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Principles of safety engineering of buildings as an important element related to state defence

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Abstract

The paper discusses the issues of construction safety engineering in construction law. Providing safe living conditions in the anthropogenic environment - shaped by building structures has been, since the dawn of time, one of the major problems of human construction activity [24]. The need to create safe solutions in this area results from the biological needs of man and the needs of the ecological balance of the environment - which are necessary for the preservation of human life and its appropriate quality and constitute the implementation of broadly understood needs in the field of national defense and security in various scales and spatial ranges [7, 17].

Keywords: safety engineering, building construction, defense

1 Introduction

Security is subjective in nature and is the overriding need of man and social groups , it is also the basic need of every state, which is why every person, social group and state try to influence their external environment and internal sphere so as to remove or, at least minimize, various potential and real threats generated in the human environment, including threats related to various **anthropogenic objects , including construction objects** that are deliberately created by humans in order to meet various needs, both individual and collective. **Safety engineering of these facilities is becoming a significant problem** consisting in their design, implementation and operation, so that they can meet specific human needs in a safe manner. That is, such facilities must be characterized by construction and material as well as functional and utility solutions that are safe for humans [1].

Safety engineering of anthropogenic objects requires not only interdisciplinary, general and specialist knowledge in the field of basic methods and tools used in solving engineering tasks related to broadly understood safety [6, 10], but also **knowledge of the principles of safety engineering** [1, 8, 9] **in the law** .

The paper presents basic information on the principles of safety engineering of building structures based on the works [1–8, 12, 15–23, 25]

2 The concept of a building object

- The term "building object" is not understood unequivocally, despite the fact that it has been defined in the above mentioned legal regulations [14]:
- Art. 2 point 5d of the Act - Public Procurement Law, as defined in Art. 1 clause 2 point b of Directive 2004/18 / EC of March 31, 2004 on the coordination of procedures for the award of public contracts for construction works. **A building object is the result of all construction works or civil engineering, which by itself fulfill an economic or technical function.** The concept of a building object was introduced into the public procurement law by the Act of 12 October 2012 amending the Act - Public Procurement Law and the Act on concessions for construction works or services (Journal of Laws of 2012, item 1271);
- Point 2 of the Annex to the Regulation of the Prime Minister of December 20, 1999 on the Polish Classification of Construction Objects (PKOB) (Journal of Laws of 1999, item 1316). Construction objects are understood

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as the **final products of construction activities, constituting structures permanently connected to the ground, made of construction materials and components as a result of construction works;**

Art. 3 point 1 of the Building Law Act defines a building structure as **a building, structure or small architecture structure, together with installations ensuring the possibility of its use in accordance with its intended purpose, erected with the use of construction products.** This amendment was introduced to the above-mentioned the act as a result of its amendment by the act of February 20, 2015 amending the act - Building Law and some other acts (Journal of Laws of 2015, item 443)

Difficulties with the proper understanding of the concept of "building object" are caused by the issue of **" permanent connection of the structure of the object with the ground ".** Hence, I am quoting, following the work [9], a well-established view in this respect, which is reflected in the jurisprudence of administrative courts. It shows that:

1) **The issue of permanent connection (bonding) with land cannot be reduced only to physical bonding .** The feature of "permanent connection to the ground" comes down to the foundation of the object on the ground permanently enough to ensure its stability and the ability to counteract external factors that may damage it or cause it to be moved or moved to another place (e.g. judgment of the Provincial Administrative Court in Warsaw, No. VII SA / Wa 1339/12 of November 8, 2012, LEX No. 1341218) .

2) **The permanent technical attachment of a building structure does not determine its permanent connection to the ground .** The legislator uses the term "permanently connected to the ground" or "not permanently connected to the ground" in those cases when he wants to clearly distinguish between two construction objects (a building and a temporary building object) that are subject to different legal requirements (judgment of the Provincial Administrative Court in Bydgoszcz No. II SA / Bd 1237/12 of 03/04/2013, LEX No. 1351438).

3) **The fact that the object has foundations or the size of the cavity in the ground is irrelevant for the assumption of permanent bond with the ground** . It is important whether the foundation is durable enough to resist factors that may damage the structure placed on it (judgment of the Provincial Administrative Court in Warsaw No. VII SA / Wa 1299/12 of October 22, 2012, LEX No. 1242383).

