

PERSPECTIVES OF DEVELOPMENT HIGHWAYS NETWORK IN UKRAINE

ПЕРСПЕКТИВИ РОЗБУДОВИ МЕРЕЖІ ШВИДКІСНИХ АВТОМАГІСТРАЛЕЙ В УКРАЇНІ



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Summary. The analysis development of highways network for general use is executed in Ukraine, and also development strategy of highways network in Ukraine is offered on a prospect 25 ... 30 years on the basis on definition of minimum and actual ranges between the biggest cities of Ukraine. For comparison, is presented an analysis of the road network in developed countries (The USA, Great Britain, France, and Germany). Calculation methodology and determination direct distance indexes is offered between the cities of Ukraine by their GPS coordinates, minimum spherical distances, minimum vehicle speed and time, and time spent on moving vehicles between the biggest cities of Ukraine. Set four groups of factors (legislative, financial, administrative and productive) that restrain development of highways network for the general use. On results technical and economic comparison is recommended to arrange coverage for highways from cement concrete.

Keywords: highways, development of network, directions, factors, strategy, highways.

Introduction. Socio-economic development of country, its integration, in a world and European community is largely depends on the development of transport infrastructure, in particular from the ramified presence of highways network. The highways of the general use provide domestic and international transportations of passengers and cargo, most accessible for the wide circle of users by automotive transport. An increase level of motorization in Ukraine, increase volumes of carrying passengers and loads, including transit transport, insolvency to satisfy growing demand of user's auto transport infrastructure in accordance with national and European requirements, requires the necessity of development highways network of the general use.

Analysis of the last researches and publications. In accordance with development Conception of road - transport complex in Ukraine until 2015 and to further period [1], Conceptions of the Government having a special purpose economic program of development highways general use are on 2013-2018 [2], Transport strategy of Ukraine on a period to 2020 [3], Transport policy of Ukraine and its approaching to the norms of European Union (ЄC)[4], development highways of general use should be made towards their integration into the Trans-European Transport Network, which is aimed at bringing the state of roads to the relevant international requirements. In these normative documents register such directions of highways development:

- providing of priority highways development of the general use and bringing them in line with the requirements of the current normative documents [3,4];
- creation of appropriate international standards corridors and roadside infrastructure and roads bring Ukraine to European levels [1];

- development network modern roads of higher categories between all regional centers and large industrial sites [3, 4];
- development network of rural roads and providing access roads paved all villages [1,3];
- improving public sector management road of Ukraine [1,2];
- establishment information-analytical road management system [2];
- improvement the material and technical base of the road economy [2];
- transition to an innovative way of development, technical re-equipment, introduction new technologies of construction and reconstruction highways, reduction of energy works intensity, preventing the harmful effects of road construction on the environment (establishment of anti-noise building, maintenance ways of animal's migration, mode of guard territories and objects of the naturally-protected fund and other nature protection setting) [2];
- strengthening of state support and introduction of world experience in relation to building highways due to credit funds and non-state investments on the basis of concessions or mechanism of state-private partnership, perfection Ukrainian legislation that regulates this sphere of activity [1, 3, 4];
- forming stable system of financing the road economy [1,2];
- making alteration to the current tax legislation in part of size rates increase of taxes and collections in the special fund of the state budget [3,4];
- paying introduction for using highways, that coincide with international transport corridors that is used by heavyweight vehicles and busses [3];
- introduction of paying for using the new highways built on concession principles [3, 4];
- development and claim norms of charges on operating maintenance of highways [2].

Analogical directions of development highways network general use are marked in scientific works by V.O. Galushko [5], N.V. Kudritska [6], U.E. Paschenko [7], D.K. Prayger [8], I.R. Uhnovsky [9] and other.

Unsolved constituents of general issue. For today there is absent determination of concept «development highways network for general use» in legislative and scientific literature, in accordance with that directions of development must be determined. There is not understanding of long-term prospect of development and necessity of building speed highways of world-class. In result, analysis the above-mentioned information can be noted, that in the brought directions development highways network Ukraine for general use is general directions that behave to development of all road economy industry. These general rules for their implementation require detailed ground and revision, wide discussion, definitions of implementation, sources and volumes of financing and etc.

Formulation of article aims. The aim of work is raising the task of development strategy of design highways network of Ukraine on a prospect 25 ... 30 years on the sensing basis of minimum and actual ranges between the most cities of Ukraine and establishment respective directions of development, that is aimed at its integration into the international transport network.

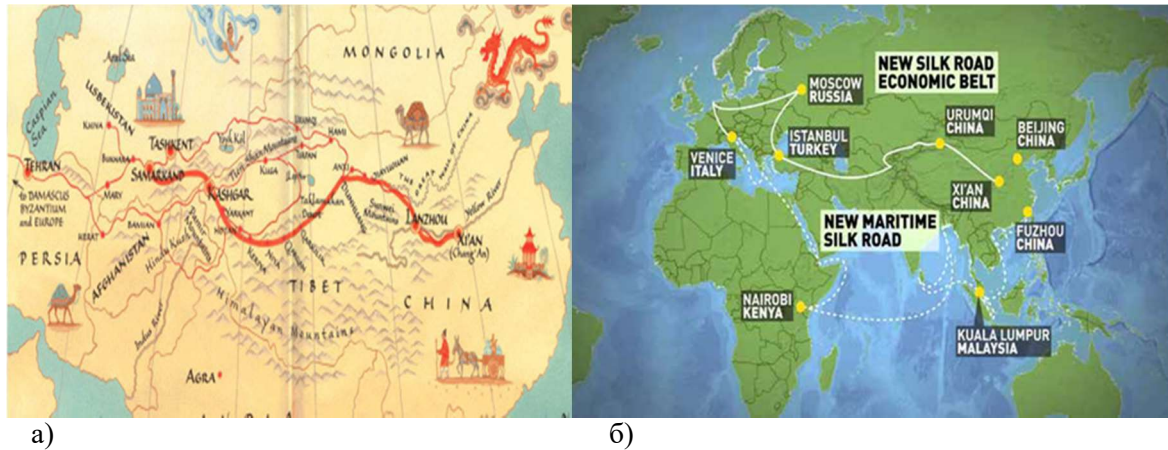
Results and Discussion. A highway is the linear complex of engineering building, intended for continuous, safe and comfortable motion of transport vehicles [10]. The highways of the general use and engineering building on them enter in the complement of road economy which is the only industrial-economic complex [11].

