CONSTRUCTION OF A NEW DISTRICT IN TOGLIATTI ON SLUMP-PRONE SOILS

N. A. Dykhovichnaya and V. I. Krutov

Editor's Note. The design and construction of bases and foundations of buildings and structures of the new district of Togliatti (known as Stavropol' unit 1964) on slump-prone loess soils were carried out by the Central Scientific-Research and Planning Institute of Standard and Experimental Designing of Housing (TsNIIEPzhhilishcha) and the Kuibyshev Hydroelectric Station Construction Administration (Kuibyshevgridrostroi) in close collaboration with the Research Institute of Bases and Underground Structure (NII Osnovani). NII Osnovani conducted, if necessary, additional investigations of the soils and tests of the effectiveness of constructing various types of bases and foundations and gave technical aid in choosing the most rational types and designs of bases and foundations with consideration of local soil conditions, in mastering methods of compacting slump-prone soils, in checking the quality of the works, and in solving other technical problems. The creative collaboration of TsNIIEPzhhilishcha and Kuibyshevgridrostroi with NII Osnovani, which has been continuing for more than eight years, made it possible to use in constructing the new district of Togliatti the most rational types of bases and foundations, to introduce successfully the latest scientific and technical developments, and to solve promptly all problems that arose during design and construction. Publishing the article of N. A. Dykhovichnaya (TsNIIEPzhhilishcha), chief project engineer of the new district of Togliatti, and V. I. Krutov (NII Osnovani), director of the laboratory of construction on slump-prone soils, which describes the successful example of the creative collaboration of scientific, design, and industrial organizations, the editor of the journal considers that the experience of such collaboration deserves wide dissemination.

Construction of the new district in Togliatti for 250,000 inhabitants began in 1966 in the free territory located on the bank of the Kuibyshev reservoir on the fourth floodplain terrace of the Volga and called for the construction of an entire complex of buildings and structures necessary for a modern city (Fig. 1). This complex included 5-, 9-, and 16-story large-panel and brick apartment buildings, 20-story monolithic concrete apartment buildings, 1-4-story general service buildings (kindergarten nurseries, schools, stores, restaurants, etc.), sports buildings, cultural structures, medical centers with a height of 2-9 stories, etc. As a consequence of the great diversity of the types of buildings the loads on the strip foundations varied from 100 to 2000 kN/m and on the foundations of the columns of frame buildings from 400 to 4000 kN.

The construction site is characterized by a relatively flat relief with the presence of saucer-shaped depressions having a diameter of 2-8 m and depth of 1 m. The soils of the site are composed of loess-like loams up to 15-24 m thick with interlayers of sandy loams and of lenses and pockets of fine sand occurring under the 0.9-1.8-m-thick top soil and which are underlain by fine sands.

The groundwaters occur at a depth of 19-24 m, are confined to Khazarian [Middle Pleistocene] deposits, and are connected hydraulically with waters of the Kuibyshev reservoir.

The loess-like loams are silty, carbonaceous, with a dry unit weight of 1.45-1.60 tons/m³ to a depth of 10 m and 1.53-1.7 tons/m³ below 10 m. Their natural water content in the upper part of the layer to a depth


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of 4 m is usually 0.07-0.16 and deeper, 0.12-0.18. At places of the saucer-shaped depressions the soil water content at depths of 4-8 m increases to 0.18-0.27. The water content of the loams at the liquid limit is 0.23-0.32 and at the plastic limit 0.16-0.18; the plasticity index is 0.07-0.15. The modulus of deformation of the loams according to the results of their tests by plates \( F = 0.5 \text{ m}^2 \) at a moisture content of 0.14-0.16 is \( E = 36-60 \text{ MPa} \) and at a moisture content of 0.17-0.22 \( E = 10-15 \text{ MPa} \).

The loess-like loams to a depth of 10-12 m from the surface have slump properties. Their relative slump proneness at a soil pressure of 0.3 MPa varies from 0.005 to 0.10 and at the natural pressure from the soil's own weight from 0.002 to 0.02. The calculated slump from the soil's own weight is 1-9 cm according to the results of laboratory tests. On the basis of this the entire site was relegated in the engineering-geological test reports to type II soil conditions with respect to slump proneness.

However, on the basis of analyzing the engineering-geological conditions, change of the physical and mechanical characteristics of the soils with depth, and results of testing soils in other districts with similar geological conditions, NII Osnovanii recommended assigning the construction site to type I soil conditions with respect to slump proneness. Subsequent experimental flooding of pits in two areas with maximum slump proneness of the soils confirmed completely their correspondence to type I soil conditions.

Refinement of the type of slump-prone soil conditions in the territory being built up made it possible to avoid additional expenditures of at least 15-20 million rubles in constructing the new district of Togliatti.

On the basis of a technico-economic analysis of different variants of providing strength and normal operation of buildings of the new district of Togliatti with consideration of the characteristics of the engineering-geological conditions of the new territory being built up and construction capabilities of Kuibyshevgidrostroi and other factors, the construction of all buildings was accomplished with complete elimination of slumping of the soils in the bases of foundations. Since the loess-like loams belonged to type I soil conditions, for complete elimination of slumping of the soils it was sufficient to compact them within the zone deformed by the foundation load. On the basis of this and with consideration of the design of the buildings, their number of stories and loads on the foundations, three main methods of compacting the slump-prone soils were used:

1) Surface compaction by heavy tampers to a depth of 2-2.5 m for buildings up to five stories high.

2) Two-layer compaction to a depth of 3.5-4 m, including compaction with heavy tampers to a depth of 2-2.5 m and placement of a soil blanket 1.5-2 m thick for buildings 6-9 stories high.

3) Deep compaction within the entire slump-prone stratum by means of soil piles with additional compaction of the buffer layer with heavy tampers for buildings more than nine stories high and for frame buildings more than 4-5 stories high and other buildings especially sensitive to nonuniform deformations of the bases.

Strip, monolithic, or precast-monolithic foundations were used for buildings with bearing walls up to 9-12 stories high. Reinforced-concrete bands were usually constructed in the foundation bed and in the upper part of foundations in buildings sensitive to nonuniform deformations of the bases.