3 The concept of building security

All construction objects (buildings, structures and small architecture objects) are designed and constructed in order to meet various human needs [6, 10, 11]. Maintaining the safety requirements in meeting these needs is of paramount importance, regardless of the type and size of the facility and the expected lifetime of the facility (permanent and temporary facilities). Each construction object must therefore be safely designed and constructed, and then safely operated.

Each construction object functions in specific environmental conditions , which constitute the "surroundings" of this object. Due to the spatial distance of the object from this environment, they can be conventionally divided into the so-called closer surroundings and further surroundings. **Each building object is in specific bilateral relations** (location, supply, emission, etc.) **with its surroundings** (both closer and more distant), which may take the form of interactions threatening both the object and its surroundings.

Thus, all construction works must display adequate resistance to all foreseeable hazards that may occur in the period of their existence, but also difficult to predict activity swimmin - kowników buildings and neglect exploitation, and the impact of incidentally occurring extreme external conditions (snow, rain, wind, temperature fluctuations, pressure fluctuations, ground shocks, etc.) and internal (impacts related to the use of the facility).

When **assessing the security of the facility, the following** should be taken into account:

1) **Internal and external features of the facility**, including its structural and functional solutions, as well as, taking into account the type of facility, the maintenance requirements;

2) **Impact on the environment and other objects**, in the form of a potential explosion hazard or emissions generated by an object, understood as the direct or indirect release of substances, energy, such as heat, noise, vibrations or electromagnetic fields into the air, water, soil or soil . In particular, the problem concerns the emission of hazardous substances which, due to their chemical, biological or radioactive properties, may, in the event of improper handling, pose a threat to human life or health or the environment.

3) **The technical condition of the facility**, as well as operating instructions regarding its principles of use and maintenance.

The safety of a building object should be considered in two problem areas [1, 13]:

In the area of the interior of a building object - with which the concept of " internal security " can be associated, understood as a state of non-threat to users inside the building, the structure of the object and its technological and installation equipment - risk factors coming from the object itself and threat factors coming from its surroundings.

In the area of the surroundings of a building object - which can be associated with the concept of external safety understood as a state of non-threat to people, objects and the environment - outside the confines of a given object - factors whose source is the object in question (i.e. its material and construction solution, technological equipment) -installation, or processes carried out within it). A special form of environmental hazards may be various emissions of hazardous pollutants, which may be harmful to human health or the state of the environment, may cause damage to material goods, may deteriorate the aesthetic values of the environment or may conflict with other, justified ways of using the environment.

A safe object is an object that under normal or other reasonably foreseeable conditions of its use, taking into account the time of use of the facility, and also, depending on the type of facility, the scope and manner of operation (use and maintenance requirements) , it does not pose any threat to the users of the facility (and its surroundings) or poses a negligible risk, compatible with its normal use and taking into account the high level of requirements for the protection of human health and life.

Taking into account the above-mentioned problem areas of the interior and surroundings of a building object as a safe building object - we will call it an object that meets both the criteria of internal safety and external safety, i.e .:

- is a facility that protects its users, the structure of the facility and its technological and installation equipment against hazards expected to occur during the period of the intended use of the facility, and
- it is an object that does not threaten its surroundings [6, 9, 10].

On the other hand, a dangerous construction object - we will call it an object that does not meet the criteria of internal security and external security at the same time [6, 9, 10], i.e .:

- it is a facility that protects its users, the structure of the facility and its technological and installation equipment against hazards expected to occur during the period of the intended use of the facility, and at the same time it is an facility that threatens its surroundings;
- it is an object that does not protect its users, the structure of the object and its technological and installation equipment against the hazards expected to occur during the period of the assumed use of the object, and at the same time it is an object that does not threaten its surroundings;
- it is an object that does not protect its users, the structure of the object and its technological and installation equipment against hazards expected to occur during the assumed use of the object, and at the same time it is an object that threatens its surroundings.

