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## **THE CURRENT STATE OF CONSTRUCTION OF PREFABRICATED PROTECTIVE STRUCTURES IN UKRAINE**

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Since the beginning of the full-scale invasion of the Russian Federation on the territory of Ukraine, the number of human losses among the civilian population has been constantly increasing. Ukrainian cities and towns are suffering from shelling of various types of ammunition. In places of active hostilities, the Russian invaders use multiple rocket launchers. Cities far from the war zone are suffering from missile strikes and Shahed drones. Even a missile destroyed by air defense systems is dangerous; debris can cause irreparable consequences to human health, or cause partial or complete destruction of buildings and structures.

To protect the civilian population, the Ukrainian government has adopted a number of legislative and regulatory documents that regulate the urgent deployment of a modern network of civil defense protective structures that can significantly increase the level of protection of citizens. One of such documents is the Law of Ukraine No. 2486-IX of 29.07.2022 “On Amendments to Certain Legislative Acts of Ukraine on Ensuring the Requirements of Civil Protection in the Planning and Development of Territories”. This document provides for the mandatory construction of reliable shelters in rebuilt and new buildings, taking into account the necessary engineering and technical measures of civil protection [1].

In addition, based on the experience of Israel, in Ukraine, in order to urgently solve the problem of increasing the fund of protective structures of civil protection under martial law in Ukraine, the construction of rapidly erected protective structures of civil protection of a modular type has been launched. Such structures should ensure the protection of the population from the local and general effects of conventional weapons (small arms, fragments of hand grenades, artillery ammunition, fragments of missiles and aerial bombs). Requirements for such types of structures are given in DSTU 9195:2022 “Prefabricated protective structures of civil protection of modular type” [2].

The prototype of the technical solution of such rapidly erected protective structures was the Anderson shelter and the Stanton shelter (Fig. 1), which were designed in 1938 and were widely used in Great Britain during the Second World War [3].

Prefabricated protective structures of civil defense are installed in crowded places: at public transport stops, near waiting pavilions, in recreational areas of the city, etc. The capacity of such protective structures is up to 50 people. This is due to the fact that people are dispersed around the city as much as possible and reduce the likelihood of getting into crowds of people to a minimum. During the shelling, the blast wave spreads a lot of debris and construction debris, which leads to the greatest number of injuries among the population.

For the installation or construction of prefabricated protective structures, special structures (block modules) are used. Depending on the purpose and capacity, such shelters can consist of one or more block modules: a technical block module for placing special equipment; block module for accommodating persons subject to shelter; combined block-module (for accommodation of persons subject to shelter and for placement of special equipment and engineering systems).



*Fig.1. Shelters in Great Britain during the Second World War: a) Anderson's shelter; b) Stanton shelter made of precast concrete*

The peculiarity of space-planning and design solutions of such shelters is: production of block module structures or their individual structural elements of full factory readiness, the possibility of easy constructive combination of several modules of a water protective structure in compliance with the requirements for the tightness of such a structure, installation or construction of a ready-to-use structure within a period not exceeding 48 hours [2].

In Ukraine, the first such shelters were installed at public transport stops in Kharkiv. The shelters were equipped with surveillance cameras and a screen, and also have wi-fi (Fig. 2) [4].



*Fig. 2. Prefabricated protective structures at public transport stops in Kharkiv*

Architects Serhii Derbin and Oleksii Yatin from Dnipro developed the Dot outdoor shelter module [5]. The module is made of concrete. And it is already being used in Dnipro – several Dots are installed at the city's checkpoints. The shelter protects against small arms and shell fragments. Up to four people can be accommodated inside. It takes 5–6 days to produce one Dot (Fig. 3).

Shelters “Hobbit House” of the Lviv company “Industry LV” LLC are made of concrete grades B35-B40 with the addition of plasticizer, additives, and, if necessary, microfiber. The concrete module consists of three parts, is buried in the ground by 1 m, has the ability to supply communications, for additional protection, the module is covered with soil [6]. The modules can be connected to each other to accommodate additional seats in case of danger or need (Fig. 4).



Fig. 3. Dot Outdoor Shelter Module

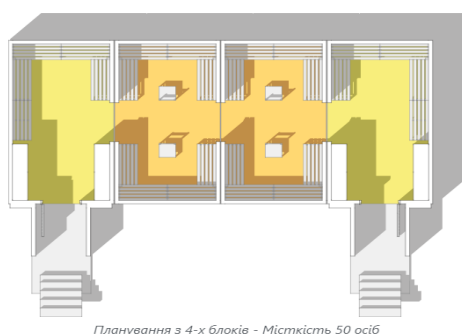


Fig. 4. Modular shelter “Hobbit House”

**Conclusions.** Today, in the conditions of war, prefabricated protective structures are used in many cities of Ukraine. However, there are still a number of problems. Firstly, the number of shelters built does not meet the needs of cities, shelters are mostly used only in the central areas of cities; secondly, the presence of such shelters can be observed only in large cities – regional centers, residents of small towns are not able to protect themselves during attacks; Thirdly, in order to reduce the cost of such structures, manufacturers and customers use cheaper materials for the manufacture of such shelters, which leads to a decrease in the safety of users.

#### References

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