

UOT: 656.1.021

DOI: <https://doi.org/10.30546/09085.2026.01.531>

ASSESSMENT OF TRAFFIC CAPACITY IN DIFFERENT SECTIONS OF THE ROAD

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ARTICLE INFO	ABSTRACT
<i>Article history:</i> <i>Received:</i>2025-10-09 <i>Received in revised form:</i>2025-10-20 <i>Accepted:</i>2025-11-20 <i>Available online:</i>2026-06-30 <i>Keywords:</i> road capacity; road intersection; roadway; traffic density; traffic speed. <i>JEL Classification:</i> R41, R42, C63	<i>The overall capacity of a road is significantly affected by the time it takes to pass through narrow spots on individual sections of the road. This time can vary from a few seconds at controlled intersections to several minutes (on steep slopes and at railway crossings). An increase in this time can lead to a sharp change in capacity and the formation of traffic jams, as well as an increase in the impact of traffic jams on the movement of vehicles. Therefore, reducing the time it takes for vehicles to pass through the road can improve traffic conditions not only in that zone, but also on the road as a whole, and increase the capacity of the road.</i>

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1. INTRODUCTION

The ability of a road to carry traffic depends on many factors: road conditions (width of the carriageway, longitudinal slope, radius of curves in plan, visibility, etc.), composition of the traffic flow, availability of control devices, weather and climatic conditions, ability of vehicles to maneuver across the width of the road, psychophysiological characteristics of drivers, and design of vehicles. The variation of these factors over the course of the day, month, season, and year leads to significant changes in the capacity to allow traffic to pass. The presence of many obstacles on the road significantly affects the speed of vehicles, which leads to the formation of a large number of vehicles moving in groups and a decrease in the average speed of the entire flow [1].

The capacity of the route is significantly affected by the time spent on passing through bottlenecks on individual sections of the road. This time can vary from a few seconds at controlled intersections to several minutes (on steep slopes and at railway crossings). An increase in this time can lead to a sharp change in the capacity of traffic and the formation of traffic jams, as well as to an increase in the impact of traffic jams on the movement of vehicles. Therefore, reducing the time spent on passing bottlenecks allows improving traffic conditions not only in that zone, but also on the road as a whole, increasing the capacity of the road.

Determining the carrying capacity of a road is important not only for identifying areas requiring traffic improvement, but also for assessing the efficiency and comfort of the entire traffic flow along the route and for selecting effective traffic management methods. Any road can operate with different traffic intensities. In this case, the maximum intensity is the one that corresponds to the carrying capacity of the road. The efficiency of the transport operation of a road can be characterized both by its carrying capacity and by the intensity at which traffic on the road is most economical and optimal, given the driver's working conditions [3].

The conditions for increasing the carrying capacity of highways are:

- 1) appropriate design of plan and longitudinal profile elements that do not cause sharp changes in speed;
- 2) determination of the width of the carriageway, which allows dividing the traffic flow according to its composition (additional lanes on slopes and at level intersections) and ensures optimal loading at which movement occurs at sufficiently high speeds;
- 3) increasing the smoothness and adhesion qualities of the coating;
- 4) reconstruction of intersections at the same level or construction of intersections at different levels;
- 5) selection of regulatory means that ensure a rational traffic regime;
- 6) provision of drivers with complete information about traffic conditions along the route;
- 7) improvement of the work of the road maintenance service.

2. ASSESSMENT OF THE TRAFFIC CAPACITY OF ROAD AREAS WITHIN SMALL SETTLEMENTS

On roads within small settlements, the ability to clear traffic is low due to unorganized pedestrian movements, buildings near the road, cars and buses parked on the shoulders or in special areas, the presence of agricultural machinery in the flow, etc. The relationship between traffic speed and traffic density on roads within small settlements is expressed as follows [2]:

$$v_q = v_0 \left[1 - \left(\frac{q}{q_{max}} \right)^\beta \right]^\gamma$$

In settlements of different lengths, if the distance from the edge of the carriageway to the line of buildings is 15 - 20 m, it is accepted according to table 1.

Table 1. Parameter values

Length of road section within the boundaries of a populated area, km	v_0	β	γ
1	2	3	4
0,30 - 0,70	68,71	2,15	4,80
0,70 - 1,25	64,37	2,03	4,85
1,25 - 1,75	60,20	1,89	4,90
1,75 - 2,25	55,90	1,75	5,00

Note: small settlements include settlements with a population of up to 1,000 people, consisting of single-story buildings of a linear shape.

When determining the carrying capacity of road sections within small settlements, the maximum density of vehicle flow can be taken as the maximum density of two-lane roads. The free

movement speed of vehicles on horizontal sections of roads with a carriageway width of 7-7.5 m and shoulder width of not less than 3 m located within settlements is determined as follows [2]:

$$\vartheta_0 = 57.28 - 8.1 \cdot L + 2.3 \cdot l - 0.38 \cdot L \cdot l$$

$0.5 \leq L \leq 2.5$ km is the length of the road section within the settlement; l - is the distance from the edge of the carriageway to the line of buildings ($5 \leq l \leq 25$ km).