People should be aware that they feel safe in the building (and in its surroundings) - this means that nothing threatens their life (construction disaster, fire) , life or health (poor hygiene and poor air quality in buildings) or well-being (no thermal comfort, noise). Ensuring the safety of construction objects is a basic requirement resulting from the provisions of the Act - Construction Law (formulated in the form of mandatory basic requirements - which should be met by construction objects) , which must be taken into account in the processes of design, implementation and operation of all construction objects.

The safety of the building structure depends on [6, 10]:

1) **the location of the facility,** in a given environment characterized by specific development and environmental conditions,

2) **design solutions for the facility** (in terms of functionality and space, construction and materials, installation and technology) ,

3) **the quality of the facility's implementation** and the time of its construction,

4) **the quality (and period) of the facility's operation** (expressing the quality of use and the maintenance quality of the facility).

4 Entities shaping the safety od construction facilities

Construction in a general sense is a team activity, therefore each participant of the broadly understood construction process (both the investment construction process and the operational construction process) affects the safety of the constructed buildings [13].

The safety of a building object at the stage of the investment construction process is shaped by the participants of this process (investor, designer, construction manager, works managers, investor's supervision inspectors) , who have a significant impact on shaping the realities in the field of functional and spatial, construction and material, as well as installation and technological solutions for facilities . In the event of improper coordination of activities or even bad will of individual partners of the aforementioned construction process, they may consciously or unconsciously deteriorate the safety of the constructed buildings. Each completed building object determines the matter of almost all strength, functional and utility and economic effects resulting from the fact of its existence in a given form in a given environment, regardless of conscious or unconscious, correct or defective programming, design and implementation decisions [13].

The safety of a building object at the stage of the operational construction process is to a large extent determined by the safety condition resulting from the investment process of this object. The safety of the facility at the stage of the operational construction process is shaped by all participants of this process (owner, manager and users of the facility) , who have a significant impact on the safety condition through the use and maintenance of the facility. They can positively influence the maintenance of the security condition of the facility or, through improper use and maintenance of the facility, deteriorate its security condition. The reasons for the mistakes may be both ignorance and too little attention to safety aspects, and often also economic reasons (irrational savings) or unreliability of the participants of the construction process, both investment and operational.

Hence, **activities aimed at comprehensive optimization in this regard of all operating systems in construction [10, 14] are of fundamental importance.**

5 Security engineer of building structures

5.1 The concept of "building safety engineering"

Engineering - is the science of performing engineering works, the ability to design and erect various types of objects. Safety engineering of construction works covers knowledge in the field of safety engineering of technical objects, relating it to a specific type of technical objects (such as construction objects) and is a technical method of achieving the intended goal, which is to obtain a safe construction object.

Building safety engineering is understood as a method of:

- **shaping** (i.e. designing and implementing) **safe construction facilities** as well as
- **operation** (i.e. use and maintenance) of **these facilities**, taking into account the rules ensuring their safety.

Safety engineering of building structures consists in taking actions to make building structures resistant to specific threats[6, 10]. **Immunization activities** consist in giving the object such features that allow it to:

- opposing the facility to the foreseen threats generated in the facility itself and in its surroundings, possible during its construction as well as during its subsequent operation, or
- elimination or reduction of anticipated impacts (which may constitute threats) generated in the facility and in its surroundings, and
- maintaining a certain level of security of the facility with the assumed degree of risk.

The safety of a building object is shaped as a result of taking actions aimed at improving its reliability (understood as a set of object features that determine the operational suitability of the object in accordance with its intended use and are conditioned by the occurrence of damage to the tested object in the process of its operation) and durability (understood as the object's property to maintaining the condition of fitness for a long time until failure or reaching the limit state).

For the purposes of safety engineering of a building object, it is essential to define :

1) **types of existing and potential threats** (external and internal) to the construction object whose safety we are interested in;

2) **sources generating threats** (internal and external) for the considered building object;

3) **the expected time and probability of the occurrence of threats** generated by the considered building object (existing and potential) for the object itself and its users as well as for the surroundings of the object during its expected existence in a given environment;

4) **the expected time and probability of the occurrence of threats** generated in the vicinity of a given building object (existing and potential) for the considered building object and its users, during its expected existence in a given environment;

5) **factors determining the safety of a building object**, which include:

- ocation and spatial solution of the facility,
- functional solution of the facility,
- construction and material solution of the facility,
- the method of installation and technical equipment of the facility,
- the method and technology of building the facility,
- method and period of use of the facility,
- organizational solutions,
- security prophylaxis of the facility taking into account all real threats.

