ANNALS OF THE FACULTY OF ENGINEERING HUNEDOARA
2006, Tome IV, Fascicole 1, (ISSN 1584 – 2665)
FACULTY OF ENGINEERING HUNEDOARA,
5, REVOLUTIEI, 331128, HUNEDOARA

KINETICS STUDY ON MECHANISMS OF PARALLEL GANG SHEARS' TYPE ASSIGNED FOR CUTTING METALLURGICAL PRODUCTS

BUDIUL BERGHIAN Adina, VASIU Teodor

"POLITEHNICA" UNIVERSITY OF TIMISOARA,
ENGINEERING FACULTY OF HUNEDOARA

ABSTRACT:
In this study is presented the kinetics study of shear type mechanisms for cutting metallurgical products at the mill train of the semi-finished steel products Rolling Mill No. 2. The kinetics study aims to determine positions, velocities and acceleration of a mechanism elements depending on angle of sight of the driving element which is in rotational movement or depending on linear movement if the driving element executes a translational movement. In situation of kinetics elements which execute a rotational movement or plane-parallel movement, having known positions, velocities and angular accelerations could be determined trajectories, speeds and linear accelerations of different points that are characteristic for these elements depending on the position of driving element.

KEYWORDS:
mechanism, positions, velocities, accelerations

1. INTRODUCTION

In order to perform the kinetics study of plane mechanisms is necessary to divide the mechanism in ASSUR kinetics groups and driving element, because most methods of kinetics study, aiming to generalize them easily, have been elaborated for such kinetics groups (dyads, triads, tetrads, etc.).

In the theory of mechanisms are known methods of graphical – analytical kinetics study that have the property to be used rapidly and simply, but as a consequence of high volume of graphical representations the accuracy of results is low. Analytical methods, for example the method of contours involves a high volume of mathematical calculus such as solving of some sets of equations for as many as positions of driving element, calculus that can be easily solved by an electronic computer. Kinetics study of the researched mechanism using the Mathcad programming environment follows to be presented.

2. MECHANISM OPERATION

Operation of this type of mechanism is performed in phases: in the first phase is lowered the superior cutter in the same time with a pad on the surface of steel semi-finished product and after this they stop and the inferior cutter which performs the cutting operation starts to lift. After cutting has done the inferior cutter comes back to the initial position then starts to lift the superior cutter too. These movements are coordinated by the crankshaft and are accomplished at a stroke of 360^0 of this crankshaft, this being the reason which for the structural analysis of studied mechanism will be performed in phases.

3. STRUCTURAL ANALYSIS OF THE MECHANISM

The mechanism will be approached depending on movement phases, because the bearers will be modified. From 270 up to 180^0, is lowered the superior cutter together with a pad up to a certain height, the inferior cutter remaining in the initial position (figure 1).

The mechanism consists of handhold 1, small driving rod 2, higher arm 3, lower arm 5, big driving rod 4 and superior slider.

From structural point of view the mechanism can be decomposed in simple triad of order 3, 3rd class, composed from small driving rod 2, upper arm 3, big driving rod 4 and superior slider 4, kinematics couplings of class V: A, B, C, D, E and translation coupling and engine element (hand-hold 1). The mechanism is plane and consists of five kinematics elements (1, 2, 3, 4, 6) and seven kinematics couplings of class V, six revolving couplings (O, A, B, C, D, E) and a translation coupling.

Formula of mobility degree for plane mechanisms (f = 3) is the following:

$$M_3 = 3 \cdot n - 2 \cdot C_5 - C_4 = 3 \cdot 5 - 2 \cdot 7 - 0 = 1 \qquad (1)$$

The mechanism has a mobility degree in value of 1.

