No 126 (126) (2023)

The scientific heritage
(Budapest, Hungary)
The journal is registered and published in Hungary.
The journal publishes scientific studies, reports and reports about achievements in different scientific fields.
Journal is published in English, Hungarian, Polish, Russian, Ukrainian, German and French.
Articles are accepted each month.
Frequency: 24 issues per year.
Format - A4
ISSN 9215 — 0365

All articles are reviewed
Free access to the electronic version of journal

«The scientific heritage»
Editorial board address: Budapest, Kossuth Lajos utca 84,1204
E-mail: public@tsh-journal.com
Web: www.tsh-journal.com

CONTENT

TECHNICAL SCIENCES

ANALYSIS OF SOFTWARE FOR CIVIL PROTECTION MATTERS

Kryshtal D.,
ph.d. in public administration, senior research fellow at the research laboratory for civil safety at the Cherkasy Institute of Fire Safety named after Heroes of Chernobyl of the National University of Civil Protection of Ukraine
Kopytin D.,
researcher at the research laboratory for civil safety at the Cherkasy Institute of Fire Safety named after the Heroes of Chernobyl, National University of Civil Protection of Ukraine
Gonchar S.
lecturer at the department of fire prevention work at the Cherkasy Institute of Fire Safety named after the Heroes of Chernobyl, National University of Civil Protection of Ukraine
DOI: 10.5281/zenodo.10299809

Abstract

Civil security is undoubtedly one of the most important fields in our lives. Engineers and scientists in this area are constantly seeking new ways to enhance people's safety. In this regard, software developers create new software suites to address civil security challenges, such as the Finite Element Method (FEM), Computer-Aided Design (CAD), and Computational Fluid Dynamics (CFD).

The application of FEM, CAD, and CFD software suites in civil security allows engineers and scientists to predict potential risks and issues in engineering systems, ensuring a higher level of safety.

Keywords: civil security, analysis, software, software suites, finite element method.

The Problem Statement. The analysis of Finite Element Method (FEM), Computer-Aided Design (CAD), and Computational Fluid Dynamics (CFD) software complexes in the context of addressing civil safety issues can be crucial for improving the processes of designing, developing, and testing new engineering systems. It aids in diagnosing and identifying problems within existing engineering systems, facilitates training and enhancing the qualifications of professionals in the field of civil safety, and enables the analysis and optimization of structures and processes to ensure maximum community safety and environmental protection.

The Objective. This article aims to provide an overview and analysis of FEM, CAD, and CFD software complexes to address civil safety issues for ensuring maximum community safety and environmental protection. It also aims to contribute to the training and enhancement of qualifications for professionals in the field of civil safety.

Presentation of the Main Material. The software complexes FEM (Finite Element Method), CAD (Computer-Aided Design), and CFD (Computational Fluid Dynamics) are widely used across various industrial and scientific domains to address diverse tasks. Overall, these software complexes aid engineers and researchers in solving design, analysis, and virtual modeling tasks of different systems. They also assist in modeling threats and risks [1].

FEM, CAD, and CFD software complexes find broad applications in civil protection.

FEM (Finite Element Method) is a numerical calculation method used to solve complex engineering problems using mathematical models. In civil protection, FEM is employed to analyze deformation, strength, and stability of buildings and structures during natural disasters. It allows modeling intricate geometric shapes, calculating stress, deformation, and other parameters arising from various loads on a structure. FEM is used to model the behavior of various structures in civil protection, reproducing complex systems like buildings, bridges, dams, etc., by breaking them into finite elements. In civil protection, FEM is applied to address various tasks such as analyzing building behavior during earthquakes, determining stress in metal structures during fires, evaluating the strength and stability of bridges and dams during floods.

The use of FEM not only forecasts structural behavior in different situations but also facilitates designing new structures using optimal materials and forms, reducing risks during catastrophic events.

CAD (Computer-Aided Design) is software used for creating, modeling, and analyzing building structures, heating and ventilation systems, editing, and analyzing various geometric models. CAD can be employed for developing any engineering structures, including those in construction, mechanical engineering, electronics. In civil protection, it is utilized for developing fire safety projects and designing automatic fire suppression systems, requiring high precision and speed. CAD also enables the creation of 3D models of buildings and structures, aiding in detecting potential issues and errors in the project before construction begins.

This software allows for the construction of accurate 3D models, enhancing understanding of a building's structure and its interaction with the environment. It enables quick and efficient creation and editing of building projects, boosting productivity and quality in civil protection, as well as designing efficient and safe evacuation spaces in emergencies [2].

