DOI:10.22337/2587-9618-2025-21-4-229-239

TITLE EMERGENCY CALCULATION OF THE INDUSTRIAL BUILDING STRUCTURE

Valeriy I. Telichenko [1], Vladimir I. Rimshin [1], Ekaterina S. Ketsko [2]

[1] Moscow State University of Civil Engineering, Moscow, RUSSIA

[2] Research Institute for Building Physics of Russian Academy of the Architecture and Construction Sciences, Moscow, RUSSIA

Abstract: Emergency situations calculation for the industrial buildings structures is an important element in ensuring their reliability and safety in conditions that contribute to the emergence of significant social, environmental and economic consequences. This calculation is mandatory for objects of a high responsibility level (class KS-3), and can be carried out on a voluntary basis for objects of class KS-2, where a large number of people are expected to be present. The article presents the calculation of the industrial building structures with a high responsibility level and analyzes its results. The calculation was performed in accordance with paragraph 5.1 in SP 56.13330.2011 «Industrial buildings» for resistance to progressive collapse as an emergency situation result. A secondary model was created based on the primary calculation model. An emergency failure case of the middle load-bearing column in the frame along the 18/H axis was selected having analyzed the space-planning and design solutions for this building. It was established that the required beams and the roof slab reinforcement obtained as a calculation result of the secondary model does not exceed that obtained as a primary model calculation result based on the calculations performed results. Also, based on the calculation results of the ozone-sorption block building secondary model (fast filter section) for an emergency situation, it was determined that when such a situation occurs - when one of the columns is turned off - the remaining load-bearing elements take on additional forces without losing strength and stability, that is, resistance to the structure progressive collapse will be ensured.

Keywords: emergency situation, industrial structure, progressive collapse, load combinations, load-bearing elements

РАСЧЁТ АВАРИЙНОЙ СИТУАЦИИ КОНСТРУКЦИИ ПРОИЗВОДСТВЕННОГО ЗДАНИЯ

В.И. Теличенко [1], В.И. Римшин [1], Е.С. Кецко [2]

[1] Национальный исследовательский Московский государственный строительный университет», г. Москва, РОССИЯ

[2] Научно–исследовательский институт строительной физики Российской академии архитектуры и строительных наук, г. Москва, РОССИЯ

Аннотация: Расчёт на аварийные ситуации для конструкций производственных зданий является важным элементом обеспечения их надежности и безопасности в условиях, способствующих возникновению значительных последствий социального, экологического и экономического характера. Этот расчёт является обязательным для объектов повышенного уровня ответственности, а именно класса КС-3, и может быть проведен на добровольной основе для объектов класса КС-2, где предполагается массовое пребывание людей. В статье приведён расчёт конструкций производственного здания повышенного уровня ответственности и проанализированы его результаты. Расчёт был выполнен согласно пункту 5.1 СП 56.13330.2011 «Производственные здания» на устойчивость к прогрессирующему обрушению в результате аварийной ситуации. На основании первичной расчётной модели выполнена вторичная модель. Проанализировав объемно–планировочные и конструктивные решения данного здания, был выбран аварийный случай выхода из строя средней несущей колонны каркаса по оси 18/Н. По результатам выполненных расчётов установлено, что требуемое армирование балок и плиты покрытия, полученное в результате расчёта вторичной модели не превышает полученного в результате расчёта первичной модели. Также по результатам выполненного расчёта вторичной модели здания озоно–сорбционного блока (отделение быстрых фильтров) на аварийную ситуацию было определено, что при возникновении такой ситуации – выключении одной из колонн из работы – остальные несущие элементы сооружения воспринимают на себя дополнительные усилия, не теряя при этом прочность и устойчивость, то есть устойчивость к прогрессирующему обрушению сооружения будет обеспечена.

Ключевые слова: аварийная ситуация, производственное сооружение, прогрессирующее обрушение, сочетания нагрузок, несущие элементы

INTRODUCTION

Emergency situations calculation for the industrial buildings structures is an important element in ensuring their reliability and safety in conditions that contribute to the emergence of significant social, environmental and economic consequences. This calculation is mandatory for objects of a high level of responsibility (class KS-3), and can also be carried out on a voluntary basis for class KS-2 objects, where a large number of people are expected in accordance with GOST 27751-2014 «Reliability of building structures and foundations». Such measures are aimed at increasing the safety and reliability level in construction projects, which is especially important in the conditions of modern construction and buildings operation [1-10].