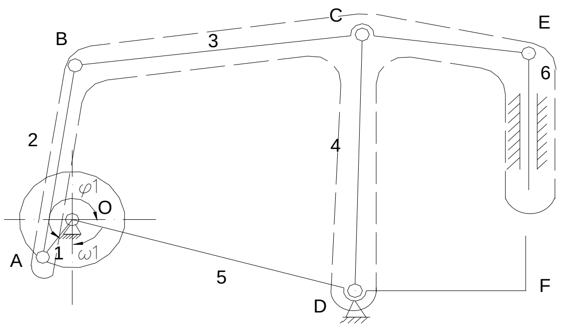

Figure 1. Kinetics scheme of the 800tf ($270\text{-}180^0$) shear

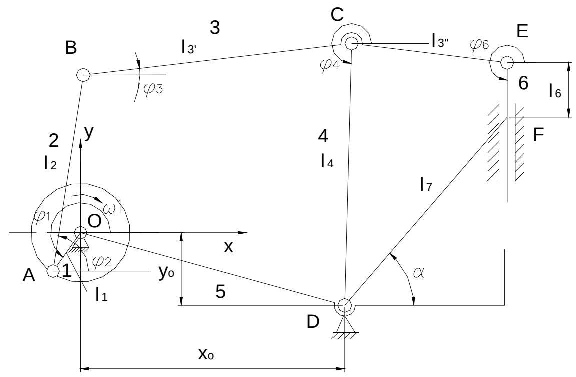

Figure 2. Kinetics scheme of ABCDE triad

4. DETERMINATION OF POSITIONS FOR COMPONENT ELEMENTS

To determine the positions will be used the figure 2. Determination of positions for ABCDE triad sown in figure 1.8 will be accomplished choosing the origin of the coordinate system of axes xy in the point O. By notations in the figure will be written the projections of contour equations for ABCDE triad:

- For the OABCD closed loops:

$$\begin{cases} l_1 \cdot \cos\varphi_1 + l_2 \cdot \cos\varphi_2 + l_3^{'} \cdot \cos\varphi_3 + l_4 \cdot \cos\varphi_4 = x_0 \\ l_1 \cdot \sin\varphi_1 + l_2 \cdot \sin\varphi_2 + l_3^{'} \cdot \sin\varphi_3 + l_4 \cdot \sin\varphi_4 = y_0 \end{cases} \qquad (2)$$

- For the CDEF closed loops CDEF

$$\begin{cases} -l_4 \cdot \cos\varphi_4 + l_{7x} = l_3^{''} \cdot \cos\varphi_3 + l_6 \cdot \cos\varphi_6 \\ l_4 \cdot \sin\varphi_4 + l_{7y} = l_3^{''} \cdot \sin\varphi_3 + l_6 \cdot \sin\varphi_6 \end{cases} \qquad (3)$$

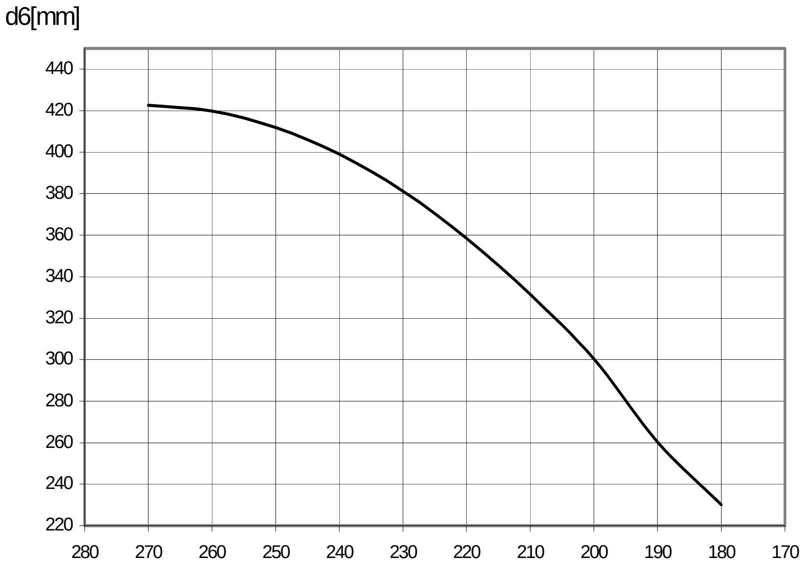

Figure 3. Graphical representation for variation d6 depending on position φ_1 of the hand-hold

Calculation phases presented above are solved by the mean of Triad Program, written in Mathcad environment, and graphical representation for variation d6 depending on position φ_1 of the hand-hold is shown in figure 3.

