STRENGTHENING OF THE FOUNDATION OF BUILDINGS WITH ROOFTOP EXTENSION

Marijana PAUNOVIĆ[1], Slavko ZDRAVKOVIĆ[2]

ABSTRACT

In the case of rooftop extension of buildings, it is often necessary to strengthen the foundation. Negative processes in the soil are those that lead to the deterioration of mechanical and deformation characteristics.

Strengthening of existing foundations can be done in several ways: expanding the foundation, by underconcreting, creating a new foundation plate, and the like. The load that the buildings with rooftop extension have to accept also originates from seismic impacts.

***Key words**: rooftop extension of buildings, load, foundation, strengthening*

[1] Marijana Paunović, master civil engineer, e-mail: marijana9518@gmail.com, Serbia.
[2] Slavko Zdravković, Full Professor, Academic of Serbian Royal Association of academics, innovators and scientists, Expert of the Federal Ministry of science, technology and development in the field: Civil engineering, Aseismic engineering, Bridge stability, The Faculty of Civil Engineering and Architecture, University of Niš, A. Medvedeva14 Niš, Serbia, slavko.zdravkovic@gaf.ni.ac.rs

1. FOUNDATION STRENGTHENING PROCEDURES IN CASE OF ROOFTOP EXTENSION

It is well known that soil, in comparison with other building materials, is much more susceptible to changing its properties under the influence of natural or artificial factors. This can also be said in many respects for the foundations - elements of construction that are constantly in the soil throughout their period of exploitation. During long-term exploitation, both positive and negative phenomena can occur in the underlying soil.

Today's landslide studies include the activity of re-zoning and grading of slopes in terms of stability in the construction and strengthening of foundations. Data and bases are needed to carry out optimal remedial measures that can make unstable slopes stable and acceptable for a particular purpose. It is especially important to pay attention to the following natural conditions: geological, engineering-geological, hydrogeological and hydrological, geodynamic processes and anthropogenic (technogenic). The sliding mass properties are: sliding surface properties (position, shape, size), sliding body properties (dimensions, volume, mass distribution, velocity and causes of movement, as well as physicochemical and mechanical properties of materials, primarily shear and deformation resistance) and groundwater properties in landslide areas (levels and fluctuations in levels over time). That should be taken into account especially in the case of facility reconstruction, rooftop extension, upgrading, changing permanent and/or live loading, etc.

Positive occurrence in soil can be considered as additional compaction of soil beneath the foundation, mostly in layers just below the foundation, which leads to a decrease in soil porosity, an increase in mechanical and deformation characteristics, and consequently an increase in bearing capacity.

Negative processes in soil are those that lead to deterioration of mechanical and deformation characteristics. These are mainly seasonal freezing of soil (in case of low depth of foundation) or change of soil moisture (due to water penetration from installations, changes in groundwater levels, floods).

In any case, additional exploration works (wells, foundation excavation, laboratory testing of specimens) are required prior to commencement of reconstruction, retrofitting, upgrading, etc., for the purpose of designing the project. Of course, the scope of investigative work should be adjusted to the specific situation and needs.

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After carrying out additional investigative works, in accordance with the foreseen works on the building, the existing and newly designed load on the foundations should be determined. On this basis, the need for strengthening of existing foundations, the manner and arrangement of strengthening should be assessed.

Here are some ways to strengthen the foundation, known in the literature or in practice:

a) strengthening of existing foundations;

b) extension of foundations;

c) under concreting;

d) construction of the base plate below the object:

e) strengthening by piles.

1.1. Strengthening of existing foundations

Strengthening of existing foundations is applied in cases where the permissible stress on the ground in the foundation joint is not exceeded, but the foundation itself is worn, cracked or deformed (e.g., foundations made of brick, stone, etc.). In such cases, either the existing foundations are injected or the lining around the foundations is made of reinforced concrete (Figure 5).

