CAPACITY ANALYSIS OF THE STREET AND ROAD NETWORK OF MODERN REGIONAL CENTER

S.V. Myronenko, A.S. Wenger, S.V. Atmazhov

Automobile and Road College of Odessa National Polytechnic University, 6 Tiraspolska Str., 65045 Odessa, Ukraine; e-mail: nrserg@ukr.net

An analysis of the capacity of the street and road network of modern regional center is presented. The study gave an objective picture of important correspondences. An assessment of degree of loading the considered road network was made. The study gave an objective picture of important correspondences. An assessment of degree of loading the considered road network was made.

Introduction. Road Transportation firmly entrenched in modern life, providing a large volume of transportation in all spheres of human activity. Motor transportation became an integral link in the transport process on almost all modes of transport.

Increasing the intensity of transport traffic, changing in restructuring and high-speed modes of transport flows more stringent requirements for controls and traffic management impose to ensure the necessary level of efficiency and safety of the transport traffic. To resolve this problem, it is necessary to build road network optimal in length, density and on transport performance indicators.

However, the experience of most developed countries shows that the development of such network can not be in isolation from the constant targeted traffic planning and road equipment with special technical devices for organizing and operating of traffic management [1…3].

Significant growth in vehicle fleet and in traffic leads to increased traffic. In terms of cities with historical buildings it causes the traffic problems. Particularly acute this problem arises in the nodal area of the city, in the area of the historic center.

Materials and Methods: All studies and calculations in paper, the authors conducted on the example of the road network of the Primorsky district of Odessa (Ukraine). Few streets that are transit arteries of the historic center were chosen to assess the road network capacity. On these streets the movement to the main railway station is happening. To assess the capacity of the considered road network the methods of field observations were used, because they are based on direct measurements of traffic characteristics in different parts of the road network.

Results: The study gave an objective picture of important correspondences. An assessment of degree of loading the considered road network was made; for that the capacity of multilane roadway was calculated. Analysis of the data showed that the state of traffic in the study area is densely saturated. It was made the recommendation for improvement of traffic of modern regional center.

Keywords: capacity, street and road network, transportation, traffic, traffic organization.
points of road network where traffic delays increases. The resulting queues and congestion cause a decrease in speed connections, unnecessarily excessive fuel consumption and increased wear of components and assemblies vehicles [1].

The most important criterion that characterizes the functioning of routes is their capacity. Under the capacity of the road authors understand the maximum number of units of rolling stock that can go on the road, driving with the calculated speed in one direction by time period.

Capacity is divided into three types: actual, estimated and project. Determining the actual capacity is only possible on active roads. These data have a particularly great practical importance, since it allows a realistic assessment of capacity while ensuring a certain level of speed and safety [4].

In the works of contemporary experts in the field of transport is described different ways of regulating of traffic on roads and complex highways, as well as methods of designing of economic transport systems with high bandwidth. The methods of calculating capacity are given in the works of N. Bellomo et al. [5], M. Garavello, and B. Piccoli [6], B.S. Kerner [7] and others.

The aim of the study is to evaluate the workload and analysis of capacity of the road network of modern regional center.

Materials and Methods. Depending on the purpose of the study of traffic there are different methods to determine its characteristics: documentary, nature, modeling [1, 2, 7].

All studies and calculations in this paper the authors conducted on the example of street and road network of the Primorsky district of Odessa (Ukraine). To assess capacity the next street were chosen: Katerynyns’ka, Risheliev’ska, Pushkins’ka, Kanatna, Greches’ka, Velyka Arnauts’ka. These streets were chosen due to the fact that they are transit arteries of the historic center. On these streets the movement to the main passenger and transport creating unit – Railway Station is happening. The historic city center has a rectangular building scheme, which helped to organize one-way traffic by streets Risheliev’ska, Pushkins’ka, and Velyka Arnauts’ka. Scheme of road network with these streets is shown in Fig. 1.

To assess the capacity of the considered street and road network the methods of field observations were used, because they are based on direct measurements of characteristics of traffic in different parts of network. In the absence of automatic counters and lack of access to video surveillance in these streets full scale methods only can achieve goal.

Results and Discussion. To get the most accurate data the information on speed and traffic density, composition of traffic flow were collected through direct observation for the period 18.-24.04.2016 at different times of the day. The data about the composition of traffic flow and road traffic received on different days of the week and at different times of day, was optimized and presented in graphs (Fig. 2...7).

In natural studies also studied the characteristics of the road conditions, such as number of traffic lanes, speed, type of road surface (Table 1).

