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ASSESSMENT OF SEISMIC RISK IN ALMATY

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ABSTRACT: *This paper provides a brief description of the latest earthquakes that have occurred in the Republic of Kazakhstan in recent years. Further detailed information is provided on the work done to assess the seismic risks of Almaty: instrumental survey, assessment of the expected degree of damage to buildings, development of recommendations; expert assessment of the seismic vulnerability of economic damage and social losses from the consequences of possible earthquakes of different intensity.*

Keywords: *earthquake, passportization, survey, expert assessment of seismic vulnerability.*

1. Introduction

The city's territory is located in one of the most seismically active regions of Central Asia. Almaty seismogenic zone is bounded on the South with the TRANS-ili, on the South-East to North-Kungeiskiy, in the South-West with Kemin, in which was located the foci of strongest earthquakes. Over the past 100 years, there have been three major earthquakes: Vernenskoe 1887, Chilikskoe 1889 and Keminskoe 1911. the Magnitude of the last of them was close to 8.2 with an intensity in the epicenter from 10 to 11 points [1]. Almaty seismogenic zone is bounded on the South with the TRANS-ili, on the South-East to North-Kungeiskiy, in the South-West with Kemin, in which was located the foci of strongest earthquakes. At the Vernensky earthquake on June 9 (may 29), 1887. the magnitude (M) is 7.3, the intensity at the epicenter (10) is 9 or more points (here and further in the text, the intensity is indicated in the points of the descriptive part of the MSK - 64 seismic scale), the local time is 4 hours and 35 minutes.most of the city's buildings were destroyed or severely damaged, and almost no houses remained that were not affected at least in a small degree. In some areas of the city, gaps were formed in the ground. In places, the width of the gaps reached 1 m at a depth of up to 5 m. At the time of the earthquake in g. According to various data, there were 1,938 houses with walls of mud brick and stone, and 938 wooden buildings in Vernon and suburban villages. During this earthquake, about 800 people were killed and injured in Vernon and suburban villages. At that time, about 30 thousand people lived in the city [2].

On the first day after the earthquake, palpable tremors followed with an interval of 2 to 3 minutes. By the end of 1887, the number of aftershocks reached 250, and in the following 1888, there were about 150 repeated aftershocks.

On the territory of the city there are zones of possible tectonic faults on the earth's surface, areas located on slopes with a steepness of more than 15% and composed of loose water-saturated and subsidence soils or in areas of possible passage of mudflows. According to the map of complex seismic microdistricting of 1981, the territory of Almaty is divided into zones with different intensity of predicted seismic impacts: zone I-8 points, zone II-9 points, zone III-10 points. Every year, on average, 15-20 earthquakes occur in Kazakhstan with an intensity of up to 3-4 points [3].

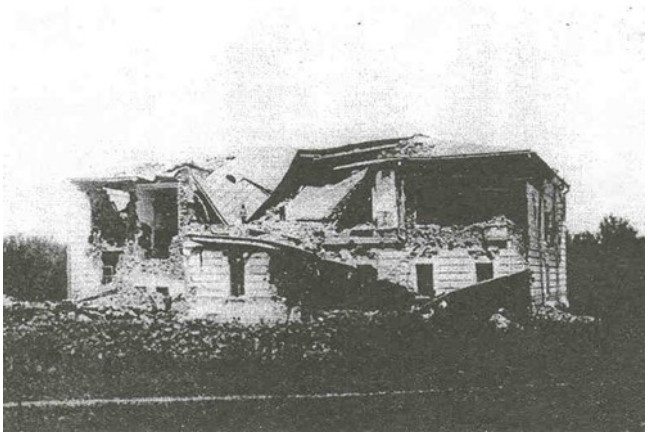

Fig.1 Vernenskoe earthquake of 1887 (M7,3)

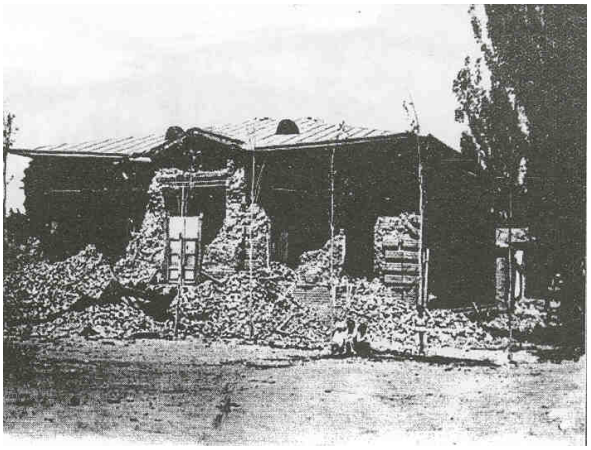

Fig.2 Chilik earthquake of 1889 (M8, 3)

2. Generalities

In the earthquake-prone regions of the Republic of Kazakhstan and in Almaty, expert assessment of the state of the existing development was carried out at different times.

An expert assessment of the condition of buildings in earthquake-prone areas of Kazakhstan, carried out in 1990, showed that, for example, residential buildings with a total area of 16.5 million m2 (19%) required seismic reinforcement; 10 million m2 (12%) - were subject to demolition.

