The American Journal of Applied Sciences
(ISSN – 2689-0992)
Published: December 27, 2020 | Pages: 90-99
Doi: https://doi.org/10.37547/tajas/Volume02Issue12-15

IMPACT FACTOR
2020: 5. 276
OCLC - 1121105553

Assessment Of Seismic Resistance Of Existing Preschool Educational Institutions And Recommendations For Their Provision Seismic Safety

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ABSTRACT

The article presents the results of calculations of buildings for seismic effects, selected preschool educational institutions in Fergana, as well as some recommendations for their further safe operation.

KEYWORDS

Damage, physical wear, inspection, earthquake-resistant construction, seismic force, displacement isofields, stress isofields, equivalent stress, dynamic characteristics.

INTRODUCTION

Similar research work was carried out in the buildings of preschool educational institutions (preschool educational institutions) in the works [1-4], the classification of preschool institutions is mainly determined depending on the building codes for earthquake-resistant construction, in force during their construction [5-11]. The results of a preliminary examination and a general assessment of the technical condition of the building structures of the selected preschool buildings are also given, taking into account the deformation, damage and physical wear of building structures. The space-planning and structural solutions of buildings and the compliance of their actual parameters with the requirements of the current normative documents on earthquake-resistant construction have been

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determined. Instrumental and computational studies have determined the dynamic characteristics of buildings, the physical and mechanical properties of the soil of the territory of preschool children and carried out verification calculations for the seismic resistance of preschool buildings.

In this article, we present the results of the verification calculations for seismic effects of the building of preschool educational institution No. 53 in Fergana.

Verification calculations of buildings of preschool educational institution No. 53

GENERAL DATA

1. Name of institutions: general educational preschool educational institution No. 53. Fergana.
2. Location of institutions: st. Kirguli house 28.
3. Verification calculation of buildings was carried out in accordance with the requirements of norms, recommendations and manuals [11-31].
4. Design materials for school buildings are not available.
5. Year of commissioning of preschool educational institutions: approximately in 1964, respectively.
6. Structural system of buildings: rigid frameless with longitudinal and transverse brick walls. The load-bearing structures of the buildings in the training blocks are three longitudinal brick walls. The buildings of educational blocks do not have protrusions in plan and differences in height of buildings in general and in anti-seismic joints.

The building of preschool educational institution No. 53 consists of three floors without a basement (Fig. 1). The block in plan has a rectangular shape with dimensions of 9.6x94.0 m. The block is divided into two compartments using an anti-seismic seam. The length of the building compartments is: 47.24 m and 46.86 m. The height of the floors from the floor to the upper part of the upper floor ceiling is 3.2 m. The basement height from the floor to the upper part of the upper floor ceiling is 2.7 m. The walls are full-bodied burnt brick 250x120x65 mm on a cement-sand mortar. The supporting structures are three longitudinal brick walls. The thickness of the outer longitudinal walls in the basement and on all floors is 0.51 m, and the thickness of the middle longitudinal wall is 0.38 m. The thickness of the transverse walls in all floors is 0.38 m. The pitch of the transverse walls differs significantly across floors and has dimensions of 2, 8 m; 3.3 m; 5.6 m; 6.0 m; 6.5 m.8.5 m; 11.4 m and 14.6 m. Cross walls do not connect all longitudinal walls. The span of the longitudinal walls consists of the width of the corridor and study rooms: 2.8x6.8 m. The partitions consist of brickwork with a thickness of 0.12 m. The width of the walls is 1.0 m. The width and height of the window openings: 1.2x2 m and 1 , 8x2 m, door poyem are: 1.2x2.4 m. Height from floor to window sill - 0.84 m. Overlap - reinforced concrete hollow-core slabs with dimensions: 1.2x2.8 m and 1.2x6.8 m. In the block there are two staircases at the ends of the block. The dimensions of the stairwells are 3.2x6.6 m. The floors are wooden in the classrooms and in the corridor, ceramic tiles in the bathrooms. The floors in the basement are concrete. The roof is attic. The supporting structures of the roof (rafters and lathing) are wooden. Roof - gable corrugated asbestos slate coverings.

