asdf

# THE TENSILE TEST ON METALLIC MATERIALS

23 November 2011

## Premessa italiana

**"Un articolo in inglese?"** si chiederanno stupiti i nostri 25 lettori italiani.
Beh, semplice: **ElectroYou** cerca di raddoppiarli, iniziando una ricerca oltre i confini del nostro **Bel Paese ;-)**

*Nota*

> Here there is the Italian version of this article.

### Introduction

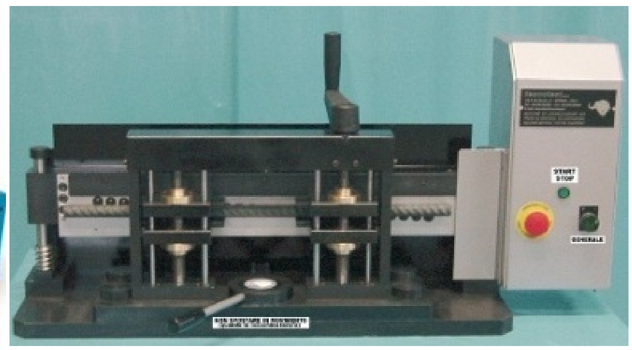
If I want to talk exhaustively about **tensile test**, which is one of the most important mechanical tests, I should write more than one article.
With this one I want to give all users a limited overwiev which explaines the main elements characterizing this test.
It is a mechanical destructive test in which an accurately prepared **specimen** is subjected to a **tensile stress** until failure, in order to define and measure several mechanical properties, which we will describe in the article.
The tensile load, initially equal to zero, slowly increseas up to the maximum established value.
The tensile test, normed by **UNI EN 10002-1**, is normally executed at room temperature.

### Description of the specimens used

The **specimen** is normally produced through a mechanical working of a piece drawn from a product. However all the products with a uniform cross-section (such as extruded profiles, bars and tubes) and rough foundry's specimens can be used without a preliminary mechanical working.
Specimen's section can be **circular** or **rectangular**. However, independently from the dimensions and the type of section, it is possible to define, in the specimen, a **length with a uniform cross-section** , $\mathbf{L_c}$ , and two **shoulders** (or *heads*), which

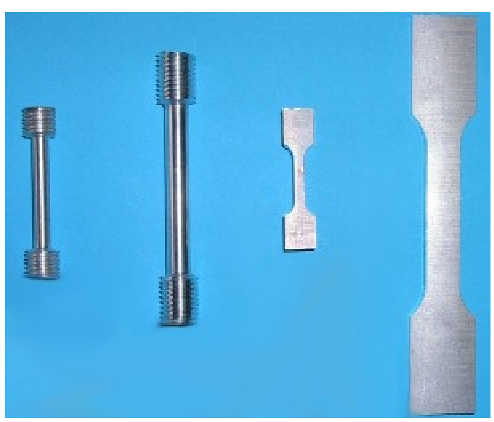
dimensions depend from the testing machine's tightening grips, filleted to the length we named $L_C$ . The fillet is necessary in order to avoid local over-stress and to have a uniform load distribution on specimen section.
In the length named $L_C$ it is also possible to recognize another characteristic length named **gauge length**, $\mathbf{L_0}$.
Before the test the gauge length is divided into five or more equal lengths by using a machine called **tracing machine** or **specimens marking machine**, in order to measure specimen's elongation after the test.

The following images show an example of tracing machine:

There aren't requirements about specimen's form and dimensions, but it is necessary a good surface finish in the length with a uniform cross-section, $L_C$.

In the following images there are represented round cross specimens and flat ones:



**Test execution**

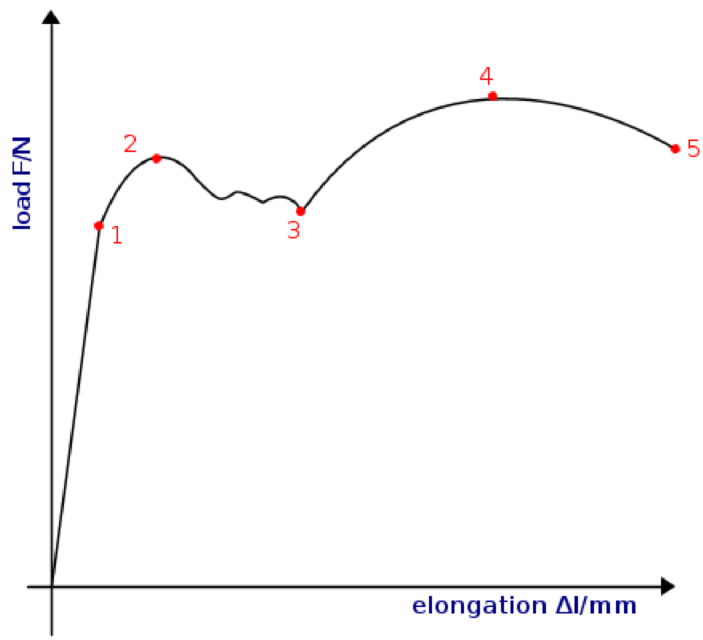
The tensile test is executed by using a **universal testing machine** (see figure below), which can be also used for other mechanical tests (e.g. *compression test*).

