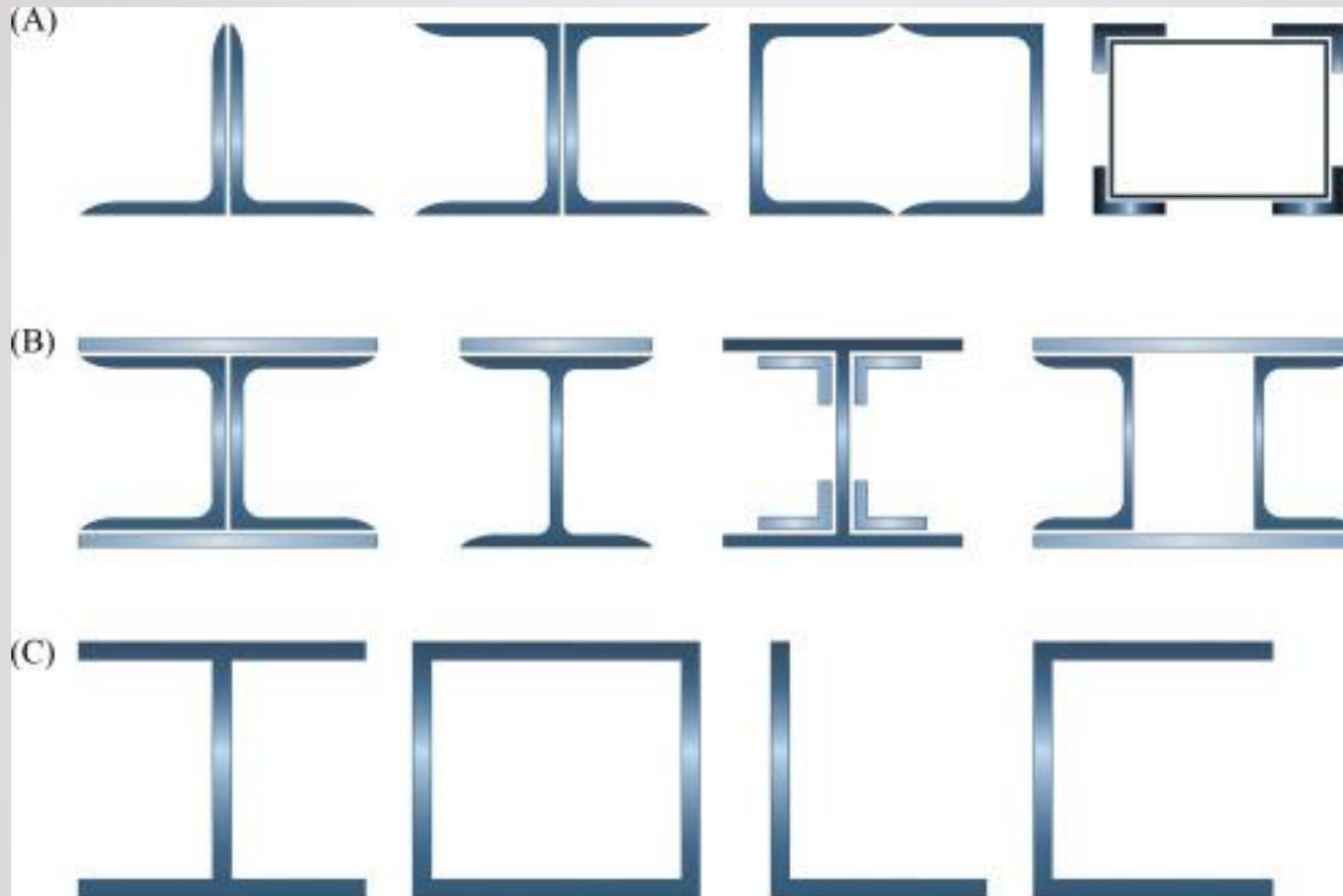
Hot Rolled Section

Rolled Sections



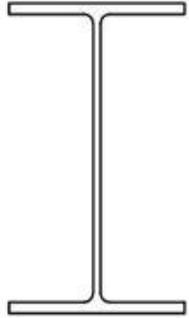
Cold Rolled Section

Built Up Sections



Built Up Section

Names of Various Steel Section



H- Shape
Section



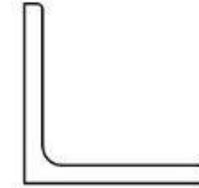
I- Shape
Section



Channel
Section



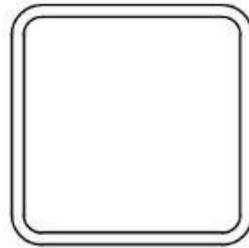
Unequal Angle
Section



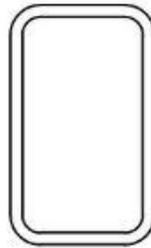
Equal Angle
Section



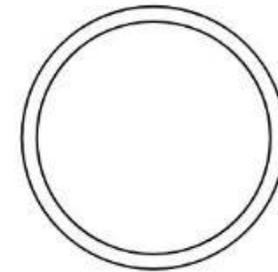
T- Shape
Section



Square Hollow
Section

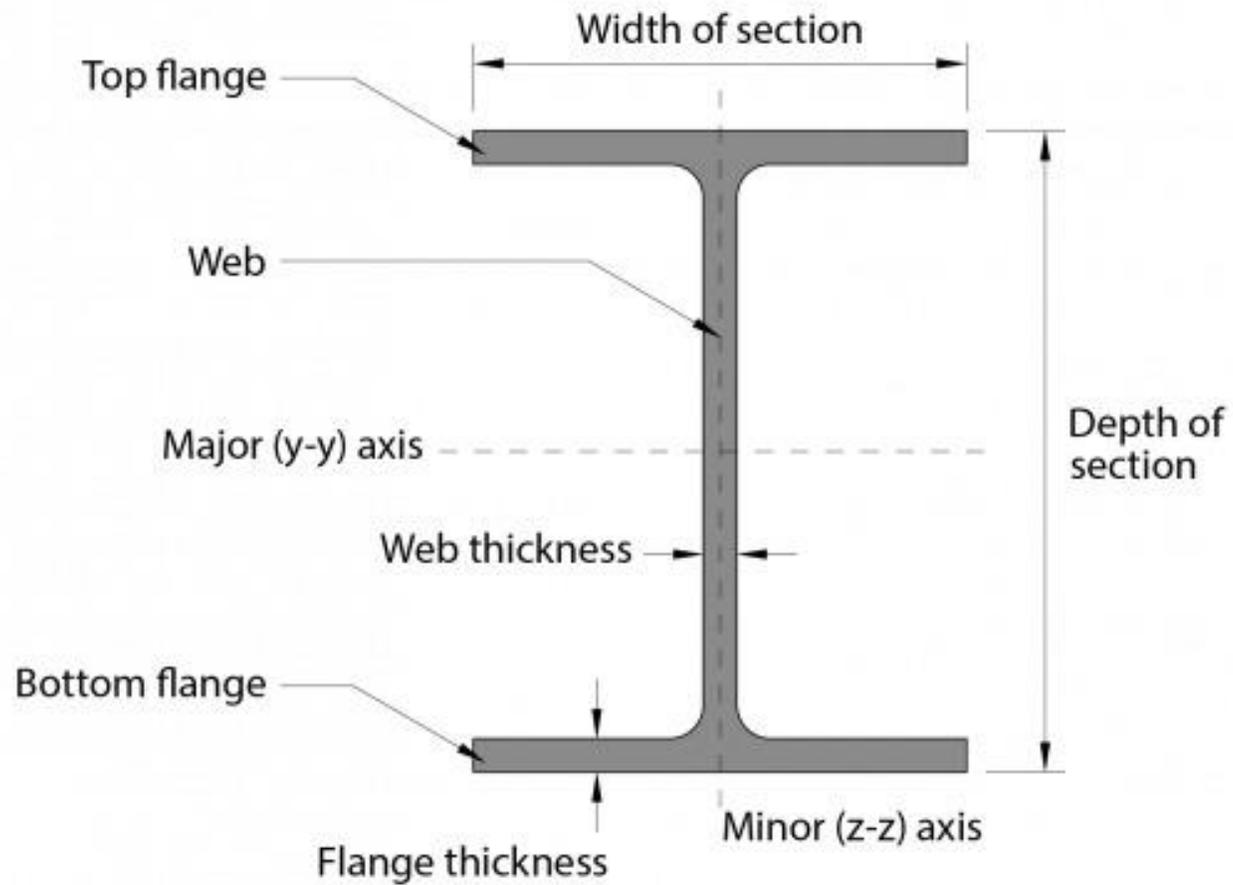


Rectangular Hollow
Section

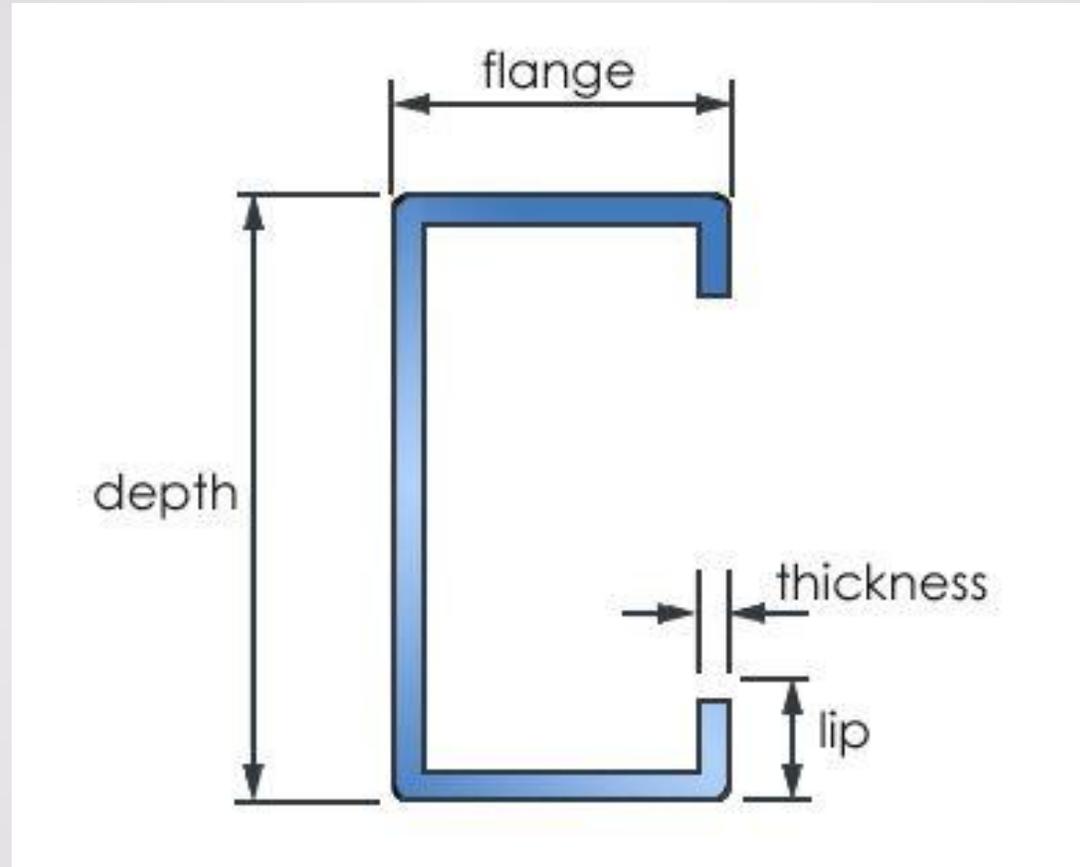


Circular Hollow
Section

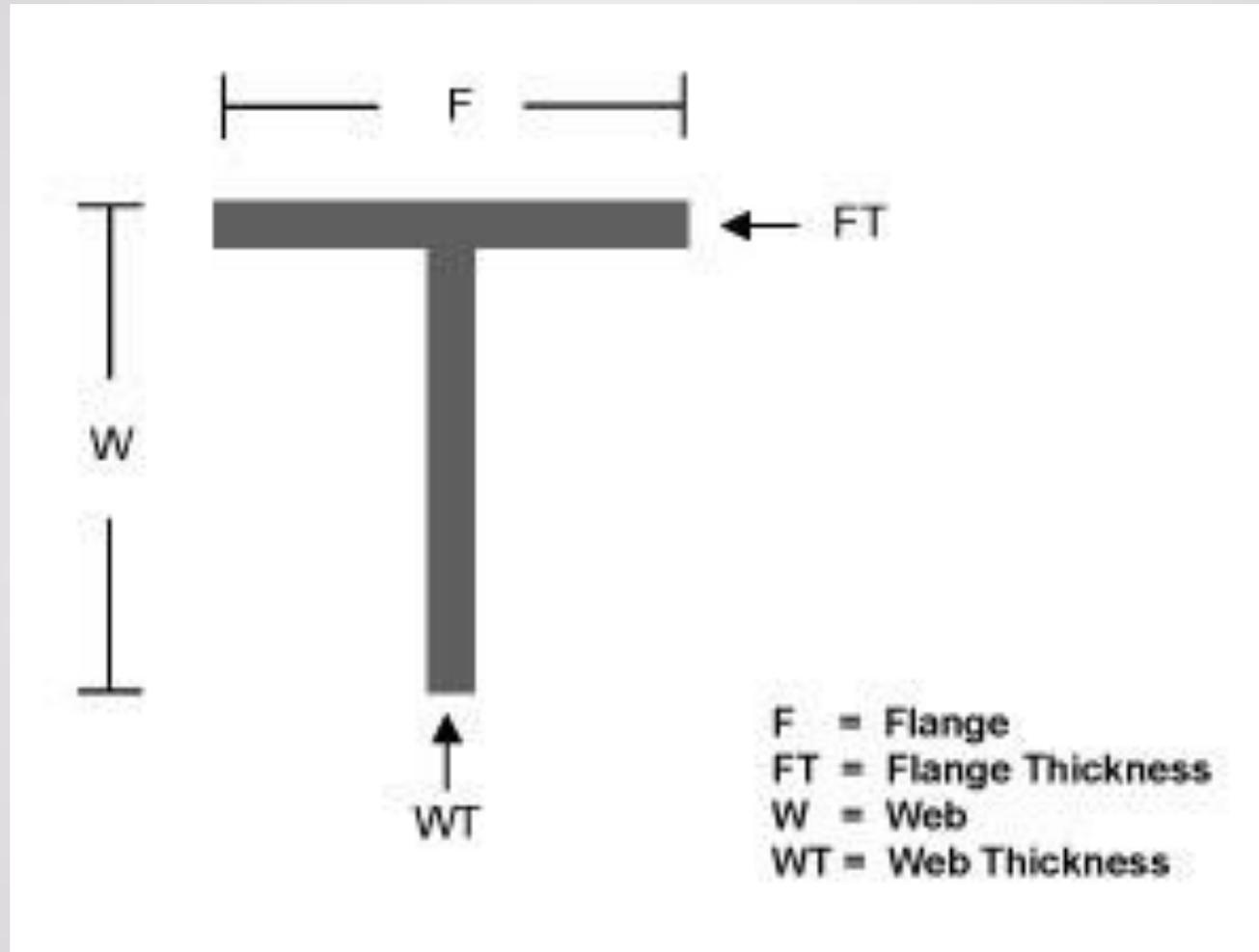
Component of I Section



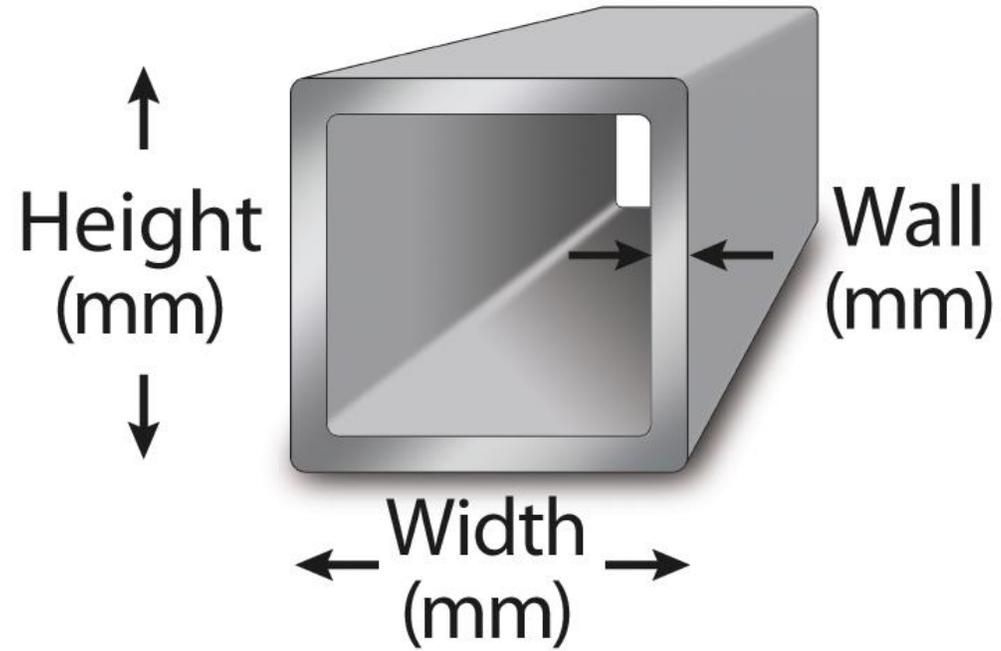
Component of C Section



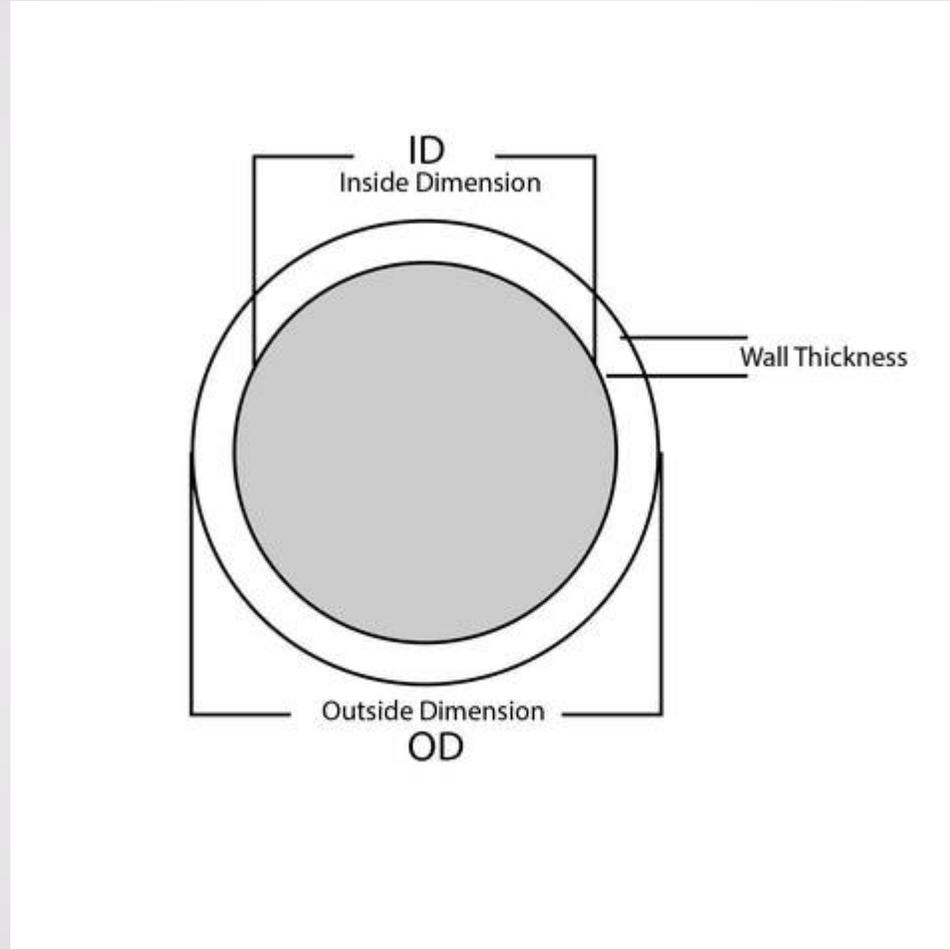
Component of T Section



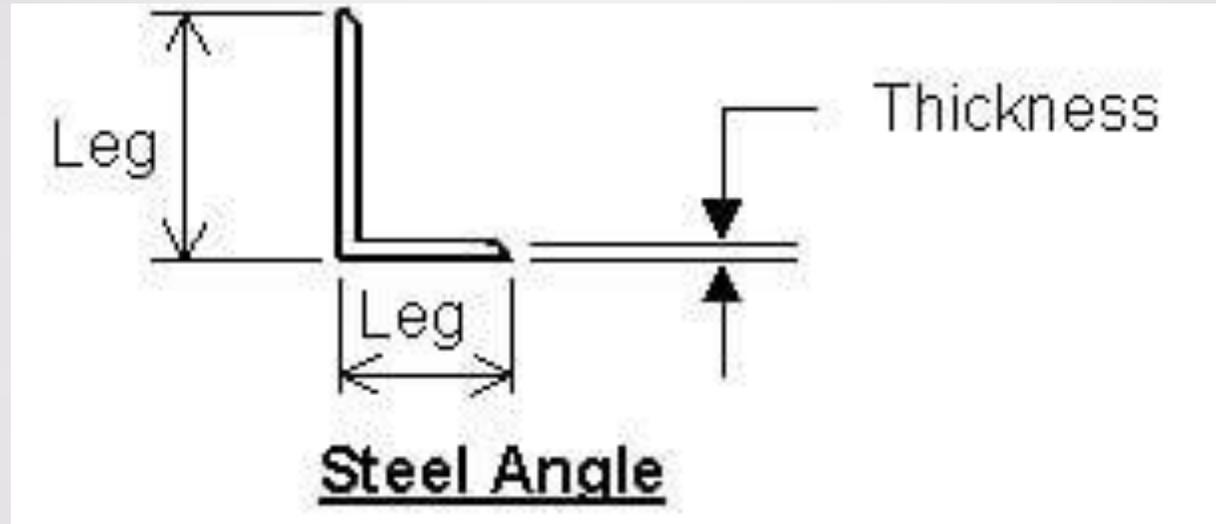
Component of Tube Section



Component of Pipe Section



Component of Angle Section





Dead and Live Load assign

Week 6

Pages 74-86

Load

Load

Loads can be defined as the forces that cause stresses, deformations, or accelerations. These loads are applied to a structure or its components that cause stress or displacement.

