The writer presents information about some problems of the seismicity of bases and foundations from results of work of specialists of the N. M. Gersevanov NIIOSP Institute carried out during 1988-1990 to establish the consequences of the Spitak earthquake of 7 December 1988 and to analyze design-research material related to different construction projects for reconstruction work in the disaster zone in Armenia.

For over two years a group of specialists of the VNIIOSP Institute participated in the work of many commissions for analysis and elimination of the consequences of the Spitak earthquake of 6 December 1988, including inspection of the soil bases, the state of the building structures, and the foundations; examination of material from engineering explorations; and coordination of projects for foundations of residential and industrial buildings and structures, intended for reconstruction and new construction in the disaster zone in Armenia.

At the present time, there is a sufficiently large number of publications of Russian and foreign investigators who have participated in similar work in Armenia. In what follows, the writer presents information on some questions of the seismic stability of bases and foundations, encountered during the carrying out of his work in building inspection and in expert commissions which have examined design-research material intended for subsequent application in reconstruction work.

Among typical failures, mention may be made of displacement of floors and enclosure panels with supports — bearing walls (Fig. 1), development of deformations of structures at rigidity variation places, failure of load-bearing walls, belts, etc. However, failure of the foundations themselves was not observed, which may be due to their comparatively small displacements in the soil.

The engineering-geologic and seismologic construction conditions in the territory of Armenia are complex and they are characterized by occurrence of portions with tectonic breaks and presence of large (up to 300 m thick) masses of deluvial deposits, which form accumulation plains between the mountains. In different portions in the mass of deluvial deposits, or almost from the surface, tufts of different strengths have been discovered. In some areas, the tuff or basalt rock is covered by a mass of loesslike loams ranging from 6-10 to 14 m in thickness. The different areas are characterized by presence of weak soils and high groundwater levels.

Analysis of the degree of failure of the buildings and structures in Leninakan, Kirovakan, Spitak, etc., performed under the direction of the Lithosphere Institute of the Academy of Sciences of the USSR confirmed substantial effects of the soil conditions. The maximum destruction was observed in areas consisting of large masses of deluvial deposits and high groundwater levels, whereas the minimum was recorded where the soil bases of the foundations consisted of rock and large-fragment soils.

For the disaster zone, a background seismicity (for the mean soil conditions) was established, which was of magnitude 9. Taking into account the engineering-geologic conditions, this circumstance led to the need for adoption of sufficiently complex solutions for reconstruction of the buildings, special substantiations for selection of new-construction sites, their engineering preparation, and design solutions for buildings and foundations of increased seismic stability.

According to the soil conditions, the sites were arbitrarily divided into three categories in conformity with Table 1 of the SNiP II-7-81 Norms: 1) suitable for construction, if the design seismicity corresponds to the background seismicity (soils of Types I and II in accordance with the seismic properties); 2) conventionally suitable, when engineering preparation of the site is necessary and it can be carried out (soils of Type III; but by engineering preparation the design seismicity can be assumed to
be equal to the background seismicity); 3) unsuitable, if the engineering preparation does not permit ensuring the background seismicity. Since for design within a short period, different organizations were engaged which had different degrees of experience in design for seismic regions, leading organizations (including the VNIIOSP Institute) were entrusted with the engineering preparation of the sites, one of which is shown in Fig. 4. It should be noted that the engineering preparation of the site by construction, for example, of earth—rubble pads (soil replacement), or by earth compaction by different methods, corresponds to the requirements of Section 10 of the SNIP 2.02.01-83 Norms. For the adopted types of residential buildings for large-scale construction (four stories with a basement), the engineering preparation increases the cost per each m² of residential area by up to 15%. However, this makes it possible to use land which had been formerly considered unsuitable for building development, which is extremely important since in Armenia there are not many settled areas suitable for agricultural use.

In the analysis of the first results of engineering explorations for regions of large-scale construction (for example, "Ani" in Leninakan or "Torony" in Kiroyakan), insufficient exploration was found: lack of data about seismic microzoning; small quantities and depths of holes, and limited volume of laboratory and field investigations of the soil properties; unusual physical properties of some varieties of loesslike loams were not reported (high porosity, high values of the initial collapse pressure, poor compactibility under heavy rammers), etc. This was one of the main causes of careful selection of the designs for buildings, foundations, and soil bases.