Quest Journals
Journal of Research in Mechanical Engineering
Volume 9 ~ Issue 5 (2023) pp: 11-15
ISSN(Online):2321-8185
www.questjournals.org

Research Paper

Simulations of the slider-crank mechanism: A mixed research approach

Iuliana Tomozei[1], Tiberiu Axinte[1*],ErolCarjali[2]
[1]*Research and Innovation Center for Navy, Constanta, Romania*
[2]*Ovidius University of Constanta, Romania*
Corresponding Author. (T. Axinte)

ABSTRACT: *The purpose of thisstudyis to simulate of the slider-crankmechanism.This mechanism is found in: compressor, feeder, pump, injector, water mill, crusher, etc. Besides, the crank-slide linkage is central to diesel, on steam engine or gasoline internal combustion engines, which play an indispensable role in modern living. This systemconsists of the following components: crank support, crank, connection rod and slider.First component is the crank support, whichis always a fixed body. Second component is the crank which a rotation motion. Third component is the connection rod. Shortly, the connection rod is generally abbreviated con-rod. The con-rod body transforms reciprocating motion to rotational motion. Fourth components is the slider. The slider has always a translation motion.Finally, it is also shown that the mechanism is adequate and the software algorithm developed simulatesthe functioning.*
KEYWORDS: *Slider-crank, Con-rod, Slider, Mechanism, System*

R*eceived 01 May, 2023;* ***R****evised 08 May, 2023;* ***A****ccepted 10 May, 2023 © The author(s) 2023.*
P*ublished with open access at* ***www.questjournals.org***

I. INTRODUCTION

The slider-crank mechanism is otherwise a typical mechanical linkage that changes rotary motion into linear motion or vice versa. This mechanism is widely used in various mechanical applications. Mechanical applications are found in: internal combustion engines, pumps, presses, compressors, robotics, toy, etc. [1].

Any slider-crank mechanism is made of four main components: a crank, a connecting rod, a slider and obviously a crank support, as shown in figure 1.

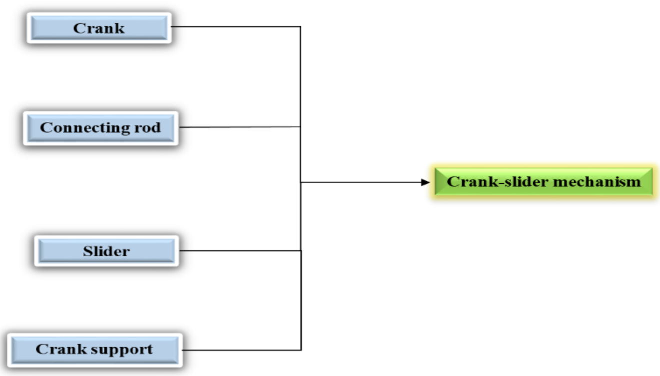

Figure1: Components → Slider-crank mechanism

The roles of the components belonging to the slider-crank system are [2]:

- The crank is a rotating shaft that is driven by an electric motor or a heat engine.
- The connecting rod is a simple linear link (a bar) that connects the crank to the slider.
- The slider is a solid sliding element whose role is to move back and forth along a straight line.

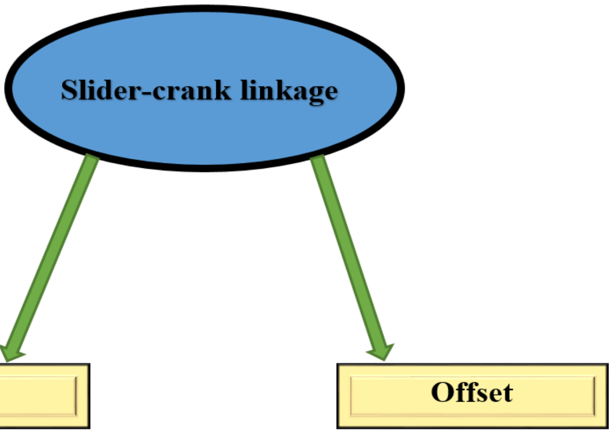

Figure2: Types of slider-crank linkage

Figure 2 shows that in practice exists two types of the slider-crank linkage:

