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1.4 Analysis of the interaction of groups of buildings within the boundaries of dense building

With the participation of the author, work was carried out on the technical inspection of buildings on Olena Stepanivna street in Lviv. The work was carried out in order to determine its actual technical condition and, if necessary, to provide recommendations on the elimination of identified deficiencies.

The structure of the street is regular with two-story and three-story buildings paired with each other and made in the style of historicism and secession. The situation diagram of the location of the building is shown in figure 1.

Figure 1. Situation diagram of the location of buildings ##31, 33, 33a, 33b on the Olena Stepanivna street

The main attention was paid to buildings #31 (an architectural monument of local importance) and #33 (Fig. 2). Both buildings are located in the area of the long-standing low-rise residential development of this street. The study of archival materials and the different sizes and colors of the bricks of the walls of the buildings indicate that house #31 was built before house #33.

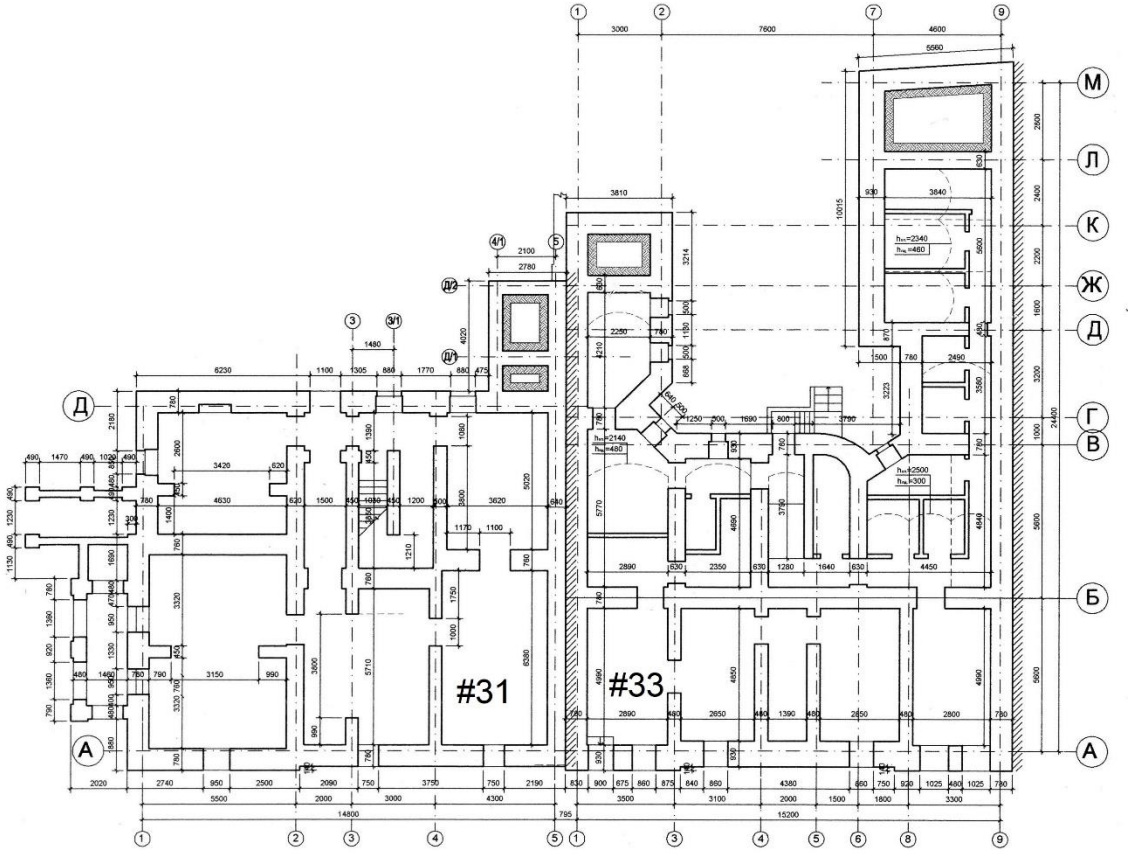


Figure 2. Basement floor plans of buildings #31 and #33

In order to take into account the impact of building #33 attached to building #31, the necessary data on the depth of laying the foundations of the existing building #33 as an extension to building #31 were determined and analyzed; characteristics of the base soils directly under the soles of the foundations; dimensions of foundation soles under bearing and self-supporting walls; materials of walls, foundations and other structural elements.

