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CAM PROFILE COMPUTER AIDED DESIGN PLOTTING

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ABSTRACT: This paper shows how to plotting the profile of a plane rotating cam and a follower in the translational move, using Matlab program. Are shown how input the variables, kinematic analysis, speeds hodograph in graphical form, respectively plane cam profile designed, with a choice of several options for the best solutions.
KEYWORDS: Cam, follower, cam profile

INTRODUCTION

The transformation of one of the simple motions, such as rotation, into any other motions is often conveniently accomplished by means of a cam mechanism A cam mechanism usually consists of two moving elements, the cam and the follower, mounted on a fixed frame. Cam devices are versatile, and almost any arbitrarily-specified motion can be obtained. In some instances, they offer the simplest and most compact way to transform motions.

A **cam** may be defined as a machine element having a curved outline or a curved groove, which, by its oscillation or rotation motion, gives a predetermined specified motion to another element called the follower. The cam has a very important function in the operation of many classes of machines, especially those of the automatic type, such as printing presses, shoe machinery, textile machinery, gear-cutting machines, and screw machines. In any class of machinery in which automatic control and accurate timing are paramount, the cam is an indispensable part of mechanism.

Cam mechanisms design, respectively profile obtaining, may be realize by many methods. The first design methods for cam mechanisms war graphical. These methods require many graphical constructions with low precision. With the new entry calculation systems, have develop analytical methods to obtain cam profile by software writing (Basic, C++, Matlab, MathCAD, etc). These methods are faster, giving to the plant designer varieties data results and charts.

Plotting a plane cam profile requires knowledge of some initial elements of calculation. These are:

The motion phases based on the technological process data, defined by the angles of lifting, high stationary, going down and down stationary, respectively follower race (linear displacement respectively oscillating)

Law of motion, which is chosed by the designer according to the angles values that define motion phases and by the value of the angular velocity of the cam. In most cases law of motion is chosen depending on the maximum acceleration of the follower (for the reasons of inertia forces equilibration), respectively on the acceleration jump from one phase to another.

Maximum pressure angle (between the follower and cam)

Motion (linear or oscillating) and follower form

Follower roller radius (if necessary), according to the minimum radius of basic circle

Expansion joints (if necessary)

Plotting a plane cam profile can be made by graphical methods and analytical method. In both cases the design involves the following steps:

Kinematic analysis of a cam mechanism, respectively the graphical representation of displacement variation and follower low speed depending on the cam rotational angle

Velocities hodograph building

Determination of minimum radius of curvature of the cam

Checking the contact pressure

Entering in calculations the expansion joints (if necessary)

Establishing minimum radius of the cam base circle, respectively the radius of the roller follower (if necessary)

Cam profile construction

PROGRAM AND RESULTS PRESENTATION

Plane rotating cam plotting profile, with follower in translation moving, was made with mathematical formulas provided by analytical methods [2], using a computer program designed and written in Matlab programming environment.

For the case study was considered a cam mechanism having the follower parabolic law of motion, respectively the following input data defined by the technological process requirements:

Follower lift: $h = 50$ mm

Uplift angle: $\varphi_1 = 150$ grade

Upper stationary angle: $\varphi_2 = 30$ grade

Down angle: $\varphi_3 = 150$ grade

Pressure angle allowed: $\delta = 30$ grade

Eccentricity: $e = 10$ mm

When the computer program is launching appear a dialog box with the user, from which will be introduced the input data (dialog box defined with the input procedure). This is shown in Figure 1.