Concordantly [4] it is planned to improve the transport-operating state over 9,1 thousand kilometers of highways on basic routes, first of all between regional centers. Reference volume of financing, necessary for implementation of Program 268880 million hrn. Thus, the cost of repair averages 29 547 252,75 hrn / km or at the course of NBU on 29.05.2018, that presents 26,1495 hrn/ \$, - 1 129 935,67 \$/ km

For today absent developments for integrations national roads transport network in a transport network type the Large Silk Way or New Silk Way.

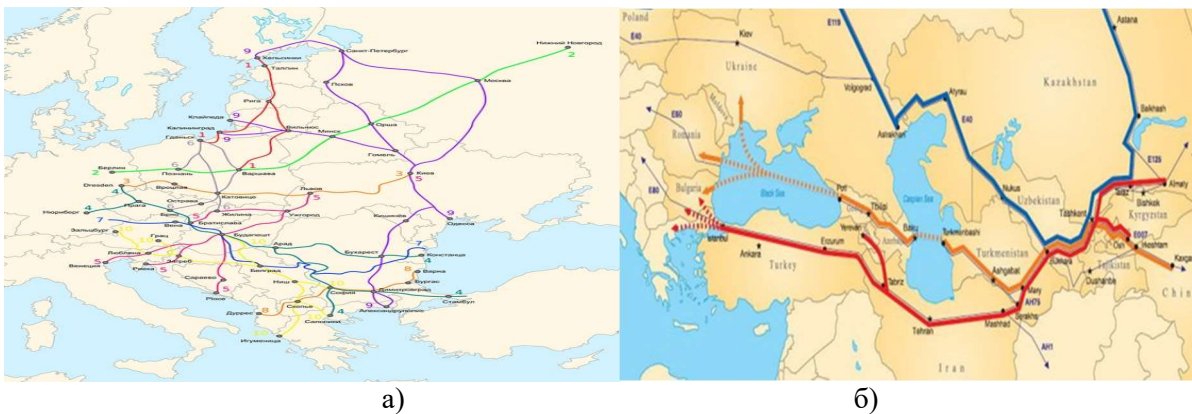
The Large Silk Way is the system of caravan roads, that connected Eurasia from Mediterranean in China and served as in the epoch of antiquity and Middle Ages a key point for the conduct of trade and cultures dialogue between East and West (Fig. 1a). The known «silk way» is a route that began in the Khan capital on east and closed in the capital of the Roman Empire on a west. This route has two directions: south and north [9].

New Silk Way or «One belt - one way» (OBOR), China strategic program started in 2013, sent to development of the large Eurasian economies through an infrastructure, trade and investments. Initiative contains two international trade connections: the surface «Economic belt – The New Silk Way» and ocean «Silk Sea Way 21 century» (Fig. 16) [10].



a) b)
 Figure 1 – Chart of passing route Old (a) [9] and New (б) Large Silk Way [10]
 Рисунок 1 – Схема маршруту стара (a) [9] та нова (б) Великого Шовкового Шляху [10]

OBOR embraces more than 65 countries there is a half of earth population and 40% GDP (Fig. 2) on that. Investments for OBOR are estimated scope from 4 to 8 trillion dollars of the USA. The China fund of the Silk way, Asian investment bank and state-private financing, is examined as potential sources of investments. Although its tasks in industry of transport are related mainly to multilateral building of infrastructure (transport lines and building), he embraces a navigation and aviation and aims to provide investments for the increase multimodality and integration modes, road safety, custom registration and development of standardized politician and positions. OBOR also will assist a management building and exploitation green and to the low carbon transport, with full impact consideration of climate change on its projects.



a) б)
 Figure 2 – Chart of passing route Asia is Europe [11] for territories European (a) and Asian (б) countries [12-13]
 Рисунок 2 – Схема маршруту Азія це Європа [11] для територій європейських (a) та азійських (б) країн [12-13]

Participating Ukraine in building of New Silk Way for today have unclear character and it is related mainly to suggestions development existent transport corridors of Ukraine (Fig. 3).

Meantime for development of the state needed strategic decisions related to the pre-eminent development of infrastructure for the next launch economy.

If to look at the map of developed countries highways will see “spider web” of roads. A map highway of Germany (Fig. 4a) is autobahn, France, (Fig. 4б) - AutoRoute, Italy is motorways Great Britain - highways, the USA is an express road (Fig. 4 in, and 4r).

In Ukraine for today there is not a single highway of world-class.

For an analysis 95 most cities of Ukraine are chosen with a population more than 60 thousand inhabitants.



Figure 3 – Chart of development transport corridors in Ukraine [14] on initiative of Ministry Infrastructure of Ukraine and Ukravtodor [15]
 Рисунок 3 – Схема транспортних коридорів в Україні [14], що розроблена за ініціативою Міністерства інфраструктури України та Укравтодору [15]

Determination of direct distance is between the cities of Ukraine on their coordinates. Determination of direct distance between the cities of Ukraine on coordinates was executed with determination coordinates every city in obedience to the location of Main Post office (center of city) for help to addition of Google Maps [1]. Found coordinates, both in latitude and longitude in degrees, and in degrees, minutes and seconds (table. 1). All indexes were registered in the Excel in the matrix of 4x95.

