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MODELING OF THE RADIAL FORCES IN THE COLD FORMING PROCESS

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Abstract: For a cold plastic forming, the sizes of the deforming forces have an important role, because, on the one hand, help to the choosing of the technological system, and, on the other hand, the sizes of these forces directly influence the deformation's irregularity and, understood the quality products obtained**.** In the forming process, radial forces present the biggest interest mare and that's why, this work presents modelling in MATLAB software of the radial deforming forces, which appear during the cold plastic forming.

1. INTRODUCTION

Gear cutting by temple (copy) cold forming consists in the formation of the piece profile (of the tooth space) by two or more adequately formed tools, the blank rotation with an angular pitch (angular spacing) and the renewal of the process. In this case there are used special tools with a working tooth space mating profile.

The temple cold teething by intermittent blow can be performed with the help of two, three or four roller-tools, which have similar processing diagrams. A processing method by temple cold teething is that named processing method by hammering (intermittent blow, shocks), at which the material forming is achieved as a consequence of a planetary motion performed by the roller tools.

The main principle of this process consists in dividing the whole deformation in a large number of partial forming processes by using a pair of profile gear cutting tools.

In the present work, it is presented the simulation of the forming forces' dependence on some parameters of the teething process, the axial advance and the forming speed and the module of the working gear.

The values of the two constituents of the gear force were backhand achieved, by measuring the deformations of several elastic bodies through the agency of an electrical parameter.

2. FORCES IN THE FORMING PROCESS

At the determination of the necessary deforming force in the processing with only one roller tool, it is admitted the hypothesis that the material from the tooth space area passes only on radial direction for the forming of the teeth, being stopped the passing on axial direction [5]. For the accomplishment of the teeth form by a certain form on the semiproducts circle (circumference), its material is plastically formed near the surface on radial and axial direction, forming spaces whose root diameter is smaller than the initial diameter of the semiproducts, and the teeth whose crest diameter is bigger than the initial diameter.

The final relation of the radial force calculation, fig.1 necessary for the material's forming in view of the teeth formation is:

$$F_n=\sigma_\rho\, t_2\, s \qquad (1)$$

where: $\sigma_\rho = \int_{t_1}^{t_2} \sigma_c (dty/ty) = 2\sigma_c \ln(t_2/t_1)$ (2)

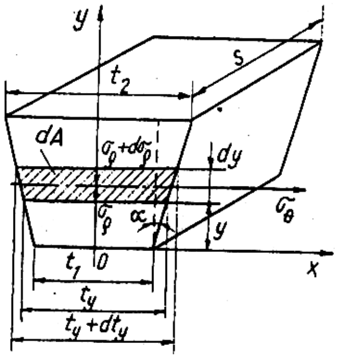

Fig.1. Determination of the forming force [5]

3. MODELLING OF THE RADIAL FORCES IN THE DEFORMATION PROCESS

For the modelling of the radial forces, which appear in the cold forming process by intermittent strike, were performed programs synthetically presented in annex 1, where it was modelled in MATLAB software the expression of the radial forming force which appear in the cold forming process, relation 1, function of the axial advance of the semiproducts s_a and the values of t_1 and t_2 which are function of the piece's module which is geared and whose signification is presented in fig. 1, the variation graphic being presented in fig. 2 and 3. The software MATLAB were effectuated for two different materials, OLC25 and OLC45, frequently used in industry.

