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Abstract. This article enlightens the seismic risk of the buildings in residential areas in the Jizzakh region. Strong earthquakes and their losses have been analyzed on the basis of construction materials of the buildings in residential areas of Jizzakh region. The damage diagrams of the buildings and structures have been made up and their values have been determined based on the maximum acceleration of building materials and seismic impact points by Using GESI_Program developed by the United Nations Global Earthquake Safety Initiative. At the same time, seismic risks due to strong earthquakes (at points 6, 7 and 8) have been assessed at regional level. Depending on the results of the research, the direct economic losses of the population and the territory of Jizzakh region in strong earthquakes have been assessed and proposals have been developed to mitigate the effects of strong earthquakes. Based on the results obtained, movement of emergency rescue units in emergencies will allow to optimize the planning of construction of individual housing estates on the basis of standard designs.

Keywords: seismic risk, construction materials, macroseismic research, seismic intensity, seismic isolines, GESI_Program, vulnerability function and degree

INTRODUCTION

At present, there is a major opportunity for long-term forecasting of the consequences of a strong earthquake. In particular, it is possible to assess the seismic safety of identified areas and buildings, the seismic resistance of structures, and as a result of it, to predict the condition of urbanized areas after earthquake.

On the basis of such a prediction, in turn, it is possible to substantiate the development of measures to mitigate and reduce the effects of earthquakes, as well as planning decisions in the development of urban areas in seismically active territories. In this regard, seismic risk assessment in urban areas is thought to be a very urgent task. According to the modern literature, seismic risk is a complex quantity that reflects different empirical manifestations of a strong earthquake and can reflect long-term economic, environmental, and social consequences.

The basis of seismic risk is the concept of scientific assessment of possible seismic risk in the area and the potential socio-economic damage of earthquakes, which may correspond to the vulnerability of construction and natural objects (type of buildings and infrastructure, quality of construction, population density, landslides, floods, ecology, etc.). As a result of seismic vulnerability of buildings and structures in settlements and seismic risk assessment, seismic risk maps can be created, as well as the expected damage based on the balance value of facilities can be estimated financially.

The analysis of the existing approaches to seismic risk assessment in the world has shown that they are all based on one common principle which is to have a large multidimensional database that distinguishes different factors in risk detection.

They include: a set of seismic maps made up for different probability periods, providing seismic risk forecast data; effects of local ground conditions, which play an important role in seismic risk assessment, as well as seismic

variability of the areas with deep cracks, rock fractures, landslides, saturation soil with water and their proximity to the surface, etc.; damage and vulnerability to earthquakes of various structural types of mostimportant objects, buildings and structures; population and its density; the volume of damage caused by earthquakes of various types; socio-economic data used in risk assessment, etc.

As a result, the levels of risk potential which determine the various factors are identified and mapped in GIS.

Although many important scientific and practical results have been obtained, there are a number of unresolved issues in this field. The assessment of seismic risk for real earthquakes in urban and regional areas and their mapping have not been fully analyzed and the scientific methodological foundations have not been established. One of them is determination of seismic risk on the basis of deterministic and probabilistic approaches in the assessment of seismic risk, as well as modeling of seismic impacts at different levels taking into account soil conditions. As a result of the analysis of the consequences of strong earthquakes, the study of the impact on the population and the environment, as well as practical assessment of the causes of damage to buildings in the event of earthquakes of various magnitudes, the issues of forecasting the losses are becoming increasingly important.

MAIN PART

The total area of Jizzakh region is 21.2 thousand square km. (4.7% of the total area of the country) and the population is 1388.5 thousand (as of April 1, 2020). 650.3 thousand people live in urban areas (46.8% of the total population) and 738.2 thousand people in rural areas (53.2%). The population density is 65.2 people per 1 sq. km. There are 12 districts and 1 city in the region, and there are 294 267 individual and multi-storey buildings in the region, consisting of 4 types: concrete (large panel), wood, burnt brick and airbrick building materials . The largest number of airbrick buildings in the region is 77%, burnt bricks - 9%, concrete (large panel) - 12%, wooden - 2% [Aktamov B.U. 2020].

