CONTRIBUTIONS TO FINE MACHINING OF TOOTH CONSTRUCTION BY COLD PLASTICAL DEFORMATION

Dipl. Dr. Eng. Dorin Eftimie, Braila Engineering Faculty
"Dunarea de Jos" University of Galati, Romania

Abstract: This issue presents a method and also tools concerning fine machining tooth construction mode with tool-machines in common with advantages which will substantially modifie the classic approach.

1. Goals

We must say from the beginning that, phenomenologically speaking, the proceses of fine machining of tooth construction by cold volumic pression are studied and experimented and all the strong developed countries are using these in technological fabrication.

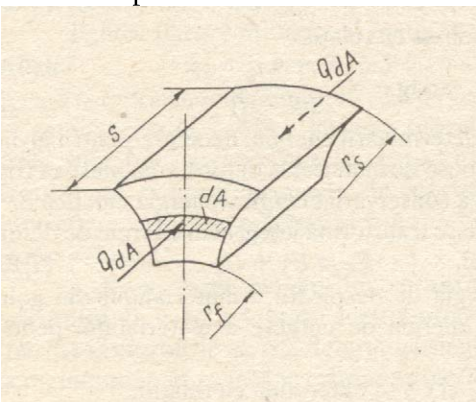
There are goals concerning fine tooth machining by plastical deformation:

1) precision and high quality of the deformed surfaces and good changes in the material structure by raising surface microhardness, in some cases that eliminates the thermal treatment.
2) using of machines with common conditions of precision and rigidity.
3) diminuating tools range for the cold plastical deformation judging their costs.
4) possibility for adapting the technical control.
5) extension of cold plastical deformation method to all range of profiles.

2. Basic elements of the fine machining tooth process by cold plastical deformation

We are trying to answer to this challenge for whom exists one conclusion: the evolution of execution technollogy and its control for profiles made by clasic method and on the other hand the existence of tool-machines which can help cold plastical deformation profiles.

We must calculate the necessary forces for plastical deformation in order to obtain the correct tooth profile.



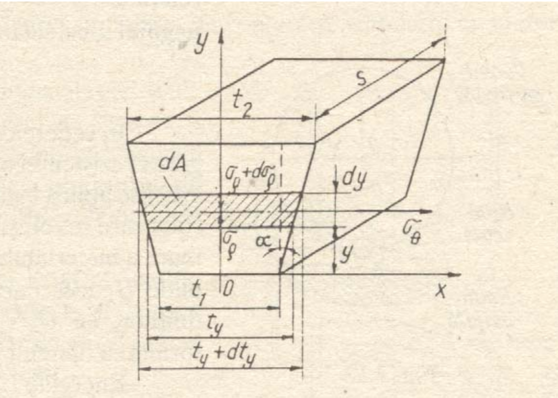


Fig. 1 Fig. 2

We correlated figures from technical literature concerning plastical deformation using section method (fig. 1). We started with simplyfied model of volume element which has the section with t_2 equal with the length of the distance measured on exterior circle of the material with r_s and t_1 equal with the length of the distance measured on foot circle with r_f on whom action radial tensions σ_ρ and $\sigma_\rho + d \cdot \sigma_\rho$ and tangential tensions σ_θ (fig. 2) where were obtained the following parameters:

A. Deformation forces for whole distance between teeth.

$$F_\rho = \sigma_\rho \cdot t_2 \cdot s$$

$$F_\theta = \sigma_\theta \cdot s \cdot (t_2 - t_1)/(2 \cdot \sin\alpha)$$

where $\sigma_\rho = 2 \cdot \sigma_c \cdot \ln(t_2 / t_1)$

$$\sigma_\theta = 2 \cdot \sigma_c \cdot [1 + \ln(t_2 / t_1)]$$

s = advance speed

σ_c = material flow limit of resistance

$$\alpha = arctg \frac{t_2 - t_1}{2 \cdot (r_s - r_f)}$$

B. The necesarly energy for defeating material resistance to plastical deformation:

$$E_c = \frac{1}{2} \cdot m \cdot R^2 \cdot \omega^2$$

where z = teeth number of the wheel

m = tool weight

R = dividing radius

ω = angle speed of tool calculated with the ecuation:

$$m \cdot \omega^2 \cdot R^2 = F_\rho \cdot (r_s - r_f) + F_\theta \cdot r_s \cdot \frac{\pi}{z}$$

C. Radial pressure force developed by the running process:

$$P = P_{sm} \cdot S_c$$

where P_{sm} = medium specific loading of the material against tool

$$P_{sm} = (3.5 \div 4)\sigma_c$$

S_c = contact zone ared.

D. 0.06÷0.1 mm added to the measurement elements touches the goals described above.
E. Theoretical studies were confirmed by tests made on tools-machines.