Observation posts, which are marked with Roman numerals in Fig. 8, were located in specific points (focus of attraction of traffic) of the considered street and road network.
Characteristics of road conditions

<table>
<thead>
<tr>
<th>Street</th>
<th>Number of traffic lanes, ps</th>
<th>Speed of movement, km/h</th>
<th>Surface type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katerynyns’ka</td>
<td>4</td>
<td>41</td>
<td>asphalt</td>
</tr>
<tr>
<td>Rishelievs’ka</td>
<td>4</td>
<td>32</td>
<td>asphalt</td>
</tr>
<tr>
<td>Pushkins’ka</td>
<td>3</td>
<td>30</td>
<td>paving stone</td>
</tr>
<tr>
<td>Kanatna</td>
<td>3</td>
<td>28</td>
<td>asphalt</td>
</tr>
<tr>
<td>Greches’ka</td>
<td>2</td>
<td>26</td>
<td>asphalt</td>
</tr>
<tr>
<td>Velyka Arnauts’ka</td>
<td>3</td>
<td>35</td>
<td>asphalt</td>
</tr>
</tbody>
</table>

Fig. 2. The graph of dependence of the intensity of traffic from the composition of traffic flow and time of day for the Katerynyns’ka Street (intensity: - 17:00...18:00; - 12:00...13:00; - 8:00...9:00)

Fig. 3. The graph of dependence of the intensity of traffic from the composition of traffic flow and time of day for the Rishelievs’ka Street (intensity: - 17:00...18:00; - 12:00...13:00; - 8:00...9:00)

Fig. 4. The graph of dependence of the intensity of traffic from the composition of traffic flow and time of day for the Pushkins’ka Street (intensity: - 17:00...18:00; - 12:00...13:00; - 8:00...9:00)

Fig. 5. The graph of dependence of the intensity of traffic from the composition of traffic flow and time of day for the Kanatna Street (intensity: - 17:00...18:00; - 12:00...12:00; - 8:00...9:00)
The study gave an objective picture of important correspondence. The graph of dependence of the intensity of traffic from the composition of traffic flow and time of day for the Greches’ka Street (intensity: – 17:00…18:00; – 12:00…13:00; – 8:00…9:00) (Fig. 6).

The next stage of research was to evaluate the degree of loading of the considered street and road network. It is necessary to calculate the estimated capacity of multilane road \( P_M \), which is a product of the actual capacity and correction factors. For this purpose, we use the formula given in [8]:

\[
P_M = P_n \varepsilon \alpha,
\]

where \( P_n \) – the estimated capacity of one lane (1070…1340 auto/hour);

\( n \) – number of lanes;

\( \varepsilon \) – coefficient of distribution of vehicles across the width of the roadway (0.95…0.85);

\( \alpha \) – factor taking into account the impact of crossing the road (0.4…0.6).

The calculation results are presented in Table 2.
The level of road downloading estimated by load factor $z$ [8] which is the ratio of the traffic intensity to estimated traffic capacity of the considered areas of the street or road. So in this case, for each direction of motion the load level is defined as

$$z = \frac{N}{P_M}.$$  

The calculation results are presented in Table 3.

**Table 3**

<table>
<thead>
<tr>
<th>Street</th>
<th>Intensity, auto/hour</th>
<th>Estimated capacity, hour</th>
<th>The level of downloading, $z$</th>
<th>State of flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Katerynyns'ka</td>
<td>979</td>
<td>2440</td>
<td>0.40</td>
<td>Partly connected</td>
</tr>
<tr>
<td>Risheliev'ska</td>
<td>2704</td>
<td>2440</td>
<td>1.11</td>
<td>Dense saturated</td>
</tr>
<tr>
<td>Pushkins'ka</td>
<td>2364</td>
<td>1830</td>
<td>1.29</td>
<td>Dense saturated</td>
</tr>
<tr>
<td>Kanatna</td>
<td>2184</td>
<td>1830</td>
<td>1.19</td>
<td>Dense saturated</td>
</tr>
<tr>
<td>Greches'ka</td>
<td>1863</td>
<td>1220</td>
<td>1.53</td>
<td>Dense saturated</td>
</tr>
<tr>
<td>Velyka Arnauts'ka</td>
<td>1882</td>
<td>1830</td>
<td>1.03</td>
<td>Dense saturated</td>
</tr>
</tbody>
</table>

From the analysis of the table data it follows that the condition of traffic on referred streets densely saturated. This means that the flow is moving with stops, there are traffic jams. Therefore, this issue needs careful study as is the basis for the study and forecasting of capacity of the street and road network.

**Conclusions.** We have analyzed the capacity of the road network of Primorsky district of Odessa. Selective study found that the road network of Primorsky district of Odessa needs a complete renovation. To improve traffic organization is first necessary to build a model of the transport network.

Special attention also require the following issues: preparation of characteristics of the provisions and appointments of the road network as systems of transport and pedestrian links between elements of planning structure of the city; analysis of the planning scheme of city; diagramming of cargo flows; determine the duration of loading operations at points; calculation of the intensity, of the level of loading and density of traffic flow; determining the capacity of roads, interval of motion, time and speed of communication on routes to improve traffic organization of public passenger transport; determining the long-term city plan of passenger transport system through modelling; assembly the topology scheme of the city; determining the capacity of transport areas; calculation of passenger traffic in the network.

For rapid traffic organization is necessary to solve the problem with sites for the parking. The study found that traffic signs of prohibiting stopping and parking do not affect the drivers therefore need to take more stringent measures, such as the use of tow trucks and the system of fines. This will increase the capacity of street and road network by 20...30% without large investments.

**Література**


References

Received October 5, 2016
Accepted November 23, 2016