DEVELOPMENT AND MONITORING OF TECHNICAL SOLUTIONS AND PRODUCTION REGULATION OF OVERPASS CONSTRUCTION IN URBAN SETTINGS

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UDC 624.21.037:625.712

Geotechnical solutions adopted for the suspended concreting of overpasses on the Businovsk Beltway in Moscow are cited in this paper as an example of an individual approach to this production process with allowance for possible deformations of the earth bed and observations of these deformations.

Preliminary geologic-engineering inspection of a construction segment of an overpass (replacement of an existing structure) on the Businovsk Beltway indicated that the earth bed is composed of a layer of fill soil to 1.0-1.5 m, which is underlain by a layer of weak clayey soils to 5 m. The State Institute for Bridge Construction and the Smolensk Bridge-Building Company turned to the State Highway Scientific-Research Institute to develop appropriate solutions with allowance for bed deformations during the suspended concreting of the span structures of this overpass.

By design, the span structures should be concreted in four longitudinal sections on supporting structures (the two extreme spans) and on temporary supports (the two middle spans) so as not to curtail vehicular traffic beneath the overpass. The supporting structures and temporary supports beneath the first and second section are placed on the natural uncompacted bed; the third and fourth sections are on compacted soil.

Additional geologic-engineering inspection of the earth bed of the overpass was carried out by a branch of the State Administration for Highway Planning and Design. The surveys in question made it possible to compile a more complete geologic-engineering curve of the construction segment. The stratum consists of clayey soils ranging from semi-hard to slightly plastic in consistency to a depth of 5-6 m. The soils are nonuniform with respect to composition and state; the layers are nonuniform with respect to thickness in both the longitudinal and transverse directions. The in-situ moisture content \( W_{\text{in}} \) varies from 20 to 30%; the relative moisture content \( W_{\text{rel}} = W_{\text{in}} / W_{\text{prod}} \) ranges from 0.8 to 1.4; and, the density of the soil varies from 1.8 to 2.0 g/cm\(^3\). The composition, state, and properties of the bed soils for the overpass on the Businovsk Beltway are analyzed in detail in [1].

The compressibility coefficient of the soils sampled from predefined design layers was determined in the Earth Dam and Geotechnics Laboratory of the State Highway Scientific-Research Institute for prediction of possible deformations (during the concreting and cure of the concrete). Compression and consolidation tests were conducted in conformity with GOST 12248-96, and also with consideration given to the conditions under which the soil performed during the construction: consolidating loads and their application regime; and, the drainage and removal of pore water. The loads acting on the earth bed due to all supporting structures \( P_1 \) and temporary supports \( P_2 \) during the suspended concreting were determined by specialists of the State Adminis-
tation for Highway Planning and Design. According to the scheme that they adopted, \( P_1 = 0.03 \) MPa and \( P_2 = 0.1 \) MPa.

Analysis of the compression tests indicated that the settlement modulus \( e \) for the soils with a slightly plastic consistency is 43.5 mm/m when \( P_1 = 0.03 \) MPa, and \( e = 50 \) mm/m when \( P_2 = 0.1 \) MPa. Analysis of the consolidation tests indicated that curves of the form \( \lambda = f(\log t) \) (where \( \lambda \) is the relative deformation, and \( t \) is time) for two identical specimens with different drainage conditions are essentially parallel, and do not have a clearly expressed point of inflection in the majority of cases (for a certain initial state and loading). The similar pattern of the curves reflects the consolidation process, the rate of which is governed primarily by the creep of the soil skeleton, and not by the filtration of pore water.

Since it was necessary to estimate the rate of bed settlement in the first two weeks of the concrete cure, consolidation curves were also plotted in the form \( u = f(t_1(t_{con})) \), where \( u \) is the degree of consolidation, \( t_1 \) is the current time, and \( t_{con} \) is the ending time corresponding to attainment of the required settlement rate, to improve the computational accuracy of settlement over time in the initial period of consolidation. This plot makes it possible to reduce the effect of test inaccuracies both at the time of load application, and in the initial period of consolidation.

In the computational scheme for settlement prediction, we took into account the design loads, drainage conditions, the thickness of the active zone, the dimensions of the load band, and the design layers of the bed, as well as the final settlement of the bed, which were determined by the method of summing layer settlements in accordance with the formula

\[
S = \sum_{i=1}^{n} L_{pt_i} H_i,
\]

where \( L_{pt_i} \) is the settlement modulus corresponding to the design load, \( H_i \) is the thickness of the layers, and \( n \) is the number of layers.

The settlement of the earth bed in the segment containing the first and second concreting sections was \( S_n = 5.7 \) cm under the supporting structures, and \( S_o = 13.9 \) cm under the temporary supports, while \( S_n = 4.9 \) cm and \( S_o = 11.2 \) cm, respectively, in the segment that includes the third and fourth sections.

N. N. Maslov’s exponential relationship, which we defined more precisely as a result of investigation of the consolidation pattern of the soils that were tested, was used to predict the time required to attain some settlement \( S_0 \) or degree of consolidation \( U_r \). As we know, the consolidation index “\( n \)” is a parameter reflecting the influence exerted on the rate of settlement not only by the filtration, but also the viscosity characteristics of the soil. Our investigations indicated that for clayey soils with a consistency index \( B \) of less than 0.5-0.6, it is more expedient to determine the value of “\( n \)” from N. N. Maslov’s diagram as a function of soil consistency, and not by calculation from the consolidation curve. Here, a distinct relationship is traced between the deformation characteristics of the clayey soils and their consistency. Results of analysis of a large number of experiments confirmed the possibility of determining “\( n \)” on the basis of the soil’s consistency. In determining “\( n \)” from a plot of the initial consolidation index, as is called for in the existing procedure, however, the effect of the load on the consolidation process is disregarded. In this connection, the index “\( n \)” was determined for the average soil consistency between the initial \( B_{in} \) and final \( B_{fin} \) corresponding to the stabilized condition during consolidation under the design load \( P_{des} \). In this case, the exponential relationship assumes the new form

\[
T_n = f\left[t_n \left(\frac{H_i}{n_f}\right)^{n_{eq}}\right],
\]