ТЕОРЕТИЧЕСКИЕ И ПРАКТИЧЕСКИЕ АСПЕКТЫ ПРЕДУПРЕЖДЕНИЯ И ЛИКВИДАЦИИ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

УДК: 614.83-614.87

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RISK MANAGEMENT IN THE AFTERMATH OF EARTHQUAKES AT CRITICAL INFRASTRUCTURE FACILITIES THROUGH THE USE OF MOBILE CONTROL POINTS

Abstract. The article deals with statistical data of seismic zones in Central Asia and the Republic of Kazakhstan. Features of emergency situations development at critical infrastructure facilities are described. The relevance of the use of mobile control points in the elimination of the consequences of destructive earthquakes at these facilities is proved. A variant of using a 40-foot sea container as a mobile control point after technical modification of its design is proposed. The topological analysis of the initial control system and the control system using mobile control points is carried out.

Keywords: risk management, earthquakes, mobile control points, critical infrastructure facilities.

Statistics show that most of the Central Asian Republics are located in a zone of high seismicity, where destructive earthquakes of up to 9-10 magnitude have been repeatedly observed (fig.1).

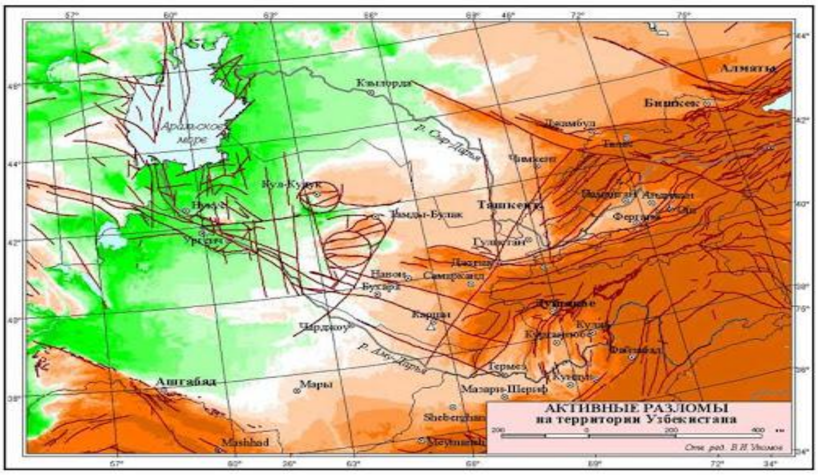

Figure 1 - Map of seismic activity in Central Asia

They caused significant destruction to a number of cities and towns and claimed tens of thousands of lives.

This is the Ashkhabad earthquake of 1948, which killed, according to various estimates, from 70 to 90 thousand people; this is the Chait earthquake of 1949, which killed 20-28 thousand people. And there are many such examples in the region (fig.2).

Figure 2 - The Ashkhabad earthquake of 1948

Seismological studies in Kazakhstan have shown that a significant area is occupied by extremely dangerous 8-9 - point zones.

Confirmation of this is the Kemin earthquake occurred on January 4, 1911 in the valleys of the Chon-Kemin, Chilik and Chon-Aksu rivers, Central Asia. Its magnitude was 8.2 on the Richter scale, and the epicenter was located at a distance of about 40 km from the city of Verny (Almaty) (fig.3).

Figure 3 - The Kemin earthquake, January 4, 1911

Despite the power of the earthquake, the number of victims was relatively small, as it occurred in a sparsely populated mountainous area, where people mostly settled in light tents.

According to official data, the number of completely destroyed residential buildings was 616, requiring major repairs-301, houses with lighter damage to foundations, stoves and plaster-1010, destroyed commercial premises and warehouses-121, damaged-397, non-residential buildings destroyed-3000, damaged-2000 [1].

In some parts of the city, deep soil breaks were formed in the form of cracks that reached 1 m wide and 5 m deep. A total of 390 people were killed, with only 44 of them in the city of Verny itself.

