ERECTION OF COLUMNAR SUBSTRUCTURES IN DEPRESSIONS OBTAINED BY TAMPING OF SAGGING GROUNDS

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The SibZNIIEP (Siberian Zonal Electric Transmission Institute) and NII Osnovanii (Institute for Foundation Research), in cooperation with the KPD-I (Large-Panel Building) Trust and Kemerovo Orgtekstroil (State Institute for Industrial Construction), have developed a new way of erecting columnar substructures in tamped out depressions in clearings with type 1 ground conditions. The gist of it is that a surface area cleared of sod and loose soil, with an elevation usually corresponding to that of the lower floor surface, is tamped down with a percussion tamper 1 (Fig. 1a) to the required depth, to form a depression with a bottom diameter of 1.0-1.5 m. Its depth is that of the substructure (0.6-1.5 m).

A compact zone with a density of 1.55-1.85 ton/m³ is formed in the floor of the depression. The loess ground within it is not subject to sagging; it is stronger and less compressible. This zone is surrounded by that of inadequate compaction, with a density varying from 1.55 ton/m³ to the natural, and characterized by lesser sagging capability and a higher strength.

A sectional substructure shoe is installed in the depression, or else reinforced concrete is poured in (Fig. 1b). Then the column support is installed (Fig. 1c).

The tamping accomplishes two tasks: it digs the pit and compacts the sag-prone loess ground. The tamping is done with an excavator-crane with a special guiding attachment 2 (Fig. 1a) which ensures a vertical drop of the tamper to a strictly predetermined point.

The tamper is a truncated cone with a height H = 1.0-1.5 m, beveled downward at 1/20-1/15 slope, to the lower diameter of 1.0-1.5 m. The specific static pressure of the ground, q = 0.35-0.40 kg/cm². A total of 20-25 impacts at the same point, from a height of 5-7 m, are necessary to form a pit 1.5 m deep in West Siberian grounds; the operation takes 5-8 min. The initial experiment has demonstrated one such excavator digs 25-40 pits to a work shift.

From NII Osnovanii specifications for tamping 1.3-m-diameter pits, the EKB (Experimental Design Bureau) worked out a special attachment suspended to the S-100 tractor; it will do away with the use of excavators.

Studies carried out in Kemerovo and Novosibirsk on the dimensions of the compacted zone and on density distribution within it (Fig. 2) have shown that the thickness of the compacted zone in tamping to at least 0.6-0.8 m is H = (1.1-1.2)d, and its maximum diameter at the floor of the pit, D = 1.5d (where d is the pit floor diameter). The boundary of the adequate compaction is drawn on loess density of 1.55 g/cm³ (as against the natural figure of 1.38-1.42 ton/cm³) at which the compacted grounds are no longer sagging (δ_sag < 0.01 at p = 2.0-3.0 kg/cm²).

The strength of columnar substructures erected in pits tamped out in sagging grounds was tested on construction landings in Novosibirsk and Kemerovo. The usual procedure was to test at the same point the strength and sagging of 1.1-1.5-m-diameter substructures on natural foundations and in pits tamped out in sagging grounds, at the natural moisture content and water-saturated. In some instances, reinforced concrete piles were driven in to test the obtained results.

The results of testing the driven piles and columnar substructures in constructing a market center in the Kirovsk district of Novosibirsk are illustrated in Fig. 3. The ground, down to 5.2 m, is sag-prone loess-like sandy loam with a natural moisture content of 11-15% and 47-48% porosity. This is underlain by virtually non-sagging loams (δ_sag = 0.005-0.01), 2-m-thick, with a 17-19% moisture content and 47% porosity; these in turn are underlain by non-sagging loess-like loams.

Figure 3 shows that the critical load for the 30 × 30-cm reinforced-concrete pile drive to 5.4 m is \( P_{cr} = 30 \) tons and \( P_{cr} = 15 \) tons, correspondingly, with the natural moisture content and with water saturation. The critical figure was not attained for the columnar substructure, in either instance; it exceeds, correspondingly, 120 and 80 tons.

The experimentally obtained deformation modulus for compacted loess-like grounds with a natural moisture content and a load as high as 80 tons is 470 kg/cm², and 265 kg/cm² for a 120-ton load. The figures for water-saturated grounds are 200 kg/cm² for the 60-ton load and 137 kg/cm² for the 90-ton load. These figures indicate a relatively low compressibility for the compacted loess-like ground, either water-saturated or with a natural moisture content.

As an interesting point, sagging at the initial loading stages is virtually the same for both the columnar substructures and piles, regardless of the moisture content.

Behavior of columnar substructures set up in pits tamped out in sagging grounds in the course of a protracted wetting (for several months) was studied on substructures set up in four corners of a 3.2 × 5.8-m rectangle. The substructures were surmounted with a network of steel girders supporting a 320-ton load, i.e., 80 tons on each corner. The results of one such experiment, in Novosibirsk, are illustrated in Fig. 4. The experimental ground has the following characteristics: \( \gamma_{sp} = 2.70-2.73; \gamma_0 = 1.63-1.75; \gamma_{sh} = 1.38-1.42; \ W_s = 13-14; G = 0.52-0.74; n = 47-49; \ v = 0.908-0.978; \) relative sagging varies from 0.003-0.005 to 0.03, at a pressure of 1-3 kg/cm².