



DETERMINATION AND COMPARISON OF THE DISPLACEMENTS IN THE ROOF SECTIONS OF BUILDINGS WITH SWIMMING POOLS OF VOLUMES 169 M³ AND 337 M³ RESULTING FROM NON-LINEAR LOADS AND SEISMIC EFFECTS.

Khodjaev A.A.

Doctor of Technical Sciences, Professor

Inomjonov S.Y. Master's Student,

Tashkent State Transport University (TSTU), Tashkent,
Uzbekistan.

Abstract: *This article analyzes the displacements that occur in the structure when swimming pools are located on the roof of a 15-story building. In the study, the building's deformational state under the influence of water pools with volumes of 169 m³ and 337 m³ was investigated. The calculations and modeling were carried out using the LIRA-PK software suite. During the calculation process, permanent, temporary, and non-conventional loads, as well as seismic effects, were taken into account. Based on the obtained results, it was determined that water reservoirs of various sizes have a significant impact on the building's overall stability and displacement values. The study's findings indicate the necessity of considering the influence of rooftop water reservoirs during the design process.*

Keywords: *seismic loads, non-conventional loads, structural displacement, reinforced concrete frame, high-rise building, rooftop swimming pool, structural analysis, deformation behavior, seismic resistance, load impact assessment, LIRA-SAPR software, dynamic analysis, building stability, structural modeling, engineering simulation.*

Introduction

Today, in the modern construction industry, innovative architectural and structural solutions are widely used in the design and construction of multi-story buildings. In particular, the practice of placing swimming pools, recreational areas, and other functional elements on building rooftops to make efficient use of the space has become widespread. This approach enhances the building's operational comfort but significantly impacts its loading conditions.

In the Republic of Uzbekistan, special attention is being paid to modernizing the construction industry and ensuring the reliability and safety of buildings and structures. In particular, under Resolution No. PQ-5963, the introduction of modern computational methods in the design process, the deepening of engineering analyses, and the enhancement of structural stability have been identified as one of the key tasks.[1]

It is well known that the territory of Uzbekistan is classified as a seismically active region. Therefore, when designing multi-story buildings, it is essential to take into account not only conventional loads but also earthquake effects and non-conventional loads. In particular, the placement of large-volume water reservoirs on the roof imposes additional static and dynamic loads on the building structures. This leads to extra stresses, displacements, and deformations in the structure.

Modern calculation programs, including LIRA PK, allow for determining the spatial performance of such complex systems, assessing the effects of loads, and analyzing the state of structural elements. This allows potential hazards to be identified and prevented at the design stage.

From this perspective, determining and comparing the displacements that occur in buildings with water reservoirs of various sizes on the roof is one of the pressing scientific and practical issues.

Initial data and methodology for the calculation

Research Objective – The primary aim of this study is to determine the displacements caused by swimming pools with volumes of 169 m³ and 337 m³ located on the roof of a 15-story building and to compare them.

Additionally, the study is intended to assess the deformational state of the building structure under non-traditional loads and seismic effects, and to determine the impact of the water reservoir volume on the structure's stability.

The building's plan is a rectangular shape, with a length of 21.6 m and a width of 13.2 m. The column spacing was set at 3.6 m, with their spacing arranged as 1.2;

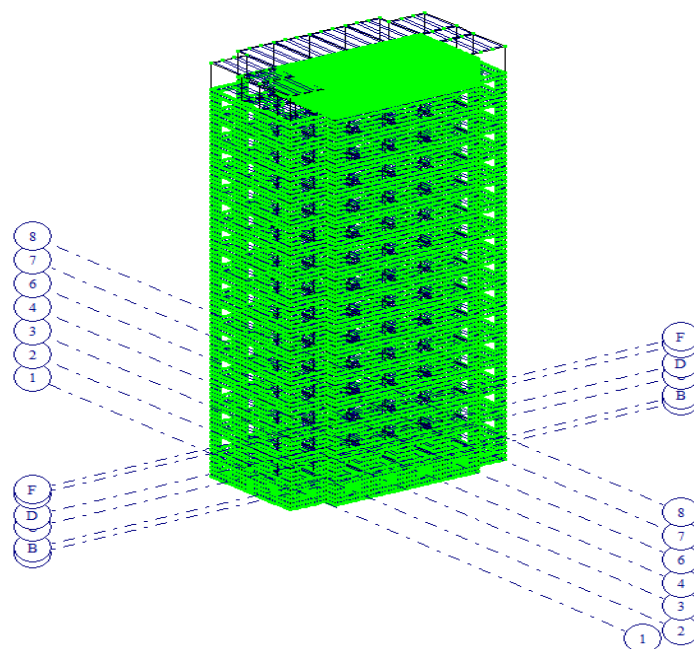
4.2; 2.4; 4.2; 1.2 m. A 15-story reinforced concrete frame building was adopted as the research object.

