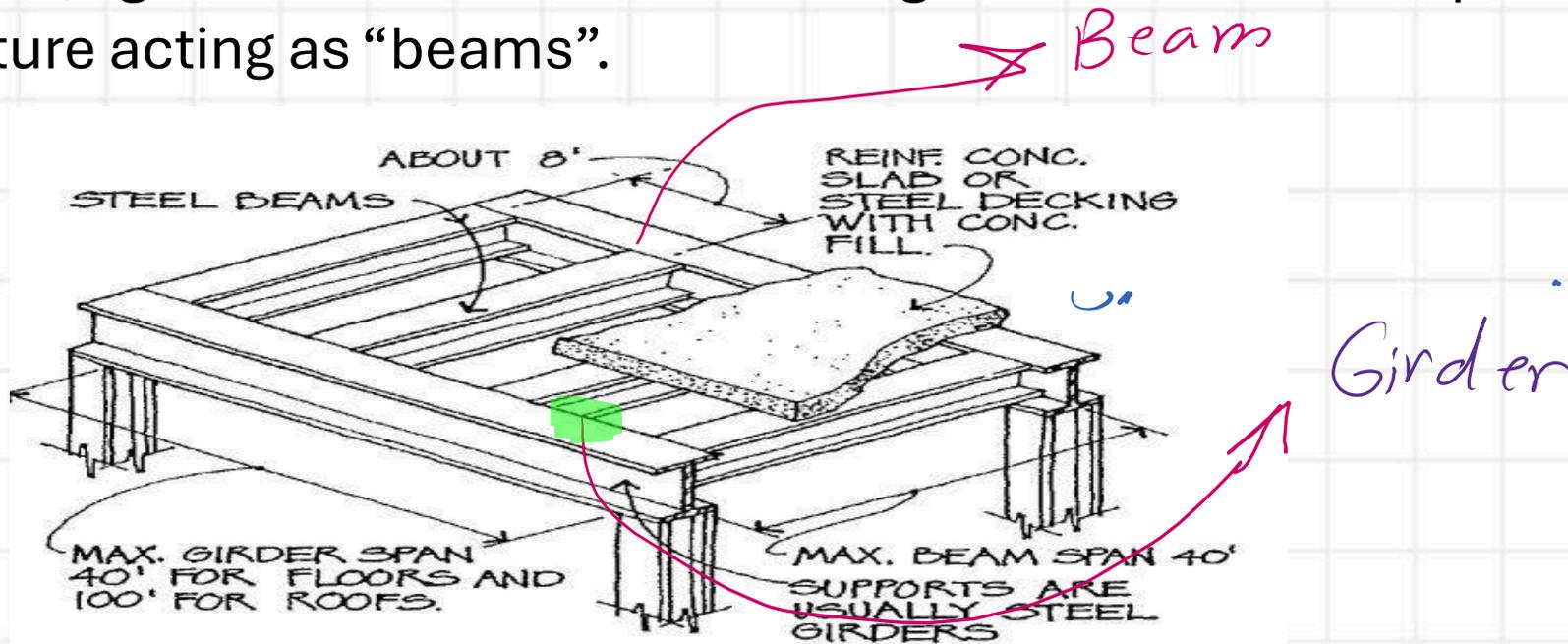


Topics

- ① Definition of steel beam.
- ② Causes of Failure of a beam.
- ③ LFB (Local flange buckling), WLB (Web Local Buckling)
LTB (Lateral torsional Buckling)
- ④ Classification of shapes (compact, non compact, slender)

Beams are an essential element of any structure, they carry loadings transversely applied to their axis. Various types of beams are encountered in the steel construction industry such as: Girders, joists, purlins, stingers, girts and lintels are among the various components in a structure acting as “beams”.