It is known that studying the damages of the buildings due to earthquakes is carried out in frames of the analysis of macroseismic researches. The consequences of strong earthquakeshave been studied in a macroseismicalway by well-known scientists such as T.R.Rashidov, K.S.Abdurashidov, U.Sh.Shamsiev, Sh.A.Khakimov, A.Djuraev and others (Tashkent, 1966, Gazli, 1976., 1984; Tovaksay, 1977; Nazarbek, 1980; Kayrakkum, 1985; Kon, 2011; Marjanbulak, 2013 and other earthquakes). On the basis of the obtained materials, the characteristics of the damage of individual houses under the influence of strong earthquakes have been distinguished. According to A. Djuraev, earthquake damage to buildings and structures can be due to 3 reasons: 1) the fact that the foundation of the building does not sink evenly, 2) as a result of resonance and 3) the increase in vibration acceleration because of the soil [Dzhuraev A., 2005,Aktamov B.U., 2020].

In our country, local building materials are widely used in the construction of rural settlements [Aktamov B.U., 2020]: clay pellet, airbrick and clay wall, and in some cases wall-framework, double-wall-framework and burnt brick. A similar situation is observed in Jizzakh region. Therefore, in this article, we have focused on the seismic strength of buildings made of clay pellet, airbrick and clay wall.

Clay pellet is a granular building material made of clay in the form of a melon and dried in the sun. Buildings made of this material are slightly and moderately damaged in earthquakes with a seismic intensity of 6 points. Moderate and severe injuries in 7-magnitude earthquakes have been observed in macroseismic studies.At intensities above 7 points, buildings built of clay pellet are destroyed and collapse.

Airbrick (without burning at high temperature) is a granular building material made of clay and dried in sunlight. This material comes in two sizes: made in standard molds and made in non-standard molds. But both do not differ in density, as they are dried in sunlight. Macroseismic studies have shown that airbrick buildings have some advantages over seismically stable buildings built of clay pellets.

Clay wall is a formless material that is brought to the level of mature (plastic) consistency as a result of processing (mixing) and compaction of healthy soil (loess rock). A metal formwork is used to erect the walls of the building from this material, or a 40 cm thick wall is raised manually and it is dried in a natural state and this process is repeated. Macroseismic surveys on clay walls have been conducted in only 7 point zones (Nazarbek earthquake, 1980). According to the study, clay wall buildings have higher seismic resistance than clay pellet and airbrick buildings.

The territory of Jizzakh region is located in the central part of the Republic,in terms of geographical location, it is situated in the transition zone from the Tianshan orogenic epiplatform to the Turan platform. The seismicity of the area is related to modern tectonic movements in the region. Mogiltau-Pistalitau, South-Fergana, Besapa-North-Nurata and North-Kuljuktau-Turkestan seismogenic zones are located in the region [Nurmatov UA. 2016, Aktamov

B.U. 2020, Ibragimov R.N. 2011, Artikov T.U.2020]. According to the seismic potential, these seismic zones have different indicators.

According to the results of the macroseismic study of the consequences of the Marjanbulak earthquake [Aktamov B.U., 2020, Usmanova MT, 2015], the degree of damage to individual buildings made of local raw materials in the region varies depending on the seismic indicators. For example: damage to buildings made of clay pellet, airbrick and clay wall falling into the epicenter zone is distributed as follows: buildings with clay pellets are of 4-5 degrees; airbrick buildings are of 3-4 degrees and clay wall buildings are of 2-4 degrees. Of course, the degree of damage to any building depends not only on the materials from which it is built, but also on its dimensions, construction quality, compliance with standards and control. In determining the degree of damage to buildings, MSK-64 or its modern interpretation is mainly based on EMS-98 scales. Depending on these results, for example, the degree of damage, the strength and intensity of the earthquake are assessed.

The methodology of the research. The methodology for assessing seismic risk at the regional level is based on the following research:

1. Seismic hazard assessment at the regional level based on deterministic and probabilistic approaches, taking into account the extinction of seismic vibrations and ground conditions.