The injection process involves drilling holes in the base, installing the injector and injecting. The grout is usually mixture of cement and water and is pressurized into the foundation soil under pressure.

Concrete lining around the existing foundation is done after excavating the trench around the foundation, cleaning the surface, installing anchors to tie the old foundation and lining. The thickness of the cladding should not be less than 15 cm, and shall be reinforced constructively by a reinforcing mesh. In some cases, the lining may be added on one side only.

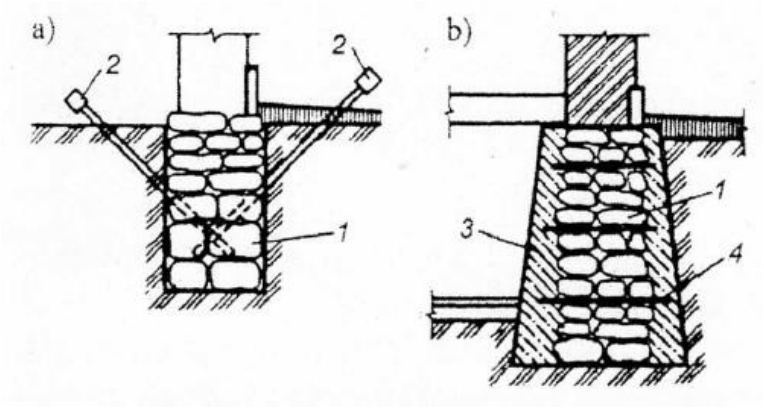

Fig. 1. Strengthening of foundations: a) injection; b) concrete lining; 1 - Existing foundation, 2 - Injectors, 3 - Concrete cladding, 4 - Anchors

1.2. The extension of the foundation

The extension of the foundation is applied in cases where the permissible stress on the ground in the base coupling, in case of an increase in the external load, will be exceeded. Formerly, the foundation extension is combined with foundation strengthening (Figure 2).

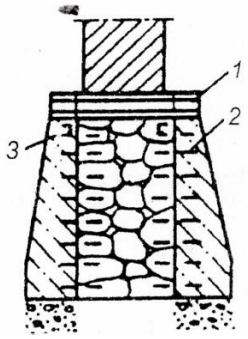

Fig. 2. Combined strengthening and extension of foundations; 1 - Support beam, 2 - Anchors, 3 - Extension of foundations

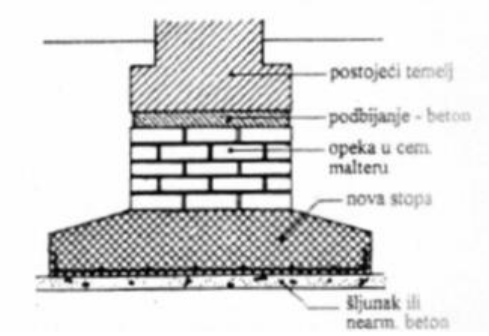

Fig. 3. Examples of foundation concreting

1.3. Underconcreting of foundations

Underconcreting of foundations is applied precisely in order to transfer the total load evenly to the base joint. Therefore, a new reinforced concrete foundation with increased width is constructed below the existing foundation (Figure 3). It is logical that a new foundation (that is, undermining and concreting) cannot be derived from one, but in the campads (Figure 4). Campads are usually about 1 m long and are skipped, with at least three days between excavation and concreting of two adjacent campads. Particularly important in this process is to ensure that the existing foundation is intimately and completely lie down to the newly constructed one. The installation of new concrete should be carried out with special care.