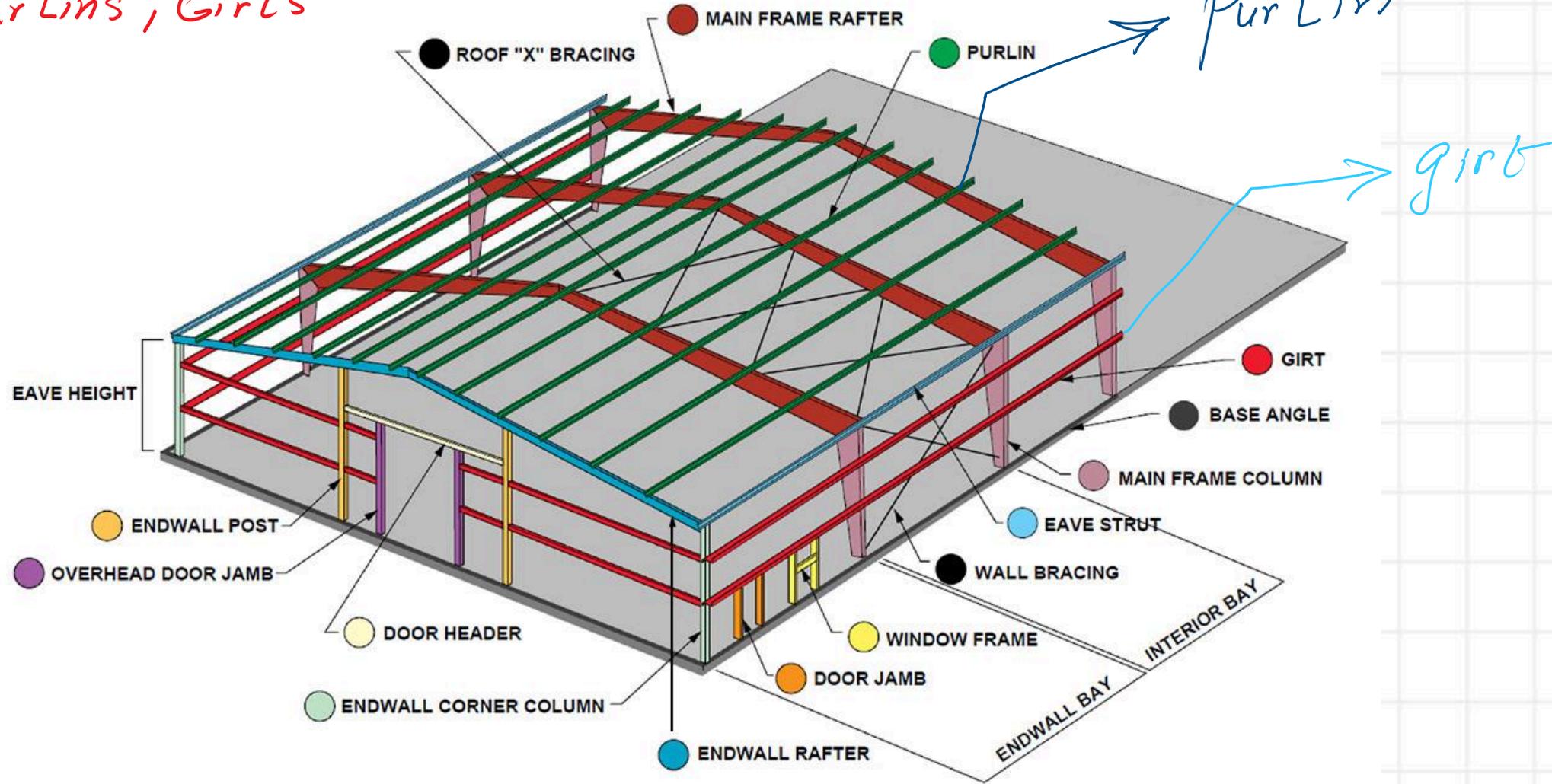


STEEL BEAM AND GIRDER SYSTEM

- BEAMS AND GIRDERS MAY BE PART OF MAIN SKELETON FRAME
- COMPOSITE ACTION BETWEEN BEAM AND SLAB POSSIBLE
- ECONOMICAL FOR MOST BUILDING LOADS

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Purlins, Girts



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Causes of Failure