In assessing the seismic risk of a regional area, it is usually analyzed and evaluated on the basis of deterministic and probabilistic approaches.

At present, the methods of estimating the seismic risk of the territory of Uzbekistan in the probabilistic approach are based on a comprehensive program "SEISMHAZARD_UZ" developed by T.U. Artikov, R.S. Ibragimov, A.H. Ibragimov and others to assess the maximum seismic vibration of earthquakes in different periods. It has calculated the maximum values of possible seismic impact between 500, 1000 and 2500 years.

The deterministic approach basically takes into account the high magnitude earthquakes that may occur in the region when assessing seismic risk. Currently, the seismic risk identified by A.A. Gusev, L.S. Shumilina, K.N. Akatova on the basis of a deterministic approach is used as a "neodeterministic" or "earthquake scenario" in the assessment of seismic risk.

Assessment of the seismic effect of strong earthquakes is carried out on the basis of instrumental and macroseismic studies. Of course, each earthquake is different with its own characteristics. But there are regularities that generalize them. Based on the determinedregularities, seismic vibration allows to assess the extinction of indicators depending on the ground conditions, to predict the degree of damage to buildings and structures.

2. Assessment of seismic vulnerability of buildings and structures of different constructions and the degree of their damage as a result of strong earthquakes.

The existing buildings in the settlements and cities of Jizzakh region are analyzed on the basis of cadastral data (194862) and all constructed buildings are divided into four groups according to their structural types:

A) type - detached houses built of local building materials (clay pellet, airbrick and clay wall).

Б) type - administrative, social, individual and multi-storey buildings, built of burnt brick (up to 2 storeys).

B) type - administrative, social and residential buildings made of wood (wooden houses, private houses built with a wooden frame).

C) type - administrative, social and residential buildings, buildings with reinforced concrete structures built using anti-seismic measures (more than 2 floors).

The seismic vulnerability functions and damage levels of the buildings have been determined for each separated group.
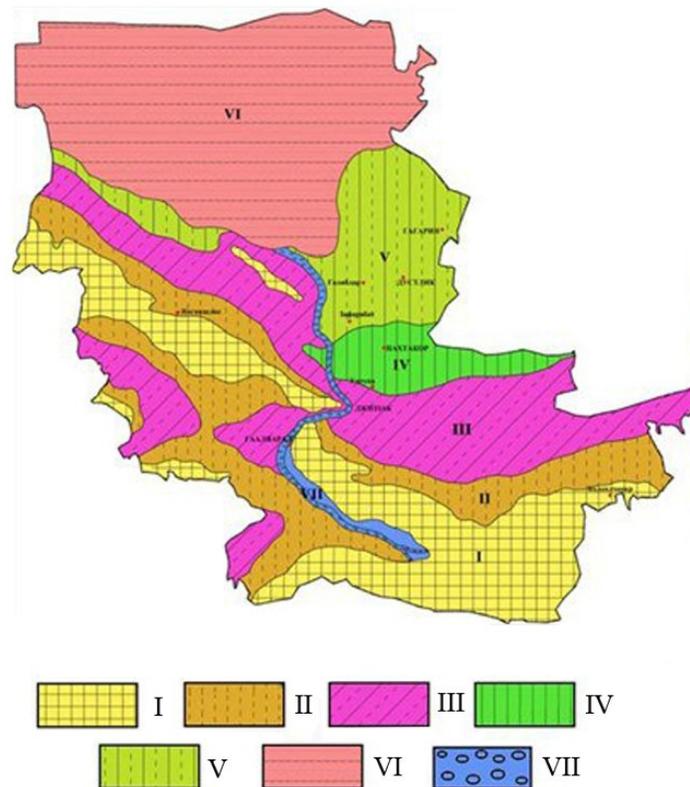
FIGURE 1. Map of division of the territory of Jizzakh region into engineering-geological types scale 1: 350 000 [Ismailov V.A., 2017]:

The value of seismic risk in local areas is greatly influenced by the engineering-geological conditions of the area. To determine the value of seismic intensity in the territory of Jizzakh region, the territory of the region is divided into types using the engineering-geological analogous method. The main factors are the slope of the relief, the lithological section at a depth of 10 meters, the groundwater level and engineering-geological processes.

