SNS College of Technology,
Coimbatore- 35(Autonomous)
Department of Civil Engineering

Academic Year 2024-2025 (Even)

VI Semester
19CET304 – DESIGN OF STEEL STRUCTURES

Unit III
DESIGN OF COMPRESSION MEMBERS

1. What is meant by strut? ***(IS800:2007-Pg: 5)***

A strut is defined as a structural member subjected to compression in a direction parallel toits longitudinal axis. The term strut is commonly used for compression members in roof trusses.

2. What is meant by effective sectional area?

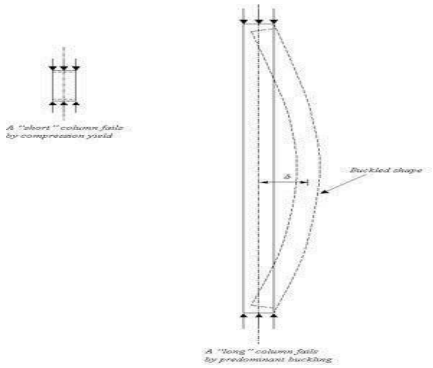
The effective sectional area of a compression member is the gross cross sectional area ofthe member. The deduction is not made for members connected by rivets, bolts and pins.

3. Define slenderness ratio of compression member.

The slenderness ratio of a compression member is the ratio of effective length of

$$\text{Slenderness ratio, } \lambda = l/r.$$

4. Draw the diagram of buckling of column.



5. Define compression member

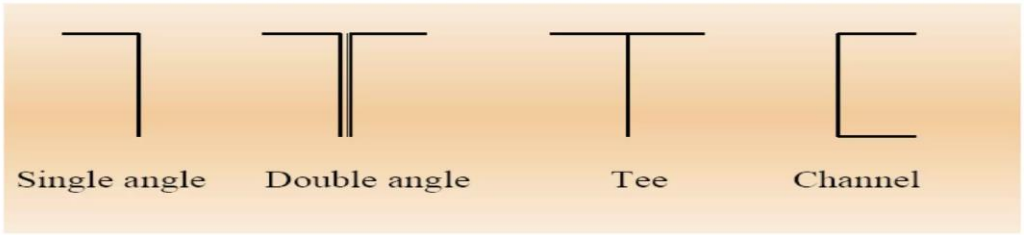
A **compression Member** is a structural member which is subjected to two equal opposite compressive forces applied at its end. Structural elements that are subjected to axial compressive forces are only called columns. A compression member may be a short column or long column based on the slenderness ratio criteria.

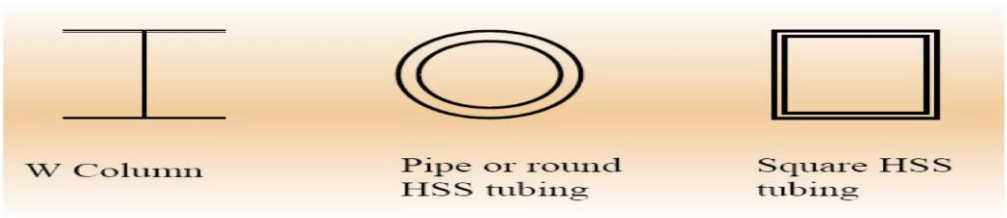
6. Classify the modes of failures in compression member.

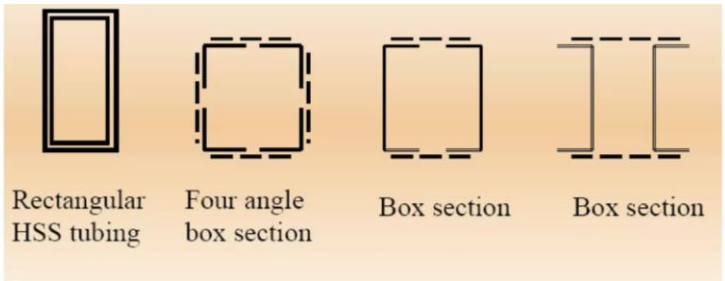
Modes of Failure in Compression Member
In a compression member, there are several factors due to which compression members fail. The failure depends on the column type (depending upon slenderness ratio).

