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Solutions of a Multicriteria Problem of Optimum Placement of Short-term Rest Areas on Highways

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Abstract

The authors consider in the article the problem of optimum placement of short-term rest areas on highways. Determination of the optimum quantity of such short-term rest areas is a multicriteria problem including diverse factors, among which there are qualitative ones. The statistical analysis of the correlation between the age and experience of the driver and the driving speed of a single-unit car on highways has proved the presence of influence, which is, however, not significant statistically. It is proposed to use a new functional dependence for short-term rest areas, in which quantitative and qualitative factors characterizing the driver, the car and the road will be taken into consideration through a set of coefficients.

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Keywords: traffic safety; short-term rest area; optimization; highway

1. Introduction

Under modern conditions, traffic safety depends on many factors. In this respect, the driver is considered to be the weakest link in the DCRE system (driver–car–road–environment), that is why the control over the driver increases (speed enforcement, observance of road traffic regulations as well as observance of the work and rest schedule for drivers are monitored) to improve traffic safety.

The installation of service area facilities of different purpose serves as one of the methods to improve traffic

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safety, especially while travelling for long distances (for more than 4 hours). Modern standards for placement of service area facilities with regard to distances between them do not conform to modern road conditions and needs of drivers and passengers.

The study objective is optimization of placement of service area facilities through an example of short-term rest areas playing a key role in maintenance of a high level of capacity for work and reliability of drivers of all types of cars travelling for considerable distances.

2. Main text

2.1. Current state of the problem of placement of service area facilities

N. P. Ornatskiy in his works (1974, 1978) proposed to determine distances between short-term rest areas according to the following formula:

$$x_{av} = \frac{66.4 \cdot q \cdot V_d}{f \cdot N_{day}} \quad (1)$$

where q — number of parking slots at the supposed parking;

V_d — design speed of a single-unit car, depending on the technical category of the designed or existing highway;

f — duration of stay at the parking, for the statement of the problem it is considered equal to 15 minutes or 0.25 hours;

N_{day} — average daily existing or prospective traffic intensity on the highway.

Ye. M. Okorokov in his research (1973) determined distances between short-term rest areas (Table 1) under the following conditions: 1) calculated capacity of short-term rest areas for three motor cars; 2) the engagement coefficient is equal to 1.5; 3) the daily intensity is accepted for the period of the maximum loading of rest areas on highways.

Table 1. Recommended distances between short-term rest areas.

Traffic intensity, cars per day	Distance between areas, km	
	Relief character	
	plain and broken	mountain
1	2	3
Less than 1000	50	25
1000–2000	50–30	25–13
2000–3000	30–22	13–10
3000–4000	22–16	10–8
4000–5000	16–13	8–7
5000–6000	13–11	7–6
6000–7000	11–10	6–5
7000–8000	10–9	5–4
8000–9000	9–8	-

The following distances between short-term rest areas are established in the modern Set of Rules [Ministry of Regional Development (2012)]: rest areas shall be provided every 15–20 km on highways of categories I–II, every 25–35 km — on highways of category III, and every 45–55 km on highways of category IV. As for the capacity, rest areas shall comprise not less than 20–50 cars simultaneously on highways of category I upon the traffic intensity up to 30,000 transport units per day, 10–15 cars simultaneously on highways of categories II–III, 10 cars simultaneously on highways of category IV (cl. 11.8).

2.2. Some provisions accepted as assumptions

Prior to the consideration of the problem of optimization of service area facilities, we will accept some axioms developed and accepted previously by other researchers:

- in calculations, the design speed is used;
- when considering time factors, the regulations of Order of the Ministry of Transport of the Russian Federation