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Construction of deep foundation ditch under a reconstructed multi-storey building on the main avenue of St.Petersburg

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Abstract

The reconstruction of the former administrative building of the beginning of the 19th century in the center of St. Petersburg on the main avenue and adaptation it to the modern Hotel is considered. The new 6-storey building is done as a concrete frame with max height 27,7 m. The underground floor 66,9 x 20,09 m for parking and technical rooms is planned under the whole area of the building. The 4-5 storey brick block of flats and 3-5 storey administrative building, the historical memorial, adjoin to the building under the reconstruction. The adjacent buildings have cracks and defects due to general wear, rigidity decrease of the building and low deformation characteristics of the soil. The soft water saturated soil under the basement become thixotropic under insignificant dynamic effect (transport, seasonal freezing and etc). Prior to dissembling the building it was done the monitoring of the adjacent buildings and the reinforcement of their foundations using the method of injecting cement grout into foundation and erecting 75 tilted anchor piles 25 m long, 200 mm diameter according to "Titan" Technology. The protection walls of the excavated pit for underground space in the reconstructed building was done by metal sheet pile "Arselor 37-700"13,5 m long, boring piles 27m long and diameter 410 mm. Additionally jet-grouting piles were erected to the depth min 2 meters from the footing of the existed foundation along the break walls of the adjacent buildings. While excavating the pit in order to provide the sheet pile stability, the strut from metal pipes was done. In order to make pile base under the frame of the building 162 bore piles 27 m long and diameter 550 mm were used. The piles were made according to the Drilling Displacement System (DDS) technology. Scheme of constructive decisions are given. The monitoring during the foundation construction and the beginning of the upper part construction showed that the additional settlement of the adjacent buildings did not exceed 20 mm, the limited allowance for this type of the building.

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1. Introduction

Being reconstructed as a hotel in the central part of Saint Petersburg (a corner of the Fontanka Embankment and Nevsky Prospekt - main avenue of the City), the former administrative building is a 6-storey building with the cast-in-situ reinforced concrete frame 24,0 m high with the maximum height of 27,7 m. The building was damaged by the direct hit of an aerial bomb (Figure 1, a).

Underneath the entire hotel building, an underground floor with an area of 66,9 x 20,1 m in plan view is provided to

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accommodate a car parking lot and technical rooms. The foundations of the building are borrowed piles 410 and 550 mm in diameter constructed by the DDS soil compaction technology using the Bauer drilling equipment (RG 25S).
Directly adjacent to the building under construction on the Fontanka Embankment, there is the 4-5-storey residential brick building (No.40) that has cracks in the structural walls (build. 40). On the other side, Building No. 70 in Nevsky Prospekt is adjacent to the reconstruction site - House of Journalists - Petersburg Merchant Society - House of I.O. Sukhozanet - a historical and architectural heritage building, which is 3- 4 -5-storey administrative building with the load-bearing longitudinal and cross walls (Figure 1 b).

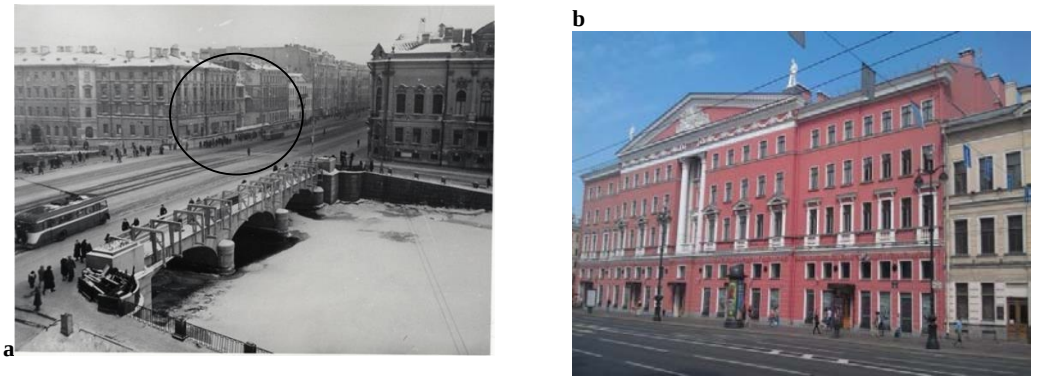

Fig.1.View of Building 68, Nevsky Prospekt.(a) before reconstruction in 1944; (b) after reconstruction in 2012

The building was constructed in 1826-1830, major repairs were done in 1946-50. The building foundations are strip rubble-stone or brick foundations on a natural bed 1,1 and 1,5 m deep from the bed surface. A hold-down slab and a protecting wall are made in the basement. The building walls are made of red solid brick on lime mortar. The external walls are 810 mm thick; the internal ones are 580 to 640 mm thick.
In the course of an engineering survey of the House of Journalists, multiple defects and damages were found out in the bearing structures. The external walls are characterized by a lot of inclined and vertical cracks in the interfenestral bands, window piers and lintels. The crack development has the overall nature, with the crack opening width reaching 15 mm. There are throughwall cracks with the opening as wide as 6 mm.
For the buildings of this category, the maximum limit of additional settlement is 20 mm, additional skewing is 0,001 and additional inclination is 0,002, while the permissible foundation vibration acceleration shall not be higher than 0, 15 m/s^2 during the reconstruction TSN 50-302-2004 [1].
The causes of the crack growth on the building facades and walls (cracks existed before the construction has been started) may be general deterioration, reduced rigidity of the entire building, low deformation properties of the foundation soils. The soils of this type are susceptible to the thixotropic changes when exposed to minor dynamic impact (in particular, transport traffic, seasonal frosting, etc.).

2.Soil conditions on construction site

In accordance with the completed engineering and geological survey, the following soil stratification was identified on the Construction Site [2] (Figure 2).
In the top part of the bed, technogenic deposits (tg IV) occur that are represented by man-made filled-up formations. A thickness of the technogenic deposits is up to 3,2 m. Beneath it, there are lacustrine-and-marine deposits (ml IV) that are represented by sand and silty clay formations: water-saturated grey silty sands, yellow and grey low-plastic silty sandy loam with bands of sand and silty high-plastic loam. The total thickness of these deposits is 4.1 to 9.0 m.
They are underlain by glacial deposits (lg III) in the form of banded and stratified, flow and very soft loams and low-plastic silty sandy loam with bands of sand. A thickness of these deposits is 3,4 to 10.2 m.
It should be noted that the recent lacustrine-and-marine deposits (ml IV) and glacial deposits (lg III) are thixotropic soils with a tendency for the transformation into the flow state when exposed to dynamic action and for the deterioration of the strength and deformation properties.
Under these soils, there are glacial deposits (g III), lacustrine-and-glacial deposits (lg II), glacial deposits (g II) that are represented by low-plastic arenaceous sandy loams with bands of sand and gravel, as well as by semi-hard loams with inclusions of gravel and individual boulders. The total thickness of these deposits is 7,8 to 20 m.