On may 22, 2003 in Zhambyl region near the railway station «Lugovaya» M = 5.5, this earthquake was the strongest after the famous «Merken» earthquake M = 6.3 occurred on 22. 03. 1865. the number of completely destroyed homes alone was about 4,000. significant damage was caused to the economy of Southern Kazakhstan, and significant efforts were required to restore the affected areas (fig.4).

Figure 4 - The earthquake in Zhambyl region near the railway station «Lugovaya»

On June 13, 2009, a strong earthquake occurred in South-Eastern Kazakhstan. The city of Tekeli, which was directly in the epicentral zone of the earthquake, was the most severely affected. The intensity of concussions in this city reached 7 points. This is the second earthquake of this magnitude in the city of Tekeli in the last 16 years. The previous earthquake occurred on December 30, 1993 (fig.5).

Figure 5 - The earthquake in Tekeli, on June 13, 2009

Analysis of the consequences shows that an earthquake, even if it is not very strong, may cause a man-made disaster at critical infrastructure facilities.

Under the objects of critical infrastructure in this article, objects of important economic significance for the region are accepted, which can include potentially dangerous objects, life-support objects, transport, etc.

The reasons can be different, from the disruption of the technological process at these enterprises, to the destruction of improperly stored and buried dangerous substances that can be released into the environment with all the resulting negative consequences. In addition, the destruction of energy facilities provokes fires not only in the room itself, but also in the open area. Fire products pollute the atmosphere and are transported over long distances, falling somewhere in the form of acid rain [2].

Accidents of railway trains loaded with dangerous goods are particularly dangerous.

The damage caused by such emergencies is usually very huge, since in addition to eliminating the consequences of the actual disaster itself (restoring transport links), we also have to deal with secondary damaging factors.

In addition, the complexity of eliminating the consequences of such emergencies is due to the remoteness and inaccessibility of the emergency zone from the points of permanent deployment of rescue and recovery units.

In these conditions, factors of mobility and responsiveness play a crucial role in the activities of national authorities and emergency response forces to effectively overcome the consequences of accidents and catastrophes of a man-made nature and natural disasters.

The mobility depends not only on the training of relevant groups, availability of technical means required for their rapid movement in areas disasters, but also on the quality of management.

One of the main requirements for the process of effective management is its continuity, which implies a constant, without any interruptions in the preparation and conduct of restoration work, the impact of management bodies on subordinate units in order to successfully perform their tasks [2].

To achieve continuity in the management of emergency response forces, it is necessary to ensure the continuous operation of control points and reliable communication between them, with subordinate, interacting units, local Executive bodies and higher management.

Currently, according to various data, only 10 % of critical infrastructure control points are ready for operation. Other structures require current – 18 %, or capital-72% repairs (fig.6).

Figure 6 - Current condition of control points

The technical condition of such points, as a rule, does not meet the requirements for their intended use, and for their restoration, configuration and current maintenance, significant financial resources are required, which are not provided for in any way by the budgets of enterprises.

Thus, in modern conditions, when organizing continuous management in the conditions of destructive earthquakes, the role and importance of rapidly erected mobile control point's increases.

A mobile control point is a set of hardware and software tools placed in a mobile module and providing the organization of linking the point to data transmission networks, including via satellite communication channels, conditions for recreation and performance by officials of their functional duties [3].

Currently, the Kokshetau technical Institute of the Ministry of internal Affairs of the Republic of Kazakhstan has formed and submitted an application for participation in grant funding of scientific projects for 2020-2022. As part of this scientific work, it is planned to adapt a 40-foot sea container for a mobile control center, which allows ensuring sustainable management of measures for the restoration of critical infrastructure in various climatic areas, without the use of special equipment when installing them in a disaster zone (fig. 7).