The types of loads acting on structures for buildings and other structures can be broadly classified as gravity or vertical loads and lateral or horizontal loads.

The gravity loads consist of dead load, live load and impact load.

The lateral loads comprises of wind load and earthquake load.

Dead Load

Definition of Dead Load

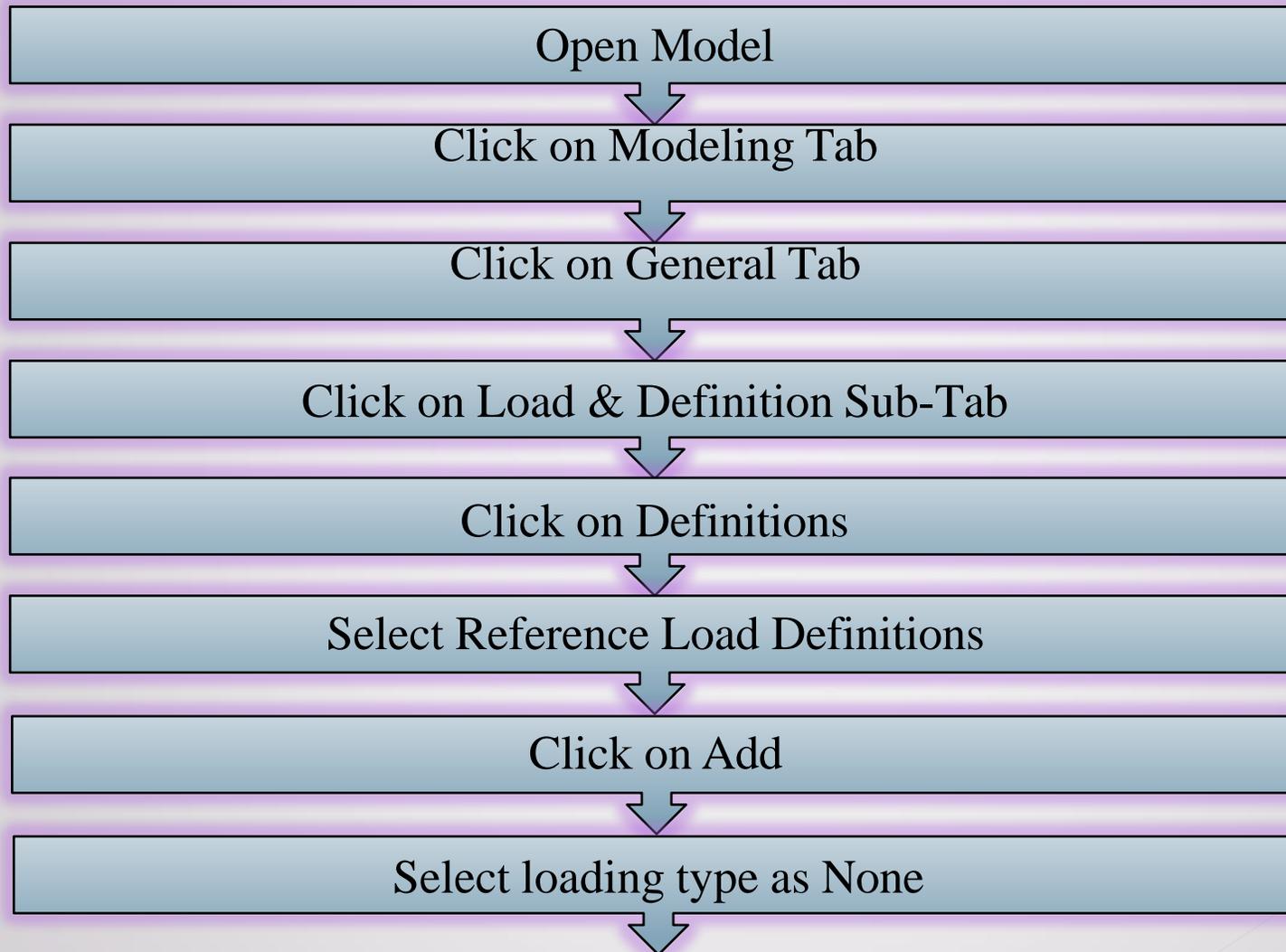
According to BNBC 2020, Part-6, Chapter-2, Section-2.2.2 *“Dead Load is the vertical load due to the weight of permanent structural and nonstructural components and attachments of a building such as walls, floors, ceilings, permanent partitions and fixed service equipment etc.”*

Calculation of Floor Finish Load

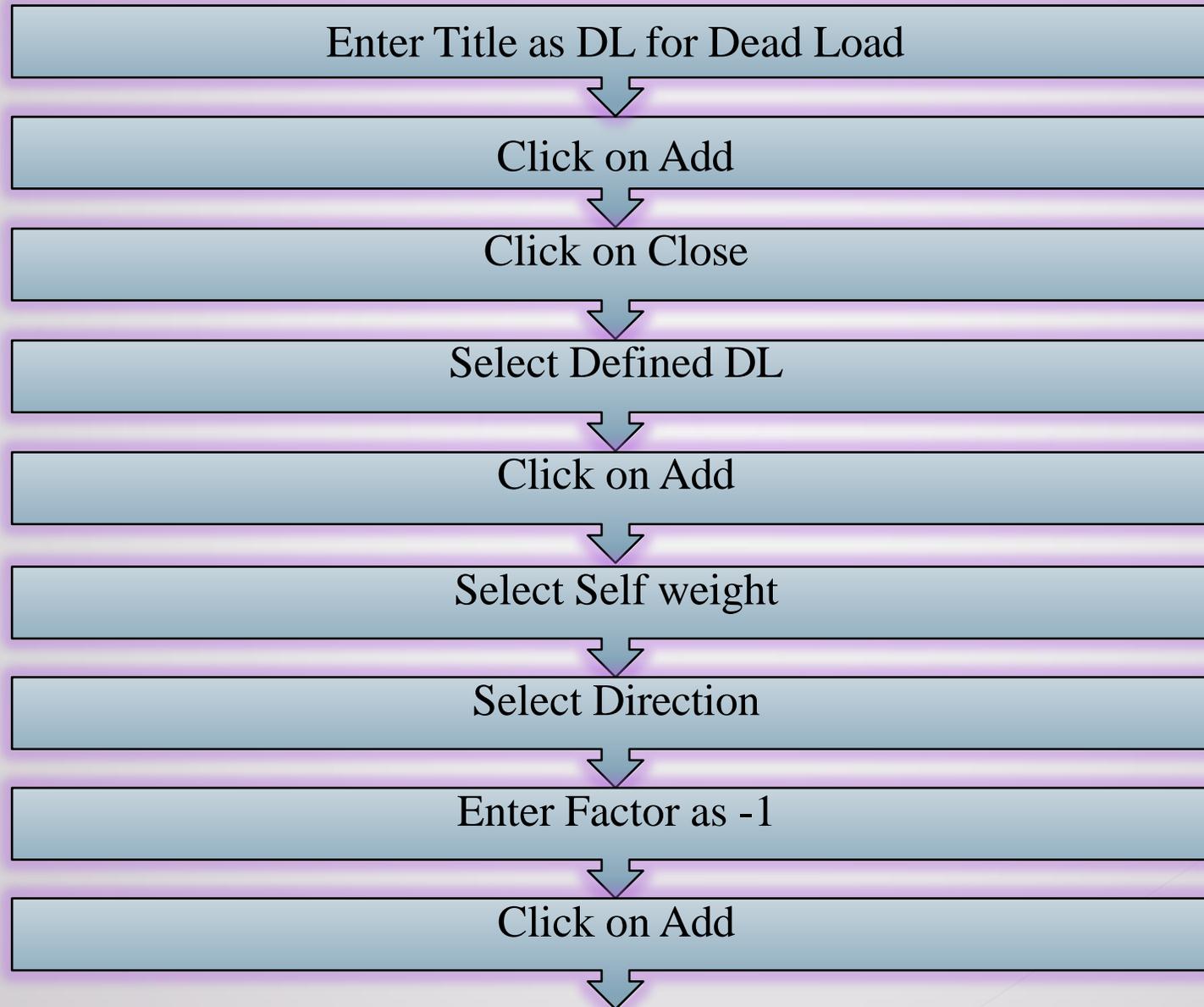
Superimposed Dead Load on Rafter		
Sheeting load on rafter =	0.077	kN/m ²
Purlin load on rafter =	0.08	kN/m ²
Total load on rafter =	0.15	kN/m²
Used Purlin and sheeting load on rafter =	0.167	kN/m²
Rafter spacing =	6.4	m
Load on rafter =	1.07	kN/m

$$1 \text{ kN/m}^2 = 20.88 \text{ psf}$$

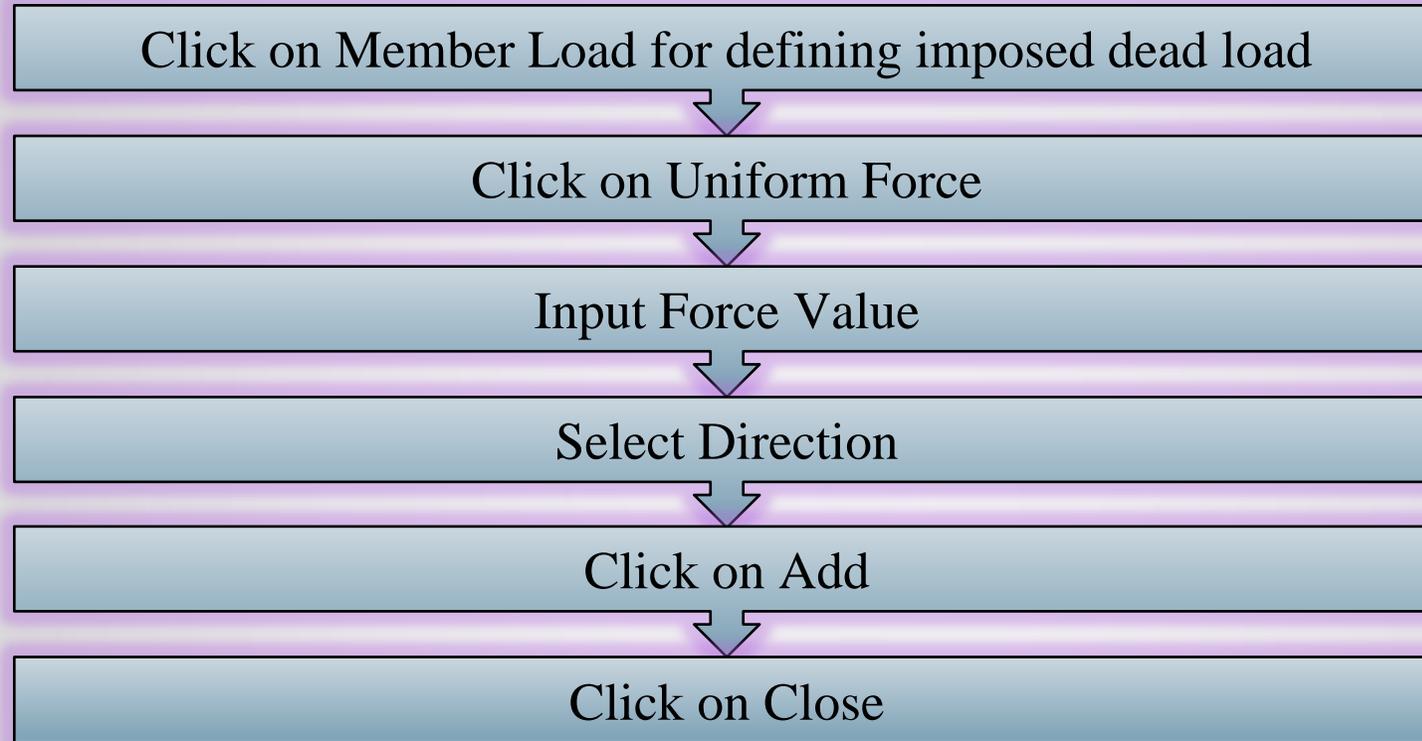
Defining & Assigning Dead Load



Continue...



Continue...