A beam can fail by reaching M_p and becoming fully plastic, or it can fail by

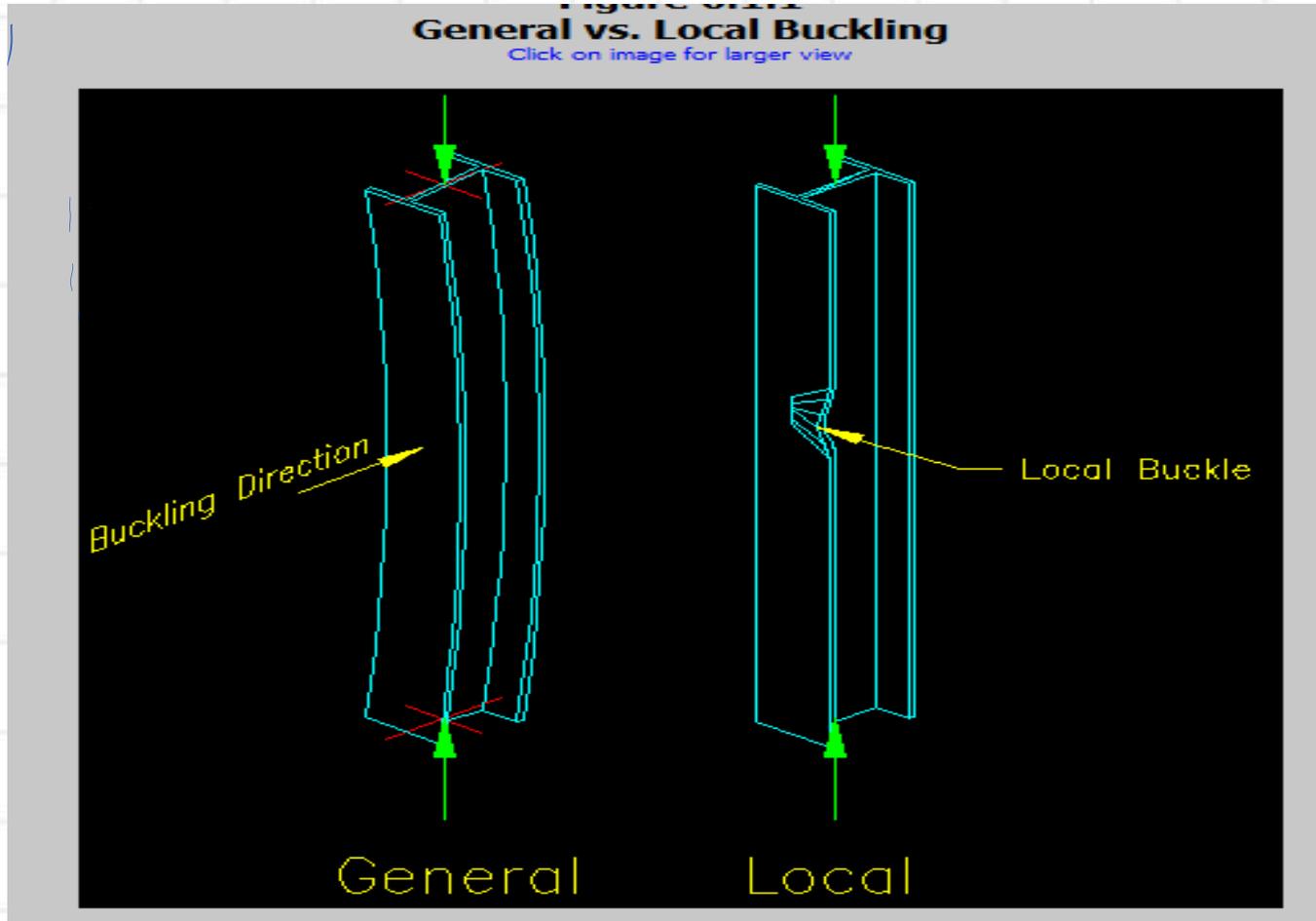
1. lateral-torsional buckling (LTB), either elastically or inelastically;
2. flange local buckling (FLB), elastically or inelastically; or
3. web local buckling (WLB), elastically or inelastically.