The structure considered in this article, the ozone-sorption unit, is a structure of a high responsibility level KS-3, accordingly, this calculation is mandatory in its design.

The purpose calculation for the emergency situations occurrence is to check and ensure the safety and reliability of the adopted design solutions, and to determine the methods for protecting the industrial building supporting structures from progressive collapse in emergency situations.

METHODS

The following methods are used to assess the structures resistance to emergency situations:

- A model describing possible emergency scenarios creation. For each scenario, external and internal impacts combinations are taken into account.
- The load-bearing elements determination, the failure of which can lead to the progressive collapse of the entire system.
- The possible failures and their impact on the overall structure stability research.
- The correlation analysis between the structure elements. Possible sequential reactions that occur when one or more elements fail are considered [11-18].

Calculation for the occurrence of an emergency situation. The calculation of the ozone-sorption block model in axes 4 - 19 m/o K - R (fast filter section) was performed in accordance with paragraph 5.1 in SP 56.13330.2011 «Industrial buildings» for resistance to progressive collapse as an emergency situation result. A secondary model was created based on the primary calculation model.

A secondary model was created based on the primary calculation model (Figure 1).

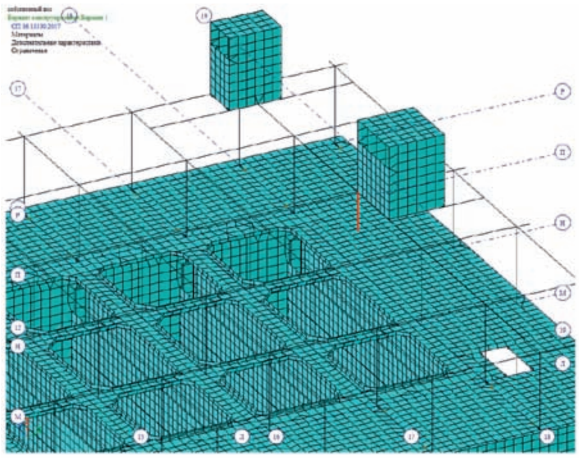

Figure 1. Calculation model

An emergency failure case of the middle load-bearing column in the frame along the 18/H axis was selected having analyzed the space-planning and design solutions for this building (marked in red in Figure 1).

The lower part of the column, 2.15 m high, was removed to simulate the failure (the covering is not shown). The calculation for progressive collapse in the emergency was performed with a special combination of standard load values, including the failure of one of the load-bearing structure elements.

The calculation is performed according to the criterion of extreme stress values at characteristic element sections points based on the rules established by regulatory documents SP 20.13330.2011 «Loads and Impacts», SP

22.13330.2011 «Foundations of Buildings and Structures», SP 63.13330.2012 «Concrete and Reinforced Concrete Structures», SP 385.1325800.2018 «Protection of Buildings from Progressive Collapse», SP 296.1325800.2017 «Buildings and Structures. Special Impacts» [19-25].

RESULTS AND DISCUSSION

The spatial static calculation was performed using the finite element method using the LIRA-SAPR software package. The walls and floor slabs and roofs were modeled using the finite elements of a universal shell in the calculation model, all rod elements were modeled using a universal spatial rod finite element [26-30].

The roof slab vertical displacements isofields is shown in Figure 2. Longitudinal forces N in the frame supporting elements after an emergency situation fragment is shown in Figure 3.

The maximum value of N occurred in columns 17/M, 18/M, 18/P, 19/N as a result of the forces redistribution.

The results of calculating the maximum force M_y in the frame supporting elements after an emergency situation is shown in Figure 4. The roof beams vertical displacements mosaic is shown in Figure 5.

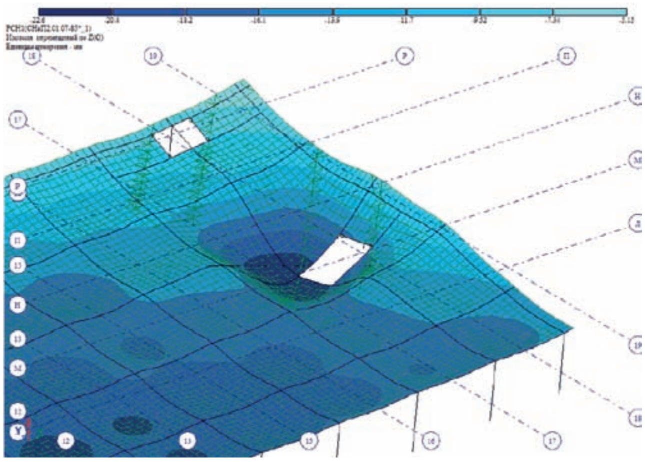

Figure 2. The roof slab vertical displacements isofields (fragment)

