EARTH-SLAG PADS IN PUNCHED TRENCHES

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A method of construction of punched (tamped-out) earth-slag pads (PESP), based on the trench-punching method, is described. The examine the results of investigations and experience with use of PESP for construction of industrial and residential buildings in Lipetsk are examined. Recommendations about the fields of PESP application and design are given.

Punched (tamped-out) earth-slag pads (PESP) are based on the trench-punching method developed at the VNIIOSP Institute [1-3] and are a modification of the so-called punched earth pads [4, 5], constructed in relatively weak clayey, collapsible, and noncollapsible soils (for the purpose of increasing the strength and reducing the compressibility of the bases of buildings and structures) when industrial slag refuse is available. In addition to the VNIIOSP Institute, the PESP method was worked out with the participation of the organizations which enter into the "Lipetskstroii" Association — the TsNIL, the "Orgtekstroii," "Lipetskstroii," "Spetsstroii," and "Promstroii" trusts, as well as the Lipetsk Polytechnic Institute and the Lipetsk Branch of the VNIIOSP Institute.

The PESP construction method includes (Fig. 1): punching of the treches at the specified distances; tamping, in their bases, of hard granular material (in this case slag) in a volume of 2-8 m³, and filling of the trenches, as a rule with the same material, applying compaction.

A PESP consists of relatively hard "reinforcing" elements — punched trenches with slag and intermediate portions with compacted earth. The distances between the trenches (on the axes) are usually established as 2-4 rammer diameters, or in a first approximation 2-4 m, so that the compacted zones are overlapped. The PESP thickness, determined as the sum of the trench depth \( d_p \), the thickness of the widening of tamped slag under the trenches \( h_{br} \), and the thickness of the compacted layer \( h_s \) (see Fig. 1) is 4-10 m depending on the rammer height and the tamped slag volume.

All the technical operations for PESP construction are performed by means of mounted equipment (on excavators or cranes) used for construction of the foundations in the punched trenches — rammers 3-5 m high, 0.9-1.2 m in diameter in the middle section, 5-20 tons in mass, and dropped along the guide rod from a height of 5-10 m.

The PESP method was investigated and applied in place of foundations for preparation of the bases of four construction installations in Lipetsk: the furnace section of mill "2500" of the Novolipetsk Metallurgical Combine, a warehouse for universal production at the "Limeks-85" plant, a nine-story brick building on Oktyabr'skaya Street, and five-story large-panel building on Frunze-Oktyabr'skaya Street (sites Nos. 1-4, respectively).

The construction-site soils consist basically of ordinary loams of hard- and soft-plastic consistency, practically water-saturated (degrees of saturation \( S_r = 0.8-0.9 \)), with a natural water content \( w = 0.22-0.3 \), a plastic limit \( w_p = 0.16-0.23 \), a liquid limit \( w_l = 0.27-0.34 \), a unit weight \( \rho = 1.82-1.90 \) tons/m³, a dry density \( \rho_d = 1.40-1.52 \) tons/m³, and a modulus of deformation \( E = 7-10 \) MPa.

For the PESP construction at the test sites and directly in the bases of the structures, trench punching was carried out by means of a 3-m high elongated rammer, 0.8 m in diameter at the bottom (above the tip) and 1.2 m in diameter at the top. The rammer was dropped from a height of 6-8 m along a shaped guide rod by means of an RDK-25 crane. The trenches

Fig. 1. Pads in punched trenches: 1) rammer for trench-punching; 2) punched trench; 3) widening using tamped hard material (rubble, gravel, slag, etc); 4) filling of trench with hard material; 5) compacted zone of soil; 6) compacted buffer layer.

Fig. 2. Plan arrangement of PESP elements and test foundations. I, II, III, a, b, IV) At sites Nos. 1, 2, 3 (2 portions), and 4, tests Nos. 1-5, respectively. 1) Punched trenches filled with slag; 2) test foundations.

were punched a depth of 2.7-2.8 m, and furnace slag of fraction 20-70 mm was subsequently tamped in their bases in a volume of 2-2.5 m³, a total of 2-3 rammer blows being applied to compact it. For the entire process, 20-30 blows were required.

At the construction sites, investigations were carried out to determine the optimal regime of trench punching, of slag tamping, and of execution of tests on PESP fragments under vertical static loading on test foundations. The PESP fragments consisted of "standard" portions of the designed bases of the above-mentioned projects. The plan distribution of the test foundations was of square dimensions 2.1 × 2.1 m and 1.8 × 1.8 m in plan (at sites Nos. 1 and 2) and of rectangular dimensions 1.5 × 2.4 m (Nos. 3 and 4), as shown in Fig. 2.

The foundations were loaded with cast-iron elements 10-20 tons in mass or with reinforced concrete foundation blocks 2 tons in mass, which were placed on a metal loading platform in 3-7 stages (with conventional settlement stabilization) to a maximum pressure of 0.29-0.42 MPa on the foundation underside. From Fig. 3, which presents graphs of the relation between the settlements s and the pressure p, it follows that:

1. The graphs s = f(p) over the entire pressure interval are rectangular, that is, the bearing capacity of the foundations for the transmitted loads and foundation underside pressures is not exhausted.