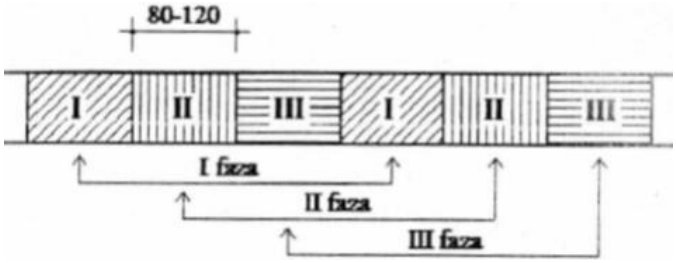

Fig. 4. Schematic representation of concreting in campads

1.4. The construction of a new foundation slab

The construction of a new foundation slab under the building may be applied in some cases, if the base of the building is not too large and access to the basement or ground floor of the building is provided. This method of strengthening should also be applied when the additional load on the foundation is too high and other methods cannot be applied. The new foundation plate should be designed to take the entire new load, but should be appropriately connected with the existing foundation. Figure 5 shows one example of strengthening by creating a new baseplate.

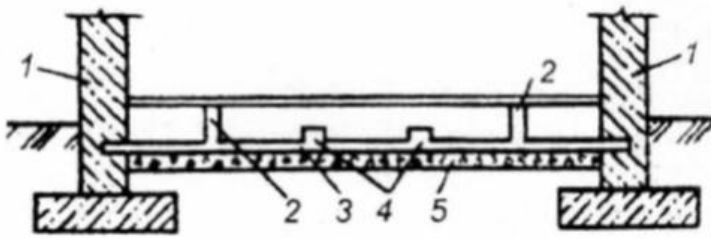

Fig. 5. An example of strengthening a foundation by creating a new foundation slab; 1 - Existing foundation, 2 - Main beams, 3 - New slab, 4 - Secondary beams, 5 - Compact gravel

1.5. Strengthening with piles

Strengthening with piles is relatively often applied in various ways. For example, it is possible to construct piles in addition to existing foundations and, afterwards, to connect piles to existing foundations. However, sometimes it is not possible to apply some method of pile construction (e.g. piles of type "Franks" due to vibration during setting-up). In practice, the most commonly used method of constructing piles called "Mega" piles. They are made of segments of steel tubes that are pressed into the ground with hydraulic presses directly below the existing foundation. The process of constructing such piles, first of all, requires the excavation of a pit below the existing foundation, about 1.5 m deep, about 1.2 m long and wide (to allow the operator to operate the equipment).

2. RECOMMENDATIONS

- Masonry buildings are generally very vulnerable to earthquake effects, especially if they are with rooftop extension, which is particularly evident in earthquakes of maximum intensity. The seismic resistance of existing masonry buildings must be assessed on the basis of a review and analysis of the existing structural system and condition of the building. If it is shown that an existing facility is not properly constructed, adequate strengthening of that building should be provided, regardless of whether the provided interventions formally meet or do not meet all the provisions of the Rulebook on Technical Standards for the Construction of Buildings in Seismic Areas (Official Gazette SFRJ no. 31/80, 49/82 and 29/83).
- The presence of "rigid" floor structures is crucial for the aseismicity of masonry buildings. Therefore, if an object is to be upgraded, it is imperative to form floor structures that are able to provide a uniform distribution of seismic influences on the vertical structural members.
- When upgrading masonry structures, special attention should be paid to existing vertical load-bearing structural elements - masonry walls. Depending on the type of walls, the quality of the material from which they are made, the level of vertical and horizontal loading or their possible damage, appropriate strengthening of those walls should be provided.
- Existing foundations of masonry structures, in the case of rooftop extension, must transmit both existing and additional vertical loads. This additional load originates from the mass of the upgraded section as well as from seismic impacts. Therefore, due consideration must be given to the condition of the foundation, the calculation and the implementation of the necessary strengthening.

3. CONCLUSION

During long-term exploitation of buildings, positive or negative phenomena occur in the underlying soil. That's why before the start of reconstruction, rooftop extension, etc. exploratory work is required in order to strengthen existing foundations. Strengthening mainly is done expanding the foundation, by under concreting, constructing a new foundation slab under the building, reinforcing with piles and the like.

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