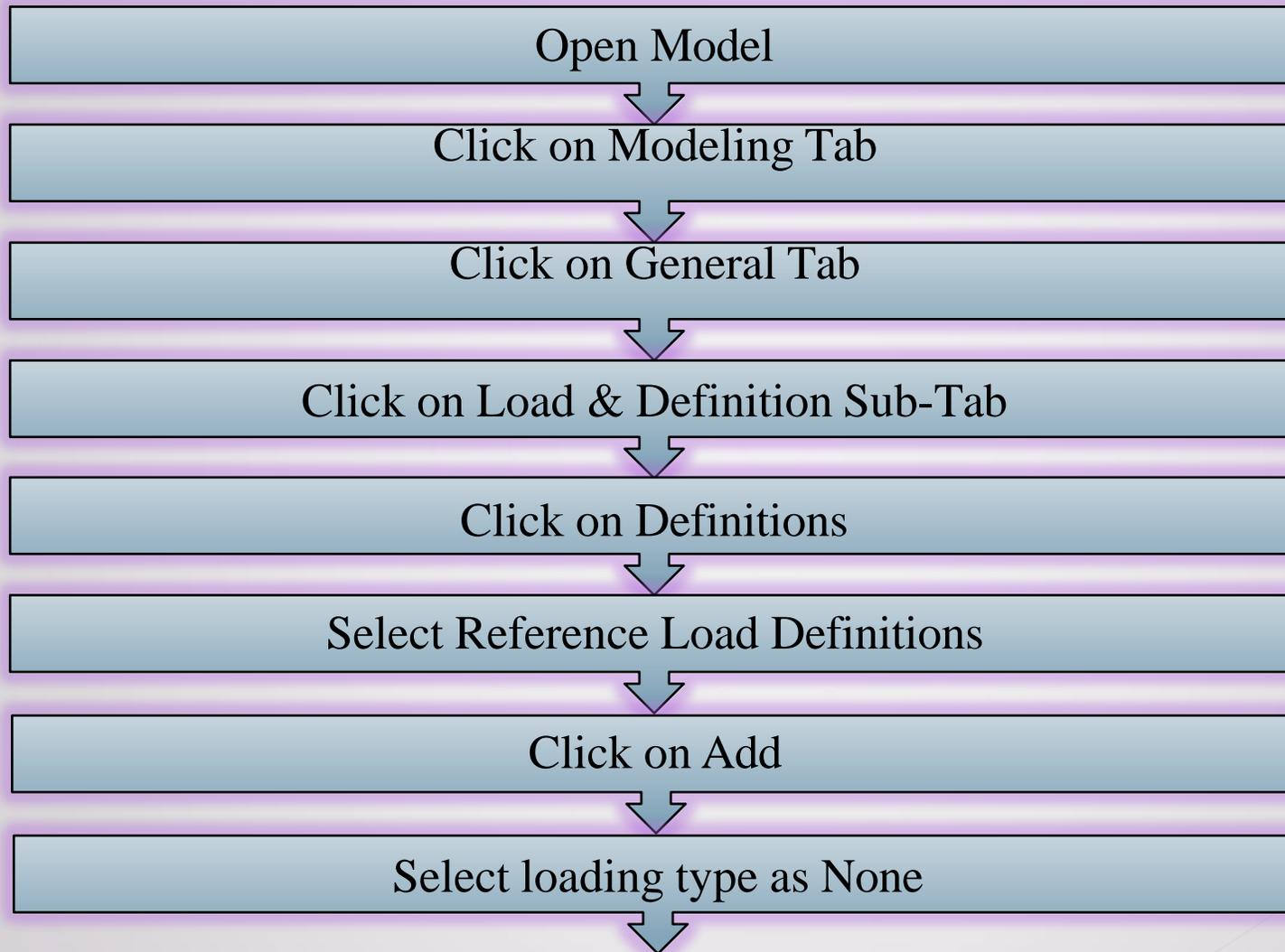


Live Load

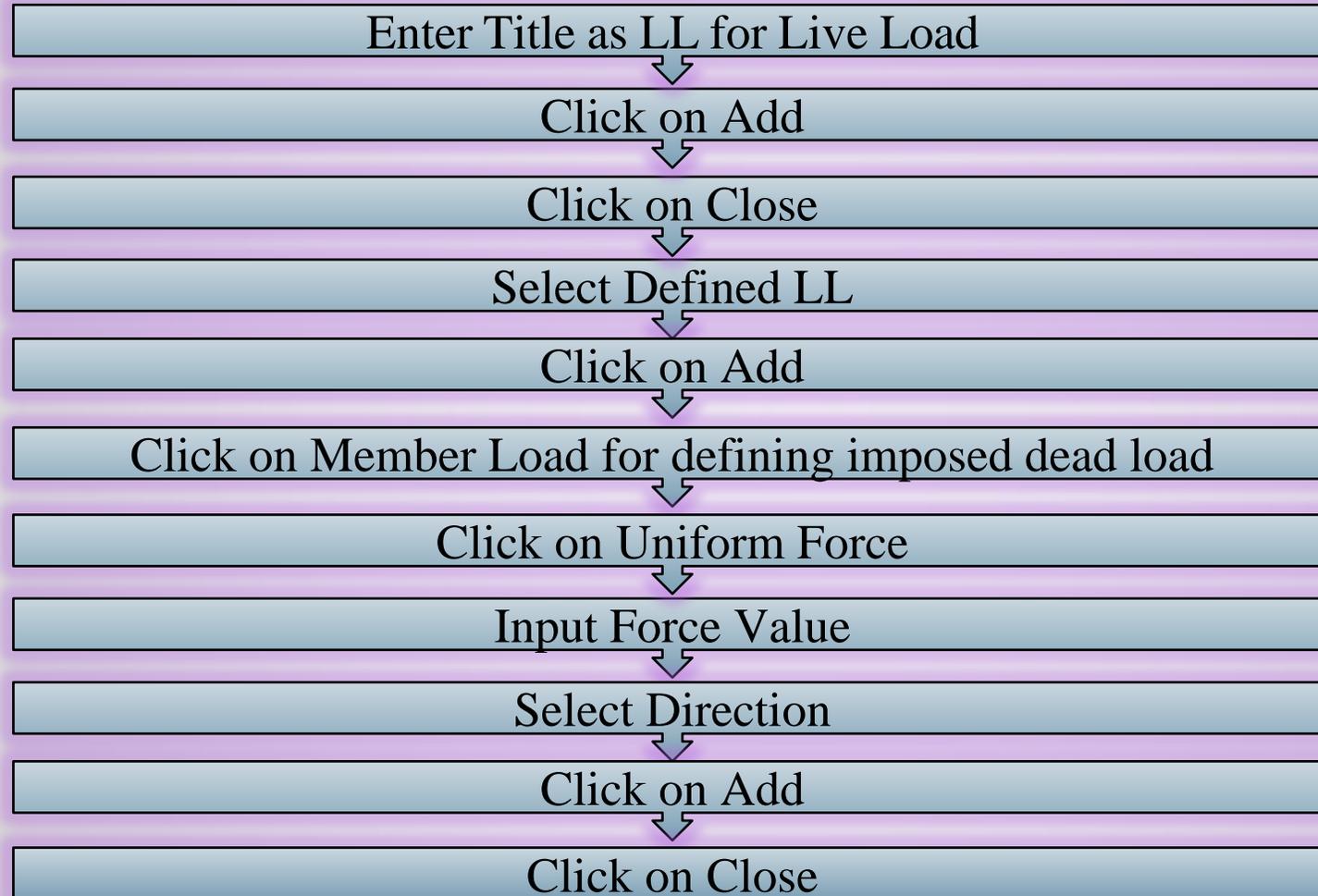
Definition of Live Load

According to BNBC 2020, Part-6, Chapter-2, Section-2.3.2 *“Live load is the load superimposed by the use or occupancy of the building not including the environmental loads such as wind load, rain load, earthquake load or dead load.”*

Defining & Assigning Live Load



Continue...





Wind and Earthquake Load assign

Week 7-8

Pages 87-140

Earthquake Load

Design Base Shear

According to BNBC 2020, Part-6, Chapter-2, Section-2.5.7.1

2.5.7.1 Design base shear

The seismic design base shear force in a given direction shall be determined from the following relation:

$$V = S_a W \quad (6.2.37)$$

Where,

S_a = Lateral seismic force coefficient calculated using Eq. 6.2.34 (Sec 2.5.4.3). It is the design spectral acceleration (in units of g) corresponding to the building period T (computed as per Sec 2.5.7.2).

W = Total seismic weight of the building defined in Sec 2.5.7.3

Continue...

2.5.7.2 Building period

The fundamental period T of the building in the horizontal direction under consideration shall be determined using the following guidelines:

- (a) Structural dynamics procedures (such as Rayleigh method or modal eigenvalue analysis), using structural properties and deformation characteristics of resisting elements, may be used to determine the fundamental period T of the building in the direction under consideration. This period shall not exceed the approximate fundamental period determined by Eq. 6.2.38 by more than 40 percent.
- (b) The building period T (in sec) may be approximated by the following formula:

$$T = C_t(h_n)^m \quad (6.2.38)$$

Where,

h_n = Height of building in metres from foundation or from top of rigid basement. This excludes the basement storeys, where basement walls are connected with the ground floor deck or fitted between the building columns. But it includes the basement storeys, when they are not so connected. C_t and m are obtained from Table 6.2.20

Continue...

Table 6.2.20: Values for Coefficients to Estimate Approximate Period

Structure type	C_t	m	
Concrete moment-resisting frames	0.0466	0.9	Note: Consider moment resisting frames as frames which resist 100% of seismic force and are not enclosed or adjoined by components that are more rigid and will prevent the frames from deflecting under seismic forces.
Steel moment-resisting frames	0.0724	0.8	
Eccentrically braced steel frame	0.0731	0.75	
All other structural systems	0.0488	0.75	

Continue...

2.5.7.3 Seismic weight

Seismic weight, W , is the total dead load of a building or a structure, including partition walls, and applicable portions of other imposed loads listed below:

- (a) For live load up to and including 3 kN/m^2 , a minimum of 25 percent of the live load shall be applicable.
- (b) For live load above 3 kN/m^2 , a minimum of 50 percent of the live load shall be applicable.
- (c) Total weight (100 percent) of permanent heavy equipment or retained liquid or any imposed load sustained in nature shall be included.

Where the probable imposed loads (mass) at the time of earthquake are more correctly assessed, the designer may go for higher percentage of live load.

Continue...

$$S_a = \frac{2}{3} \frac{ZI}{R} C_s \quad (6.2.34)$$

Where,

S_a = Design spectral acceleration (in units of g) which shall not be less than $0.67\beta ZIS$

β = Coefficient used to calculate lower bound for S_a . Recommended value for β is 0.11

Z = Seismic zone coefficient, as defined in Sec 2.5.4.2

I = Structure importance factor, as defined in Sec 2.5.5.1

R = Response reduction factor which depends on the type of structural system given in Table 6.2.19. The ratio $\frac{I}{R}$ cannot be greater than one.

C_s = Normalized acceleration response spectrum, which is a function of structure (building) period and soil type (site class) as defined by Equations 6.2.35a to 6.2.35d.

$$C_s = S \left(1 + \frac{T}{T_B} (2.5\eta - 1) \right) \quad \text{for } 0 \leq T \leq T_B \quad (6.2.35a)$$

$$C_s = 2.5 S \eta \quad \text{for } T_B \leq T \leq T_C \quad (6.2.35b)$$

$$C_s = 2.5 S \eta \left(\frac{T_C}{T} \right) \quad \text{for } T_C \leq T \leq T_D \quad (6.2.35c)$$

$$C_s = 2.5 S \eta \left(\frac{T_C T_D}{T^2} \right) \quad \text{for } T_D \leq T \leq 4 \text{ sec} \quad (6.2.35d)$$

Continue...

C_s depends on S and values of T_B , T_C and T_D , (Figure 6.2.25) which are all functions of the site class. Constant C_s value between periods T_B and T_C represents constant spectral acceleration.

S = Soil factor which depends on site class and is given in Table 6.2.16

T = Structure (building) period as defined in Sec 2.5.7.2

T_B = Lower limit of the period of the constant spectral acceleration branch given in Table 6.2.16 as a function of site class.

T_C = Upper limit of the period of the constant spectral acceleration branch given in Table 6.2.16 as a function of site class

T_D = Lower limit of the period of the constant spectral displacement branch given in Table 6.2.16 as a function of site class

η = Damping correction factor as a function of damping with a reference value of $\eta=1$ for 5% viscous damping. It is given by the following expression:

$$\eta = \sqrt{10 / (5 + \xi)} \geq 0.55 \quad (6.2.36)$$

Table 6.2.16: Site Dependent Soil Factor and Other Parameters Defining Elastic Response Spectrum

Soil type	S	T_B (s)	T_C (s)	T_D (s)
SA	1.0	0.15	0.40	2.0
SB	1.2	0.15	0.50	2.0
SC	1.15	0.20	0.60	2.0
SD	1.35	0.20	0.80	2.0
SE	1.4	0.15	0.50	2.0

Continue...

Table 6.2.14: Description of Seismic Zones

Seismic Zone	Location	Seismic Intensity	Seismic Zone Coefficient, Z
1	Southwestern part including Barisal, Khulna, Jessore, Rajshahi	Low	0.12
2	Lower Central and Northwestern part including Noakhali, Dhaka, Pabna, Dinajpur, as well as Southwestern corner including Sundarbans	Moderate	0.20
3	Upper Central and Northwestern part including Brahmanbaria, Sirajganj, Rangpur	Severe	0.28
4	Northeastern part including Sylhet, Mymensingh, Kurigram	Very Severe	0.36

Continue...

Table 6.2.15: Seismic Zone Coefficient Z for Some Important Towns of Bangladesh

Town	Z	Town	Z	Town	Z	Town	Z
Bagerhat	0.12	Gaibandha	0.28	Magura	0.12	Patuakhali	0.12
Bandarban	0.28	Gazipur	0.20	Manikganj	0.20	Pirojpur	0.12
Barguna	0.12	Gopalganj	0.12	Maulvibazar	0.36	Rajbari	0.20
Barisal	0.12	Habiganj	0.36	Meherpur	0.12	Rajshahi	0.12
Bhola	0.12	Jaipurhat	0.20	Mongla	0.12	Rangamati	0.28
Bogra	0.28	Jamalpur	0.36	Munshiganj	0.20	Rangpur	0.28
Brahmanbaria	0.28	Jessore	0.12	Mymensingh	0.36	Satkhira	0.12
Chandpur	0.20	Jhalokati	0.12	Narail	0.12	Shariatpur	0.20
Chapainababganj	0.12	Jhenaidah	0.12	Narayanganj	0.20	Sherpur	0.36
Chittagong	0.28	Khagrachari	0.28	Narsingdi	0.28	Sirajganj	0.28
Chuadanga	0.12	Khulna	0.12	Natore	0.20	Srimangal	0.36
Comilla	0.20	Kishoreganj	0.36	Naogaon	0.20	Sunamganj	0.36
Cox's Bazar	0.28	Kurigram	0.36	Netrakona	0.36	Sylhet	0.36
Dhaka	0.20	Kushtia	0.20	Nilphamari	0.12	Tangail	0.28
Dinajpur	0.20	Lakshmipur	0.20	Noakhali	0.20	Thakurgaon	0.20
Faridpur	0.20	Lalmanirhat	0.28	Pabna	0.20		
Feni	0.20	Madaripur	0.20	Panchagarh	0.20		

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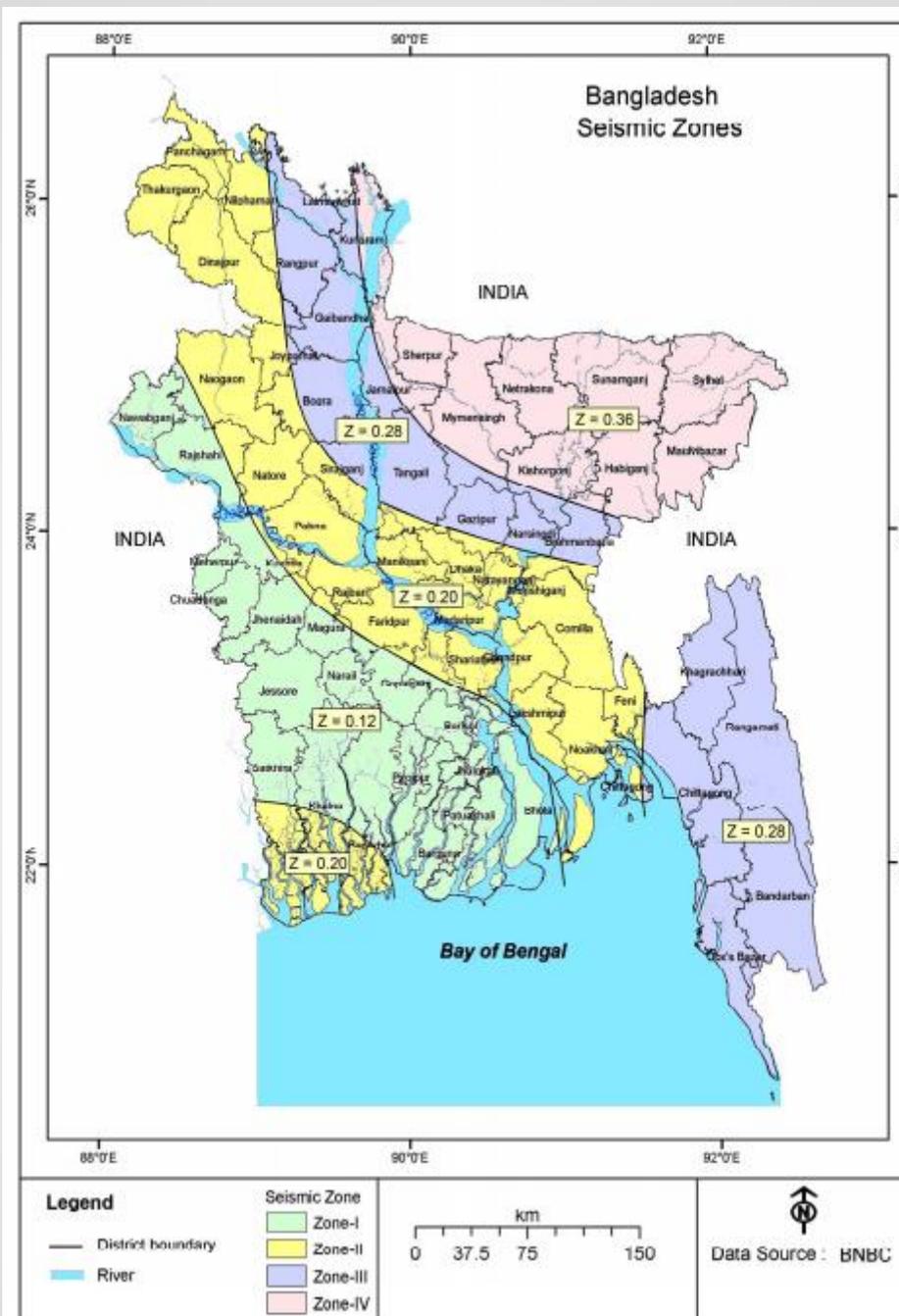


Figure 6.2.24 Seismic zoning map of Bangladesh

Continue...

2.5.5.1 Importance factor

Buildings are classified in four occupancy categories in Chapter 1 (Table 6.1.1), depending on the consequences of collapse for human life, on their importance for public safety and civil protection in the immediate post-earthquake period, and on the social and economic consequences of collapse. Depending on occupancy category, buildings may be designed for higher seismic forces using importance factor greater than one. Table 6.2.17 defines different occupancy categories and corresponding importance factor.

Table 6.2.17: Importance Factors for Buildings and Structures for Earthquake design

Occupancy Category	Importance factor I
I, II	1.00
III	1.25
IV	1.50

Continue...

Table 6.2.19: Response Reduction Factor, Deflection Amplification Factor and Height Limitations for Different Structural Systems

Seismic Force-Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
A. BEARING WALL SYSTEMS (no frame)						
1. Special reinforced concrete shear walls	5	2.5	5	NL	NL	50
2. Ordinary reinforced concrete shear walls	4	2.5	4	NL	NL	NP
3. Ordinary reinforced masonry shear walls	2	2.5	1.75	NL	50	NP
4. Ordinary plain masonry shear walls	1.5	2.5	1.25	18	NP	NP

Continue...

Seismic Force-Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
B. BUILDING FRAME SYSTEMS (with bracing or shear wall)						
1. Steel eccentrically braced frames, moment resisting connections at columns away from links	8	2	4	NL	NL	50
2. Steel eccentrically braced frames, non-moment-resisting, connections at columns away from links	7	2	4	NL	NL	50
3. Special steel concentrically braced frames	6	2	5	NL	NL	50
4. Ordinary steel concentrically braced frames	3.25	2	3.25	NL	NL	11
5. Special reinforced concrete shear walls	6	2.5	5	NL	NL	50
6. Ordinary reinforced concrete shear walls	5	2.5	4.25	NL	NL	NP
7. Ordinary reinforced masonry shear walls	2	2.5	2	NL	50	NP
B. Ordinary plain masonry shear walls	1.5	2.5	1.25	1B	NP	NP
C. MOMENT RESISTING FRAME SYSTEMS (no shear wall)						
1. Special steel moment frames	8	3	5.5	NL	NL	NL
2. Intermediate steel moment frames	4.5	3	4	NL	NL	35
3. Ordinary steel moment frames	3.5	3	3	NL	NL	NP

Continue...

Seismic Force-Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category	Seismic Design Category	Seismic Design Category
				B	C	D
Height limit (m)						
4. Special reinforced concrete moment frames	8	3	5.5	NL	NL	NL
5. Intermediate reinforced concrete moment frames	5	3	4.5	NL	NL	NP
5. Ordinary reinforced concrete moment frames	3	3	2.5	NL	NP	NP
D. DUAL SYSTEMS: SPECIAL MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES (with bracing or shear wall)						
1. Steel eccentrically braced frames	8	2.5	4	NL	NL	NL
2. Special steel concentrically braced frames	7	2.5	5.5	NL	NL	NL
3. Special reinforced concrete shear walls	7	2.5	5.5	NL	NL	NL
4. Ordinary reinforced concrete shear walls	6	2.5	5	NL	NL	NP
E. DUAL SYSTEMS: INTERMEDIATE MOMENT FRAMES CAPABLE OF RESISTING AT LEAST 25% OF PRESCRIBED SEISMIC FORCES (with bracing or shear wall)						
1. Special steel concentrically braced frames	6	2.5	5	NL	NL	11
2. Special reinforced concrete shear walls	6.5	2.5	5	NL	NL	50
3. Ordinary reinforced masonry shear walls	3	3	3	NL	50	NP

Continue...