- <u>In-line</u>. A system that has the slider positioned so that the line of travel of the hinged joint of the slider passes through the base joint of the crank.
- <u>Offline</u>. In the second system, if the line of travel of the pivot joint of the slider cannot pass through the base pivot of the crank, then the movement of the slider is not symmetrical. And the cursor moves faster in one direction than the other. This system is called a quick return mechanism.

II. STUDY OF CRANK-SLIDER MECHANISM

As in figure 3, we designed in 3D a crank-slider mechanism with its components.

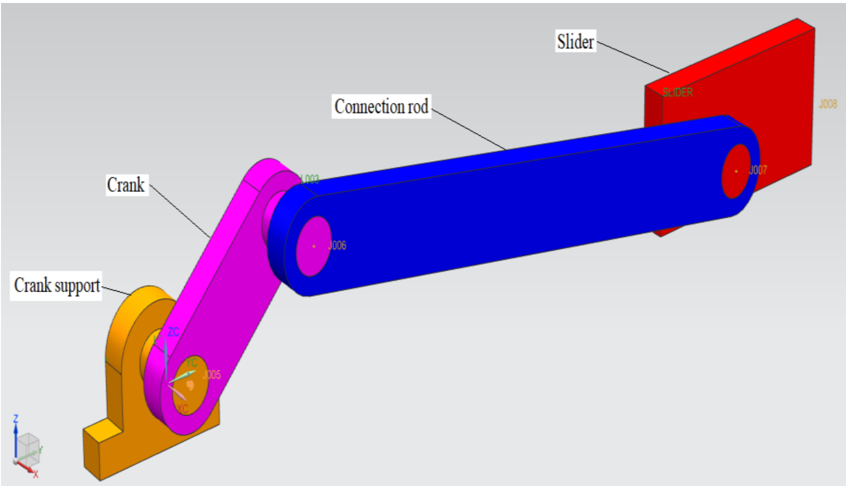

Figure3:A crank-slider mechanism in 3D

The mechanism bodies are made of different types of aluminum alloys, as in Table 1.

Table 1: Bodies of mechanism

Bodies	Element	Aluminum alloy	Density (kg/m^3)
Body 1	Crank support	2024	2800
Body 2	Crank	2024	2780
Body 3	Connection rod	3003	2730
Body 4	Slider	3105	2720

The elements of the mechanism designed by us are [3]:

- Link 1 → l1.
- Link 2 → l2.
- Angle AOB → β.
- Angle ABO → φ.

*Corresponding Author: Tiberiu Axinte

- Constant angular velocity → $\square_0$.

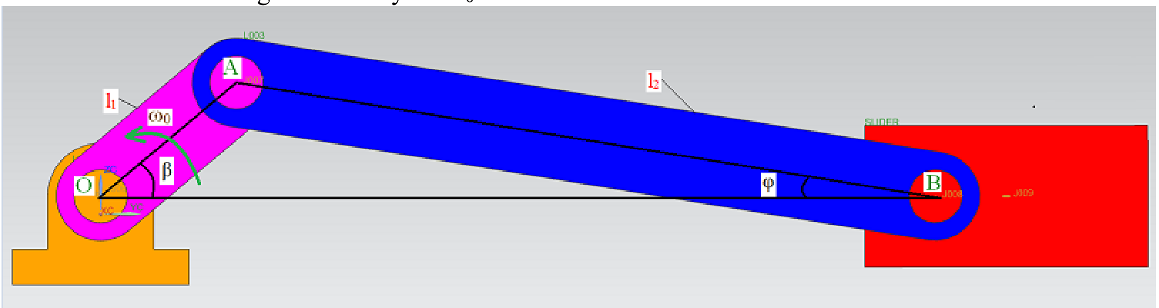

Figure4: Schematic view of the crank-slider linkage

Considering the triangle OAB, we can set up the following two equations for the mechanism [4]:

$$\omega_{AB} = \frac{l_1 \omega_0 cos\beta}{l_2^2 \left(1 - \frac{l_1^2}{l_2^2} sin^2\beta\right)^{\frac{1}{2}}} \rightarrow (1)$$

$$\propto_{AB} = \frac{l_1 \omega_0^2 \left(\frac{l_1^2}{l_2^2} - 1\right) sin\beta}{l_2 \left(1 - \frac{l_1^2}{l_2^2} sin^2\beta\right)^{\frac{3}{2}}} \rightarrow (2)$$

Where:

- ω_{AB} → angular velocity of the connecting rod AB.
- α_{AB} → angular acceleration of the connecting rod AB.
- β → changes uniformly with time t.

Moreover, the parametersα_{AB} and ω_{AB} are positive counterclockwise [5].
Figure 5 below shows a diagram of the angular acceleration (α_{AB}) from the connecting rod AB.

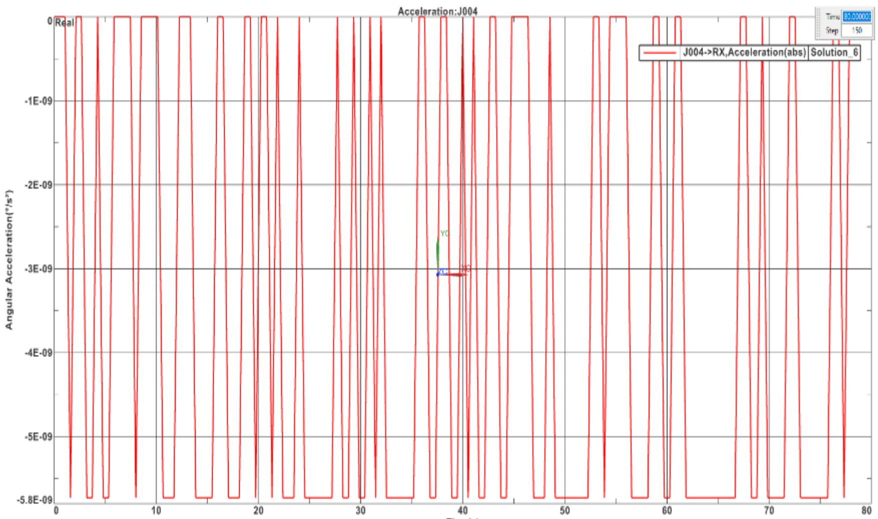

Figure5: Diagram of angular acceleration (α_{AB})

Using the MATLAB software, we did a simulation for the slider-crank mechanism.
Figure 6 shows an image of the final part of editor from system, [6].

```
Bx = Ax + sqrt(a^2-(Ay-e-c/2).^2);
By = e + c/2;
axislimits = [min(Ax)*1.1 max(Bx)*1.2 min(Ay)*1.1 max(Ay)*1.1]
sliderY = [e e+c e+c e e];
groundX = [min(Bx)-d/4 min(Bx)-d/4 max(Bx)+d/2 max(Bx)+d/2 min(Bx)-d/4];
groundY = [e-t e e e-t e-t];
for ii = 1:n
    plot(Ax,Ay,'--',0,0,'ko');
    axis equal
    hold on
    plot([0,Ax(ii)], [0,Ay(ii)], 'm', 'linewidth',2)
    plot(Ax(ii), Ay(ii),'ko')
    plot(Bx(ii), By,'ko')
    axis(axislimits)
    plot([Ax(ii), Bx(ii)], [Ay(ii), By],'b', 'linewidth', 2)
    sliderX = [Bx(ii)-d/2 Bx(ii)-d/2 Bx(ii)+d/2 Bx(ii)+d/2 Bx(ii)-d/2];
    fill(sliderX, sliderY,'r')
    fill(groundX, groundY,'c')
    hold off
    pause(1.000000005)

end
```

Figure6: Slider-crank mechanism → Editor

The simulation of a slider-crank mechanism with MATLAB in this manuscript is represented in four stages [7]. As in figure 7, the slider-crank mechanism is in the initial position, as it were t = 0s and $\beta = 0^0$.

