ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 5, May 2025

Increasing The Efficiency of Operating Parameters of Auto-Somosvals

Gaffarov Azamat Alisherovich

Senior Lecturer, Navoi State University of Mining and Technology, Navoi Region, Uzbekistan

ABSTRACT: The article developed a mathematical model that allows determining the optimal ratio of operational parameters based on the design of dump trucks, ensuring the stability of their movement when passing uneven, deep sections of roads. The theory of damage to truck drives due to the influence of road unevenness during the movement of a dump truck on roads of quarries with different parameters is presented.

I. INTRODUCTION

Systematic study of the vibrations of dump trucks moving along highways in quarries is of great practical importance. Solving this problem allows calculating the forces acting on the dump truck equipment, determining their safety limits, the degree of rotational resistance, as well as other performance indicators. In addition, after determining the magnitude and direction of the forces acting on the structural elements of the dump truck, vibrations lead to the appearance of cracks and fractures in the frame, which is the main part of the dump truck, when moving along the technological routes of quarries with pits of varying depths. Suspended oscillations of kinematically moving dump trucks caused by road unevenness, including the determination of the main energy ratios for calculating the total work of a dump truck when passing through an uneven road surface, and as a result, an increase in additional fuel consumption during movement along the quarry. The connecting link between the dump truck frame and the road surface is performed by the front and rear suspensions.

The gas pressure in the cavity of the front and rear suspension cylinders is 3.15±0.025 and 3.79±0.028 MPa. Nitrogenous shock absorber fluid is used as the working fluid in the suspension cylinder. The frame is connected by welding or stamping of two 4 and 7 longitudinal members and transversely installed metals (Fig. 1).

The longitudinal members have a box-shaped section of variable height along the length of the frame. The first transverse metal 1 is made of a pipe with a diameter of 245x45 mm, and the central lever of the front axis is connected by a bracket. The second transverse metal 2 is the lower transverse metal connecting the side parts of the frame, which is attached to the front suspension frame by brackets. The front suspension rod is attached to the lower transverse metal. A third transverse metal 3 is welded to the side members, which reinforces the middle part of the frame.

II. INFORMATION AND METHODOLOGY

The central lever of the rear axle is attached to the third transverse metal. The lower supports of the deflection mechanism cylinders and brackets are welded to the ends of the third transverse metal.Two connected cast pipes with a diameter of 325x36 mm consist of supports. The lengths and transverse metals are made of alloy steel grade 10HSND GOST19281-89. A 10XSND alloy steel frame has the following mechanical properties: tensile strength σV= 540 MPa, yield strength σT= 400 MPa, impact force at minus 70°C aN=30 N.m/sm2. The platform is made of high-quality, wear-resistant alloy steel grade 18XGNMFR, and its mechanical properties are as follows: tensile strength σV= 1100 MPa, fluidity σT= 1000 MPa, impact force at minus 40°C aN=30 N.m/sm2.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 5, May 2025