Overloading of foundations under the foundation of the load-bearing wall along axis "5" of building #31 and its increased subsidence caused by additional loading of the base of the foundation of building #33, which is located along this same axis "5" and lies 0,5 m above the base of the foundation along axis "5" building #31 (Fig. 3, 4). The soles of the foundations of building #33 along axis "1" are located in the backfill of the foundation along axis "5" of building #31, which was built 3 years earlier.

Figure 3. The sole of the foundation of building #31 is located 0,5 m below the sole of the foundation of building #33

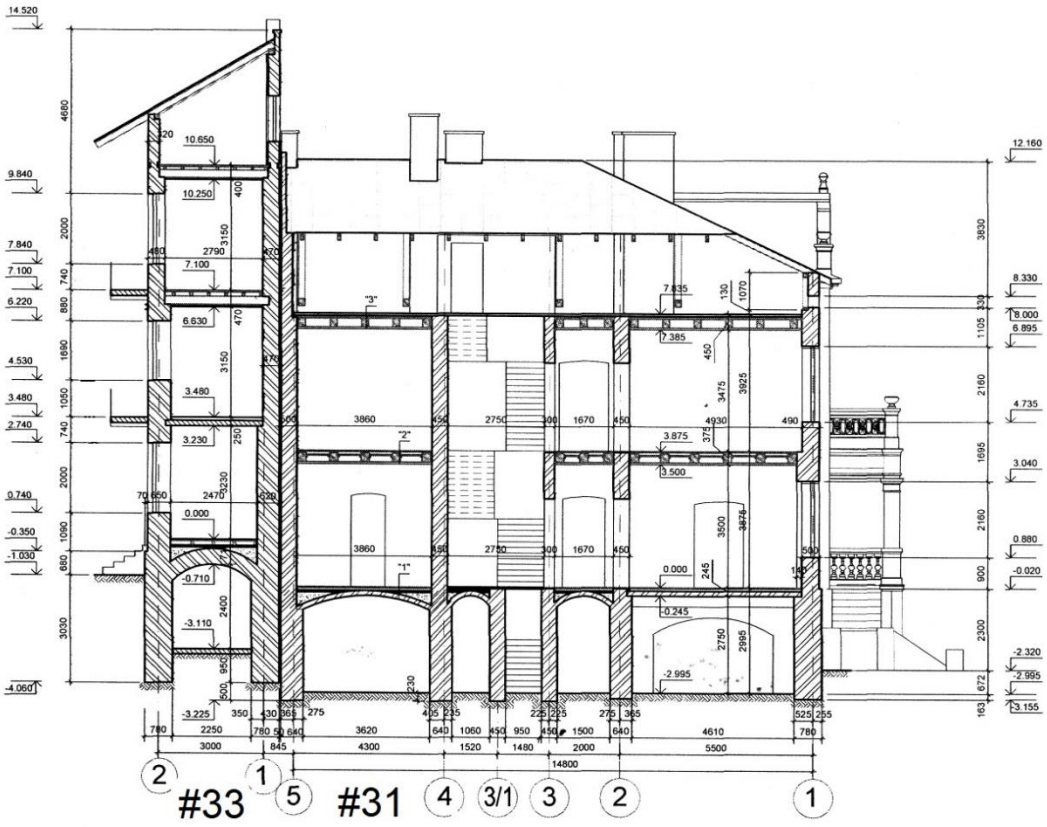


Figure 4. Cross section of buildings #33 and #31

During the inspection, it was determined that, first of all, the formation of cracks in the wall of building #33 should be considered as a consequence of the unsatisfactory operation of the drainage system in the building itself and from its yard. Rainwater

easily seeps into the sandy soils of the foundation, creating problems both in the foundations of building #33 itself and in the adjacent building #31.

Also, at the time of the survey, the actual spatial deformations of three grouped buildings #31, #33 and #33a were determined together with the foundations under their foundations, which made it possible to analyze their mutual influence, which is proposed to be carried out according to the norms [34].

The directions of tilts, bends and vertical displacements of buildings #31, #33 and #33a are recorded, calculated and shown on the graphs (Figs. 5, 6, 7).