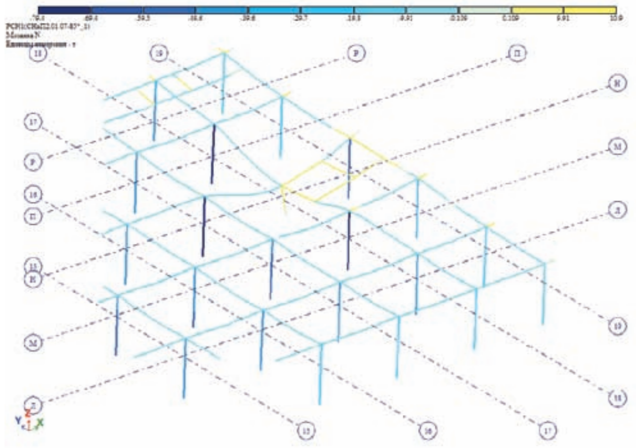

Figure 3. Longitudinal forces N in the frame supporting elements after an emergency situation (fragment)

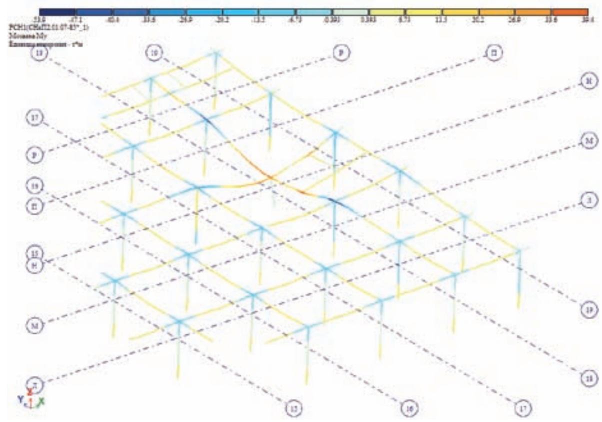

Figure 4. Maximum forces M_y in the frame supporting elements after an emergency situation (fragment)

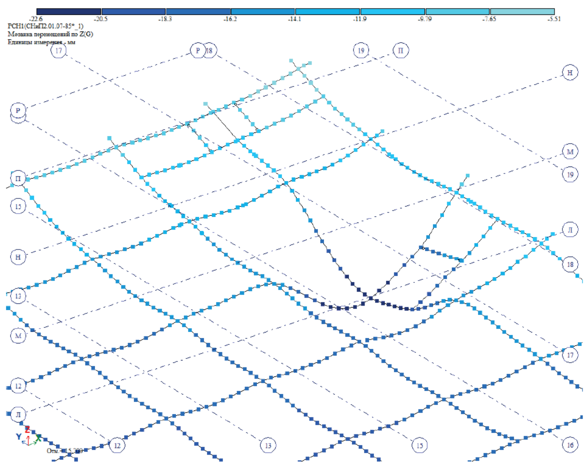

Figure 5. The roof beams vertical displacements mosaic (fragment)

The results of calculating the required reinforcement in beams with a cross-section of 40x80 cm and the reinforcement calculation diagram are shown in Figures 6, 7 and 8. The results of calculating the required reinforcement in columns are shown in Figure 9.

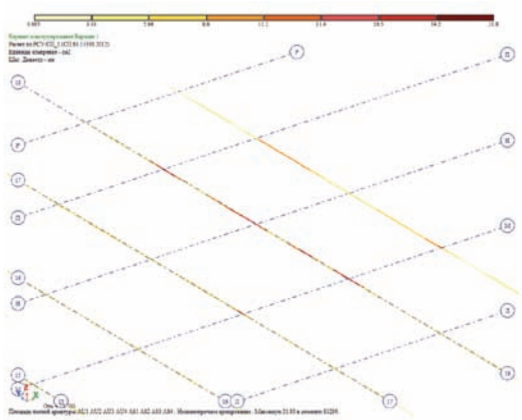

Figure 6. Required reinforcement in beams 40x80 mm (fragment)

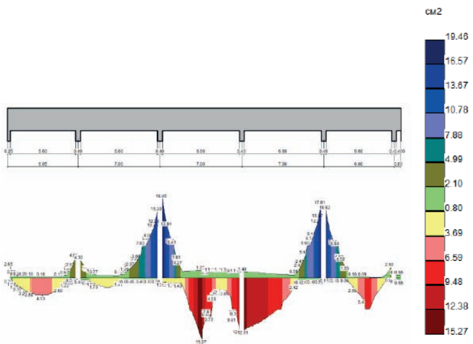

Figure 7. Required reinforcement in beams 40x80 mm (diagram)

