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ANALYSIS OF THE BRAKING PROPERTIES OF THE MAN CLA 16.220 FOR SEVERE OPERATING CONDITIONS

Maxammadjon Qobulov

Assistant, Department Of Land Transport Systems And Their Exploitation, Fergana Polytechnic Institute, Fergana, Uzbekistan

Asrorjon Ismadiyorov

Assistant, Department Of Land Transport Systems And Their Exploitation, Fergana Polytechnic Institute, Fergana, Uzbekistan

Xaydarali Fayzullayev

Lecturer, Department Of Land Transport Systems And Their Exploitation, Fergana Polytechnic Institute, Fergana, Uzbekistan

ABSTRACT: - The braking feature is provided by the operation of the brakes. According to current state standards, cars are equipped with three mandatory braking systems (working, stopping and spare). Vehicles weighing more than 12 tons or intended for use in mountainous areas must also be equipped with an auxiliary brake system.

KEYWORDS: Car, braking, slope, mountain roads.

INTRODUCTION

The rapid development of the country's economy, along with the creation of great opportunities for the transport of goods and passengers by road, complicates the flow of traffic on the roads of the country, resulting in an increase in the number of road accidents. The braking properties of the car, which play an important role in ensuring the safety of road accidents and drivers, passengers and pedestrians, are calculated on the example of the car "MAN CLA 16.220" [1-7].

METHODS

The forces acting on the vehicle during braking are shown in Figure 1. The deceleration forces between the wheel and the road are and . They will be in the opposite direction to the traffic [8-17].

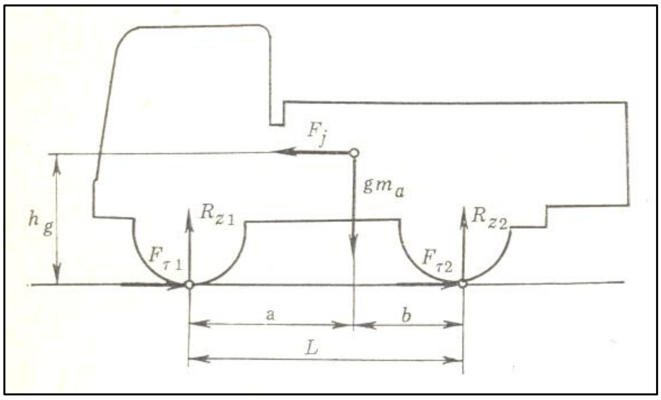


Figure 1. Forces acting on the vehicle during braking

The sum of the forces projected on a plane parallel to the base plane is equal to the inertial force:

$$\delta_T \cdot M_a \cdot j_c = P_{T1} + P_{T2} + P_{f1} + P_{f2} + P_i + P_w; \quad (1)$$

Where: M_a - vehicle mass, kg

j_c - deceleration of the car, *m/s*^{2}

δ_T - coefficient of account of rotating masses during braking (δ_T =1,03...1,05)

P_{T1} and P_{T2} - Brake force on the front and rear wheels, *N*

$$P_{Ti} = \varphi \cdot R_{Zi};$$

P_{f1} and P_{f2} - wheel resistance of the front and rear wheels, *N*

$$P_{fi} = f \cdot R_{Zi};$$

P_i - resistance to climbing, *N*

$$P_i = M_a \cdot g \cdot i;$$

P_w - air resistance, *N*

$P_w = K \cdot F \cdot V_a^2$;

We make the following definitions: $P_{T1} + P_{T2} = P_T$; $P_{f1} + P_{f2} = P_f$; in which case:

$$\delta_T \cdot M_a \cdot j_c = P_T + P_f + P_i + P_w; \quad (2)$$

When constructing $j_c = f(v_a)$ a given vehicle, two different braking modes are considered, namely, the deceleration of the vehicle when the vehicle is braked only by the brake system and when the vehicle is braked together with the brake system and the engine [18-23].

If the vehicle is braked using only the brake system, the deceleration is determined as follows:

$$j_{c_T} = \frac{P_T + P_f + P_i + P_w + P_{xx}}{G_a \cdot \delta_H} \cdot g, m/s^2; \quad (3)$$

Where: P_{xx} - the force expended to overcome the resistance in the transmission when the car is moving in cash; (brought to the front wheels), *N*

$P_{xx} = (2 + 0{,}025 \cdot V_a) \cdot M_a \cdot g \cdot 10^{-3}$;

G_a - car weight; *N*

$G_a = M_a \cdot g$

δ_H - Coefficient taking into account the issues of rotation when the car is moving in cash: $\delta_H = 1 + \frac{I_k}{G_a \cdot r^2} \cdot g \approx 1 + \delta_2$;

