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Ensuring environmental safety during the construction and operation of tunnels in residential areas

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Abstract

In recent years the rate of construction of transport tunnels and metro tunnels has increased in Russia. The geography of their facilities covers almost the entire territory of our country, including megalopolises with dense building system.

The construction and operation of all types of tunnels are associated with the negative impact of technological processes on the environment.

This article describes the differences of negative impact features of the tunnel construction comparing to the impact from construction of facilities on the surface. The factors affecting the level of negative impact are shown. Some results of environmental impact assessment and ecological monitoring are given.

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1. Introduction

In the contemporary megalopolises, the subway is one of the main means of transport with a unit of traffic of 40-50%. The increasing of areas of cities results in both raise of population and increasing of people's trip time to their

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work, cultural or trading centers. All this leads to the necessity of developing the existing underground lines with new stations opening in residential districts as well as constructing new underground lines.

Table 1. World megalopolises underground characteristics.

City, country	Year of opening	Last development	Number of lines	Length of lines (km)	Number of stations	Human traffic a year/a day (mln people)
London, Great Britain	1863	2008	11	402	270	1340 / 4,8
New York, the USA	1868	2017	36	380	472	1763 / 5,7
Paris, France	1900	2013	16	214	303	1527 / 4,2
Berlin, Germany	1902	2009	10	152	173	493,3 / 1,4
Madrid, Spain	1919	2015	13	293	289	569,7 / 1,6
Tokyo, Japan	1927	2008	13	310	285	3217 / 8,8
Moscow, Russia	1935	2016	12	339	203	2385 / 6,5
Saint-Petersburg, Russia	1955	2015	5	114	67	741,8 / 2,0
Pekin, China	1969	2015	18	527	343	3209 / 10,2
Singapore, Singapore	1987	2015	5	170	102	1050 / 2,9

2. Material and methods

According to “The Concept of Development of the Underground and other means of rapid transit in Saint-Petersburg for the period up to year 2020” up to year 2020 the exploited length of the underground lines will increase by 25.8 km and will be 139.4 km. 13 new stations will be brought into use. The following existing underground lines will be developed: Line 3 (Nevsko-Vasileostrovskaya) from “Primorskaya” station to “Ulitsa Savushkina” station including “Novokrestovskaya” station; Line 4 (Pravoberezhnaya) from “Spasskaya” station to “Bolshoi prospect” station including “Teatralnaya” station; Frunzenskiy radius of Line 5 (Frunzensko-Primorskaya) from “Mezhdunarodnaya” station to “Yuzhnaya” station including “Prospekt Slavy” and “Dunayskiy prospekt” stations. Line 6 (Krasnoselsko-Kalininskaya) will be brought into use as a part of a launch system from “Obvodniy kanal-2” station to “Yugo-Zapadnaya” station. Two electro engine houses will be brought into use to provide work of the underground lines – “Yuzhnoe” and “Krasnoselskoe” [1].

Meanwhile, construction of underground stations and tunnels and their subsequent exploitation are associated with negative impact of industrial processes on the environment.

2.1. Features of negative impact of the tunnel construction

The distinguishing features of this impact in comparison with construction of objects on the surface are:

- simultaneous operations on and under the surface which influences all the elements of the biosphere: the atmosphere, the earth, the surface and the subterranean waters, the flora and the fauna, the population;
- use of different technologies for tunnel constructions and surface complexes: hand mining of the first coat, tunnel boring machines (TBM), tunneling machines, digging of the first coat, drilling and piling works and concrete works;
- use of a wide range of building machines and mechanisms;
- meaningful duration of works reaching up to five-year period with temporary changing of degrees of negative impact.

Periods of construction and exploitation of the underground are characterized by a combination of different negative factors influencing the condition of the environment (Fig.1).

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