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# Geotechnical Practice of Strengthening the Foundation Base of a Three-Storey Administrative Building

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Reconstruction of facilities often involves a change in the structural scheme of the building, in connection with which a significant increase in external loads under the existing load-bearing elements is possible. In addition, it is possible to create additional load-bearing structures with correspondingly new foundations. There is an urgent need to increase the load-bearing capacity of the foundation foundations. The arrangement of bored injection piles of reinforcement, arranged according to geotechnical electric discharge technology (ERT piles), is the most acceptable for conditions of especially cramped conditions.

**Keywords:** geotechnical construction, electrohydraulics, monolithic reinforced concrete grillage, bored injection piles ERT, especially cramped geotechnical conditions.

**Introduction**

Reconstruction of facilities always faces technical and technological problems [1-7] associated with the choice of a technically expedient and economically effective method of strengthening building structures. This is of particular relevance for the purpose of strengthening the foundations [8-18]. The article under consideration discusses the case of strengthening the foundation base of a three-storey public building under reconstruction. As a rule, the initial documents for the development of project documentation are [1-7, 8-18].

a) Conclusion on the results of the engineering and technical inspection of the building

b) Technical report on the results of engineering and geological surveys for the preparation of project documentation.

In the engineering-geological structure of the investigated area, in the process of drilling, experimental and laboratory studies of these surveys up to the explored depth of 15.0 m, the following were identified (from top to bottom): Upper Quaternary formations of problematic genesis (prQIII) and Middle Quaternary eluvial-deluvial formations (edQII), overlain from above by technogenic soils. From the surface to a depth of 3.20 m, man-made deposits were exposed throughout the site, represented by brown loam, with the inclusion of small construction debris and soil with a road structure in the roof. At a depth of 2.0-3.2 m (79.11 – 80.62 m) there

are Upper Quaternary formations of problematic genesis (prQIII), represented by loess-like, light-brown, grayish-brown, ferruginous sandy loams, with humus points in the roof, with calcareous ties, with gray inclusions, with a thickness of 8.7 m to 10.6 m. Middle Quaternary eluvial-deluvial formations (edQII) exposed under the Upper Quaternary formations of problematic genesis from a depth of 11.70 – 12.60 m (abs. elevation 68.51 – 71.95 m) are represented by brownish-brown, ferruginous, sandy loams, with the inclusion of bedrock (red clay, marl, sand, limestone, etc.).

Based on the analysis of drilling, pilot and laboratory materials in accordance with the standards of the Russian Federation GOST 25100-2020 and GOST 20522-2012 in the section of the studied area, three engineering and geological elements were identified (see Fig. 1): 1. Light sandy loam, hard-plastic loam (tQIV); 2. Sandy loams are sandy, plastic, non-subsiding (prQIII); 3. Loams are light, sandy, semi-hard (edQII). For the period of engineering and geological surveys (August, 2023), the hydrogeological conditions of the work site are characterized by the absence of groundwater within the drilling depth of up to 15.0 m. During spring floods, heavy rainfall, as well as in case of accidental leaks from water-bearing utilities and runoff of surface water from asphalt surfaces, it is possible to form a local surface water horizon of the “verkhovodka” type at a depth of water-bearing communications - 2.0 m. In accordance with the requirements of Appendix “E” of the Code of Rules SP 22.13330.2016 Updated Edition of SNiP 2.02.01-83\* “Foundations of Buildings and Structures”, the value of the maximum additional deformation of the foundation base for single-storey and multi-storey frameless buildings with walls made of brick or large blocks without reinforcement should not exceed 2 cm in a limited operable technical condition of the structure.

Inclined piles of solid cross-section with a drilling diameter of 150 mm, reinforced to the full height with spatial reinforcement cages; Accepted pile markings: SR-17-15 (length 17 m, drill diameter 150 mm), SR-16-15 (length 16 m, drill diameter 150 mm), SR-15-15 (length 15 m, drill diameter 150 mm), SR-14-15 (length 14 m, drill diameter 150 mm); Embedding the pile top into a prefabricated reinforced concrete foundation of at least 1000 mm. In the detailed design, special requirements have been developed and adopted to improve the requirements for the installation of ERT bored injection piles: 1. For ERT bored injection piles, use self-compacting fine-grained concrete mixtures of strength class B25, waterproof grades not lower than W8 in accordance with GOST 26633-91, prepared at the construction site or at specialized concrete plants. 2. The concrete mixture must meet the requirements of GOST 7473-94; 3. Workability of concrete mixture P4... P5, tested by AZNII cone; 4. Water separation of fine-grained concrete mixture should not exceed 2%; 5. The concrete mixture should not have inclusions of crushed stone and gravel with a size of more than 10 mm; 6. For concrete mixtures, use Portland cement without mineral additives with a strength grade of at least M500; 7. Quartz sand serves as an aggregate for concrete. It is allowed to use clean fine sands with a fineness modulus of at least 1.7; 8. The following additives may be used in the manufacture of piles: superplasticizers, hardening