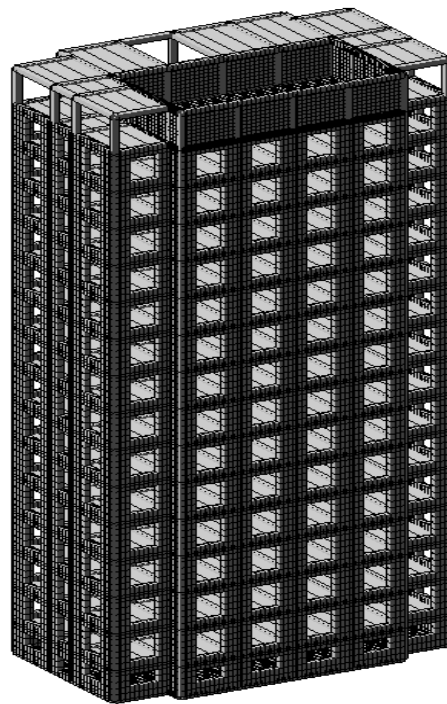
The structural parameters of the building were defined as follows: the columns have a cross-section of 400×400 mm, and the beams were also assumed to have a 400×400 mm cross-section. The structure is located in the Tashkent region, and the seismic intensity for this area was taken to be 9 points.

The calculations were performed using the LIRA-SAPR PK 2017 software suite. In the program, a three-dimensional spatial model of the building was created, and all loads were applied to the structural elements in accordance with their distribution.

During the calculation process, current regulatory documents and structural requirements were used as the basis, and the stress-deformation state of the building's structure was comprehensively analyzed and compared.

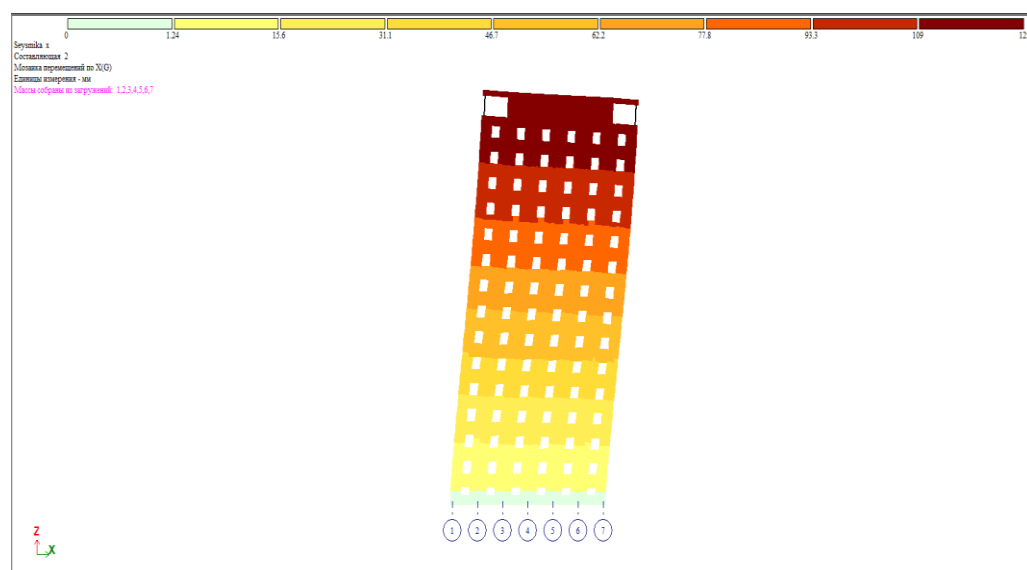
The building's three-dimensional spatial model was created in the LIRA-SAPR PK software. A 337 m³ swimming pool is located on the roof (Figure 1). Based on this model, the structural deformation state and maximum displacements of the building are determined.