7. Characteristics of the construction area:

7.1. Seismicity of the region and the construction site - 8 points [KMK 2.01.03-2019, Appendix 2];

7.2. Standard snow load: I - area s0 = 0.50 kPa (KMK 2.01.07-2019, Appendix 5).

7.3. Normative high-speed wind pressure: II-region Wo = 0.48 kPa (KMK 2.01.07-2019, Appendix 5.), terrain type - V.

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8. Characteristics of the building according to the regulatory document:

8.1. Building responsibility class - I (first);

8.2. The safety factor for the purpose □n = 1 (КМК 2.01.07-2019, Appendix 7).

8.3. Building responsibility category - III (third);

8.4. Coefficient of responsibility Ko = 1.2 (KMK 2.01.03-2019, Table 2.3.);

8.5. The base soils are loess-like loams. Soil category by

seismic properties - II (second);

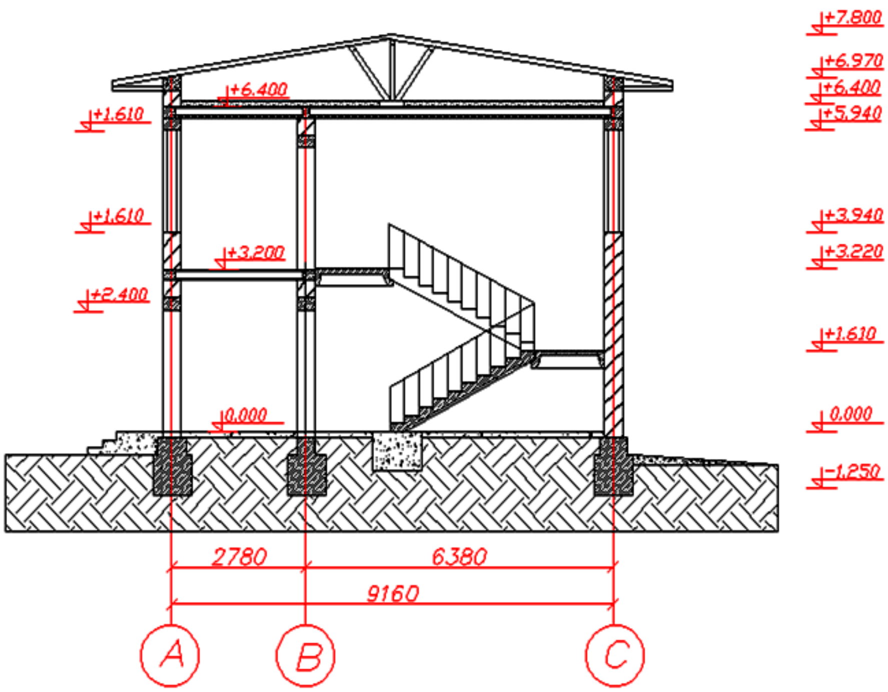

Fig. 1. Cross section of the block of preschool educational institution No. 53

The calculation of the preschool educational institution was carried out using the LIRA 9.6 software package. The design diagrams of the block compartments are taken as a spatial diagram with the corresponding finite elements. The initial indicators of the building according to the normative document KMK 2.01.03-2019 are shown in Table 1.

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Table 1. Initial indicators of buildings according to the regulatory document KMK 2.01.03-2019

Name of calculated indicators	Coefficient
1. Number of considered vibration modes	10
2. Mass matrix	Diagonal
3. Correction factor for seismic forces	1,0
4. Coefficient of responsibility of the structure, (KMK 2.01.03-2019, Table 2.3)	1,2
5. Coefficient of accounting for the recurrence of earthquakes, (KMK 2.01.03-2019, Table 2.4)	1,0
6. Coefficient of number of storeys of the structure, (KMK 2.01.03-2019, Table 2.10)	1,0
7. Regularity coefficient, p. 2.25 (KMK 2.01.03-2019, Table 2.12)	1,0
8. Seismicity factor of the site, (KMK 2.01.03-2019, Table 2.7)	1,0
9. Index of the region, (KMK 2.01.03-2019, Table 2.2)	III
10. Category of soil, tab. 1.1 (KMK 2.01.03-2019, Table 1.1)	II
11. Decrement of fluctuations, (KMK 2.01.03-2019, table 2.9)	0,3

STRENGTH AND MECHANICAL CHARACTERISTICS OF BUILDING MATERIALS

During the construction of the preschool educational institutions, brick of the M75 brand and the mortar of the M50 brand were used. The category of masonry based on the strength characteristics of masonry according to KMK 2.01.03-2019 was I with a temporary design axial tensile resistance along unbound seams (normal adhesion): 120 kPa≤ Rtb <180 kPa.