accelerators, setting retardants, corrosion inhibitors and antifreeze additives; 9. Tap and technical water for concrete mix, free of sugars and phenols of more than 10 mg/l, petroleum products and fats. Hydrogen index (pH) from 4 to 12.5; 10. It is forbidden to add water to the fine-grained concrete mixture to increase its mobility; 11. Selection of the composition of the concrete mixture with the determination of the composition and amount of additives is carried out by the construction laboratory; 12. Reinforcement of piles is provided for the entire length and is carried out in separate sections of spatial welded frames. Connect these frames to each other by overlapping with the use of binding wire with a diameter of 1.5-2.0 mm; 13. Reinforcement with a diameter of 12 mm of A500C class was adopted as longitudinal bars of the spatial frame. Transverse reinforcement made of reinforcement with a diameter of 8 mm of A240 class. Protective layer of concrete not less than 30 mm; 14. The rigidity of the spatial frame is provided by steel rings made of pipes with a diameter of 54 mm and a wall thickness of at least 3 mm; 15. To provide a protective layer of concrete, centralizers made of steel strips with a width of 20 mm and a thickness of 4 mm are provided in the amount of at least 5 in one cross-section of the reinforcement cage with a step along the length of the frame of no more than 1.5 m; 16. Manual arc welding of spatial frame elements is carried out with electrodes of E42A, E46A, E50A types; 17. It is forbidden to use reinforcement made of 35GS steel for the manufacture of welded frames.

The technological sequence for the manufacture of bored injection piles ERT (RIT, FORST, ERST) includes the following technological operations: 1. Formation of a well of the required depth and diameter by auger drilling; 2. Injection of fine-grained concrete mixture into the borehole; 3. Electric discharge treatment of a well filled with concrete mixture; 4. Installation of spatial frames with their simultaneous docking with each other; 5. Maintenance of the concrete head. In addition, special technical and technological measures have been developed to facilitate the manufacture of bored injection piles ERT: 1. When installing ERT piles, the next well should be arranged at least 2.0 m from the previous one. Drilling of wells next to previously manufactured piles is allowed only after at least 48 hours after the completion of concreting of the latter. 2. Prior to the commencement of work, the protective zones of existing underground and overhead communications, as well as underground structures, shall be indicated with the indication of the protective zone established in accordance with clause 3.22 of SNiP 3.02.01-87 “Earthworks, Bases and Foundations”. 3. In case of detection of underground structures, communications or signs designating them not specified in the working design, the work shall be suspended, representatives of the customer and organizations operating the discovered communications shall be summoned to the place of work, and measures shall be taken to protect the discovered underground devices from damage. It is allowed for the customer to remove existing communications from the work area with the written permission of the operating organizations (Figures 1 & 2).