3. Super-finishing method and tool for gearings

Super-finishing gears manufactured from steels having hardness ≤ 320 HB represents a technological option only when advantages come first. Gears quality and the low cost price for the technological operations may lead to the extension of the process, compared to the existing ones.

The above-mentioned method and tool for super-finishing gears is destined for obtaining a roughness of 0,8 for the toothed surfaces, also for increasing the hardness of the superficial layer (≥ 5 ÷ 15 HB) using cold plastic deformation method, using classic gear-cutting machine-tools, all these being major advantages.

The gear-cutting tools presented in the figures below are able to obtain straight and tapered teeth cylinder wheels (figure 3), gear racks and groove shafts (figure 4) and taper wheels with curved teeth (figure 5).

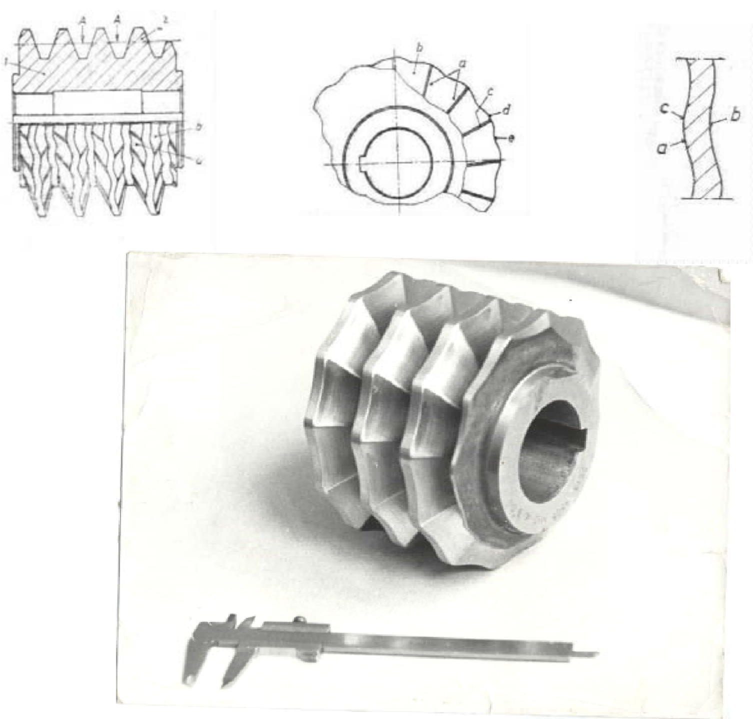


Fig. 3

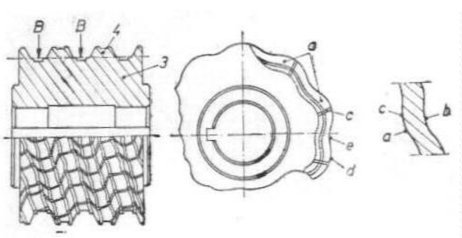


Fig. 4

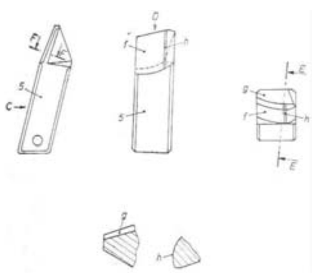


Fig. 5

This method can also be used for worm cutters, disk milling machines or front cylinder millers. Machining ratios will be increased as much as 50 ÷ 60 % compared to the classic ones. Given m ≤ 1,5, teeth cutting can be achieved starting with bulk parts. The semi-finished product will have the outer diameter similar to those obtained using the cold plastic deformation method, following to be corrected by chipping, operation noticed at the previous method. For the other modules, depending upon the hardness of the material to be machined, the machining allowances will vary between 0,5 ÷ 0,05 mm. Shall other allowances be used, there is a possibility for the hardened layer to exfoliate. In order to avoid any deviation from quality parameters, mineral oils for cooling shall be used. There are no vibrations to alter the quality of the machining process, since the machine-tool rigidity parameter is good. The electric power consumption of this machine-tool does not differ from any ordinary machining process.

As a conclusion, the easiness of manufacturing the teeth-cutting tools, the use of the machine-tools the company is endowed with, the hardening of the superficial layer obtaining a superior hardness for the same material with or without heat treatment, but having a higher roughness value, can make this process expand.

Conclusion

The above study presents a new technological process used for superfinishing gearings by cold plastic deformation, using the machine-tools the company is endowed with. The easiness of manufacturing the machining tools and the quality of the geared surfaces (roughness and hardening of the superficial layer) can make this process expand.

Bibliography : Dorin Eftimie. Invention Bulletin no. 94559, Romania