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INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI: 10.21474/IJAR01/17051
DOI URL: http://dx.doi.org/10.21474/IJAR01/17051

ISSN NO. 2320-5407

RESEARCH ARTICLE

DYNAMIC PROCESSES OF A HAND-HELD MOTORIZED MOWER DURING THE START OF THE MOWING PROCESS

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Manuscript Info

Manuscript History
Received: 05 April 2023
Final Accepted: 10 May 2023
Published: June 2023

Key words:-
Mower, Blade, Rotor, Shaft, Segment

Abstract

From the point of view of revitalization of agrarian processes in our country, the perspective of its development showed us that animal husbandry remains one of the priority sectors, which is due to the production of animal husbandry products. Based on this, the problem of producing rough feed for mining conditions remains a problematic issue in small farms and peasant farms, where it is impossible to use large-capacity machines and food production is still done manually. The purpose of the research is the methodology of calculating the internal dynamic processes of a small power hand motorized rotary mower during the start of the mowing work process. The scientific paper presents the dynamic load of a small power hand motorized mower at the moment of starting mowing, which is highly dependent on the work of the working body, so as to perform the mowing process with quality and less losses.

Introduction:-

The aim of the study was was to reduce risk of injury associated with operating a rotary mower driven by a tractor power take-off (PTO) by developing and evaluating design improvements and determining their economic feasibility. Researchers have concluded that alteration of machinery design has a greater impact on the reduction of accidents than safety training. Implementation of an Operator Presence Sensing System (OPSS) and removal of the PTO are the two injury-reducing, engineering modifications evaluated by this research. Hydraulic power allows this to occur by providing dynamic braking, few moving parts (removal of the PTO), and controllable power. A hydraulic circuit was developed to power the mower and to enable an OPSS. Tractor hydraulics were simulated using a hydraulic training bench. Two mower configurations were tested: 6.55 cm3 rev -1 (0.4 in.3 rev -1) displacement motor with a 0.748 kg blade and 47.5 cm^3 rev -1 displacement motor with a 9.4 kg blade. A PTO-driven rotary mower was not used to test the circuit due to spatial and safety limitations of the hydraulic training bench. Results from the first mower configuration verified the concepts behind the hydraulic circuit. The second configuration verified the OPSS and indicated the applicability of the circuit to a rotary mower (K. L. White at all)

A rotary mower with five different blade cutting angles was tested at five different cutting speeds to determine the resultant pulverized percentage of sweet potato vine (< 28 mm) and the power consumed (Joule). The best results for effects of interaction between blade angles and mower speeds was achieved by the 30° blade angle at 2440 rpm with

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highest percentage of pulverized vine at 61.27% while the best performance for effects of interaction between blade angles and mower speeds was achieved by the 30° blade angle at 1830 rpm with lowest power consumption of 44.00 Joule (Amer N.N. at all)

Materials And Methods:-

For the study of the dynamic issues of the motorized hand mower, great importance is attached to the optimal options of durability and construction, in particular, in the process of moving small mechanized technical means, starting, stopping and braking during working resistance is meant, which implies the formation of a dynamic loading process. During the start of the mechanism, under a large working dynamic load, the sudden braking or stopping of the working body requires an irrational calculation of the machine details, and the small mechanized means of the hand becomes technologically difficult, and from the point of view of work is faulty or unsafe, and if the turning moment is insufficient at this time, the engine will stop, Because the magnitude of the resistance will exceed the established norms of the work process.

Consider the lifting moment of a rigid shaft in a free state, when there is no mowing process, and consider its kinematics as a two-ring mechanism. (Fig. 1)

If we use the Lagrange method for this mechanism, then the equality of the second order will take the form:

$$\frac{d}{dt}\left(\frac{\partial t}{\partial q}\right)-\frac{\partial t}{\partial q_i}+\frac{\partial \Pi}{\partial q_i}+\frac{d\Phi}{\partial q_i}=Q \qquad (1)$$

Where T and M ares the total kinetic and potential energy of the system.

Φ - Energy dissipation function

Q - Driving Force

If we look at Figure 1, we get:

$$I_{(\varphi)}\frac{d\omega}{dt}+\frac{\omega}{2}\frac{dI_{(a)}}{dt}=M_g(\omega)-M_g(\varphi,\omega,t) \qquad (2)$$

Where- ω is the angular velocity of the actuator.