5. DETERMINATION OF LINEAR VELOCITY FOR ELEMENT 6 (FOR THE POSITION OF HAND-HOLD OF 270-180^0)

In order to determine the linear velocity of element 6 will be used the figure 2 and will be differentiated the sets of equations (2) and (3):

$$\begin{cases} -l_1 \cdot \omega_1 \cdot \sin\varphi_1 - l_2 \cdot \omega_2 \cdot \sin\varphi_2 - l_3^{'} \cdot \omega_3 \cdot \sin\varphi_3 - l_4 \cdot \omega_4 \cdot \sin\varphi_4 = 0 \\ l_1 \cdot \omega_1 \cdot \cos\varphi_1 + l_2 \cdot \omega_2 \cdot \cos\varphi_2 + l_3^{'} \cdot \omega_3 \cdot \cos\varphi_3 + l_4 \cdot \omega_4 \cdot \cos\varphi_4 = 0 \end{cases} \quad (4)$$

$$\begin{cases} l_4 \cdot \omega_4 \cdot \sin\varphi_4 = -l_3^{''} \cdot \omega_3 \cdot \sin\varphi_3 \\ l_4 \cdot \omega_4 \cdot \cos\varphi_4 = l_3^{''} \cdot \omega_3 \cdot \cos\varphi_3 + v_6 \end{cases} \quad (5)$$

Graphical representation of linear velocity variation for the element 6 depending on position φ_1 of the hand-hold is shown in figure 4:

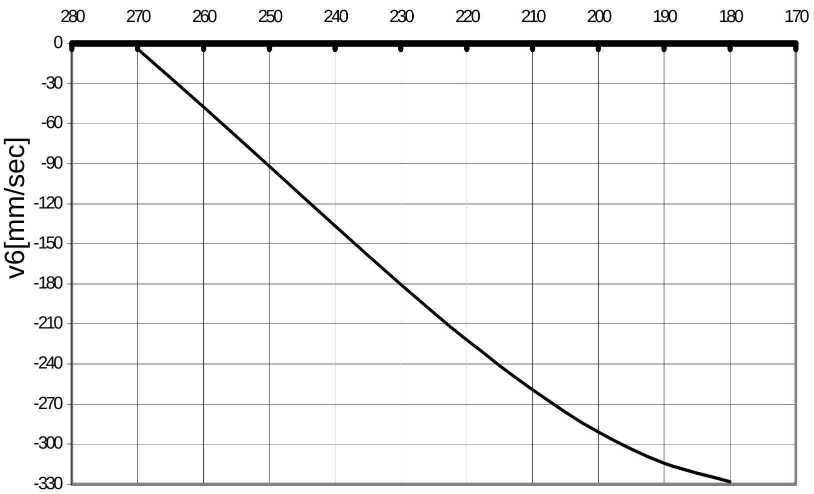

Figure 4. Graphical representation for variation d6 depending on position φ_1 of the hand-hold

6. DETERMINATION OF LINEAR ACCELERATION FOR THE ELEMENT 6 (FOR THE POSITION OF HAND-HOLD OF 270-180^0)

In order to determine the angular accelerations for elements 2, 3, 4 and linear acceleration for element 6, will be differentiated the equations of velocities, keeping notations shown in figure 2:

$$\begin{cases} -l_2\varepsilon_2 \sin\varphi_2 - l_3'\varepsilon_3 \sin\varphi_3 - l_4\varepsilon_4 \sin\varphi_4 = l_1\omega_1^2 \cos\varphi_1 + l_2\omega_2^2 \cos\varphi_2 + l_3'\omega^2 \cos\varphi_3 + l_4\omega_4^2 \cos\varphi_4 \\ l_2\varepsilon_2 \cos\varphi_2 + l_3'\varepsilon_3 \cos\varphi_3 + l_4\varepsilon_4 \cos\varphi_4 = l_1\omega_1^2 \sin\varphi_1 + l_2\omega_2^2 \sin\varphi_2 + l_3'\omega_3^2 \sin\varphi_3 + l_4\omega_4^2 \sin\varphi_4 \end{cases} \quad (6)$$

$$\begin{cases} l_4\varepsilon_4 \sin\varphi_4 + l_3''\varepsilon_3 \sin\varphi_3 = -l_4\omega_4^2 \cos\varphi_4 - l_3''\omega_3^2 \cos\varphi_3 \\ l_4\varepsilon_4 \cos\varphi_4 - l_3''\varepsilon_3 \cos\varphi_3 - a_6 = l_4\omega_4^2 \sin\varphi_4 - l_3''\omega_3^2 \sin\varphi_3 \end{cases} \quad (7)$$

Graphical representation for variation of linear acceleration with respect to element 6 depending on position φ_1 of hand-hold are shown in figure 5:

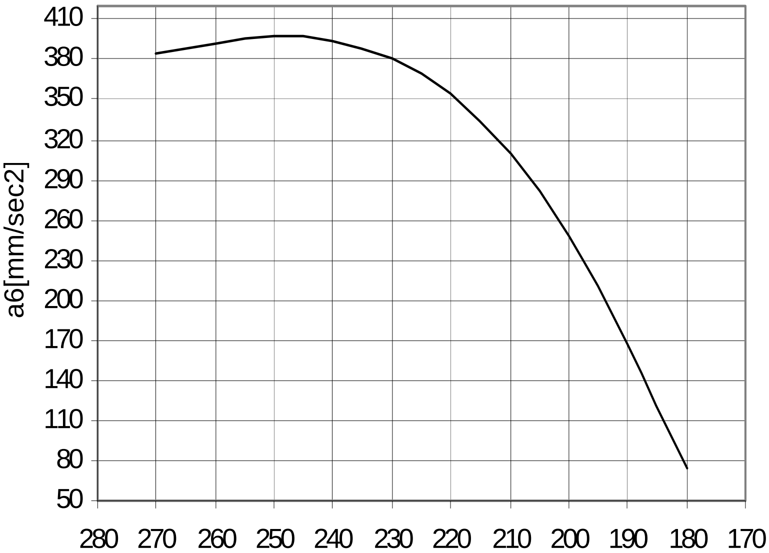

Figure 5. Graphical representation for variation of linear acceleration with respect to element 6 depending on position φ_1 of hand-hold

7. CONCLUSIONS

The conclusion of calculus performed is that both velocities and accelerations have low values because the angular velocity of the driving element has a low value too. Variations of accelerations give us information with respect to variations of inertia forces that act on kinetics elements, which are necessary in the kinetics – static design. Kinetics study is also necessary to determine the relative positions of elements at mechanism assemblage.

BIBLIOGRAPHY

[1.] Budiul-Berghian, A., Analiza cinematică şi cinetostatică a mecanismelor tip foarfecă pentru debitat produse metalurgice, Referat doctorat, Universitatea din Petroşani, 2005.

[2.] Budiul-Berghian, A., Stadiul actual privind mecanismele de debitat produse metalurgice, Referat doctorat, Universitatea din Petroşani, 2004.

[3.] Moldovan, V., Maniu, A., Utilaje pentru deformări plastice, Editura Didactică şi Pedagogică, Bucureşti, 1982.

[4.] Zamfir, V., Albăstroiu, P., Mecanisme şi organe de maşini, partea I-a, Mecanisme, Litografia Institutului de Mine Petroşani, 1975.

[5.] * * * , Instrucţiuni tehnologice pentru liniile de laminare Blooming 1300 şi 1000 mm