Table 1 – Coordinates of center cities of Ukraine
 Таблиця 1 – Координати центрів міст України

Name of settlement	Longitude	Width	Longitude, deg.	Width, deg.
Kyiv	50°27'00.3"N	30°31'23.5"E	50,450094	30,523206
Kharkiv	49°59'08.7"N	36°15'28.0"E	49,985753	36,257781

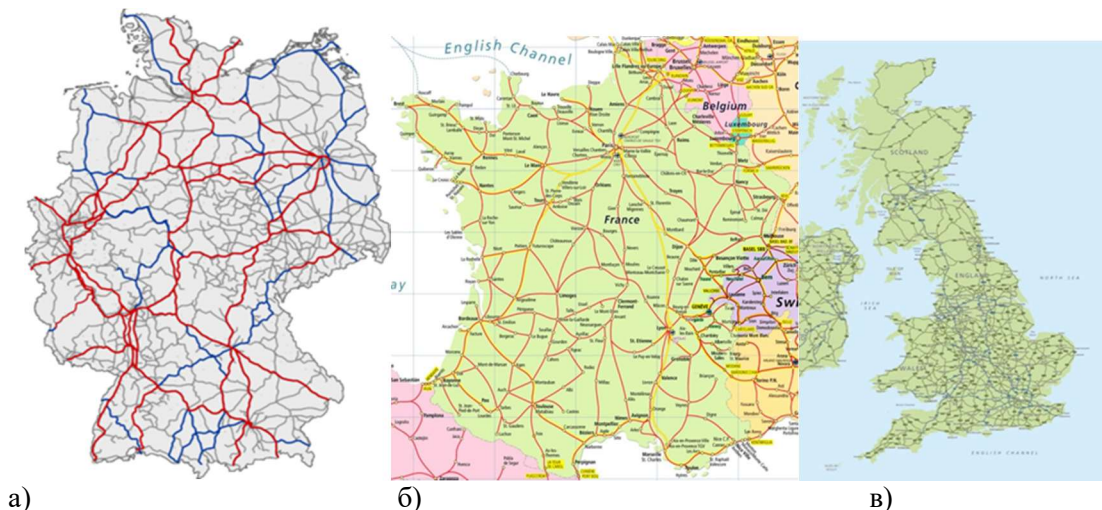
Knowing the center of city point coordinates, it is possible to define a line distance between cities after the chosen points. The formula spherical theorem of cosines is used for this purpose [1]:

$$\Delta\sigma = \arccos \left\{ \sin \varphi_1 \sin \varphi_2 + \cos \varphi_1 \cos \varphi_2 \cos \Delta\lambda \right\}, \quad (1)$$

where, $\varphi_1, \lambda_1; \varphi_2, \lambda_2$ it is a width and longitude of two points in radians

$\Delta\lambda$ - difference of coordinates on longitude

$\Delta\sigma$ - angular difference.





г) Figure 4 – Map of motorways in the developed countries
 Рисунок 4 – Карта автомобільних доріг розвинутих країн

For translation of angular distance in metrical, an angular difference is needed to multiply on an Earth radius ($R_3=6372795$ meters, units of eventual distance equal units, in what expressed radius (in this case meters).

$$L_{sf} = \Delta\sigma \cdot R_3, \quad (2)$$

Example. Knowing the center cities coordinates table 1, width and longitude transferred in radians, using a formula (3):

$$radians = \frac{deg^\circ \cdot \pi}{180}, \quad (3)$$

It is accordingly got:

Name of settlement	Width	Longitude	Φ radian	Λ radian
Kyiv	50,45009	30,52319	0,880520	0,532730
Kharkiv	49,98575	36,25778	0,872416	0,632818

Knowing coordinates in radians a calculation is executed by formula 1:

$$\Delta\sigma = \arccos \left\{ \begin{array}{l} \sin(0,880520) \cdot \sin(0,872416) + \cos(0,880520) \cdot \cos(0,872416) \times \\ \times \cos(0,532730 - 0,632818) \end{array} \right\} = 0,064537, \quad (4)$$

Distance (minimum distance between points on a sphere or spherical distance) between cities, which is equal to

$$L_{sf} = 0,064537 \cdot 6371,21 = 411,2, \text{ km} \quad (5)$$

For verification of direct distances between cities by coordinates, used on-line calculation on a site Garmin [16].

The values of distance expected by formula (3) between the city center built in the matrix 95x95, that is created in Excel.

This matrix is basis for further calculations of such parameters:

- rush on the intercity route, equal to the difference distance actual L_{exis} and minimum L_{sf} :

$$\Delta L = L_{exis} - L_{sf}. \quad (6)$$

- coefficient of rejection existent network L_{exis} , from optimal as the ratio of distance between cities at passage roads an existent network to minimum spherical distance:

$$K_{rej} = \frac{L_{exis}}{L_{sf}}. \quad (7)$$

At approaching of this coefficient to 1,0 this direction is optimally provided road on intercity connection. At the value K_{rej} more than 1,20 between cities unsatisfactory connection.

coefficient of overrally:

-

$$K_{Or} = \frac{\Delta L}{L_{sf}} = \frac{L_{exis} - L_{sf}}{L_{sf}} = K_{rej} - 1. \quad (8)$$

- loss of time at passage between cities

$$\Delta t = t_{actual} - t_{min}, \quad (9)$$

where t_{actual} is actual time of passage between cities, on the existent roads network.
 t_{min} , is minimum time of passage at permissible speed $V_{allowed} = 60$ (90) km/h.

$$t_{min} = \frac{L_{sf}}{V_{allowed}}.$$

Coefficient of loss time at passage between cities

$$K_t = \frac{\Delta t}{t_{min}}. \quad (10)$$

A comparison of the actual speed of vehicles between cities and speed at a minimum distance L_{sf} . The results of calculations by formulas (1 - 10) are tabulated (1 - 4).