The greatest impact on the reduction of the capacity to pass traffic and the speed of vehicles is exerted by pedestrians crossing the roadway. Pedestrian crossings within residential areas are considered to be places that limit the capacity to pass traffic on motor roads [2]. The speed of vehicles at pedestrian crossings is determined as follows:

$$\vartheta_a = 25.4 - 0.06 \cdot N_p - 0.008 \cdot N + 0.38 \cdot \vartheta_0$$

N_p - pedestrian traffic intensity during the "peak" hour, pedestrians/hour; N - vehicle traffic intensity, vehicles/hour.

This statement is true for a pedestrian flow of 18-20% children, 50-60% adults, and 20-35% elderly.

In cases where the percentages of pedestrians change, the speed of movement of cars at pedestrian crossings is determined as follows:

$$\vartheta_a = 14.95 - 0.031 \cdot N_u - 0.041 \cdot N_B - 0.29 \cdot N_y + 0.62 \cdot \vartheta_0$$

N_u, N_B, N_y - the intensity of movement of children, adults and the elderly, respectively, in the composition of the pedestrian flow, pedestrians/hour.

The reduction in the speed of cars in residential areas is influenced by car parks and their planning features. If the park is located outside the edge of the roadway and there are acceleration lanes at the entrances to them, the speed of movement practically does not decrease. For the same reason, if there are no acceleration lanes at the entrances, the speed of movement decreases by 10-20 km/h. If there are no parks and cars are parked on the shoulder of the road, the speed of movement decreases by 20-40 km/h [4, 5]. Planda ayrırsı olan kiçik yaşayış məntəqələri hüdudundakı sahələrdə avtomobillərin sürəti aşağıdakı kimi təyin edilir:

$$\vartheta_d = \overline{\vartheta_0} - 1.29 \cdot k$$

$k = 1000/R$; R - plana ayrının radiusu ($50 > R > 100$ m).

The capacity to pass traffic on straight, horizontal road sections within small settlements is determined as follows [2]:

$$P_{ym} = (1968.8 - 487.5 \cdot L + 11.2 \cdot l + 7.5 \cdot l) \cdot k_1 \cdot k_2 \cdot k_3$$

k_1 - coefficient taking into account the impact of the pedestrian crossing; k_2 - coefficient taking into account the impact of stops in front of service points; k_3 - coefficient taking into account the radius of the curve in the plan.

Initial approximate values of the traffic capacity of road sections within the boundaries of small settlements can be determined based on figure 1.

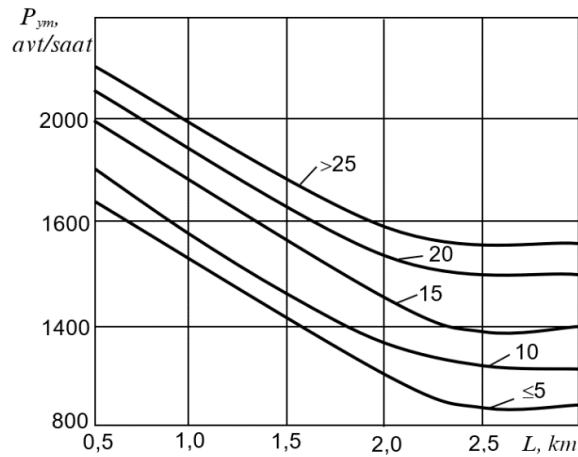


Figure 1. Dependence of the road's capacity on the length of the settlement and the distance from the roadway boundary to the building line (5-25 m).

When determining the value of the traffic capacity of the road area within the boundaries of pedestrian crossings, traffic capacity reduction coefficients are used (table 2).

Table 2. Reduction coefficients of the ability to release movement k_1

Pedestrian traffic intensity during peak hours, pedestrians/hour	Depending on the percentage of passenger cars in the stream k_1		
	100	70	50
<100	1,00	1,00	0,90
100-200	0,95	0,90	0,80
200-300	0,90	0,80	0,70
300-400	0,80	0,70	0,60

The capacity to pass traffic varies at a distance of 50 m in each direction from the pedestrian crossing. The reduction factor is equal to 1.0 at different level pedestrian crossings.

When determining the capacity of a road section in parking areas, the k_2 coefficient is used. The capacity of the traffic flow changes over a distance of 50 m in both directions from the boundary of the parking spaces in front of the service point. If a parking space is located beyond the shoulder of the roadway and is equipped with an acceleration-transition zone, $k_2 = 1.0$ is adopted; if a parking space is created by widening the shoulder, $k_2 = 0.8$; and for parking spaces without equipment, $k_2 = 0.6$ is adopted. If a parking space with equipment is located on one side of the roadway and left turns are not prohibited, the value of the k_2 coefficient should be reduced by 1.5 times [4, 5].

