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The MSC Adams/View and Simulation of the Crank Rocker Mechanism

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Abstract In the paper we show the possibilities of physical modeling in MSC Adams of the crank mechanism. The aim of this article is to develop a functional model of crank rocker mechanism in ADAMS/View software and his following complete kinematics analysis. We analyze the movement of the members of the mechanism. Kinematics analysis was performed analytically and graphically. Finally, the work presents the results with graphical representation of parameters such as angular velocity and angular acceleration of the members of the mechanism.

Keywords: *simulation, mechanism, crank rocker mechanism, kinematics analysis*

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1. Introduction

Computer modeling is an effective tool to accelerate and improve the design of new mechanical systems. The MSC Adams/View [1] is appropriate software tools for creating computer models. In addressing the motion of machine parts, machines and equipment it is necessary first to create a kinematics model. Conventional numerical solution uses vector calculus as the basic mathematical apparatus because the main kinematics variables are vector quantities. Kinematics model of a device schematically captures all its properties which are essential in kinematical analysis i.e. individual members with dimensions, kinematics pairs, and so on. Classical numerical solution of movement kinematics is often lengthy and difficult especially for complex kinematics models with different movements. To simplify and expedite the analysis a graphical solution may be used which is nowadays replaced with a solution using computer techniques using various software products. These software products ease the investigator's effort. Investigator enters the model configuration and the input data and the program calculates the required outputs. These data can be presented in a tabular form or the program draws graphical results.

2. Description of the Model

MSC Adams is one of the most widely used multi-function computing software [2]. The aim of this article is to create a functional model crank rocker mechanism in ADAMS/View and to make its complete kinematics analysis [3]. The aim is to investigate the movement of individual members of the mechanism and its points.

We analyze the movement of point A and point B on the member 3 (Figure 1). The member 3 is performing planar motion. The point A of the member 2 moves in a circle with radius l_2 and point B of the member 4 also moves in circle with radius l_4. We determine angular velocity and angular acceleration of member 2, angular velocity and angular acceleration of member 4.

Kinematical analysis of the mechanism means to solve kinematical variables of movement of the driven members with respect to the kinematics variables of movement of the driving members [4].

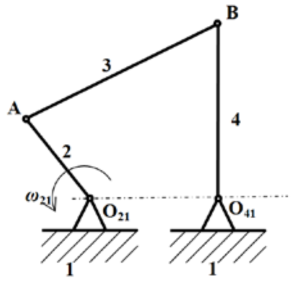

Figure 1. Crank Rocker Mechanism

Respective lengths of the mechanism are: l_2=120 mm, l_3= 250 mm, l_4=260 mm, $O_{21}O_{41}$=300 mm. Driving link $O_{21}A$ has a counterclockwise angular velocity ω_{21}=1 (rad/s). Our task is to determine angular displacement φ_{41}, angular velocity ω_{41} and angular acceleration α_{41} of the link $O_{41}B$ graphically for the crank position indicated and then to create a model of a mechanism in MSC Adams/View environment.

The crank $O_{21}A$ rotates around point O_{21}, motion of the connecting member AB is a general planar motion and member $O_{41}B$ rotates around point O_{41}. When we determine lengths of the members we indicate velocities of the points A and B. The angular velocity of the member 2 is ω_{21}.

3. Kinematics Analysis of the Model

The velocity of points A and B can be obtained by using the rule of the viewing angles [4]. Tangent of the angle βv_{21} under which we see the endpoints of velocity from the permanent center of rotation is proportional to the angular velocity of the rotating member. If we denote the angular velocity ω_{21} of the member 2 with respect to 4, then for the velocity v_A and acceleration a_{An} at point A shall apply [5]:

$$v_A = \overline{O_{21}A} \cdot \omega_{21}, \quad (1)$$

$$a_{An} = \frac{v_A^2}{O_{21}A} \quad (2)$$

$$tg\beta_{v21} = \frac{v_A}{O_{21}A} = \dot{\phi}_{21} = \omega_{21} \quad (3)$$

$$\beta_{v21} = arctg\,\omega_{21} \quad (4)$$

$$tg\beta_{v31} = \frac{v_A}{K_{31}A} = \frac{v_B}{K_{31}B} = \omega_{31} \quad (5)$$

$$v_B = \overline{K_{31}B} \cdot \frac{v_A}{K_{31}A} \quad (6)$$

Angular velocity ω_{41} of the member 4 we determine:

$$\omega_{41} = \frac{v_B}{O_{41}B} \quad (7)$$

The member 3 is moving in the plane in form 3:1=3:2+2:1 and also 3:1=3:4+4:1. For the velocity of the point A:

$$v_{A31} = v_{A32} + v_{A21} \quad (8)$$

For the velocity of the point B:

$$v_{B31} = v_{B34} + v_{B41} \quad (9)$$

$$v_{B31} = v_{A31} + v_{BA31} \quad (10)$$

Acceleration a_B of the point B [6]:

$$a_B = a_A + a_{BA} \quad (11)$$

where:
a_{Bt} - known direction,
a_{Bn} - can be obtained by Euclidean construction,
a_{At} - is zero because

$$\omega_{21} = konšt. \Rightarrow \alpha_{21} = 0, a_{At} = \alpha_{21} \cdot \overline{O_{21}A} = 0 \quad (12)$$

a_{An} – is normal component of the acceleration of the point A:

$$a_{An} = \frac{v_A^2}{O_{21}A} \quad (13)$$

Graphical solution of the above vector equation is in the Figure 2. Angular velocity ω_{41} and angular acceleration α_{41} is then calculated according to:

$$\omega_{41} = \frac{v_B}{O_{41}B} \quad (14)$$

$$\alpha_{41} = \frac{a_{Bt}}{O_{41}B} \quad (15)$$

In Figure 2 there is the model in graphic form with velocities of points A and B.

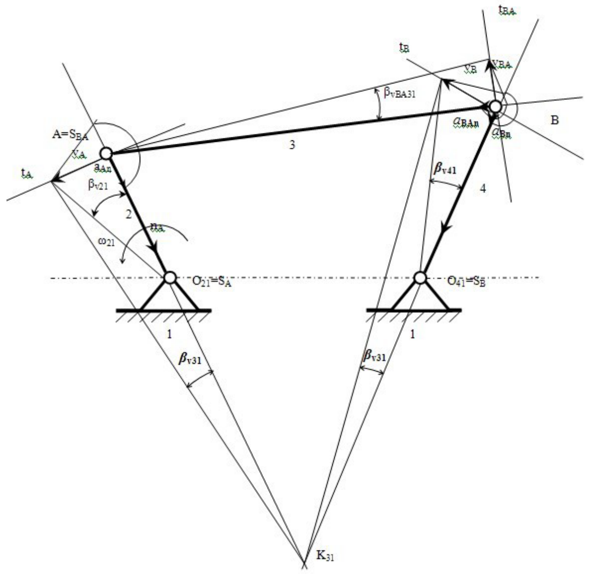

Figure 2. Crank Rocker Mechanism - velocity of the point A and velocity of the point B.

4. Simulation of the Crank Rocker Mechanism Using MSC Adams/View

The given crank rocker mechanism was modeled in MSC ADAMS/View and the initial parameters were provided [1]. In the initial window of the program Adams we set data folder, name of the project, units and the working grid. We created the individual bodies of the mechanism. We selected the rigid body link from the Toolbox. We defined the geometry, length, width and depth. The lengths of the four links crank rocker mechanism are: l_2=120 mm, l_3=250 mm, l_4=260 mm, $O_{21}O_{41}$=300 mm. Driving link $O_{21}A$ (Figure 1) has a counterclockwise angular velocity ω_{21}=1 rad/s.

We created the member 2 and the member 4 shown in the Figure 3 and Figure 4.

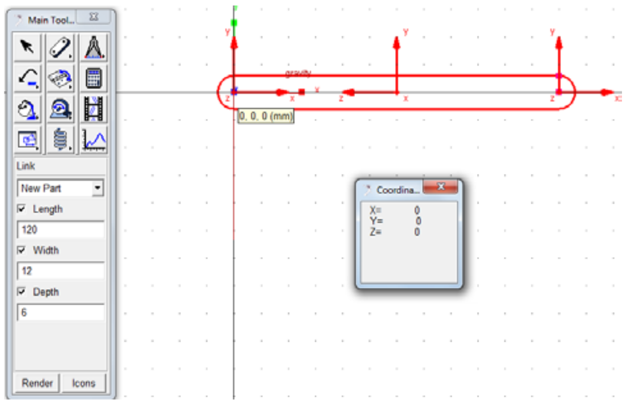

Figure 3. Creation of the member 2 of the crank rocker

We select link tool in Main Toolbox. Move the cursor to (0, 0, 0) position and member 2 is created a named automatically. Then move the cursor to (300, 0, 0) position and created the member 4.