The effectiveness of building safety engineering is determined by:

- **stage and scope of immunization measures taken** and
- **selection of appropriate methods and forms of immunization.**

Each structure, depending on how the safety issue is solved, can be assigned one of two types of capabilities (potential) :

- **positive** (defensive) **potential** - expressing the ability of the analyzed object to: resist the destructive impact of the environment (including other objects in its vicinity) as well as the impact generated in the analyzed object (own interactions) and
- **negative** (destructive) **potential** - expressing the ability of the analyzed object to: destructively affect other objects in the vicinity of the analyzed object and destructively influence the users of the object.

Examples of the positive potential of a building object may be: location outside floodplains, favorable spatial solution of the object, appropriate strength of the structure of the object, resistance to certain types of threats, etc.

Examples of the negative potential of a building object may be: unfavorable location in the flood area, excessive intensity of electromagnetic radiation generated by a given object, excessive load on the structure, potential explosion hazard of materials stored in the object under analysis, etc.

5.2 Methods and forms of making a building object resistant to specific threats

The following methods of activities aimed at making the object resistant to specific threats can be distinguished:

- **active method** (active) - consisting in influencing the source of the threat in order to reduce the size of the threat, the time of its impact or the complete elimination of the threat;
- **passive** (passive) **method** - assuming accepting the existence of threats and taking actions aimed at adapting to this situation, and
- **a method that uses both elements of the active and passive method.**

In the practice of immunization of buildings, the most frequently used combinations of the above-mentioned methods of operation are adapted to the socially acceptable level of risk (related to the occurrence of specific threats) , resulting from the current economic conditions and technical possibilities of a given society.

5.3 Stages of immunization of the building object

From the point of view of the time of taking these actions, two stages of immunization of the building object can be distinguished:

- **pre-operational** (primary) **immunization** - performed during the creation of the object (at the stage of programming, design and implementation) in the scope of the above-mentioned factors determining the security of this facility;
- **operational** (secondary) **immunization** - carried out during the existence of the building object.

The most effective is the application of primary immunization in relation to the constructed structures, and in the case of a building object in relation to which such measures have not been taken or in the case of or changes in the environmental conditions of the functioning of a specific building object - secondary immunization measures can be taken.

The procedure for adopting the method of immunizing a specific building object depends on the assessment of the significance of the impact of the building object on its surroundings, as defined in the provisions of the environmental protection law.

5.4 Forms of immunization of a building object at the pre-exploitation stage

At the pre-exploitation stage of shaping the safety of construction objects, one of the following forms of immunization or their combination is used:

1) Immunization of building objects with the active (active) method, carried out by influencing the sources of danger , consisting in:

- elimination of the source of the threat;
- introducing the obligation to estimate the environmental impact of the planned facility and legal enforcement to prepare an environmental impact report for a project that may have a significant impact on the environment, taking into account the impact of the project at the stages of its implementation, operation or use and decommissioning;
- defining the environmental conditions for the implementation of the investment in the form of an administrative decision;
- forcing specific activities in the field of design and implementation of investments specified in the form of an administrative decision on a building permit, taking into account the decision on environmental conditions for the implementation of the investment;
- preventing the location of the hazard source in a specific place due to the effects of this location on the environment;
- limiting the functioning of the hazard source aimed at limiting the size or duration of the impact of the threat generated by this source to an acceptable level;
- prohibition of the operation of the source of danger;
- changing the way of using a source of hazard aimed at reducing the risk generated by this source to an acceptable level;

2) Immunization of buildings with the passive (passive) method by:

a) **Their appropriate location** outside the area of impact of the hazard source, which enables the elimination or reduction of the impact of threats, e.g. location of objects outside the protective zones of shooting ranges, location of objects outside flood plains, location of objects outside the area of mining damage, etc.

b) **Creating areas of limited use** for projects that may always have a significant impact on the environment;

c) **Creating industrial zones.**

d) **Determining the environmental quality standards** that should not be exceeded during the operation of the installation outside the area to which the operator of the installation has legal title, and in the case of establishing an area of limited use or establishing an area of an industrial zone - outside this area.