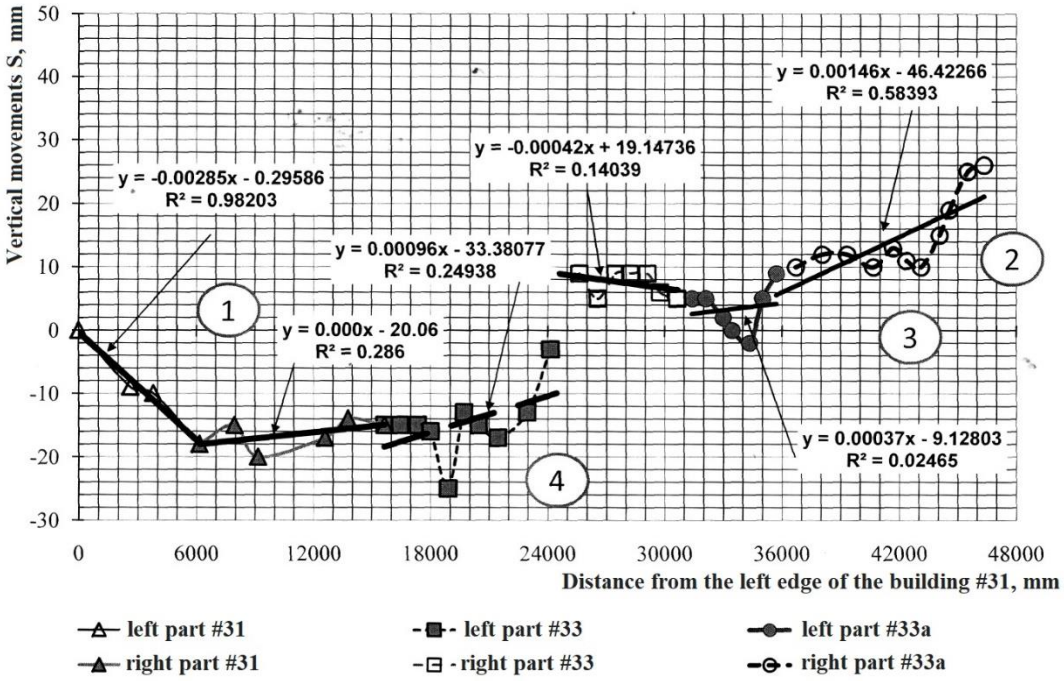


Figure 5. The nature of the distribution of measurements of vertical deformations along the lengths of the front walls of four buildings #31 (1), #33 (4), #33a (3) and #33b (2) (numbers 1-4 – construction sequence). Integral distribution of deformations obtained by approximating experimental data with linear equations

