Traffic intensity on highway R-255 Siberia in Irkutsk region

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Abstract. In modern conditions, traffic intensity and transport composition undergo significant changes. The article aims to study changes in the number of road vehicles on the federal highway R-255 "Siberia" in Irkutsk region. The article presents results of decennial traffic intensity measurements for individual segments of the road. Graphs of distribution of traffic flows were built taking into account types of road transport. Dependences of the traffic intensity on hourly, daily and monthly changes were determined. The share of passenger cars was determined. Changes in the actual average daily intensity were revealed. The result of research is identification of distribution patterns for the types of road transport by road segments and time intervals.

1 Introduction

Increasing automobilization of our country imposes high requirements for road safety. Currently, the level of automobilization of Irkutsk region amounts to 480-550 cars per 1000 inhabitants [1]. An increase in the fleet of cars increases the traffic intensity.

One of the main tasks for development of the road sector in Siberia is to increase the capacity of roads, primarily along the main lines, and create city roundabouts. Reconstruction road measures allow for enhancement of the road in order to integration of Siberia into the Russian system of transport communication.

For accurate assignment of road reconstruction work, it is necessary to conduct long-term monitoring of changes in traffic intensity. Passenger cars have high dynamic characteristics requiring a capacity benefit. Their share in the transport flow is most susceptible to changes.

In Irkutsk Region, there are three federal highways whose total length is 1,550,870 km:
- P-255 Siberia Novosibirsk-Kemerovo-Krasnoyarsk-Irkutsk, 746.896 km;
- R-258 Baikal" Irkutsk - Ulan-Ude - Chita, 77.491 km;
- A-331 Vilyuy-Tulun-Bratsk - Ust-Kut - Mirny - Yakutsk, 726,018 km.

The federal road R-25 Novosibirsk-Kemerovo-Krasnoyarsk-Irkutsk passes through Irkutsk Region from km 1166 + 800 (the border with Krasnoyarsk Krai) to km 1867 + 000 (Irkutsk), as well as on the Irkutsk bypass segment 0 + 000 - km 23 + 940, connecting the main direction of the highways R-255 "Siberia" and R-258 "Baikal".

The road passes through Taishet, Nizhneudinsk, Tulun, Kuitun, Zima, Zalary, Alar, Cheremkhovo, Usolye, Irkutsk, Shelekhov districts and Angarsk urban district, and through 13 settlements, including Nizhneudinsk, Bulyushkina, Tulun, Shergul, Tulyushka, Kuitun, Kimiltey, Ukhtui, Shamanaevo, Sredniy, Usolye-Sibirskoye, and Thelma [2].
2 Materials and methods

Improvement of the road infrastructure depends on the intensity and capacity of roads. Indicators of intensity vary in time by hours, days and months. As the distance from large settlements and cities increases, traffic intensity decreases, and composition of the traffic flow changes. Multi-year research and practical observations of traffic flows allowed for development of objective indicators for evaluating these data.

To study the traffic intensity and analyze the results obtained, it is necessary to have complete data on road conditions. Characteristics of traffic flows are main sources of information when developing complex transport schemes and engineering projects for traffic management. One of the main traffic flow indicators are traffic intensity and types.

Traffic intensity is taken into account when assigning a category of road, determining the number of lanes, designing pavement.

The study of changes in the traffic flows of the federal highway R-255 was carried out on the basis of data analysis for 10 years (2008-2017). The article presents indicators of actual traffic intensity and traffic intensity reduced to a passenger car taking into account a road segment.

The methods for calculating traffic intensity on different highways differ by assessment procedures. On federal highways, systematic recording of traffic intensity is carried out using an automated traffic accounting system. On regional and local roads, field observations are carried out sometimes accompanied by recording of the traffic flow using video recording devices when performing road diagnostics and certification activities.

The segment was selected accounting for traffic flows in the cross section of the main road between settlements and adjacencies along the R-255 Siberia Novosibirsk-Kemerovo-Krasnoyarsk-Irkutsk highway across the territory of Irkutsk Region.
The average daily traffic intensity was determined in accordance with RIMD 218.4.005-2010 “Traffic safety recommendations” (2001).

Changes in traffic intensity by hours, days and months are taken into account by the coefficients of uneven traffic intensity.

The annual daily average traffic intensity through hourly intensity was calculated by formula

\[ N_{\text{days}} = \frac{4 N_\text{ч}}{K_t K_n K_g 365} \]  

vehicles per day

where \( K_t \), \( K_n \), \( K_g \) – non-uniformity traffic coefficients according by hours (0.05-0.06), days (0.14-0.16), and months (0.076).

For 2008-2017, the average daily traffic intensity on R-255 “Siberia” highway (М-53 “Baikal”) for nine segments is presented in Table 1. The table shows actual traffic intensity based on field observations and calculated traffic intensity reduced to a passenger car.

To determine the traffic intensity reduced to a passenger car (\( N_{\text{red}} \)), the coefficients specified in SP 34.13330.2012 Motorways were used.