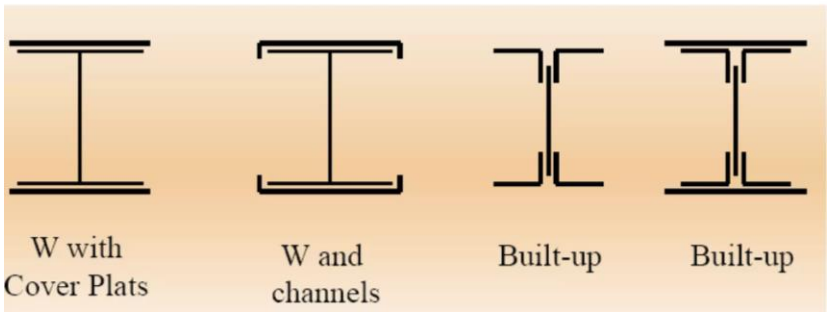
- The compression member fails due to buckling and crushing in the case of the column.
- Crushing or Yielding failure is shown in a short column.
- Buckling failure is further classified into elastic buckling and inelastic buckling. When the compression member translates perpendicular to the applied load, It shows in the long column.
- The intermediate column fails due to inelastic failure. This failure is the combination of yielding and lateral buckling in a column.

7. Name the Types of Sections for Compression Members



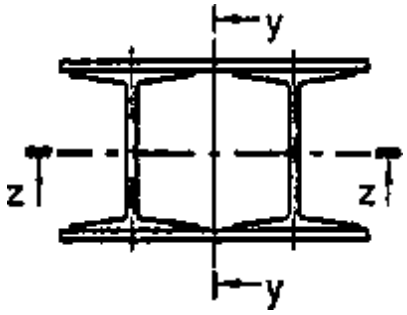






8. What is meant by built-up compression members?

The built-up compression members are needed when the single rolled steel sections are not sufficient to furnish the required cross-sectional area. A built-up compression member may consist of two or more rolled structural steel sections connected together effectively and acts as one compression member.



9. *Define effective length.*

The effective length of a compression member is the distance between the points of contra flexures of a buckled column. It depends on the actual length and the end conditions in regards to restraint against rotation and transverse displacement.

10. *What is meant by actual length?*

The actual length is taken as the length from centre-centre of intersections with the supporting members.

12. H

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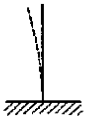
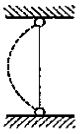
13. *on?*

Table 11 Effective Length of Prismatic Compression Members

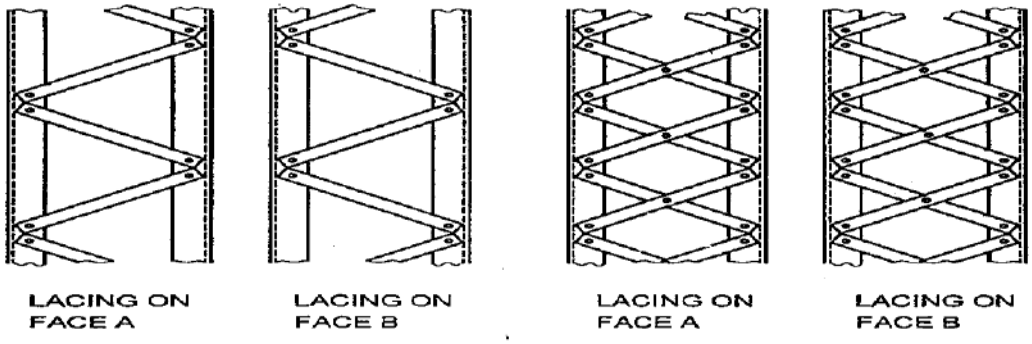
(*Clause* 7.2.2)

Boundary Conditions				Schematic Representation	Effective Length
At One End		At the Other End			
Translation	Rotation	Translation	Rotation		
(1)	(2)	(3)	(4)	(5)	(6)
Restrained	Restrained	Free	Free		2.0*L*
Free	Restrained	Free	Restrained		
Restrained	Free	Restrained	Free		1.0*L*
Restrained	Restrained	Free	Restrained		1.2*L*
Restrained	Restrained	Restrained	Free		0.8*L*
Restrained	Restrained	Restrained	Restrained		0.65*L*

14. **Define single lacing & double lacing.** ***(IS800:2007-Pg: 48 & 49)***

7.6.1.4 Single laced systems, on opposite faces of the components being laced together shall preferably be in the same direction so that one is the shadow of the other, instead of being mutually opposed in direction.