According to SNiP II-22-81 * "Stone and reinforced masonry structures", the design resistance of the masonry to axial tension and compression are:

design compressive resistance of the masonry: R = 1300 kPa (SNiP II-22-81 *, Table 2);

axial design resistance along the unbound section (normal adhesion, in the horizontal direction): Rt = 80 kPa (SNiP II-22-81 *, Table 2);

axial design resistance along the tied section (normal adhesion, in the vertical direction): Rt = 160 kPa;

design tensile resistance of the masonry in bending along untied sections: Rtb = 120 kPa (SNiP II-22-81 *, Table 10);

design tensile resistance of the masonry in bending along the tied sections: Rtb = 250 kPa;

design resistance to the main tensile stresses along the seams of the masonry along untied sections: Rtw = 120 kPa (SNiP II-22-81 *, Table 10);

design resistance to the main tensile stresses along the seams of the masonry along the tied sections: Rtw = 250 kPa;

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design shear resistance of the masonry in a horizontal untethered section (tangential adhesion): Rsq = 160 kPa (SNiP II-22-81 *, Table 10);

design shear resistance of masonry in a vertical tied section (in the vertical direction): Rsq = 240 kPa.

Below are the mechanical characteristics of the brickwork.

The modulus of elasticity of brickwork according to SNiP II-22-81 * is determined as follows:

$$E_0 = \alpha \cdot k \cdot R, (1)$$

where coefficient k (Table 14) characterizing the type of masonry and take 2, coefficient α

(Table 15), characterizing the elasticity of the masonry and taking 1000 based on the strength characteristics of the masonry, R is the design compressive resistance of the masonry

As a result of the calculation according to the obtained data of brickwork, the elastic modulus is: $E_0 = 1000 \cdot 2 \cdot 13 = 26000$ kgf / 〖cm〗 ^ 2 = 2.6 10 ^ 6 kPa, Poisson's ratio of the brickwork: μ = 0.25, specific the weight of the brickwork is: γ = 18 kN / m3.

For concrete products, the following mechanical properties were obtained: E = 30 · 10 ^ 6 kPa, Poisson's ratio - μ = 0.2, specific gravity of the concrete product - γ = 25 kN / m3.

COLLECTING LOADS

When collecting external loads, a total of 6 load cases were obtained, including two seismic, corresponding in the transverse X and longitudinal Y directions.

The collection of loads is shown in Table 2.

The verification calculation of the building was carried out for the basic and special combination of loads.

Loading 1. Constant loads (the dead weight of the building is set automatically with a safety factor: γf = 1.1)

Loading 2. Permanent loads, round hollow-core slabs, coverings, ceilings, insulation, floor, partition, corrugated board and continuous purlins.

Loading 3. Long-term - payload (with a safety factor: γf = 1.2 according to KMK 2.01.07-96, see paragraph 3.10 - 3.11).

Loading 4. Short-term load - snow (with a safety factor: γf = 1.4 according to KMK 2.01.07-96, see paragraph 5.7).

Load cases 5 and 6. Seismic intensity along the X and Y axes - 9 points.

