

## THE ANALYSIS OF THE TRANSPORT SYSTEM IN DNIPROPETROVSK REGION

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**Abstract.** The article studies and analyzes indicators of all types of transport services in Dnipropetrovsk region, namely, freight traffic activity, supply turnover, passenger transportation, passenger turnover and route density by different transport modes. The analysis was carried out in 2005-2015 in districts and cities of the region and the place of the region in the transport sector of Ukraine is analyzed. The recommendations on priority directions of developing transport sector in Dnepropetrovsk region are proposed.

**Keywords:** transport, modes of transport, transport infrastructure, freight traffic activity, supply turnover, passenger transportation, passenger turnover, route density.

*DOI: <http://dx.doi.org/10.23856/2005>*

### Introduction

The developed transport system of the state provides conditions for the socio-economic development, improves the production efficiency, national economy and people's welfare. The territory of the country or region must have such a transportation infrastructure that would fully satisfy demand for transport services.

Dnipropetrovsk transport system is an important part of transport communication in the country. It provides the needs of the population and social production in the transportation of passengers and goods. This is a sphere of functioning of a significant number of business entities, both legal entities and individual entrepreneurs.

The transport system must meet high requirements on quality, regularity and reliability of transport links, cargo safety condition and passenger transportation safety, deadlines and cost of delivery corresponding to the European integration of Ukraine.

The analysis of the transport system in Ukraine, its advantages, disadvantages and ways of development were highlighted in the works of various scholars, including S.G. Frysheva, I.I. Melnyk, S.M. Bondar, O.G. Topchiev, V.L. Mokriak, G.A. Levykov, O.G. Dykan and others. However, this issue is urgent and requires a thorough study.

### **Determination of Dnipropetrovsk region transport in frastructu restatus, the identification of weaknesses and development prospects**

Dnipropetrovsk region, an area of 31.9 thousand square kilometers and a population of 3560.0 thousand people (representing 7.5% of the population of Ukraine), is located in the central part of Ukraine on the banks of the middle reaches of the Dnieper River crossing the region from the northwest to the southeast and almost divides it into equal parts.

The administrative-territorial division of Dnipropetrovsk region is 20 cities, including 13 cities of regional importance, 22 districts, 46 towns, 1435 rural settlements, 287 villages and 40 village councils.

Through freight and passenger transportation in the region there is an interaction of different modes of transport forming the transport system: air, rail, pipeline and river transport for long distances, municipal electric transport lines and subway.

Despite placing the regional center close to the geographical center of the region, because of the territory elongation, the internal availability index of the region is well below the average in Ukraine (0.80). The region has an extensive transport network. A number of districts, including such as Pokrovsky, Mezhyvskyy, Tomakivsky, Apostolovsky, and Shyrokiivsky are too far from the regional center which is an additional obstacle to their development. In the region Donbas black coal, Kryvorizhzhia iron ore and Nikopol manganese ore are mined which are the largest ore deposits not only in Ukraine but also in Europe.

Kryvbas provides benefits and influences the development of the transport system of other cities and districts of the region. It performs quasi metropolitan functions in the southwestern part of the region, Shyrokiivsky, Apostolovsky and Sofiiivsky districts are geographically connected to it.

In the structure of the transport sector of the region there are almost all types of transport developed in Ukraine: air, railway, road and river transport. The purpose of the article is an analysis of the transport system in Dnipropetrovsk region.

**Railway transport.** Railways in Dnipropetrovsk region are the heaviest traffic in Ukraine. By the density of railways and rail infrastructure quality it holds the leading positions among the Ukrainian regions. The operational length of railways of general use is 1560 km, including electrified ones (1250 km). The density of a railway track per 1 thousand square kilometers in the region is 49 km (in Ukraine this indicator is 36 km), 83.4% railway tracks are equipped with the automatic control system of the traffic, 90% stations are equipped with the electric centralization of which more than 55% are joint less railway tracks. The transportation work is carried out by 244 stations, including 4 marshalling stations, 7 passenger stations, 67 freight stations and 19 line-network stations.