Taking into account the above (Figure 1)given factors, 7 types have been identified in Jizzakh region according to engineering-geological conditions:

I type - this area mainly consists of metamorphic, igneous and sedimentary rocky soils. Groundwater can be found in cracks and is common at depths of up to 60 m. According to the engineering-geological and seismic characteristics, it belongs to the rocks, and the increase in seismic intensity is -1 point.

II type - the lithological composition of these deposits consists of pebbles, gravels and sand, which are the products of physical erosion of rocks, the upper part of which is covered with thin supes deposits. Groundwater has a temporary flow property. According to the engineering-geological conditions, the seismic intensity of the allotted area is 0 point.

III type is characterized by quaternary deluvial-proluvial formations up to 30 m thick. This layer is characterized by the alternation of loesstype rocks, sands and gravel-sandy layers. Groundwater is at a depth of more than 20 m. Depending on the thickness of coarse-grained soils in the area of distribution of this type of soils, the increase in seismic intensity varies from 0 to +1 point.

IV type – this type is bounded between the foothills and the Mirzachul plateau. It is mainly represented by proluvium loess rocks with a thickness of 50-70 m. Groundwater lies at a depth of 5-10 m depending on the relief, in some areas it is distributed close to the surface. The increase in seismic intensity in these areas varies from 0 to +1 points depending on the seismic properties of the soil.

V type - proluvium loess plains, common within the Mirzachul loess plains. Unlike the fourth type, groundwater is very close to the surface. This is due to the process of flooding the area as a result of intensive irrigation. Seismic intensity reaches +1 point.

VI type - luvium-proluvium loess planes within the lowlands formed as a result of accumulative activity of the Syrdarya stream. Groundwater lies at a depth of up to 5 m, sometimes 7-10 m. Wetlands are observed near Aydarkol Lake. Loess rocks are up to 70 m thick. Seismic intensity reaches +1 point.

VII type - this type crosses the eastern valley of the Gallaorol depression and occupies the modern valley of the Sangzor River. The riverbed is characterized by rock and pebble sediments up to 10 m thick. The increase in seismic intensity of the region is 0 and -1 points.
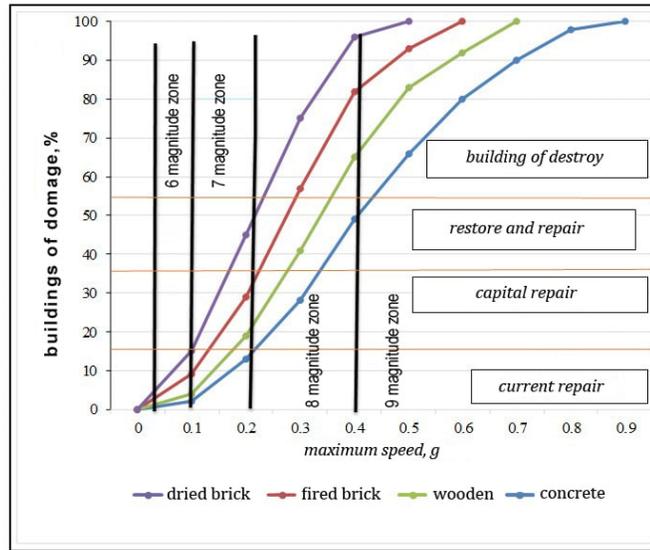

FIGURE 2. Vulnerability function of building made of clay pellet, clay wall, airbrick and burnt brick. [Aktamov B.U.2020]

Cadastral balance value of all airbrick buildings in Jizzakh region and seismic risk have been calculated for the size of their useful areas on the basis of the above methodology.

Thus, taking into account the engineering-geological conditions, seismic hazards at 6, 7 and 8 points in the territory of Jizzakh region and at 9 points in local areas have been identified.

