General aspects of dynamometers

The term **dynamometer** refers to an instrument used to measure force. It can also be used to refer to a testing machine capable of applying force of a given precision. Only the first of these meanings is referred to in this text.

A dynamometer is composed of a **transducer** comprising a metallic test specimen which receives the force to be measured and deforms elastically by the application of this force. In modern transducers such deformation (strain) is communicated to a miniature electric circuit attached to the test specimen, resulting in a modification of the electric resistance. This resistance variation is measured by the Wheatstone bridge method, whereby two legs of the electric circuit are supplied with an analog voltage, continuous or intermittent, and an analogue voltage variable according to the force applied to the dynamometer is collected between the two other legs in the circuit

The necessary equipment to supply voltage, collect and process the output signal and display usable values constitutes the electronic element connected to the transducer. Traditional electronic instruments - stabilized and multimeter supply - can be used. Transducer manufacturers have developed specific **electronic equipment** allowing to optimize settings, measurement conditions and precision.

The latest advances in the technique of dynamometers consist in integrating the electronic equipment associated to the digitalization of the signal and the transducer, so as to constitute a single device that, powered by 220 V, releases an **output digital signal** according to the force applied to the transducer.

When the relationship between the force applied to a dynamometer and the measurement of its output signal cannot be accurately determined by means of a calculation, it is necessary to **calibrate** the dynamometer, which consists in establishing the exact relationship between the force applied to a dynamometer - input - and the electrical signal it releases - output. In essence, the operation consists in applying forces that can be accurately measured to a dynamometer and registering the values provided by the electronic equipment connected to the transducer. This operation is generally performed by applying the protocol established by the international standard **ISO 376**. This standard provides for a classification of the dynamometer according to precision criteria. The results of the calibration of a dynamometer lead to the determination of a mathematical polynomial of 2nd or 3rd degree, which allows to calculate the value of the force applied to the dynamometer based on the indication provided by the electronic equipment. The formula allowing to calculate the level of uncertainty of this value is also part of the calibration.

Dynamometers are often used as the sensitive element of **weighing instruments**. In this case, the shape of the test specimen is determined so as to obtain an output signal that is exactly proportional to the mass of the specimen placed on the of the instrument loading tray.

Another application of dynamometers concerns testing machines used to characterize the resistance of materials or products. This field is largely covered by standards such as international standard **ISO 7500-1** covering uniaxial static tests for metallic materials, or European Standard **EN 12390** section 4, dealing with hardened concrete.

"Force magnitude" is, from the mechanical theory point of view, a vectorial input and the **precision measures** must take this characteristic into account, as well as other mechanical laws, such as action and reaction principles, action-at- a distance, etc. This approach leads to adopt a certain number of precautions, both in the design and application of a dynamometer