Double laced system, on opposite faces of the components being laced together shallpreferably be in mutual opposed in direction**.**

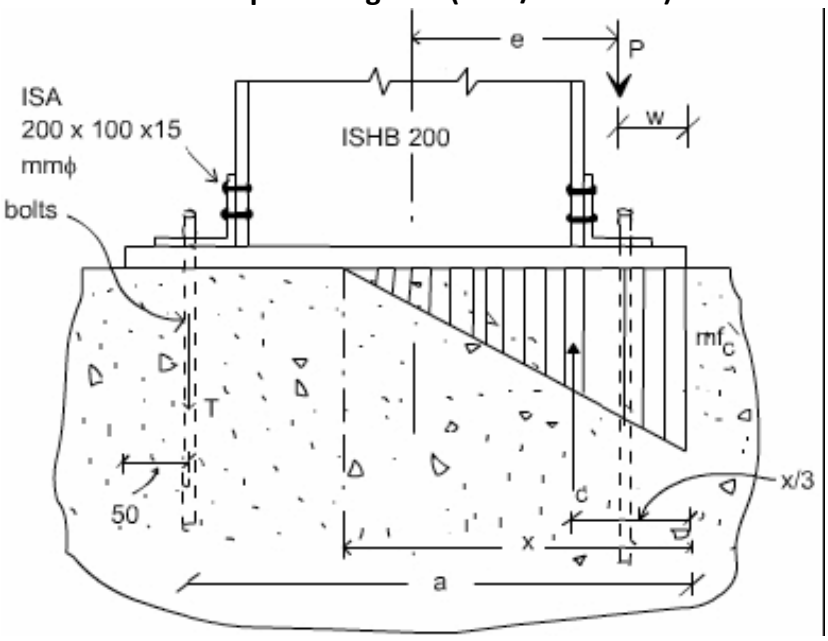


10A Single Laced System 10B Double Laced System

16. What are the forces acting on lacing system?

The forces acting on lacing system are transverse shear force and axial force.

17. Draw the column base plate diagram. (Nov / Dec 2005)



18. *Where should the splice plate be located in a column?(IS800:2007-Pg:46)*

7.3.4.1 Where the ends of compression members are prepared for bearing over the whole area, they shall be spliced to hold the connected members accurately in position, and to resist bending or tension, if present. Such splices should maintain the intended member stiffness about each axis. Splices should be located as close to the point of inflection as possible. Otherwise their capacity should be adequate to carry magnified moment

19. Define Column Base

The column base is the interface between the columns and their foundation. Column base reduces the intensity of loading and distributing it over the foundation. The area of the column base or base plate is chosen so that the intensity of load distributed is less than the bearing capacity of concrete on which the plate resists. It also maintains the proper alignment of columns in a plan**.**

20. Which type of column is used for heavy loading?

Gusseted base plates are used for columns carrying heavy loads and loads accompanied by moments. In this case, fastenings are used to connect the base plate and the column in the form of vertical gusset plates and gusset angles.

21. What are the types of bases provided for connecting the column to the base?

- Slab base
- Gusseted base
- Moment resisting base

22. Under what circumstances gusset base is used?

When the load on the column is large or when the column is subjected to moment along with axial load, gusseted base is provided. It consists of a base plate, gusset plate, connecting angles provided on either side of the column and web cleat angle.

23. Write about batten plates in compression member.

Batten plates are structural elements used in built-up compression members to provide stability and ensure the individual components act as a single unit. They are typically used in latticed columns, built-up sections, and trussed structures to resist buckling and shear forces.

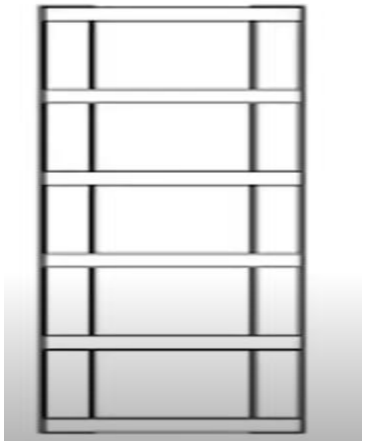
Functions of Batten Plates

Maintain Structural Integrity: Batten plates connect the individual components (e.g., angles, channels, or I-sections) to make them function as a single unit.

Reduce Buckling: They help in preventing local buckling by providing lateral stability.

Transfer Shear Forces: They distribute axial and shear forces among different members.

Increase Load Carrying Capacity: By ensuring the sections work together, they improve the overall strength of the compression member.



24. Which column formula is recommended in IS 800:2007? (Pg: 34)

7.1.2.1 The design compressive stress, f_{cd} of axially

where

ϕ = $0.5\,[1 + \alpha\,(\lambda - 0.2) + \lambda^2]$

λ = non-dimensional effective slenderness ratio

$$= \sqrt{f_y / f_{cc}} = \sqrt{f_y \left(KL/r\right)^2 / \pi^2 E}$$

f_{cc} = Euler buckling stress $= \dfrac{\pi^2 E}{\left(KL/r\right)^2}$

where

KL/r = effective slenderness ratio or ratio of effective length, KL to appropriate radius of gyration, r;

α = imperfection factor given in Table 7;

χ = stress reduction factor (*see* Table 8) for different buckling class, slenderness ratio and yield stress

$$= \frac{1}{\left[\phi + \left(\phi^2 - \lambda^2\right)^{0.5}\right]}$$

γ_{m0} = partial safety factor for material strength.

