Torque measurement

Definitions :

Torque measurement is based on the fundamental notion of the moment of a force, defined as follows (cf. fig. 1):

The **moment of force** F, M being its application point, in relation to point O is defined by:

$$\vec{\mathcal{M}}_O = O\vec{M} \wedge \vec{F}(M)$$

It is a pseudovector $\overrightarrow{M_o}$ produced by the vectorial product of vector $\overrightarrow{OM}$ by vector force $\vec{F}$It is applied to O, perpendicularly to the plane containing the vector force and point O, and its intensity is equal to the product of the intensity of force F by length OH of the lowered perpendicular of point O in the direction of the force.

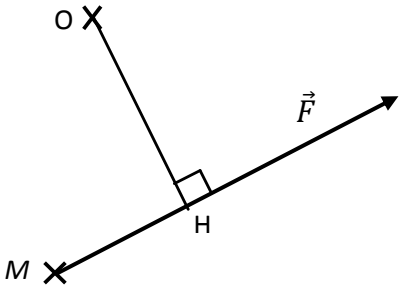
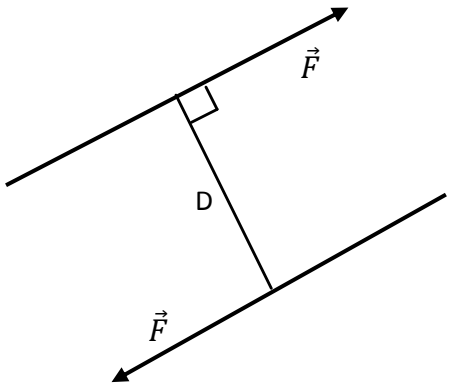


Figure 1 : Moment of a force

A system of two parallel non co-linear forces of equal intensity and opposite direction constitutes a "**torque**" of forces. The moment of such a torque is equal to the sum of the moments of each of the forces. Its intensity is therefore equal to the product of intensity F, common to both forces, by distance D of both forces, measured perpendicularly to their action line.



It is always necessary to establish whether we are in the presence of the moment of a force or of a torque, given that the conditions to perform an effective measurement of one and the other are very different.

Torque meter

A torque meter is a measurement instrument analogue to a dynamometer, designed to operate in torsion. Its test specimen has a cylindrical shape, subject to shearing strains measured by strain gauges. This type of strain provides measurements which are exactly proportional to the torque applied to the transducer.

The same as for a dynamometer, the torque meter is linked to a measurement point allowing to feed the transducer and to process of the transmitted signal.

Measurement using a torque meter

A torque meter can be used for operations of two types:

- pure torque measurement
- calibration or verification of a dynamometric wrench

The required operation conditions for a torque meter are more difficult to achieve than those required for a dynamometer. In fact, a torque meter is subject to two main torques, the first one coming from the torque being measured and the second one coming from the reaction torque preventing the torque meter from turning around its axis. These two torques are joined by interfering torques and efforts arising from failures in the application devices of the two main torques. The quality of measurement mainly depends on the alignment of tree axes:

- the axis of the torque pseudovector being measured
- the axis of the reaction torque pseudovector
- the torque meter axis

For this to happen, all three axes must be materialized by means of mechanical elements centred and aligned in relation to one another. Alignment failures cause interfering moments perpendicular to the torque meter axis, so as to induce measurement errors by a variation of several percentage points from the torque measurement performed.

A significant reduction of interfering torques can be achieved by means of specific linking mechanical devices allowing to limit the effect of alignment failures. They are of the type of a cardan joint, elastic blades or discs. The Rexnord type coupling devices are particularly effective.

The use of a torque meter to calibrate or verify a dynamometric wrench requires the adoption of specific precautions. In fact, a great majority of these wrenches are composed of only one lever arm which applies the moment of a force rather than a pure torque to the torque meter. In this case, the torque meter is subject to the combined action of the moment applied by the wrench and of a transversal force equal to the force applied to the lever arm of the wrench. Apart from its inherent effect, this force also applies a very significant interfering torque perpendicularly to the torque meter. If by its construction, the torque meter is insensitive to this force and to the interfering torque, the measurement of the moment applied to the dynamometer is correct. If this is not the case, a specific assembly - for example, of the ball bearing type - is required so that the transversal force and the torque induced by it will be captured by this device.