**Table 1.** Average daily traffic intensity for R-255 "Siberia" (М-53 "Baikal") highway.

| Segment                          | Actual traffic intensity, vehicles per day | Corrected traffic intensity, moto vehicles per day |
|----------------------------------|-------------------------------------------|---------------------------------------------------|
| from 1167 km до 1210 km          | 1845/ 1398/ 2245/ 2447/ 2681/ 1766/ 2606/ 2287/ 3054/ 2816/ | 3054/ 2816/ |
| Krasnoyarky krai – Taishet       | 2949 2202 4262 4646 5185 2387 3656 3280 4535 4256 | 4256 |
| from 1341 km to 1486 km          | 2449/ 2139/ 2362/ 2584/ 2910/ 3193/ 3548/ 3481/ 2713/ 2694/ | 2694/ |
| Nizhneudinsk - Tulun             | 3923 3215 4579 5179 5727 4438 5052 5411 3892 3869 | 3869 |
| From 1486 km to 1560 km Tulun -  | 2335/ 2717/ 3135/ 3417/ 3071/ 2930/ 2633/ 1953/ 2085/ 2334/ | 2334/ |
| Kuitun                           | 3641 4069 5392 5877 5853 3952 3700 2983 3188 3597 | 3597 |
| from 1626 km to 1679 km          | 2600/ 5257/ 3295/ 3677/ 3800/ 4667/ 5646/ 5221/ 5164/ 5374/ | 5374/ |
| Zima - Zalari                    | 4383 8787 5517 6542 6842 6328 7365 6741 6719 7105 | 7105 |
| From 1751 km to 1799 km          | 9365/ 10146/ 11886 8784 9565 12180 1246 11354 9188/ 1085/ 12589 | 12589 |
| Southern route to Cheremkhovo     | 15015 15062 11886 8784 9565 12180 1008 11354 10529 | 10529 |
| from 1810 km to 1831,2 km        | 11956/ 14309 12588 13684 15938/ 14298 1922 17100 1531 15844 | 15844 |
| Usoyie Sibirskoe – route to Angarsk | 20588 20506 19329 21502 25068 17394 2319 19691 1784 18593 | 18593 |
| from 1831,2 km to 1861 km        | 9481/ 16254 19175 20901 12952/ 13863 1504 13563 1185 10077 | 10077 |
| ring road near Angarsk           | 14758 23860 26289 28655 23382 17819 1929 16738 1720 14949 | 14949 |
from 1854.7 km to 1873 km Angarsk - Irkutsk

Analysis of the results shows an increase in traffic intensity when approaching large cities. The segments from Angarsk to Irkutsk are congested. It decreases speed of the traffic flow, and causes congestion and environmental pollution.

During the period under review, there are minor fluctuations in intensity. One can identify segments with one or more traffic intensity peaks during these years, as well as segments with unchangeable traffic intensity values (Fig. 2).

**Figure 2.** Distribution of traffic intensity for R-255 "Siberia" (M-53 "Baikal") in 2017.

The traffic intensity reduced to a passenger car has a different nature of changes in comparison with the actual traffic intensity. In some segments, there is a decrease in traffic intensity reduced to a passenger car (Fig. 3). This is due to changes in the share of passenger cars in the transport flow (Table 2).

**Table 2.** Shares of passenger cars on R-255 Siberia (M-53 Baikal) highway.

| Segment | Actual traffic intensity for passenger cars, % |
|---------|-----------------------------------------------|
|         | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 |
| from 1167 km до 1210 km Krasnoyarky krai – Taishet from 1341 km to 1486 km Nizhneudinsk - Tulun From 1486 km to 1560 km Tulun - Kuitun from 1626 km to 1679 km Zima - Zalari From 1751 km to 1799 km Southern route to... | 71 | 77 | 50 | 50 | 51 | 51 | 52 | 59 | 58 | 57 |
|         | 63 | 76 | 48 | 46 | 48 | 44 | 45 | 51 | 55 | 58 |
|         | 64 | 76 | 60 | 60 | 50 | 65 | 49 | 52 | 53 | 48 |
|         | 60 | 63 | 64 | 59 | 58 | 74 | 68 | 69 | 67 | 65 |
|         | 64 | 72 | 73 | 66 | 65 | 67 | 69 | 72 | 73 | 76 |
Cheremkhovo

from 1810 km to 1831.2 km
Usolye Sibirskoe – route to Angarsk
from 1831.2 km to 1861 km
Angarsk
from 1854,7 km to 1873 km
Angarsk - Irkutsk

The percentage of passenger cars in the flow along the road varies from 41% to 82%. At the same time, the largest number of cars is observed when approaching the regional center in the area from 1854.7 km to 1873 km (Angarsk – Irkutsk). In general, over the ten-year observation period, the actual average annual daily traffic intensity grows by of 30% (Fig. 3).

Figure 3. Changes in the traffic intensity, passenger cars per day for 2008-2017 on R-255 Siberia highway (M-53 Baikal).

Traffic intensity and types of road transport depend on many factors associated with the cyclical nature of different types of production, seasonality of construction works, uneven use of personal vehicles, location of the road segment, etc.

These changes have to be accounted for when planning road reconstruction and repair works, selecting measures aimed at the improvement of safety and driving comfort.

3 Conclusion
1. Transport composition is heterogeneous and changeable. The share of passenger cars ranges from 41 to 82%. This distribution increases the average speed of vehicles and the number of accidents.

2. Annual changes in intensity are characteristic of the entire length of R-255 “Siberia” highway. When approaching regional and district centers, there is an annual increase in traffic intensity.

3. Based on the results of changes in traffic intensity, it is necessary to develop recommendations for reconstruction of individual road segments that do not meet safety and comfort requirements.

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