Based on input data (defined by the technological process) computer program make graphic representation of displacement and follower low speed depending on cam rotation angle (Fig. 2),

respectively velocities hodograph (velocity and displacement graphic dependence of the follower) (figure 3).

```
MATLAB Command Window
File  Edit  Options  Windows  Help
»
cursa h[mm]=50

unghiul de ridicare fi1[grd]=150

unghiul de stationare superioara fi2[grd]=30

unghiul de coborire fi3[grd]=150

unghiul de presiune admis delta[grd]=30

excentricitatea e[mm]=10
```
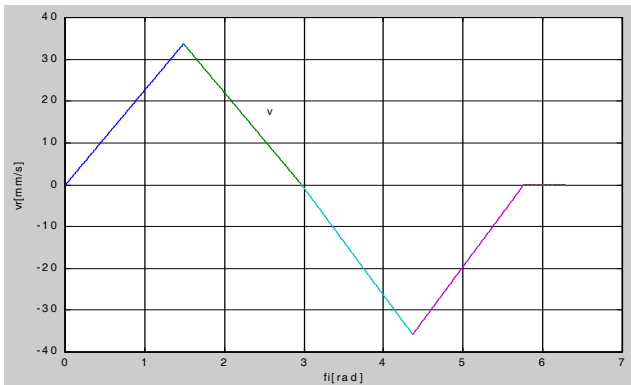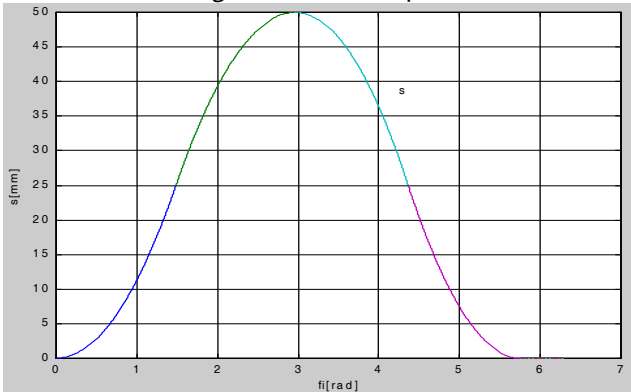*Fig.1. Initial dates input*

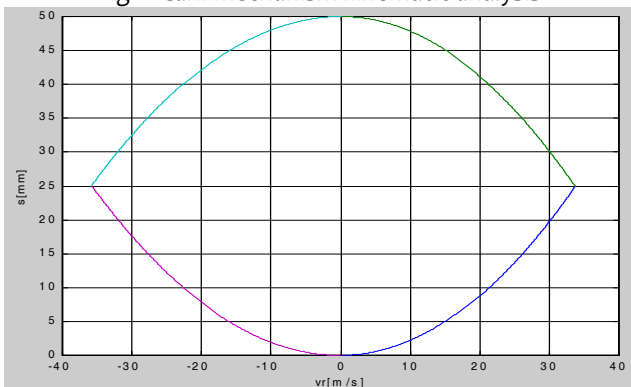*Fig.2. Cam mechanism kinematic analysis*

Fig.3. Velocity hodograph

It is known that on synthesis graphical method of cam mechanisms, the velocities hodograph is used to determine minimum radius on graphical method of basic circle. In case of analytical methods based on known relations [2], computer program determines the minimum value of basic circle, showing more options, the user entering through an input procedure, the chosen value, fig.4.

```
excentricitatea e[mm]=10

r =

   12.5901   12.5902    8.2049    8.2049   10.8307   10.8315


raza cercului de baza r=|
```
Fig. 4. Choosing the minimum radius of basic circle

Further, the program performs roll follower radius calculation, follower and cam contact verification, respectively determines by graphic representation cam profile (based on user input data) Fig. 5.
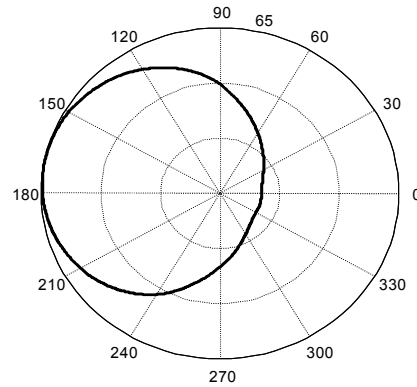

Fig. 5. Cam profile with parabolic motion law

CONCLUSIONS

The presented calculation program is very easy to use by the designer, through introduction of initial data, given by the technological process; in a very short time it can get the cam profile, respectively kinematics on cam mechanism graphic representations.

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