If the maximum bending stress is less than the proportional limit when buckling occurs, the failure is said to be *elastic*. Otherwise, it is *inelastic*. (See the related discussion in Section 4.2, "Column Theory.")

Elastically: Maximum stress due to B.M is $<$ proportional limit stress
Inelastically: Maximum stress due to B.M is $>$ proportion limit stress

→ Link

<http://www.bgstructuralengineering.com/BGSCM15/BGSCM006/index.htm>



Beginner's Guide to the Steel Construction Manual, 15th ed.

Chapter 6 - Buckling Concepts

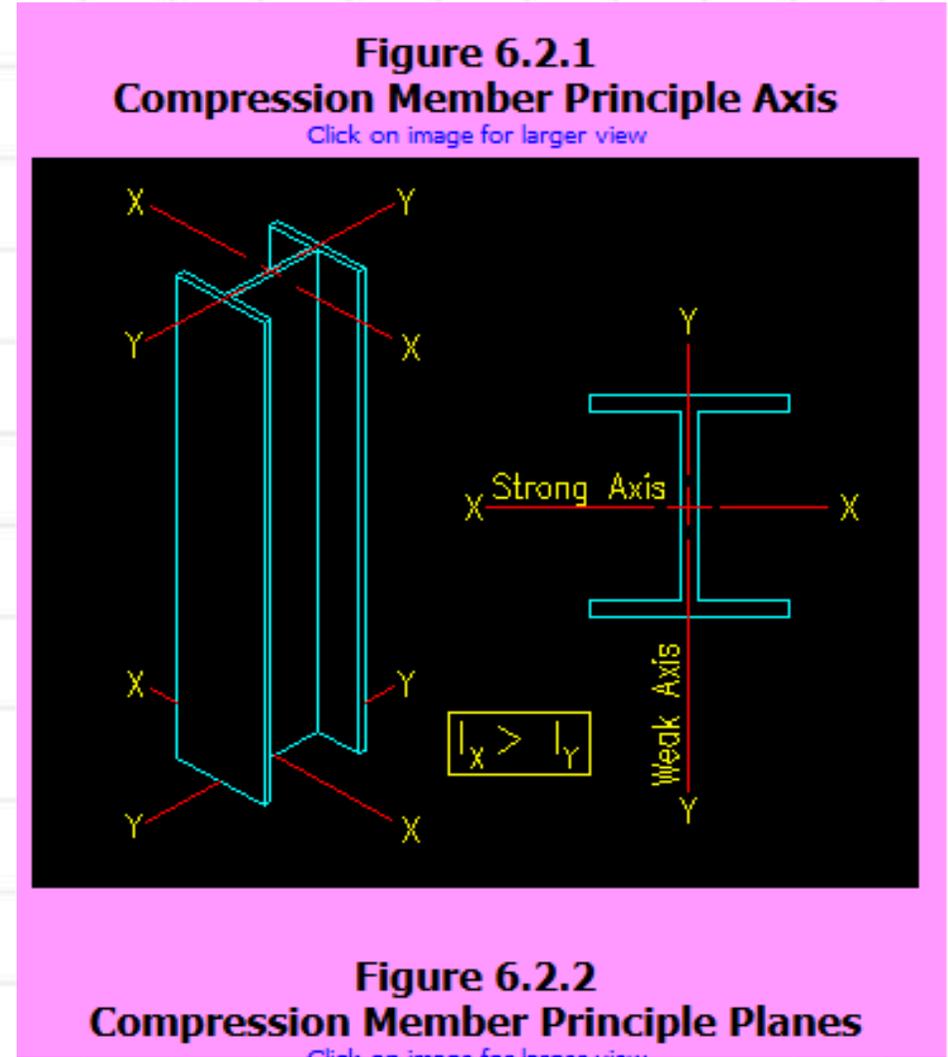
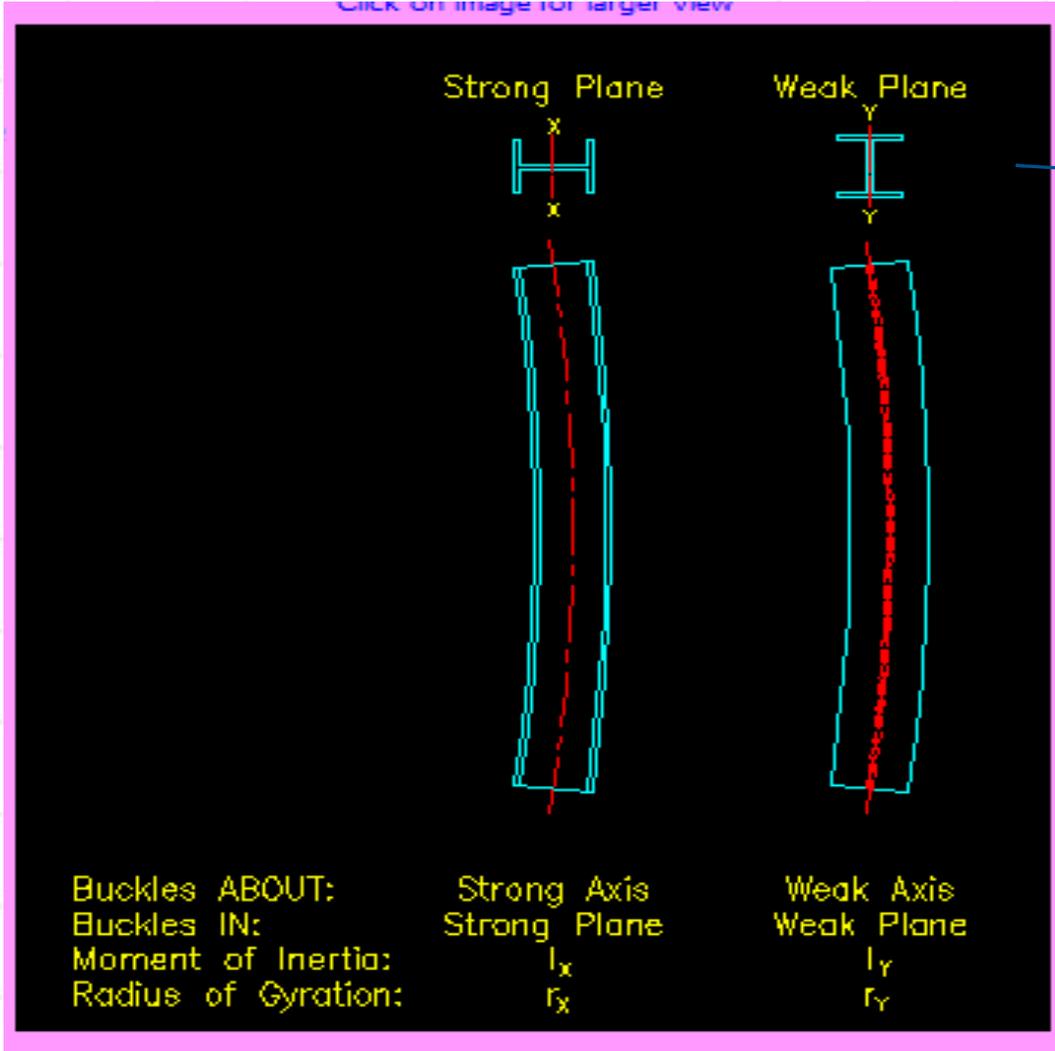
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The difference between
Local buckling
and general buckling.