Determining the degree of damage to buildings under the influence of strong earthquakes is largely dependent on the process of studying the effects of a strong earthquake that has taken place. It is not necessary to expect a strong earthquake to assess the seismic strength of buildings, as practical applications have been developed based on all the statistics collected. One of them is GESI_Program [Aktamov B.U. 2020, http://iisee.kenken.go.jp/net/saito/gesi_program/index.htm, Tyagunov S. 1999, Bindi D. 2011., Munson R.V. 2009, Parolai S. 2010, Tyagunov S. 2006, Cua G. 2007].

This program was developed in 1999-2001 as part of the United Nations Organization (UN) in frames of Global Earthquake Safety Initiative (GESI) Pilot Project. The program is written in *.xls format and is based on five indicators: the type of building, the specificity of the design, the quality of construction and the maximum acceleration of the level of seismic impact. Based on these indicators, a function diagram of the vulnerability of buildings to damage and seismic impact is made up. Damage to buildings is assessed on four levels: mild, moderate, severe, and very severe. Buildingsare divided into 9 types: wood, metal, reinforced concrete, reinforced concrete or steel, reinforced brick, unreinforced brick, raw brick, stone and lightweight cladding. Project quality is divided into four: designed with seismic design, developed without seismic design, undesigned (without seismic design) but with symmetrical proportions of building shape, unplanned (without seismic degign) in which building shape is not symmetrical. It is also divided into four in terms of construction quality: low, average, good and very good. In terms of building materials,it is divided into good and bad. Local indicators suitable for each building type are selected and a vulnerability function is made up (Figure 2)[Aktamov B.U. 2020].

TABLE 1. Damaging volume of different buildings and structures constructed in Jizzakh Region while seicmic intensity is 6, 7 and 8 points; % in relation to total quantity

Types of buildings	Levels of loss	Volume of damage to construction at seismic intensity,%		
		6 points	6 points	8 points
A	0	-	-	
	1	80,5	0,8	
	2	19,5	99,2	
	3	-	-	38,3
	4	-	-	61,7
B	0	64,0	-	-
	1	36,0	52,5	0,3
	2	-	47,5	99,7
	3	-	-	-
	4	-	-	-
V	0	100	-	-
	1	-	80,5	4,5
	2	-	19,5	95,5
	3	-	-	-
	4	-	-	-
C	0	100	-	-
	1	-	94,7	32,0
	2	-	5,3	68,0
	3	-	-	-
	4	-	-	-

Damage status is determined by the following indicators:

1. Midlife repair degree loss (repair costs are up to 15% of the building's book value).

2. Loss in the degree of capital repairs (when repair costs are up to 35% of the book value of the building).

3. Reconstruction (when the cost of reconstruction of buildings and structures is up to 55% of the book value). It should be noted that the issue of restoration will be decided by a special commission.

4. Demolition of the building (when the cost of renovating the building and structures is higher than 55% of the balance value and the need for demolition is accepted).

The results of the regional distribution of seismic risk in the settlements of Jizzakh region for different types of buildings which are subject to seismic impact at the level of 6, 7 and 8 points are presented

CONCLUSIONS AND SUGGESTIONS

As a result of the above given analysis, the following conclusion has been made. Seismic impact assessment of buildings and structures, technologies for determining the seismic vulnerability of buildings and structures depending on the type of construction and damage allows to make a reliable and high-quality prediction of earthquake losses in regional areas by taking into account seismic risk and ground conditions at the regional level in the assessment of seismic risk through GIS technologies and the extinction of seismic vibrations over a distance.

Database for quantitative assessment of direct losses of constructive types of buildings and structures in all settlements of Jizzakh region under the influence of different seismic intensities (6, 7 and 8 points)will be the basis for the development of loss reduction programmes based on preparedness measures for possible strong earthquakes in the region.

On the basis of the collected and systematized database on the identified seismic vulnerability functions of buildings and structures constructed in all settlements of the territory of Jizzakh region and the degree of damage at different seismic intensities, it is recommended to form and use electronic technical passports containing the information necessary to assess the seismic vulnerability of existing individual buildings, as well as multi-storey residential buildings and various structures.

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