In 2008, under the auspices of the Japan International cooperation Agency (JICA), a sample survey of 320 multi-family residential buildings located in different administrative districts of Almaty was conducted. The survey showed that at least 30% of existing apartment buildings are not earthquake-resistant.

International experience shows that every devastating earthquake leads to a change in building regulations in the direction of stricter requirements. In connection with the observed tightening of the requirements of the standards, researchers and designers are faced with problems related to the assessment of seismic resistance and seismic safety of previously constructed objects [4].

At the same time, the deployment of a set of works to prepare cities for natural disasters is currently constrained by the lack of information about the amount of necessary costs for carrying out protective measures of various significance. These costs can be justified by estimates of expected damage and possible manifestations of earthquakes made in the form of forecasts. At the same time, forecasting the consequences of earthquakes should become an intermediate stage between forecasting earthquakes and carrying out protective measures, and a strategy for preparing for single strong earthquakes should be adopted as the basis for the comprehensive implementation of forecasts [4].

3. Purpose of work

determination of the need to implement priority measures to account for seismic risk, prevent socio-economic losses, to ensure safety and improve the quality of life of the population, sustainable socio-economic development;

creating conditions for the sustainable functioning of the main social infrastructure facilities, life support systems and housing stock in Almaty;

achieving an acceptable level of seismic safety of buildings and structures in Almaty;

reducing possible economic, social and environmental damage from seismic impacts;

creation of passports for seismic survey of real estate objects (multi-apartment houses and buildings of schools, kindergartens, hospitals, clinics) in Almaty;

creating a risk map with reference to the materials of certification of the surveyed objects in Almaty.

4. Task of work

Passportization of real estate objects in Almaty includes the following stages of work: visual inspection of buildings in Almaty in the context of administrative districts;

creating an electronic passport of real estate objects in the GIS program with reference to the local coordinate system of Almaty;

identification of seismically vulnerable objects, in relation to which measures should first be developed to reduce the seismic risk of their further operation to an acceptable level;

identification of the most earthquake-prone objects that require priority demolition or reinforcement;

development of recommendations for further operation, seismic strengthening or demolition of the object;

assessment of the expected degree of damage to buildings and structures depending on their design solutions, wear and seismic strength at maximum seismic impacts;

assessment of economic and social damage from the consequences of possible earthquakes, assessment of economic costs of seismic reinforcement by indicators of the degree of damage to buildings in case of possible calculated earthquakes;

preparation of a scientific and technical report.

5. Execited work

Passportization was carried out to obtain up-to-date data on the seismic vulnerability of buildings and structures, primarily residential and social facilities, which is an urgent task not only for Almaty, but also for all localities located in earthquake-prone regions of the Republic of Kazakhstan.

Work on certification was carried out in 2017-2018.

In 2017, a survey was conducted of 7027 real estate objects in Almaty, including 6493 multi-family residential buildings and 534 social objects (schools, kindergartens, hospitals, clinics).

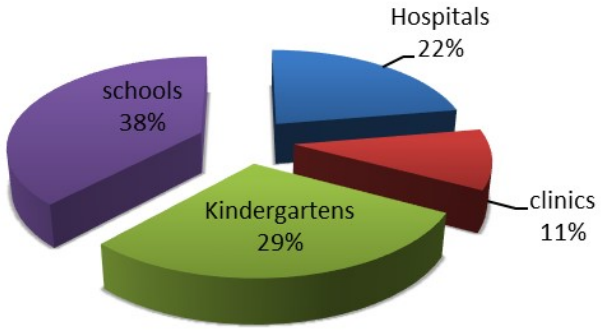

Fig. 3 structure of certification of municipal property objects by type of service

According to the results of the work performed in 2017 on the certification of real estate objects in Almaty, it was revealed:

Of the total number of buildings surveyed, the following are earthquake – resistant: schools-190 out of 323 (58.9%), kindergartens – 129 out of 246 (52.5%), hospitals – 76 out of 191 (39.8%), clinics – 69 out of 89 (77.6%), apartment buildings – 4147 out of 6490 (62.5%). By construction volume (total area), 73.6% of

schools, 62.1% of kindergartens, 77.6% of hospitals, 91.5% of polyclinics, and 82.1% of multi-family residential buildings are earthquake-resistant.

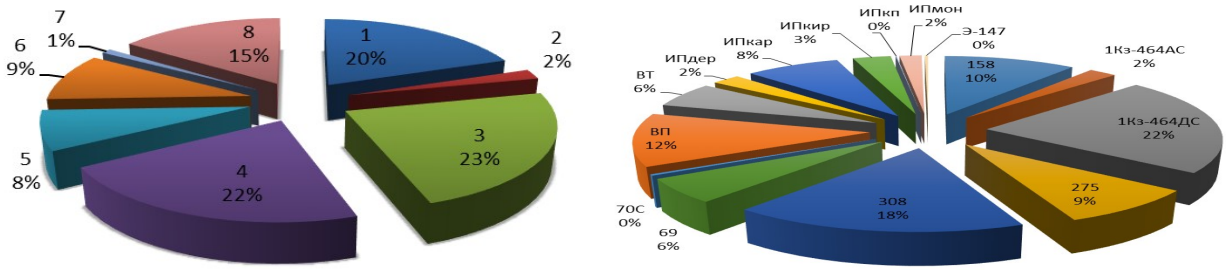

Fig.4 the Structure of apartment buildings by administrative districts and by type series

In 2018, a survey of 3,169 residential and civil buildings in Almaty was conducted, including 1,683 multi-family residential buildings, 1,486 civil and public buildings (administrative buildings, shopping centers, sports facilities, school and pre-school buildings, health resort buildings, recreation and tourism buildings, and polyclinics).