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$$I_y \ll I_x$$

Buckling about y \rightarrow x-direction

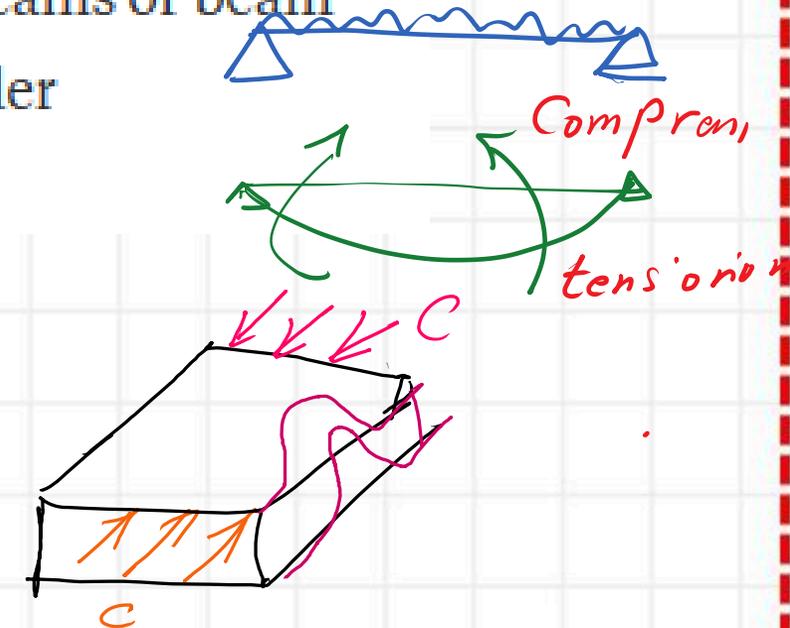
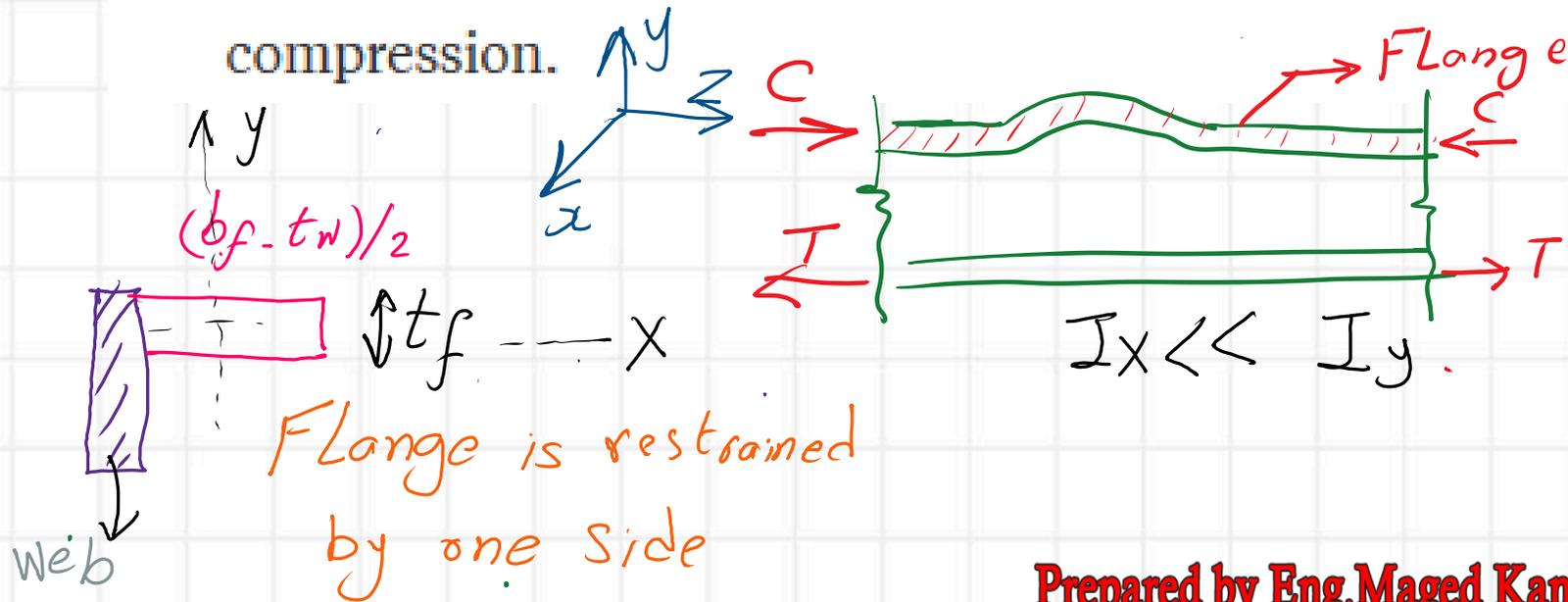


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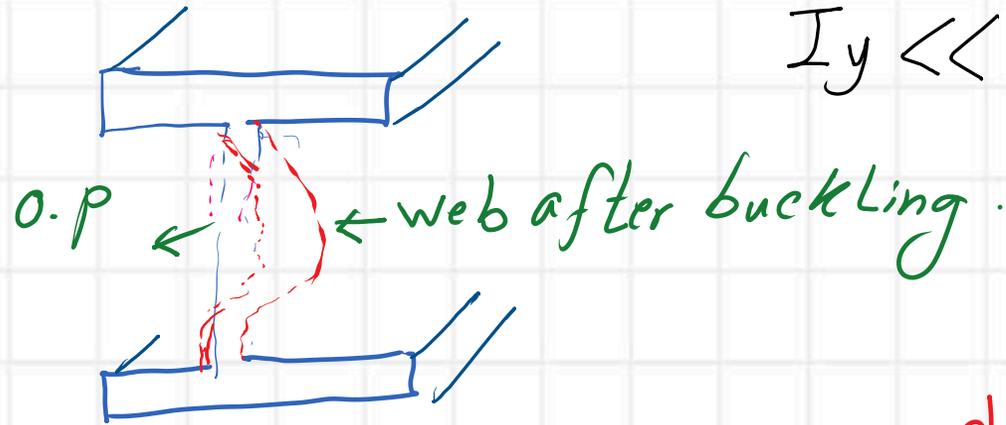
Local Flange buckling → FLB

① Buckling ^{will be} in the direction of y .

