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CALCULATION OF A FOUR-STORY BUILDING UNDER THE INFLUENCE OF SEISMIC FORCES USING LIRA 9.6 SOFTWARE

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Abstract

When calculating the effect of seismic forces on a four-story building, the general data of the construction area, geometric indicators of the building, dynamic characteristics of the building, strength and mechanical indicators of construction materials were analyzed according to the norm.

Keywords. Seismic forces, geometric indicators, dynamic forces, stability, earthquake, dynamic characteristics.

Introduction

When calculating the effect of seismic forces, the following were taken into account: general information of the construction area; geometric indicators of the building; General information of the building according to the regulatory document QMQ 2.01.03-19 “Construction in seismic areas”; dynamic characteristics of the building, strength and mechanical indicators of construction materials; consolidation of loads; statement and analysis of calculation results; conclusions and recommendations.

1. General information about the building and the construction area

1. Structural system of the building: 4-story building.

2 Construction indicators of the area:

2.1. Seismicity of construction site - 7 points (QMQ 2.01.03-19, Appendix 2);

2.2. Normative snow load: II - region s_0 = 0.7 kPa (70 kgs/m^2) (QMQ 2.01.07-96, Appendix 5).

2.3. Normative pressure of wind speed: II - district Wo=0.38 kPa (38 kgs/m2) (QMQ 2.01.07-96, Appendix 5),

3. The indicators of the building according to the regulatory document:

3.1. The building's responsibility class is I (first);

3.2. Reliability coefficient by appointment: γn=15 (QMQ 2.01.07-96, Appendix 7).

3.3. Category of responsibility of the building - III (third);

3.4. Coefficient of responsibility: K_o= 1.2 (QMQ 2.01.03-19, table 2.3);

2. Geometric indicators of the building

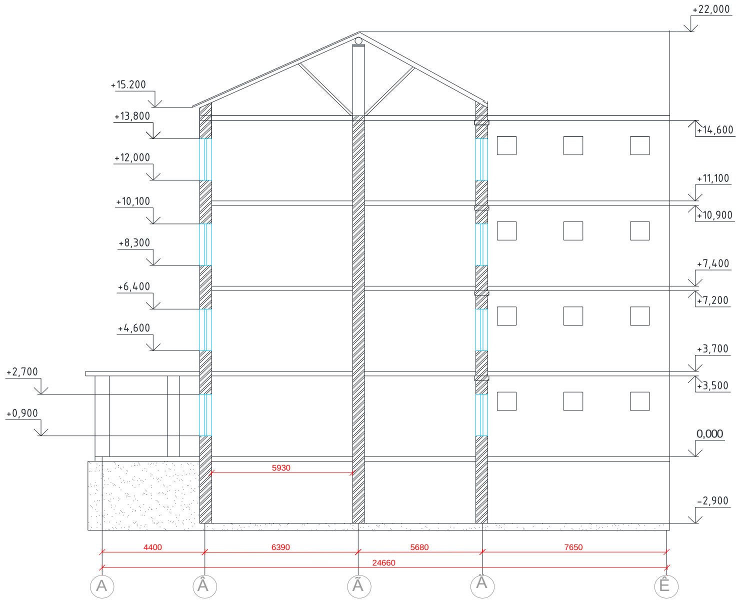

Figure 1.1. 1-1 section of the building.

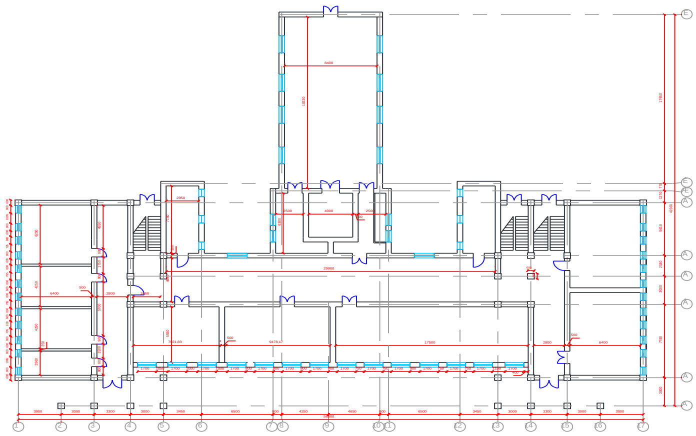

Figure 1.2. 1st floor wall plan.

