The object of research is the fire resistance of reinforced concrete ribbed slabs. The subject of research is the effect of the level of mechanical load on the fire resistance of the studied reinforced concrete ribbed slab under the influence of fire. Currently, the assessment of the fire resistance of such structures using the tabular method is significantly limited by certain geometric parameters of these plates. It is also not considered possible to apply the zone method, since reinforced concrete ribbed slabs consist of components that receive thermal effects according to various scenarios and geometric parameters, which is not taken into account in Eurocode 2.

Experimental calculations carried out in the current work using a refined procedure involving the finite element method allow solving the actual scientific and technical problem related to the determination of the dependence of the fire resistance of these structures on the level of load applied.

The calculation of the temperature spread over a reinforced concrete ribbed slab under the influence of the standard temperature regime of fire was carried out using convection and radiant heat exchange, which is recommended by Eurocode 2. The iterative implicit Newton-Raphson method was used to solve the mechanical problem. Evaluation of fire resistance of reinforced concrete ribbed slabs was carried out according to the onset of signs of the limit state of fire resistance due to the loss of load-bearing capacity. According to the results, it was established that at 100 % load level of the structure under investigation, the critical deflection of more than 268 mm and the rate of growth of deformation exceeding 18 mm/min were recorded simultaneously on minute 43.9.

According to the results of the research, the regularity of the limit of fire resistance of reinforced concrete ribbed slabs from the level of the applied mechanical load was established. This will make it possible to design and build buildings and structures using the specified building structures with guaranteed fire resistance classes, which improves the level of safety for people at the facilities

Keywords: reinforced concrete ribbed slabs, fire resistance, iterative Newton-Raphson method, finite element method

UDC 624.012
DOI: 10.15587/1729-4061.2023.289930

REVEALING PATTERNS IN THE BEHAVIOR OF A REINFORCED CONCRETE SLAB IN FIRE BASED ON DETERMINING ITS STRESSED AND DEFORMED STATE

Stanislav Sidnei
Corresponding author
PhD*
E-mail: sidney-1980@ukr.net
Andriy Berezovskyi
PhD, Associate Professor*
Serhii Kasiarum
PhD**
Olha Lytvynenko
PhD, Associate Professor
Department of Language Training
National University of Civil Defence of Ukraine
Chernyshevska str., 94, Kharkiv, Ukraine, 61023
Ihor Chastokolenko
PhD, Associate Professor**
*Department of Safety of Construction and Occupational Safety***
Department of Higher Mathematics and Information Technology*
***Cherkasy Institute of Fire Safety named after Chornobyl Heroes of National University of Civil Defence of Ukraine
Onoprienka str., 8, Cherkasy, Ukraine, 18034

Received date 08.08.2023
Accepted date 16.10.2023
Published date 30.10.2023

How to Cite: *Sidnei, S., Berezovskyi, A., Kasiarum, S., Lytvynenko, O., Chastokolenko, I. (2023). Revealing patterns in the behavior of a reinforced concrete slab in fire based on determining its stressed and deformed state. Eastern-European Journal of Enterprise Technologies, 5 (7 (125)), 43–49. doi: https://doi.org/10.15587/1729-4061.2023.289930*

1. Introduction

The use of industrial and warehouse buildings and facilities involves large areas of premises without supporting structures, which forces builders to design ceilings or coverings with large spans. One of the types of structures that makes it possible to cover large spans is reinforced concrete ribbed slabs [1]. Due to design features that increase the rigidity and load-bearing capacity of these structures, namely the arrangement of longitudinal and transverse ribs, reinforced concrete ribbed slabs are able to cover large spans without passing to the limit states of the 1st and 2nd groups.

Such structures are designed to absorb constant load from natural weight, equipment, as well as periodic load from rainfall.

The main principles of modern construction are to guarantee the safety of people who plan to use construction facilities and buildings for the required period [2]. In addition, it is necessary to provide comfort, predicting the most rational financial costs for the implementation of relevant construction projects. One of the decisive directions for guaranteeing people's safety during a fire is to reduce the risk of a threat during evacuation before the onset of critical indicators of dangerous fire factors. To achieve this goal, it is necessary to guarantee the operation of especially responsible structures for a certain time under the thermal influence of fire with minimal risks, regarding the threat to human life and health. The implementation of this aspect is implied, including when assessing the fire resistance of building structures. There are several methods for assessing the fire resistance of structural elements of buildings. The principles of these methods involve determining the time from the beginning of thermal exposure according to the standard fire temperature regime to the onset of one of the limit states of fire resistance. The possibilities of full-scale and experimental tests are limited by the arrangement of the necessary configurations