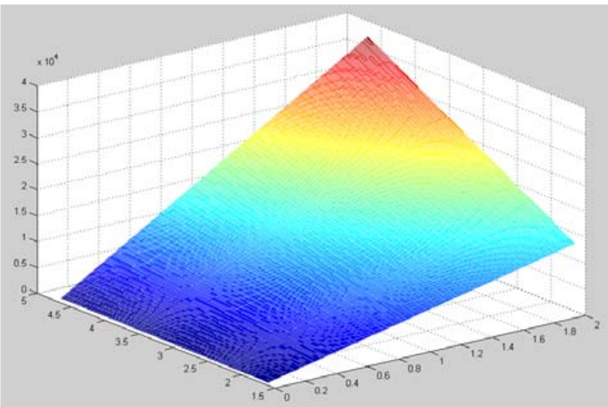

Fig. 2. F_n- function of the axial advance and of t_2(m) material OLC 25

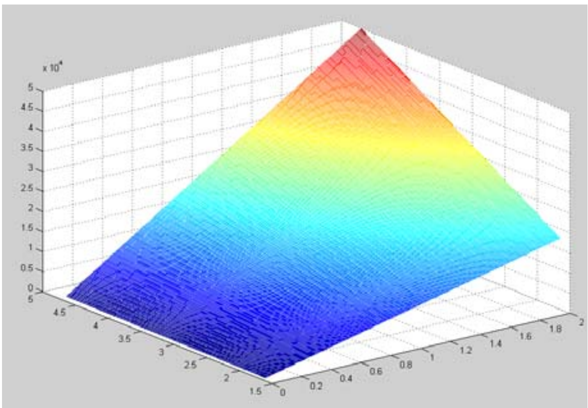

Fig. 3. F_n- function of the axial advance and of t_2(m) material OLC 45

APPENDIX 1a
Program F_n, material OLC 25

```
%t1=1.902;
tt2=(1.662:0.01:4.71);
sigc=370;
%sigc=(150:50:600);
```

```
%sigro=2*sigc*log(t2/t1)
%sigtet=2*sigc*(1+log(t2/t1))
s=(0.025:0.025:2);
rs=16.8;
rf=15.75;
%alf=tan((t2-t1)/(2*(rs-rf)))
[X,Y]=meshgrid(s,tt2);
n=length(s);
m=length(tt2)
%  fro(i)=sigro*t2*ss(i);
%  ftet(i)=sigtet*(ss(i)*(t2-t1)/(2*sin(alf)));
for i=1:1:m
t2=1.662+(i-1)*0.01;
t1=t2/1.7;
alf=tan((t2-t1)/(2*(rs-rf)))
for j=1:1:n
ss=0.25*j;
%sigro=2*ssigc*log(t2/t1);
sigtet=2*sigc*(1+log(t2/t1));
ftet(j)=sigtet*ss*(t2-t1)/(2*sin(alf));
Z(i,j)=ftet(j);
end;
end;
%[X,Y]=meshgrid(xx, yy);
%surf(X,Y,Z)
meshc(X,Y,Z)
```

APPENDIX 1b
Program F_n, material OLC 45

```
%t1=1.902;
tt2=(1.662:0.01:4.71);
sigc=500;
%sigc=(150:50:600);
%sigro=2*sigc*log(t2/t1)
sigtet=2*sigc*(1+log(t2/t1))
s=(0.025:0.025:2);
rs=16.8;
rf=15.75;
%alf=tan((t2-t1)/(2*(rs-rf)))
[X,Y]=meshgrid(s,tt2);
n=length(s);
m=length(tt2)
%  fro(i)=sigro*t2*ss(i);
%  ftet(i)=sigtet*(ss(i)*(t2-t1)/(2*sin(alf)));
for i=1:1:m
t2=1.662+(i-1)*0.01;
```

```
t1=t2/1.7;
alf=tan((t2-t1)/(2*(rs-rf)))
for j=1:1:n
ss=0.25*j;
sigro=2*sigc*log(t2/t1);
fro(j)=sigro*t2*ss;
Z(i,j)=fro(j);
end;
end;
%[X,Y]=meshgrid(xx, yy);
%surf(X,Y,Z)
mesh(X,Y,Z)
```

4. CONCLUSIONS

The deforming radial forces in the cold forming process realize the movement of the material on radial direction, presenting the biggest interest and depend on the axial advance of the semiproducts s, on the quantity of deforming material and on its characteristics represented by module m and respectively the flowing resistance σ_c. With the increase of the axial advance, of the module and of the flowing resistance, the radial forces increase. This thing can also be observed from fig. 2 and 3, where it was represented in MATLAB software, the variation of the radial force function of the advance s_a, and of the material characteristics represented by σ_c for two different materials, OLC25 and respectively OLC45.

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