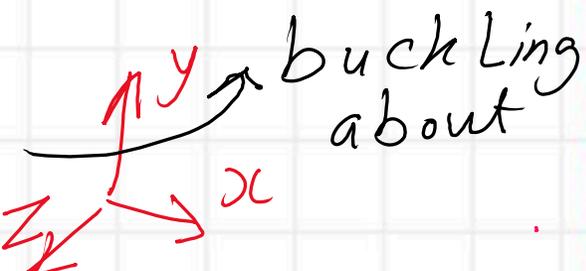
- Rolled steel sections usually have outstanding flange elements that have unsupported edge and are thin and slender. → which is \perp to x -axis.
- These sections are used for members such as columns, beams or beam columns in which at least a part of the section comes under compression.



Web Local buckling W.L.B



$I_y \ll I_x \Rightarrow$ buckling in the x -direction

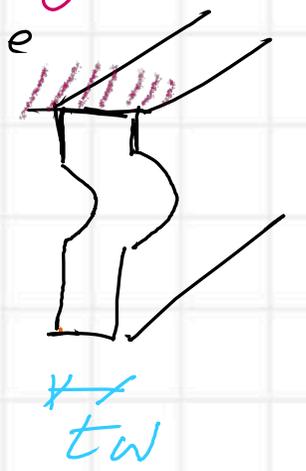
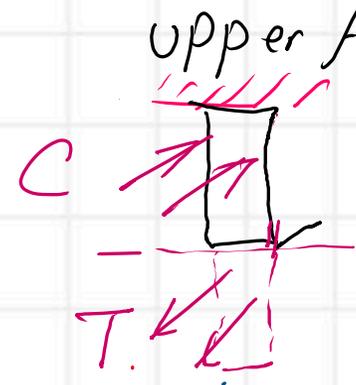
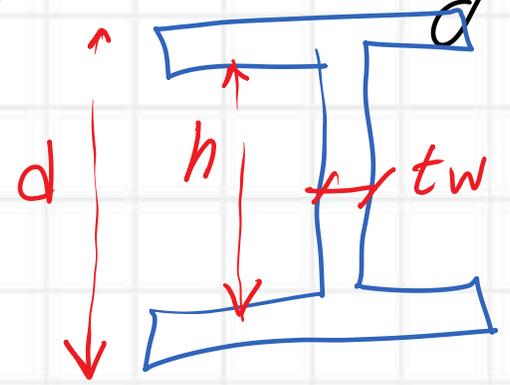


Buckling depends on

$$\lambda_w = \frac{h_w}{t_w}$$

Partially fixed

upper flange



Partially restrained by Flange at one edge, and at the other edge by web in tension.

1.1 What causes the lateral deflection?

The applied vertical load results in compression and tension in the flanges of the section. The compression flange tries to deflect laterally away from its original position, whereas the tension flange tries to keep the member straight. The lateral movement of the flanges is shown in *Figure 2*.