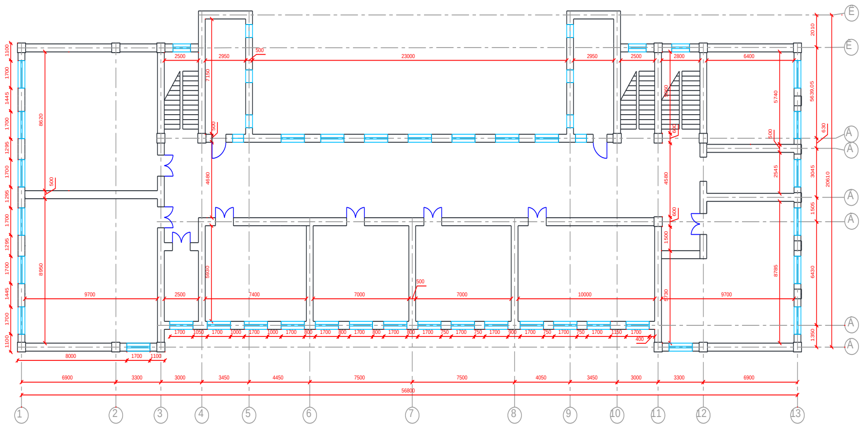

Figure 1.3. Floor 2-4 wall plan.

3. General information of the building according to the normative document QMQ 2.01.03-19 "Construction in seismic areas"

Calculation of the impact of seismic forces of the building was carried out using the LIRA 9.6 program complex. According to QMQ 2.01.03-19, the normative indicators of the building are presented in Table 3.3 below. Table 1.1. Normative indicators of the building.

Naming of calculation indicators	Coefficient
1. Counting number of vibration forms	10
2. Matrix of mass	Diagonal
3. Coefficient correcting seismic forces	1,0
4. Responsibility coefficient of the facility, (QMQ 2.01.03-19, 2.3 - table)	1,2
5. Coefficient that takes into account the frequency of earthquakes (QMQ 2.01.03-19, Table 2.4)	1,25
6. Coefficient that takes into account the number of floors of the building (QMQ 2.01.03-19, 2.10 - table 2.10)	1,5
7. Regularity coefficient, p.2.25 (QMQ 2.01.03-2019, 2.12 - table)	1,0
8. Coefficient that takes into account the seismicity of the area, (QMQ 2.01.03-19, Table 2.7)	1.0
9. Address index, (QMQ 2.01.03-19, table 2.2)	II
10. Ground category, 1.1. table (QMQ 2.01.03-19,1.1 - table)	II
11. Decrement of oscillations, (QMQ 2.01.03-19, table 2.9)	0,3

4. Durability and mechanical indicators of construction materials

The following mechanical indicators were obtained for concrete structures: $E = 300000\ kgs/cm^2$, Poisson's coefficient μ=0.2, betonning solishtirma og'irligi γ=2500 kgs/m^3 .

5. Consolidation of loads

A total of 6 loadings were adopted in summing up the external effects, two of which consist of seismic impact forces in the transverse X and longitudinal Y directions.

The calculation of the building is based on the effects of special loads.

Loading 1. Permanent load (the specific weight of the building, gf =1.1 is accepted with a reliability factor).

Loading 2. Constant load, multi-cavity slab, cladding, insulation, heat-retaining layer, floor, curtain wall, profiled and integral progons (see table 1.2).

Loading 3. Long-term load - useful load (the weight of people and equipment, γ_f = 1. accepted with a reliability coefficient according to QMQ 2.01.07-96, clauses 3.10-3.11).