The highways network of Ukraine is formed in a middle 70's past century, according to the requirements that time economy, weak industrial production. It is necessary to form the new network of highways, that must provide the requirements of society in mobility, to steady development, necessities of communication and tourist development, to comply requirements of ecological and road safety.

A task stands before Ukraine, how to convert possibilities of the state with the most index of transit in concrete investments sent to development for road infrastructure. How to leave off a barrier for movement traffic flows between East and the West, by North and South in roads and bridges for the mobile and safe movement goods and passengers.

In the near time necessary development Conception of long-term development highways network of national value (with a prospect on 20 – 30 years). It is especially important to link territories which were long time under the rule of different empires in one state road system (North Bukovyna, Prykarpattia and Zakarpattia with Center, North and South of country, Center, North and South with Donbas). The total length of new highways must be about 8 - 10 thousand km. At the same time, new roads should not pass on existent routes, which must be attributed to the lower level roads that together with entrances to the cities and ports will provide work of logistic chains.

Table 1 – Minimum spherical distances between the biggest cities of Ukraine

Таблиця 1 – Мінімальні сферичні відстані між найбільшими містами України

Cities	Kyiv	Kharkiv	Dnipro	Odesa	Donetsk	Zaporizhzhya	Lviv	Krivij Rig	Mykolaiv	Mariupol	Luhansk	Makijivka	Vinnitsya	Simferopol	Sevastopol	Kherson	Poltava	Chernihiv	Tcherkasy
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Kyiv		411,2	393,8	441,0	594,5	444,0	468,0	349,4	401,2	634,6	666,6	594,5	199,7	667,1	687,6	450,8	303,3	128,0	156,7
Kharkiv	411,2		190,5	564,7	248,0	252,4	875,2	314,4	459,0	334,7	270,7	248,0	566,8	582,6	632,7	459,3	130,3	387,4	307,8
Dnipro	393,8	190,5		391,9	211,2	70,5	814,8	140,6	281,9	240,9	314,0	211,2	487,8	397,4	444,8	272,9	129,5	430,0	243,3
Odesa	441,0	564,7	391,9		559,9	365,9	621,0	252,8	110,7	522,8	684,0	559,8	348,6	312,4	301,8	145,2	446,8	558,3	343,6
Donetsk	594,5	248,0	211,2	559,9		199,2	1025,9	332,4	451,1	102,3	128,1	0,0	698,9	441,8	500,5	419,4	296,5	607,7	450,9
Zaporizhzhya	444,0	252,4	70,5	365,9	199,2		842,7	134,4	255,5	198,0	319,1	199,2	514,7	330,5	380,3	232,7	199,4	491,8	288,5
Lviv	468,0	875,2	814,8	621,0	1025,9	842,7		714,1	668,4	1040,3	1116,7	1025,9	328,1	931,6	922,4	728,3	756,8	544,2	579,9
Krivij Rig	349,4	314,4	140,6	252,8	332,4	134,4	714,1		144,8	327,7	447,5	332,4	387,4	333,3	367,1	151,1	207,1	425,4	195,5
Mykolaiv	401,2	459,0	281,9	110,7	451,1	255,5	668,4	144,8		420,3	574,2	451,1	362,4	277,6	288,8	60,2	346,7	505,1	274,7
Mariupol	634,6	334,7	240,9	522,8	102,3	198,0	1040,3	327,7	420,3		210,7	102,3	712,4	356,9	416,5	377,8	354,1	665,9	482,1
Luhansk	666,6	270,7	314,0	684,0	128,1	319,1	1116,7	447,5	574,2	210,7		128,1	794,0	565,0	624,3	545,5	363,7	657,0	536,8
Makijivka	594,5	248,0	211,2	559,8	0,0	199,2	1025,9	332,4	451,1	19,5	128,1		699,0	441,8	500,5	419,4	296,5	607,7	450,9
Vinnitsya	199,7	566,8	487,8	348,6	698,9	514,7	328,1	387,4	362,4	673,3	794,0	699,0		638,3	641,4	422,2	441,3	321,1	260,7
Simferopol	667,1	582,6	397,4	312,4	441,8	330,5	931,6	333,3	277,6	261,7	565,0	441,8	638,3		59,7	220,0	516,5	756,3	522,7
Sevastopol	687,6	632,7	444,8	301,8	500,5	380,3	922,4	367,1	288,8	505,9	624,3	500,5	641,4	59,7		236,8	559,4	783,5	549,4
Kherson	450,8	459,3	272,9	145,2	419,4	232,7	728,3	151,1	60,2	580,0	545,5	419,4	422,2	220,0	236,8		358,0	548,3	314,7
Poltava	303,3	130,3	129,5	446,8	296,5	199,4	756,8	207,1	346,7	310,8	363,7	296,5	441,3	516,5	559,4	358,0		312,9	180,6
Chernihiv	128,0	387,4	430,0	558,3	607,7	491,8	544,2	425,4	505,1	468,4	657,0	607,7	321,1	756,3	783,5	548,3	312,9		234,2
Tcherkasy	156,7	307,8	243,3	343,6	450,9	288,5	579,9	195,5	274,7	508,0	536,8	450,9	260,7	522,7	549,4	314,7	180,6	234,2	

