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Life Cycle of Protective Structures

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Abstract

The article reviews the concepts related to defining protective structures and their location in legal regulations. A life cycle model of a protective structure has been proposed, which may be helpful in the implementation of construction projects related to planning, designing, construction and operation of construction facilities related to population protection.

Key words: construction, civil defense, protective structures, crisis management

1. Introduction

Protective structures are construction objects (anthropogenic structures) belonging to a group of material and immaterial objects of a technical nature created by humans. They are characterized by specific features and functional-utility attributes tailored to meet human needs and those of the surrounding environment, serving the broader purpose of civil protection [1].

A construction object (building, structure, or small architectural form), as a whole and in its individual parts, including related technical installations, must be designed and constructed in accordance with applicable laws, including technical-construction regulations and principles of technical knowledge, ensuring, among other things, civil protection in accordance with civil defense requirements [28].

In Poland, civil defense issues are regulated by the Act on Civil Protection and Civil Defense [30]. The purpose of protective structures is to provide collective protection for the population against various threats that may occur during the existence of these structures, particularly:

- threats arising from military actions and their consequences;
- radioactive and chemical contamination, including toxic industrial agents.

Additionally, protective structures may serve other purposes, such as:

- protection against the effects of external fires;
- securing and concealing mobile cultural assets, especially important documentation, information carriers, valuable equipment, and reserves of food and medicine in crisis situations such as natural disasters, industrial accidents, social unrest, terrorism, and military operations [2].

It is important to note that protective structures can function both in peacetime and wartime. In wartime, they can be prepared as shelters.

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2. Etymology of Protective Structures as Special Construction Objects within Anthropogenic Structures

In civil engineering, protective structures are considered construction objects located within the domain of anthropogenic structures, intended to meet safety needs in accordance with safety engineering principles [1,15].

From the perspective of shelter engineering, a protective structure is defined as a room or group of rooms designed to protect people, equipment, material reserves, or other assets from the effects of warfare, extreme weather events, ecological or industrial disasters, or other threats [6].

Construction practitioners define protective structures as specific construction objects known as shelters and coverings [23,24,25,27,31].

According to the Head of National Civil Defense, a protective structure is understood as a room or group of rooms intended to protect people, equipment, material reserves, or other assets from warfare, extreme weather, or other threats [32].

From the perspective of the State Fire Service, a protective structure is a building or group of buildings designed and constructed to protect people and valuable property from various threats [20].

Design firms and internet portals similarly define protective structures as rooms or complexes intended for protective purposes [3].

In the engineering view of military specialists, protective structures are classified into two categories:

- Shelters: fully enclosed structures providing comprehensive protection against all expected threats;
- Coverings: open structures that provide directional protection only [26].

According to current legislation [30], a protective structure is defined as a construction object or part thereof that is recognized as a protective structure based on designation by the competent civil protection authority—either through an agreement between the authority and the building's owner or manager, or by administrative decision, in accordance with legal provisions.

The law distinguishes three types of protective structures: shelters, coverings, and emergency shelters.

A shelter, considered a protective structure, is a construction object or part thereof with a closed and hermetically sealed design, equipped with filtration-ventilation systems or regenerative filters.

A covering is defined as a protective structure that is a construction object or part thereof with a non-hermetic design.

An emergency shelter refers to collective protection facilities that are construction objects adapted for the temporary sheltering of people. These are used in the event of the introduction of a state of emergency or during wartime, when the number of shelters and coverings is insufficient to ensure adequate protection of the population [30].

New legal regulations have been introduced concerning "existing protective structures" that were built prior to the enactment of the Act on Civil Protection and Civil Defense of December 5, 2024 [21]. According to this regulation, an existing protective structure may be recognized as a protective structure if it currently ensures—or, after reconstruction or adaptation, will ensure—the fulfillment of specific protective functions in terms of safeguarding individuals against threats resulting from natural disasters, terrorist incidents, or acts of war.

It should be emphasized that protective structures, throughout their lifespan, should be functional, practical, and safe, and should form a coherent whole (Fig. 1) [18,19,25].

