

Ensuring the projects' environmental safety based on a risk-based approach

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Abstract. The modern construction pay attention to fundamentally new requirements, the quality of products and service and improve the quality management system of green building and environmental safety facilities. The integration of new energy efficient technologies and energy efficient buildings is one of the priority options in the development of modern cities. The article use the methods of comparative analysis of the various international standards of green buildings and eco-certification of greening systems were applied, based on a risk-based approach. Risks are calculated using complex methods. The assessment of green building sustainability was considered as is a key factor of reducing technogenic risks and be the guarantee that the green building is environmentally friendly. The analysis showed the main regulatory and technical documents used in the construction of buildings with the use of greening systems, considered the basic safety requirements when working at height, and also evaluated the application of standards in the field of environmental certification of materials of new technologies used, developed by authors. The ecological certificate allows to increase the competitiveness of products in the market, which is economically beneficial. The principles of green building are aimed at creating a healthy and comfortable environment due to a large amount of daylight and fresh air.

1 Introduction

Today, in the modern sector of construction, special attention is paid and fundamentally new requirements are imposed on the quality of products and services. This is due to the high competition, which necessitates the development of quality improvement programs and constant improving the quality management system of green building and environmental safety facilities.

To date, the process of studying and implementing improvement programs quality affects not only the problems of product and service quality, but also the quality of the management itself responsible for the formation process appropriate level of product quality. There is practice application of various quality management systems, but for successful the functioning of the environmental safety facilities, they must ensure the ability to implement eight key principles that have been mastered and are successfully

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implemented by leading international companies and constitute the basis of international standards in the field of quality management ISO series 9000. The integration of new energy efficient technologies and energy efficient buildings is one of the priority options in the development of modern cities. One of the manifestations of the development of environmental diseases in the metropolis is the creation of "green islands" - ecological "green" structures on buildings and structures. In addition to the obvious benefits of using these structures in an ecosystem, there is also an energy-saving effect of the city, which is realized in combination with the interaction of building protection and minimization of heat losses through a counting design for modular systems.

2 Methods

In this study the methods of comparative analysis of the various international standards of green buildings and eco-certification of greening systems were applied, based on a risk-based approach.

Raising the requirements for the quality management system (QMS), ISO 9001-2015 standard focuses attention guidance on the need to develop risk-based thinking. Risk management becomes part of the construction process management system based on the PDCA continuous improvement cycle(see Fig.1).

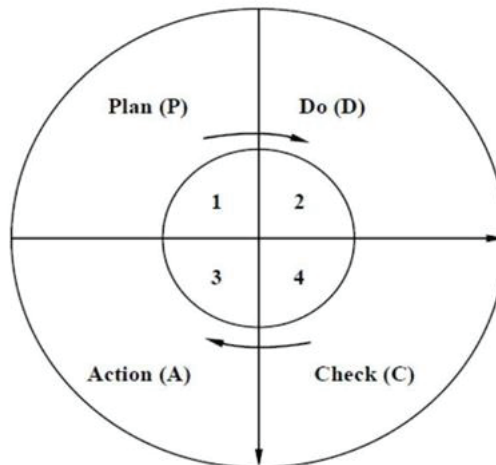


Fig. 1. Scheme of the Deming-Shewhart Cycle.

The content of the cycle includes a set of procedures, divided into several stages: planning (plan) - implementation (do) - examining the result (check) - action (act). The cycle of measures to improve working conditions has a circular character, to reduce the level of occupational hazards. The PDCA is a kind of algorithm for the actions of the management team to achieve the planned goals in the field of labor protection [1,2]. Works at the height, in particular, work on the roof with greening systems requires increased demands and the quality of construction work. Therefore, when working at height, use certified personal protective equipment such as a safety harness, safety system against falls from a height. The safety of work at height is a guarantee in the construction industry. At the moment, this sector of work does not have the best statistical indicators with taking into account labor protection, when considering accidents by the number of accidents when performing injury at height is in the first place, accidents due to a person falling from a height occupy more than 30% of all severe and "fatal statistics", if we consider only deaths, more than 35%. The main regulatory document regulating the area and safety when

working at height is the Order of the Ministry of Labor of Russia dated March 28, 2014 No. 155n (As amended on December 20, 2018) "On approval of the Occupational safety rules when working at height" [3]. In accordance with these occupational safety regulations, high-altitude work includes work when there is a risk of a worker falling from a height of 1.8 m or more, as well as when a worker is ascending to a height of more than 5 m or descent from a height of more than 5 m, and therefore, working on the green roof should always consider these risks.

