3) – Basic of milling

Constructive characteristics of milling cutters

The constructive characteristics of milling cutters, including the number of teeth, the inclination and direction of the helix, the front rake angles and the rilief angle, etc.. depend on many factors, among which are the main the material worked and the kind of tool that can be more or less likely to have certain shape of teeth.
Other elements of great importance are the power and efficiency of the milling machine and the attitude to cover a wide range of applications.
In the past we considered only two simple categories of milling cutters:

- *Normal milling cutters*
- *High performance milling cutters*

The first was designed to work different materials on machines with limited power and no longer in perfect condition and efficiency.
The second category was designed to work on milling machines with more power, more stable and allowed to remove more material per time unit.
But now we must refer to UNI 3899 (Application range of milling cutters type N, D, T).
Basically they divide the processed materials into three main classes and each provides a particular type of tool, with characteristics that optimize the performance.
The constructive characteristics, such as number of teeth, of the helix angle and rake angles, are not fixed by the above normative ; every manufacturer has the option, based on their experience, to choose the values that he believes the most appropriate.
It's obvious that today if you want good performance should be coating with TiN or TiAlN the new tool and after each sharpening.
In general, however, the UNI normative fixing the basic characteristics as follows.

Type N
These milling cutters have, in general, the construction characteristics of what in the past were called high-performance milling cutters, that is:

- Teeth large and strong able to withstand great efforts, with spaces between the tooth and tooth very large to facilitate the discharge of chips.
- Large front rake angle.
- Back of the tooth with large clearance angle with the possibility to have a continuously curved profile.
- Inclination of the helix very large (from 25 ° to 45 °).
- Alternate helical teeth in the disc milling cutters with 3 cuts and those for T-slots

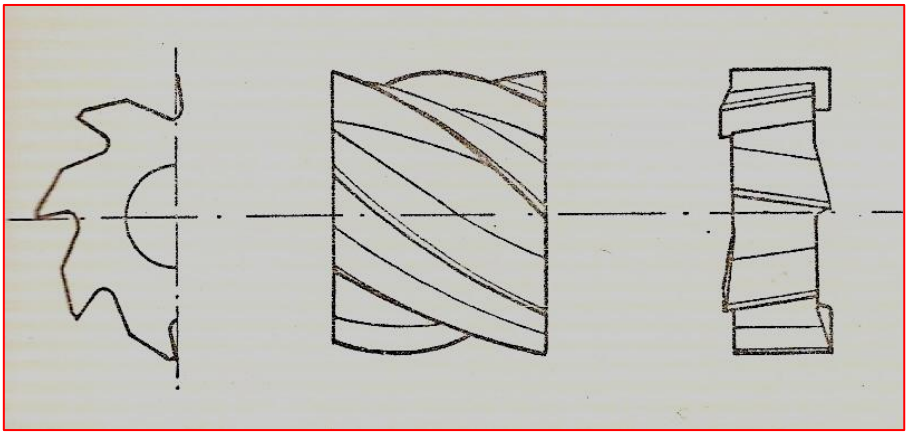

Fig. N°1- *Milling cutters type N*

Type D

The milling cutters of this type are designed to process very hard and tough materials which are generated strong friction that wear out quickly the cutting edges and raise the temperature in the points of contact between tool and workpiece.

To reduce the difficulties that may result (rapid wear, reducing the cutting speed and advancement, higher cost of processing), you must first use in high-alloyed steels with high content of cobalt, powder steels with TiN or TiAlN coating, and abundant cooling.

The teeth should be quite thick, with small rake angles and the back of the tooth reinforced.

The helix angle will be very high, ie close to 45° and a special care must be taken to the finish step of sharpening, and in some cases must lapping of the gashes.

These milling cutters are used to working steel with R from 1000 to 1300 N/mm^2, cast irons with hardness exceeding 180 Brinell, manganese steels and vanadium steels.

