

Review Article

Studies of the possibility of determining amplifications in kinematic pairs

IH Aliyev*

Doctor, Philosophy in Technology, Azerbaijan State Agrarian University, Ganja, Azerbaijan

Annotation

The article discusses approaches to solving problems of accurately determining strength in kinematic pairs. It is known that the nature of the bonds imposed by kinematic pairs is determined by the geometric shapes of the elements of the pairs. For what, here, the bonds acted during the entire time the mechanism was moving, so that the elements of the kinematic pairs would continuously touch each other. Where it is recognized that one of the simplest methods for taking into account the inertia of a link is the principal moment method. How the contradiction is sought is here because the normal acceleration has a direction opposite because normal acceleration has a direction opposite to the link (directed toward the center), and the image of tangential acceleration is directed parallel to this acceleration. The following simplification can be made if the main vector of inertia is considered together with the weight of the link.

Introduction

The solids from which the mechanism is formed are called links. This refers to both absolutely rigid, and deformable and flexible bodies. Liquids and gases in the theory of mechanisms are not considered links. A link is either one part or a combination of several parts.

Study materials

United in one kinematic immutable system. The links are distinguished by design features (piston, gear, connecting rod, etc.) and but by the nature of their movement.

For example, a link that rotates a full revolution around a fixed axis is called a crank; for an incomplete revolution, a field is covered: a ring about a slider that performs linear translational motion, etc. kinematic links: a pair is called the lowest, whether its elements of the links touch only along the surface and the higher, if only along the lines or at the points.

The nature of the bonds imposed by kinematic pairs is determined by the geometric shapes of the elements of the pairs. In order for the bonds to act throughout the entire movement of the mechanism, the elements of the kinematic pairs must continuously touch each other.

Study moves

One of the simplest methods for accounting for link inertia

More Information

***Address for Correspondence:** IH Aliyev, Doctor, Philosophy in Technology, Azerbaijan State Agrarian University, Ganja, Azerbaijan, Tel: +994504242130; Email: zakirakademik@mail.ru

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is the principal moment method. The disadvantage of this method is partial errors for certain directions of angular acceleration.

To avoid this, we can suggest the following rule: on the acceleration plate, the angular acceleration of the link is directed from full acceleration to normal.

How a contradiction is sought is because the normal acceleration has a direction opposite because the normal acceleration has a direction opposite to the link (directed toward the center), and the image of the tangential acceleration is directed parallel to this acceleration (Figure 1).

The following simplification can be made if the main vector of inertia is considered together with the weight of the link.

We will call them the combined force and denote by c with the link index, and denote the image of the corresponding acceleration by Z with the same index.

To do this, on the acceleration plan, it is necessary to subtract the acceleration of gravity from the acceleration of the center of gravity of the link.

The opposite sign for the acceleration of gravity was obtained because this acceleration is parallel to the weight, while the inertia is directed opposite to the corresponding acceleration.

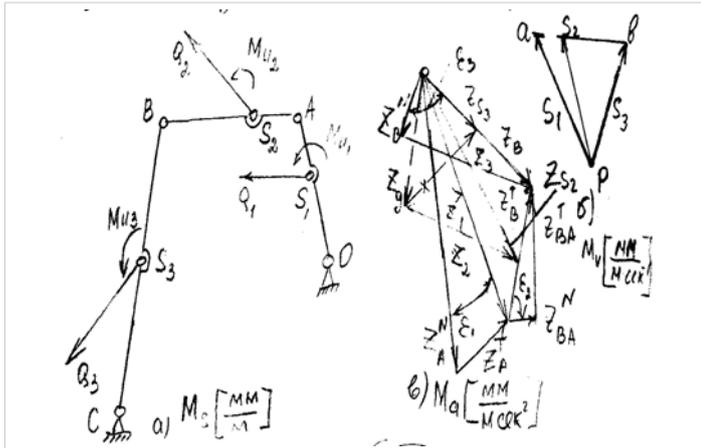


Figure 1: Depicting the centers of gravity of the links.

Graphically, this reduces to the fact that it is necessary to take the new pole down in terms of accelerations at a distance equal to the image of the acceleration of gravity $Z_g = M_{ag}$, where M_a [mm/(m s²)] The scale of the acceleration plan. the pole must connect all the points of the plan of accelerations depicting the centers of gravity of the links.

Based on the obtained segments (they are shown by a dotted line in figure), we can determine the magnitude and direction of the combined forces of each link.

A third simplification can be obtained if, in the formulas for determining the moments (which are substituted into the equilibrium equation), constant values are calculated once for all positions of the mechanism. For external forces and forces in kinematic pairs, this formula will take the form:

$$M_Q^A = (W_Q h_Q^A) / (M_Q M_S) \quad (1)$$

where M_Q^A is the moment of force Q relative to point A ;

W_Q - a segment depicting the strength of Q ;

M_Q - force scale mm/kg

M_S - length scale mm/kg

h_Q^A - image of the force Q in the drawing, mm.

The value of the product $M_Q M_S$ (mm²/kg.m) is calculated once for all positions of the mechanism.

The moment of the combined force Q_i (as well as the moment of inertia) is determined through the mass m_i - acceleration Z_i / M_a - and another force h_{Q_i} / M_S ;

$$[M]_{Q_i}^A = m_i z_i / M_a \cdot (h_{Q_i}) / M_S = (z_i h_{Q_i}^A) / (M_Q \cdot M_S) \quad (2)$$

The value $M_i M_S / m_i$ [mm²/(kg.m)] is also calculated once for all positions (this value is taken in the banner of the body for the convenience of calculations on a slide rule).

The formula for the inertial moment will be

$$M_{U_i} = L_i \epsilon_i = L_i Z_T / M_a \cdot 1 / L_1 = Z_T / ((M_a L_i) / L_i) \quad (3)$$

where Z_T is the image of the tangential acceleration of one end of the link relative to the other;

The value $(M_a L_i) / L_i$ [mm/(kg.m)] is also calculated once for all positions.

To control the correctness of the calculations of the constant values in formulas (1), (2) and (3), a comparison of them for different parts of the mechanism can serve;

The constant values $M_a M_e$ in the formula (1) are the same for all links; the constant values $(M_a M_S) / m_i$ in the formula (2) for various links are inversely proportional to the masses.

The constant values $(M_a L_i) / L_i$ in the formula (3) for various links are directly proportional to their length and inversely proportional to the moment of inertia.

Conclusion

It should be noted that the derived formulas are suitable not only for taking into account inertia by the main vector and main moment method, but also for other methods, for example, still mass.

Editing in the latter case, formula (3) becomes unnecessary.

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