Seismic Force-Resisting System	Response Reduction Factor, R	System Overstrength Factor, Ω_o	Deflection Amplification Factor, C_d	Seismic Design Category B	Seismic Design Category C	Seismic Design Category D
				Height limit (m)		
4. Ordinary reinforced concrete shear walls	5.5	2.5	4.5	NL	NL	NP
F. DUAL SHEAR WALL-FRAME SYSTEM: ORDINARY REINFORCED CONCRETE MOMENT FRAMES AND ORDINARY REINFORCED CONCRETE SHEAR WALLS	4.5	2.5	4	NL	NP	NP
G. STEEL SYSTEMS NOT SPECIFICALLY DETAILED FOR SEISMIC RESISTANCE	3	3	3	NL	NL	NP

Notes:

1. Seismic design category, NL = No height restriction, NP = Not permitted. Number represents maximum allowable height (m).
2. Dual Systems include buildings which consist of both moment resisting frame and shear walls (or braced frame) where both systems resist the total design forces in proportion to their lateral stiffness.
3. See Sec. 10.20 of Chapter 10 of this Part for additional values of R and C_d and height limits for some other types of steel structures not covered in this Table.
4. Where data specific to a structure type is not available in this Table, reference may be made to Table 12.2-1 of ASCE 7-05.

Continue...

Table 6.2.18: Seismic Design Category of Buildings

Site Class	Occupancy Category I, II and III				Occupancy Category IV			
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 1	Zone 2	Zone 3	Zone 4
SA	B	C	C	D	C	D	D	D
SB	B	C	D	D	C	D	D	D
SC	B	C	D	D	C	D	D	D
SD	C	D	D	D	D	D	D	D
SE, S ₁ , S ₂	D	D	D	D	D	D	D	D

Table 6.2.13: Site Classification Based on Soil Properties

Site Class	Description of soil profile up to 30 meters depth	Average Soil Properties in top 30 meters		
		Shear wave velocity, \bar{V}_s (m/s)	SPT Value, N (blows/30cm)	Undrained shear strength, \bar{S}_u (kPa)
SA	Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface.	> 800	--	--
SB	Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterised by a gradual increase of mechanical properties with depth.	360 – 800	> 50	> 250

Continue...

Site Class	Description of soil profile up to 30 meters depth	Average Soil Properties in top 30 meters		
		Shear wave velocity, V_s (m/s)	SPT Value, \bar{N} (blows/30cm)	Undrained shear strength, \bar{S}_u (kPa)
SC	Deep deposits of dense or medium dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres.	180 - 360	15 - 50	70 - 250
SD	Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft-to-firm cohesive soil.	< 180	< 15	< 70
SE	A soil profile consisting of a surface alluvium layer with V_s values of type SC or SD and thickness varying between about 5 m and 20 m, underlain by stiffer material with $V_s > 800$ m/s.	--	--	--
S ₁	Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index ($PI > 40$) and high water content	< 100 (indicative)	--	10 - 20
S ₂	Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types SA to SE or S ₁	--	--	--

Continue...

2.5.3.2 Site classification

Site will be classified as type SA, SB, SC, SD, SE, S₁ and S₂ based on the provisions of this Section. Classification will be done in accordance with Table 6.2.13 based on the soil properties of upper 30 meters of the site profile. Average soil properties will be determined as given in the following equations:

$$\bar{V}_s = \sum_{i=1}^n d_i / \sum_{i=1}^n \frac{d_i}{V_{si}} \quad (6.2.31)$$

$$\bar{N} = \sum_{i=1}^n d_i / \sum_{i=1}^n \frac{d_i}{N_i} \quad (6.2.32)$$

$$\bar{s}_u = \sum_{i=1}^k d_{ci} / \sum_{i=1}^k \frac{d_{ci}}{s_{ui}} \quad (6.2.33)$$

Where,

n = Number of soil layers in upper 30 m

d_i = Thickness of layer i

V_{si} = Shear wave velocity of layer i

N_i = Field (uncorrected) Standard Penetration Value for layer i

k = Number of cohesive soil layers in upper 30 m

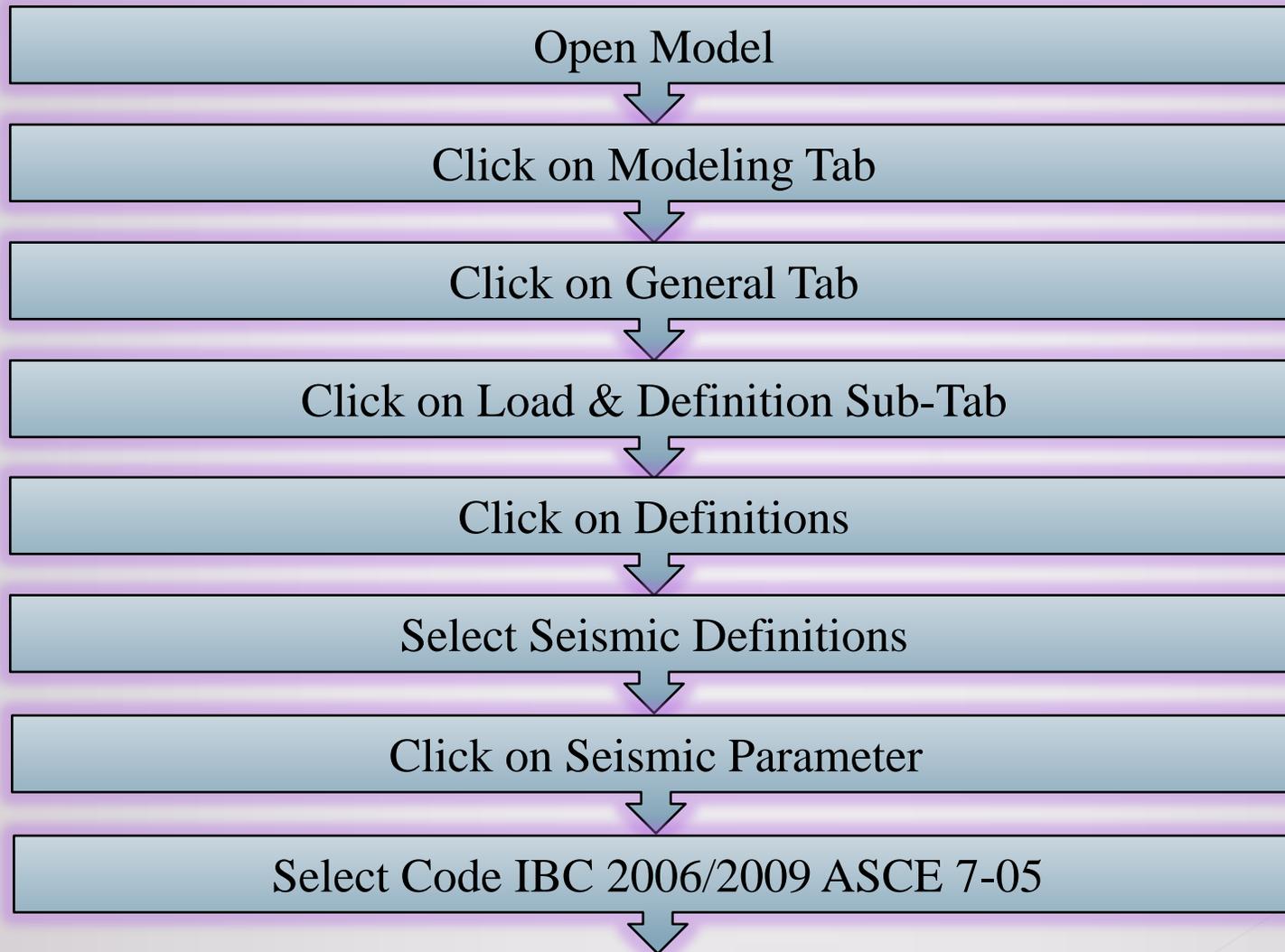
d_{ci} = Thickness of cohesive layer i

s_{ui} = Undrained shear strength of cohesive layer i

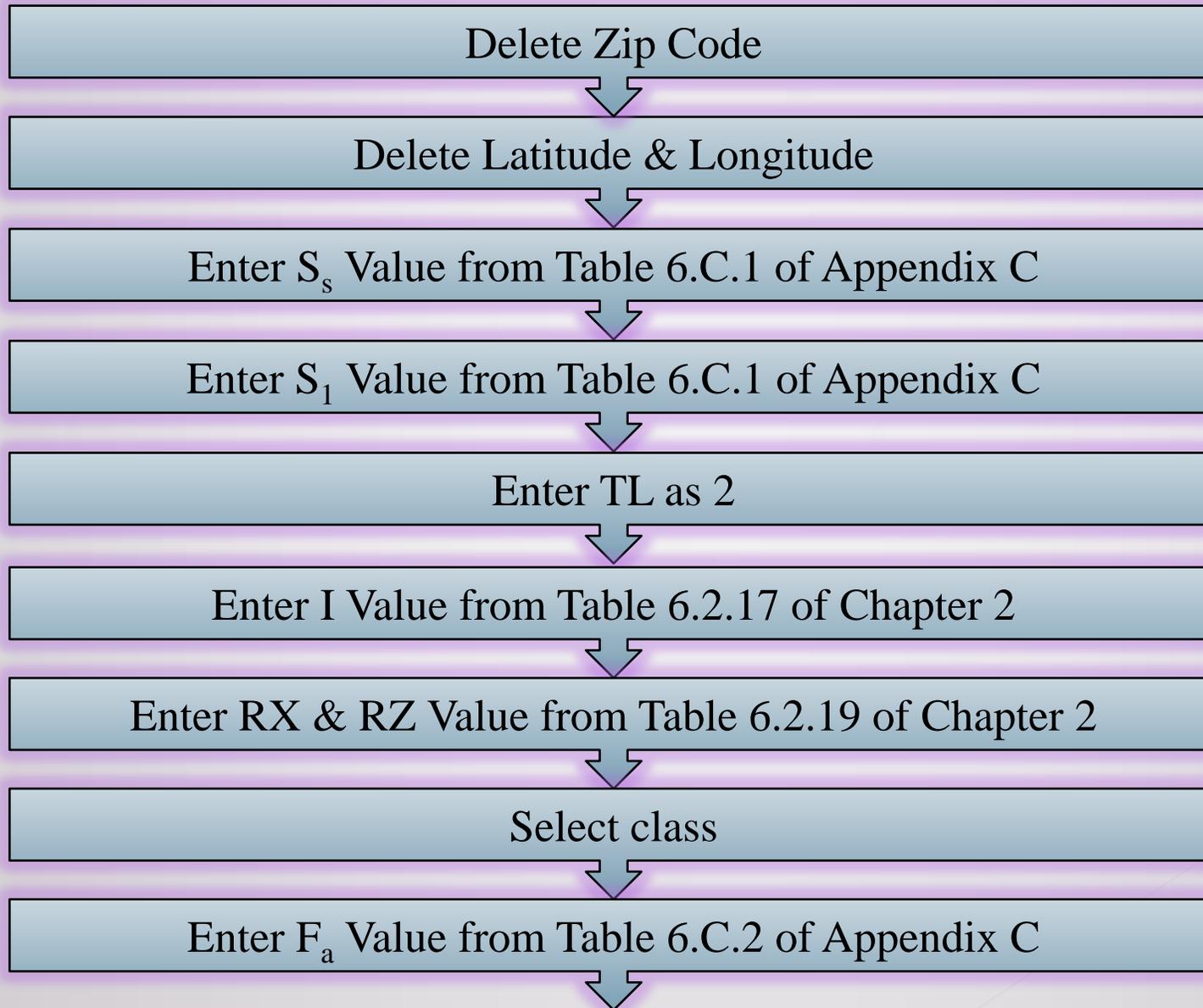
The site profile up to a depth of 30 m is divided into n number of distinct soil or rock layers. Where some of the layers are cohesive, k is the number of cohesive layers. Hence $\sum_{i=1}^n d_i = 30$ m, while $\sum_{i=1}^k d_{ci} < 30$ m if $k < n$ in other words if there are both cohesionless and cohesive layers. The standard penetration value N as directly measured in the field without correction will be used.

The site classification should be done using average shear wave velocity \bar{V}_s if this can be estimated, otherwise the value of \bar{N} may be used.

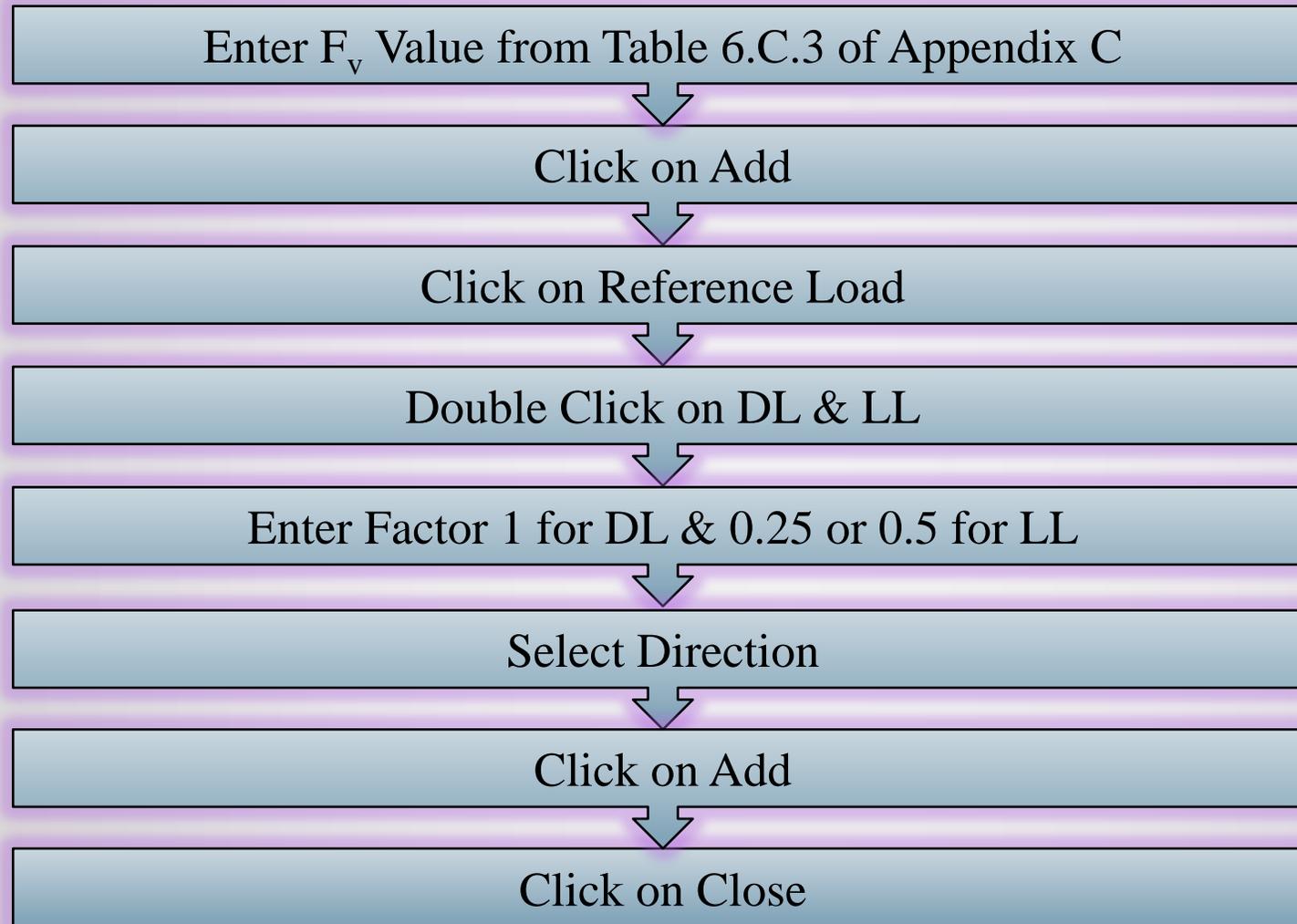
Defining Earthquake Load



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Table 6.C.1: Spectral Response Acceleration Parameter S_s and S_1 for Different Seismic Zone

Parameters	Zone-1	Zone-2	Zone-3	Zone-4
S_s	0.3	0.5	0.7	0.9
S_1	0.12	0.2	0.28	0.36

Table 6.C.2: Site Coefficient F_a for Different Seismic Zone and Soil Type

Soil Type	Zone-1	Zone-2	Zone-3	Zone-4
SA	1.0	1.0	1.0	1.0
SB	1.2	1.2	1.2	1.2
SC	1.15	1.15	1.15	1.15
SD	1.35	1.35	1.35	1.35
SE	1.4	1.4	1.4	1.4

Table 6.C.3: Site Coefficient F_p for Different Seismic Zone and Soil Type

Soil Type	Zone-1	Zone-2	Zone-3	Zone-4
SA	1.0	1.0	1.0	1.0
SB	1.5	1.5	1.5	1.5
SC	1.725	1.725	1.725	1.725
SD	2.7	2.7	2.7	2.7
SE	1.75	1.75	1.75	1.75

Table 6.C.4: Spectral Response Acceleration Parameter S_{DS} for Different Seismic Zone and Soil Type

Soil Type	Zone-1	Zone-2	Zone-3	Zone-4
SA	0.2	0.333	0.466	0.6
SB	0.24	0.4	0.56	0.72
SC	0.23	0.383	0.536	0.69
SD	0.27	0.45	0.63	0.81
SE	0.28	0.466	0.653	0.84

Table 6.C.5 Spectral Response Acceleration Parameter S_{D1} for Different Seismic Zone and Soil Type

Soil Type	Zone-1	Zone-2	Zone-3	Zone-4
SA	0.08	0.133	0.186	0.24
SB	0.12	0.2	0.28	0.36
SC	0.138	0.23	0.322	0.414
SD	0.216	0.36	0.504	0.648
SE	0.14	0.233	0.326	0.42

Wind Load

Design Wind Load Procedure

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.1

Allowed Procedures: The design wind loads for buildings and other structures, including the Main Wind-Force Resisting System (MWFRS) and component and cladding elements thereof, shall be determined using one of the following procedures:

Method 1: Simplified Procedure as specified in Sec 2.4.2 for buildings and structures meeting the requirements specified therein;

Method 2: Analytical Procedure as specified in Sec 2.4.3 for buildings and structures meeting the requirements specified therein;

Method 3: Wind Tunnel Procedure as specified in Sec 2.4.16.

Method 2: Analytical Procedure

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.3.1

Scopes and limitations:

A building or other structure whose design wind loads are determined in accordance with this Section shall meet all of the following conditions:

- (1) The building or other structure is a regular-shaped building or structure as defined in Sec 2.1.3.
- (2) The building or other structure does not have response characteristics making it subject to across-wind loading, vortex shedding, instability due to galloping or flutter; or does not have a site location for which channeling effects or buffeting in the wake of upwind obstructions warrant special consideration.

Design Procedure

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.3.4

Design procedure:

- (1) The basic wind speed V and wind directionality factor K_d shall be determined in accordance with Sec 2.4.4.
- (2) An importance factor I shall be determined in accordance with sec 2.4.5.
- (3) An exposure category or exposure categories and velocity pressure exposure coefficient K_z or K_h as applicable, shall be determined for each wind direction in accordance with Sec 2.4.6.
- (4) A topographic factor K_{zt} shall be determined in accordance with Sec 2.4.7.
- (5) A gust effect factor G or G_f as applicable, shall be determined in accordance with Sec 2.4.8.
- (6) An enclosure classification shall be determined in accordance with Sec 2.4.9.

Continue...