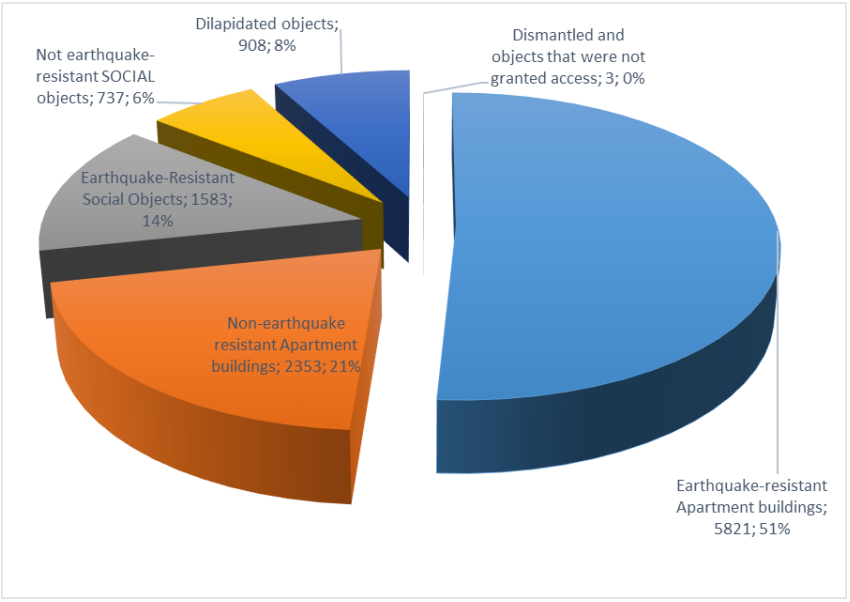

Fig.5 Structure of municipal property by type of service

Of the total number of buildings surveyed, the following are earthquake-resistant: schools – 80 out of 96 (83.4%), kindergartens – 84 out of 104 (80.8%), medical and health institutions – 267 out of 365 (73.2%), other buildings (multifunctional, administrative, shopping and entertainment centers, shops, sports, etc.) -778 out of 922 (84.4%), apartment buildings – 1662 out of 1683 (98.8%). By construction volume (total area), 81.5% of kindergartens, 91.2% of schools, other buildings (multifunctional, administrative, shopping and entertainment centers, shops, sports, etc.), and 99.6% of multi-family residential buildings are earthquake-resistant.

6. Conclusion

The results of passportization made it possible to identify earthquake-prone buildings, assign priority objects for their seismic strengthening or demolition, and determine the amount of costs for strengthening earthquake-prone buildings and demolishing dilapidated housing [5].

According to the data of Passportization was revised to state program (for demolition of residential houses) and the old residential houses in Almaty are being demolished and in place of them to build new earthquake-resistant houses.

A spatial-territorial analysis of the data obtained with a seismic micro-zoning scheme was performed.

The classification of construction objects is based on the MSK-64 (K) seismic scale.

Based on the results of passportization, electronic passports of the surveyed buildings were created with an assessment of their seismic vulnerability.

An expert assessment of the economic costs of seismic reinforcement, economic damage and social losses from the consequences of possible earthquakes of different intensity is given.

Based on the results of certification, an electronic database on the seismic vulnerability of buildings and structures in Almaty was created, which will improve the reliability of life support systems, reduce damage to buildings and structures, and reduce the loss of population from destructive earthquakes.

An information model of urban development was created in the ArcGIS "ArcScene" program.

Based on the results of the research work, work will continue on creating an electronic map of the seismic risk of Almaty.

7. References

[[1] SN RK 2.03-28-2004 "MSK-64 (K) earthquake intensity assessment Scale", Almaty 2004.

[2] Taubaev A. S. "Analytical note on the seismic regime of the territory of the city of Almaty and the seismic stability of its development", Almaty, 2008.

[3] SP RK 2.03-30-2017* "Construction in seismic zones".

[4] lessons from the Lugovsky earthquake of May 23, 2003 in Kazakhstan. UN Development programme in Kazakhstan, Almaty 2004.

[5] Ashimbaev M. U., Shokbarov E. M., Tuleyev T. D., Aldakhov S. D., Taubaev A. S. "Recommendations for the design, construction and strengthening of residential buildings from local construction materials (Adobe, slag blocks) in the seismic regions of Kazakhstan" Almaty, 2008.