The region is crossed by main railway lines that connect Donbas, Kryvorizhzhia and Nikopol.

Dnipropetrovsk region has a huge potential for the passenger transportation by rail. The region is crossed by two major trends "East" – "West" combining Donbas and the south of the Russian Federation with the west of Ukraine, Kyiv and Europe and "North" – "South" combining Slobozhanshina and Moscow with the south of Ukraine.

Railways of Dnipropetrovsk region are: Oleksandria - Piatikhatki - Verkhivtseve - Dnipro - Synelnykove - Chaplyne - Krasnoarmiysk, Lozova - Pavlograd - Synelnykove - Zaporizhzhia, Piatikhatki - Kryvyi Rig - Apostolove - Nikopol - Zaporizhzhia, Snigurivka - Apostolove - Zustrichnyi, Novomoskovsk - Krasnohrad, Dolynska - Kryvyi Rig - Verkhivtseve, Chaplyne-Pology, Novomoskovsk - Pavlograd - Krasnoarmiysk, Baglii - Kamianske - Balivka - Novomoskovsk, Dnipro - Sukhachivka.

Not all railways of the region are electrified. Areas Snigurivka - Apostolove - Zustrichnyi, Novomoskovsk - Krasnohrad and Chaplyne-Pology are not electrified. In areas of Prydniprovsky and Donetsk railways there is a constant current, only beginning from Piatikhatki-Stykova towards Oleksandria there is an alternating current.

In 2005-2015 railway passenger turnover decreased from 3644.8 to 2409.9 million passengers per km, respectively, dispatching cargo by rail increased from 88.9 to 90.5 million

tons, freight turnover decreased by 20.4 billion ton-kilometers (compared to 28.6 billion ton-kilometers in 2014). Almost half of all freights sent by railways are iron and manganese ore of Kryvyi Rig and Nikopol basins. Only 1/3 of ore (55.3 million tons) is for the internal freight transportation, another part of it is sent to metallurgical plants in Donbas and for export. The second place in the structure of cargo sent by Prydniprovsk Railway is for coal (17.4 million tons) and others are ferrous metals (9.2 million tons).

As for the number of passengers Prydniprovsk Railway is second only to South Western Railway of Ukraine (23.8% of total).

Railways of Dnipropetrovsk region comprise 106 stations. Dnipro Management of Rail Traffic has 55 stations, Kryvyi Rig Management of Rail Traffic has 44 stations, Yasinuvata Management of Donetsk Railway has 3 stations, and Zaporizhzhia Management of Rail Traffic and Znamyanka Management of Odesa Railway have two stations.

Passenger transportation by rail in 2005-2015 increased from 36.8 to 37.1 million representing 0.82%. All transport operations are performed by electric locomotives B18, ЧС7 and ЧС2 and diesel locomotives 2Т3116, of which 95% for electric traction. The Ukrainian electric locomotives ДЕ1 of Dnipro Electric Locomotive Construction Plant are operated on the landfill of the railway. 12 locomotive and 14 wagon depots are engaged in repair and maintenance of rolling stock, track superstructure, technical facilities and equipment.

The railway transport provides the ability to relatively fast, regular and relatively low cost price of delivery of cargo and passenger traffic for long distances in all weather conditions.

**Road transport.** The road transport is the main type in providing freight and passenger traffic. Almost all the inhabited localities are connected with roads. The largest passenger terminals are bus stations in Dnipro and Kryvyi Rig, as well as Verkhnodniprovsk, Kamyanka, Magdalinivka, Nikopol, Novomoskovsk, Pavlograd and Tsarichanka bus stations. Bus terminals and bus stations are in all cities and regional centers except Zelenodolsk, Shyroke and Yuriivka. Almost all bus stations merged into JSC "Dnipro Regional Enterprise of Bus Stations" that facilitates coordination between different carriers and passenger service.