- (7) Internal pressure coefficient GC_{pi} shall be determined in accordance with Sec 2.4.10.1.
- (8) External pressure coefficients C_p or GC_{pf} or force coefficients C_f as applicable, shall be determined in accordance with Sections 2.4.10.2 or 2.4.10.3, respectively.
- (9) Velocity pressure q_z or q_h as applicable, shall be determined in accordance with Sec 2.4.9.5.
- (10) Design wind load P or F shall be determined in accordance with Sec 2.4.11.

Step-1

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.4

2.4.4 Basic Wind Speed

The basic wind speed, V used in the determination of design wind loads on buildings and other structures shall be as given in Figure 6.2.1 except as provided in Sec 2.4.4.1. The wind shall be assumed to come from any horizontal direction.

2.4.4.1 Special wind regions

The basic wind speed shall be increased where records or experience indicate that the wind speeds are higher than those reflected in Figure 6.2.1. Mountainous terrain, gorges, and special regions shall be examined for unusual wind conditions. The authority having jurisdiction shall, if necessary, adjust the values given in Figure 6.2.1 to account for higher local wind speeds. Such adjustment shall be based on adequate meteorological information and other necessary data.

2.4.4.2 Limitation

Tornadoes have not been considered in developing the basic wind-speed distributions.

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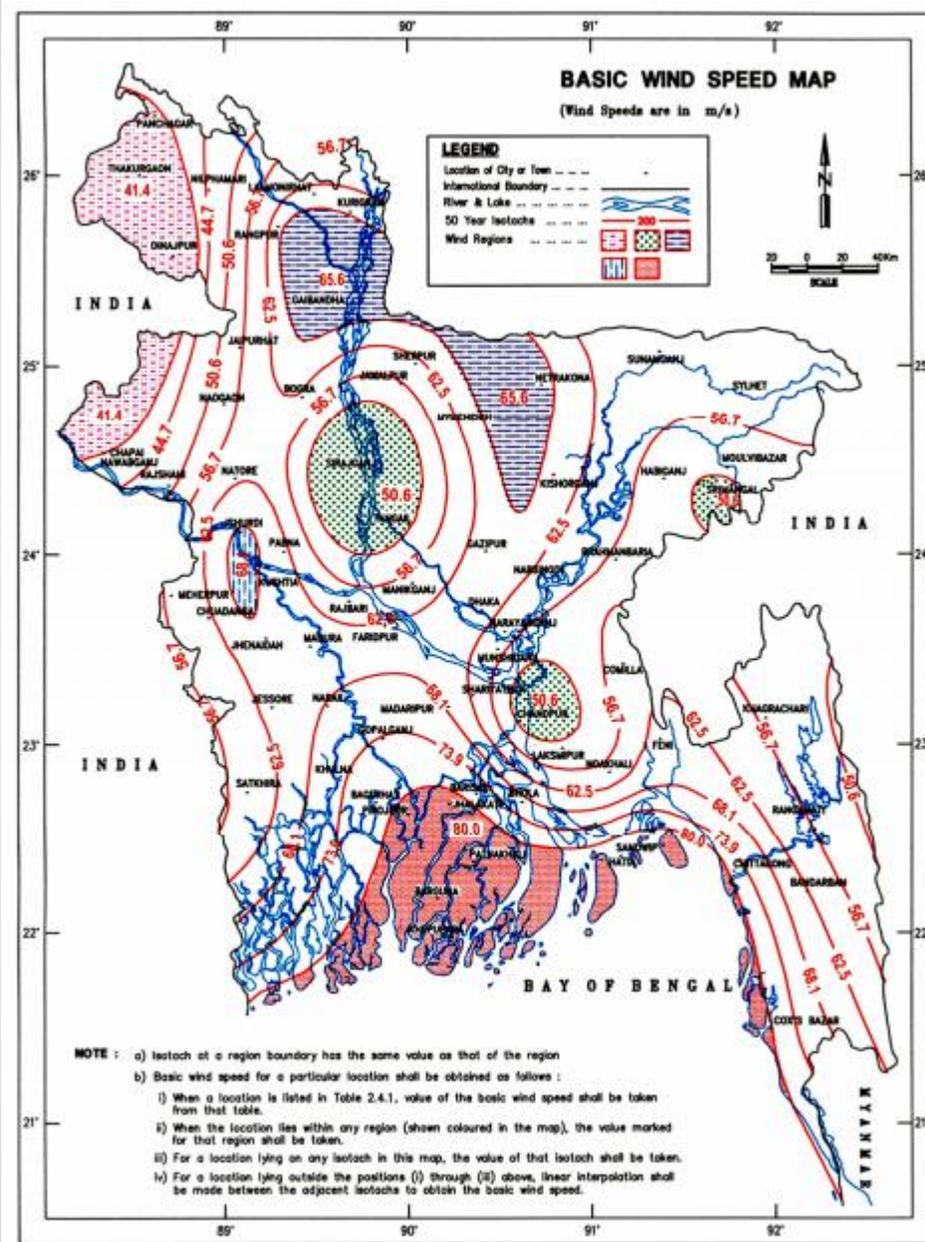


Figure 6.2.1 Basic wind speed (V_b , m/s) map of Bangladesh

Continue...

Table 6.2.8: Basic Wind Speeds, V , for Selected Locations in Bangladesh

Location	Basic Wind Speed (m/s)	Location	Basic Wind Speed (m/s)
Angarpota	47.8	Lalmonirhat	63.7
Bagerhat	77.5	Madaripur	68.1
Bandarban	62.5	Magura	65.0
Barguna	80.0	Manikganj	58.2
Barisal	78.7	Meherpur	58.2
Bhola	69.5	Maheshkhali	80.0
Bogra	61.9	Moulvibazar	53.0
Brahmanbaria	56.7	Munshiganj	57.1
Chandpur	50.6	Mymensingh	67.4
Chapai Nawabganj	41.4	Naogaon	55.2
Chittagong	80.0	Narail	68.6
Chuadanga	61.9	Narayanganj	61.1
Comilla	61.4	Narsinghdi	59.7
Cox's Bazar	80.0	Natore	61.9
Dahagram	47.8	Netrokona	65.6
Dhaka	65.7	Nilphamari	44.7
Dinajpur	41.4	Noakhali	57.1
Faridpur	63.1	Pabna	63.1
Feni	64.1	Panchagarh	41.4
Gaibandha	65.6	Patuakhali	80.0
Gazipur	66.5	Pirojpur	80.0
Gopalganj	74.5	Rajbari	59.1
Habiganj	54.2	Rajshahi	49.2
Hatiya	80.0	Rangamati	56.7
Ishurdi	69.5	Rangpur	65.3
Joypurhat	56.7	Satkhira	57.6
Jamalpur	56.7	Shariatpur	61.9
Jessore	64.1	Sherpur	62.5
Jhalakati	80.0	Sirajganj	50.6
Jhenaidah	65.0	Srimangal	50.6
Khagrachhari	56.7	St. Martin's Island	80.0
Khulna	73.3	Sunamganj	61.1
Kutubdia	80.0	Sylhet	61.1
Kishoreganj	64.7	Sandwip	80.0
Kurigram	65.6	Tangail	50.6
Kushtia	66.9	Teknaf	80.0
Lakshmipur	51.2	Thakurgaon	41.4

Continue...

2.4.4.3 Wind directionality factor

The wind directionality factor, K_d shall be determined from Table 6.2.12. This factor shall only be applied when used in conjunction with load combinations specified in this Chapter.

Table 6.2.12: Wind Directionality Factor, K_d

Structure Type	Directionality Factor K_d *	Structure Type	Directionality Factor K_d *
Buildings		Solid Signs	0.85
Main Wind Force Resisting System	0.85	Open Signs and Lattice Framework	0.85
Components and Cladding	0.85	Trussed Towers	
Arched Roofs	0.85	Triangular, square, rectangular	0.85
Chimneys, Tanks, and Similar Structures		All other cross section	0.95
Square	0.90		
Hexagonal	0.95		
Round	0.95		

* Directionality Factor K_d has been calibrated with combinations of loads specified in Sec 2.7. This factor shall only be applied when used in conjunction with load combinations specified in Sections 2.7.2 and 2.7.3.

Step-2

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.5

2.4.5 Importance Factor

An importance factor, I for the building or other structure shall be determined from Table 6.2.9 based on building and structure categories listed in Sec 1.2.4.

Table 6.2.9: Importance Factor, I (Wind Loads)

Occupancy Category¹ or Importance Class	Non-Cyclone Prone Regions and Cyclone Prone Regions with $V = 38-44$ m/s	Cyclone Prone Regions with $V > 44$ m/s
I	0.87	0.77
II	1.0	1.00
III	1.15	1.15
IV	1.15	1.15

¹ The building and structure classification categories are listed in Table 6.1.1

Step-3

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.6

2.4.6 Exposure

For each wind direction considered, the upwind exposure category shall be based on ground surface roughness that is determined from natural topography, vegetation, and constructed facilities.

2.4.6.2 Surface roughness categories

A ground surface roughness within each 45° sector shall be determined for a distance upwind of the site as defined in Sec 2.4.6.3 from the categories defined in the following text, for the purpose of assigning an exposure category as defined in Sec 2.4.6.3.

Surface Roughness A: Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.

Surface Roughness B: Open terrain with scattered obstructions having heights generally less than 9.1 m. This category includes flat open country, grasslands, and all water surfaces in cyclone prone regions.

Surface Roughness C: Flat, unobstructed areas and water surfaces outside cyclone prone regions. This category includes smooth mud flats and salt flats.

Continue...

2.4.6.3 Exposure categories

Exposure A: Exposure A shall apply where the ground surface roughness condition, as defined by Surface Roughness A, prevails in the upwind direction for a distance of at least 792 m or 20 times the height of the building, whichever is greater.

Exception: For buildings whose mean roof height is less than or equal to 9.1 m, the upwind distance may be reduced to 457 m.

Exposure B: Exposure B shall apply for all cases where Exposures A or C do not apply.

Exposure C: Exposure C shall apply where the ground surface roughness, as defined by Surface Roughness C, prevails in the upwind direction for a distance greater than 1,524 m or 20 times the building height, whichever is greater. Exposure C shall extend into downwind areas of Surface Roughness A or B for a distance of 200 m or 20 times the height of the building, whichever is greater.

For a site located in the transition zone between exposure categories, the category resulting in the largest wind forces shall be used.

Exception: An intermediate exposure between the preceding categories is permitted in a transition zone provided that it is determined by a rational analysis method defined in the recognized literature.

Continue...

Surface Roughness and Exposure

Surface Roughness and Exposure	Definitions	Examples
B	Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.	
C	Open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m). This category includes flat open country, grasslands, and all water surfaces in hurricane prone regions.	
D	Flat, unobstructed areas and water surfaces outside hurricane prone regions. This category includes smooth mud flats, salt flats, and unbroken ice.	

Continue...

2.4.6.6 Velocity pressure exposure coefficient

Based on the exposure category determined in Sec 2.4.6.3, a velocity pressure exposure coefficient K_z or K_h , as applicable, shall be determined from Table 6.2.11. For a site located in a transition zone between exposure categories that is near to a change in ground surface roughness, intermediate values of K_z or K_h between those shown in Table 6.2.11, are permitted, provided that they are determined by a rational analysis method defined in the recognized literature.

Continue...

Table 6.2.11: Velocity Pressure Exposure Coefficients, K_h and K_z

Height above ground level, z (m)	Exposure (Note 1)			
	A		B	C
	Case 1	Case 2	Case 1 & 2	Case 1 & 2
0-4.6	0.70	0.57	0.85	1.03
6.1	0.70	0.62	0.90	1.08
7.6	0.70	0.66	0.94	1.12
9.1	0.70	0.70	0.98	1.16
12.2	0.76	0.76	1.04	1.22
15.2	0.81	0.81	1.09	1.27
18	0.85	0.85	1.13	1.31
21.3	0.89	0.89	1.17	1.34
24.4	0.93	0.93	1.21	1.38
27.41	0.96	0.96	1.24	1.40
30.5	0.99	0.99	1.26	1.43
36.6	1.04	1.04	1.31	1.48
42.7	1.09	1.09	1.36	1.52
48.8	1.13	1.13	1.39	1.55
54.9	1.17	1.17	1.43	1.58
61.0	1.20	1.20	1.46	1.61
76.2	1.28	1.28	1.53	1.68
91.4	1.35	1.35	1.59	1.73
106.7	1.41	1.41	1.64	1.78
121.9	1.47	1.47	1.69	1.82
137.2	1.52	1.52	1.73	1.86
152.4	1.56	1.56	1.77	1.89

Continue...

Notes:

1. Case 1:

- (a) All components and cladding.
- (b) Main wind force resisting system in low-rise buildings designed using Figure 6.2.10.

Case 2:

- (a) All main wind force resisting systems in buildings except those in low-rise buildings designed using Figure 6.2.10.
- (b) All main wind force resisting systems in other structures.

2. The velocity pressure exposure coefficient K_z may be determined from the following formula:

$$\text{For } 4.57 \text{ m} \leq z \leq z_g: \quad K_z = 2.01 (z/z_g)^{2/\alpha}$$

$$\text{For } z < 4.57 \text{ m:} \quad K_z = 2.01 (4.57/z_g)^{2/\alpha}$$

Note: z shall not be taken less than 9.1 m for Case 1 in exposure A.

- 3. α and z_g are tabulated in Table 6.2.10.
- 4. Linear interpolation for intermediate values of height z is acceptable.
- 5. Exposure categories are defined in Sec 2.4.6.3.

Step-4

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.7

2.4.7 Topographic Effects

2.4.7.1 Wind speed-up over hills, ridges and escarpments

Wind speed-up effects at isolated hills, ridges, and escarpments constituting abrupt changes in the general topography located in any exposure category shall be included in the design when buildings and other site conditions and locations of structures meet all of the following conditions:

- (i) The hill, ridge, or escarpment is isolated and unobstructed upwind by other similar topographic features of comparable height for 100 times the height of the topographic feature ($100 H$) or 3.22 km, whichever is less. This distance shall be measured horizontally from the point at which the height H of the hill, ridge, or escarpment is determined.
- (ii) The hill, ridge, or escarpment protrudes above the height of upwind terrain features within a 3.22 km radius in any quadrant by a factor of two or more.
- (iii) The structure is located as shown in Figure 6.2.4 in the upper one-half of a hill or ridge or near the crest of an escarpment.
- (iv) $H/L_h \geq 0.2$
- (v) H is greater than or equal to 4.5 m for Exposures B and C and 18.3 m for Exposure A.

Continue...

2.4.7.2 Topographic factor

The wind speed-up effect shall be included in the calculation of design wind loads by using the factor K_{zt} :

$$K_{zt} = (1 + K_1 K_2 K_3)^2 \quad (6.2.5)$$

Where, K_1 , K_2 , and K_3 are given in Figure 6.2.4. If site conditions and locations of structures do not meet all the conditions specified in Sec 2.4.7.1 then $K_{zt} = 1.0$.

Step-5

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.8

2.4.8 Gust Effect Factor

2.4.8.1 Rigid structures

For rigid structures as defined in Sec 2.1.3, the gust-effect factor shall be taken as 0.85 or calculated by the formula:

$$G = 0.925 \frac{1+1.7g_Q I_z Q}{1+1.7g_v I_z} \quad (6.2.6)$$

2.4.8.2 Flexible or dynamically sensitive structures

For flexible or dynamically sensitive structures as defined in Sec 2.1.3 (natural period greater than 1.0 second), the gust-effect factor shall be calculated by

$$G_f = 0.925 \left(\frac{1+1.7I_z \sqrt{g_Q^2 Q^2 + g_R^2 R^2}}{1+1.7g_v I_z} \right) \quad (6.2.10)$$

Step-6

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.9

2.4.9 Enclosure Classifications

2.4.9.1 General

For the purpose of determining internal pressure coefficients, all buildings shall be classified as enclosed, partially enclosed, or open as defined in Sec 2.1.3.

BUILDING, OPEN A building having each wall at least 80 percent open. This condition is expressed for each wall by the equation $A_o \geq 0.8A_g$ where,
 A_o = total area of openings in a wall that receives positive external pressure (m²).
 A_g = the gross area of that wall in which A_o is identified (m²).

Continue...

BUILDING, PARTIALLY ENCLOSED

A building that complies with both of the following conditions:

1. The total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10 percent.
2. The total area of openings in a wall that receives positive external pressure exceeds 0.37 m^2 or 1 percent of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20 percent.

BUILDING, ENCLOSED

A building that does not comply with the requirements for open or partially enclosed buildings.

Step-7

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.10.1

2.4.10.1 Internal pressure coefficients

Internal Pressure Coefficient. Internal pressure coefficients, GC_{pi} shall be determined from Figure 6.2.5 based on building enclosure classifications determined from Sec 2.4.9.

Enclosed, Partially Enclosed, and Open Buildings: Walls & Roofs		
Enclosure Classification	GC_{pi}	Notes:
Open Building	0.00	1. Plus and minus signs signify pressures acting toward and away from the internal surfaces, respectively. 2. Values of GC_{pi} shall be used with q_z or q_h as specified in Sec 2.4.11. 3. Two cases shall be considered to determine the critical load requirements for the appropriate condition: (i) a positive value of GC_{pi} applied to all internal surfaces (ii) a negative value of GC_{pi} applied to all internal surfaces.
Partially Enclosed Building	+0.55	
	-0.55	
Enclosed Building	+0.18	
	-0.18	

Figure 6.2.5 Internal pressure coefficient, GC_{pi} main wind force resisting system component and cladding - Method 2 (All Heights)

Step-8

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.10.2 & 3

2.4.10.2 External pressure coefficients

Main Wind-Force Resisting Systems: External pressure coefficients for MWFRSs C_p are given in Figures 6.2.6 to 6.2.8. Combined gust effect factor and external pressure coefficients, GC_{pf} are given in Figure 6.2.10 for low-rise buildings. The pressure coefficient values and gust effect factor in Figure 6.2.10 shall not be separated.

Components and Cladding: Combined gust effect factor and external pressure coefficients for components and cladding GC_p are given in Figures 6.2.11 to 6.2.17. The pressure coefficient values and gust-effect factor shall not be separated.

2.4.10.3 Force coefficients

Force coefficients C_f are given in Figures 6.2.20 to 6.2.23.