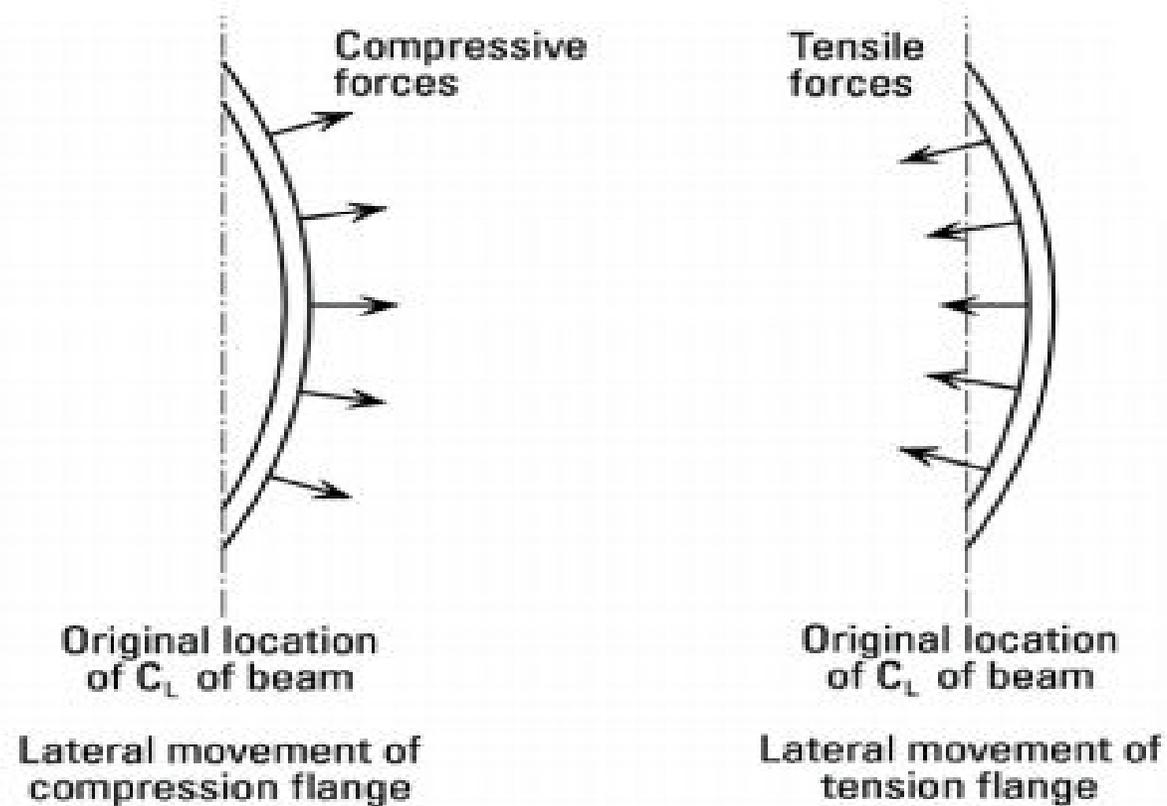


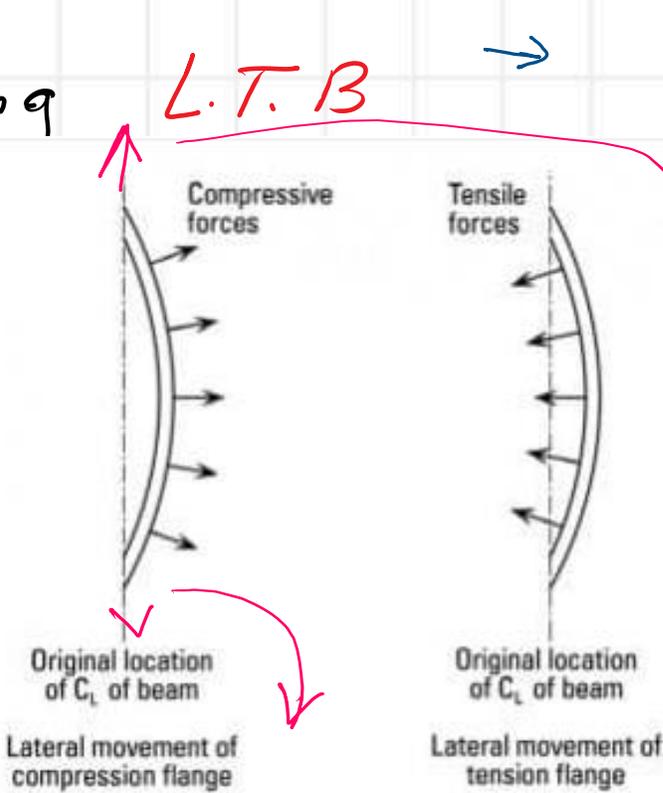
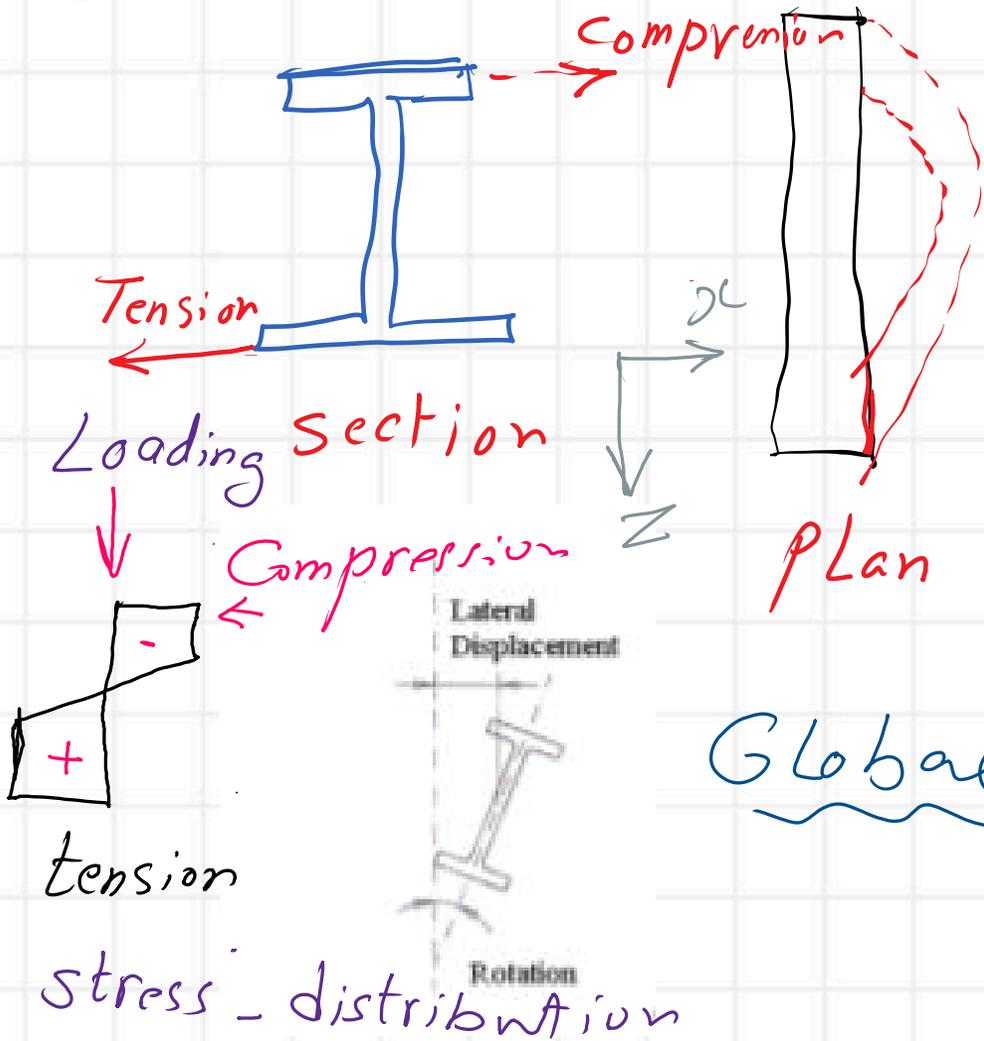
Figure 2