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Table 2. Collection of loads on the design model of buildings

№ п.п.	Name of loads	Unit Rev.	Norm. value	Coef. condition. work	Calculated value
1.	Constant coating loads				
1.1.	Corrugated asbestos slate: 1750 × 1130x5.2	Па	104,2	1,05	109,4
1.2.	Solid purlins 6 m and 3 m long.	Н/м	240	1,05	252
1.3.	Insulation - expanded clay t = 150 mm; γ = 800 kg / m3	Па	1200	1,3	1560
1.4.	Cement-sand screed: t = 30 mm; γ = 1800 kg / m3	Па	540	1,3	700
1.5.	Hollow-core floor slab, thickness - 220 mm	Па	3000	1,1	3300
	Total:	Па			5560
2.	Constant floor loads				
2.1.	Cement-sand screed: t = 40 mm; γ = 1800 kg / m3	Па	720	1,3	940
2.2.	Floor covering (linoleum or ceramic tiles)	Па	100	1,2	120
2.3.	Partitions (brickwork)	Па	1000	1,2	1200
2.4.	Hollow-core floor slab, thickness - 220 mm	Па	3000	1,1	3300
	Total:	Па			5560
3.	Long				
3.1.	Useful	Па	1500	1,3	1950
4.	Short-term				
4.1.	Snow	Па	500	1,4	700

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RESULTS AND ANALYSIS OF THE CALCULATION

Using the initial materials, as well as on the basis of the results of instrumental - survey research, using the software package LIRA 9.6 calculated natural periods and frequencies of oscillation, displacement and stress in the masonry walls of the compartment of the building of preschool educational institution No. 53 with seismic intensity of impact - 8 points.

The obtained results of the stress-strain state of the preschool educational institution are shown in Figure 2. The figures show the distributions of displacement in the transverse direction (a) and the highest value of tensile stress (b) in the masonry of the walls of the building of the preschool educational institution No. 53 with seismic impact of 8 - points.