e) **Counteracting environmental pollution** by preventing or limiting the release of substances or energy into the environment.

f) **Compensation of threats**, consisting in the introduction of an established immunization program into a building object, assuming knowledge of the future state of threat as well as the structure and parameters of this object. This type of immunization can be achieved through:

- simplifying the solution of the facility;
- the use of better elements;
- use of safer facility structures;
- introducing normative excesses (strength, parametric, structural, functional, technological and information) in newly constructed buildings and transformed existing buildings;
- creation of facilities with functional and construction-material solutions, enabling the limitation of the impact of risk factors to the permissible level;
- "Cutting off" the inflow of threats to the object, generated in its surroundings (eg acoustic screens located along communication routes or acoustic screens located next to other objects generating excessive noise)
- "Cutting off" the inflow of threats generated by the object to its surroundings (eg acoustic screens located next to objects generating excessive noise);
- implementation of renewal processes (repair, replacement, renovation) and reconstruction;

g) **Natural compensation** - understood as a set of activities including, in particular, construction works, earthworks, soil reclamation, afforestation, tree planting or the formation of vegetation clusters, leading to the restoration of natural balance or the creation of vegetation clusters, leading to the restoration of the natural balance in a given area, compensation of damages made in the environment by the implementation of the project and the preservation of landscape values.

5.5 Forms of immunization of a building object at the operational stage

At the operational stage of shaping the safety of existing buildings, the following are applied. forms of immunization or a combination thereof, consisting of:

a) **Stabilization of the** facility's **operating conditions** and optimization of loads,

b) **Conducting technical diagnostics** of buildings, including periodic inspections of the technical condition and assessing the possibility of safe use of facilities, forecasting the emergency state of damage and determining the scope of necessary actions to prevent the emergence of a state of threat to the safety of facilities. c) **Implementation of renovation processes** (repair, replacement, renovation) and reconstruction of the facility.

d) **Conducting the state environmental monitoring**, which is a system for measuring, assessing and forecasting the state of the environment, as well as collecting, processing and disseminating information about the environment.

e) **Protection against pollution** arising in connection with the operation of building structures by ensuring: the use of technical solutions limiting the spread of pollution, in particular:

- acoustic security,
- protection against contaminated rainwater entering the soil or ground,
- measures for the disposal of waste generated during the operation of construction works, and
- proper organization of facility operation.

- **Conducting ecological reviews of**installations that are qualified as projects that may always have a significant impact on the environment
- **Obligation to submit a safety report** for plants with a high risk of an industrial accident (to the competent authority of the State Fire Service and the voivodship inspector of environmental protection at least 30 days before the date of commissioning a new plant) and **obtain its approval**.

- **Applying financial and legal measures** in the form of fees for the use of the environment, administrative fines, different tax rates and other public levies serving the purposes of environmental protection.

5.6 Forms of surplus applied to construction works in the pre-production and operational phases

The following forms of excess can be distinguished in the immunization of a building object at the pre-production and operational stages:

- **structural excess**, consisting in duplicating important structures of the object and reducing its sensitivity to dangerous situations;
- **functional excess**, consisting in adapting some elements of the object to take over specific additional functions and reducing the object's sensitivity;
- **parametric excess**, consisting in maintaining more energy and functional capabilities in relation to average needs, reducing the sensitivity and increasing the durability of the object;
- **information redundancy**, consisting in the existence of redundant information in the facility regarding important events (e.g. light or sound signaling);
- **technological excess**, consisting in the introduction of duplication of important elements of the technological process carried out in a building structure, reducing the sensitivity of this process to dangerous situations;
- **excess strength** (mechanical, electrical), consisting in increasing resistance to damage or destruction, reducing the sensitivity to a specific type of shock;
- **time excess**, consisting in the existence of increased time for the implementation of various types of activities in the facility, enabling appropriate responses under risk conditions;
- **element redundancy**, consisting in introducing to the system additional elements used in a dangerous situation (safety devices, safety devices, safety systems).

6 Conclusions

The paper presents the basic information on the principles of building safety engineering, exposing the basic concepts of a building structure, building object safety and building safety engineering. The methods, stages and forms of safety engineering, which consist in making the objects resistant to the expected threats, are discussed.

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