CFD (Computational Fluid Dynamics) is a numerical calculation method used to analyze the movement of liquids and gases. In civil protection, it models airflow in buildings and determines optimal positioning of ventilation and conditioning systems, ensuring maximum safety for people.

In civil protection, CFD is employed to study the behavior of airflows and smoke gases during building fires, research optimal positioning of ventilation systems and fire exits, and forecast the spread of pollutants in the atmosphere. CFD visualizes airflow, temperature, and concentration fields in rooms, helping identify potential problems and errors in civil protection systems before their operation begins. Additionally, it optimizes the operation of ventilation systems and fire exits, ensuring more effective and safe building functioning during fires [3].

This software complex is also used to analyze gas leakage during fires, explosions, technological catastrophes, or similar situations. It allows analyzing gas movement and dynamics based on various factors such as temperature, pressure, flow rate, room shape, etc. CFD determines gas speed, direction, concentration, and temperature in a room, enabling risk assessment for people, forecasting the event's progression, and identifying necessary measures to mitigate consequences.

Software complexes FEM (Finite Element Method) are utilized in civil safety to solve a wide spectrum of tasks, including:

Analysis of stresses and deformations in building structures and other facilities under external loads like wind, seismic shocks, floods, and others.

Modeling engineering systems such as water supply, sewage, and heating networks to evaluate their operability, efficiency, and safety.

Research into material behavior at high temperatures, particularly during fires, and assessing its impact on the structures' ability to withstand loads.

Calculation of bridge strength and other transport structures, along with evaluating their safety and durability.

Modeling the behavior of buildings and other structures during natural disasters such as earthquakes, landslides, floods, and others.

Calculation of heat transfer parameters and airflow in buildings to ensure the efficiency of heating systems.

Modeling industrial plant operations and processes, especially in the oil and gas and energy industries [4].

The application of FEM software complexes effectively addresses complex technical challenges in civil safety, improving the safety and operational efficiency of engineering systems and structures.

CAD (Computer-Aided Design) software complexes are extensively used in civil safety to address the following tasks:

Designing buildings and other structures: enables the creation of 2D and 3D models, identifying potential issues before construction and allowing necessary project modifications.

Designing ventilation and air conditioning systems: creating detailed 3D models to detect problems and enhance system efficiency.

Designing security systems: creating detailed 3D models of security systems such as fire alarm, access control, and video surveillance, improving their efficiency and ensuring higher safety levels.

Analysis of potential hazards: creating detailed 3D models of existing structures to analyze potential hazardous situations, such as studying fire behavior to develop optimal evacuation plans.

Emergency preparedness: simulating emergency situations to train personnel for extreme conditions, reducing risks and preparing for potential hazards.

Creating drawings and documentation: generating drawings and technical documentation for construction, repair, and maintenance, ensuring proper safety during operations [5].

CFD (Computational Fluid Dynamics) software complexes are widely used in civil safety to address the following tasks:

Analysis of airflow in enclosed spaces: used to analyze airflow in buildings and structures, ensuring proper living and working conditions.

Analysis of hazardous substance spills: modeling hazardous substance spills in industrial conditions or accidents, assessing their impact and devising protective measures.

Fire analysis: modeling fire, smoke, and heat spread in buildings during fires, assessing risks for people and property, and developing effective fire safety systems [6].

Air pollution analysis: modeling the spread of pollutants in the atmosphere, assessing their impact on health and the environment, and planning pollution reduction measures.

Prediction of water behavior and pollution in aquatic environments: useful for water resource issues such as oil spills and assessing the impact of different pollution sources on water bodies.

Fire prediction and spread in buildings: studying temperature and airflow in buildings to assess the likelihood of fire spread, improving fire prevention measures, and reducing fire risks [7].

Predicting structural stability during natural disasters: studying forces acting on buildings during natural disasters like hurricanes, earthquakes, or floods, aiding in designing more resilient and safe structures [8].

Conclusions: The article demonstrates that software complexes based on FEM, CAD, and CFD can be highly beneficial in addressing civil safety issues. The application of such programs allows modeling the behavior of various materials, structures, and systems under different conditions, considering their interaction with the environment. Specifically, these programs can be used to determine material strength, wear, and forecast behavior in potentially hazardous situations.

Overall, the article highlights that employing software complexes based on FEM, CAD, and CFD to address civil safety challenges can assist engineers and researchers in more efficiently developing and testing materials, structures, and systems to ensure safety across various sectors, including construction, transportation, energy, and more. Furthermore, integrating the study of these tools in higher education can cultivate highly qualified civil protection professionals who can effectively prevent various emergencies in the future.

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