On the region's territory there are the following highways:

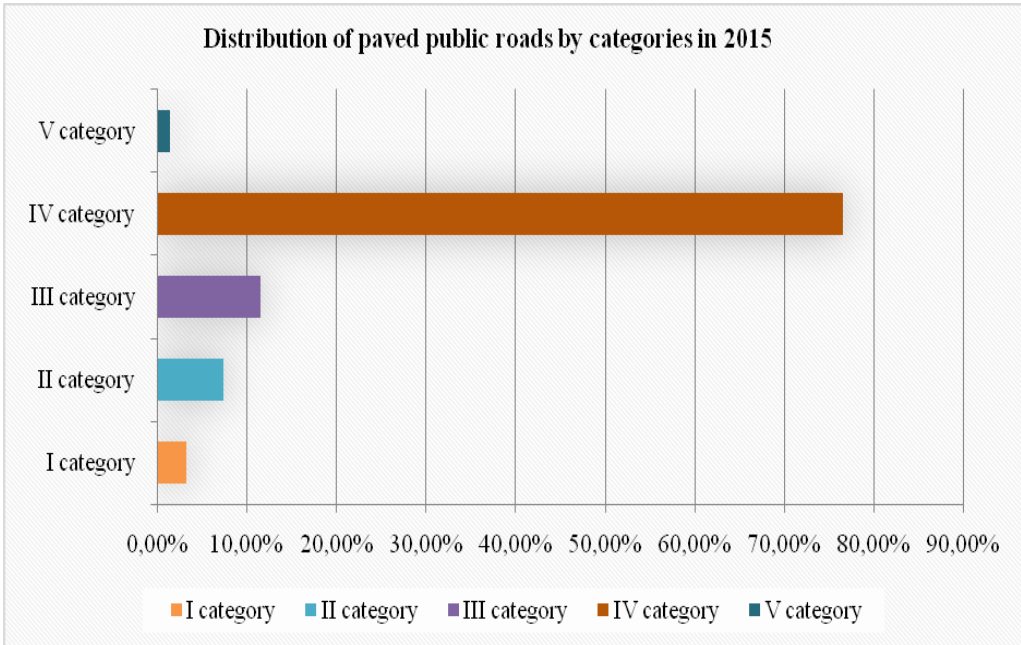
- 1) Two highways of the international importance: Kyiv-Luhansk, Kharkiv-Sevastopol;
- 2) Three highways of the national importance: Boryspil - Zaporizhzhia, Dnipro - Nikolaev, Kropivnitskiy - Zaporizhzhia;
- 3) Three highways of the regional importance: Merefa-Pavlograd, Dnipro - Kobeliaky, Piatikhatki - Kryvyi Rig.

The length of the highways in the region is 9144 km, including 417 km of international roads, 442 km of national roads, 78.5 km of regional roads, 1900 km of territorial roads and 6357 km of local roads: 2689 km of regional roads, 3668 km of district roads and 653 bridges.

In 2005-2015 the length of public roads in Dnipropetrovsk region was from 9182.4 to 9172.0 km respectively, including paved roads (from 9175.6 to 9165.2 km). For the last three years their figures have been remained unchanged.

