In connection with requirements of Construction Rules and Regulations [1], the probability of manifestation of the slump-type settlement of a soil mass is currently determined by means of its wetting via trenches. Sand-filled weep holes, which accelerate the ingress of water to the soil mass, are occasionally established in the bottom of the trench. Moreover, the slump-type settlement of the surface, which develops during wetting of the entire mass of loess soils, is determined.

Two types of soil conditions relative to the proneness to slump-type settlement of construction sites composed primarily of loess soils are adopted in current standards. Soil masses composed of loess soils, which can be characterized by a slump-type settlement of less than 5 cm and more than 5 cm during wetting, are referred to as first and second types, respectively.

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The load on bed soils due to utility networks and soil-reclamation canals is usually less than 0.02 MPa, basic deformations developing in the beds are determined only by consolidation deformations when the mass of the overlying stratum is wetted (natural or in-situ pressure). For the majority of utilities, all methods of bed preparation can be proposed as a function of slump-type settlement under the in-situ pressure.

For the majority of reinforced-concrete and ceramic pipes, as well as pipes formed from polymeric materials connected by rubber or polymeric rings, stable operational serviceability is ensured for maximum slump-type settlements to 5 cm. If, however, the soils are characterized by the second type of slump-type settlements, and slump-type settlement of the utility pipes exceed 5 cm, it is necessary to implement additional measures to ensure the long-term operational serviceability of these connections.

Recommendations for defining the type of soil areas with respect to proneness to slump-type settlement contain instructions for the wetting of trenches by fresh water. As our research, which was conducted in 1992-1996, indicates, slump-type deformations, which differ in terms of magnitude from those determined during wetting by fresh water, develop, in fact, during the wetting of loess bed soils by aqueous acidic or alkaline solutions.

It is demonstrated that existing methods used to determine the proneness of soils to slump-type settlement in accordance with effective Construction Rule and Regulation 2.02.01-83* predict slump-type settlement well in analyzing utility networks and reclamation systems on soils prone to slump-type settlement. This Construction Rule and Regulation is, however, unsuitable for analysis of the slump-type settlement of soils in the foundation beds of industrial and public structures, since errors of up to 60% are permitted in determining deformations.

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This division of soil masses in terms of proneness to slump-type settlement is the basis for the design and laying of utility networks (water supply, heating ducts, water disposal, industrial pipelines, etc.), and also soil-reclamation canals. Since the load on bed soils due to utility networks and soil-reclamation canals is usually less than 0.02 MPa, basic deformations developing in the beds are determined only by consolidation deformations when the mass of the overlying stratum is wetted (natural or in-situ pressure). For the majority of utilities, all methods of bed preparation can be proposed as a function of slump-type settlement under the in-situ pressure.

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Since utility flows and industrial solutions transported through corresponding pipelines differ from fresh water in terms of chemical composition, it is necessary to consider their effect on loess bed soils prone to slump-type settlement. A number of cases are known where breaks in the continuity of utility pipes and deformations of industrial structures situated alongside develop as a result of emergency failure of industrial pipelines laid in soils of the first type with respect to proneness to slump-type settlement.

Thus, slump-type settlements of up to 26 cm in the columns of industrial shops and 14-22-cm settlements of the floor of a shop were observed at a chemical plant in Armyansk (Crimea) when an industrial pipeline situated at a depth of 1.3 m failed. After removal of the pipes, it was established that maximum slump-type settlement of the pipe amounted to 46 cm near the breach. The role of the industrial solution was the discharge of a 5% solution of sulfuric acid.

According to data derived from geologic-engineering surveys, the plant site is classed among the first type with respect to proneness to slump-type settlement, and the thickness of the soils prone to slump-type settlement is 6-7 m.

This suggests that in designing deep utility and industrial pipelines, it is expedient to conduct experimental wetting of trenches with appropriate flows and solutions, which may gain ingress to the foundation bed during emergencies, and after this, establish the type of soil conditions at the construction site in terms of proneness to slump-type settlement.

In Norm and Technical Specification 137-56 [2], which was compiled by Yu. M. Abelev, it was proposed to determine the coefficient of relative proneness to slump-type settlement $\delta_{sl,i}$ for a pressure $p = 0.3$ MPa without regard to the dependence on the effective actual (in-situ) pressure, and to sum the $\delta_{sl,i}$ values to the layer of soil with $\delta_{sl,i} \leq 0.02$ when calculating the conditional proneness to slump-type settlement $\Delta_{sl}$, i.e., the slump-type settlement due to the weight of the soil itself. The category of a soil’s proneness to slump-type settlement was assigned as a function of $\Delta_{sl}$: 1) if $\Delta_{sl} \leq 15$ cm; 2) $\Delta_{sl} = 16$-50 cm; and, 3) $\Delta_{sl} > 50$ cm.

Measures for the installation of artificial beds (compaction by heavy tampers, installation of soil cushions and soil piles, preliminary wetting of soils, etc.), as well as to ensure normal service of the structure in question under large settlements/slump-type settlement (reinforced-concrete foundation slabs, ceiling collars, sectioning of the building by settlement joints, etc.) were assigned as a function of soil category.

The method used to determine $\delta_{sl,i}$ for $p = 0.3$ MPa gave rise to objections in designing soil-reclamation systems, pipelines, and other lightweight structures, especially in regions of Central Asia, where villages were constructed with one-two-story residential buildings in the foundation beds of which strata of soils highly prone to slump-type settlement occurred at a depth to 30-40 m. An unsuccessful solution was adopted to change the established practice of investigating loess soils for industrial and public structures, and not to issue supplements to the Construction Rules and Regulations regarding the design of low-rise buildings and irrigation systems, but to change them as a whole.

In the Construction Rules and Regulations [3], it was recommended to determine $\delta_{sl,i}$ for the actual pressure in the soil layer under consideration, and to sum layer-by-layer the $\delta_{sl}$ for all soil layers for which $\delta_{sl} \geq 0.01$. For determination of $\Delta_{sl}$, it was recommended to introduce a working-condition factor $m = 2$ within the limits of a stratum with a height of $1.5b$, which is directly adjacent to a foundation with a width $b$, and $m = 1.5$ for the entire underlying stratum, i.e., in calculating the slump-type settlements of soils under their own weight, the expected slump-type settlement of the stratum should be increased by a factor of 1.5.

According to recommendations of the Construction Rules and Regulations [3], it is possible to install more economic beds and foundations for low-rise and soil-reclamation structures on thick strata of loess soils prone to slump-type settlement. Observations of slump-type settlements of the foundations of residential and public buildings of more than five stories and heavy-duty industrial structures have indicated, however, that actual slump-type settlements are frequently 30-60% higher than the computed settlements when the soils in the foundation bed are subject to long-term wetting.

It should be pointed out that the computed slump-type settlement of bed soils cannot be compared with the actual settlement when the structure is in service. The computed slump-type settlement may be manifested only in cases where a very small amount of water percolates into the soil, and wetting takes place over an extended period.