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METHOD FOR CALCULATING THE SUSPENSION MECHANISM OF A UNIVERSAL ENERGY VEHICLE

***Komilov Mukhriddin Raqibbek ugli*,**
Assistant, Andijan State Technical University
Department of "Transport Engineering"

Abstract: This work is dedicated to calculating the lifting force of the suspension mechanism based on its kinematic diagram. The calculation analyzes two main states of the mechanism: the conditional working state (CWS) and the upper extreme position (U), determining the forces and moments under load step by step. Considering the maximum lifting force in the upper position of the mechanism, the number and type of hydraulic cylinders are selected. This ensures the mechanism's load-bearing capacity (3.5 tons). Additionally, the line of action of the hydraulic cylinder is determined through kinematic analysis.

Keywords: suspension mechanism, kinematic diagram, lifting force, hydraulic cylinder, working position, moment analysis

Introduction. The lifting force of the suspension mechanism is calculated by sequentially determining the forces and moments in the joints of the links for a load applied at a conditional point (center of gravity) in the kinematic diagram (Fig. 1).

In this case, the calculation is performed for two positions of the suspension mechanism: the conditional working position "CWS" (in the horizontal position of the longitudinal rod) and the upper extreme position "U," since in the lower extreme position "L" the applied force arm is relatively small, therefore its lifting force is less than in the previous positions.

The universal power unit is designed for a suspension mechanism with a lifting capacity of 3.5 tons (34.34 kN). Based on the maximum lifting force obtained in two cases, the number and model of hydraulic cylinders to be installed are selected. In this case, the line of action of the hydraulic cylinders is determined through kinematic analysis of the suspension mechanism.

The calculation of the lifting force of the suspension device is performed based on the kinematic diagram of the suspension mechanism for the upper extreme position "B."

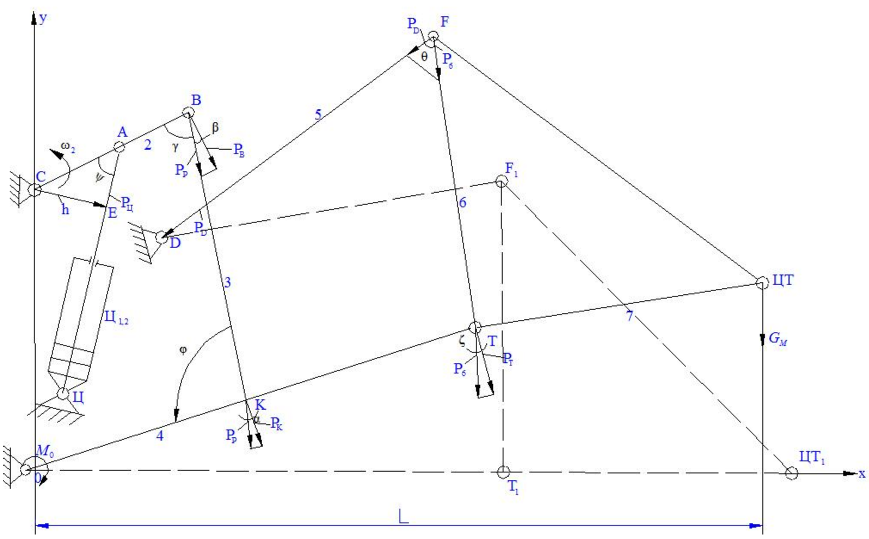

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Figure 1. Kinematic diagram of the suspension mechanism

The resistance moment M_0 at the *O* hinge of the *OMN* longitudinal rod is equal to [17]

$$M_0 = L \ G_M , \tag{1}$$

where: *L* - is the load arm *of GM* relative to *the O* hinge.
The force *Pk* applied to point *K* perpendicular to the segment *OK* is equal to

$$P_K = \frac{M_0}{OK}, \tag{2}$$

KB force *Pp* acting in the direction of inclination

$$P_p = P_K \ \cos\alpha , \tag{3}$$

where *α=φ - 90°* is the angle between the *KB* inclination direction and the perpendicular to the longitudinal tension segment *OK.*
From the triangle ΔOBK according to the law of cosines

$$OB^2 = OK^2 + KB^2 - 2 \ OK \ KB \ \cos\varphi ,$$

from this

$$\varphi = \arccos\frac{OK^2 + KB^2 - OB^2}{2 \ OK \ KB}$$

Force P_B (component of P_p) acting at point *B* perpendicular to the opposite direction of the turning lever *CB*

$$P_B = P_p \ \cos\beta , \tag{4}$$

where *β=90° - γ* is the angle between the *KB* inclination direction and the perpendicular to the turning lever *CB; γ* is the angle between *KB* inclination and *CB* turning lever where *β=900 - γ* - angle between the direction of inclination *KB* and the perpendicular to the turning lever *CB;*
From the triangle ΔCBK based on the law of cosines

$$\gamma = \arccos\frac{CB^2 + KB^2 - CK^2}{2 \ CB \ KB}$$

The resistance moment *MC* at the *C* hinge of the *CB* turning lever is determined as follows:

$$M_C = P_B \ CB . \tag{5}$$

The required lifting force *PP* applied to *point A* of the *CB* turning lever *PP* in the direction of the hydraulic cylinder *force*

$$P_П = \frac{M_C}{h}, \tag{6}$$

where: *h* - *C* is the *PP* arm relative to the hinge.
Δ*CAE*, based on the sine theorem, the following ratio is obtained

$$\frac{CA}{\sin E} = \frac{h}{\sin\psi},$$

from this

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(since =90o),
where ψ - *PC is* the angle between the direction of force action and *the CB* turning lever
ΔCAC from the triangle according to the cosine theorem

$h = CA \ \sin\psi / \sin E = CA \ \sin\psi$ (чунки E =90º),

The force generated by the hydraulic cylinder P_C is determined by the following relationship:
,
where p_f - pressure of the fluid in the line, MPa; *D* - cylinder diameter, m.
Based on the maximum lifting force, the number of hydraulic cylinders to be installed n_C is determined:

$$n_Ц = \frac{P_n}{P_Ц} = 1{,}89 \,. \qquad (7)$$

We select two $_{C100}$ hydraulic cylinders for the suspension mechanism, with a total force of $_{2PC100}$ = 264.4 kN, which is PP =232.73 kN ΔPC =13.67 kN (5.87%) greater than the calculated force.
Conclusion. Thus, a method for calculating the mounting mechanism of a tractor with increased load capacity has been proposed. Based on this, the force and resistance moments in the hinged joints of the tractor's suspension mechanism links were determined. As a result of the calculations, it was shown that with the help of two C100 hydraulic cylinders, it is possible to lift a load of 3.5 t placed at the conditional point MN of the kinematic scheme of the HOT.

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