GENERAL ASPECTS OF THE APPLICATIONS OF KINEMATICS IN ENGINEERING

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ABSTRACT: Mechanics is one of the disciplines that provides students with basic knowledge in their preparation as future engineers. One of the important parts of mechanics is Kinematics, whose applications are found in engineering. Knowledge of kinematic concepts helps students develop their analytical thinking and problem-solving skills necessary to understand complex mechanical phenomena.

KEY WORDS: mechanics, kinematics, applications, engineering

1. INTRODUCTION

In training as future specialists in the field of mechanical engineering, students acquire a wealth of knowledge within the disciplines studied. The acquired notions provide important information to students regarding: different types of materials, types of stress to which bodies or parts are subjected, technologies for obtaining parts or technologies for processing them, machine parts and mechanisms, etc.[1-5].

Mechanics is one of these studied disciplines, being a fundamental discipline, which provides students with the basic knowledge necessary for the study of other disciplines that contribute to their training as future engineers.

An important component of mechanics is also Kinematics, whose applications find, in turn, numerous uses in engineering [6,8,9,10]. This studies the movement of bodies without taking into account the causes of the movement [7,9,11]. Within it, the way in which the movement of bodies takes place is presented, analyzing in this sense, parameters such as: position, speed, acceleration, but also the mathematical relationships between these parameters [9,12].

2.TECHNICAL REQUIREMENTS

In mechanics, movement represents the change in position of a material system, over time, with respect to another material system [7]. The movable elements that make up a system, from a kinematic point of view, can transmit the motion they receive from another system or from a driving device, or transform it [12].

In this sense, a system of bodies that are connected to each other and that perform well-determined movements constitutes a mechanism. It is, therefore, built to transmit or transform some movements [10].

In the specialized literature, different types of mechanisms that transmit or transform movements are studied, some of them being mentioned as examples of applications of kinematics in technology [6,10,12]. Among these mechanisms for transmitting or transforming motion, it can be mentioned: plane mechanisms,

gear transmissions, belt transmissions, cam mechanisms, etc. [10]. With the help of these mechanisms, different types of motion can be transmitted. An example, in this way, is rotational motion, in gear transmissions or belt transmissions [8]. Also, through them, different types of motion can be transformed, as in the case of the connecting rod-crank mechanism [10].

The possibility of transmitting movement, in the case of gear transmissions, is given by the engagement achieved through the teeth of the gear wheels.

Thus, the study of the kinematics of a gear is approached within the discipline of Mechanisms, where important kinematic parameters such as the angular velocities of the gear wheels, the transmission ratio and the correct engagement conditions can be determined.

At the same time, within the discipline of Machine Parts, the study of gear kinematics is completed, in addition to dimensioning, by the analysis of the mechanical stresses to which it is subjected, by the analysis of the resistance of materials, but also by the determination of the transmission efficiency [14].

These determinations are carried out in order to obtain reliable and efficient gears, which are adapted to the appropriate operating conditions.

Thus, knowledge of the notions of gear kinematics represents the theoretical basis necessary for the correct design of motion and power transmission systems.

In this sense, the kinematics of a gear involves determining its transmission ratio [8,9,10,13,14,15], as can be seen below:

$$i_{12} = \frac{\omega_1}{\omega_2} \qquad (1)$$

where: ω_1 – the angular velocity of the driving wheel,

ω_2 – the angular velocity of the driven wheel.

Thus, for example, in the case of an external spur gear in the figure below, it can be observed the transmission of the rotational movement between the two gear wheels [6]. To transmit rotational motion, it is necessary that the teeth of the two wheels have the same pitch, on the rolling circles [8].

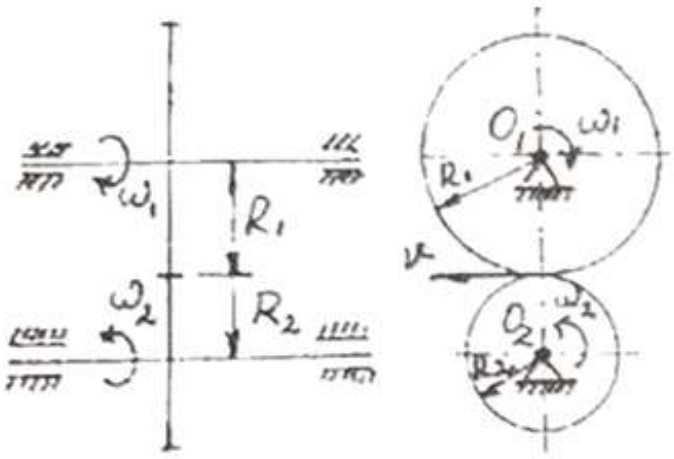

Figure. 1 Example of gear transmission [6]

As it is presented in the specialized literature, at the point of tangency of the rolling circles of an external gear, the speed of the two wheels is the same and the following relation can be written [10]:

$$v = \omega_1 \cdot R_1 = -\omega_2 \cdot R_2 \qquad (2)$$

where:
ω_1, ω_2 – represents the angular velocities of the wheels;
R_1, R_2 – the radii of the rolling circles.

With the help of the relation above, another important element of the gear that can be determined is the transmission ratio.
For example, in the case of an external spur gear, the transmission ratio will have the expression [8]:

$$i_{12} = \frac{\omega_1}{\omega_2} = -\frac{z_2}{z_1} \qquad (3)$$

With regard to an internal spur gear then the transmission ratio will be written as follows [8]:

$$i_{12} = \frac{\omega_1}{\omega_2} = \frac{z_2}{z_1} \qquad (4)$$

Starting from the mentioned relations, one can proceed to the design of the gear, so as to find the geometric elements, thus achieving its dimensioning.
Following the dimensioning, one can perform its verification so as to obtain a gear that corresponds to the appropriate operating conditions, thus giving students the opportunity to gain important knowledge about gear design.
By providing the theoretical basis for analyzing the motion of various types of mechanisms, kinematics is an essential tool for students in the design, simulation and optimization of engineering systems.

3. CONCLUSION

The importance of kinematics stems from the fact that any mechanical system involves motion. From simple mechanisms to complex structures all of these systems require rigorous motion analysis to function optimally.

Part of Mechanics, Kinematics, provides students with the tools necessary to understand how the position of bodies varies over time. Applications of kinematics in engineering are also important because they help analyze the movement of bodies and design machines and mechanisms.

Through kinematics, models and laws are established that allow the description of the trajectory of a body, whether it is a rectilinear movement, a circular movement or a more complex movement.
In this way, kinematics provides a solid theoretical framework for understanding the phenomena of movement of bodies.
For students in the field of mechanical engineering, the study of kinematics contributes to the development of essential skills in analyzing and modeling the movement of mechanical systems, as well as in interpreting kinematic parameters: position, velocity, acceleration.
Knowledge of kinematics concepts also represents the basis for other engineering disciplines, such as: strength of materials, mechanisms, machine parts, etc.
Kinematics also develops the technical thinking of the students, necessary both in design activity, but also in optimizing and verifying the functioning of industrial mechanisms and equipment.

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