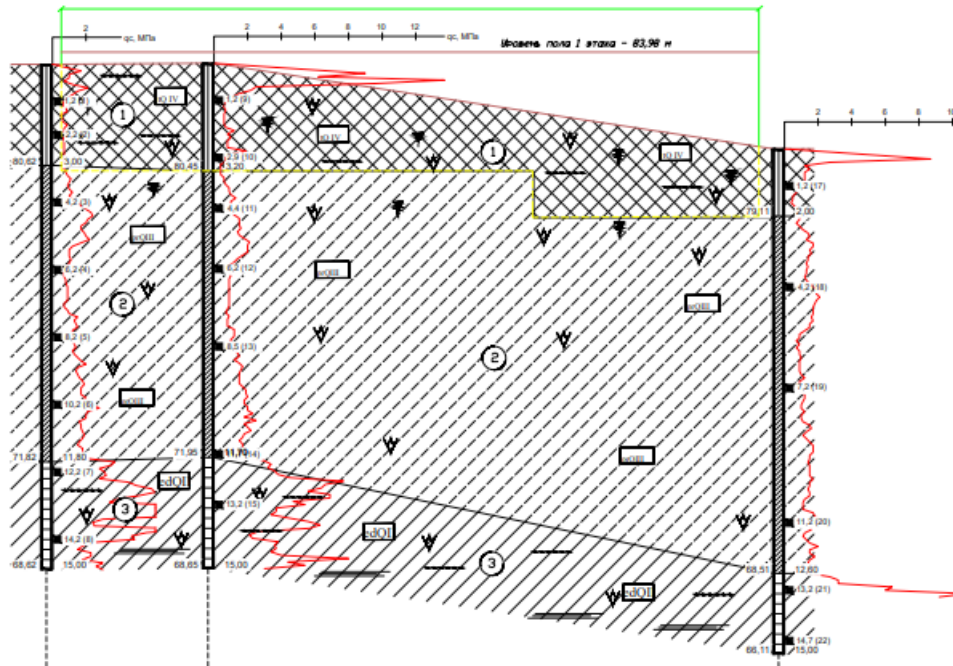


Figure 1: Geotechnical section.

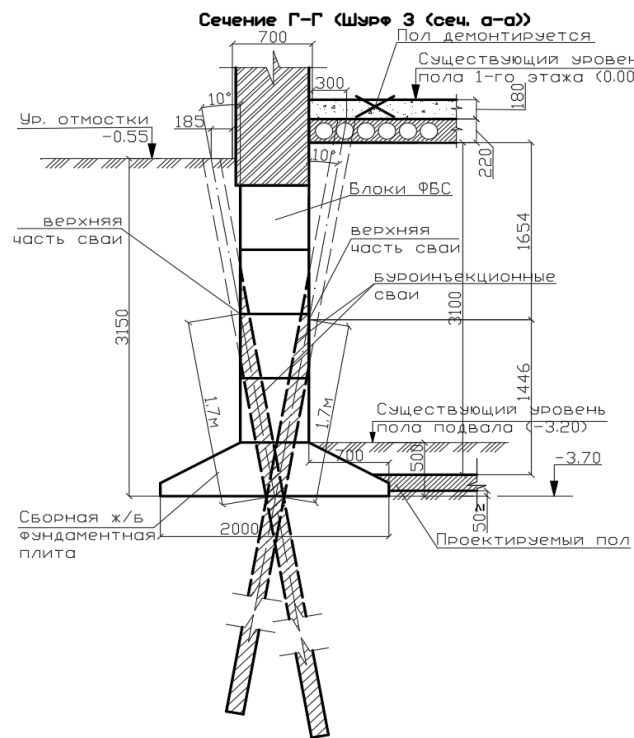
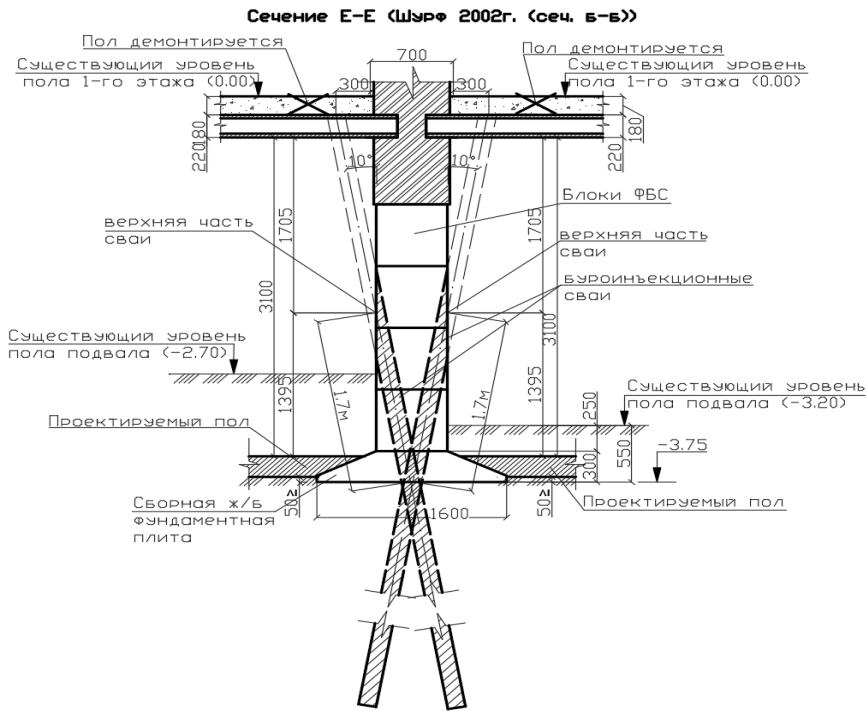
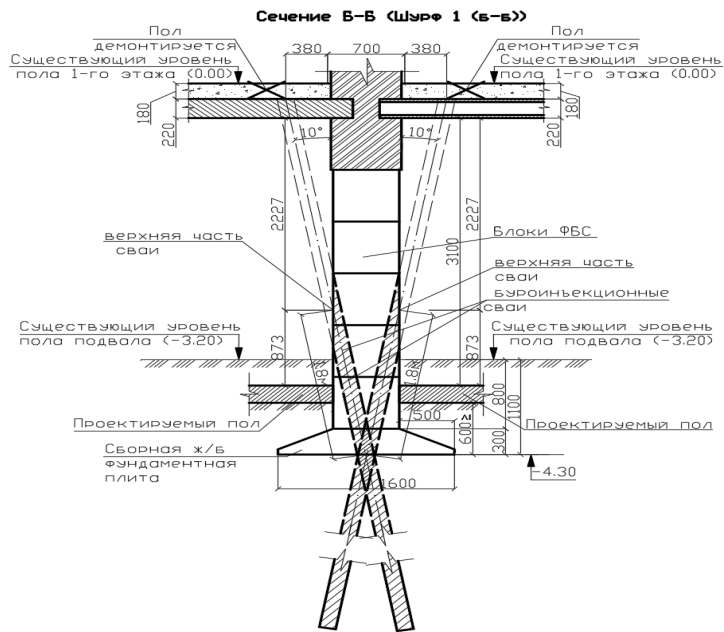


