

Innovative Solutions for the Spatial Organization of the Road Network in the Republic of Sakha

Borisov A.I.

North-Eastern Federal University
Yakutsk, Russia
tbbai@mail.ru

Pesterev A.P.

North-Eastern Federal University
Yakutsk, Russia
pesterev.a@mail.ru

Arkhipov E.P.

North-Eastern Federal University
Yakutsk, Russia

Kardashevskaja E.G.

North-Eastern Federal University
Yakutsk, Russia

Andreev D.V.

North-Eastern Federal University
Yakutsk, Russia
verviL@List.ru

Poiseeva S.I.

North-Eastern Federal University
Yakutsk, Russia

Gabyshev I.N.

North-Eastern Federal University
Yakutsk, Russia

Nikolaeva V.M.

North-Eastern Federal University
Yakutsk, Russia

Abstract – The Republic of Sakha (Yakutia), compared with the other regions of our state, is currently considered to be poorly studied in terms of introducing innovative solutions for the spatial organization of the road network. Today's financial constraints and the geographical location of the Republic of Sakha (Yakutia) exclude the formation of transport infrastructure in the planned terms with the required quality without introducing innovative solutions. In this article, innovations are considered not as an end in themselves, but as a means of improving the efficiency of the road network. Innovation policy in the development of the road network is not a one-time campaign, but the very essence of the modernization of the republic's economy, therefore, innovation activity is impossible without the use of high production technologies and management of the economic complex, without the involvement of management personnel and production personnel of high qualification and moral qualities.

Keywords – Republic of Sakha (Yakutia); innovative solutions; roads.

I. INTRODUCTION

The Republic of Sakha (Yakutia) is a classic raw material province: its economy is based on a variety of minerals with stable export demand, and living conditions are among the least favorable in Eurasia, which requires enormous expenses for maintaining the livelihoods of existing settlements and does not contribute to the emergence of new ones.

At the moment, the length of public roads is 36.9 thousand km., of which with a hard surface - 11.7 thousand km. The density of public roads per 1 sq. km: RS (Y) - 2.6 km., Far Eastern Federal District - 6 km., The Russian Federation - 36.8 km. [1]

Over the past year, the leadership has been updated in Yakutia, including the head, the prime minister and a number of ministers, as well as the mayor of the capital. Together with the new team, the innovation-technological and scientific-educational intention in the transport sector, unexpected for such an economic structure, has increased. It is fully reflected in the new development strategy of the RS (Y) until 2032, approved by the head of the republic Aisen Nikolaev at the end of 2018.

The Republic of Sakha (Yakutia), following the example of the advanced countries, intends to invest its raw materials revenues in breakthrough technologies in the development of the road network.

II. METHODS AND MATERIALS

The transportation problem is the second most acute after the cold for the republic, which has the largest area among all RF constituents and a poorly developed road network: less than 10% of the territory (16% of the republic's population) is available all year round, 92% of roads are operated during certain seasons, have low payload and bandwidth. One of the most protracted projects in this area is the bridge of two bridges - automobile and railway across the r. Lena.

The republic's leadership is actively breaking through the project implementation in parts: for example, in December last year, the construction of an automobile bridge was discussed at the Federal Road Agency with the participation of potential investors - the company PowerChina International Group Ltd, ready to participate in the project on concession terms. Chinese experts have estimated the cost of the bridge at 104 billion

rubles, which is almost twice the 2008 estimate. The bridge, as conceived by the Strategy developers, will not only reduce the cost of shipping products to Yakutsk, but will also become the main link in the so-called Northern Latitudinal Belt, a transport corridor from Irkutsk to Magadan, which connects Eastern Siberia with the ports of the Okhotsk Sea. [3]

There are difficulties with the construction of high-quality roads, as qualified contractors prefer areas with less severe construction conditions and lower cost, for example, the Khabarovsk Territory. In general, the field of automobile construction is considered promising for innovative development (including for their digitalization), and Yakutia can be considered as a natural testing ground for testing advanced technological solutions in low temperature conditions.

Today's financial constraints and the geographical location of these regions preclude the creation of transport infrastructure here within the planned time frame with the required quality without innovation. In this article, innovations are considered not as an end in themselves, but as a means of improving the efficiency of highways.