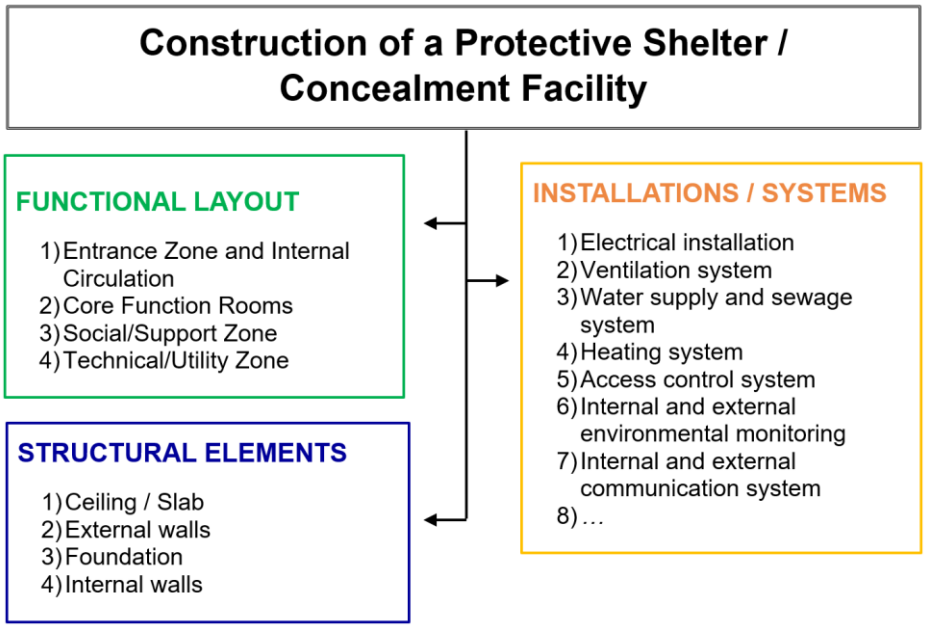

Fig.1. Construction of a shelter / covering [17]

The Construction Law Act regulates activities related to the design, construction, maintenance, and demolition of construction objects, and defines the principles of operation of public administration bodies in these areas. A construction object is defined as:

- a building along with its installations and technical devices,
- a structure forming a technical and functional whole, along with installations and devices,
- a small architectural object.

The investment process, within which a protective structure "exists," is a sequence of coordinated activities of a technical, legal, technological, organizational, and financial nature. It encompasses the preparation, implementation, and operation of a planned construction investment over a specific period and under limited financial resources.

The activities of the investment process, within which a protective structure "operates," can be located in two areas: construction and operation (Fig. 1).

The construction investment process consists of two main stages: the investment preparation stage and the implementation stage. The preparation stage includes three phases: the pre-design phase, the design phase, and the investment preparation for implementation. The implementation stage involves the construction phase of the structure – specifically, the protective structure.

The operational investment process comprises the stage of using the construction object/protective structure and the stage of investment termination. The usage stage includes the phase of commissioning the facility and the phase of its maintenance. Meanwhile, the investment termination stage includes the diagnostic phase, the demolition of the structure, and the final phase of concluding the investment [7,8].

Actions related to the course of the investment process in construction, as well as the rights and duties of its participants, are regulated by the relevant provisions concerning:

- Construction – The Construction Law [28] identifies the key participants in the construction process (investor, construction supervisor, designer, construction manager or site manager) and the facility manager, and outlines their responsibilities. The function of overseeing the proper course of the entire investment process is carried out by the construction supervision authority.
- Civil defense – Related to crisis situations [22,29]. The regulation defines basic concepts related to special construction, while the law governs the establishment and assigns duties to the Government Crisis Management Team. This team serves as the advisory and consultative body to the government in matters concerning the initiation and coordination of actions taken within the scope of crisis management.

3. Life Cycle of a Protective Structure

All construction investments begin with an idea. Subsequently, the process involves planning the investment process, designing, implementation, transferring the completed structure – protective construction – to operation, and the use of the building. This entire process is often referred to as the life cycle of a construction object [4,5]. It is important to note that a protective structure can be a part of a building.

The life cycle of a construction object / protective structure should be a collection of well-thought-out, harmonized technical, technological, organizational, legal, and financial activities aimed at the realization and operation of a given construction object / protective structure or its part, within defined financial resources and within an established time frame. This cycle, treated as a process, is divided into two main areas:

- Area A - the construction investment process, in which a virtual construction object / protective structure is created,
- Area B - the operational investment process, in which a real construction object / protective structure exists.