25. What are the functions of providing column bases?

The basic function of bases is to distribute the concentrated load from the column over a larger area. The column load is distributed over the base plate and then to supporting concrete and finally to the soil.

26. What is meant by column splice?

A joint in the length of a column provided, when necessary, is known as column splice. Itis also described as column joint.

27. List the limiting slenderness ratio of compression member carrying dead load & live load. (April / May 2008)(IS800:2007-Pg: 20)

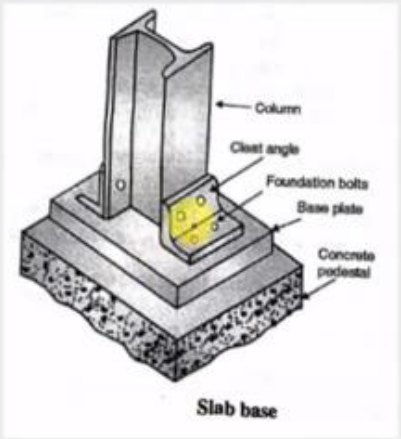
Table 3 Maximum Values of Effective Slenderness Ratios

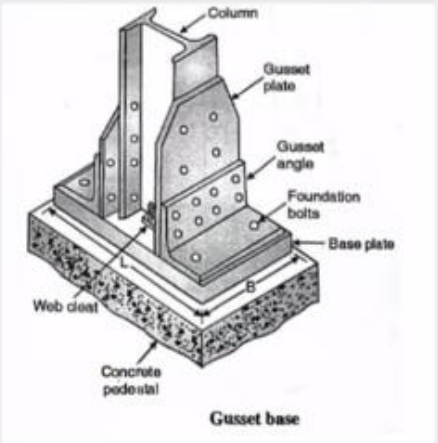
Sl No.	Member	Maximum Effective Slenderness Ratio (*KL/r*)
(1)	(2)	(3)
i)	A member carrying compressive loads resulting from dead loads and imposed loads	180

27. What is meant by slab base?

The slab base as shown in Figure consists of cleat angles and base plate. The column end is faced for bearing over the whole area. The gussets (gusset plates and gusset angles) are not provided with the column with the slab bases. The sufficient fastenings are used to retain the parts securely in plate and to resist all moments and forces, other than the direct compression. The forces and moments arising during transit, unloading and erection are also considered

28. Differentiate between slab base and gusseted base for the steel column





- Slab base are used in columns carrying small loads. In this type, the column is directly connected to the base plate through cleat angles
- The load is transferred to the base plate through bearing.

- For columns carrying heavy loads gusseted bases are used. In gusseted base, the column is connected to base plate through gusset.
- The load is transferred to the base Partly through bearing and partly through gusset.

Part B

1. Determine the axial load capacity of the column section ISHB250@547N/m, if the length of the column is 3m and both ends of column are pinned.

2. Design the compressive strength of a bolted steel angle section 90 x 90 x12mm @158 N/m with length of the member is 2.8m.If both ends are hinged.

3 .Design a double angle discontinues strut to carry a factored load of 135kN. The centre to centre length of strut is 3. The angles are placed back to back (with long legs connected) and are bolted. The Angles are place on opposite sides of 12mm gusset plate

4. Determine the load carrying capacity of a compound column consisting of ISMB400@61.6kg/m with one cover plate of 300 x200mm on each flange and having a length of 5m. One end of column is fixed and other end is pinned. Take f_y = 250N/mm$^{2.}$

5. Design a built-up column 10m long to carry factored axial load of 1080kN. The column is restrained in position but not in direction at the both ends. Design the column with two channels placed back to back. Provide single lacing system with bolted connections. Assume Fe410 grade steel and 4.6 grade bolt

6.. Design a slab base for a column ISHB350@67.4kg/m carrying factored load of 100kN. Also design the welded connection between slab base column. Use M20 grade concrete.

7. A column ISHB350@661.2N/m subjected to a compressive factored load of 1800kN. Design suitable bolted gusseted base. The base rests on M20 grade concrete pedestal. Use 24mm diameter bolt of grade 4.6 for making connection between gusset plate and column flange**.**

8. A column ISHB400@77.4kg/m with one 300mmx12mm flange plate each side. The column carries an axial load of 2600kN. Design suitable bolted gusseted base, if the column is supported on concrete pedetstal with a bearing pressure of 5N/mm2