

THEORETICAL BASIS OF AUTOMOBILE FREIGHT SYSTEM WITH CHANGEABLE TRAILERS

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Summary. In the article the theoretical basis for calculating the productivity of the vehicle and determination of the rational distance while organizing the cargo transportation with the change of trailers is offered.

Key words: car, semitrailer, cargo transportation, cost, distance

INTRODUCTION

A very important role in the performance of road freight traffic plays the organization of the rolling stock movement, execution of the loading and unloading work, which can take up to 40% of the car haul time [1]. There is a well-known method of trucks shipments with removable semitrailers, which can significantly reduce the time of loading and unloading. For example, the automobile with the trailer arrives to the point of loading, and instead of loading it, its empty trailer is changed to the loaded one before [1,2]. The downtime of the vehicle reduces as the replacement of the trailer takes 20 - 40 minutes instead of 40 - 90 downtime for loading. However, the organization of the shuttle transportation needs more trailers, therefore, the analysis of a car performance, cost accounting and rational transportation distance is needed.

RESEARCH OBJECT

Automobile transportation with removable trailers helps to reduce the downtime of the vehicle. The is a task to calculate the increase of

the vehicle performance and to determine maximum sustainable transportation distance.

RESULTS OF THE TEORETICAL RESEARCHES

The analysis of the automobile performance is made by hourly productivity [3].

$$W_Q = \frac{q \cdot \gamma \cdot V \cdot \beta}{l + t_1 \cdot V \cdot \beta}, \quad (1)$$

where: q - capacity of vehicle, t;
 γ - static coefficient of load-lift capacity;
 V - technical vehicle speed, km/h;
 β - ratio of run;
 l - transportation distance, km;
 t_1 - time for loading and unloading, hours.

The resulting dependence of the change of performance (fig. 1) leads to the following conclusions:

- increase in hourly productivity of the vehicle when using the removable trailers is 30 - 130% depending on the load-lift capacity and distance of transportation;
- the effect increases with increasing of the load-lift capacity and decreasing of the distance of transportation.

To quantify the changes in performance the formula can be used:

$$\Delta W_Q = \frac{q \cdot \gamma \cdot (t_1 - t_3)}{(t_2 + t_1) \cdot (t_2 + t_3)}, \quad (2)$$

where: t_2 – the time of trailers movement, h;
 t_3 - time of trailer's replacement, h.