The load must be increased from zero up to the end of the test, so that its increase is constant. Before the test, the machine must be calibrated. Moreover the gripping of specimen's shoulders must be such as to obtain a distribution of a uniaxial tension in the same specimen.

In this table there are the values of the *rate of unit load increase* related to the *modulus of elasticity*:

| **Modulus of elasticity E/GPa** | **Rate of unit load increase (min value) MPas$^{-1}$** | **Rate of unit load increase (max value) MPas$^{-1}$** |
|---|---|---|
| < 150 | 2 | 20 |
| ≥ 150 | 6 | 60 |

After the test, it is possible to deduce, by using a plotter, the **strain-stress curve**, that is a diagram in which the loads **F** are a function of the elongations **Δl**.
The following one belongs to a mild steel, which is an example of ductile material:




From the stress-strain curve it is possible to extract some characteristic values, that are:

- **proportional limit stress $F_l$** : up to this value, indicated by point 1, is respected **Hooke's law**:

$$F = k\Delta l$$

  in this lenght the material has a linear elastic behavior, defined by a linear stress-strain relationship in which deformations completely disappear after the removal of the load;
- **yield strength**, whose maximum, $F_{eH}$, is at point 2 and the minimum, $F_{eL}$, is at point 3; beyond this value deformations are **plastic** and so specimen will not return to its original dimensions and form after the load is removed;
- **maximum strength** (given by point 4) : this value represents the maximum load which can be tolerated by specimen;
- **ultimate strength** (given by point 5) : beyond this value the specimen goes to failure.

**Unit loads and characteristic values**

The **unit load R** is given by :

$$R = \frac{F}{S_0},$$

where $S_0$ is specimen's initial section and F is the applied load.
Other values of unit characteristic loads are:

- **Unit load of higher yield strength**, $\mathbf{R_{eH}}$ :

$$R_{eH} = \frac{F_{eH}}{S_0};$$

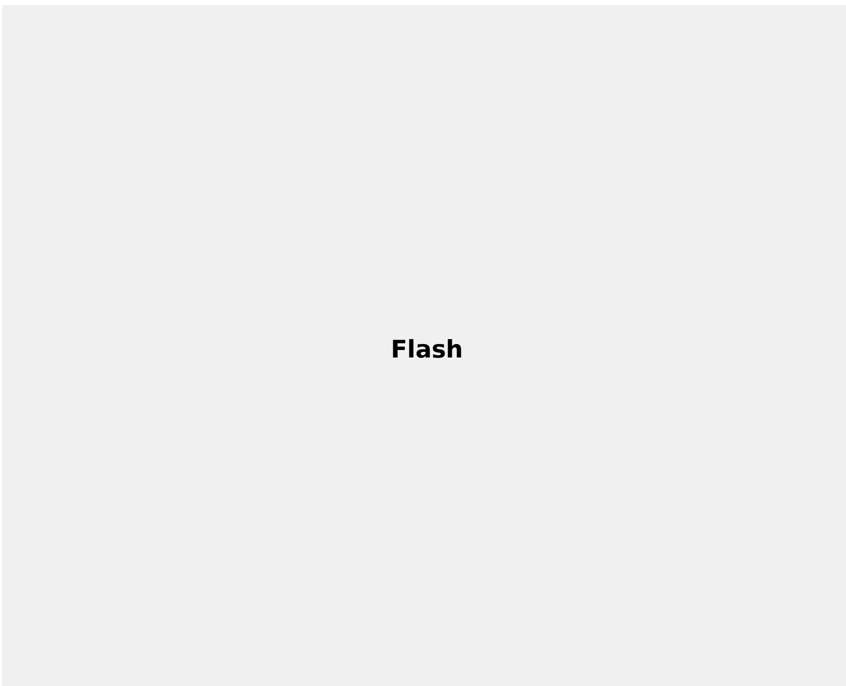
- **Unit load of lower yield strength**, $\mathbf{R_{eL}}$ :

$$R_{eL} = \frac{F_{eL}}{S_0};$$

- **tensile strength**, $\mathbf{R_m}$ :

$$R_m = \frac{F_m}{S_0}.$$

**An interesting video about tensile test**




Estratto da "http://www.electroyou.it/mediawiki/index.php?title=UsersPages:Asdf:the-tensile-testing-on-metallic-materials"