If the vehicle is braked together with the brake system and the engine [24-31], the deceleration is determined as follows:

$$j_{c_{TD}} = \frac{P_{TD} + P_T + P_f + P_i + P_w + P_{xx}}{G_a \cdot \delta_{bp}} \cdot g, \text{ m/s}^2;$$

here: P_{TD} - total friction of the engine (applied to the drive wheel), $P_{TD} = \frac{M_{TD} \cdot u_{TP}}{r \cdot \eta_{TP}}$;

M_{TD} - total friction torque of the engine, $H \cdot м$

$M_{TD} = V_л (a_1 \cdot n_{ei} - b_1) \cdot g$;

a_1=0,0008, b_1=0,15 - for gasoline engines

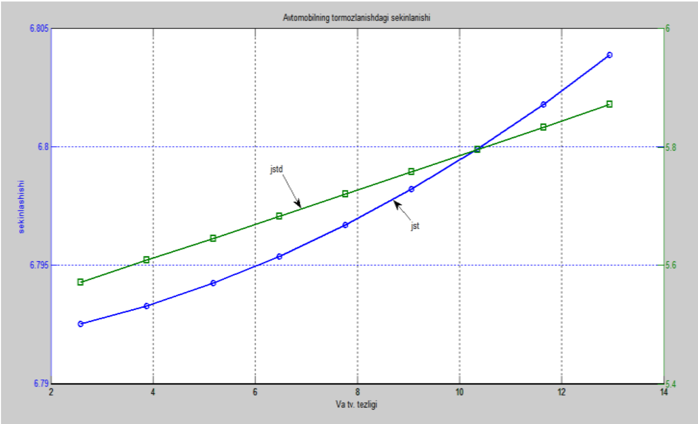
a_1=0,001, b_1=0,2 - for diesel engines

$V_л$ –– engine capacity, *l*

n_e – number of revolutions of the engine shaft, rpm/min

$\delta_{вр}$ – coefficient of account of rotational masses when braking together with the engine; $\delta_{вр} = 1 + \frac{I_M \cdot u_{TP}^2 + I_k}{G_a \cdot r^2} \cdot g$

$\approx 1 + (\delta_1 \cdot u_{KП}^2 + \delta_2)$;



$$\delta_1 = \frac{I_M \cdot u_{гл}^2}{G_a \cdot r^2} \cdot g \approx 0{,}04 \ldots 0{,}06; \qquad \delta_2 = \frac{I_k}{G_a \cdot r^2} \cdot g \approx 0{,}03 \ldots 0{,}05;$$

It is advisable to brake the car together with the brake system and the engine only if the $j_{c_{TD}} > j_{c_T}$ condition is met. The higher the braking speed of the car, the higher the value of P_{TD}, so $j_{c_{TD}} > j_{c_T}$. However, since $\delta_{вр}$ is always greater than δ_H, $j_{c_{TD}} > j_{c_T}$ will occur when the vehicle's braking speed is low [32-40]. The projection of the point of intersection of the two curves on the abscissa axis shows the minimum speed at which the vehicle brakes together with the brake system and the engine.

RESULTS

Braking time is the time taken for a vehicle to stop with a steady deceleration. Its value is determined using the above formula:

$$t_T = \frac{V_a}{3{,}6 \cdot j_c} = \frac{V_a \cdot k_э}{3{,}6 \cdot g \cdot \varphi}, \ c;$$

The braking distance is the distance travelled during braking. It is defined as follows:

$$S_T = \frac{V_a^2}{26 \cdot j_c} = \frac{V_a^2 \cdot k_э}{26 \cdot g \cdot \varphi}, \ m;$$

There are two different braking modes for constructing the v_a dependence of t_T and S_T for a given vehicle:

1) when the wheels are braked before locking (pH = 0.7);

2) when braking with locked wheels (phb = 0.8 ph).

Draw a graph of the dependence of t_T and S_T on v_a:

The braking characteristics of the MAN CLA 16.220 were calculated accordingly: When moving at a speed of $V_a = 50$, when ϕ=0.7, $j_s = 5.28$ and stopping time $t_t = 4.32\ s$. The higher the braking speed of the car, the higher the value of P_{TD}, so $j_{c_{TD}} > j_{c_T}$. However, since $\delta_{вр}$ is always greater than δ_H,

$j_{c_{TD}} < j_{c_T}$ occurs when the vehicle's braking speed is low. at n_{emax} and when the gearbox moved in 3rd gear, $j_{c_{TD}}$ =5.87 m/s^2 j_{c_T} =6.8 m/s^2 achieved deceleration values because at that time the speed assumed a value of $V_a = 12.9\ m/s$.

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