$M_{g(\omega)}$ Engine starting moment (engine from mechanical characteristics)

$M_g(\varphi,\omega,t)$- Moment of rising resistance for individual values

t - time

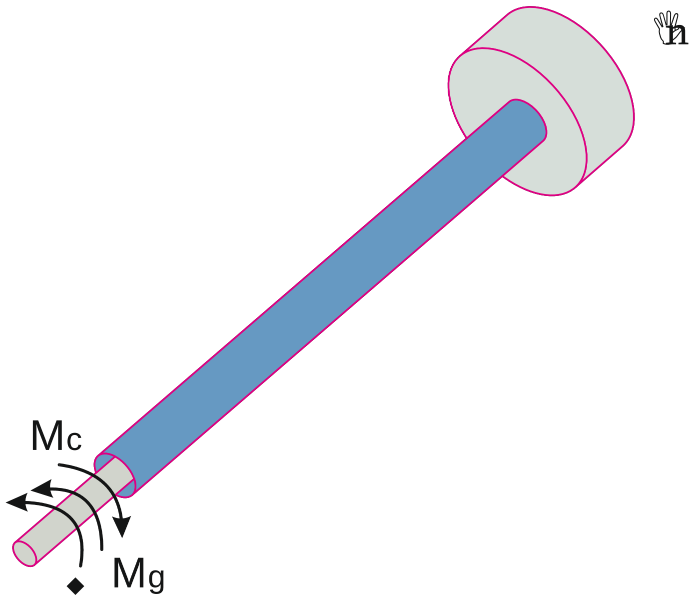

Fig.1:- Arrangement of inertia and dynamic forces on a rigid shaft.

If we consider a rigid shaft and a cutting machine, then formula (2) can be written as follows: (Maxaroblidze at all)

$$\begin{cases} I_1 \dfrac{d^2\varphi_1}{dt^2} + C(\varphi_1 - \varphi_2) = M_g \\ I_2 \dfrac{d^2\varphi_2}{dt^2} + C(\varphi_1 - \varphi_2) = -M_c \end{cases} \qquad (3)$$

Where φ_1 და φ_2 - is I_1 and I_2 Angle of rotation of masses

C - Stiffness of the drive shaft

(3) including the deflection moment in the formula will take the form:

$$\frac{d^2M}{dt^2} + \omega^2 M = \frac{CM_g}{I_1} \qquad (4)$$

When the machine and the working body are started at the same time $t = 0, \varphi_1 = \varphi_2 = 0, \dfrac{d\varphi_1}{dt} = \dfrac{d\varphi_2}{dt} = 0$

(3) The formula can be written as follows:

$$M = \frac{CM_g}{I_1} \frac{1}{P^2 + \omega^2} \qquad (5)$$

As a result of calculations, the formula of the deflection moment can be written as follows:

$$M = \frac{M_g I_2}{I_1 + I_2}\left(1 - \cos\sqrt{\frac{C(I_1 + I_2)}{I_1 I_2}} \cdot t\right) \qquad (6)$$

When

$$t_{\max} = \frac{\pi}{\sqrt{\dfrac{C(I_1 + I_2)}{I_1 \cdot I_2}}} \qquad (7)$$

The maximum deflection moment is determined by the formula:

$$M_{\max} = \frac{2M_g I_2}{I_1 \cdot I_2} \qquad (8)$$

or

$$\frac{M_{\max}}{M_g} = \frac{2\frac{I_1}{I_2}}{1+\frac{I_2}{I_1}} \qquad (9)$$

If we relate the ratio of the moments of inertia of the working body to the dynamic tension of the car, we get the following relation:

Results And Discussion:-

Tab.1:- Dependence of the inertia ratio on the dynamic tension of the lift.

