3. Tkach D.I. *Filosofske obgruntuvannya sistemnosti teoriï i praktiki oborotnih zobrazhen*. *Visnik PDABA*. No. 5, 2019, pp. 75– 82.

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DYNAMIC INCREASE FACTOR FOR CALCULATION OF STRUCTURAL RESPONSE AGAINST PROGRESSIVE COLLAPSE

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Problem statement. Last years the problem of safety in buildings has been paid a lot of attention. Very often explosions, fires, earthquakes, sudden destructions of supports cause the accident and lead to progressive collapse. Thus, the calculation of the stability to progressive collapse of building structures is very acute question today. It should pay particular attention to the considerations of dynamic effect during destruction and it should take into account dynamic increase factor. The analysis and review of the standards and the scientific literature on this problem indicates that we have not a clear understanding of the value of dynamic increase factor of different failure types [1−6].

Purpose of the study. To review the standards and the scientific literature on emergency load calculations that are linked with stability to progressive collapse of building structures and dynamic influence of localized structural component damage (failure) on the building structure. To study the dynamic influence on the building structure of its localized structural component damage by laboratory experiment and numerical simulation.

Maine results. To reach the goal the existing standards and the scientific literature of different countries on calculations and design of resistant to progressive collapse buildings and structures were reviewed. The laboratory bench was created (fig. *a*).

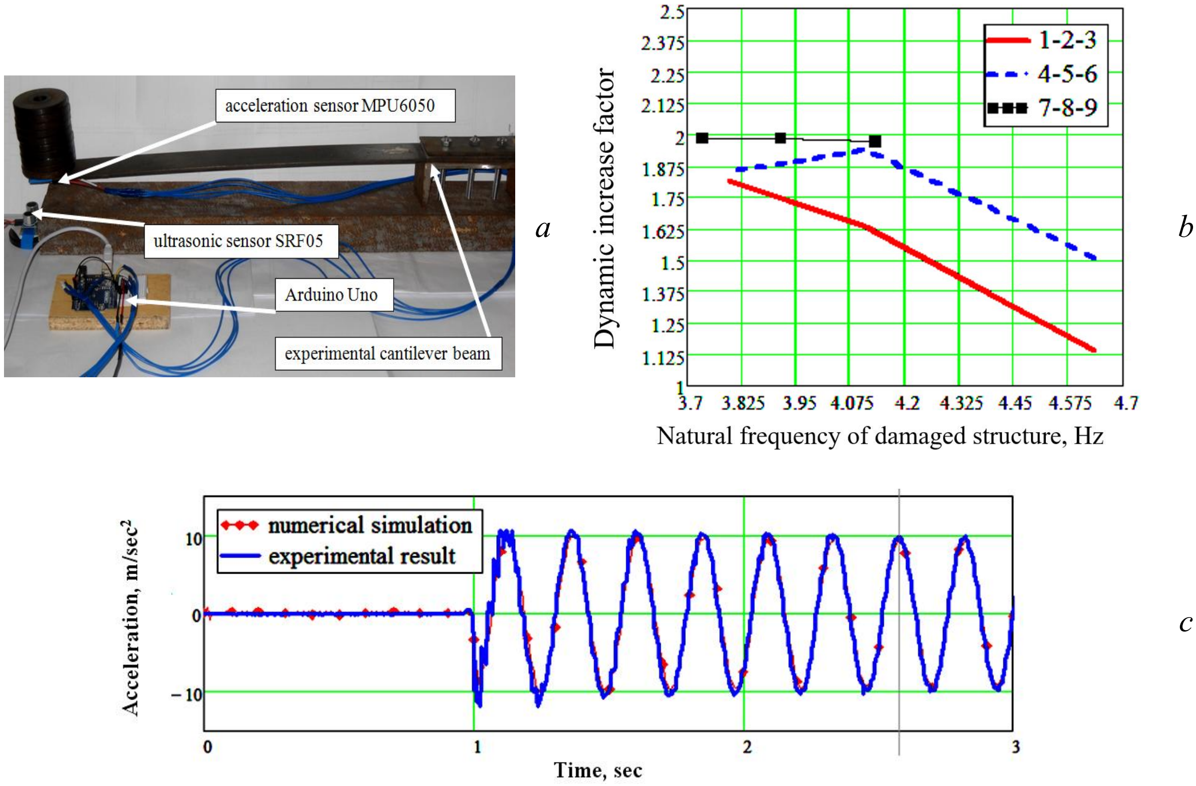

Fig. Laboratory bench – (a); schedule of experimental results – (b); comparation of numerical and experimental accelerogram – (c)

Experimental and numerical studies were conducted by modelling dynamic behaviour of the building structure. The laboratory bench was statically indeterminate system in order to localized structural component (flexible stud under the end of the cantilever beam) damage (failure) did not lead to the hole structure destruction but only to its qualitative reconfiguration. During the laboratory experiment the vibrational accelerations and displacements for characteristic point of structure were registered. By processing vibrational diagrams, the values of the frequencies and the laboratory bench free vibrations logarithmic decrements were received, as well as the value of the dynamic increase factor by different load levels and different failure types. Experimental results were checked by numerical simulation (fig. *c*).

Conclusion. The studies allow to evaluate dynamic effect of localized structural component damage two types. It was also discovered that the values of dynamic displacements and accelerations may be different by several times by the comparable values of the dynamic increase factors of different failure types.

The results suggest that in the case of total structural component failure the value of dynamic increase factor (stresses and accelerations) is more than that in the case of structural component damages while retaining partial functionality. In such a case when carrying out practical engineering calculations it would be sufficient to consider the total structural component failure while the possibility of partial damages would be as reserve of power.

Schedule of experimental results (fig. *b*). In the legend of the graph numbers 1−6 – the results -for the case of buckling failure of flexible stud and 7−9 – the results for the cases of sudden and complete failure of flexible stud from work at different masses at the end of the cantilever beam.

References

1. Design of buildings to resist progressive collapse. UFC 4-023-03. 2016.

2. GSA Alternate Path Analysis and Design Guidelines for Progressive Collapse Resistance. 2016.

3. Kong D.-Y., Yang Y., Yang B. and Zhou X.-H. Experimental Study on Progressive Collapse of 3D Steel Frames under Concentrated and Uniformly Distributed Loading Conditions. *Journal of Structural Engineering*. 2020, vol. 146, iss. 4. URL: DOI: https://doi.org/10.1061/ (ASCE)ST.1943-541X.0002537

4. Mahmoudi M., Teimoori T. and Kozani H. Presenting displacement-based nonlinear static analysis method to calculate structural response against progressive collapse. *International Journal of Civil Engineering*. 2015. Vol. 13, No. 4A. P. 478–485. URL: https://www.researchgate.net/publication/287260608_Presenting_displacement-based_ nonlinearstatic_analysis_method_to_calculatestructural_response_againstprogressive _collapse

5. Mashhadiali N., Kheyroddin A., Zahiri-Hashemi R. Dynamic Increase Factor for Investigation of Progressive Collapse Potential in Tall Tube-Type Buildings. *Journal of Performance of Constructed Facilities.* 2016, vol. 30, iss. 6. URL: https://doi.org/ 10.1061/(ASCE)CF.1943-5509.0000905

6. Zhu Y., Chen Ch., Yao Y., Keer L. M. and Huang Y. Dynamic increase factor for progressive collapse analysis of semi-rigid steel frames. *Steel and Composite Structures*. 2018, vol. 28, no. 2, pp. 209−221. URL: https://doi.org/10.12989/scs.2018.28.2.209