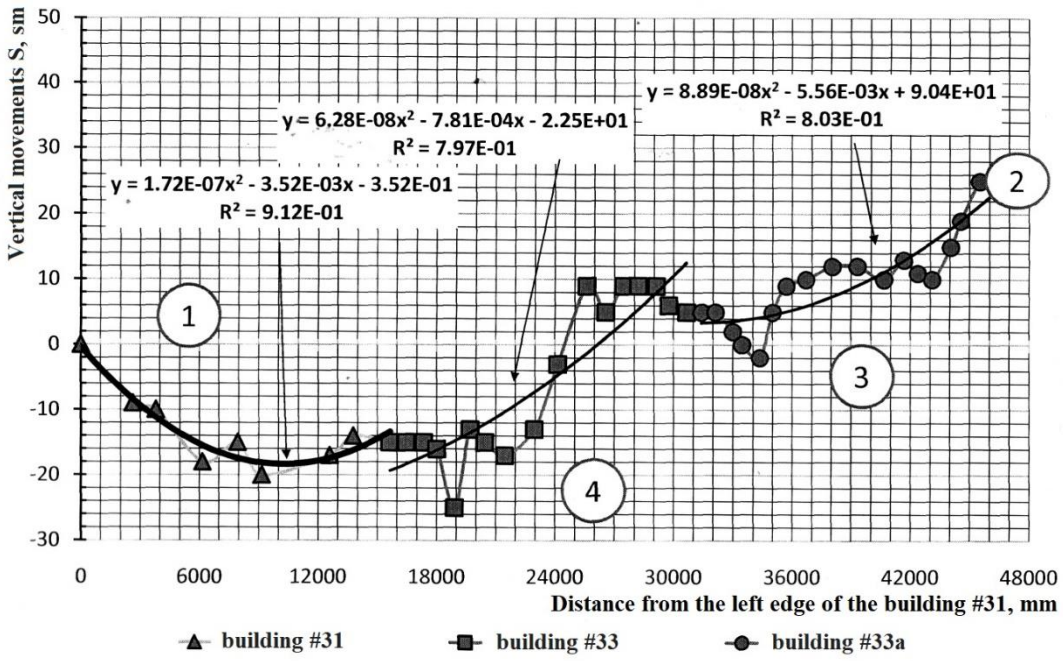


Figure 6. Distribution of vertical deformations along the length of the front walls of three buildings ##31, 33, 33a. Integral regularities of their distribution obtained by approximating the measured data by polynomial equations of the second degree

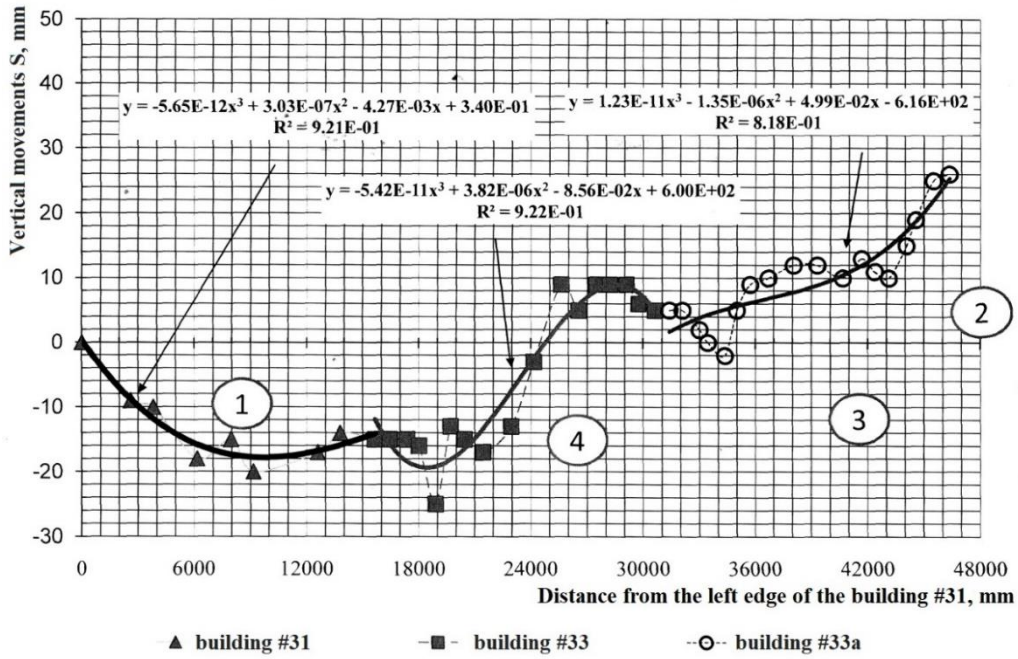


Figure 7. Distribution of vertical deformations along the length of the front walls of three buildings ##31, 33, 33a. Integral regularities of their distribution obtained by approximating the measured data by polynomial equations of the third degree

The analysis of these directions and their actual values showed that in the process of operation and successive additions of new buildings to the existing #31, unfounded decisions were made at the time of construction from the point of view of the mutual influence of the additions and adjacent existing buildings.

According to the current regulatory document [35], buildings located in the area of long-established low-rise dense old buildings have long been subject to inspection for their technical condition.

If the plots for new construction are located in close proximity to dense old buildings, then the possibility of an adverse effect of new construction on the formed old buildings and vice versa should be determined. The construction (extension) of each successive building with breaks in time should be considered as the construction of a new object next to the existing one.

The considered buildings on the site of the old building were not specially designed for the forces that arise when they interact with the foundation.

The study of the material of the wall masonry showed a sufficiently high strength of the brick f_b=7,5 MPa and a very low strength of the mortar f_m=0,5 MPa, which did not provide sufficient strength of the wall masonry at the bound and unbound seams and the absence of steel tie-down horizontal elements in complex engineering and geological conditions of the construction site.

But, according to the norms [36], it is allowed to use:

- with seismicity of 6, 7 points - full-body bricks of the brand not lower than M75 and solutions of the brand not less than 50 kg/cm^2 based on cement to ensure adhesion of the solution to the brick.