Table 2 – Minimum rates movement of cars between the biggest cities of Ukraine
 Таблиця 2 – Мінімальні автомобільні маршрути між найбільшими містами України

Cities	Kyiv	Kharkiv	Dnipro	Odesa	Donetsk	Zaporizhzhya	Lviv	Krivij Rig	Mykolaiv	Mariupol	Luhansk	Makijvka	Vinnytsya	Simferopol	Sevastopol	Kherson	Poltava	Chernihiv	Tcherkasy
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Kyiv		65	55	65	56	56	69	53	60	55	58	59	63	60	58	60	66	58	56
Kharkiv	65		58	53	47	59	66	57	47	48	49	47	63	59	56	51	55	60	54
Dnipro	55	58		42	49	47	65	51	40	48	44	51	52	56	53	46	54	58	47
Odesa	65	53	42		56	56	59	41	52	56	54	57	61	55	53	51	54	67	61
Donetsk	56	47	49	56		52	62	50	57	49	42	34	51	59	56	56	51	56	49
Zaporizhzhya	56	59	47	56	52		62	56	46	53	50	54	53	57	53	44	55	56	51
Lviv	69	66	65	59	62	62		53	55	60	62	63	53	56	55	56	68	67	65
Krivij Rig	53	57	51	41	50	56	53		34	55	46	55	50	49	48	46	48	56	50
Mykolaiv	60	47	40	52	57	46	55	34		57	53	57	27	46	43	10	45	39	28
Mariupol	55	48	48	56	49	53	60	55	57		48	53	57	60	55	56	52	57	53
Luhansk	58	49	44	54	42	50	62	46	54	48		42	60	55	53	53	54	57	54
Makijvka	59	47	51	57	34	54	63	55	57	53	42		52	60	56	57	55	58	50
Vinnytsya	63	63	52	61	51	53	53	50	55	57	60	52		56	55	55	65	62	50
Simferopol	60	59	56	55	59	57	56	49	60	60	55	60	56		31	55	58	61	52
Sevastopol	58	56	53	53	56	53	55	48	53	55	53	56	55	31		51	55	59	51
Kherson	60	51	46	51	56	44	56	46	49	56	53	57	55	55	51		48	62	56
Poltava	66	55	54	54	51	55	68	48	46	52	54	55	65	58	55	48		61	52
Chernihiv	58	60	58	67	56	56	67	56	62	57	57	58	62	61	59	62	61		59
Tcherkasy	56	54	47	61	49	51	65	50	46	53	54	50	50	52	51	56	52	59	

The statistical analysis of rate movement specifies on the following:

High speed from Kyiv in Rivne 72 km/h. Minimum speed from Kyiv to Brovarys 41 km/h., and for the road of Kropivnitsky- Mykolaiv rate of movement 17 km/h. For comparison in Germany regulation speed on autobahn is 130 km/h.

Table 3 – Time spends on moving of cars between the biggest cities of Ukraine
 Таблиця 3 – Час руху автомобілів між найбільшими містами України

Cities	Kyiv	Kharkiv	Dnipro	Odesa	Donetsk	Zaporizhzhya	Lviv	Krivij Rig	Mykolaiv	Mariupol	Luhansk	Makijvka	Vinnytsya	Simferopol	Sevastopol	Kherson	Poltava	Chernihiv	Tcherkasy
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Kyiv		7:24	8:15	7:28	13:41	9:08	7:50	7:53	8:00	14:18	14:12	13:14	4:16	13:36	15:23	9:05	5:12	2:27	3:25
Kharkiv	7:24		3:46	13:44	6:41	5:00	15:17	6:30	11:37	8:43	6:47	6:22	11:43	11:06	13:33	10:52	2:35	8:57	6:58
Dnipro	8:15	3:46		10:46	5:24	1:49	15:51	2:52	7:59	6:37	8:32	5:34	10:54	8:13	10:40	7:12	3:38	9:31	5:54
Odesa	7:28	13:44	10:46		13:03	9:56	13:33	7:31	2:33	11:07	16:37	13:03	6:57	8:26	10:20	3:56	10:47	9:07	7:17
Donetsk	13:41	6:41	5:24	13:03		4:24	20:43	8:09	10:33	2:18	3:53	0:28	16:12	9:15	11:41	9:23	8:01	14:24	11:12
Zaporizhzhya	9:08	5:00	1:49	9:56	4:24		17:04	3:44	7:35	5:08	8:04	4:40	11:47	6:36	9:03	6:35	5:00	10:51	6:46
Lviv	7:50	15:17	15:51	13:33	20:43	17:04		15:30	14:36	22:01	21:56	20:57	6:57	20:12	22:06	15:41	12:55	10:14	11:08
Krivij Rig	7:53	6:30	2:52	7:31	8:09	3:44	15:30		5:07	8:45	11:19	8:20	8:50	7:59	9:53	5:00	5:43	9:46	4:54
Mykolaiv	8:00	11:37	7:59	2:33	10:33	7:35	14:36	5:07		8:38	5:53	2:29	16:05	7:19	9:45	7:27	9:23	15:36	11:31
Mariupol	14:18	8:43	6:37	11:07	2:18	5:08	22:01	8:45	8:38		5:53	2:29	16:05	7:19	9:45	7:27	9:23	15:36	11:31
Luhansk	14:12	6:47	8:32	16:37	3:53	8:04	21:56	11:19	14:09	5:53		3:41	18:18	13:03	15:30	13:11	9:09	15:32	13:33
Makijvka	13:14	6:22	5:34	13:03	0:28	4:40	20:57	8:20	10:45	2:29	3:41		16:23	9:26	11:53	9:34	8:10	14:33	11:23
Vinnytsya	4:16	11:43	10:54	6:57	16:12	11:47	6:57	8:50	7:47	16:05	18:18	16:23		13:29	15:23	8:59	9:19	6:38	6:48
Simferopol	13:36	11:06	8:13	8:26	9:15	6:36	20:12	7:59	5:38	7:19	13:03	9:26	13:29		2:52	4:51	11:06	15:38	12:23
Sevastopol	15:23	13:33	10:40	10:20	11:41	9:03	22:06	9:53	7:52	9:45	15:30	11:53	15:23	2:52		6:43	13:20	17:30	14:15
Kherson	9:05	10:52	7:12	3:56	9:23	6:35	15:41	5:00	1:27	7:27	13:11	9:34	8:59	4:51	6:43		10:10	11:04	11:06
Poltava	5:12	2:35	3:38	10:47	8:01	5:00	12:55	5:43	9:11	9:23	9:09	8:10	9:19	11:06	13:20	10:10		6:38	4:39
Chernihiv	2:27	8:57	9:31	9:07	14:24	10:51	10:14	9:46	9:57	15:36	15:32	14:33	6:38	15:38	17:30	11:04	6:38		5:04
Tcherkasy	3:25	6:58	5:54	7:17	11:12	6:46	11:08	4:54	6:50	11:31	13:33	11:23	6:48	12:23	14:15	11:06	4:39	5:04	