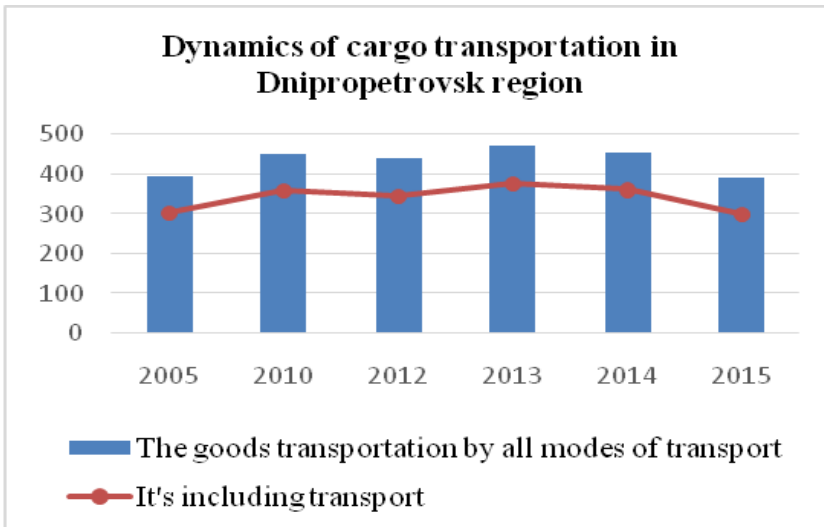
The use of the road transit potential of the region is complicated by significant road depreciation – 44% (the average indicator for Ukraine is 47%), poor quality of roads – 3.10% (the average indicator for Ukraine is 3.29%) and a small number of first class roads - 3%. The density of all paved roads of a regional significance is 287 kilometers/ 1000 square kilometers which is lower than the average indicator in Ukraine.

The distribution of paved public roads by categories in 2015 is presented by the diagram in Figure 1. According to it, the largest percentage is for paved roads of category IV.



**Fig. 1. Distribution of paved public roads by categories in 2015**  
 (Information of Statistical Yearbook of Dnipropetrovsk region, 2015)

Dynamics of cargo transportation in Dnipropetrovsk region is presented in Figure 2.



**Fig.2. Dynamics of cargo transportation**  
 (Information of Statistical Yearbook of Dnipropetrovsk region, 2015)

Auto carriers in 2015 transported 300.4 million tons of cargo and it was 17% less than in 2014. They are characterized by a total volume of cargo that is loaded and transported by the rolling stock of individual modes of transport. Indicators of freight turnover amounted to 3.6 billion ton-kilometers, respectively, and decreased by 4.1%. They are defined as the total volume of cargo transportation which is the sum of the products of the transported cargo over a transportation distance for each shipment.

Passenger transport services region in 2015 were used by 417.1 million passengers (which is 15% less than in 2014), 163.2 million passengers were transported (which is 38.4% less than in 2014) and the passenger traffic accounted for 6.3 billion passengers per kilometer (which is 17.5% less than in the previous year).

The largest cities and districts of the region engaged in the cargo transportation by motor transport in 2005-2015 are presented in Table 1. The undisputed leader among them is the city of Kryvyi Rig. It increased freight from 78.5% to 81.1% and Kryvorizky district increased these figures almost 4 times. This allows us to conclude the development of volumes of iron ore transportation in the district.

Table 1

**Cargo transportation by motor transport in cities and districts of Dnipropetrovsk region**

(Thousand tons)

	2005	2010	2012	2013	2014	2015
<b>Dnipropetrovsk region</b>	<b>303674.9</b>	<b>359200.7</b>	<b>345104.2</b>	<b>376121.6</b>	<b>361676.5</b>	<b>300356.8</b>
Kryvyi Rig	238461.8	299963.1	281868.5	304291.7	291810.9	243846.7
Vilnogirsk	23214.8	19947.5	23002.0	29212.2	25511.2	16392.3
Dnipro	6295.6	6479.9	8515.6	8097.2	7526.7	7229.7
Ordzhonikidze	9222.0	6865.0	6445.8	5595.7	6166.1	5148.1
Pavlograd	2229.8	1364.3	1848.9	1768.4	3697.6	2175.4
<b>districts</b>						
Dniprovskiyi	1477.7	2382.1	3264.4	5783.5	6396.9	6762.7
Kryvorizky	351.3	293.8	381.3	494.6	395.2	1419.9
Novomoskovsky	1735.0	1330.6	1161.0	1408.1	1404.2	1341.6

Main Department of Statistics in Dnipropetrovsk region. <http://www.dneprstat.gov.ua>

Freight turnover of road transport in cities and districts in 2005-2015 is shown in Table 2. According to it, the primacy of freight turnover belongs to Dnipro (26.8%), Kryvyi Rig (25.2%) and Dniprovskiyi district (17.5%).

