

### **Evolution of the typology of air traffic service buildings in the course of the development of airports**

*The provided results of a study of the features and changes in the typology of buildings intended to ensure the functioning of air traffic services at airports are presented.*

**Problem.** The development of airports is accompanied not only by an increase in the volume of air transportation but also by an increase in the size of their territories and areas that require dispatching control, in particular visual control.

The estimated heights of buildings for placing control rooms for visual monitoring of situations on the territory of modern airports can be 100 m and exceed it. This requires solving an array of issues related to technological, urban planning, architectural and design, structural, and engineering tasks during their design, construction, and operation [1–3].

**Relevance.** In the two years since the beginning of the military aggression, the total direct damage to infrastructure in Ukraine, according to preliminary estimates, amounted to \$36.8 billion, including airports – \$1.5 billion as calculated using the World Bank methodology.

Damage and destruction of aviation industry facilities worth \$2.04 billion were estimated in March–December 2023, including airports – \$0.3 billion, airbases–\$0.04 billion, air navigation equipment of the state enterprise of air traffic services of Ukraine (SE Ukraerorukh) – \$0.2 billion [4].

Restoration and reconstruction of domestic airports require new approaches to the design, construction, and operation of air traffic service facilities and complexes, with dominant ideas of modern practices and trends regarding high-rise building formation, etc to be considered.

**The originality of research** is determined by the goal and the array of tasks set, and the chosen approach to solving them.

**Research results.** The history of design, construction and operation of air traffic service buildings, in particular flight control towers, dates back more than 100 years and is divided into several stages.

Each stage is characterized by appropriate technological, spatial planning and engineering solutions, and the use of modern building materials, structures, systems, etc.

The first of them – 1914-1939, 1940-1945, 1945-1960 – are associated with two world wars and the post-war periods [5].

At that time, buildings of flight control towers:

- They performed the functions of dominant buildings, having initially small calculated heights;

- small volumes of control posts or halls that were located on the upper floors were clearly expressed in the structure;

- they had solid glazing systems for control rooms to provide visual monitoring of the situation at the airfield, and so on.

In particular, the wooden tower of the British navigation service NATS, built on the territory of London's first Croydon Airport for operation during 1916-1920, was 4.5 m high.

It is this tower that is considered to be a "reference point" for studying the history of construction and operation of buildings flight control towers, as well as for analysing the processes of changing their typology, and so on.

The next stage, that being the second half of the twentieth century, is a period of rapid development of aviation technology, expansion of the network of international and regional airports, growth in the volume of air traffic, and the capacity of components of airfield and airport complexes [5].

As a result, the requirements for flight safety, the level and quality of ground support for air transportation, in particular the relevant buildings and structures, were changed.

The average level of airport provision with air traffic control buildings and structures reached 70% (as of 1985). This indicated that for flight safety and the implementation of current and long-term air transportation plans, significant capital investments and projects were needed. They provided for

- reduce the cost of building materials, structures and systems, and construction time;

- introduction of industrial methods for performing construction and installation works, etc [6].

At that time, the design of new, reconstruction and technical re-equipment of flight control tower buildings were regulated by departmental standards of technological and construction design. They were focused on supporting the mass use of unified technological, architectural, construction and engineering solutions.

In particular, for Ukrainian airports, this period was characterized by the presence of objects of restrained architecture, most of which were built using industrial methods according to standard designs [5].

Standard designs were developed for flight control tower buildings of I–VI categories and were intended to be linked to the real conditions of airports of I–V classes. Only flight control tower buildings of the first category were built using individual designs [1].

In particular, in 1965, the individual design was employed to build a multi-storey building of the flight control tower of the Boryspil International Airport as part of the airport complex (currently Terminal B). It still ensures the implementation of relevant technological operations related to air traffic maintenance.

Depending on the category, the buildings were normalized by:

- options for its placement on the airport master plan;
- options for blocking air traffic control units and pre-flight training of aircraft crews;

- requirements for spatial planning solutions for individual groups of premises and the building as a whole.

Key layouts for blocking flight control towers were proposed for three groups of airport complexes: large ones, medium ones, and small ones in terms of capacity.

A number of these layouts provided for the possibility of expansion (stage-by-stage construction). At the same time, not only linear schemes of planning solutions for airport complexes were taken into account, but also compact ones, with a central and ring version of the placement of the air passenger service unit.

At the end of the twentieth century, there were trends in the construction of new types of flight control tower buildings at large airports – airfield control towers, with the additional functions of advertising and commercial nature provided [7–9].

They were also reflected in new approaches to their design and spatial organization of the airport territory, especially in cases where a need arose for the construction and operation of second, third and other airfield control tower buildings [2, 3].

Large calculated heights of airfield control tower buildings turned them into high-rise dominants – objects of increased urban planning and compositional significance both in the airport development system and in the areas they affected [1–3, 7–9].

This, in turn, requires the search for original architectural, design, structural and engineering solutions that, at heights of more than 100 m, provide airfield control tower buildings with leading positions among the world's high-rise objects. [1, 3, 8, 9].

The implementation of creative ideas of the formation of the latter contributes to:

- creating a sustainable image of the airport architectural environment [3, 8];
- creation of cultural resources of airport environments and areas of the impact of the airports [1, 7–9];
- using images of airport control tower buildings for graphic designations of airport goods and services [8] and so on.

The practice of design and construction of airport control towers during 2012–2014 in domestic airports commissioned by the State Enterprise Ukraerorukh includes objects 51 m high (Donetsk), 43.6 m high (Kharkiv), etc.

They do not occupy leading positions in the rating of the corresponding special-purpose objects. However, they played an important role in modernizing strategic airports in the country's preparation for hosting the final part of the UEFA Euro 2012.

At the same time, the outline of the Donetsk International Airport airfield control tower building, ruined in 2014, became a symbol of the invincibility of the human spirit during the Anti-Terrorist Operation [10].

## **Conclusions**

The restoration of domestic airports is not only a reconstruction of what was destroyed during the fighting but also an opportunity to apply the latest approaches of urbanism and architecture to implement the concepts of sustainable development in their areas of impact.

The design and construction of new air traffic service buildings based on individual designs do not exclude the possibility of using unified solutions.

Unification can relate to technological, spatial planning, structural and engineering solutions.

However, urban planning and architectural solutions for airfield control tower buildings require considering the peculiarities of the spatial organization of airport impact areas. They can contribute to creating cultural resources, and improve the image positions of territories of impact areas. They can also be involved in appropriate branding and rebranding strategies.

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