The statistical analysis of spending time on moving of cars specifies on the following:

Maximal spending time from Uzgorog to Konstantinivka of 23 h 59 min
 Minimum spending time is from Torez to Snizhne 20min.

Table 4 – Coefficient of rejection *Kвідх* existent network, from optimal for biggest cities of Ukraine
 Таблица 4 – Коэффициент відхилення *Kвідх* існуючої мережі, від оптимальної для найбільших міст України

Cities	Kyiv	Kharkiv	Dnipro	Odesa	Donetsk	Zaporizhzhya	Lviv	Krivij Rig	Mykolaiv	Mariupol	Luhansk	Makijivka	Vinnitsya	Simferopol	Sevastopol	Kherson	Poltava	Chernihiv	Tcherkasy
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Kyiv		1,17	1,15	1,10	1,28	1,16	1,16	1,20	1,20	1,24	1,23	1,31	1,34	1,22	1,31	1,21	1,13	1,11	1,23
Kharkiv	1,17		1,15	1,29	1,27	1,18	1,16	1,17	1,19	1,26	1,22	1,22	1,31	1,13	1,20	1,20	1,10	1,40	1,23
Dnipro	1,15	1,15		1,16	1,25	1,20	1,26	1,04	1,14	1,32	1,20	1,34	1,16	1,16	1,26	1,21	1,53	1,29	1,15
Odesa	1,10	1,29	1,16		1,30	1,52	1,29	1,22	1,20	1,19	1,31	1,34	1,22	1,49	1,81	1,38	1,30	1,09	1,30
Donetsk	1,28	1,27	1,25	1,30		1,15	1,25	1,23	1,33	1,10	1,29	-	1,19	1,24	1,30	1,26	1,38	1,33	1,21
Zaporizhzhya	1,16	1,18	1,20	1,52	1,15		1,25	1,56	1,37	1,37	1,25	1,25	1,22	1,13	1,26	1,23	1,39	1,24	1,19
Lviv	1,16	1,16	1,26	1,29	1,25	1,25		1,15	1,20	1,27	1,21	1,28	1,12	1,22	1,32	1,20	1,16	1,26	1,25
Krivij Rig	1,20	1,17	1,04	1,22	1,23	1,56	1,15		1,22	1,46	1,18	1,37	1,15	1,19	1,30	1,53	1,32	1,29	1,26
Mykolaiv	1,20	1,19	1,14	1,20	1,33	1,37	1,20	1,22		1,17	1,34	1,37	1,18	1,21	1,44	1,18	1,22	1,22	1,15
Mariupol	1,24	1,26	1,32	1,19	1,10	1,37	1,27	1,46	1,17		1,34	1,29	1,29	1,23	1,30	1,11	1,38	1,32	1,28
Luhansk	1,23	1,22	1,20	1,31	1,29	1,25	1,21	1,18	1,34	1,34		1,22	1,37	1,28	1,32	1,29	1,35	1,35	1,35
Makijivka	1,31	1,22	1,34	1,34	-	1,25	1,28	1,37	1,37	6,76	1,22		1,21	1,28	1,34	1,31	1,53	1,40	1,25
Vinnitsya	1,34	1,31	1,16	1,22	1,19	1,22	1,12	1,15	1,18	1,36	1,37	1,21		1,19	1,31	1,17	1,37	1,28	1,31
Simferopol	1,22	1,13	1,16	1,49	1,24	1,13	1,22	1,19	1,21	1,68	1,28	1,28	1,19		1,51	1,20	1,24	1,25	1,23
Sevastopol	1,31	1,20	1,26	1,81	1,30	1,26	1,32	1,30	1,44	1,07	1,32	1,34	1,31	1,51		1,46	1,32	1,31	1,32
Kherson	1,21	1,20	1,21	1,38	1,26	1,23	1,20	1,53	1,18	0,72	1,29	1,31	1,17	1,20	1,46		1,35	1,24	1,20
Poltava	1,13	1,10	1,53	1,30	1,38	1,39	1,16	1,32	1,22	1,58	1,35	1,53	1,37	1,24	1,32	1,35		1,29	1,33
Chernihiv	1,11	1,40	1,29	1,09	1,33	1,24	1,26	1,29	1,22	1,88	1,35	1,40	1,28	1,25	1,31	1,24	1,29		1,28
Tcherkasy	1,23	1,23	1,15	1,30	1,21	1,19	1,25	1,26	1,15	1,21	1,35	1,25	1,31	1,23	1,32	1,20	1,33	1,28	



Figure 5 – Scheme of development highways network

Рисунок 5 – Схема розвитку мережі автомобільних доріг

The rays, forming the system of radial roads, leave the largest cities of Ukraine in different directions.