Load 4. Short-term load - snow (paragraph 5.7 of QMQ 2.01.07-96 according to reliability coefficient γ_f =1.4).

Loading 5 and 6. Seismic effects in the corresponding X and Y directions Tashkent city - 8 points.

A summary of the loads is given in Table 1.2 below.

1.2 - table. Aggregation of loads.

№	**Naming of loads**	**Unit of measure**	**Normative value**	**Working conditions coeff.**	**Computational value**
1	2	3	4	5	6
1.	The specific weight of the building is accepted with a reliability factor of $\gamma_f = 1.1$				
2.	**Permanent loads applied to the coating**				
2.1.	Wavy asbestos slate 1750×1130x5.2	kgs/m^2	10,42	1,05	10,94
2.2.	6 m and 3 m integrated progon	kgs/m	24	1,05	25,2
2.3.	Heat preservation layer - expanded clay t=150 mm; γ=800 kg/m^3	kgs/m^2	120	1,3	156
2.4	Cement-sand mixture layer t=30 mm; γ=1800 kg/m^3	kgs/m^2	54	1,3	70
2.5.	The thickness of the multi-cavity plate is 220 mm	kgs/m^2	115	1,1	126,5
2.	**Constant loads applied to the rolling plate**				
2.1	Wooden floor, cross-sectional surface dimensions 0.05x0.2 m.	kgs/m2	77	1,1	84,7
2.2	The size of the cross-sectional surface of a wooden beam is 0.25x0.3 m.	kgs/m2	115	1,1	126,5
2.3.	Floor covering (linoleum)	kgs/m2	10	1,2	12
2.4.	Curtain walls (brick wall)	kgs/m^2	100	1,2	120
3.	**Long term**				
3.1.	Useful	kgs/m^2	200	1,3	260
4.	**A short term**				
4.1.	Snow load	kgs/m^2	70	1,4	98