To protect against falls from a height and minimize risks of injuries, workers use a harness (strapping) - a combination of textile materials that wrap around the human body in order to position and hold the user during a fall and after stopping a fall, containing adjustment elements and power fastening elements (see figure 2). The harness is a means of personal protection against falls from a height, called also as a Personal Protective Equipment, used as a component of a fall arrest system, it should be noted that harnesses are used not only during construction work, but also during various sports activities at height [4].

Such risks are calculated using complex methods. The International Labor Organization (ILO) recommends for these tasks the development of the American specialist G.-U. Heinrich. According to it, economic damage consists of two parts - direct losses and indirect or contingent losses. Direct losses represent one-time production losses as a result of an accident or accident:

$$L_{dir} = L_{hum} + L_{eq} + L_t + L_{mat} + L_{buil} \quad (1)$$

where $L_{eq} + L_t + L_{mat} + L_{build}$ - the cost of damaged equipment, tools, materials and elements of the building;

Taken into account $-L_{hum}$ - the costs associated with the restoration of human health, as well as the costs of training a new employee.

The second group of economic damage is indirect losses, they have a complex structure and can be felt over a long period of time - several months or even years. Due to the huge number of influencing factors, ordinary accounting is not able to estimate their size. Indirect damage includes, for example, losses from stopping production and reducing or stopping production, the payment of penalties, the diversion of resources for repairs and restoration, the loss of part of the profit, the payment of interest on a bank loan, losses from staff turnover, etc. In recent years, indirect losses include reputational losses of the enterprise, reflecting on its competitiveness.

Occupational accidents have a major impact upon human integrity, but they also bring about high costs for a national security system [5-7]. National occupational safety normative documents, which regulates personal protective equipment against falls from a height are following: ESCI 2018 Individual protection equipment to prevent falling from heights. Testing Methods, EN 364 Personal Protective Equipment against Falls from a Height – Test Methods and EN 355 Occupational Safety Standards System. Personal Protective Equipment against Falls from a Height. Energy Absorbers. General Technical Requirements. Test Methods.

When installing a greening system on the roofs of buildings, it is also important to know the international standards systems in green buildings, which developed to assess the environmental friendliness of buildings, such as LEED (USA); BREEAM (UK); DGNB (Germany); Green Star (Australia) and CASBEE (Japan). These international green standards include the quantitative and qualitative indicators characterizing the level of comfort, energy efficiency and environmental friendliness of buildings [8]. The assessment of green building sustainability was considered as is a key factor of reducing technogenic risks and be the guarantee that the green building is environmentally friendly. In the BREEAM rating system, the availability of credits in the Land Use section and

Environment section is of the highest importance for roof greening systems. The exact number of loans available will vary by location and the type of application, as for example, schools earn loans using green roofs in education, there are two main ways to increase the number of loans: replacing habitats and creating new habitats that will increase the site's environmental value and provide long-term biodiversity benefits, while green roof solutions can be designed to achieve points in both categories. These International standards welcomes contributions that support and advance the UN's sustainable development goals, in particular SDG 7 (Affordable and clean energy) and SDG 13 (Climate Action). While mentioning the benefits of certification, it is important to note the increase in the reputation of the organization. As green building is only gaining popularity, we can conclude that there are not so many certified objects, which means that the construction of green real estate objects allows companies to reach a new level and increase their competitiveness. That is, when a building is certified, both the image of the organization and sales increase. Another benefit of green building certification is the assurance that the site is environmentally friendly - for the construction of this facility, such technologies were used that correspond to the principles of sustainable ecological development of territories, this is what gives a high assessment to the facility. This high valuation increases sales.

President of Moscow State University of Civil Engineering Valery Telichenko noticed that the BREEAM rating system was applied in Russia for the Olympic buildings at Sochi, and it is now being applied to the sporting objects for the FIFA World Cup 2018, in Russia there are currently around 60 construction projects, which have BREEAM certificates, not only sports facilities [9,10]. For example, green roof and green walls have been BREEAM Excellent to create an enjoyable outdoor space for the residents of premium mixed-use development in central London (see fig.2).



Fig. 2. Green roof and green wall system for the Bentnick street project.