For the statistical period Kryvyi Rig city took a leading position and gave way Dnipro city concerning freight turnover only in 2015. Dniprovskiyi district increased freight turnover of road transport almost 6 times for the same period.

Table2

**Freight turnover of road transport in cities and districts of Dnipropetrovsk region**  
(Million ton-kilometers)

	<i>2005</i>	<i>2010</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>
<b>Dnipropetrovsk region</b>	<b>2180.6</b>	<b>3587.1</b>	<b>3738.0</b>	<b>3730.1</b>	<b>3798.3</b>	<b>3641.6</b>
Dnipro	762.6	703.2	999.8	906.4	896.9	977.6
KryvyiRig	633.5	1016.0	1133.9	1086.7	1066.5	918.6
<b>districts</b>						
Dniprovskiyi	108.9	389.7	407.8	526.6	625.7	658.9
Kryvorizky	10.4	2.8	10.2	22.7	15.8	31.3
Nikopolsky	24.4	16.6	31.3	38.5	20.5	20.3
Novomoskovsky	25.3	30.7	23.8	27.0	30.2	28.2

Main Department of Statistics in Dnipropetrovsk region.<http://www.dneprstat.gov.ua>

Table 3 shows the largest passenger transportation by road transport in cities and districts of Dnipropetrovsk region and the city of Kryvyi Rig has 51.97%. Kryvorizky district ranked first among districts of the region. Absolute figures of it decreased from 3962.9 thousand to 2237.1 thousand for the statistical period. However, the percentage increased from 1.16 to 1.36 in the regional ranking.

Table3

**Passenger transportation by road transport in cities and districts of Dnipropetrovsk region**

(Thousand)

	<i>2005</i>	<i>2010</i>	<i>2012</i>	<i>2013</i>	<i>2014</i>	<i>2015</i>
<b>Dnipropetrovsk region</b>	<b>341420.8</b>	<b>347588.7</b>	<b>313854.6</b>	<b>316443.7</b>	<b>264926.5</b>	<b>163231.2</b>
KryvyiRig	105473.8	106447.9	130833.6	122786.6	130870.6	84837.0
Dnipro	142981.7	155313.9	130062.4	139868.9	82570.9	37639.0
Kamiansk	38771.0	36958.5	8599.7	9652.6	12001.4	11118.0
Nikopol	12246.8	15974.2	15641.2	17491.3	16560.3	10413.6
<b>districts</b>						
Kryvorizky	3962.9	2810.8	3646.6	3457.8	2929.5	2237.1
Apostolivsky	751.9	401.5	395.3	415.4	400.1	354.7

Main Department of Statistics in Dnipropetrovsk region.<http://www.dneprstat.gov.ua>

The road transport provides quick and mobile delivery of cargo and passengers for relatively short distances and for a short time.

**Water transport.** Dnipropetrovsk region has the main water artery of the country that is the Dnipro River, 55 rivers longer than 25 km and more than 100 small water reservoirs. There is freight traffic by public and private water transport which tonnage decreased from 1524.2 to 419.7 thousand tons from 2005 to 2015, respectively. In 2015, the cargo amount transported by water transport in the region was 419.7 thousand tons and freight operation amounted to 39.6 million tons per kilometer (which are 1.6 times and 2.4 times more than in 2014, respectively). Building materials and cereals predominate in the carriage of goods. In the

region there are Dnipro, Dneprodzerzhinsk and Nikopol river ports. These ports, except Nikopol river port, carry out the international freight transportation with the access to the Black Sea by ships like "river-sea".

Dnipropetrovsk region (419.7 thousand tons) ranked second after Odesa region (1093.6 thousand tons) in cargo transportation by river transport in 2015 among the regions of Ukraine. Unfortunately, in recent years, there is no passenger traffic at the state level and it coincides with the general trend in Ukraine. The passenger turnover of river transport has the lowest rate among all types of transport and it is 0.4 million passengers per kilometer.