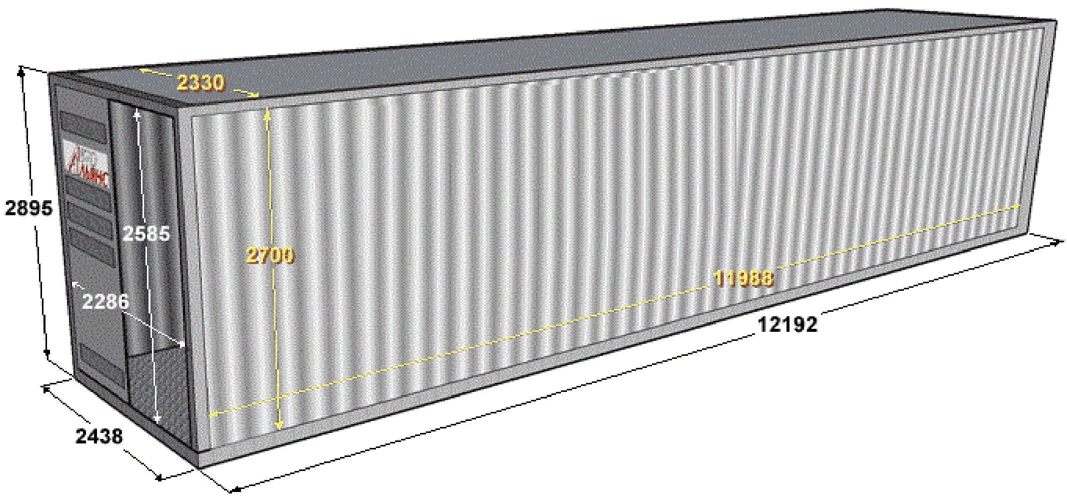

Figure 7 - 40-foot sea container for a mobile control center

The present invention relates to the construction of container-type civil defense structures capable of protecting people sheltered in them from the effects of air shock waves, radiation, chemical contamination, high-explosive effects of conventional weapons that are subject to transportation by almost any type of transport, as well as being quickly installed in a safe and reliable style with the formation of hermetic structures for the required number of sheltered [4-9].

The effectiveness of which is confirmed by the results of mathematical calculations (fig 8, 9).