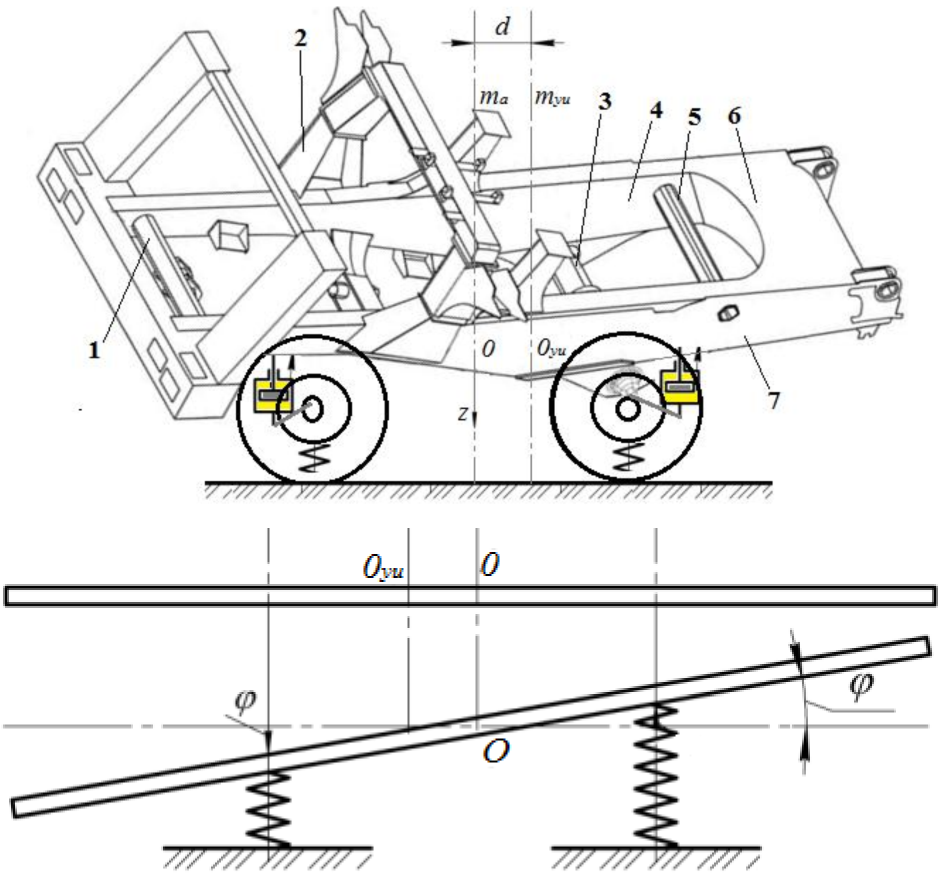

Fig 1. Calculation scheme of generalized coordinates

The compilation of differential equations and the calculation scheme of the coordinates of oscillations around the horizontal axis passing through the center of mass of the dump truck, i.e., the frame, are summarized in Fig. 1. Since the dump truck oscillates in its vertical longitudinal plane, the system has two degrees of freedom. For generalized coordinates, the vertical displacement Z of the center of mass of the dump truck 0 and the angle of its rotation are taken around an axis passing parallel to the axes of the dump truck.

During the movement of a dump truck, vibrational movement of the front and rear wheels relative to the center occurs as a result of the displacement of the load on the body by a certain distance from the center. Since this oscillatory process is complex, the solution through the Lagrange function was analyzed.

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}}\right) - \frac{\partial L}{\partial q} = 0 \qquad (1)$$

here; L - Lagrange function, L=$E_K - E_P$, E_K, E_P - The following kinetic energies are generated as a result of uniform parallel motion of the generalized coordinate system after loading the truck body: q - kinetic and potential energy (J), q - kinetic and potential energy (J).

$$E_K = \frac{mv^2}{2} + \frac{J\omega^2}{2} = \frac{Q}{2g}(\dot{x}^2 + \rho^2\varphi^2) \qquad (2)$$

Potential energies; $E_P = E_{P1} + E_{P2}$,

E_{P1} - Potential energy of the dump truck's weight (J), E_{P2} - potential energy of the dump truck suspension (J).

$$E_{P1} = -Qx \qquad (3)$$

$$E_{P21} = \frac{k_1}{2}(x_o + x - l\varphi)^2, \qquad E_{P22} = \frac{k_2}{2}(x_o + x + l\varphi)^2; \qquad (4)$$

here; Q - the force of gravity of the load and the dump truck (kg), x_o - the initial coordinate of the suspension in the equilibrium position, l - the distance between the two wheels (m), φ - the angle formed by the dump truck frame with

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 5, May 2025

the horizon (degree), k_1- the stiffness of the suspension on the rear wheel (N/m), k_2 - the stiffness of the suspension on the front wheel (N/m).bu yerda;