The life cycle of a construction object is presented in the model (Fig. 2) and consists of four stages and nine phases. After the investor decides on the form of the object, which will result from the project (Area A, Stage I), technical, economic, and environmental feasibility studies are conducted to evaluate the technical, economic, and environmental impact conditions of the project (Phase 1). These studies concern the conditions for project realization at the construction site and the operation of the building. Based on these, a concept is prepared, and the project for the realization of the venture is developed, including the construction project (Phase 2) and the preparation of the project for implementation (Phase 3). In Area A, the building does not exist. It is a virtual object, which during construction is transformed into a real construction object (Stage II, Phase 4), and is then used (Stage III, Phases 5, 6) until the decision for its decommissioning (Stage IV, Phases 7, 8, 9) or decision for its modernization is made.

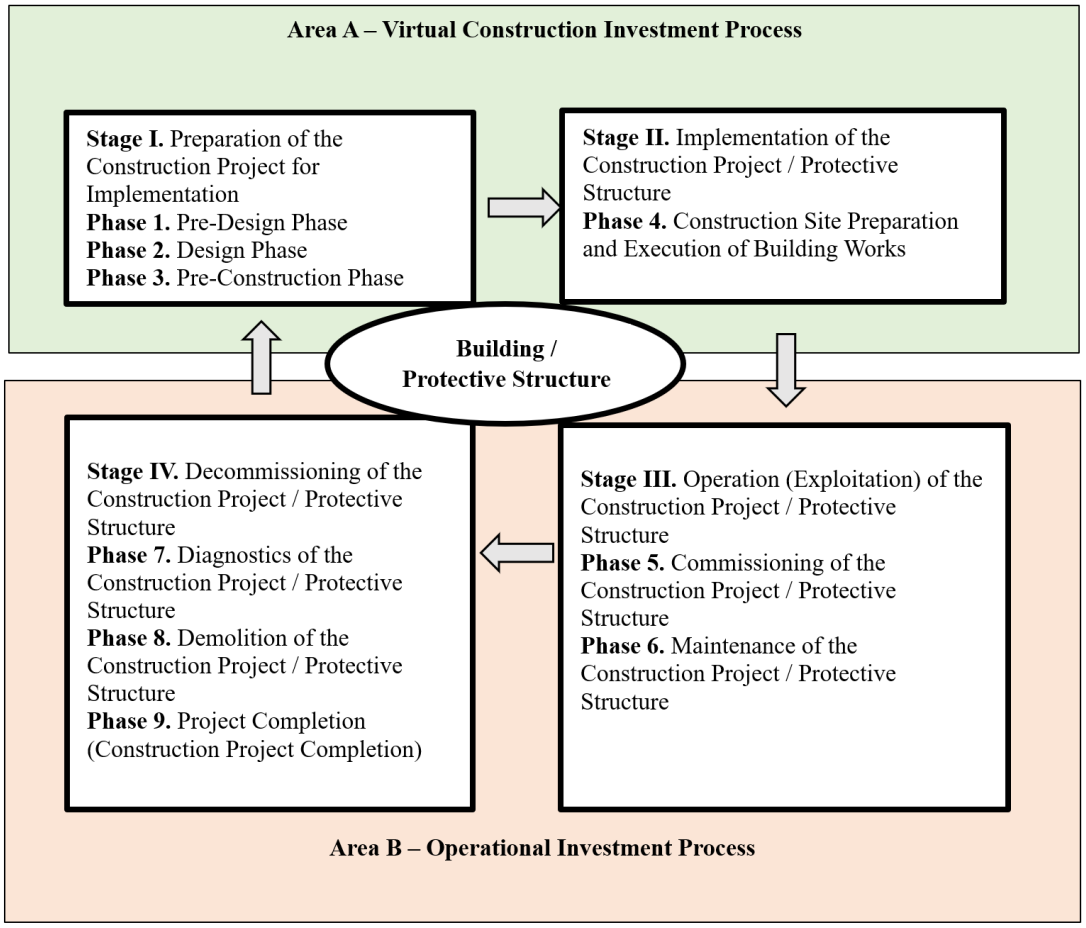

Fig. 2. The life cycle model of a building structure / protective structure [8,9,10,16,11,12,13,14]

4. Conclusion

With the increasing threats to civil security, the interest in protective structures is growing. Modern protective buildings should be functional, useful, and safe throughout their entire life cycle, including planning, design, construction, and operation. Meeting these requirements is achieved through the collaboration of all participants in the construction investment process: architects, civil engineers, and managers..

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