**Air transport.** Air transport of the region is represented by two international airports in the cities of Dnipro and Kryvyi Rig. Airports of the region are connected by airlines with all major cities of Ukraine and a considerable number of foreign countries. Air traffic is made with Lviv, Kyiv, Ivano-Frankivsk; there are international connections to Verona, Sharm el Sheikh, Hurhada, Tel Aviv, Antalya, Istanbul and Tbilisi. Every day 2.516 passengers can fly from airports.

In 2015 the number of passengers transported by air transport of the region was 135.1 thousand and it decreased by 13.5% compared to the previous year.

In 2015 1.2 tons of cargo were transported, the freight turnover amounted to 3.8 million tons per kilometer which respectively by 3.1 times and 3 times more than in the previous year. Freight turnover of air transport in the overall transport system of the region has the lowest indicator – 1.3 million tons per kilometer (0.0004%). Traditionally, air transport is used to carry passengers.

**Pipeline transport.** Pipeline transport is important to Dnipropetrovsk region. It provides the area with oil, petroleum products, gas, coming from other regions. In the region's territory there are gas pipeline routes Shebelinka - Odesa – Dnipro, Kremenchug - Kryvyi Rig - Kropyvnytskyi, and Kremenchug - Kherson oil pipeline. These pipelines have a transit nature.

A significant share of the passenger traffic is taken by the urban passenger transport which is divided into tram, trolley transport and subway.

Dnipro subway is the shortest in Europe. It consists of only one line – Central Zavodska which has six stations. The length of the subway line is 7.1 km, the track width is 1.524 m and the length of platforms is 102 m. Moving time one way is 14 minutes, the interval of train movements is from 10 to 16 minutes and in rush hours it is from 4 to 7 minutes.

Passenger transportation by subway in Ukraine is only in three cities of Kyiv, Kharkiv and Dnipro. In 2015 passenger transportation by subway increased by 8.2% compared to the previous period. Dnipro city has less than 12% (7950.1 thousand) passengers comparing with cities of Ukraine where there are subways.

In Kryvyi Rig there is only one high-speed tram in Ukraine which has a line of 18 km. Most lines of it are on the surface and have 15 stations. Four stations are underground, three stations are fully above ground and the others are above ground covered. Due to the lengthening of the city from north to south, this type of transport is the fastest and economical. 16% of the passenger traffic of Kryvyi Rig is made by the high-speed tram being developed and it becomes more and more popular among different segments of the population.

The operational length of trolleybus lines in the length of public traffic connections in the region is 445.6 km and the operational length of tram lines is 374.0 km. This is the lowest indicator in the length of public traffic connections in Dnipropetrovsk region. However, it is the cheapest type of the urban transport, as evidenced by the increase in passenger

transportation by trams and trolleybuses from 12.8% in 2014 to 17.7% in 2015. The fare is 2.5 hryvnas that is twice cheaper than travelling by road transport.

Dynamics of the passenger turnover by types of transport in 2005-2015 is presented in Table 4 and Figure 3. According to these data, in 2015 there was a significant decrease in passenger turnover by rail, road, air and river transport modes. There is a tendency of increasing passenger turnover by electric transport (trolleybus, tram and subway). This is due to the deteriorating of the economic situation and low income of the general population.