Innovations are extremely slowly implemented, not only in the construction and operation of transport routes. This is the problem of the entire Russian economy. An analysis of the literature on innovation in the construction and operation of highways demonstrates an underestimation of the economic approach to innovation in this area. Monitoring for 2015–2016 shows that the absolute majority of the proposed technical innovations are not evaluated from the standpoint of economic efficiency and road construction and operation from the standpoint of economic efficiency are analyzed very little. [1]

The importance of direct cooperation between builders and scientists is also explained by the uniqueness of each innovation – scientists, developers of innovations should receive a feasibility study for a technical solution from the business. This will create conditions for the development of such solutions, which will require smaller investments, and not only, as now, increase technical efficiency or, at best, reduce the current costs of operating and repairing the highway. The ultimate goal of cooperation of scientists of all directions should be the formation of proposals for innovations. Along with the solution of current technical and economic problems, new products should be offered, not only satisfying modern social needs, but also forming promising ones. An ideal system should be such a unity of specialists of various directions, in which new products and services are offered to business, allowing to form a new demand.

Scientists who are developing innovations in the field of road construction are faced with such a serious problem as the lack of sites for pilot-scale testing of modern materials, experimental testing of new technologies, and progressive technology. Without them, it is impossible to complete Research and Advanced Development, which dramatically increases the risk of obtaining low-quality scientific research, which can be detected during testing at the site. However, the creation of such a landfill is effective only when a certain amount of research and development is achieved, and moreover in a wide area of research in the field of road network organization. [4]

According to its concept, the innovative development of the transport system is important for the implementation of the transport strategy. The scientific and technical policy of the transport industry involves the development of science, innovative technologies and training systems in all areas, encouraging the development and implementation of innovative technologies for construction, reconstruction and maintenance of transport infrastructure, etc. Accelerated implementation of innovative solutions should be ensured by various measures: organizational, economic, legal, etc. In this regard, it seems that modern Russian legislation does not fully use legal leverage to accelerate the introduction of innovative solutions and advanced technologies in the road sector. Various legal tools can be used, formulated as a result of scientific research aimed at accelerating innovation processes.

To extend the life of the road surface, increase the coefficient of adhesion of wheels of motor vehicles to the road surface, for the past five years, the technology of rough surface treatment has been successfully applied, where fiberglass is used as a reinforcing component.

The use of innovative technologies and materials allows road builders to keep up with the times, thereby improving the transport performance of the road, increasing its service life and turnaround time. The use of geosynthetic material based on BentIzol sodium bentonite during the overhaul of the A-360 “Lena” section of the road protects pollutants from penetration into the soil and groundwater during construction; the material has a low water permeability and high chemical resistance; it can withstand an unlimited number of freeze-thaw and hydration-dehydration cycles.

The use of a chemical (glue bonded) anchor Hilti HIT (glue composition - Hilti HIT-RE 500) during the repair of a bridge over the Aldan River allows the installation of studs and large diameter fittings due to the low speed of solidification of the composition. Also, the advantages of using this innovation are the absence of tension in concrete, the possibility of using it in wet holes, water-saturated concrete and under water. Simple packaging allows for quick and easy assembly. The use of Superstreet LED luminaires in the restoration of artificial lighting on the road section is an increase in service life, light weight, large luminous flux, energy saving, and overvoltage resistance. [6]

The federal highway M-56 “Lena”, which currently has no alternative, has important socio-economic and strategic importance both for the republic and for the country as a whole, and the main task is to make it as comfortable and safe as possible.

Strategically, the republic, along with the whole of Russia, has embarked on the path of innovative development, effective management of the economic complex and budget, the path of mastering new competitive technologies and products. Let us not forget that the modernization of the production forces is based on the development of transport as a nutrient system of the economy of the region as a whole. [1]

Today, a full-fledged regional innovation system is being formed in the republic - the Yakutia Technopark has been created, an agreement has been signed with the Skolkovo

Innovation Center, and the fixed capital of the Yakutia venture company has been increased to 800 million rubles. [3]

The innovation course covers all directions and all types of the economy of the Republic of Sakha (Yakutia), first of all its infrastructure part is transport. Here, the main innovative content and the main task is the transition of the transport system from seasonal types of transport to year-round.