So away from Kyiv radiated eight directions: 1) Kyiv - Chernobyl' – Pripjat; 2) Kyiv - Desna - Slavutich - Gomel. 3) Kyiv - Kaniv - Smila - Kropivnitsky- Mykolaiv. 4) Kyiv –BilaTserkva -Uman - Blagovischensky–Krive Ozero - Shiraevo– Odesa; 5) Kyiv - Fastiv - Vinnitsya - Zhmerinka - Kam'ianets'-Podil's'kyi - Chernivtsi. 6) Kyiv - Zhytomyr –Staro-Konstantiniv - Terebovlia - Monastirska - Kalush-Chop 7, 8) II direction is considered higher.

Farther necessary development Strategy of development highways network top level with such calculations that distance from a large settlement with a population more than 100 thousand inhabitants to the modern highways from 6 - 8 lines did not exceed a 50 - 70 km.

For example, the coefficient of rejection $K_{відх}$ represents for directions: Chernivtsi - Odesa - 1,65, Lviv - Uzhhorod - 1,45, Ternopil - Ivano-Frankivsk - 1,40, Kherson - Odesa - 1,38, Vinnytsya - Poltava - 1,37, Kyiv - Vinnytsya - 1,34, Kyiv - Ivano-Frankivsk - 1,34, Kyiv - Chernivtsi - 1,28 and ect.

Realization Strategy and Conception must come true by development 4 - five-year or 3 years - seven-year construction plans for highways network. Experience of reconstruction a road Kyiv - Odesa showed that repairs on the route of roads built on Soviet technologies are not rational due to poor quality of the basis, insufficient soil compression and layers of road pavements, the occurrence of weak soils in the bases of embankments, etc.

All points Strategy, Conception and Plans must be concrete, in detail done, to have concrete terms of implementation, have the financial and skilled providing.

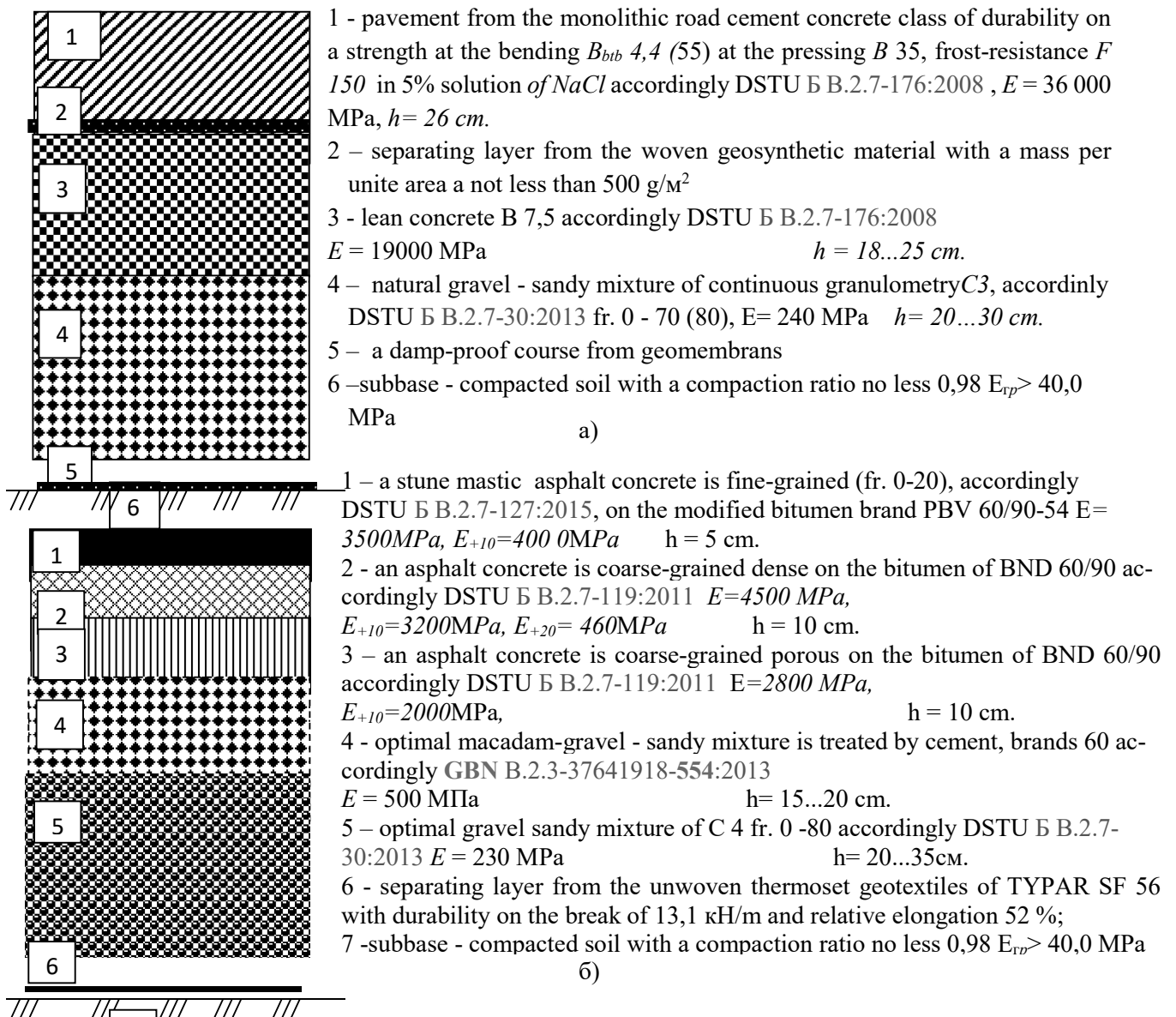


Figure 1 – Recommended construction of rigid (a) and flexible (б) road pavement
 Рисунок 1 – Рекомендовані конструкції жорстких (а) та нежорстких (б) дорожніх одягів

Necessary development of strategy highways network in Ukraine on a prospect 25 – 30 years.