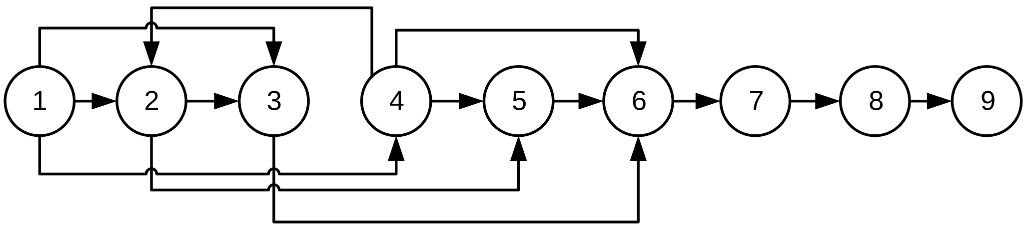

Figure 8 - Decision making process

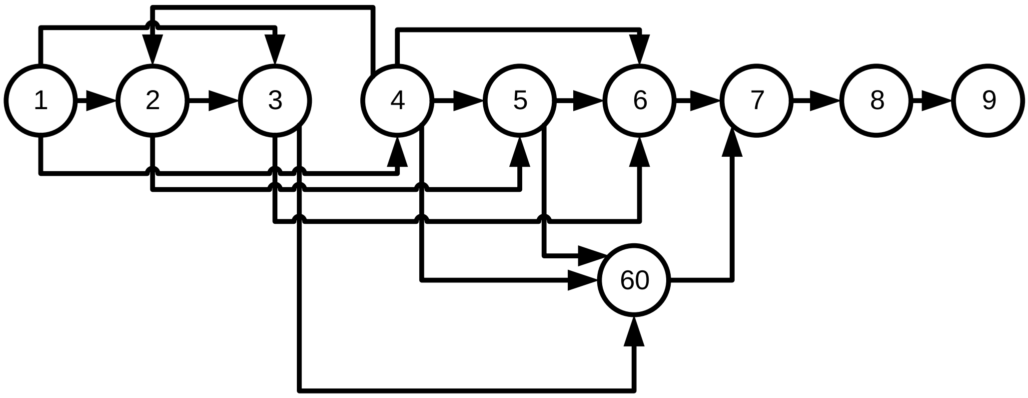

Figure 9 - Decision-making process with the use of mobile control points

So, if we assume that the management of a group of forces intended for conducting rescue operations is a complex organizational and technical system, then there are at least two ways to improve the efficiency of the system's functioning: extensive and intensive.

The extensive path involves an increase in the number of forces and resources (without restrictions on funding). An intensive path is associated with increasing the degree of realization of the potential of existing forces by improving the management system [10].

To evaluate the control system, we will use a topological analysis of the structure. The structural characteristics of the system allow us to evaluate its quality from the point of view of the system approach.

As a rule, when studying the structures of control systems, the most interesting properties are those that have a significant impact on the effectiveness of the system, such as: connectivity, structure diameter, compactness, degree of centralization, structural redundancy, the indicator of uneven distribution of connections, complexity of the structure.

As a result of the analysis of the initial management structure for earthquake response at critical infrastructure facilities we get the following values:

The connectivity index characterizes that the structure of the management system for earthquake response at critical infrastructure facilities is medium-connected [11].

The structure contains an insufficient number of information (communication) links, that is, there is a need for duplication.

The index of inequality in the distribution of links revealed an underutilization of the structure's capabilities in achieving maximum connectivity. The parameter value depends on the design and purpose of the structure, and does not determine the optimal system.

The overall structural proximity between elements is average. The structure has a lot of direct connections between elements, which indicates a high reliability of information within the system, but at the same time this fact shows a large load of system elements.

The degree of centralization of the structure is 0.46 (average), which is lower than the indicator of absolute centralization equal to one. The structure contains elements that are centers for processing and issuing information. This indicates the ability of the system to simultaneously perform several operations, which is very important for rapid response to emergencies.

The complexity of the structure is high. Due to the small number of ways of passing information inside the system, however, the risk of mixing and distortion of information processed in the system is reduced.

The diameter of the structure showed that many elements are connected to each other by direct connections, so there are information delays in the system. The system under study has an insufficient number of connections, i.e. there are no backup options (channels) for transmitting information, which indicates a low reliability of the system.

The results of the analysis of the topological characteristics of the system with the inclusion of mobile control points showed that the quality indicators of the structure have been improved or preserved, namely: - the diameter of the structure is preserved (i.e., there are no additional message delays);

- increased connectivity and structural redundancy, and with it the stability of the system;

- reduces the degree of centralization, which allows you to unload some of the individual elements of the system.

This increases the complexity of the system structure numerically, but this only occurs by increasing the number of paths from input elements to output.

Thus, analyzing the results obtained, we can conclude that the use of mobile control points improves the indicators of the studied management structure, such as efficiency, structural stability and inertia.

The management structure with the inclusion of mobile points is able to perform tasks for the intended purpose with the possibility of error-free operation at least specified.

References

1. The Committee of emergency situations of the Ministry of interior of the Republic of Kazakhstan [Electronic resource] // Official website of the Committee for emergency situations of the Ministry of interior of the Republic of Kazakhstan [website]. Mode of access: http://emer.gov.kz/ru/deyatelnost

2. Brushlinsky N. N. Safety of cities. Simulation modeling of urban processes and systems [Text] / N. N. Brushlinsky, S. V. Sokolov, P. Wagner [et al.]. - M.: FAZIS, 2004. - 172 p.

3. Shelters of civil defense: constructions and calculation / V. A. Kotlyarevsky [et al.]. - M.: stroizdat, 1989, p. 195.

4. Special tools for improving the explosion and seismic stability of buildings and fortifications: textbook / A. I. Shubnik [et al.]- Nizhny Novgorod: NFVIU, 2003, p. 39.