Ratio of moments of inertia	Climb the dynamic tension
0,01	0,1
0,02	0,16
0,03	0,25
0,04	0,32
0,05	0,42
0,06	0,69
0,07	1,2
0,8	1,32

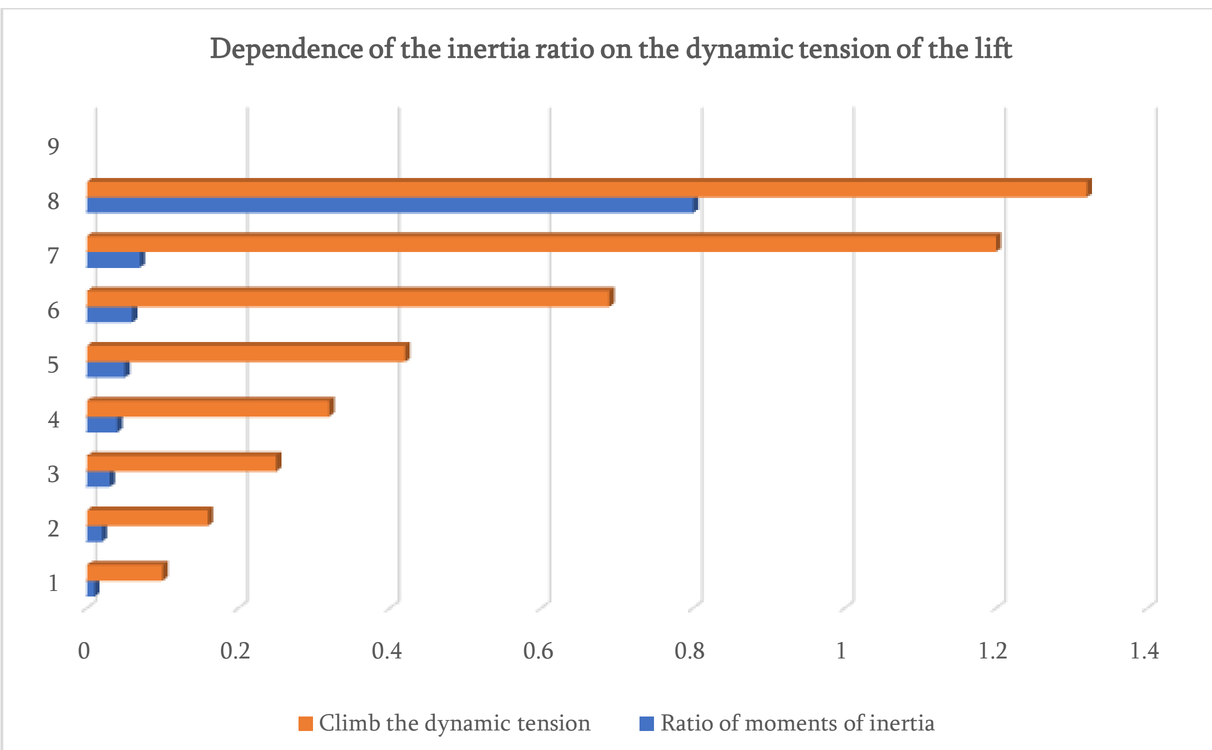

Fig.2:- Dependence of the inertia ratio on the dynamic tension of the lift.

From this it can be seen that the greater the torque of the working body, the greater the dynamic tension of the lift (Mamuladze M. at all)

Consider the case when a clutch mechanism is placed between the working body and the engine, then we will have formula (3) in expanded form:

$$t = 0, \varphi_1 = \varphi_2 = 0, \frac{d\varphi_2}{dt} = 0, \frac{dM}{dt} = C\omega_0 \quad (10)$$

And the differential equation can be written as follows

$$M = C\omega_0 \frac{P^2}{P^2 + \omega^2} - \frac{CM_g}{I_1} \cdot \frac{1}{p^2 - \omega^2} \quad (11)$$

from here

$$M(t) = \sqrt{\frac{CI_1I_2}{I_1 + I_2}}\omega_0 \sin\sqrt{\frac{C(I_1 + I_2)}{I_1 + I_2}}t + \frac{M_g I_2}{I_1 + I_2}\left(1 - \cos\sqrt{\frac{C(I_1 + I_2)}{I_1 I_2}}t\right) \quad (12)$$

Let's introduce the notation

$$z\cos\varphi_0 = \omega_0\sqrt{\frac{CI_1I_2}{I_1 + I_2}} \qquad z\sin\varphi_0 = \frac{M_g I}{I_1 + I_2}$$

then

$$z = \sqrt{\frac{\omega_o^2 CI_1\, I_2}{I_1 + I_2} - \frac{M_g I_2^2}{(I_1 + I_2)^2}} \quad (13)$$