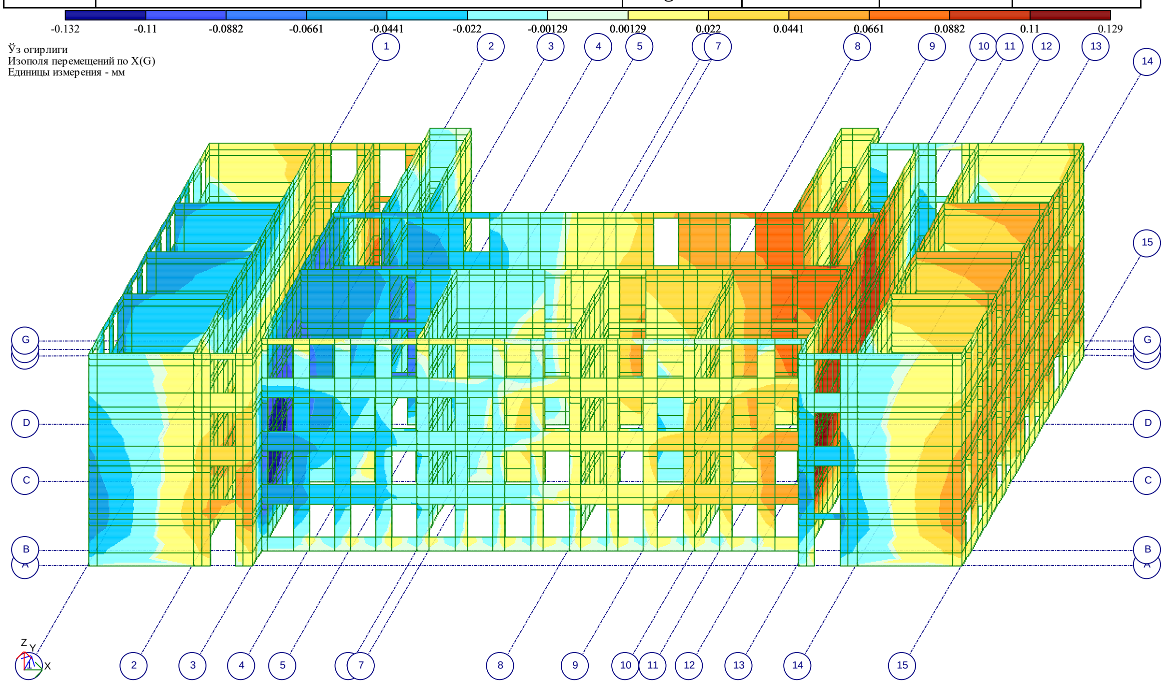

Fig. 1.4 isopoly of equivalent stresses in tension in building structures

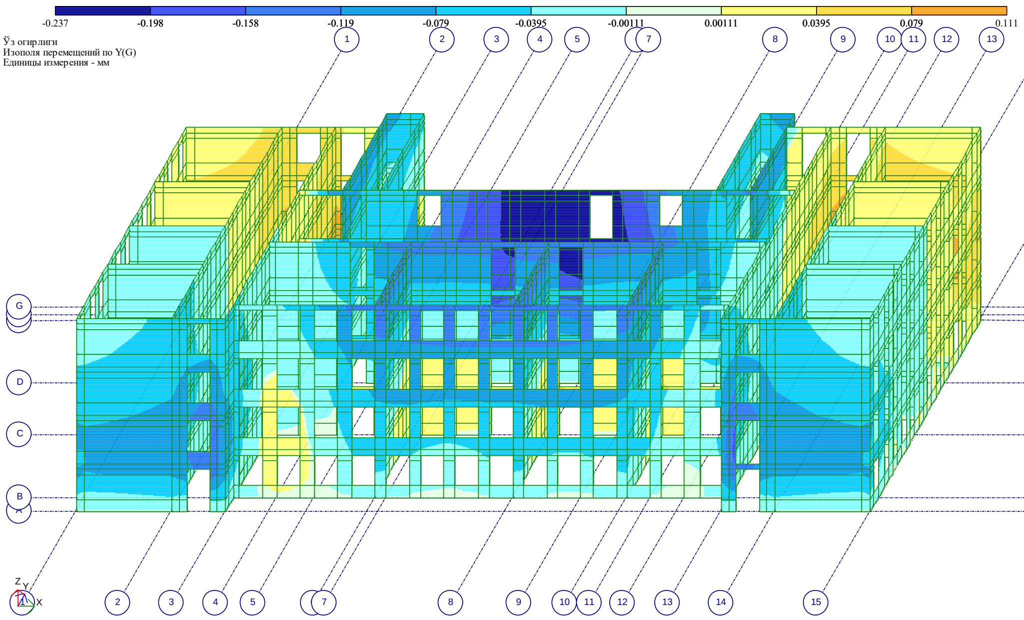

Figure 1.5. Isopoly of displacements of longitudinal walls of the building along the Y axis

Conclusion*:*

Based on the results of calculation of the four-story building under the influence of 8-point seismic forces, the states of deformation and stress of the building, the frequency of specific vibrations of the building, the maximum displacements and stresses of its walls were analyzed.

2. It was found that the characteristic vibration period of the building obtained by theoretical calculation (Th=0.23 sec) is significantly different from the characteristic vibration period (Te=0.14 sec) obtained by recording microseismic vibrations experimentally.

3. There are two reasons for such a difference: firstly, the period of specific vibration is determined by the method of microseismic vibrations through the initial elasticity modulus of the dynamic integrity of the building; secondly - since the partitions of the building are made of wooden beams and do not form a single unified spatial unit, under the influence of 8-point seismic forces, it causes large deformations, especially along the transverse X-axis, as a result of special vibration period will also be large.

4. The maximum displacement of the building under the influence of 8-point seismic forces along the X axis is 0.19 mm<(1/200)l =0.25 mm, that is, it is specified in the normative document QMQ 2.01.03-19 less than the threshold value.

5. The maximum displacement of the building under the influence of 8-point seismic forces along the Y axis is 0.11mm <(1/200)l =0.25mm, that is, it exceeds the limit value specified in the normative document QMQ 2.01.03-19 small.

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