UDC 725:69.059.28

DETERMINATION OF THE PARAMETERS OF DESTRUCTION OF CONSTRUCTION OBJECTS AS A RESULT OF MILITARY OPERATIONS

Authors - Danylo Goncharov[1], Dmytro Nikolayev[2], Stud. of gr. PCB-22a,
Supervisor - Professor of the Department of Construction and Road Machines
Serhiy Shatov[3]
[1] *aldoran.flameheart@gmail.com,* [2] *ksjyshan80@gmail.com,* [3] *shatov.sv@ukr.net*
Prydniprovska State Academy of Civil Engineering and Architecture

Problem statement. The consequences of warfare, man-made disasters, accidents or natural disasters are the destruction or damage to buildings and structures. Under their rubble, there may be victims who need to be rescued within a shorter period of 6...8 hours. Depending on the source of the event, its power, duration and other factors, the destruction of structures and buildings is probable. At the same time, certain patterns of their destruction have been identified [1; 2]. Knowledge of these patterns will allow to plan, organize and execute the work on dismantling the destruction reasonably and in a short time, increase the probability of rescuing victims and improve the safety of rescuers. Therefore, surveying the nature of the destruction using modern approaches, including unmanned aerial vehicles (UAVs), is an urgent scientific and technical problem.

The purpose of the study is to develop proposals for the use of UAVs to determine the nature and parameters of destruction of buildings and structures.

Presentation of the basic material. The organization of debris removal work is based on information about the structure of the debris: the parameters of the debris and its quantity [3]. Currently, this information is obtained through direct inspection of the rubble by rescuers: visual inspection, instrumental measurement of debris, photo and video recording (Fig. 1).

a *b* *c*

Fig. 1. Determination of the nature of structural damage by visual inspection:
a – Dnipro (2007); b – New York (2001); c – a – Kharkiv (2022)

These approaches to determining the parameters of the debris are dangerous (collapse of debris elements or unstable structures of partially destroyed objects is possible). Such an analysis of the debris structure does not provide complete information, which increases the error in planning and execution of disaster relief activities.

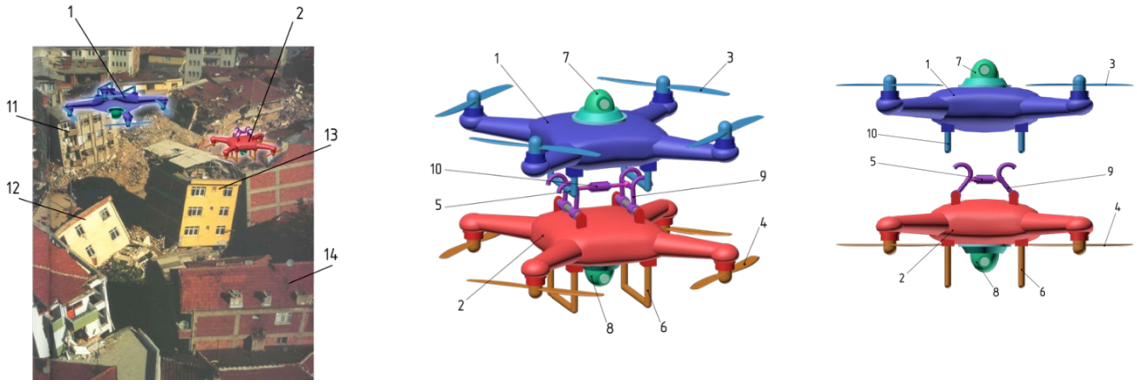
It is proposed to determine the parameters of wreckage and building elements by photo-video shooting of UAV objects with subsequent computer processing of the results [4]. The following sequence of work is envisaged. The rubble with the destroyed object is photographed with electronic equipment (Fig. 2).

a *b* *c*

Fig. 2. Using a UAV to inspect the destruction of a building (Dnipro, 2012): a − house, 25 Artema Street; b − UAV operator; c − UAV video recording

Three main dimensions can be determined from the wreckage, which allows to calculate its volume $V_{fr.}$ and weight $m_{fr.}$ (due to the density of its material), and then the number of vehicles to dismantle the wreckage. The point from which the rubble and the destroyed building are photographed is important for the accuracy of the results obtained. The smallest error in the images will be found in debris that is strictly perpendicular to the survey axis and is located at a small distance from the reference building element. Therefore, in most cases, it is advisable to photograph the rubble from above from a UAV. This way, it is possible to analyze the structure of the rubble, the size of the debris and make a decision on the rational technology of work in the shortest possible time.

In the case when it is necessary to inspect many objects that have been damaged as a result of hostilities, it is advisable to use several UAVs (Fig. 3). Moreover, they can have a device for delivering one UAV to another. After arriving at the survey site, the UAV tandem is separated and each vehicle surveys its own area. This will accelerate the acquisition of information about the nature of the damage and reduce the time required for restoration work. This method of determining the size of debris allows you to record debris located on the surfaces of the rubble. Therefore, data processing should be performed continuously and in parallel with the debris removal work.



a *b* *c*

Fig. 3. Inspection of the destruction of structures by several UAVs: a – general view, b – UAV tandem, c – independent flight of each UAV

Thus, the use of unmanned aerial vehicles will significantly reduce the labor intensity of work on diagnosing the technical condition of construction projects and improve the safety of these works.

Conclusions. 1. Inspection of the destruction of buildings is carried out visually and visually-instrumentally, which is dangerous for workers, as well as laborious and time-consuming processes. The rubble is dismantled without taking into account its structure and the fractional composition of the debris. 2. It is advisable to use unmanned aerial vehicles to determine the technical condition of construction objects, which allow for effective research to determine the condition of external and internal surfaces of construction objects. This, in turn, will ensure a reliable determination of the causes of defects and damage, reduce labor costs and time for collecting information, and as a result, reduce the cost of debris removal and subsequent restoration of buildings and structures.

References

1. Kazakov B. Organization and conduct of emergency rescue operations in residential buildings and structures. Emergency Situation. 2007, no. 6, pp. 44–49.

2. Civil protection is one of the priorities of national security. Emergency Situation. 2009, no. 2, pp. 34–38.

3. Shatov S.V. Organizational and technological solutions for dismantling damaged and reconstructed structures and buildings. *Visnyk Prydniprovs'koyi derzhavnoyi akademiyi budivnytstva ta arkhitektury* [Bulletin of the Prydniprovska State Academy of Civil Engineering and Architecture]. 2013, no. 4, pp. 12–17. (in Ukrainian).

4. Shatov S.V. Determination of the parameters of the wreckage of destroyed structures and elements of buildings under reconstruction. *Visnyk Prydniprovs'koyi derzhavnoyi akademiyi budivnytstva ta arkhitektury* [Bulletin of the Prydniprovska State Academy of Civil Engineering and Architecture]. 2011, no. 3, pp. 8–14. (in Ukrainian).