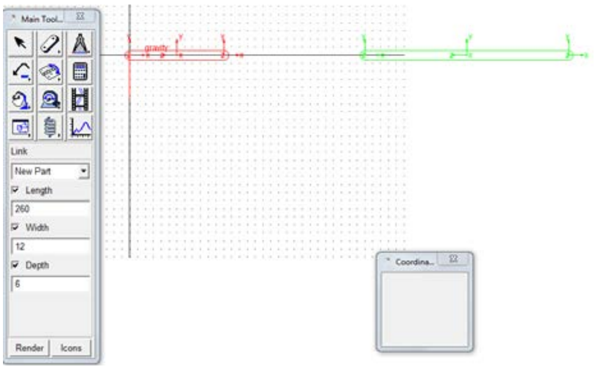

Figure 4. Creation of the member 4 of the crank rocker mechanism

The member 4 should be rotated about point from horizontal position to counterclockwise rotated 114º (Figure 5).

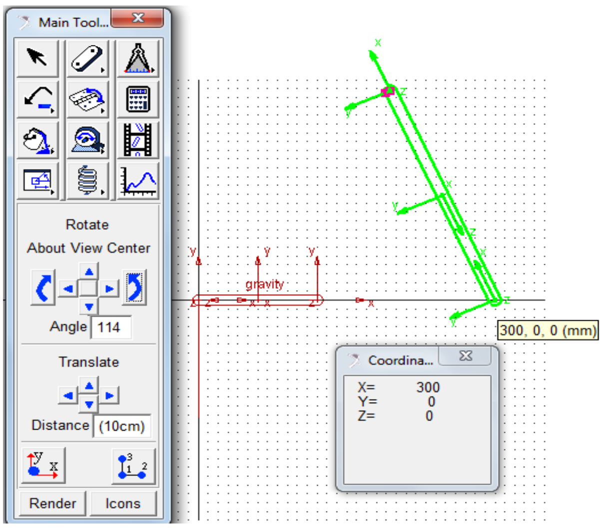

Figure 5. Rotation of the member 4

Then connected the member 2 and 4 with member 3 (Figure 6).

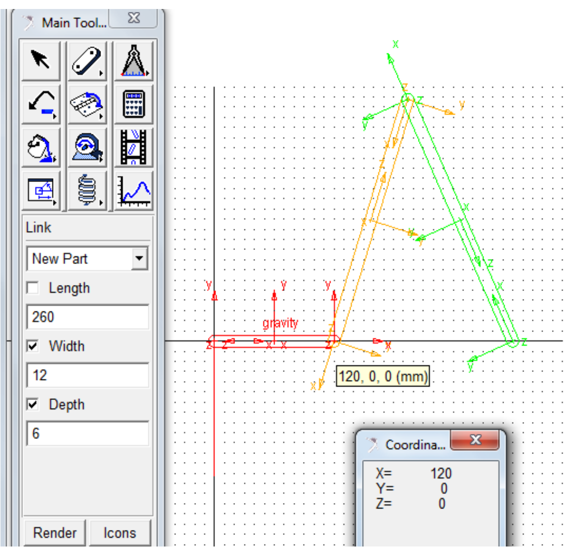

Figure 6. Connecting member 2 and member 4 with member 3

Next we created joints between the members and ground (Figure 7).

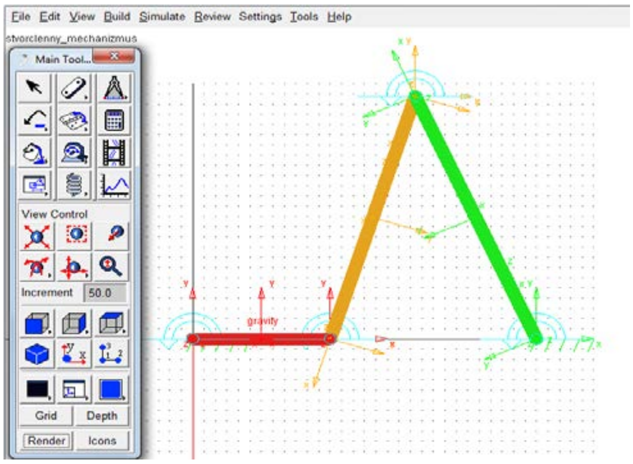

Figure 7. Connecting members with joints

Select rotational joint motion tool with speed 1 rad/s [6] (Figure 8).

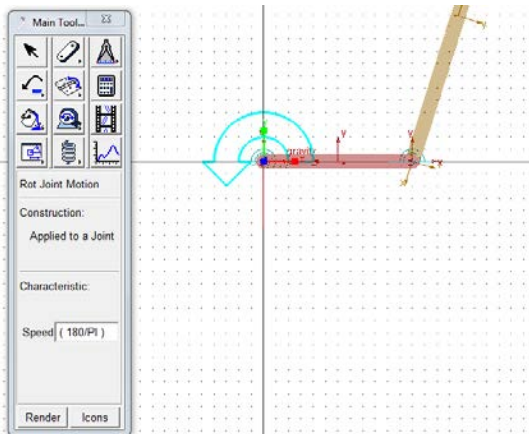

Figure 8. Create the rotation joint motion in point O_{21}

Final model of the mechanism is shown in Figure 9.