According to the computational results obtained using the spatial model, the maximum displacements in the building structure were determined under the influence of a 337 m³ volume reservoir (Figure 2).

(X)



(Y)

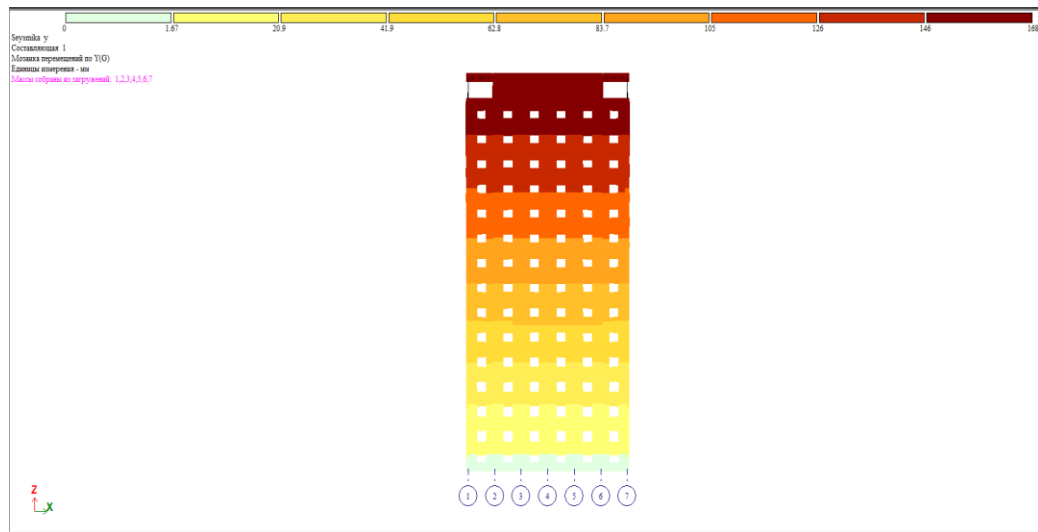
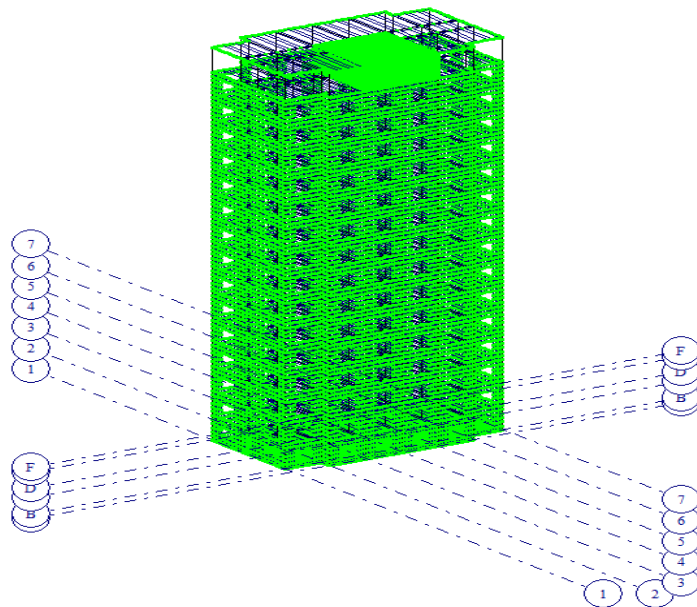


Figure 2. Displacements along the X and Y axes of the building with a 337 m³ water reservoir in its roof.

The spatial model of the building also included a 169 m³ swimming pool (Figure 3).