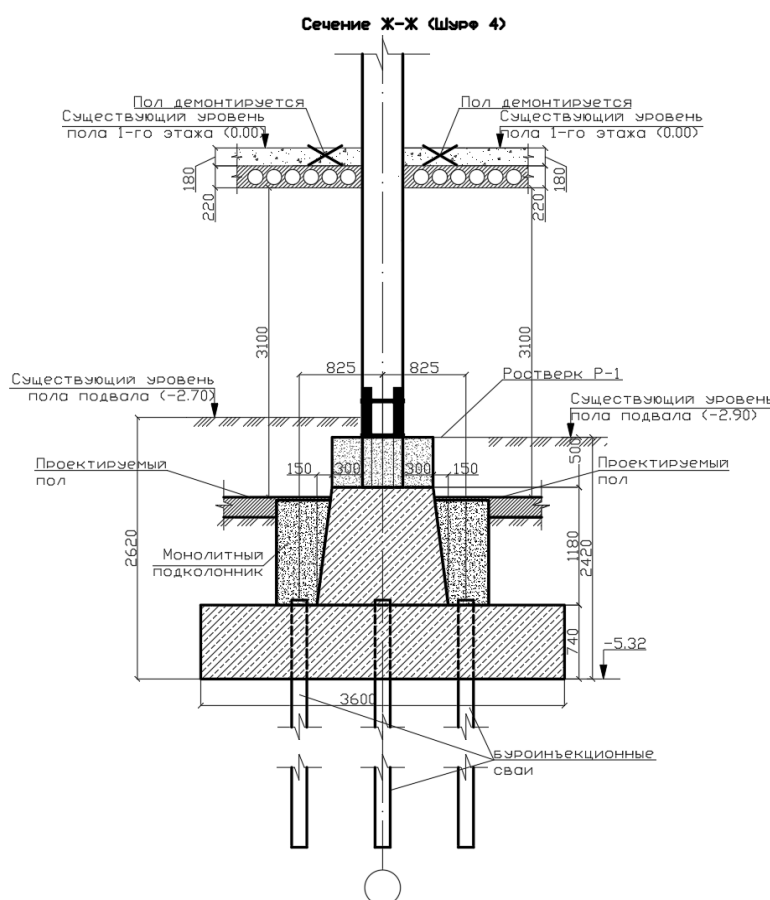
Figure 2a: Schemes of reinforcement of the strip foundation base using bored injection piles ERT (RIT, FORST, ERST) (on the one hand, the basement or pavement, on the other – from the basement floor).



**Figure 2b:** Schemes of reinforcement of the strip foundation base using bored injection piles ERT (RIT, FORST, ERST) (from the level of the basement floor).



**Figure 2c:** Schemes of reinforcement of the strip foundation base with the use of bored injection piles ERT (RIT, FORST, ERST) (from the basement floor).



**Figure 2d:** Schemes for strengthening the base of a columnar foundation using bored injection piles ERT (RIT, FORST, ERST) (from the basement floor level).

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