It is suggested to link 95...100 most cities of Ukraine into a single network as combination of the parallel and radial system of network development. It is necessary to build five practically parallel roads in the direction of North - West to South-East (Fig. 5) :

I) The border with Belarus - Ripky, Sivshi. from Chernihiv, Konotop, Southwards from Summy-Kharkiv - Severodonetsk- Luhansk. Length of road I - 708,547 km.

II) On Brest - Kamin - Kashrsky - Sarny-Korosten - Borodianka - Kyiv -Yahotyn - Lubny-Myrhorod - Dykanka - Krasnograd - Lozova- Donetsk. Length of route II is a 1119,968 km.

III) The border with Poland on Holm - Kovel- Lutsk - Rivne -Novograd-Volinsky - Zhytomyr - BilaTserkva-Korsun-Shevchenkovsky - between Smila and Tcherkasy - Kremenchuk- Dnipro - Pokrovske-Mariupol. Length of route III is a 1147,557 km.

IV) Novoyavorivsk- Lviv - to the North Ternopil - Khmelnytskyi-Vinnytsya - Uman - Novoukrainka-South Kropivnitsky-Krivij Rig- Nikopol - Melitopol- Berdiansk. Length of route IV is a 1072,655 km.

V) Old Sambir - SouthDrohobych-Kalush-Ivano-Frankivsk - vil. Zalischiky- Kam'ianets'-Podil'skyi - South Mogilev Podolsk - Korisha - Lubashivka - Nikolaevsk- Kherson - on Skadovsk (Armiansk). Length of route V is a 807,971 km.

VI) Chop - SouthMukachevo-Hust - Rahiv-Verkhovyna - Vizhnitsa- Chernivtsi. Length of route VI is a 289,213 km.

General length is a 4437,364 km.

From Kharkiv, except for 2 directions of the 1st level, 4 directions to the south depart, etc.

Necessary accumulation facilities on building of new roads and bringing investments, but not loans, creation of concession roads and development state - private partnership. Necessary wide discussion in relation to passing routes and their benefit for a population resident in the zone of route highways. It is also required a technical and economic comparison of variants constructions of rigid and non-rigid pavement taking into account charges on building, maintenance and repair on 40 years' summer prospect (rice. 6) with a return on 20 years to Contractor on maintenance and repair. Variants of construction of rigid, non-rigid road pavements at the action of loading 115 кН/axis expected for the project of entrance road to the airport city of Turkmenobad in Turkmenistan brought around to Fig. 6. In the conditions of Ukraine for motion of heavy transport vehicles more the best is a variant of rigid road pavements.

Conclusions. In Ukraine presence own resources, especially, as basic astringent material for preparation concrete, (but not the imported bitumen) requires the revision strategy of development road industry to the necessity building highways from concrete.

For development of road net in Ukraine it is necessary:

- Development Conception of long-term development highways network (with a prospect on 25 – 30 years).
- Link land Ukraine in one state system with a network of modern highways.
- Length of new modern highways must present a not less than 10 thousand km.
- Highways must not pass on existent routes (there must be an alternative passage for speed roads).
- Establishment Strategy of development highways network, that distance from a large settlement with a population more than 50 - 100 thousand inhab. to the modern highways with 6 ... 8 stripes of motion did not exceed a 70 - 75 km.
- Strategies and Conceptions must be development on 4 - five - year or 3 – 7 years plans for the construction highways network.
- Modern highways must be built with cement-concrete coverage.
- It is necessary to define criteria that allow attributing the concrete projects of bilateral and multilateral collaboration to initiative «One belt - one way» public, scientists and economists, and to the participants in a project to the countries - to develop the general plan of actions on the basis of the declared principles, mechanisms and priorities.

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ПЕРСПЕКТИВИ РОЗБУДОВИ МЕРЕЖІ ШВИДКІСНИХ АВТОМАГІСТРАЛЕЙ В УКРАЇНІ

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Анотація. Виконано аналіз розвитку мережі автомобільних доріг загального користування в Україні, а також запропоновано стратегію розвитку мережі швидкісних автомагістралей України на перспективу 25 ... 30 років на основі визначення мінімальних та фактичних відстаней між найбільшими містами України. Для порівняння наведено аналіз мережі автомобільних доріг в розвинутих країнах (США, Великобританія, Франція Німеччина). Запропоновано методику розрахунку та визначення показників прямої відстані між містами України за їх GPS координатами, визначені мінімальні сферичні відстані, мінімальні швидкості руху автомобілів та час затрачений на переміщення автомобілів між найбільшими містами України. Встановлені чотири групи факторів (законодавчі, фінансові, управлінські та виробничі), що стримують розвиток мережі автомобільних доріг загального користування. За результатами техніко – економічного порівняння рекомендовано влаштовувати покриття швидкісних автомобільних доріг із цементобетону.

Ключові слова: автомобільні дороги, розбудова мережі, напрями, фактори, стратегія, швидкісні автомагістралі.

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