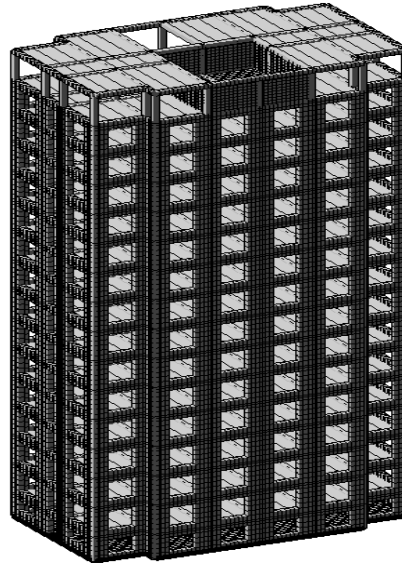


Figure 3. Spatial computational model of the building with a 169 m³ swimming pool.

Based on the spatial model, the maximum displacements on the X and Y axes in the building's structure are determined for a 169 m³ swimming pool placed on the roof. (Figure 4)

(X)



(Y)

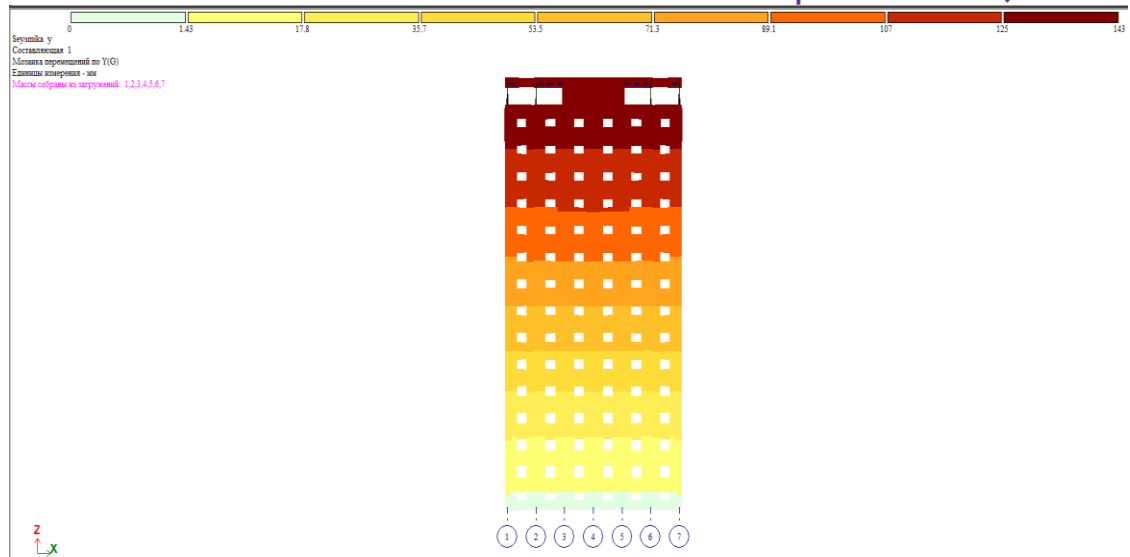


Figure 4. Translations of the building along the X and Y axes, which has a 337 m³ water reservoir in its roof.

Summarizing the above results, they can be presented in the following table:

№	Structural system and dimensions of the reinforced concrete frame	Maximum displacement in the X-axis direction, mm	Maximum displacement generated in the y-axis direction, mm
1	A building with a 337 m ³ water reservoir on the roof.	125	168
2	A building with a 169 m ³ water reservoir on the roof.	94.3	143

Conclusion

The research results show that the volume of the water reservoir located on the roof of the building has a significant impact on the maximum displacements that occur in the structure. For the existing building, the maximum displacement is 125 mm for a 337 m³ pool in the X-axis direction, while for the y-axis it was 168 mm, for the existing building with a 169 m³ pool, the corresponding values were 94.3 mm and 143 mm, respectively.

As can be seen, as the pool volume increases, the deformations in the building also increase. This indicates that when placing water pools on the roof during the design process, it is necessary to consider their volume and impact on the structure.

Overall, to ensure the stability and seismic safety of the building, the stress and displacement parameters of structural elements in buildings containing large-volume water reservoirs must be analyzed in detail.

References

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