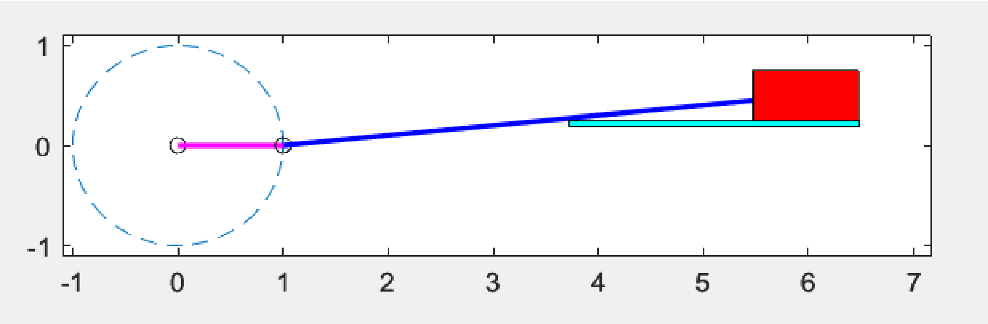

Figure7: Slider-crank mechanism → t = 0s

In figure 8, the slider-crank mechanism has the following values: t = 5s and $\beta = 45^0$.

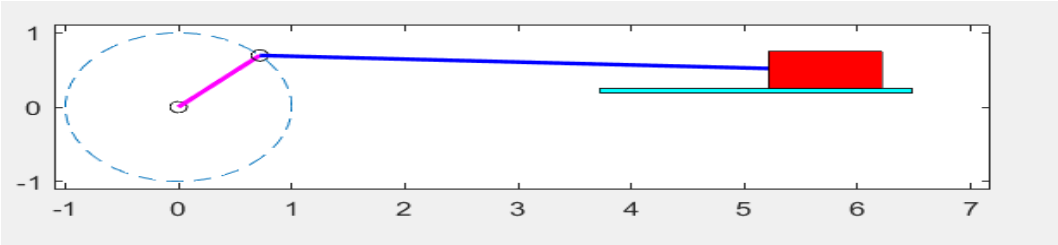

Figure8: Slider-crank mechanism → t = 5s

In figure 9, the slider-crank mechanism has the following values: t = 10s and $\beta = 90^0$.

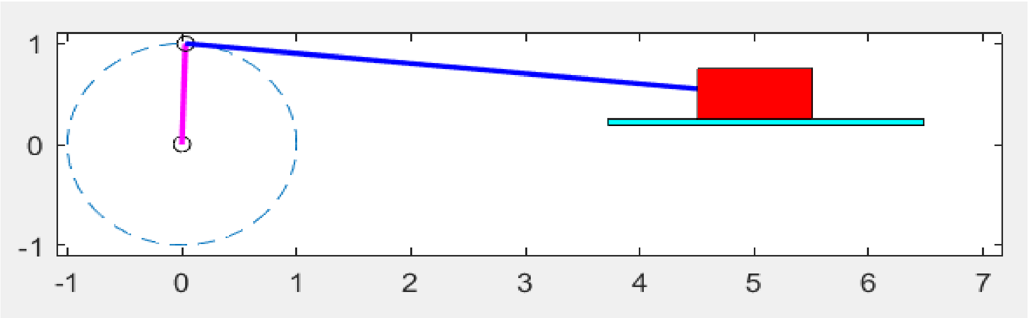

Figure9: Slider-crank mechanism → t = 10s

*Corresponding Author: Tiberiu Axinte

In figure 10, the slider-crank mechanism has the following values: t = 12s and β = 110^0.