The Fund for Infrastructure and Educational Programs (FIEP) and the Federal Road Agency (Rosavtodor) signed an agreement on cooperation in the implementation, application and development of innovations, including nanotechnologies, in the construction of roads and road infrastructure in the Republic of Sakha (Yakutia) and in the Russian Federation.

The load on the axle of vehicles that carry cargo on our roads is increasing, traffic intensity is increasing every year - in order to ensure the normal service life of road structures under such conditions it is necessary to actively introduce new technical solutions and innovative materials. On this basis, a set of technical measures has been approved aimed at increasing the service life of roads with an improved type of coating up to 12 years. Innovations will also make it possible to accomplish the task of bringing all the federal highways of the country to a regulatory state by the end of 2019.

Russian nanoindustry already produces a number of innovative products that can be used for the construction of roads and road infrastructure - from pavement components to intelligent security systems and controls. The goal of cooperation with Rosavtodor is to accelerate the introduction of technologies and solutions in order to ultimately make the Russian roads durable and reliable.

In accordance with the agreement, FIEP and Rosavtodor will coordinate actions on the introduction of innovations and the use of nanotechnologies in the construction and reconstruction of highways, jointly prepare proposals for improving the regulatory framework in this area.

FIEP and Rosavtodor can create scientific and technical councils and working groups that will develop recommendations for the introduction of innovative technologies.

The parties will also cooperate in the areas of technical regulation and the introduction of scientific and technical developments, stimulate the demand for nanoproducts, develop training programs.

It is worth noting that the Ministry of Transport and Road Management of the Republic of Sakha (Yakutia) has developed strategic directions for the development of the transport complex. It was determined that the strategic goal is the transport system, which will ensure the competitive development of basic and new industries, comfortable living conditions, communication freedom and transport mobility of the population.

To fulfill this goal, the following strategic objectives are solved: [7]

- Formation of an all-season transport network with access to a single transport network of the country;

- Ensuring the availability and quality of transport services for the population;
- Realization of the transit potential of Yakutia;
- Provision of modern vehicles for cargo and passenger transportation, especially in hard-to-reach areas of the republic;
- Reducing the harmful effects of transport on the environment and increasing safety to world standards.

To perform the above tasks, it was determined that by 2030 it is necessary to carry out:

- Construction of bridges across the Lena River near the city of Yakutsk, across the Aldan River on the Kolyma highway and a number of bridges on the Vilyui highway
- Construction and reconstruction of federal highways "Lena", "Kolyma" and "Vilyuy";
- Construction of regional motor roads "Amga" with access to the Khabarovsk Territory with the further transfer of "Kobiai", "Umnas", "Abalakh", "Aldan", "Bethune" to federal ownership;
- Ensuring year-round transport accessibility of settlements, where there is no connection on paved roads with the network of public roads of the republic and the country as a whole.

Until 2050, the following activities were identified: [7]

- Construction of highways "Anabar", "Yana", "Arctic", "Indigir" as strategic roads of the Arctic;
- Construction of the highway "Arktika" with access to the Chukotka Autonomous Region with further transfer to federal ownership;
- Construction of highways "Lensk - Peledui", "Tommot - Belkachi - Ust-Mil";
- Reconstruction of the road "Amga" in the sections "Nizhny Bestiakh - Amga", "Eldikan- Iugorenok".

The effect of the implementation of these activities will be:

- reducing the cost of importing resources for the needs of the republic;
- acceleration of the strategic economic development of the adjacent populated areas of the republic;
- reducing the level of economic and social imbalances between Arctic and central Yakutia;
- increase in transport mobility of the population;
- reducing the cost of the consumer basket;
- increase the turnover of goods and access to new markets and sales;
- development of small and medium-sized businesses, domestic tourism;
- development of the Northern Sea Route.