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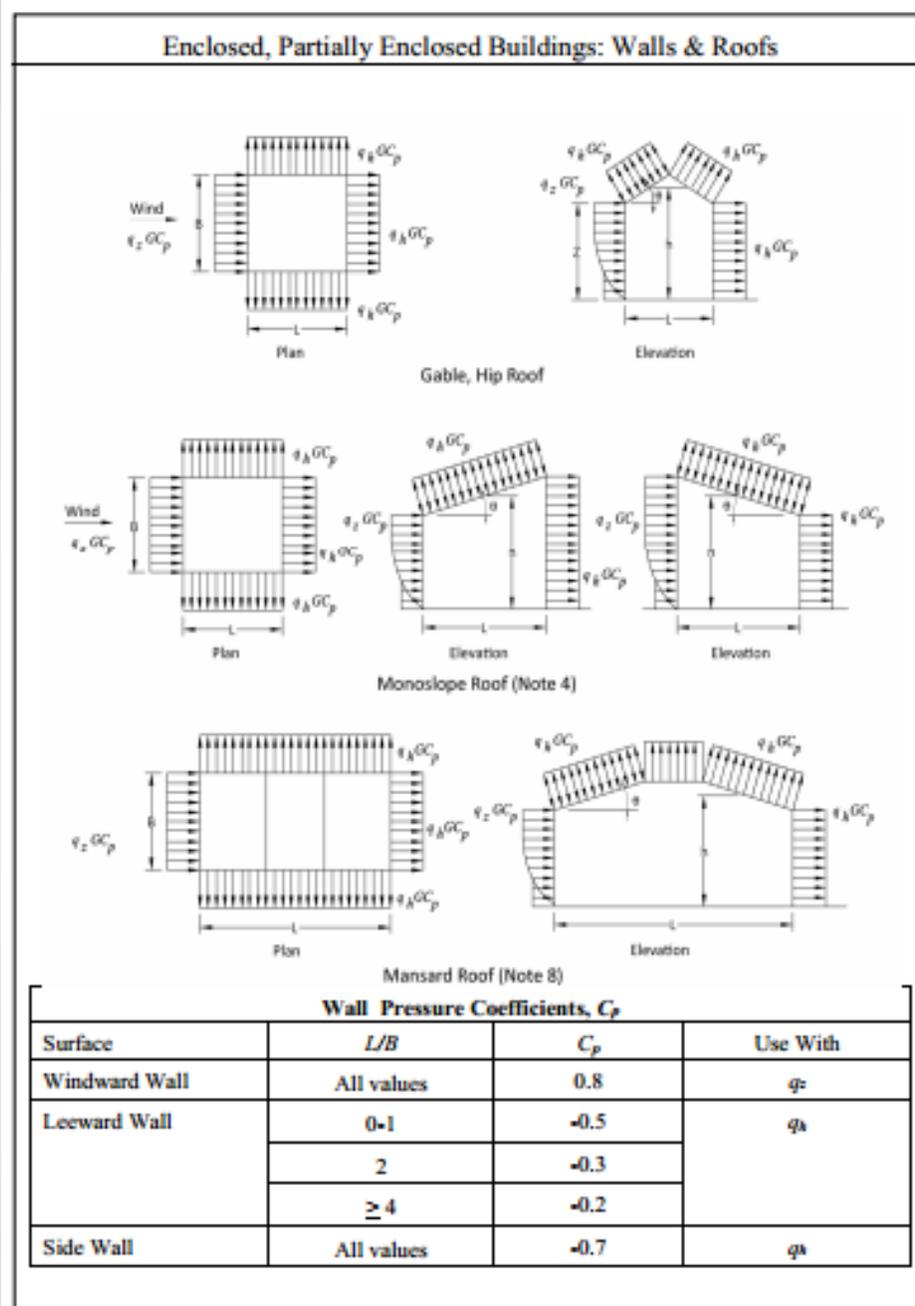


Figure 6.2.6 External Pressure Coefficients, C_p main wind force resisting system - Method 2 (All Heights)

Step-9

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.9.5

2.4.9.5 Velocity pressure

Velocity pressure, q_z evaluated at height z shall be calculated by the following equation:

$$q_z = 0.000613K_zK_{zt}K_dV^2I; \text{ (kN/m}^2\text{), } V \text{ in m/s} \quad (6.2.17)$$

Where K_d is the wind directionality factor, K_z is the velocity pressure exposure coefficient defined in Sec 2.4.6.6, K_{zt} is the topographic factor defined in Sec 2.4.7.2, and q_z is the velocity pressure calculated using Eq. 6.2.17 at mean roof height h . The numerical coefficient 0.000613 shall be used except where sufficient climatic data are available to justify the selection of a different value of this factor for a design application.

Step-10

According to BNBC 2020, Part-6, Chapter-2, Section-2.4.11

2.4.11 Design Wind Loads on Enclosed and Partially Enclosed Buildings

2.4.11.1 General

Sign Convention: Positive pressure acts toward the surface and negative pressure acts away from the surface.

Critical Load Condition: Values of external and internal pressures shall be combined algebraically to determine the most critical load.

Tributary Areas Greater than 65 m²: Component and cladding elements with tributary areas greater than 65 m² shall be permitted to be designed using the provisions for MWFRSs.

Continue...

2.4.11.2 Main wind-force resisting systems

Rigid Buildings of All Heights: Design wind pressures for the MWFRS of buildings of all heights shall be determined by the following equation:

$$p = qGC_p - q_i(GC_{pi}) \quad (\text{kN/m}^2) \quad (6.2.19)$$

Where,

$q = q_z$ for windward walls evaluated at height z above the ground

$q = q_h$ for leeward walls, side walls, and roofs, evaluated at height h

$q_i = q_h$ for windward walls, side walls, leeward walls, and roofs of enclosed buildings and for negative internal pressure evaluation in partially enclosed buildings.

Continue...

$q_i = q_z$ for positive internal pressure evaluation in partially enclosed buildings where height z is defined as the level of the highest opening in the building that could affect the positive internal pressure. For buildings sited in wind-borne debris regions, glazing that is not impact resistant or protected with an impact resistant covering, shall be treated as an opening in accordance with Sec 2.4.9.3. For positive internal pressure evaluation, q_i may conservatively be evaluated at height $h =$
($q_i = q_h$)

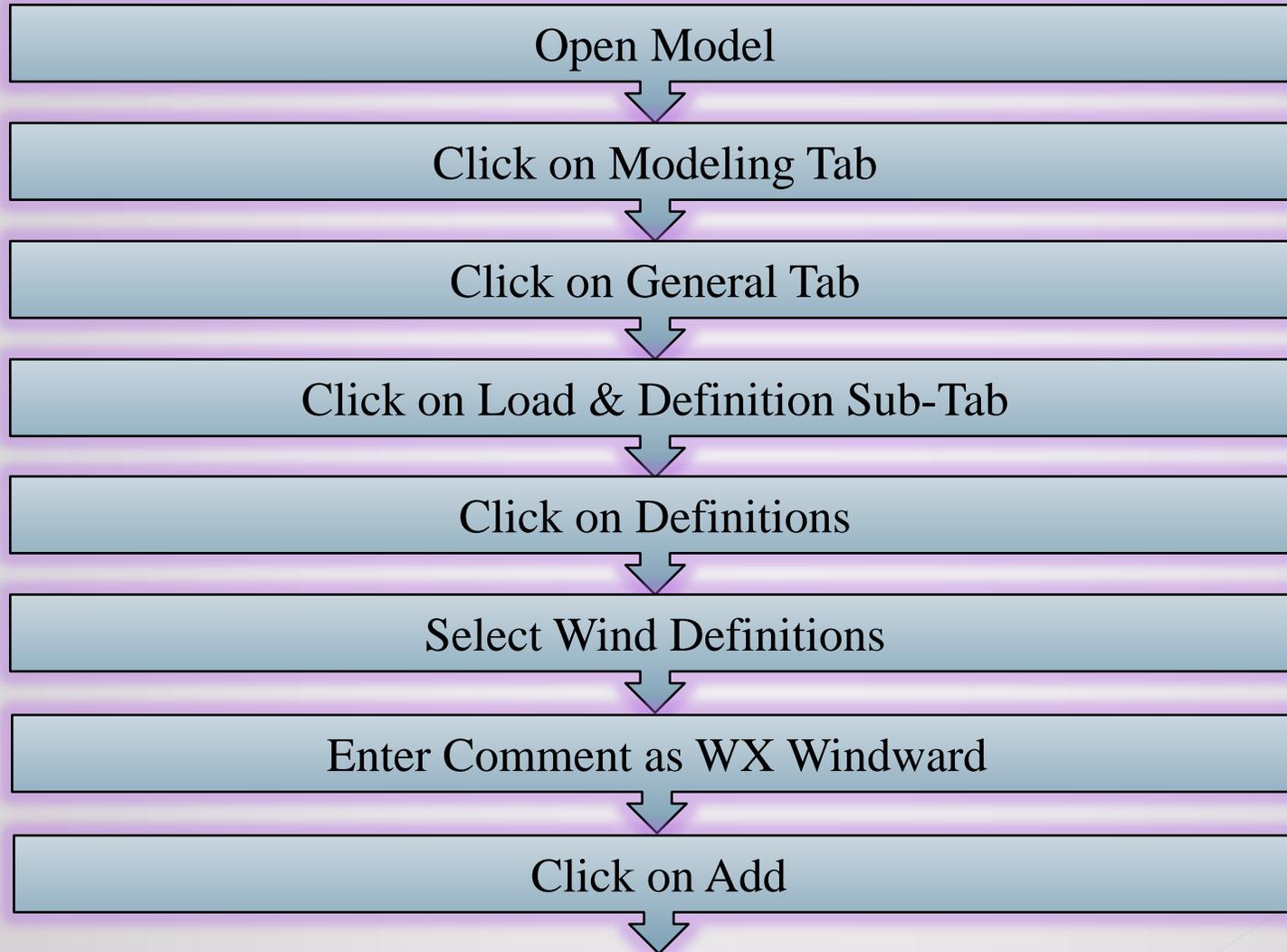
G = gust effect factor from Sec 2.4.8

C_p = external pressure coefficient from Figures 6.2.6 or 6.2.8

GC_{pi} = internal pressure coefficient from Figure 6.2.5

q and q_i shall be evaluated using exposure defined in Sec 2.4.6.3. Pressure shall be applied simultaneously on windward and leeward walls and on roof surfaces as defined in Figures 6.2.6 and 6.2.8.

Defining Wind Load



Continue...



Continue...

Enter Calculated Intensity per height



Click on Add



Do same procedure for WX Leeward, WZ Windward & WZ Leeward



Load Combinations assign

Week 9

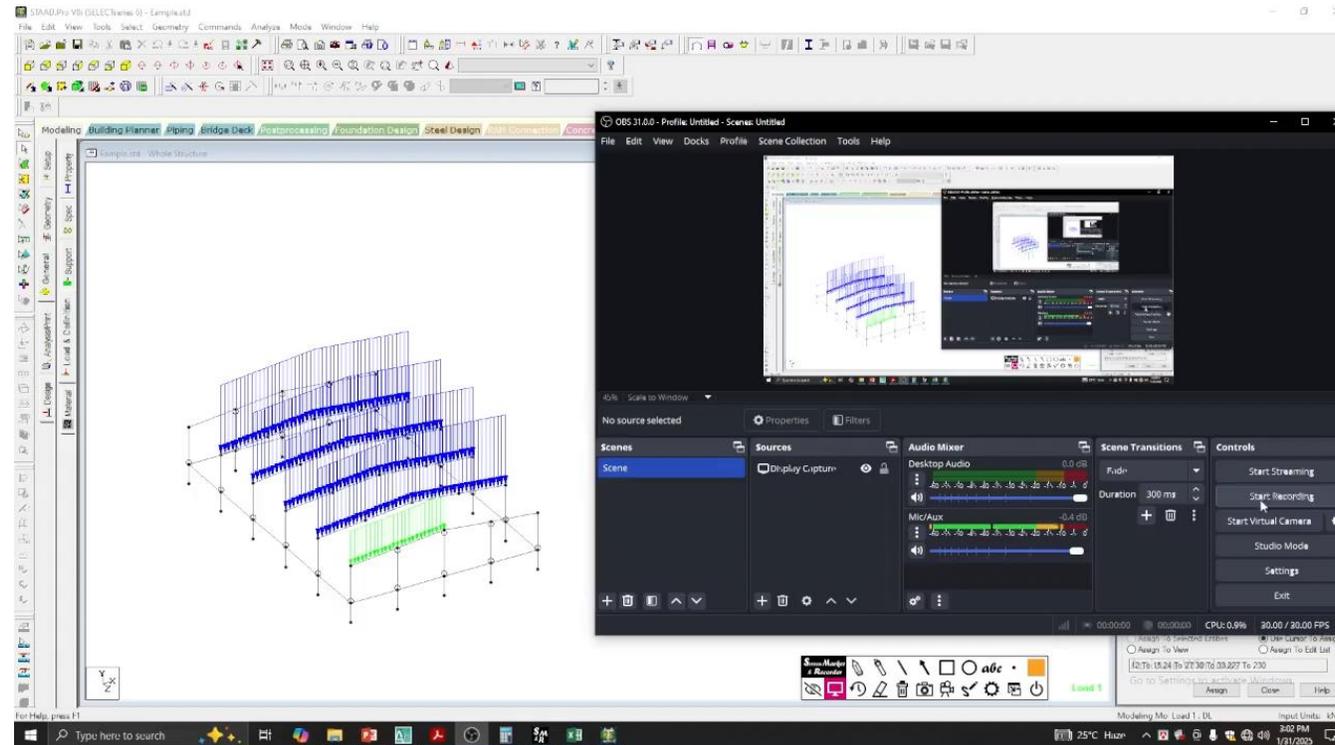
Pages 142-143

Assigning critical load combination according to AISC (2010) Guidelines



Microsoft Excel Worksheet

Load Calculation Excel Sheet



Load Assign (Video)



Steel Joint design (Moment Releasing Techniques)

Week 10-11

Pages 144-159

Key Skills:

- Designing hinged joint (Flexible)
- Designing rigid joint (Fixed)

Different Types of Connections in Steel Building Structures

What are connections in steel structure?

Connections are structural elements that are used for joining different members of the structural steel framework. The steel structure is the assembly of different members like beams, columns. These various steel members are interconnected using Rivets, Bolts, and Welding.

Types of Connection According to Connecting Medium

According to connecting medium connection is three types-

- Riveted Connections
- Bolted Connections
- Welded Connections

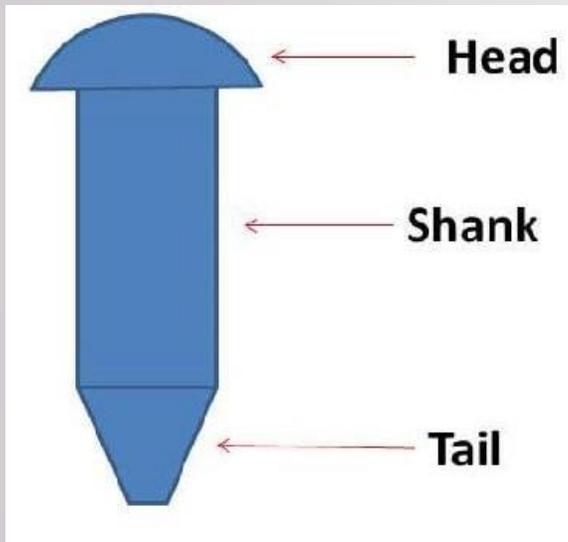


Fig.: Riveted Connections

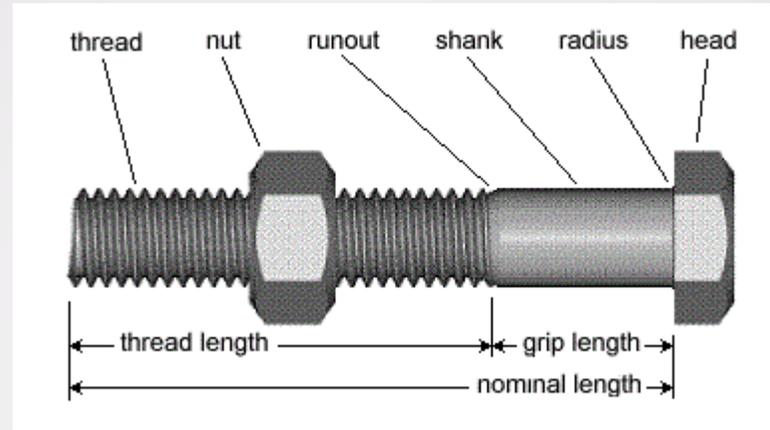


Fig.: Bolted Connections



Fig.: Welded Connections

Types of Connection

According to Connecting Members

The classification of steel connections is also commonly made to the structural members that they are to connect. In fact, the consideration for connecting columns and beams should act as one of the primary considerations when needing to design a steel connection. The common configurations include:

- Beam to Column Connections
- Beam to Beam Connections
- Column to Column Connections
- Column Base Plate Connections

Beam to Column Connections

The beam to column connection comprises the joint plus portions of the beams, columns and slab immediately adjacent to the joint.



Fig.: Beam to Column Connections

Beam to Beam Connections

For beam to beam connections, there are generally two types, depending on beam geometry. The first type is a primary beam connected to an adjacent secondary beam. The second type is through the use of a beam splice for linearly aligned members.

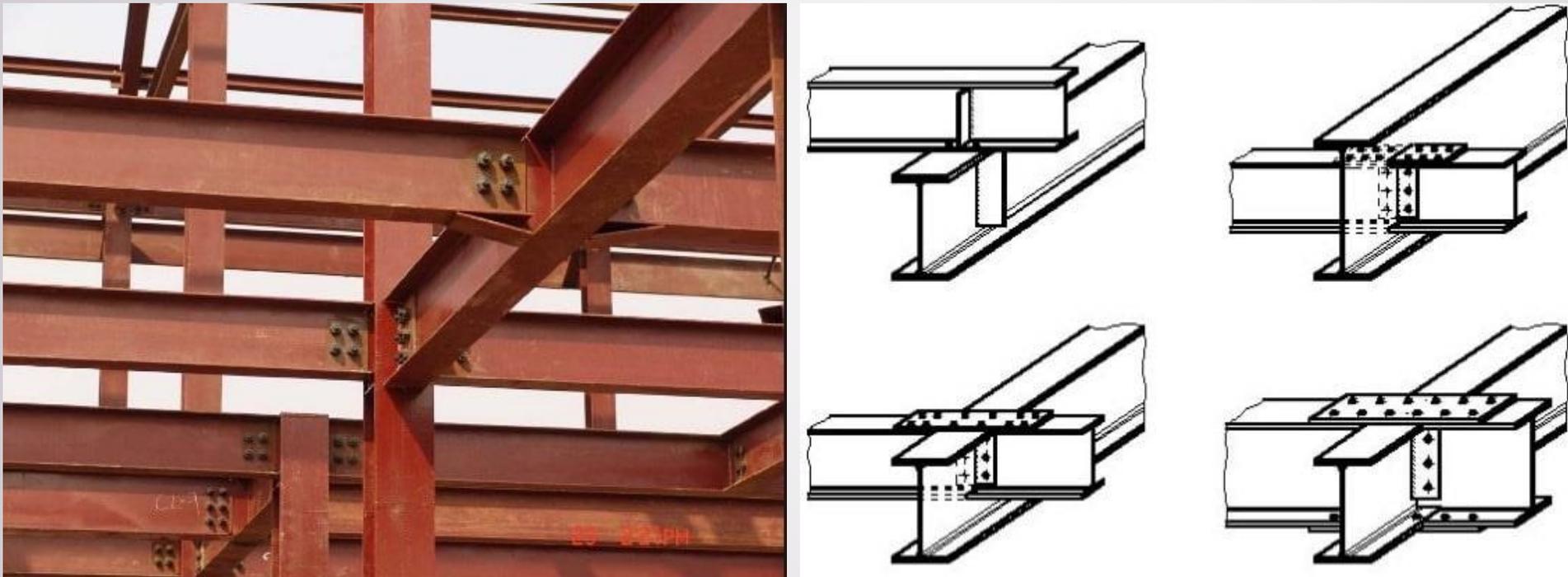


Fig.: Beam to Beam Connections

Column to Column Connections

Column to column connections are usually accomplished with the use of a column splice. A common application is with the connecting of columns of different cross sectional size.

