Chapter III: Calculation of parts stressed in simple tension

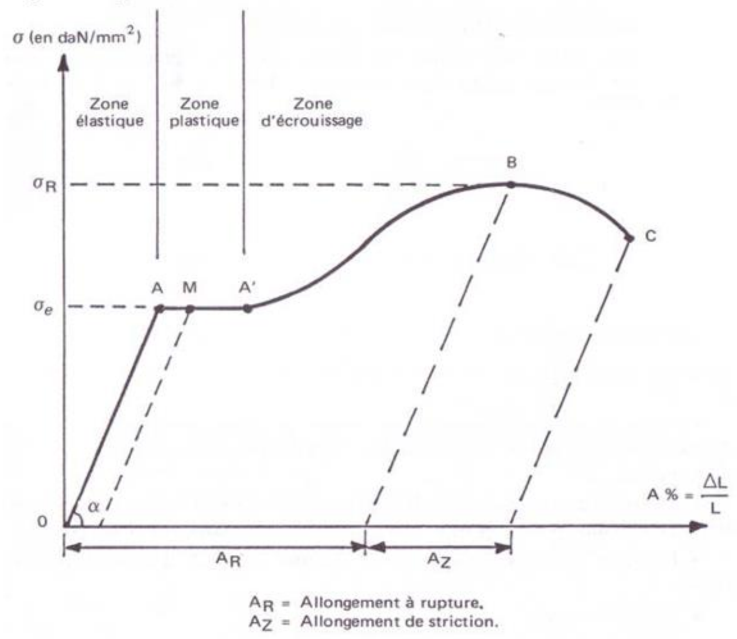
1- Use of tensioned pieces

- Tensioned elements transmit forces very effectively:
  - They therefore lead to relatively small steel cross-sections
  - They are thus susceptible to high elongation under axial load.
- As a result, they can lead to:
  - A very large displacement of a structure if the tie rod is part of a bracing system.
  - A significant deflection under self-weight.
- Thin profiles can be easily damaged during transport.

In practice, the slenderness of the tensioned elements is limited to:
  - 300 for the main elements.
  - 400 for secondary elements.

2- Behavior of the taut parts

Subjected to a tension according to its cross-section, a steel bar extends uniformly to a certain limit, called the yield limit. There is reversibility of the phenomenon: if the load is removed, the steel bar returns to its original dimension (Hooke's law). zone (OA)



The ductility bearing AA' represents a safety reserve, thanks to the phenomenon of plastic adaptation: if a part is stressed beyond the elastic limit, it has this bearing to discharge in the surrounding areas. As the carbon content increases, the ductility bearing shortens and the elongation at fracture decreases. (see chapter 1)

3- Calculation of the area of the net section

The sizing of a tensioned element is very simple:

The cross-section of the element must be sufficient

To withstand the stress applied.

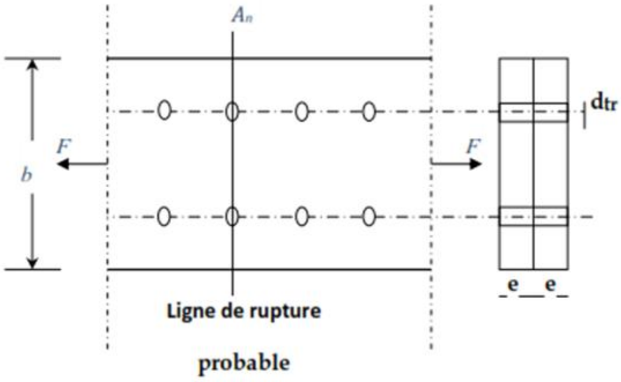
$$\boxed{\text{section nécessaire} = \frac{\text{effort appliqué}}{\text{résistance de l'acier}}}$$

- Connections of tensioned elements are important

- In many cases, assemblies govern the calculation.