Further, it is worthwhile to demonstrate in Figure 1 an increase in the year-round transport accessibility of the territory of the Republic of Sakha (Yakutia) in accordance with the

Strategy of Social and Economic Development of the Republic of Sakha (Yakutia) until 2030 with the definition of the main directions until 2050. [3]

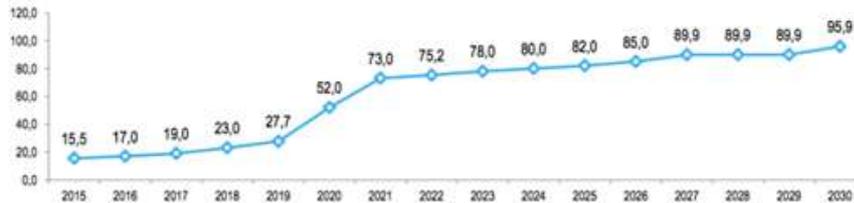


Fig. 1. Proportion of population with year-round transport activities

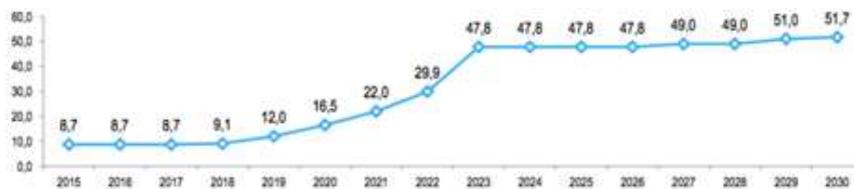


Fig. 2. Increasing the year-round transport accessibility of the territory of the Republic of Sakha (Yakutia)

Figure 2 demonstrates an increase in the year-round transport accessibility of the territory of the Republic of Sakha (Yakutia).

Therefore, it is necessary to conclude that the Sakha Republic (Yakutia) has serious strategic plans for the innovative development of the spatial organization of the Sakha Republic (Yakutia) highway network. It is necessary to work out in detail all the necessary measures so that the strategic measures are implemented in reality.

III. RESULTS

Thus, the expected results of the development of innovative solutions for the spatial organization of the highway network of the Republic of Sakha (Yakutia) until 2030 are:

- The share of the population that has year-round transport accessibility is 91.3 percent;
- The share of rural settlements that are connected by paved roads with a network of public roads is 61.2 percent;
- Improving the quality of roads;
- Growth in passenger turnover by 1.5 times compared to the level of 2017 (4,600.4 million passenger-km against 3,098.7 million passenger-km)
- Growth of transit traffic by 3 times;
- Improving the reliability of vehicles.

IV. CONCLUSION

The innovative development of the spatial organization of the network of highways of the Russian Federation remains an

urgent task of science and production. This also applies to the road sector, which provides for the construction and modernization of the country's road infrastructure.

With constant underfunding of the road sector in the Republic of Sakha (Yakutia), the problem of effective use of modern and innovative technologies and materials in the road sector comes to the fore, the solution of which will significantly improve the quality of Russian roads and save budget funds allocated for road construction.

The introduction of innovative technologies in the road sector presupposes the corresponding development of personnel potential: advanced training of designers, engineers and specialists in the application of new materials, equipment and technologies, mastering the methodology of innovative activity.

References

- [1] Roads, no. 1–12, 2013; no. 1–11, 2014.
- [2] V.V. Alekseenko, V.B. Balabanov, "Asphalt concrete based on bitumen-rubber composite binders for road construction", The Bulletin of ISTU, no. 12, pp. 112–114, 2011.
- [3] Roads. Innovation, no. 22, 2012; no. 34–37, 2014.
- [4] A.N. Zedgenizova, A.S. Antipin, P.V. Khazuraev, "Evaluation of the correlation between correspondences of different types of road use", The Bulletin of ISTU, no. 5, pp. 111–116, 2013.
- [5] I.F. Kostiaev, A.S. Merkulov, O.G. Terekhova, "Political economy as a unity of positive and normative economic sciences", The Bulletin of ISTU, no. 5, pp. 173–177, 2013.
- [6] K.V. Mogilny, S.L. Mamulat, "On rationing, technical control and innovation in the production and use of bitumen binders", Roads innovation in construction, no. 35, 2014.
- [7] Order of the Government of the Russian Federation no. 1734-p of November 22, 2008, "On the Transport Strategy of the Russian Federation". Moscow: Collection of Legislation of the Russian Federation, no. 50, pp. 59–77, 2008.

- [8] United States Code. Title 23, Highways.
- [9] Directive 2004/18/EC of the European Parliament of 31 March 2004 on the coordination of procedures for the award of public works contracts, public supply contracts and public service contracts.
- [10] F.C.M. Wegran, M. Slop, "Safety Effects of Road Design Standards in Europe", International Symposium on Highway Geometric Design Practices, Boston, Institute for Road Safety Research, 1995.