The actual grade of the main brick of the walls M75 meets the regulatory requirements. The actual grade of solution M5 does not meet the regulatory requirements even in the presence of dynamic influences corresponding to seismicity.

It is necessary to constructively ensure the adhesion of the mortar to the brick by introducing vertical reinforcement to combine the foundation slab walls with the new monolithic slabs of the basement, 1st and 2nd floors in the vertical struts of the walls.

Geodetic research made it possible, based on the results of the obtained experimental results, which characterize the deformed state of individual buildings ##31, 33, 33a, 33b and their foundations within the compacted development, to evaluate the order in the construction sequence of the specified buildings through the analysis of their mutual influence within of the considered group of buildings without their previous theoretical calculation.

According to the characteristic geometric parameters of deformations of buildings obtained during the survey, it is possible to obtain:

- the actual nature and consequences of transferring loads from buildings to foundations;

- diagrams of the actual non-uniform development of base deformations along the length of each building;

- impact on additional deformations of the foundations, first from the skeletons of existing buildings, and then from the impact of the skeletons of adjacent buildings, successively attached or built into the existing ones;

- buildings that are attached or integrated with significant intervals of time and are gradually blocked in groups of dense buildings have a more complex relationship between stress zones and movements in the base from uneven stresses under the foundations and rigidity of the frameworks of the buildings in the formed group.

The analysis of the recorded vertical deformations of buildings of the old construction showed that for an objective approach, the obtained data of relative vertical movements should be approximated by equations of different orders.

After that, one should analyze and select from the entire set of approximation equations of vertical movements, those that have the greatest correlation dependence between experimental and theoretical data and more logically describe and characterize the deformed state of an individual building, and accordingly, a group of buildings within the old dense building.

According to the analysis of the actual spatial deformations of the group of buildings within the block of the old building on the Olena Stepanivna street, the order of their construction is indicated in figure 8, 9, 10.

Figure 8. Photos of buildings: 1 - #31, 2 - #33b, 3 - #33a; 4 - #33, according to the sequence of their construction in the old compacted building