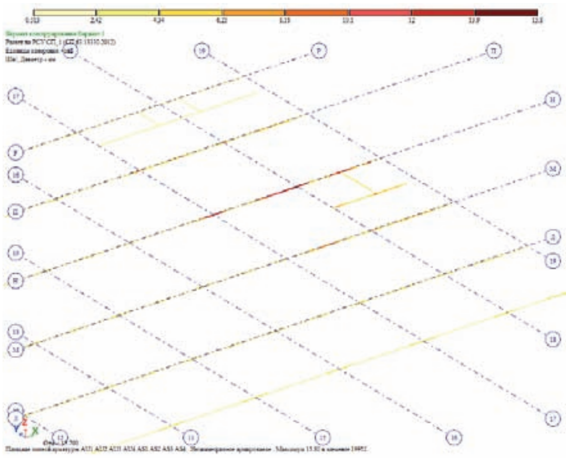

Figure 8. Required reinforcement in beams 40x80 mm (fragment)

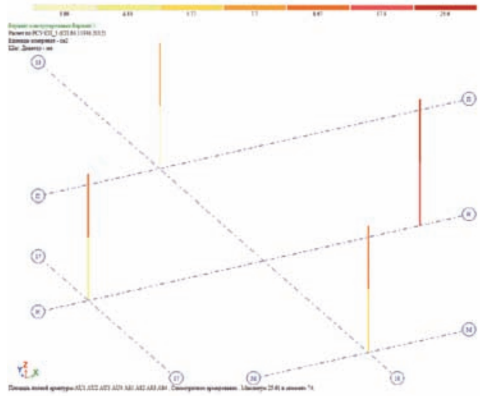

Figure 9. Required reinforcement in columns (fragment)

The authors proposed a reinforcement variant for the considered column KmK74, shown in Figure 10. The KmK74column specification and the steel specifications are given in Tables 1 and 2, respectively.

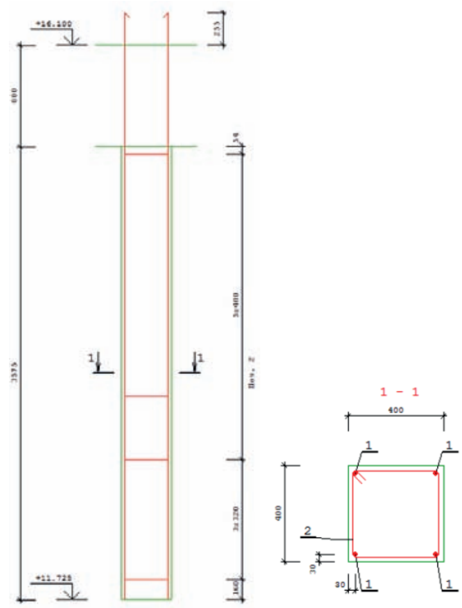

Figure 10. Column reinforcement option

Table 1. The column specification KmK74

Position	Name	Quantity	Weight, kg	Notes
	Specifications			
1	Ø32 A500 l=4630 mm	4	29.2	
2	Ø8 A240 l=1540 mm	9	0.6	
	Materials			
	Concrete class B25			0.6 m^2

Table 2. Steel consumption statement

Unit	Reinforcement products				
	Reinforcement class				Total, kg
	A240		A500		
	GOST 5781-82		GOST 5781-82		
	Ø8	Total	Ø32	Total	
KmK74	5	5	117	117	122

The forces in the roof slab Mx and My, Nx and Ny (fragments) are shown in Figures 11-14, respectively.