The total potential energy for the Lagrange function is

$$E_P = -Qx + k[(x_0 + x)^2 + l\varphi^2] \tag{5}$$

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{\varphi}}\right) = \frac{Q}{g}\rho^2\ddot{\varphi}\ , \frac{\partial L}{\partial \varphi} = -2kl^2\varphi \tag{6}$$

From the above equations, the following system is obtained.

$$\frac{Q}{g}\rho^2\ddot{\varphi} + 2kl^2\varphi = 0 \tag{7}$$

$$\text{if } 2kx_0=Q \text{ whereas } \quad \frac{Q}{g}\ddot{x} + 2kx = 0 \tag{8}$$

According to the theory of harmonic oscillations, the phase and angle of oscillation are as follows.

$$x = A\sin(\omega_1 t + a); \quad \varphi = B\sin(\omega_2 t + \beta); \tag{9}$$

here; $\omega_1,\ \omega_2$ - oscillation frequency (rad/s),

total stiffness of the front and rear suspensions,

$$k_2 = \frac{C_1C_0}{C_1+C_0};\ k_1 = \frac{2C_2C_0}{C_2+2C_0} \tag{10}$$

Gross gravity

$$Q=(m_{yuk} + m_a)g; \tag{11}$$

From the above equation of harmonic oscillations, the following frequencies were determined.

$$\omega_1 = \sqrt{\frac{2k_1g}{Q}};\quad \omega_2 = \sqrt{\frac{2k_2gl^2}{Q\rho^2}}; \tag{12}$$

For dump trucks, the vibration frequencies for the front and rear wheels are:

$$\omega_1 = \sqrt{\frac{2C_1C_0g}{(C_1+C_0)(m_{yuk}+m_a)}} \qquad \omega_2 = \sqrt{\frac{4C_2C_0gl^2}{(C_2+2C_0)(m_{yuk}+m_a)\rho^2}}; \tag{13}$$

The oscillation frequencies of two wheels differ mathematically according to two different laws, mainly the loading distance can make these oscillations different. It is advisable to continue with forced oscillatory motion and harmonic (free) oscillatory motion.

III. SYSTEM ANALYSIS

If the center of mass changes from the center of mass of the body to ρ=1÷50 cm, Q=324 (tons), C0=2.5*106 (N/m), C1=2*106 (N/m), C2=2.2*106 (N/m), l=6.65 (m), the frequency of oscillations in two wheels is shown in Fig. 2.

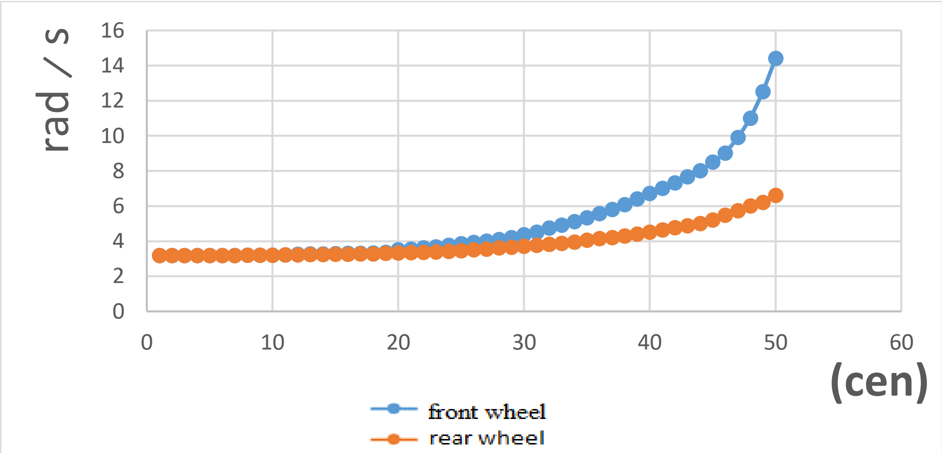

Fig 2. The frequency of oscillations generated by the front and rear wheels.