The **"Anette"** net section is the section with the shortest break line, it is
Less than the rough section **"Abrute»** and depends on the number of holes it passes through and their layout.

a/ Case of regularly distributed holes:



$A_{brute/une\ plaque} = b.e$

$A_{nette/une\ plaque} = A_{brute/brute/une\ plaque} - 2.d_{tr}.e$

$$\boxed{A_{nette} = A_{brute} - n.d_{tr}.e}$$

b/ If the holes are not staggered:

The cross-section to be reduced is the ***maximum sum*** of the cross-sections of the holes located on any perpendicular to the axis of the member.

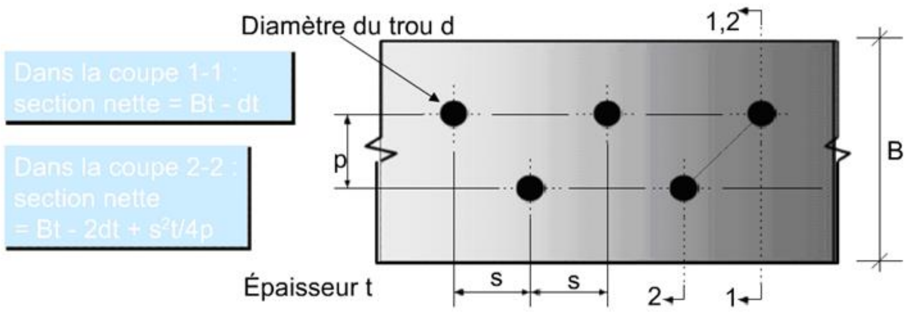
- Special rules apply to wing-attached angles for T's and U's attached by their console parts.

Staggered fastening:

The total cross-section to be reduced is the greater between:

- The section of the holes located in a section perpendicular to the axis of the bar.
- The sum of the sections of the holes located on any broken line minus as many times

that there are intervals between two successive holes encountered.



Generally:

$$\boxed{A_{nette} = A - n.d_{tr}.t + \sum\left(\frac{s_i^2 t}{4p_i}\right)}$$

T: The thickness of the sheet metal
A: Gross Section Area (A=B×t)
D_{tr}: hole diameter
n: number of holes in the section under consideration
S_I: Longitudinal distance between holes
p_i: transverse distance between holes

The diameter of the holes is calculated according to the diameter of the bolts:

$$d_{tr} = d_{bl} + 1 \text{ mm} \qquad \text{pour } d \leq 14 \text{ mm}$$

$$d_{tr} = d_{bl} + 2 \text{ mm} \qquad \text{pour } d \leq 24 \text{ mm}$$

$$d_{tr} = d_{bl} + 3 \text{ mm} \qquad \text{pour } d \geq 27 \text{ mm}$$

4- Verification of the parts tensioned to the ultimate limit state:

An element subjected to simple tension is dimensioned according to the resistance.

It is necessary to check that:

$$\boxed{\sigma_{Np}^{max} = \frac{N_p^{max}}{A_{nette}} \leq \sigma_e}$$

N_{max}: worst-case weighted normal effort [kg] (tractive effort).
Σ_E : Yield Strength [kg/ mm²]
A_{sharp}: net cross-section [mm²]

5- Taking into account the effects of assembly eccentricities in the calculation of tensioned parts:

Section strength

- For welded elements, the design strength is

$$\boxed{N_{pl.Rd} = \frac{Af_y}{\gamma_{M0}}}$$

A: is the raw cross-section of the element.

- for bolted elements, the design resistance section is reduced because of the holes. It is equal to the lesser of:

$$\boxed{N_{pl.Rd} = \frac{Af_y}{\gamma_{M0}}} \text{ ou } \boxed{N_{u.Rd} = 0{,}9\frac{A_{net}f_u}{\gamma_{M2}}}$$

The 0.9 reduction is intended to take into account the effect of the eccentricity of the assembly.

γ_{M0} and γ_{M2} : are safety coefficients recommended by the codes in force.