3 Results and Discussion

In the article, we have analyzed the main regulatory and technical documents used in the construction of buildings with the use of greening systems, considered the basic safety requirements when working at height, and also evaluated the application of standards in the field of environmental certification of materials of new technologies used, developed by authors. The Russian scientists have conducted research on the approach to high-rise

operations safety [11-17]. In addition, the high-rise operations safety closely related to the roof structure and development of green technologies and environmental safety facilities [18-24]. The eco-certification demonstrates that, in accordance with international standards, the use of building materials for the green buildings and environmental safety facilities are safe. The use more sustainable materials in construction, derived from less energy-intensive methods, can be an alternative to reduce their environmental impacts. Davide di Summa and Van den Heede et al. [25] studied the traditional and sustainable concretes incorporating wastes. According to the authors, supplementary cementitious materials such as blast-furnace slag and fly ash are good alternatives to produce ecological concretes, since their environmental impacts are considerably lower if compared to Portland cement.

The ecological certificate allows to increase the competitiveness of products in the market, which is economically beneficial. Eco-labeling gives products a chance to enter international markets, an advantage in public procurement. The certificate of compliance with environmental standards can be obtained from authorized bodies accredited on the basis of the regulations of the environmental certification system. The green buildings and environmental safety facilities certification process begins with the application. Further, the documentation is analyzed. Then the specialists make decisions and an agreement is signed for the environmental certification procedure, which, if necessary, includes laboratory tests of product samples. After the results of laboratory tests, if necessary, a decision is made to issue an eco-certificate (see fig. 3A).

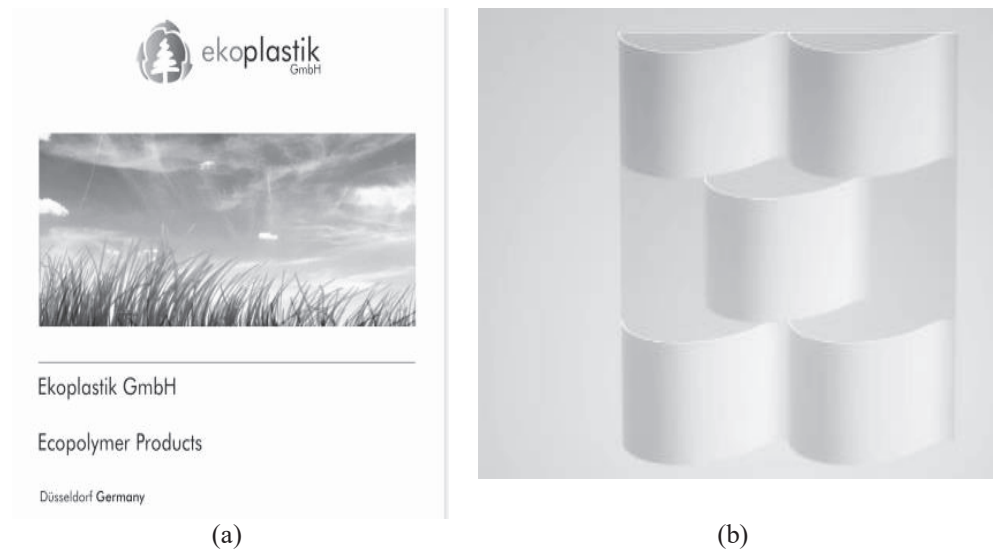


Fig. 3. Green roof and green wall system for the Bentnick street project.

For a comparative analysis, it is necessary to consider green wall and roof systems. Modular green wall systems are substrate-based systems use substrate-holding containers made of eco-plastic. The advantages of using modular greening systems for buildings are that they are lightweight, easy to use and maintain, and are also made of environmentally friendly plastic. And these new technologies were patented by the authors (see fig. 3B).

4 Conclusions

Thus, searching about environmental safety facilities based on a risk-based approach and the advantages of certification of green building, we could notice the increase in the reputation

of the construction organization, since green construction is only gaining its popularity and, along with this, security systems in high-rise construction are becoming especially important. Green building is a key factor of reducing technogenic risks. Due to the increasing requirements for energy conservation and sustainable goals, the construction of high-rise buildings with eco-materials is developing. The principles of green building are aimed at creating a healthy and comfortable environment due to a large amount of daylight and fresh air.

When the green building is certified, its cost increases, as does the image of the organization. Another great advantage in the certification of green building is the guarantee that the green building is environmentally friendly, which means that technologies were used for the construction of this facility that comply with the principles of sustainable environmental development.

Ensuring life safety is one of the most important tasks at any stage of construction and operation of buildings and structures. The development and strengthening of the objective safety factor implied ongoing process to reduce the level of occupational risk. A fall from a height occupies one of the first places in terms of the number of victims among all traumatic factors at a construction site, therefore, it is necessary to provide comprehensive protection for all workers exposed to such a risk, based on the principals of International Occupational safety management systems.

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