CLASSIFICATION OF CROSS SECTIONS & FLEXURAL STRENGTH AND LATERAL STABILITY OF BEAMS

The classification of a specific cross-section depends on the width-to-thickness ratio, b/t, of each of its compression elements. Compression elements include any component plate which is either totally or partially in compression, due to axial force and/or bending moment resulting from the load combination considered; the class to which a specified cross-section belongs, therefore, partly depends on the type of loading this section is experiencing

Components of cross-section

A cross-section is composed of different plate elements, such as web and flanges; most of these elements, if in compression, can be separated into two categories:

- internal or stiffened elements: these elements are considered to be simply supported along two edges parallel to the direction of compressive stress.
- outstand or unstiffened elements; these elements are considered to be simply supported along one edge and free on the other edge parallel to the direction of compressive stress.

These cases correspond respectively to the webs of I-sections (or the webs and flanges of box sections) and to flange outstands (Figure 1).

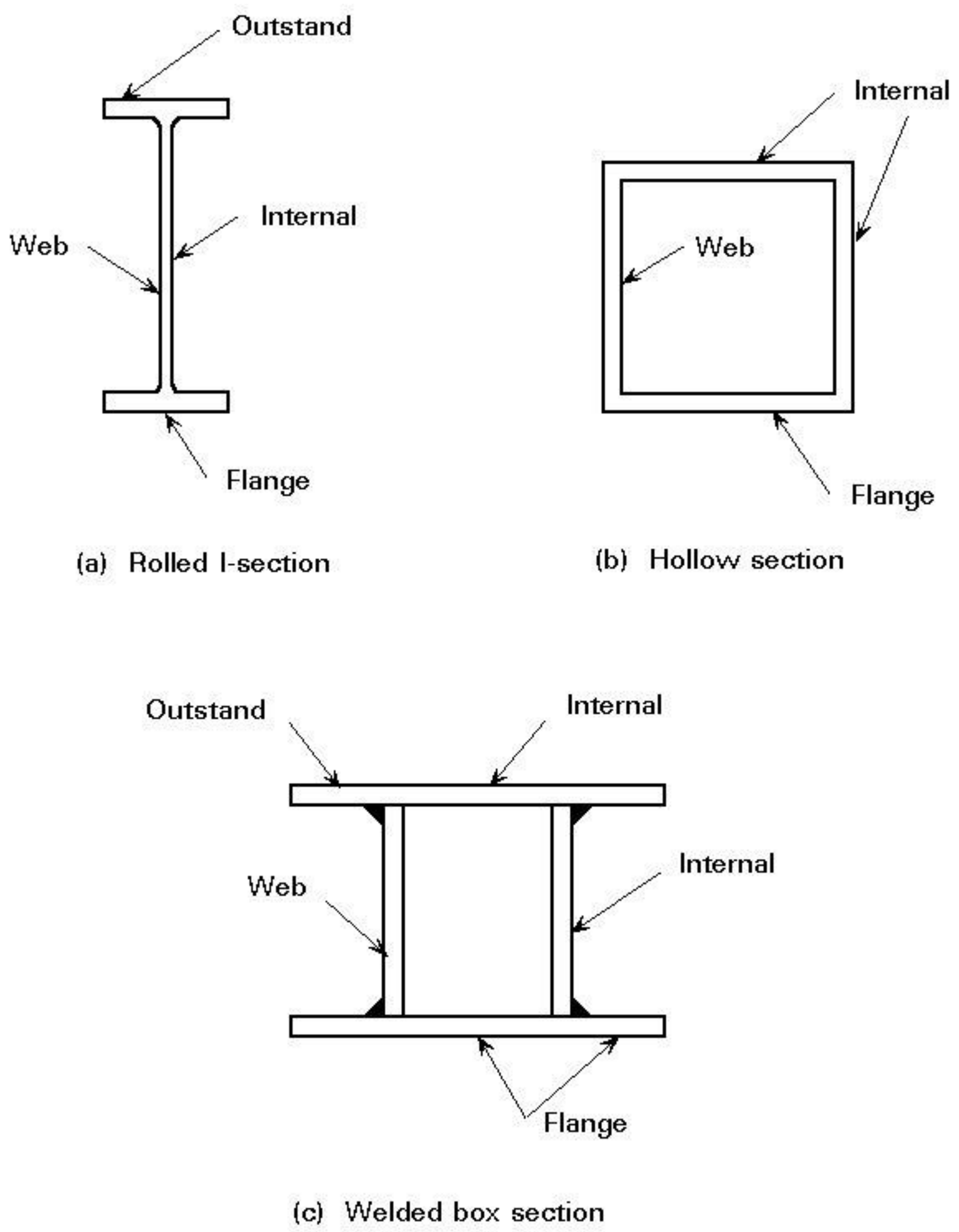

Figure 1 Internal or outstand elements

b. **Behaviour of plate elements in compression**

For a plate element with an aspect ratio, $\alpha = a/b$ (length-to-width), greater than about 0,8, the elastic critical buckling stress (Euler buckling stress) is given by:

$$\sigma_{cr} = k_\sigma \frac{\pi^2 E}{12(1-\nu^2)}\left(\frac{t}{b}\right)^2 \quad (1)$$

where k_σ is the plate buckling factor (see below),

υ Poisson's coefficient,

E Young's modulus.

The critical buckling stress is proportional to $(t/b)^2$ and, therefore, is inversely proportional to $(b/t)^2$. The plate slenderness, or width-to-thickness ratio (b/t), thus plays a similar role to the slenderness ratio (L/i) for column buckling.

In accordance with the definition of Class 3 sections, the proportions of the plate element, represented by the b/t ratio, must be such that s_{cr} would exceed the material yield strength f_y so that yielding occurs before the plate element buckles. The ideal elastic-plastic behaviour of a perfect plate element subject to uniform compression may be represented by a normalised load-slenderness diagram, where the normalised ultimate load:

$$\overline{N}_p = \sigma_u/f_y$$

and the normalised plate slenderness:

$$\overline{\lambda}_p = \sqrt{f_y/\sigma_{cr}}$$

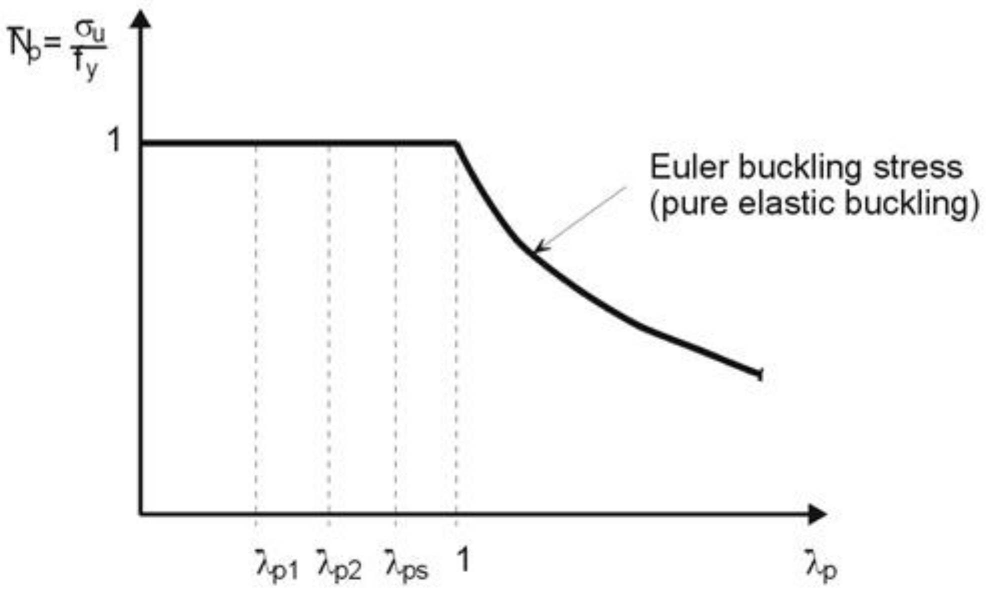

Figure 2 Dimensionless representation of the elastic-plastic buckling stress

Lateral stability of Beams

Concept:

Lateral stability of steel beams:

- A steel beam loaded predominantly in flexure would attain its full moment capacity if the local and lateral instabilities of the beam are prevented.
- If adequate lateral restraints are not provided to the steel beams in the plane of their compression flanges, the beams would results in lateral instability and would buckle laterally resulting in a reduction of their maximum moment capacity.
- As per clause number 8.2.2 of IS 800: 2007, The design bending strength of laterally unsupported beam as governed by lateral torsional buckling is given by, $M_d = \beta_b Z_p f_{bd}$ where β_b= 1.0 for plastic and compact sections, Z_p is plastic sectional modulus and f_{bd} is the bending compressive stress in the beam.
- As, bending compressive stress in the beam increases the design bending strength will increase which in turn implies that the lateral stability is increasing.