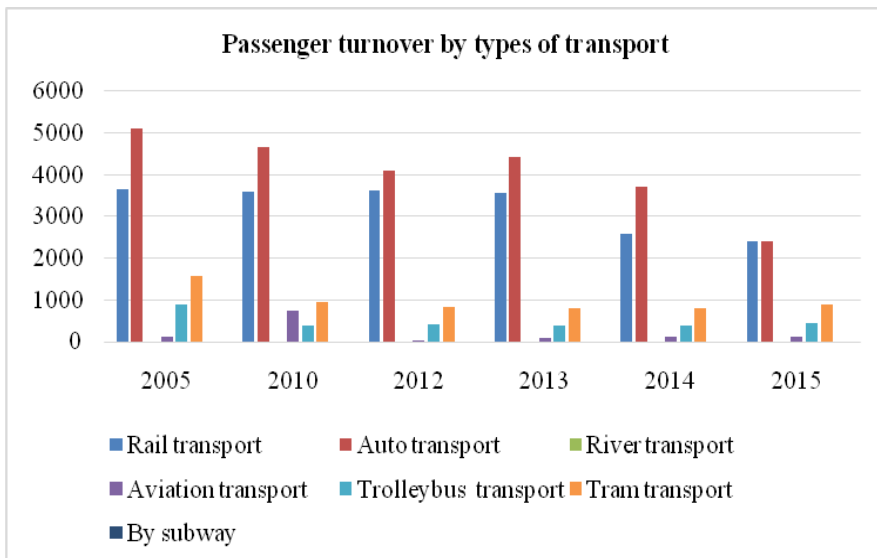
Table 4

### Passenger turnover by types of transport

(Million passengers per kilometer)

Type of transport	2005	2010	2012	2013	2014	2015
<b>Total</b>	<b>11383.8</b>	<b>10390.5</b>	<b>9082.1</b>	<b>9272.9</b>	<b>7663.2</b>	<b>6325.2</b>
Railway	3644.8	3581.8	3624.6	3554.9	2597.1	2409.9
Automotive (buses)	5098.0	4677.8	4106.2	4413.4	3719.3	2404.1
River	1.4	–	0.3	0.6	0.4	0.4
Air	110.2	744.5	44.3	89.1	120.4	109.2
Trolleybus	893.7	398.4	427.4	383.9	388.7	457.9
Tram	1572.8	944.2	840.3	795.0	802.0	905.5
Subway	62.9	43.8	39.0	36.0	35.3	38.2

Main Department of Statistics in Dnipropetrovsk region. <http://www.dneprstat.gov.ua>



**Fig. 3. Passenger turnover by types of transport** (Information of Statistical Yearbook of Dnipropetrovsk region, 2015)

According to Table5, in 2015 there was a significant fall in freight turnover of main types of transport in the region. However, the railway was impaired the most significantly as the main carrier of industrial products which reduced the freight turnover by almost three times due to the fall of the Ukraine's economy.

Table5

### Freight turnover by types of transport

(Million tons per kilometer)

Type of transport	2005	2010	2012	2013	2014	2015
<b>Total</b>	<b>37660.2</b>	<b>35984.6</b>	<b>38578.1</b>	<b>37332.8</b>	<b>32423.2</b>	<b>24097.3</b>
Railway	35316.8	32319.7	34751.4	33520.8	28606.9	20412.3
Automotive	2180.6	3587.1	3738.0	3730.1	3798.3	3641.6
River	149.4	62.8	84.6	75.9	16.7	39.6
Air	13.4	15.0	4.1	6.0	1.3	3.8

Information of Statistical Yearbook of Dnipropetrovsk region, 2015

### Conclusions and suggestions

In the system of the sustainable development of Ukraine Dnipropetrovsk region transport plays an important role. The transport system of the region is an integral part of the industrial infrastructure of the national economy. Also, it provides the necessary conditions for the development of other sectors of the material production and sectors of the non-production sphere.

Based on the analysis conducted in the article, we propose the following priority areas of the transport sector in Dnipropetrovsk region, namely:

- The development of transport communications in the region – the formation of the international road transport corridor between Europe and Asia with concomitant infrastructure for the following administrative districts of Dnipropetrovsk region: Vasytkivsky, Kryvorizky, Krinichansky, Mezhyvsky, Pokrovsky, Piatykhatsky, Sinelnykivsky, Soloniansky, Sofiiivsky;
- Strengthening and development of international highways, construction of by-pass roads, strengthening of main sectors of the railways;
- Improvement of the railway infrastructure;
- Development and modernization of airports and river ports;
- Reconditioning and renewal of the rolling stock.

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