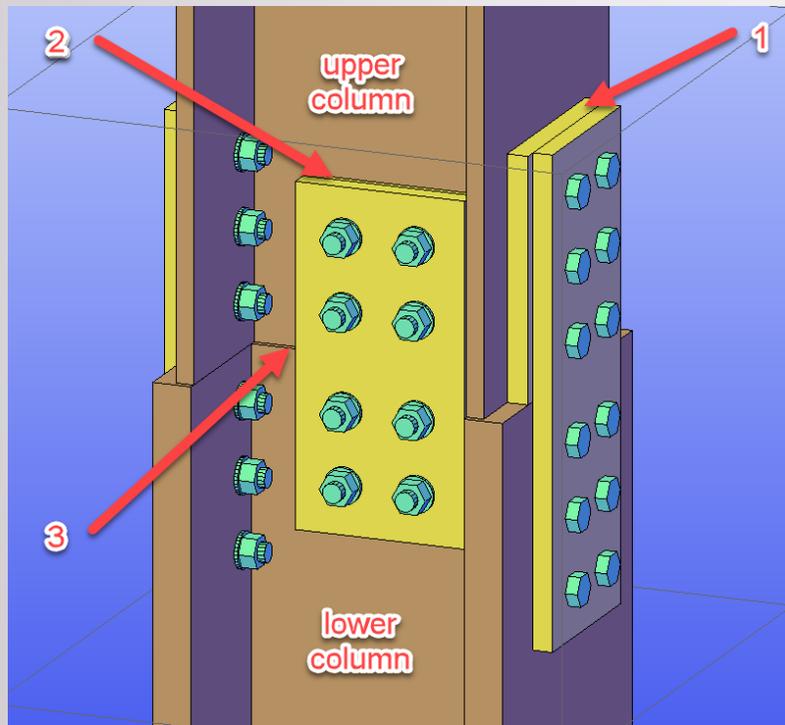


Fig.: Column to Column Connections

Column Base Plate Connections

The Column Base Plate connection is a rectangular steel plate welded to the bottom of a steel column. The steel plate sits on the top of a concrete support (with or without a grout pad between). The plate is bolted to the concrete with headed bolts that are embedded in the concrete.

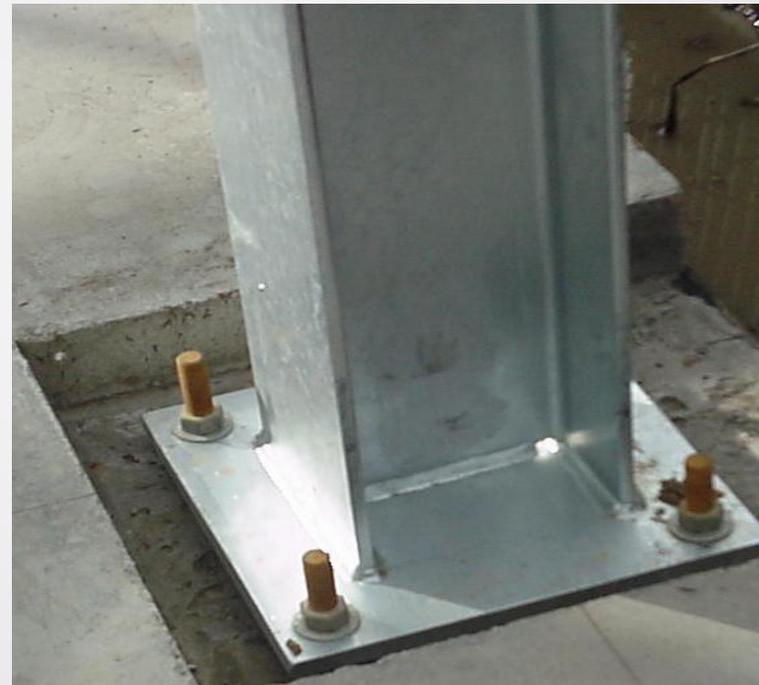
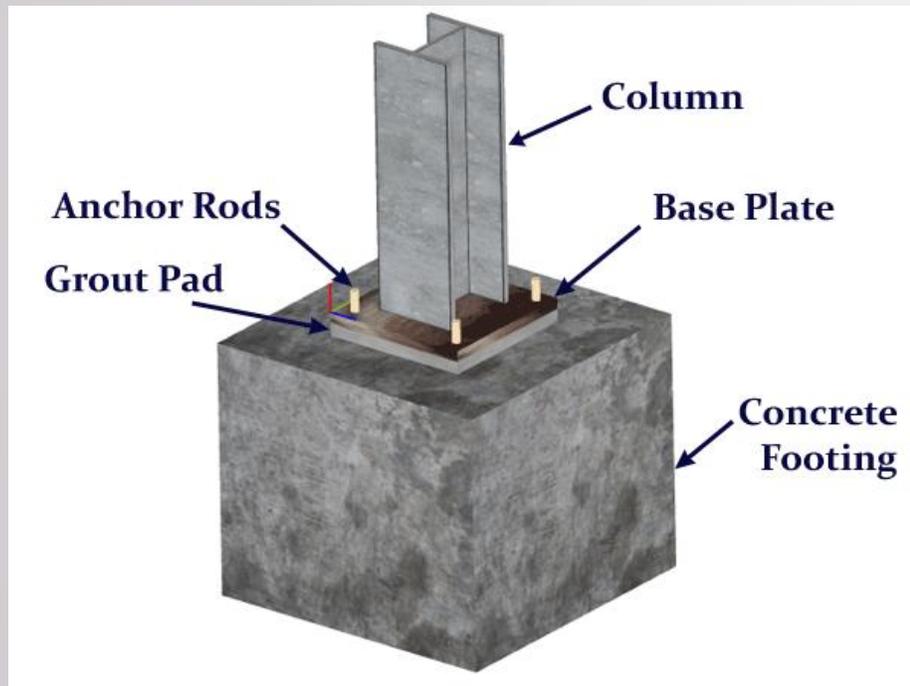


Fig.: Column Base Plate Connections

Types of Connection According to Internal Forces

According to internal force connection is three types-

- Axial Connections
- Shear or Simple or Semi-rigid Connections
- Moment or Rigid Connections

Axial Connections

Axial connections primarily carry axial loads and include splices, bracing, truss connections, and hangers. They are typically used to connect columns to columns, or beams to beams sometimes with different section sizes.



Fig.: Axial Connections

Shear or Simple or Semi-rigid Connections

Shear connections primarily carry shear loading (although they typically also carry axial loading). They are the most common type of structural steel connection, and are referred to as “simple” or “semi-rigid” connections because no bending moment is considered at the beam bends. Common shear connections include plates, web angles, and seat angles.

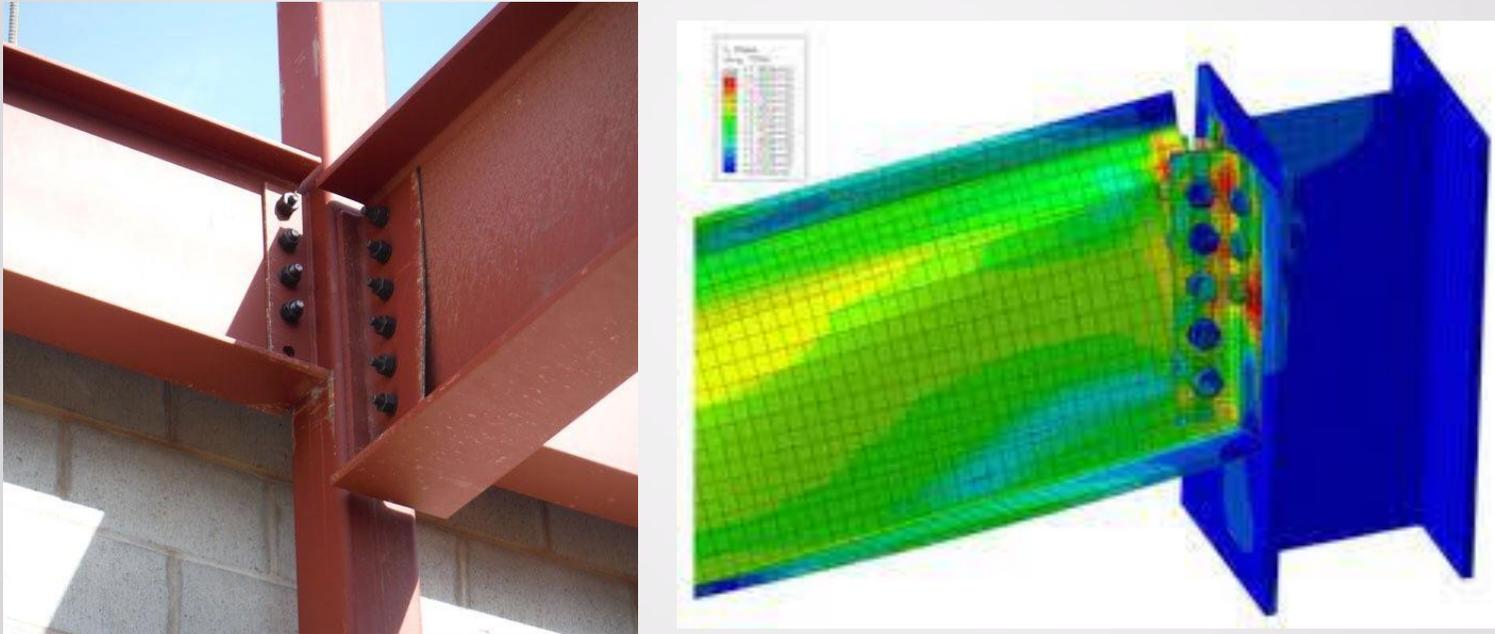


Fig.: Shear Connections

Moment or Rigid Connections

Moment connections primarily carry moment loading, however are usually designed to resist shear and axial loading as well. For this reason, they are referred to as “rigid” or “fully restrained” connections and are used to create a frame. Common moment connections include directly welded members, flange plates, and end plate connections.



Fig.: Moment Connections

Continue...

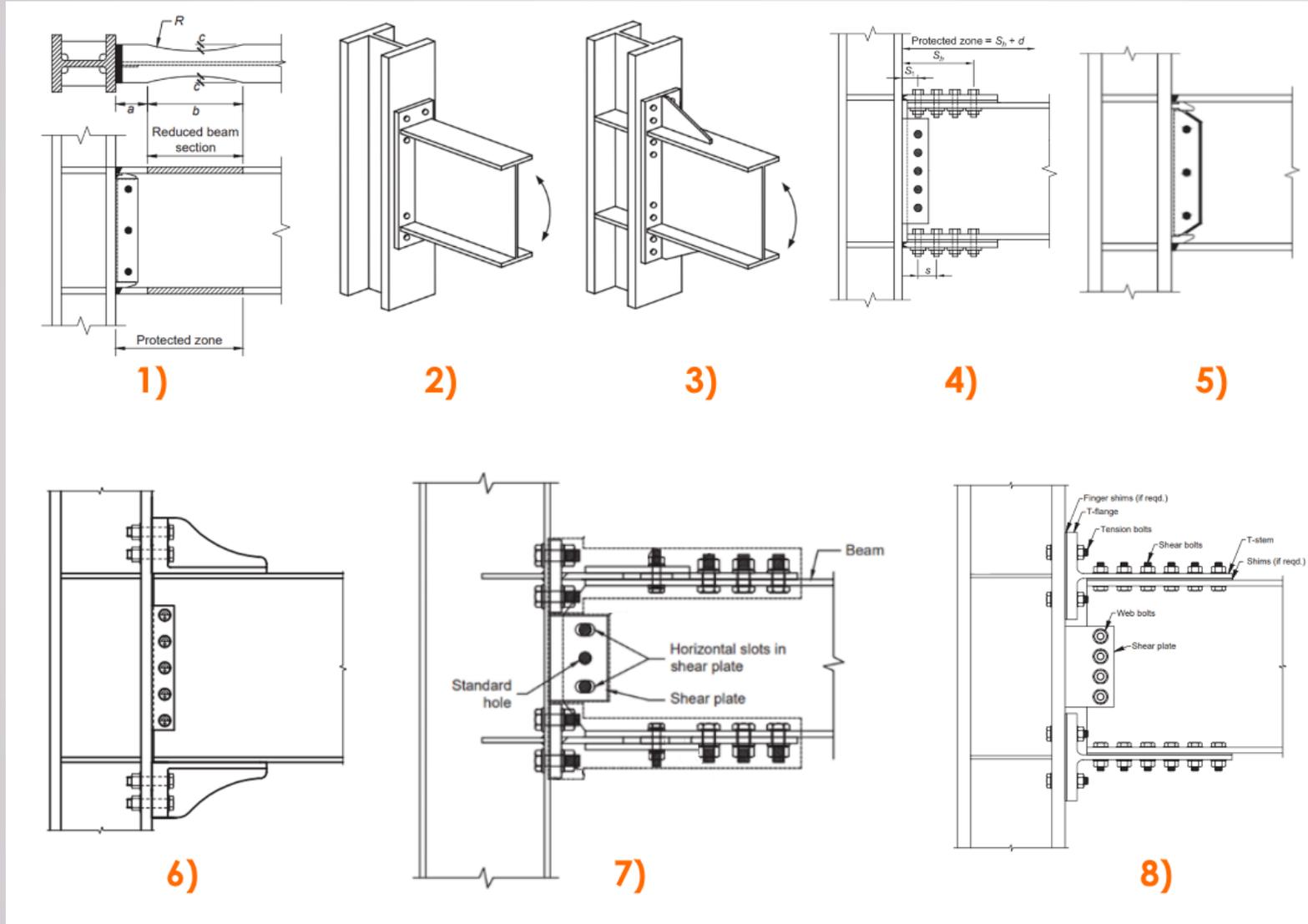


Fig.: Different Types of Moment Connections

Difference Between Shear & Moment Connections

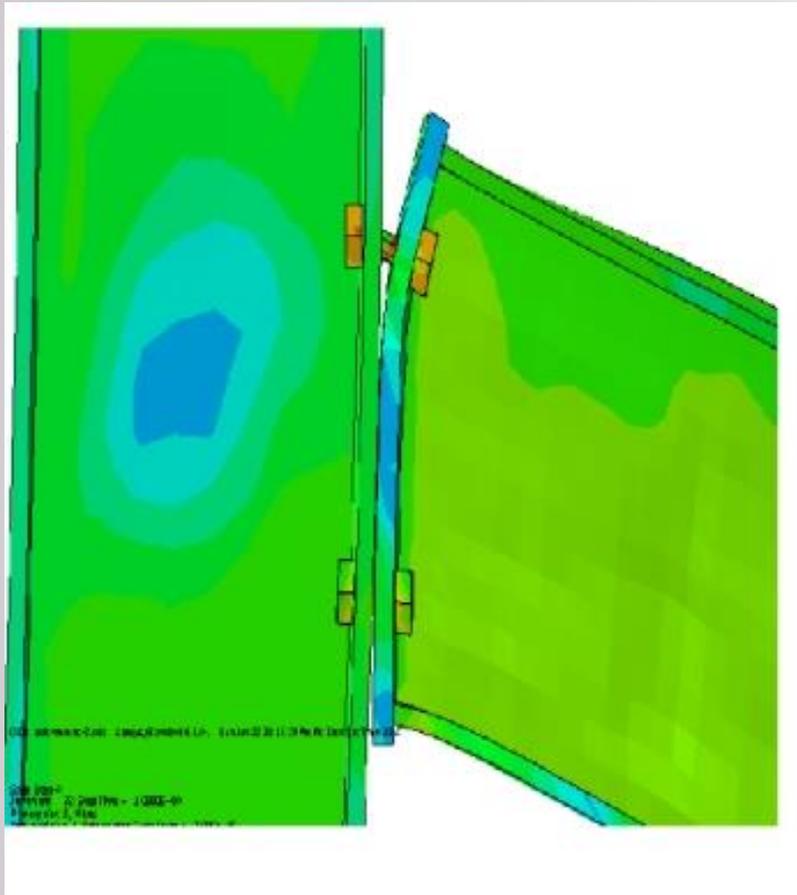


Fig.: Shear Connections

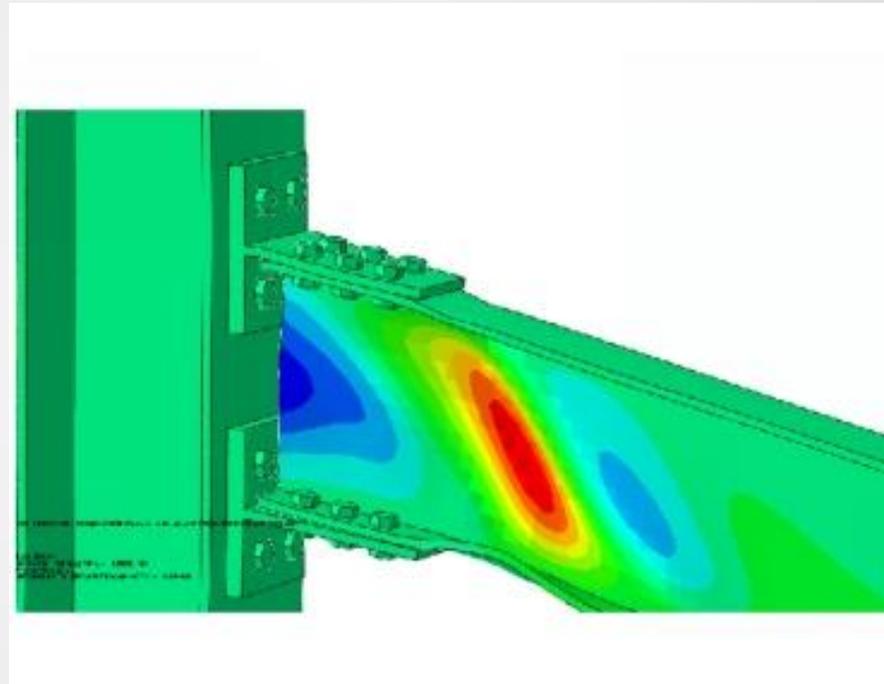


Fig.: Moment Connections

Fig.: Difference Between Shear & Moment Connections



Analysis and checking

Week 12

Pages 160-161

Skill Types:

- Checking and fixing the error
- Run the model
- Checking axial force – bending moment diagram
- Checking torsional force – bending moment diagram
- Checking area of reinforcement of each member



Serviceability Check

Week 13-14

Pages 163-164

Deflection Check

Table 6.1.2: Deflection Limits^{a, b, c, h} (Except earthquake load)

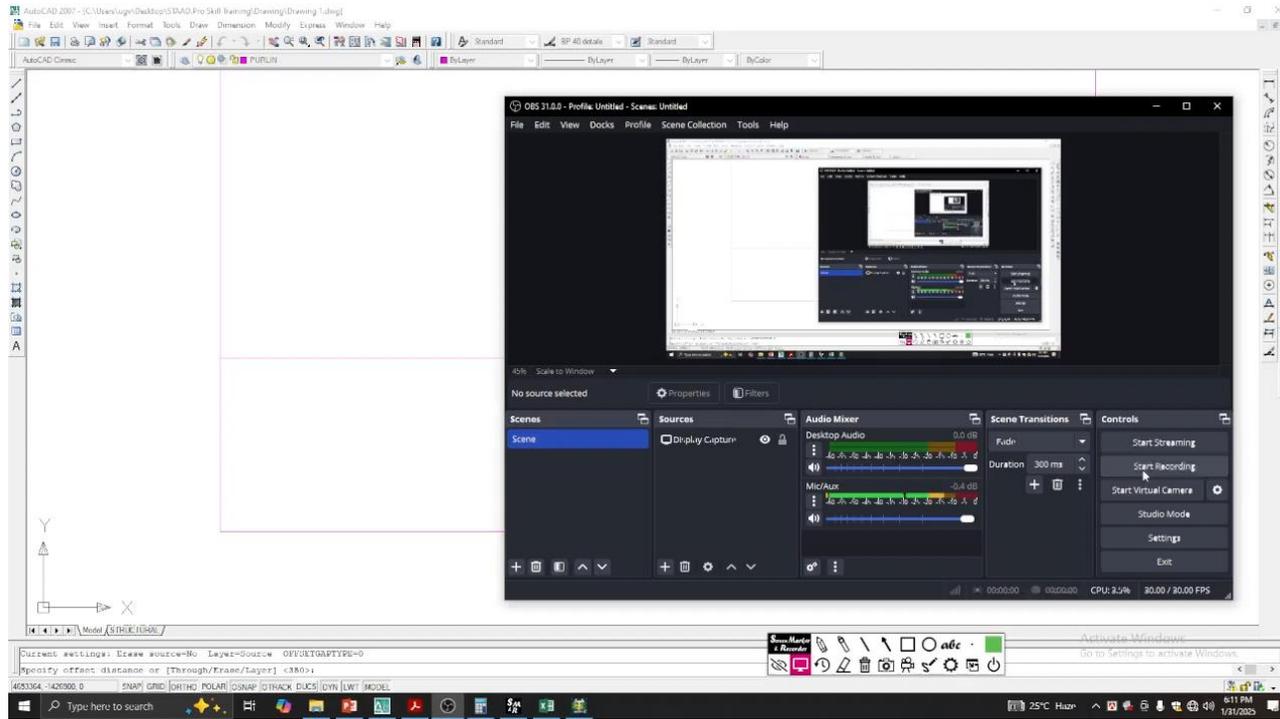
Construction	L	W^f	$D^g + L^d$
Roof members: ^e			
Supporting plaster ceiling	$l/360$	$l/360$	$l/240$
Supporting non-plaster ceiling	$l/240$	$l/240$	$l/180$
Not supporting ceiling	$l/180$	$l/180$	$l/120$
Floor members	$l/360$	-	$l/240$
Exterior walls and interior partitions			
With brittle finishes	-	$l/240$	
With flexible finishes	-	$l/120$	
Farm buildings	-		$l/180$
Greenhouses	-		$l/120$

Where, l , L , W and D stands for span of the member under consideration, live load, wind load and dead load respectively.