The frequency of oscillations of the wheels at a constant velocity, when the center of mass is displaced from the equilibrium position by a certain distance, is shown in Fig. 2. When the center of mass in the front wheel begins to shift by more than centimeters from equilibrium, the frequency difference begins to differ significantly from each other. At a

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 5, May 2025

displacement of 1 cm, the frequency on two wheels will begin to be around 3.171 and 3.174 rad/s. If this displacement was 50 cm, the values of 14.4 and 6.6 rad/s were determined. During the operation of quarry dump trucks, a horizontal displacement of the center of mass from 0 to 50 cm showed that the frequency of the rear wheel is equal to 6.6 rad/s, and the frequency of the front wheel is equal to 14.4 rad/s. These values indicate the displacement of the center of gravity due to vibrations during the operation of dump trucks. If we take into account the change in values depending on expression 9, then the phase and angle of oscillation will be as in Fig. 3.

IV. INPUT DESIGN

Due to the displacement of the center of mass, a change in the angle arising horizontally in the dump truck frame occurs. These values are shown in Fig. 3, which are explained by the formation of an angle of inclination of the dump truck in the horizontal plane with the displacement of the center of gravity. Of course, work is carried out according to the maximum value of this angle.

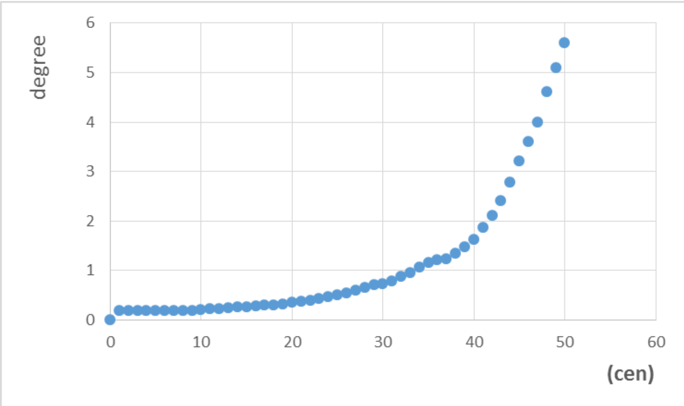

Fig 3. Change in the angle formed in the dump truck frame due to the displacement of the center of mass.

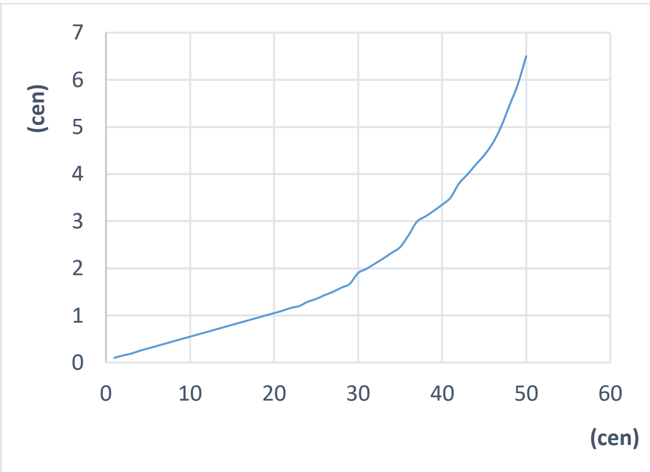

Fig 4. Graph of the frame's deviation from its normal position

The graph of the compression distance of the dump truck in the horizontal plane by the value of the angle formed on the frame is shown in Fig. 4. Thus, if the distance of deviation is maximum 6.5 cm, it is expressed through expression 7 above as the ratio of loads to the acceleration of free fall.