5. Fortifications of pliable construction: scientific and methodological development on design and calculation / E. S. Kolibernov [et al.] - Moscow: izdanie VIA, 1982, p. 117.

6. Bonen, Kh. I. Construction of protective structures / B. I. Bonen. - M.: Stroyizdat, 1986, p. 39.

7. Petrov, M. V. Modern principles of design, construction and equipment of protective structures of the CD FRG /M. V. Petrov, A.V. Fomichev // Objects of civil defense: collection of scientific papers. - M.: Central research Institute of industrial development, 1991, pp. 74-91.

8. Construction norms and rules: standards for designing protective structures of civil defense / Gosstroy of the USSR. - M.: TSITP Gosstroy of the USSR, 1985, p. 60.
9. Recommendations for the design, construction and operation of pre-erected protective structures of civil defense / GKChS of Russia. - M.: Voenizdat, 1993, p. 151.
10. Arifjanov S. B. Topological analysis of the organizational structure of the duty shift, the daily management body of the emergency situations Committee of the Ministry of Internal Affairs of the Republic of Kazakhstan. Information collection VINITI RAS "Problems of security and emergency situations" - 2016. - № 3. - P. 41-47.
11. Kusainov A. Assessment of integral fire risks by the matrix method // Bulletin of the Kokshetau Technical Institute. – 2018. - № 1(29) – P. 21-27.

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ҰТҚЫР БАСҚАРУ ПУНКТТЕРІН ПАЙДАЛАНУ ЕСЕБІНЕН СЫНДАРЛЫ ИНФРАҚҰРЫЛЫМ ОБЪЕКТІЛЕРІНДЕГІ ЖЕР СІЛКІНІСІ САЛДАРЫН ЖОЮ КЕЗІНДЕГІ ТӘУЕКЕЛДЕРДІ БАСҚАРУ

Аңдатпа. Мақалада Орталық Азия мен Қазақстан Республикасының сейсмикалық аймақтарының статистикалық деректері қарастырылады. Сындарлы инфрақұрылым объектілерінде төтенше жағдайлардың даму ерекшеліктері сипатталған. Осы объектілердегі қиратушы жер сілкіністерінің салдарын жою кезінде мобильді басқару пункттерін пайдаланудың өзектілігі дәлелденді. 40 футтық теңіз контейнерін оның дизайнын техникалық өзгертуден кейін мобильді басқару орны ретінде пайдалану ұсынылады. Мобильді бақылау нүктелерін қолдана отырып, бастапқы басқару жүйесі мен басқару жүйесіне топологиялық талдау жүргізілді.
Түйінді сөздер: тәуекелдерді басқару, жер сілкіністері, мобильді басқару пункттері, сыни инфрақұрылым объектілері.

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УПРАВЛЕНИЕ РИСКАМИ ПРИ ЛИКВИДАЦИИ ПОСЛЕДСТВИЙ ЗЕМЛЕТРЯСЕНИЙ НА ОБЪЕКТАХ КРИТИЧЕСКОЙ ИНФРАСТРУКТУРЫ ЗА СЧЁТ ИСПОЛЬЗОВАНИЯ МОБИЛЬНЫХ ПУНКТОВ УПРАВЛЕНИЯ

Аннотация. В статье рассматриваются статистические данные сейсмических зон Центральной Азии и Республики Казахстан. Описаны особенности развития чрезвычайных ситуаций на объектах критической инфраструктуры. Доказана актуальность использования мобильных пунктов управления при ликвидации последствий разрушительных землетрясений на этих объектах. Предложен вариант использования 40-футового морского контейнера в качестве мобильного пункта управления после технической модификации его конструкции. Проведен топологический анализ исходной системы управления и системы управления с использованием мобильных контрольных точек.
Ключевые слова: управление рисками, землетрясения, мобильные пункты управления, объекты критической инфраструктуры.

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