Notes:

- a.* For structural roofing and siding made of formed metal sheets, the total load deflection shall not exceed $l/60$. For secondary roof structural members supporting formed metal roofing, the live load deflection shall not exceed $l/150$. For secondary wall members supporting formed metal siding, the design wind load deflection shall not exceed $l/90$. For roofs, this exception only applies when the metal sheets have no roof covering.

- b.* Interior partitions not exceeding 2 m in height and flexible, folding and portable partitions are not governed by the provisions of this Section.
- c.* For cantilever members, l shall be taken as twice the length of the cantilever.
- d.* For wood structural members having a moisture content of less than 16% at time of installation and used under dry conditions, the deflection resulting from $L + 0.5D$ is permitted to be substituted for the deflection resulting from $L + D$.
- e.* The above deflections do not ensure against ponding. Roofs that do not have sufficient slope or camber to assure adequate drainage shall be investigated for ponding. See Sec 1.6.5 for rain and ponding requirements.
- f.* The wind load is permitted to be taken as 0.7 times the “component and cladding” loads for the purpose of determining deflection limits herein.
- g.* Deflection due to dead load shall include both instantaneous and long term effects.
- h.* For aluminum structural members or aluminum panels used in skylights and sloped glazing framing, roofs or walls of sunroom additions or patio covers, not supporting edge of glass or aluminum sandwich panels, the total load deflection shall not exceed $l/60$. For continuous aluminum structural members supporting edge of glass, the total load deflection shall not exceed $l/175$ for each glass lite or $l/60$ for the entire length of the member, whichever is more stringent. For aluminum sandwich panels used in roofs or walls of sunroom additions or patio covers, the total load deflection shall not exceed $l/120$.



Serviceability Check (Video)



Detailing and Discusses about design codes

Week 13-14

Pages 166-177



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Training\Gazetted-

Bangladesh National building Code (2020) pdf
(Click here)

AISC (American Institute of Steel Construction)-
2010-Guidelines

Click this link to read this pdf

Steel Design Parameters

D1.B.1.2 Design Parameters

The program contains a large number of parameter names which are needed to perform designing and code checking. These parameter names and their default values, are listed in the following table. These parameters communicate design decisions from the engineer to the program.

The default parameter values have been selected such that they are frequently used numbers for conventional design. Depending on the particular design requirements of an analysis, some or all of these parameter values may have to be changed to exactly model the physical structure. For example, by default the KZ (k value in local z-axis) value of a member is set to 1.0, while in the real structure it may be 1.5. In that case, the KZ value in the program can be changed to 1.5, as shown in the input instructions. Similarly, the TRACK value of a member is set to 0.0, which means no allowable stresses of the member will be printed. If the allowable stresses are to be printed, the TRACK value must be set to 1.0.

The parameters PROFILE, DMAX, and DMIN are only used for member selection.

Table 1. AISC (9th Ed.) Design Parameters

Parameter Name	Default Value	Description
<u>AXIS</u>	1	Select axis about which single angles are design 1) Design single angles for bending about their principle axis. 2) Design single angles for bending about their geometric axis.
<u>BEAM</u>	1.0	Used to specify the number of sections at which the member design is evaluated. 0.0 = design at start and end nodes and those locations specified by the SECTION command. 1.0 = design at 13 evenly spaced points (i.e., 1/12 th points) along member length, including start and end nodes. Note: See D1.A.6 Design Parameters.
<u>BMAX</u>	83.3333 ft	Maximum allowable width of the flange. Used in the design of tapered sections.

Continue...

Parameter Name	Default Value	Description
<u>CAN</u>	0	Specifies the method used for deflection checks 0) deflection check based on the principle that maximum deflection occurs within the span between DJ1 and DJ2. 1) deflection check based on the principle that maximum deflection is of the cantilever type (see note 1)
<u>CB</u>	1.0	Cb value as used in Section 1.5 of AISC. Use 0.0 to direct the program to calculated Cb. Any other value be used in lieu of the program calculated value.
<u>CDIA</u>	0.0	The diameter of circular openings. If a member has more than one circular opening, they can have different diameters.
<u>CHOLE</u>	NONE	Section locations of circular openings along the length of the member. Maximum three locations can be specified for each member when there is no rectangular opening.
<u>CMP</u>	0	Composite action with connectors 0) design as non-composite beam 1) design as a composite beam if the slab is in bending compression throughout the span, design as a non-composite beam if the slab is in tension anywhere along the span 2) design as a composite beam only. Ignore moments which cause tension in the slab.
<u>CMZ</u>	0.85 for sidesway and calculated for no sidesway	Cm value in local y and z axes, respectively.
<u>CYC</u>	500,000	Cycles of maximum stress to which the shear connectors are subject.
<u>DFE</u>	none (mandatory for deflection check)	"Deflection Length" / Maximum allowable local deflection
<u>DIA</u>	0.625 in.	Diameter of the shear connectors

Continue...

Parameter Name	Default Value	Description
<u>DINC</u>	1 in	Incremental depth value used in the design of tapered sections.
<u>DJ1</u>	Start Joint of member	Joint No. denoting starting point for calculation of "Deflection Length" (see note 1)
<u>DJ2</u>	End Joint of member	Joint No. denoting end point for calculation of "Deflection Length" (see note 1)
<u>DMAX</u>	1000 in.	Maximum allowable section depth.
<u>DMIN</u>	0.0 in.	Minimum allowable section depth.
<u>DR1</u>	0.4	Ratio of moment due to dead load applied before concrete hardens to total moment.
<u>DR2</u>	0.4	Ratio of moment due to dead load applied after concrete hardens to total moment.
<u>ELECTRODE</u>	1	Weld material to be used for reinforced opening. 0) E60XX 1) E70XX 2) E80XX 3) E90XX 4) E100XX 5) E110XX
<u>FBINC</u>	0	Incremental bottom flange width used in the design of tapered sections. In this case, the top flange width will remain unchanged.
<u>FLX</u>	1	Single angle member bracing 1) Single angle member is <i>not</i> fully braced against lateral torsional buckling. 2) Single angle member is fully braced against lateral torsional buckling. 3) Single angle member is braced against lateral torsional buckling at the point of maximum moment.
<u>FPC</u>	3.0 ksi	Compressive strength of concrete at 28 days

Continue...

Parameter Name	Default Value	Description
<u>E</u> SS	1	Is the full section to be used for shear design? 0) No (False) 1) Yes (True)
<u>E</u> TBINC	0	Incremental flange width (top and bottom) used in the design of tapered sections.
<u>E</u> TINC	0	Incremental top flange width used in the design of tapered sections. In this case, the bottom flange width will remain unchanged.
<u>E</u> U	Depends on FYLD	Ultimate tensile strength of steel in current units. If FYLD < 40 KSI, then FU = 58 KSI If 40 KSI ≤ FYLD ≤ 50 KSI, then FU = 60 KSI If FYLD > 50 KSI, then FU = 65 KSI
<u>F</u> YLD	36 KSI	Yield strength of steel in current units.
<u>H</u> ECC	0.0	Eccentricity of opening with respect to the centerline of the member.
<u>K</u> X	1.0	K value used in computing KL/r for flexural torsional buckling for tees and double angles.
<u>K</u> Y	1.0	Effective length factor to calculate slenderness ratio for buckling about local y-axis. Usually this is the minor axis.
<u>K</u> Z	1.0	Effective length factor to calculate slenderness ratio for buckling about local z-axis. Usually this is the major axis.
<u>L</u> X	Member Length	Length value used in computing KL/r for flexural torsional buckling for tees and double angles.

Continue...

Parameter Name	Default Value	Description
<u>LY</u>	Member Length	Length used to calculate slenderness ratio for buckling about the local y-axis.
<u>LZ</u>	Member Length	Same as LY, but in the local z-axis.
<u>MAIN</u>	0.0	Toggles the slenderness check 0.0) check for slenderness 1.0) suppress slenderness check Any value greater than 1 = Allowable KL/r in compression.
<u>NSE</u>	1.0	Net section factor for tension members.
<u>OVR</u>	1.0	Overstress factor. All the allowable stress are multiplied by this number. It may be assigned any value greater than 0.0. It is used to communicate increases in allowable stress for loads like wind and earthquake.
<u>PLTHICK</u>	0.0	Thickness of cover plate welded to the bottom flange of the composite beam.
<u>PLWIDTH</u>	0.0	Width of cover plate welded to the bottom flange of the composite beam.
<u>PROFILE</u>		Used in member selection. Refer to TR.48.1 Parameter Specifications for details.
<u>RATIO</u>	1.0	Permissible ratio of actual to allowable stress.
<u>RDIM</u>	0.0	Dimensions of rectangular openings (at each section, RDIM has a length term and a depth term – see syntax below). If a member has more than one rectangular opening they can have different dimensions.
<u>RHOLE</u>	None	Section locations of rectangular openings along the length of the member. Maximum three locations can be specified for each member when there is no circular opening.
<u>RBHEIGHT</u>	0.0	Height of ribs in the form steel deck.
<u>RBWIDTH</u>	2.5 in.	Width of ribs in the form steel deck.
<u>SHE</u>	0	Option for calculating actual shear stress.

Continue...

Parameter Name	Default Value	Description
		0) Compute the shear stress using VQ/Ib 1) Computer the shear stress based on the area of the section element.
<u>SHR</u>	0	Indicates use of temporary shoring during construction. 0) Without shoring 1) With shoring
<u>SSY</u>	0.0	Sidesway 0.0) Sidesway in local y-axis. 1.0) No sidesway
<u>SSZ</u>	0.0	Same as SSY, but in local z-axis.
<u>STIFF</u>	Member Length or depth of beam, whichever is greater	Spacing of stiffeners for plate girder design.
<u>STP</u>	1	Section type as defined in ASD Manual table. 1) Rolled 2) Welded
<u>TAPER</u>	1.0	Design basis for tapered members 0.0) Design tapered I-section based on rules of Chapter F and Appendix B of AISC only. Due not use the rules in Appendix F of AISC-89. 1.0) Design tapered I-sections based on the rules of Appendix F of AISC-89.
<u>THK</u>	4.0 in.	Thickness of concrete slab or the thickness of concrete slab above the form steel deck.

Continue...

Parameter Name	Default Value	Description
<u>TMAIN</u>	300	Any value greater than 1 = Allowable KL/r in tension.
<u>TORSION</u>	0.0	Toggles the check for torsion 0.0) No torsion check is performed 1.0) Perform torsion check based on rules of AISC T114.
<u>TRACK</u>	0.0	Controls the level of detail to which results are reported: 0) minimum detail 1) intermediate detail 2) maximum detail (see Figure 2.1)
<u>UNB</u>	Member Length	Unsupported length of the bottom* flange for calculating allowable bending compressive stress. Will be used only if flexural compression is on the bottom flange
<u>UNT</u>	Member Length	Unsupported length of the top* flange for calculating allowable bending compressive stress. Will be used only if flexural compression is on the top flange.
<u>WELD</u>	1 for closed sections, 2 for open sections	Weld type as described in D1.B.1.10 Weld Design : 1) welding is on one side only except for wide-flange or tee sections, where the web is always assumed to be welded on both sides. 2) welding on both sides. For closed sections like a pipe or tube, the welding will be on one side only.
<u>WIDTH</u>	0.25 times the member length	Effective width of the concrete slab.
<u>WMAX</u>		Maximum welding thickness.
<u>WMIN</u>		Minimum welding thickness.
<u>WSTR</u>	$0.4 \times FYLD$	Allowable weld stress. Refer to D1.B.1.10 Weld Design for how WELD, WMAX, WMIN, and WSTR parameters are used in weld design.

Continue...

*Top and Bottom represent the positive and negative side of the local Y axis (local Z axis if SET Z UP is used).

Notes

1. When performing the deflection check, you can choose between two methods. The first method, defined by a value θ for the CAN parameter, is based on the local displacement. See [TR.44 Printing Section Displacements for Members](#) for details on local displacement.

If the CAN parameter is set to 1, the check will be based on cantilever style deflection. Let $(DX1, DY1, DZ1)$ represent the nodal displacements (in global axes) at the node defined by DJ1 (or in the absence of DJ1, the start node of the member). Similarly, $(DX2, DY2, DZ2)$ represent the deflection values at DJ2 or the end node of the member.

$$\text{Compute Delta} = \sqrt{(DX2 - DX1)^2 + (DY2 - DY1)^2 + (DZ2 - DZ1)^2}$$

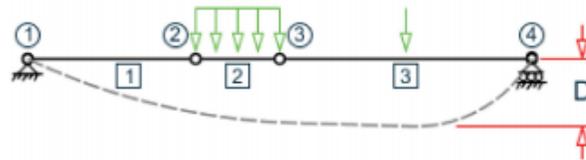
Compute Length = distance between DJ1 and DJ2 or, between start node and end node, as the case may be.

Then, if CAN is specified a value 1, $dff = L/\text{Delta}$

Ratio due to deflection = DFF/dff

2. If $CAN = \theta$, deflection length is defined as the length that is used for calculation of local deflections within a member. It may be noted that for most cases the "Deflection Length" will be equal to the length of the member. However, in some situations, the "Deflection Length" may be different.

For example, refer to the figure below where a beam has been modeled using four joints and three members. The "Deflection Length" for all three members will be equal to the total length of the beam in this case. The parameters DJ1 and DJ2 should be used to model this situation. Also the straight line joining DJ1 and DJ2 is used as the reference line from which local deflections are measured. Thus, for all three members here, DJ1 should be "1" and DJ2 should be "4".



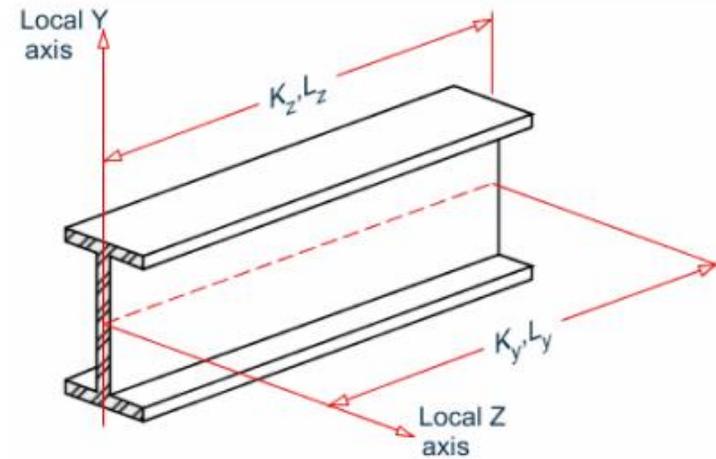
D is equal to the maximum local deflection for members 1, 2, and 3.

Continue...

PARAMETERS
DFF 300. ALL
DJ1 1 ALL
DJ2 4 ALL

3. If DJ1 and DJ2 are not used, "Deflection Length" will default to the member length and local deflections will be measured from original member line.
4. It is important to note that unless a DFF value is specified, STAAD.Pro will not perform a deflection check. This is in accordance with the fact that there is no default value for DFF.
5. A critical difference exists between the parameters UNT/UNB and the parameters LY and LZ. Parameters UNT and UNB represent the laterally unsupported length of the compression flange. It is defined in Chapter F, page 5-47 of the specifications in the AISC 1989 ASD manual as the distance between cross sections braced against twist or lateral displacement of the compression flange. These parameters are used to calculate the allowable compressive stress (FCZ and FCY) for behavior as a beam. Parameters LY and LZ are the unbraced lengths for behavior as a column and are used to calculate the KL/r ratios and the allowable axial compressive stress FA.
6. Parameters SSY and CMY are based upon two values defined in page 5-55, Chapter H of the AISC 9th ed. manual. SSY is a variable which allows you to define whether or not the member is subject to sidesway in the local Y direction. CMY is a variable used for defining the expression called Cm in the AISC manual. When SSY is set to 0 (which is the default value), it means that the member is subject to sidesway in the local Y direction. When SSY is set to 1.0, it means that the member is not subject to sidesway in the local Y direction. The only effect that SSY has is that it causes the program to calculate the appropriate value of CMY. If SSY is set to 0 and CMY is not provided, STAAD.Pro will assume CMY as 0.85. If SSY is set to 1 and CMY is not provided, STAAD.Pro will calculate CMY from the equation on page 5-55. However, if you provide CMY, the program will use that value and not calculate CMY at all, regardless of what you defines SSY to be.

Continue...



Terms used in calculating slenderness ratios KL/r for local Y and Z axes

7. For a T shape which is cut from a parent I, W, S, M or H shapes, the PROFILE parameter should be assigned a value corresponding to the parent shape. For example, if the T desired is an American WT6, specify W12 for the PROFILE parameter.



Review and Problem solving class

Week 16-17

Questions?



Thank you