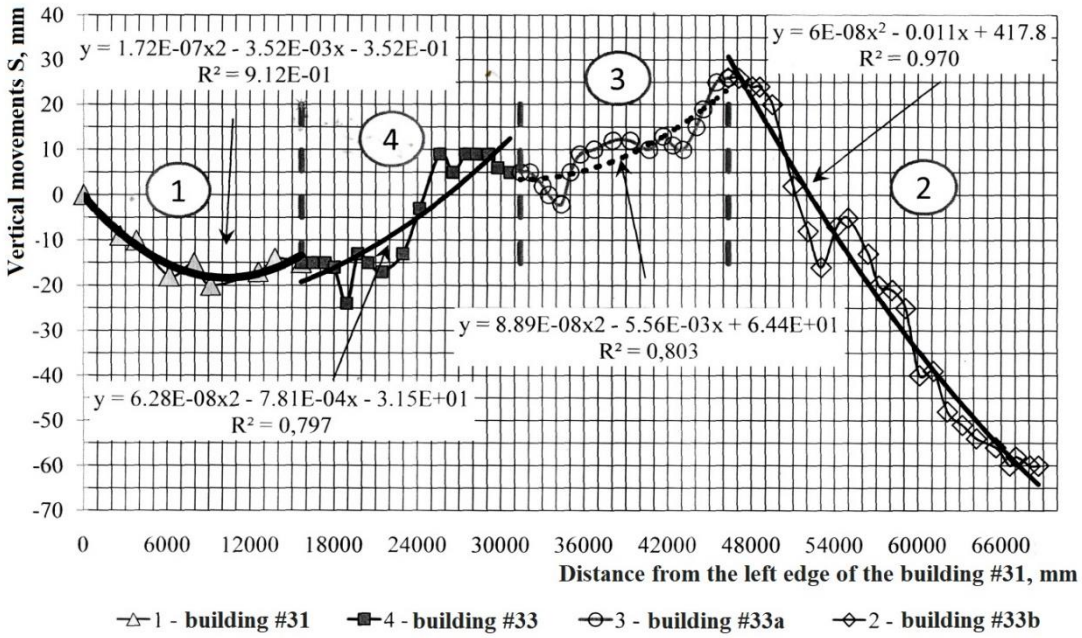
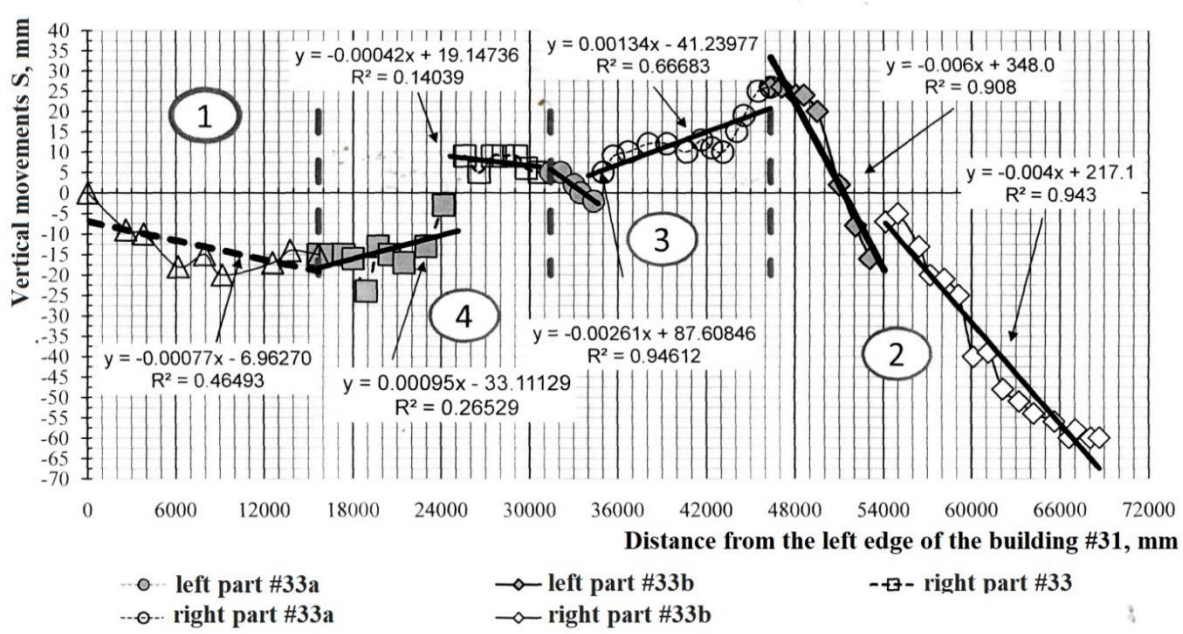


Figure 9. The nature of vertical deformations along the length of the facade walls and the construction sequence of four buildings: 1 - #31; 2 - #33b; 3 - #33a; 4 - #33. The integral distribution of deformations is obtained by approximating the experimental data with equations of the second degree



i=-0,00077	i=+0,00095; i=-0,00042	i=- 0,00261; i= +0,00134	i=- 0,006; i=- 0,004
#31	#33	#31a	#33b

Figure 10. Approximation by linear equations of vertical deformations of characteristic areas on the walls of the main facades of four buildings ##31, 33, 33a, 33b to determine their slopes

Approximation by linear equations of vertical deformations of sections of facades of four buildings ##31, 33, 33a, 33b made it possible to determine the roll of each section, the values of which are shown in figure 9.

The increase in the spatial deformation of the frame of building #31 is mainly caused by the uncontrolled, uneven settlement of wet foundations under its foundations. This especially applies to the wall along the "5" axis. This was an unreasonable decision of the designers, from the point of view of the mutual influence of the extension on the adjacent existing building. At the same time, the sole of the foundation of building #33 is 500 mm higher than the sole of the foundation of building #31 and lies on the backfill of its foundation along the "5" axis.

First, the cracks formed in the walls within the wet rooms, and their spread to other areas of the building walls is associated with gradual long-term wetting and washing

of sand from the base under the soles of the foundations, first from under building # 33, then from under building #31.

The formation of cracks in the wall of building #33 should be considered as a consequence of the unsatisfactory operation of the drainage system in this building and from its yard. Rainwater easily seeps into the sandy soils of the foundation, creating problems both in the foundations of building #33 itself and in the adjacent building #31.

Increasing the strength and spatial rigidity of buildings should be achieved by strengthening structures in accordance with the results of its calculations in interaction with the foundation.