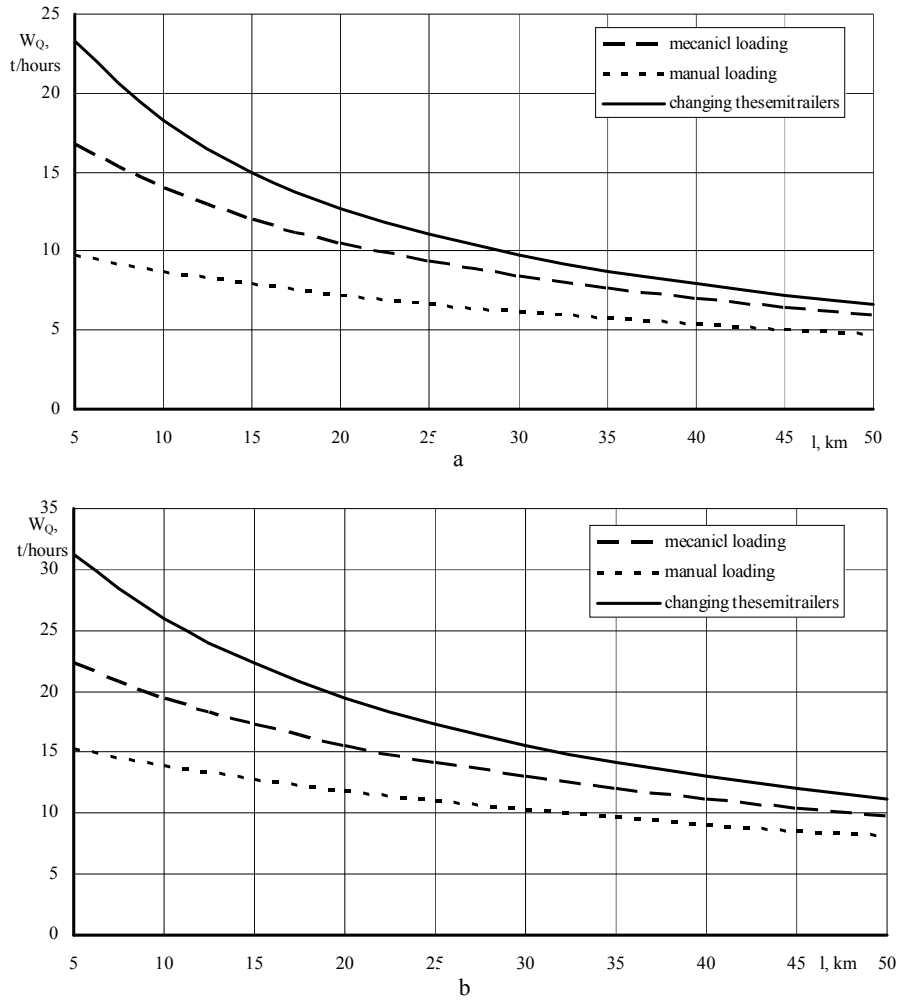


Fig.1. Hourly production of a road-train: a – lifting capacity of 14 tones; b – lifting capacity of 26 tones

It should be noted that when increasing the distance of transportation, the time of loading, unloading in the total time of circulation is reduced and thus decreases the effect of its reducing. So it makes sense to limit the maximum distance at which it's appropriate to use the changeable trailers.

The rational distance can be determined from the condition of providing a positive economic effect. The economic effects of reducing vehicle downtime must be greater than the cost for additional trailers. For reimbursement the costs for trailers it is needed to perform N transportations it means that the next condition must be fulfilled:

$$\Delta t_1 \cdot S_t \cdot n \geq K, \tag{3}$$

where: Δt_1 - downtime for loading and unloading a vehicle, h;

S_t - one hour of downtime cost, c.u. / h;

K - the cost of trailers, c.u.

Then, taking into consideration (3), we obtain:

$$n \geq \frac{K}{\Delta t_1 \cdot S_t}. \tag{4}$$

The required number of transportations is determined by the amount of labor-time of the vehicle for which the capital investments should be recouped. Fund of tractor's working time:

$$T = t_y \cdot D \cdot t_w \cdot n_w, \tag{5}$$

where: t_y - the term of the cost recovery for trailers, years;

D - the number of working days per year, days;

t_w - the transition time, h;

n_w - number of shifts.

The number of transportations is defined as the ratio of the total working time to time of one transportation. Considering that a single transportation time is the amount of time of movement and time of replacing the trailer, we get:

$$n = \frac{T}{t_2 + t_3}. \tag{6}$$

Then, considering (6) и (4):

$$\frac{T}{t_2 + t_3} \geq \frac{K}{\Delta t_1 \cdot S_t},$$

or

$$t_2 + t_3 \leq \frac{T \cdot \Delta t_1 \cdot S_t}{K}. \quad (7)$$

Since the movement time is determined by the distance of transportation and vehicle speed, the next formula can be written for the maximum sustainable distance of the transportation:

$$l \leq \left(\frac{T \cdot \Delta t_1 \cdot S_t}{K} - t_3 \right) \cdot V \quad (8)$$

SONCLUTIONS

Basing on the structural analysis of the prime cost and terms of the organization and performance of cargo traffic with a change of trailers the following conclusions are made:

- when using removable trailer car's performance increases;
- degree of increase in productivity increases with decreasing of transportation distance;
- the area of effective application of changeable trailers system is limited to maximum distance;
- the technique of determining the maximum transport distance is proposed.

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ТЕОРЕТИЧЕСКИЕ ОСНОВЫ СИСТЕМЫ АВТОМОБИЛЬНЫХ ПЕРЕВОЗОК СО СМЕННЫМИ ПРИЦЕПАМИ

Максим Слободянюк, Михаил Гривиниченко

Аннотация. Предложены теоретические основы расчета производительности автомобиля и определения рационального расстояния перевозки при организации грузовых перевозок со сменой прицепов.
Ключевые слова: автомобиль, полуприцеп, грузовые перевозки, себестоимость, расстояние