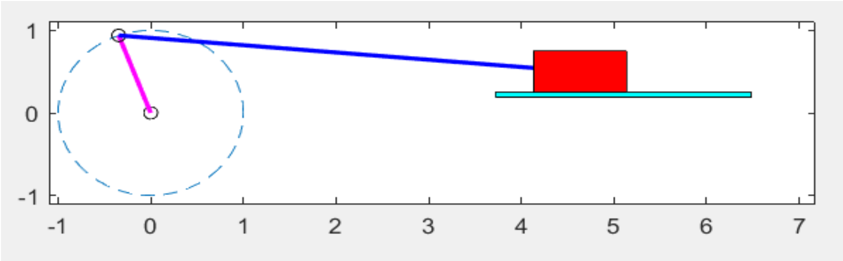

Figure10: Slider-crank mechanism → t = 12s

The parameters (time and angular) of simulations results is shown in Table2 [8].

Table 2: Parameters of simulations

Simulations	Time (s)	Angular (deg)
1	0	0
2	5	45
3	10	90
4	12	110

ACKNOWLEDGEMENT

My sincere gratitude to my Ph.D. supervisor Professor Dr. Eng.VasileNastasescu from the Military Technical Academy "Ferdinand I", for the continuous support of my research study and related research. This article would have been an uphill without Prof. VasileNastasescucontinuous direction.

III. CONCLUSION

The slider-crank mechanism is an usualsystem. But, although this system is very old, the slider-crank model is still studied.In the present days, thanks to development in the area of engineering technologies [3], once not so long ago very intricate simulation tasks, are now widely available to be performed using various simulation software tools. Nevertheless, most of thesesimulations arein generally carried out in research institutions or technical universities.Furthermore, these simulations focus on the design of new elements and the use of new materials. We have chosen to study the simulation of this mechanism in MATLAB because it is a program widely used in the field of mechanics. The crank-slider linkage made in MATLAB transforms the rotary motion into reciprocating motion by means of a rotating running crank, a connecting rod and a sliding body.

In the future, we want to develop the simulation of other systems much more complex than the slide-crank mechanism with the MATLAB program.

REFERENCES

[1]. Craciun, E.M and E. Soos, Crack propagation in the third fracture mode. Revue Romain du mathematique Pures et Appliquees, 2000. **45**(2): p. 229-234.
[2]. Nastasescu, V. and S. Marzavan. Upon impact numerical modeling of foam materials.Materiale Plastice - Journal Metrics, 2017.**54**(1): p. 195-202.
[3]. Nutu, C.S., Perspectives on Advanced and Basic Engineering Technologies.Scientific Bulletin of Naval Academy,Journal article, 2021, DOI: 10.21279/1454-864x-21-i1-009.
[4]. Panaitescu, M., et al., Modeling the Equipment Shape of the Technological Flow of the Waste Water Treatment Station. HIDRAULICA, 2019. **4**(2): p. 16-22.
[5]. Nutescu, C. and I.C. Dutu. Study on the Dynamics of the Tiling Aggregate. HIDRAULICA, 2015. **1**(3): p. 65-69.
[6]. Millen, J. and A. Xuereb, The rise of the quantum machines, 2016.**29**(1): p. 23-26.
[7]. Bonnici, A. and K. Camilleri, A constrained genetic algorithm for line labelling of line drawings with shadows and table-lines. Journal Computers & Graphics, 2013. **37**(5): p. 302-315.
[8]. Vella, P., et al., DESIGN FOR MICRO MILLING GUIDELINES. INTERNATIONAL CONFERENCE ON ENGINEERING DESIGN (ICED), 2007.