When determining the traffic capacity of road sections located on horizontal curves, the values of the reduction coefficients in table 3 should be used.

Table 3. The capacity of road sections located on horizontal curves to allow traffic to pass k_3

Length of settlement, km	Depending on the radius of the horizontal curve, k_3				
	100	100-250	250-450	450-600	600
0,30 - 0,70	0,81	0,89	0,95	0,96	0,97
0,70-1,25	0,84	0,92	0,97	0,98	0,98
1,25 -1,75	0,86	0,94	0,97	1,00	1,00
1,75 - 2,25	0,88	0,95	0,98	1,00	1,00
2,25 - 2,75	0,90	0,96	1,00	1,00	1,00

3. ASSESSMENT OF THE TRAFFIC CAPACITY OF BRIDGE CROSSINGS ON TWO-LANE ROADS

The capacity of bridge crossings to allow traffic depends on the design of the bridges, the condition of the carriageway and the approaches to the bridges. The actual capacity is significantly affected by the density of the flow, technical regulation means, the presence of level crossings on the approaches to the bridges, etc.

The capacity of bridges and their approaches is determined separately. The capacity of bridge approaches is evaluated as the capacity of highways.

The traffic capacity of the traffic lane of bridges located in a straight section in the plan and having a longitudinal slope of less than 10‰ is determined as follows [2]:

$$P_k = 420 + 43 \cdot Q - 2.285 \cdot L + 0.257 \cdot QL$$

Q – bridge dimensions, m ($Q7 \div Q13$); L – bridge length, m ($100 \leq L \leq 300 m$).

When determining the traffic capacity of bridges, the composition of the traffic flow should be taken into account. The traffic capacity of bridges located in a curved area in the plan and with a longitudinal slope of more than 10‰ is determined as follows:

$$P_k = P \cdot k_k$$

P – the capacity of the traffic lane taking into account the influence of curves in the plan, longitudinal slope and flow composition; k_k – the coefficient of reduction of the capacity of the bridge lane.

The values of the reduction coefficient of the traffic capacity of the bridge lane are adopted according to table 4, depending on the length and dimensions of the bridge.

Table 4. Values of the reduction coefficient of the traffic capacity of the bridge traffic lane k_k

L, m	Depending on the size of the bridge, k_k				
	Q-7	Q-8	Q-9	Q-11,5	Q-13
100	0,562	0,625	0,750	0,812	0,937
200	0,475	0,600	0,720	0,812	0,937
300	0,375	0,562	0,680	0,812	0,937

The reduction coefficients of traffic capacity for intermediate values of bridge length are taken based on nomogram 2.

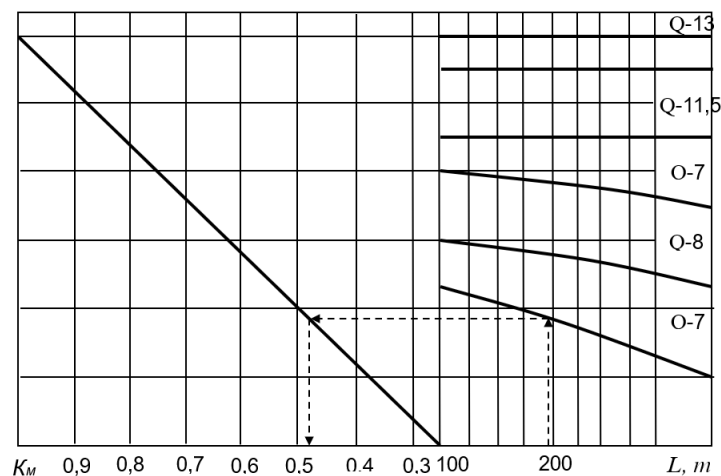


Figure 2. Nomogram for determining the reduction factor of the traffic capacity of a traffic lane on large bridges

The practical traffic carrying capacity of the traffic lane of large bridges is determined as follows [2]:

$$P_k = 0.101 \cdot v_0 \cdot q_{max}$$

P_k – traffic capacity of the traffic lane on bridges and in their zone of influence, vehicles/hour; v_0 – vehicle speed in free conditions, km/hour; q_{max} – maximum traffic density, vehicles/km.

The free movement speed of passenger cars on large bridges with a length of 100-300 m is determined as follows:

$$v_0 = 30.6 + 3.125 \cdot Q - 0.206 \cdot L + 0.01875 \cdot QL$$

4. CONCLUSION

Measures to increase the carrying capacity of the road may include:

- determining the width of the roadway, which allows the traffic flow to be divided according to its composition and ensures optimal loading at a sufficiently high speed;
- division of traffic flows into types of vehicles - this leads to the creation of unified traffic flows;
- increasing the smoothness of the pavement surface and its adhesion qualities;
- speed regulation taking into account the road load;
- selection of regulatory means ensuring a rational traffic regime;
- providing drivers with complete information about traffic conditions;
- improving the work of the road maintenance service.

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