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The lateral bending of the section creates restoring forces that oppose the movement because the section wants to remain straight. These restoring forces are not large enough to stop the section from deflecting laterally, but together with the lateral component of the tensile forces, they determine the buckling resistance of the beam.

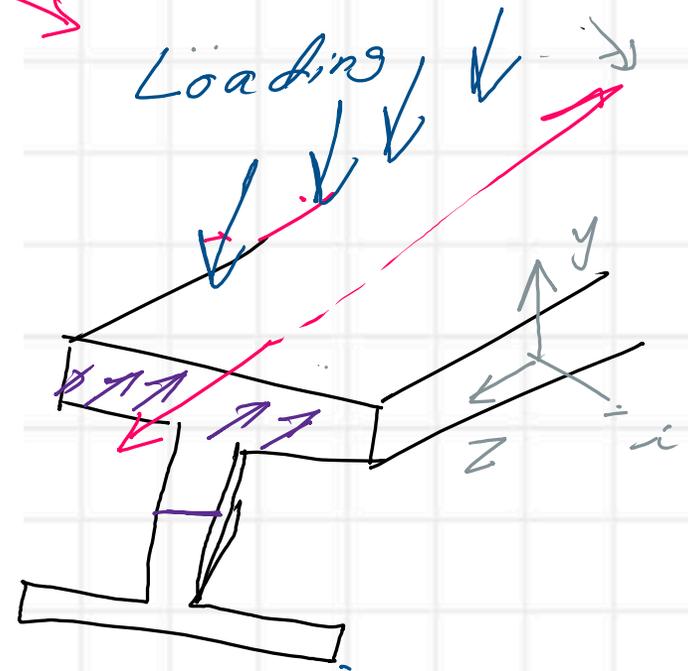
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Lateral Torsional Buckling



cause of lateral deflection in beam

Un-restrained I-section



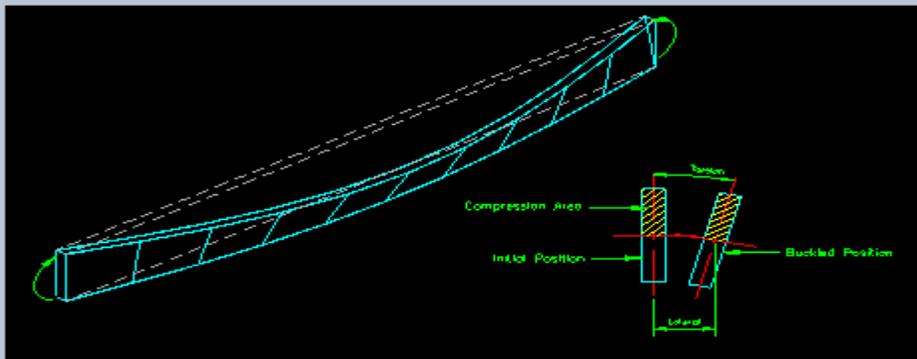
Global buckling

<http://www.bgstructuralengineering.com/BGSCM15/BGSCM008/Flexure/BGSCM0080201.htm#LTB>

When a member is subjected to bending, one side of the member is in compression and wants to behave like a column while the other side is in tension. This means that the compression side is subject to flexural buckling. Since the compression side is connected to the tension side (which is not prone to buckling), it cannot buckle in the plane of loading. This leaves the lateral direction as the direction of buckling. The tension side resists the buckling, resulting in the rotated cross section (i.e. the torsion)

A simple experiment can be used to demonstrate this behavior. Take a thin, flat bar of any rigid material (a typical "yard stick" works well) and apply end moments about the end with your hands. As you apply bending about the strong axis, the member will buckle sideways and the section will rotate so that it is no longer vertical. This is lateral torsional buckling (LTB). The experiment is illustrated in Figure 8.2.1.4.

Figure 8.2.1.4
Lateral Torsional Buckling
Click on hotlinks in image for larger views



⇒ No Buckling in the
Plane of Loading

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