Chapter 1 : Elastic instability phenomena

1.1. Introduction

Structural analysis requires that static stability be ensured under all possible load combinations defined by regulations.

The study of elastic instability phenomena is particularly important in steel construction, as they occur very frequently due to the use of thin and highly slender elements. For these elements, instability may occur even if the stresses remain below the elastic limit of the material.

To ensure a desirable level of safety, stresses and deformations must remain below acceptable limits.

➢ there are two cases:

- ✓ The case of small deformations:

When the small-deformation domain is not exceeded, that is, when the loads do not vary, or vary only slightly, as a result of deformations, it is sufficient to verify that the stresses remain lower than the failure (ultimate) stress.

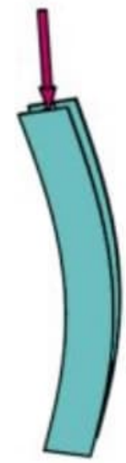
- ✓ The case of large deformations:

In such cases, specific calculations must be carried out.

Large deformations affect the compressed zones of the members, which may subsequently exhibit three (03) types of behavior, referred to as elastic instability phenomena, namely:

In this course, we focus on the following three types of elastic instability phenomena (buckling, lateral–torsional buckling, and local buckling), considering their theoretical, experimental, and regulatory aspects.

a) Buckling: which affects slender members subjected to pure compression (simple buckling) or subjected to combined compression and bending (flexural buckling).



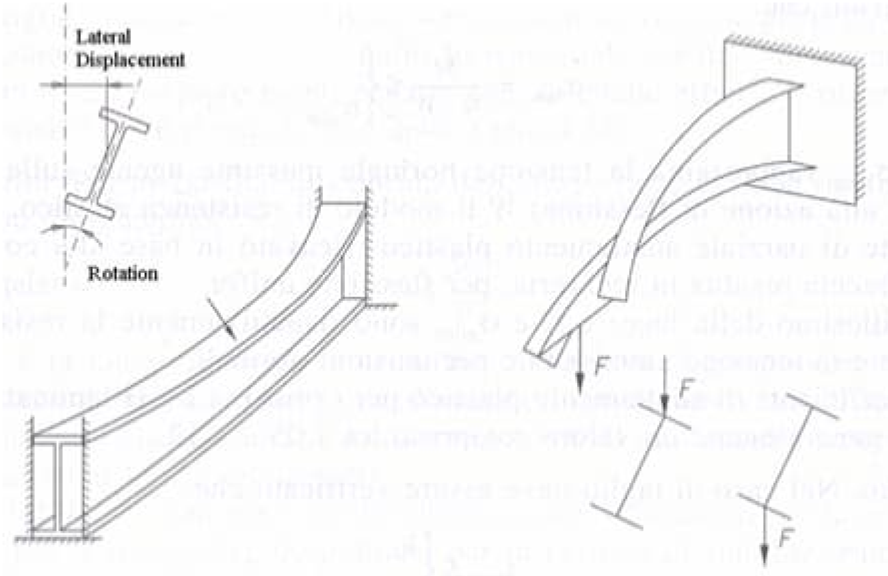
Mechanism: The structure loses its stability and shifts from a state of pure compression to a state of lateral deformation

Factors influencing buckling: The critical buckling load depends on the stiffness of the member (Young's modulus and section moment of inertia) and its effective length.

b) Lateral-torsional buckling: This phenomenon occurs in beams under bending, particularly those with an I-shaped cross-section, when they are subjected to bending moments, causing a combination of lateral displacement and twisting.

Mechanism: The compressed flanges of the beam lose their stability and undergo rotation or lateral displacement to relieve the load.

It is a form of instability that can lead to premature failure of the beam, even if the stresses remain within the elastic range.



***c) Local buckling (Warping)*:** This phenomenon affects thin structural elements, such as beam webs or panels.

<u>Mechanism</u>**:** It appears as a local wavy deformation under compressive or shear stresses, causing the surface to warp.