ISSN: 2350-0328
International Journal of AdvancedResearch in Science, Engineering and Technology
Vol. 12, Issue 5, May 2025

V. OUTPUT DESIGN

When a dump truck moves along an uneven road, the horizontal displacement of the center of mass and the angle of rotation of the mass around the horizontal axis passing through the center of mass represent harmonic oscillations. For a loaded dump truck, the cyclic frequency of natural oscillations decreases slightly compared to unloaded ones, due to which the inertial forces change. When moving on an uneven road with an unacceptably large amplitude of oscillations, the dump truck's movement always has a sharp speed, as a result of which the load on the dump truck's equipment increases beyond acceptability. As a result of vibrations, fractures, twisting, stretching, and several deformations can occur in the working parts of a dump truck

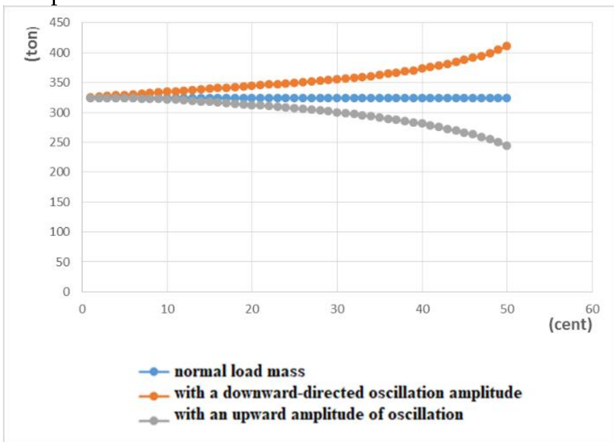

Fig 5. Graph representing the load arising in an oscillatory state in terms of mass.

VI. RESULTS

Figure 5 shows that at a dump truck speed of 30 km/h with a total load of 324 tons and a difference in the center of mass of the dump truck by 50 cm, a load equal to 441 tons is formed. If the tensile strength of the dump truck under consideration in the article is σV= 540 MPa, this is considered a sufficient condition, but at a speed of 45 km/h, when the total load is 324 tons and the center of mass differs up to 50 cm. With the formation of such a load, if the material of the frame does not have a higher strength limit, cases of breakage, torsion, and tension are observed.

Depending on the loading mass of dump trucks in the normal position, the increase in nominal force by 36% at the upper frequency and a decrease by 24% at the lower frequency of amplitude oscillations caused by inertial and traction forces during movement made up 60% of the difference in the upper and lower frequencies of the total amplitude.

REFERENCES

[1]. Arefev S.A. Otsenka i obosnovaniye ratsionalnых dorojnых usloviy ekspluatatsii karyernых avtosamosvalov bolshoy gruzopodyemnosti nauchnaya dissertatsionnaya rabota Yekaterinburg, 2015.
[2]. O treshinoobrazovanii v metallokonstruksiyax bolshegruznix avtosamosvalov pri ekspluatatsii na razrezax Kuzbassa Vestnik injenernoy shkolы dvfu. 2018. № 3(36).
[3]. Bolotin V.V., Smirnov V.P., Kuleshov A.A. Prognoz resursa mashin i konstruksiy. M.: Mashinostroyeniye, 1984. 334 s.
[4]. Vasilyev M.V. Ekspluatatsiya karyernogo avtotransporta / pod общ. red. M.V. Vasilyeva. M.: Nedra, 1979. 280 s.
[5]. Gold B.V., Obolenskiy V.P. Prochnost i dolgovechnost avtomobilyey. M.: Mashinostroyeniye, 1974. 345 s.
[6]. Zыryanov I.V. Povыsheniye effektivnosti sistem karyernogo avtotransporta v ekstremalnых usloviyax ekspluatatsii: dis. d-ra tex. nauk. SPb., 2006. 378 s.
[7]. Kuleshov A.A. Proyektirovaniye i ekspluatatsiya karyernogo avtotransporta: spravochnik. Ch. 2. SPb.: Sankt-Peterburgskiy gornыy in-t, 1995. 203 s.
[8]. Panachev I.A., Kuznetsov I.V. Management procedure for life cycle of rear axle metalworks of heavy haulers. J. of Mining Sciyence. 2015(51);2:267–273.