But

$$M_{(t)} = \frac{M_g I_2}{I_1 I_2} + \sqrt{\frac{\omega_0^2 CI_1 I_2}{I_1 + I_2} + \frac{M_g^2 I_2^2}{(I_1 + I_2)^2}}\sin(\omega t - \varphi_o) \quad (14)$$

Where

$$\begin{cases} tg\varphi_o = \dfrac{M_g I_2}{\omega_0\sqrt{CI_1I_2(I_1 + I_2)}} \\ \omega = \sqrt{\dfrac{C(I_1 + I_2)}{I_1 \cdot I}} \end{cases} \quad (15)$$

The bending moment reaches its maximum when

$$\omega t - \varphi_0 = \frac{\pi}{2}$$

$$t_{\max} = \frac{\pi = 2\varphi_0}{2\omega} \quad (16)$$

therefore

$$M_{\max} = \frac{M_g I_2}{I_1 + I_2} + \sqrt{\frac{\omega_o^2 CI_1 I_2}{I_1 + I_2} + \frac{M_g^2 I_2^2}{(I_1 + I_2)^2}} \quad (17)$$

or

$$M_{\max} = \frac{M_g I_2}{I_1 + I_2}\left[1 + \sqrt{1 + \frac{\omega_0^2 CI_1(I_1 + I_2)}{M_g^2 I_2}}\right] \quad (18)$$

When $\omega_0 = 0, C = 0$ We get formula (8).

Let's imagine the formula (18) in a dimensionless form, we get:

$$\frac{M_{\max}}{M_g} = \frac{\rho}{\rho+1}\left[1 - \sqrt{1 + \frac{\omega_o^2 CI}{M_g^2} \cdot \frac{1+\rho}{\rho}}\right] \qquad (19)$$

where:

$$\rho = \frac{I_2}{I_1}$$

(17) formula allows us to determine the stiffness and deflection moment of the hand motorized rotary mower then we have:

$$C = \frac{1}{\omega_0^2 I_1}\left[\frac{I_1 + I_2}{I_2}(M)^2 - 2M_g(M)\right] \qquad (20)$$

Consider the possibility of choosing the optimal parameters with the following considerations, namely from formulas (19) and (20) it can be seen that the deviation improves the dynamic load twice, therefore the dynamic coefficient should be close to 2 and we get:

$$k = 1 + \sqrt{1 + \frac{\omega_0^2 CI_1}{M_g^2} \cdot \frac{1+\rho}{\rho}} = 2{,}1 \qquad (21)$$

therefore

$$\frac{\omega_0^2 CI_1}{M_g^2} = 0{,}2\frac{\rho}{1+\rho}$$

$$C = 0{,}21\frac{M_d^2}{\omega_0^2 I_1} \cdot \frac{\rho}{1+\rho}$$

The study was conducted on the "Taiga Electron" engine, based on its technical data:

$I_1 = 0{,}2$ б/∂² $I_2 = 0{,}04$ б/∂² $\omega = 732$ ҩ∂⁻¹ [1] $M_g = 732$ б.

$$\frac{I_1}{I_2} = \frac{0{,}04}{0{,}2} = 0{,}2$$

then:

$$C = 0{,}04\frac{M_g^2}{\omega_0^2 I_1} = 0{,}04\frac{179^2}{732^2 \cdot 0{,}2} = \frac{32041}{107164} = 0{,}2$$

and

$$t_{\max} = \frac{3{,}14}{\sqrt{\frac{0{,}2(0{,}2+0{,}04)}{0{,}2 \cdot 0{,}04}}} = \frac{3{,}14}{\sqrt{\frac{0{,}2}{0{,}008}}} = 0{,}6 \text{ ҩ∂}$$

$$M_{\max} = \frac{2M_g\frac{I_1}{I_2}}{1+\frac{I_2}{I_1}} = \frac{2{,}732\frac{0{,}2}{0{,}04}}{1+\frac{0{,}04}{0{,}2}} = 6100 \text{ б.}$$

Conclusion:-

The dynamic load of the motorized hand mower, the rigid shaft and the segmented rotary device at the moment of mowing was calculated. The value of stiffness was calculated for the maximum time s, the maximum deflection moment n, which is highly dependent on the work of the working body during the production of mowing technological processes for mining conditions.

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