FOUNDATIONS SETTLEMENTS OF THE NEVSKAYA WALL ENCLOSURE
FOR THE SUMMER GARDEN IN SAINT PETERSBURG

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Vibration that develops during the passage of heavy vehicles has been the basic cause of foundations settlements. Strengthening of the foundation beds by grouting is an effective means of curtailing settlements.

Construction of the wall enclosure for the Summer Garden was closely related to work performed on the building of the granite embankment of the Neva River, which were begun in 1763 [1]. Prior to installation of the embankment, the garden was close the river bank. The fill soil beneath the currently existing embankment near the Summer Garden is 50 m wide.

Construction on the wall enclosure for the Summer Garden was begun in 1774. It extends from the Fontanka River to the Lebyazh'ya Canal for a distance of more than 230 m, and consists of granite posts-columns and wrought-iron sheet members with ornamental decorations. Architect Yu. M. Fel'ten authored the design of the wall enclosure. The structure is classed among the masterpieces of Russian classicism of the 18th century. The largest repairs to the lattice were made in 1866-1867, and in the 1950s.

According to pitting data (investigations conducted by the Leningrad Civil-Engineering Institute and the Scientific-Production Union Rand Saint Petersburg), a strip foundation (Fig. 1) built of rubble concrete, and, according to all appearances, is a continuous strip, lies beneath the Nevskaya wall enclosure for the Summer Garden below the daylight surface of the ground. Three rows of wooden piles with an interrow spacing of 0.65 m, an interpile spacing of 0.8 m in a row, and a pile diameter of 25-30 cm were driven in alternating order into the foundation bed. A grillage formed from wooden beams (ground braces) were placed in two mutually perpendicular directions along the ends of the piles. The ground braces are fastened at their points of intersection by metallic cleats. The space between the ground braces is filled with broken brick and stone in a limestone grout. The height of the foundation masonry is 2.30 m, and the height of the grillage 0.4 m. In the absolute Baltic system (BS), the elevation of the embedment depth of the foundation is +0.10 m.

According to data of geologic-engineering surveys, the course of the wall enclosure is represented by the following soil stratifications to a depth of 8 m.

An upper layer of fill 2.8-3.5 m thick. The fill soils are nonuniform in terms of composition and are primarily coarse-grain sands with gravel, granite fragments, and construction refuse.

Post-glacial coarse-grain sands of medium density, which are saturated below absolute elevation -0.000 m, are exposed below. The thickness of this layer fluctuates from 2.2 to 2.9 m. According to survey data, the density of the solid particles \( \rho_s = 2.66 \text{ tons/m}^3 \), the density of the soil \( \rho_d = 1.91 \text{ tons/m}^3 \), the void ratio \( e = 0.50 \), and the normalized angle of internal friction \( \varphi_n = 37^\circ \).
Post-glacial sandy loams of plastic consistency with the following characteristics are encountered beneath the sands: \( \rho_s = 2.69 \text{ tons/m}^3 \), \( \rho_w = 1.91 \text{ tons/m}^3 \), moisture content \( w = 26\% \), liquid limit \( I_L = 0.471 \), \( e = 0.793 \), \( \varphi_s = 18^\circ \), and the normalized cohesion \( c_n = 8.1 \text{ kPa} \).

The hydrogeologic conditions along the run of the wall enclosure confirmed the existence of a pressure-free ground-water horizon, the surface of which lies at a depth of 2.7-3.2 m. The ground water is supplied by infiltration of atmospheric precipitation and is directly associated with the water level in the Neva River. According to multiyear observations, constant fluctuations of the water level in the Neva occur, disregarding pile-up-induced flooding. The average minimum water level in the river is \(-0.50\), and the maximum \(+1.60\) m with an average water-surface elevation of \(+0.50\) m. Thus, the wooden grillage and upper portion of the piles function within the limits of a variable ground-water table.

Results of inspections of the wooden piles in pits opened by the Leningrad Civil-Engineering Institute in 1970 and the Scientific-Production Union Rand in 1996 indicated that the grillage beams and the upper ends of the piles have rotted away, and the cavities that have formed to date are not completely filled with soil. Partial scouring of the bed soil from the rotted piles has occurred in sections where the pile heads have failed.

Figure 2 shows the longitudinal profile of the granite socle of the wall enclosure based on data derived from leveling performed by specialists of the Scientific-Production Union Rand in 1997. The current settle-