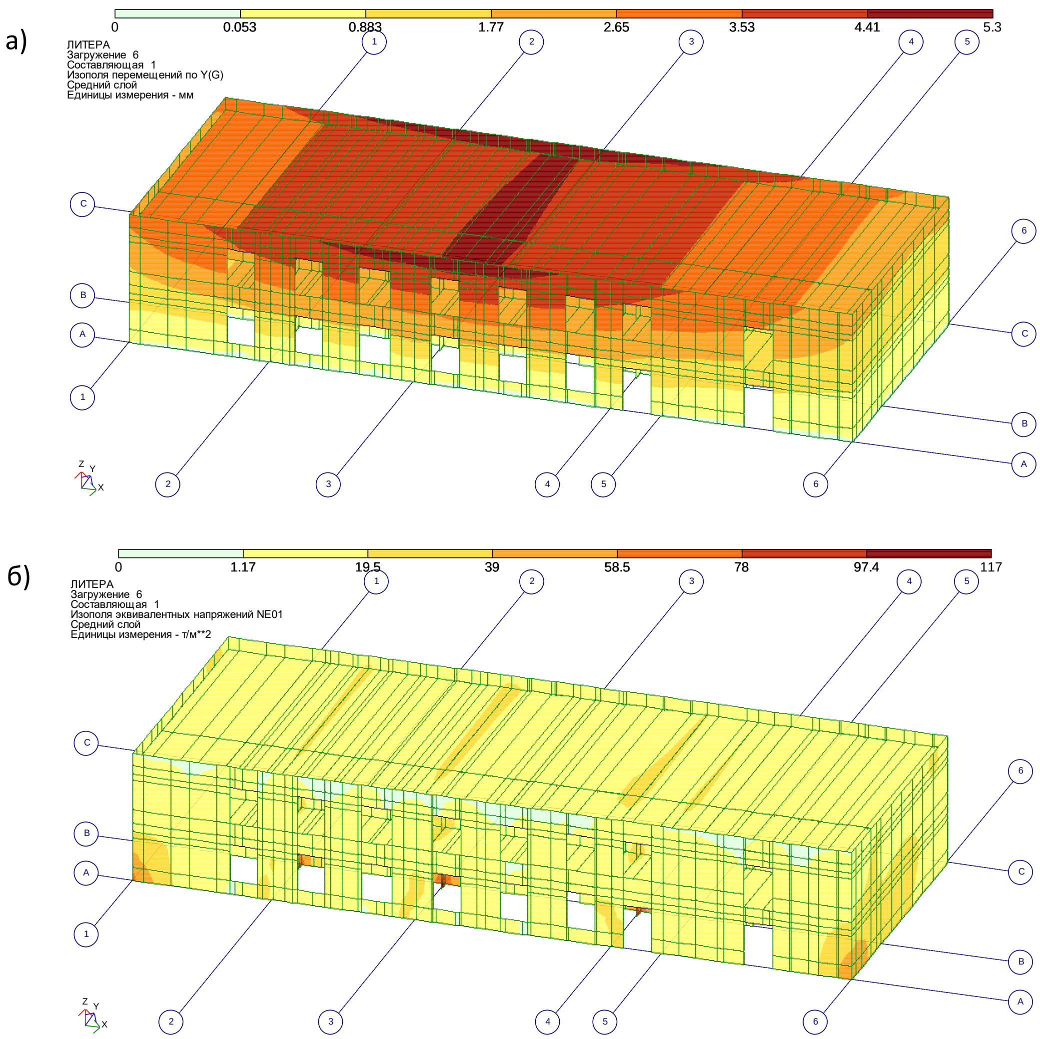

Fig. 2. Displacement (a) and stress (b) in the laying of the wall of the building of preschool educational institution No. 53

CONCLUSION AND RECOMMENDATIONS

1. No defects and damages were found in the bearing and non-bearing structures of the floors of the blocks, which reduce the bearing capacity of the buildings of the blocks, except for peeling of plaster and traces of water leakage in some places. General physical deterioration of building structures in block floors is up to 20%, the degree of damage is low.
2. Comparing the limiting and actual parameters of structural systems, it was found that the buildings of the preschool educational institution do not meet the standards of earthquake-resistant construction [1-3]. The results of the analysis show that more than half of the presented parameters of preschool educational institutions do not correspond to the limiting parameters of the norm for buildings made of brickwork of the II category [11].
3. Based on the results of the analysis of the calculation results, the natural vibration frequencies, the maximum values of displacements and stresses in the masonry of the walls of school buildings No. 53 under seismic impact were determined - 8 points.
4. The maximum displacements of the building of preschool educational institution No. 53 along the horizontal axes are within the limits of the norms [11] and are, respectively: 5.3 mm. The stresses in the walls of the preschool educational institution are greater than the design resistance to axial tension along unbound seams (normal adhesion) and are, respectively, 1170 kPa.
5. For the further normal operation of the buildings of preschool educational institution No. 53, it is recommended to use constructive measures to strengthen the building structure. When carrying out major repairs (reconstruction), mandatory constructive measures are framing openings and reinforcing walls.

On the basis of the studies carried out, it is recommended to conduct a detailed examination of the buildings of preschool educational institution No. 53 in Fergana, to determine the strength of load-bearing structures by instrumental methods and a verification calculation for seismic loads, taking into account their deformation and physical wear of structural elements. The use of constructive measures to strengthen (restore) buildings and ensure their seismic safety, reducing seismic risk and damage in case of possible strong earthquakes.

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Мавжуд мактабгача таълим муассасалари биноларини сейсмик мустаҳкамлигини баҳолаш ва уларнинг хавфсизлигини таъминлаш бўйича тавсиялар

Аннотация. Мақолада танлаб олинган мактабгача таълим муассаси биносини сейсмик кучлар таъсирига ҳисоблаш натижалари ҳамда уни хавфсиз эксплуатация қилиш учун тавсиялар келтирилган.

Калит сўзлар: шикастланиш, физик эскириш, тадқиқ қилиш, сейсмик мустаҳкам қурилиш, сейсмик куч, кўчишлар изополяси, кучланишлар изополяси, эквивалент кучланиш, динамик кўрсаткичлар.

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Оценка сейсмостойкости существующих зданий дошкольных образовательных учреждений и рекомендации по обеспечению их сейсмической безопасности

Аннотация. В статье приведены результаты расчетов зданий на сейсмические воздействия, выбранных дошкольных образовательных учреждений г.Фергана, а также некоторые рекомендации по дальнейшей их безопасной эксплуатации.

Ключевые слова: повреждение, физический износ, обследование, сейсмостойкое строительство, сейсмическая сила, изополя перемещений, изополя напряжений, эквивалентное напряжение, динамические характеристики.