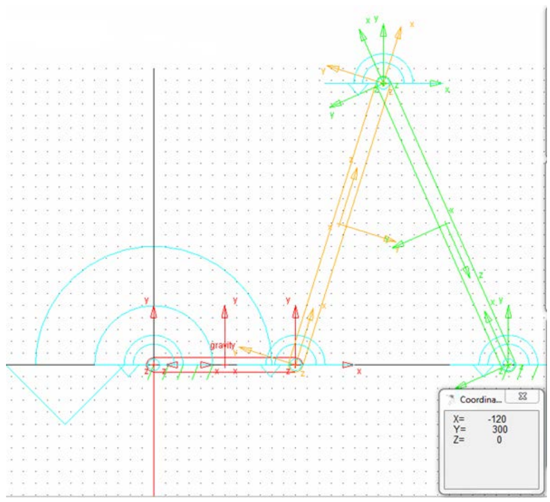

Figure 9. Model of the crank rocker mechanism in Adams View

We create the measure windows for angle φ_{41}, angular velocity ω_{41} and angular acceleration α_{41} of the member 4. Then we start simulation and we determine angle φ_{41}, angular velocity ω_{41} and angular acceleration α_{41} of the member 4 (Figure 10).

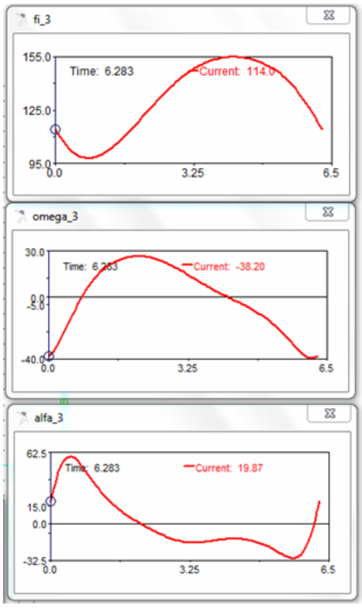

Figure 10. Illustration of the windows measures for angle φ_{31}, angular velocity ω_{31} and angular acceleration α_{31} of the member 3

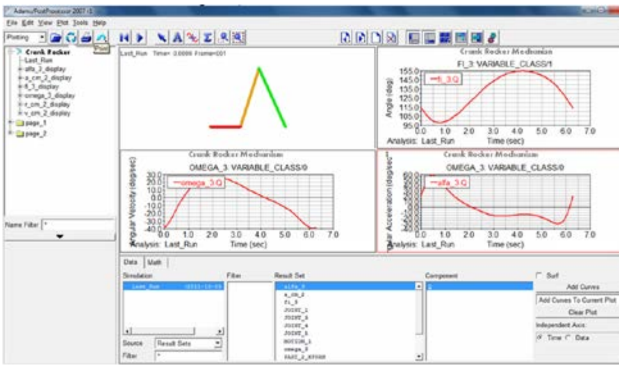

Figure 11. Window of the Postprocessor with animation window and measure windows

In the window of the Postprocessor we selected window with animation of the mechanism and windows with results data in graphics form for angle φ_{41}, angular velocity ω_{41} and angular acceleration α_{41} of the member 4 (Figure 11).

5. Conclusion

The MSC ADAMS/View software products is program suitable for kinematics analysis that allows to modeled kinematics chains and solve their motion.

We investigated a functional model of a crank rocker mechanism. The whole modeling simulation was carried out by simulation program MSC ADAMS/View. Subsequent simulation of several configurations of the crank rocker mechanism and the comparison of the outputs showed the impact of the change of the respective parameter.

In the work is shown a procedure for solving kinematics problem of the mechanism using analytical and graphical solution. Results are obtained in form of time diagram of the desired variables. The results obtained by the simulation of the crank rocker mechanism were processed by the postprocessor program of MSC Adams/View. [7]

Program MSC Adams/View makes it easy to analyze complex mechanical systems with multiple degrees of freedom. In the paper one module of the number of modules namely MSC Adams/View was used as a tool which allows a better simulation and visualization of the model and easier evaluation of the results obtained. With the module MSC Adams/View they represent a tool that is able to addresses various types of mechanisms with many degrees of freedom. Mastering this methodology provides a suitable tool for solving problems of teaching and practice.

Acknowledgement

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