The determination of the lateral soil pressure against retaining walls is one of the classical problems in soil mechanics. Since Coulomb's time (1773), many scientists have attempted to solve this problem. At the present time, significant experience has been accumulated in studies in this field; the results obtained by different researchers are, however, frequently in disagreement and do not provide well-defined answers to questions that have been posed. This is explained primarily by the fact that the majority of investigations have been conducted on small models at low stress levels, i.e., when measurable pressures were of the same order as the errors generated by imperfection of the measuring apparatus, by the difference in the methods employed to conduct the experiments, by the different properties of the granular soils employed, etc. Since soils will react differently not only quantitatively but also qualitatively under low and high stresses, their accurate results, even when obtained on small models, cannot be directly transferred to a real structure.

The problem is aggravated by the fact that according to data of recent investigations, the deformations of a wall and the soil itself during its compaction assume major significance in the formation of lateral soil pressure and its further variation with time. Even if it were possible to simulate wall deformations in ordinary laboratory experiments (although the unsolved problem of small stresses remains here), we have not yet succeeded in modeling the natural deformations of soil during its consolidation.

This problem can be solved by the method of centrifugal modeling, which makes it possible to obtain the same stresses in a small model as in a real structure.

Hveem and Aliev made the first attempts to use this method as early as the 1940s. Major difficulties with the organization of measurements and the transfer of data from a model rotating at high velocity and also the absence of a reliable mechanism providing for the wall's displacement at the time of the experiment, however, did not make it possible to obtain the expected results, and further work in this direction was curtailed for some time.

Only in recent years have new attempts been made to use the method of centrifugal modeling in connection with the increasing urgency of this problem. The Scientific-Research Department of the S. Ya. Zhuk All-Union Scientific-Research Institute for Design and Exploration has developed and fabricated a measuring apparatus and a device that provides for wall displacement in accordance with a prescribed program at the time of the experiment.

Two forms of measuring devices were employed: a two-component displacement meter and sensors to measure soil pressure. The displacement meters made it possible at the time of the experiment to record simultaneously the settlement and horizontal displacement of a model being tested at a centrifugal acceleration to 300 g. The maximum measured settlement was 25 mm, and the maximum horizontal displacement was 20 mm. In this case, the measurement error was no more than 2% at a confidence level of 0.9 for the upper measurement limit. The lateral soil pressure was measured using strain-gage pressure transducers operating within the ranges 0-0.3 and 0-0.6 MPa.

An apparatus equipped with a remotely controlled electric drive was employed to conduct experiments with a retaining wall, which is displaced during the testing period. It is an experimental steel magazine of rigid frame construction, which is open from the top and which has double lateral walls (internal walls of polished acrylic plastic overlaid by a coordinate grid, and outer walls formed from a steel plate reinforced by stiffeners). A rigid retaining wall, hinge connected along the lower face itself, was mounted in the end portion of the container (Fig. 1).
Using an electromechanical drive, the wall could be cyclically rotated about the lower support onto and away from the soil. The maximum total load exerted by the wall on the soil was approximately 40 kN, and the amplitude of displacements of its top was assigned within the range from 0.1 to 15 mm from the experimenter's control board. The displacement of the wall was measured using an inductive displacement sensor with an error of 0.05 mm.

All sensors were built into a computerized controller, which was used to process the results and plot graphs. The tests were initially conducted with air-dried medium-grain Lyuberetsk sand. In this case, it was important to ensure the uniform density of the backfill soil. If the soil was carefully placed in the backfill with the same density over the depth, the lateral-pressure curve assumed a form close to triangular. In cases where the placement procedure was violated (variation in the thickness of the layers being placed, discontinuities in placement, etc.), the curve developed a sawtooth shape, which was extremely significant in some cases. It should be noted that the above enumerated data derived from field observations of soil pressure on retaining walls also indicates a curve with a significant sawtooth form.

Fig. 2. Curves showing lateral pressure of sand against stationary inclined (12°) wall. a) under centrifugal accelerations; 1) 100 g; 2) 75 g; 3) 50 g; 4) 25 g; b) combined into graph plotted in relative coordinates.