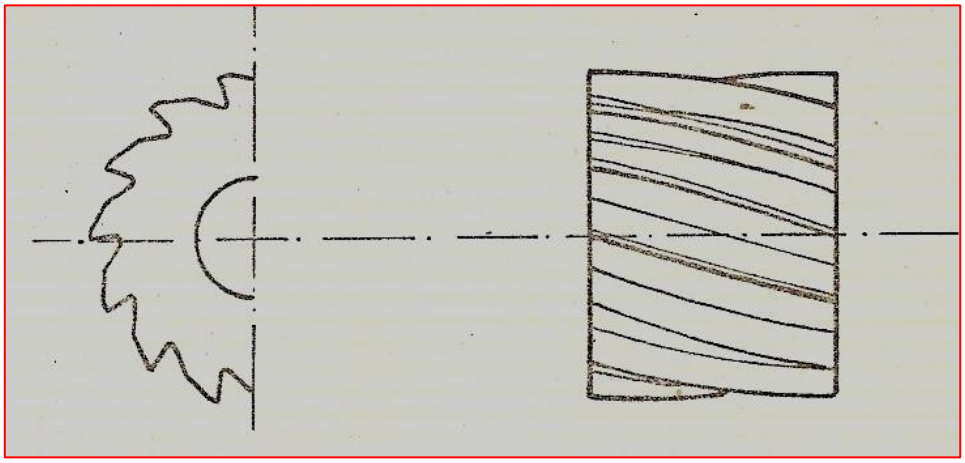

Fig. N°2- *Milling cutters type D*

Type T

Suitable for the machining of soft and malleable materials.

They have few teeth, with large clearance angles and discharged in order to facilitate the detachment and discharge of large chips, the helix must have very large inclinations.

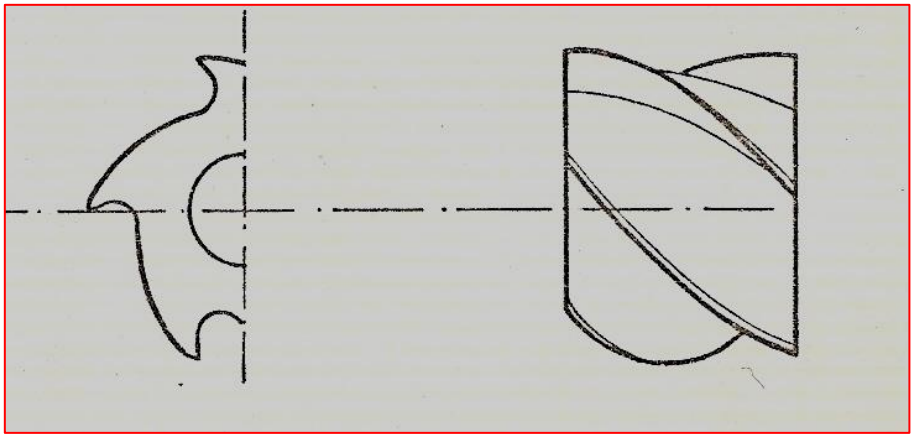

Fig. N°3- *Milling cutters type T*

The following table summarizes the types of tool indicated for each material.

Materiale lavorato	Type prescribed	Possible type
Steel with R = 500 N/mm^2	*N*	*T*
Steel with R = 500 – 800 N/mm^2	*N*	*--*
Steel with R = 800 – 1000 N/mm^2	*N*	*D*
Steel with R = 1000 – 1300 N/mm^2	*D*	*--*
Casting steel	*N*	*D*
Cast iron with $HB_{10/3000}$ < 180 HB	*N*	*--*
Cast iron with $HB_{10/3000}$ > 180 HB	*D*	*--*
Malleable cast iron	*N*	*--*
Copper ; soft alloys of copper	*T*	*N*
Copper alloys	*N*	*D*
Zinc alloys	*T*	*N*
Aluminum; Soft aluminum alloys	*T*	*--*
Semi-hard aluminum alloys	*N*	*T*
Hard aluminum alloys (low cutting speed)	*N*	*--*
Hard aluminum alloys (high cutting speed)	*T*	*--*
Magnesium alloys	*T*	*N*
Synthetic not stratified materials	*N*	*T*
Synthetic stratified materials	*T*	*--*