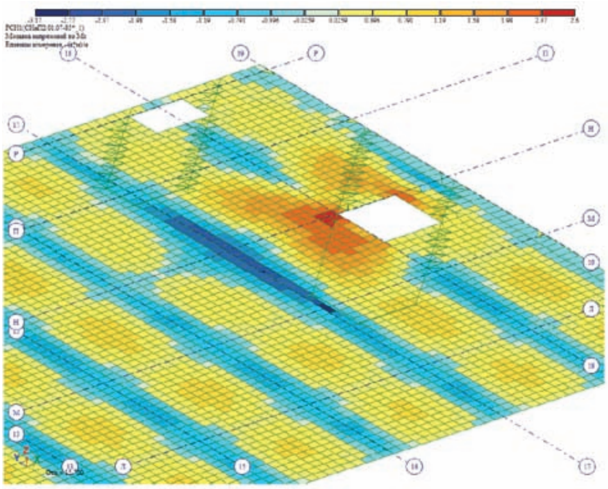

Figure 11. Forces in the roof slab M_x (fragment)

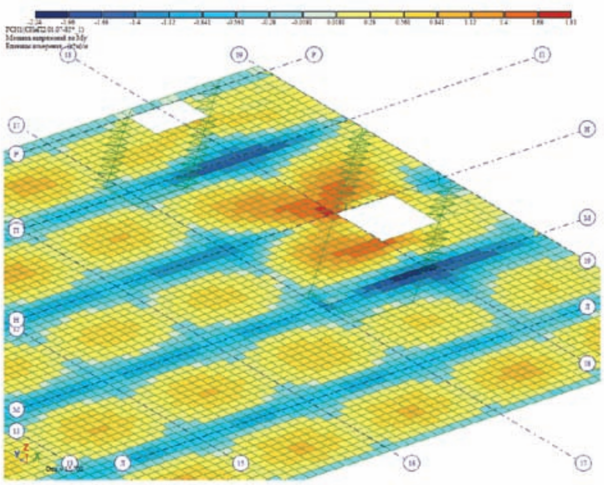

Figure 12. Forces in the roof slab M_y (fragment)

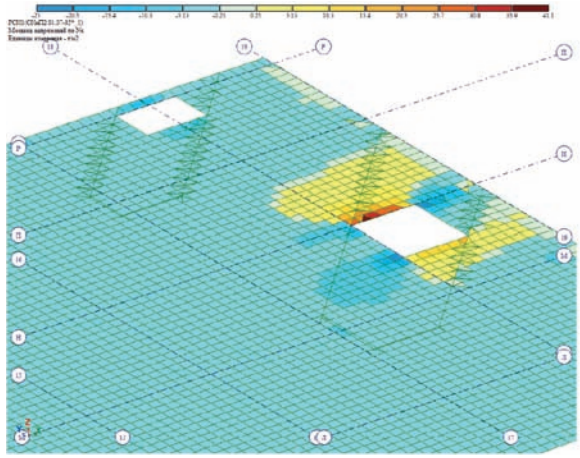

Figure 13. Forces in the roof slab Nx (fragment)

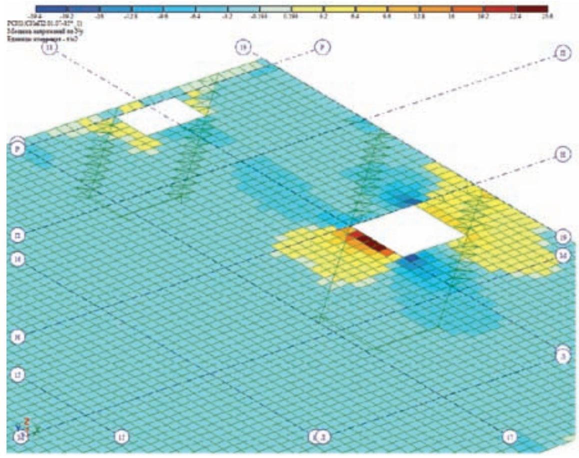

Figure 14. Forces in the roof slab Ny (fragment)

The calculation results for the required reinforcement in the roof slabs are shown in Figures 15-18, respectively.

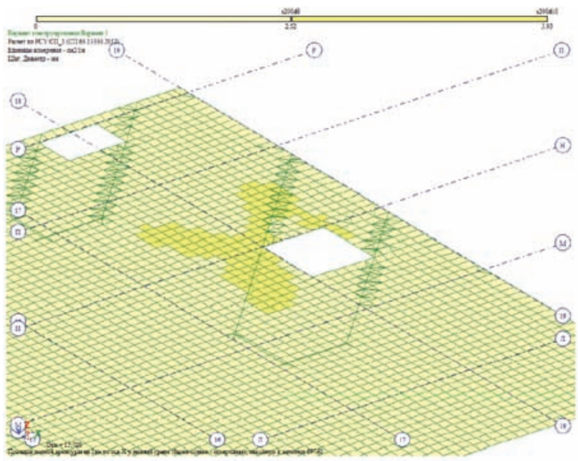

Figure 15. Required reinforcement in the roof slab. Lower along the X axis (fragment)

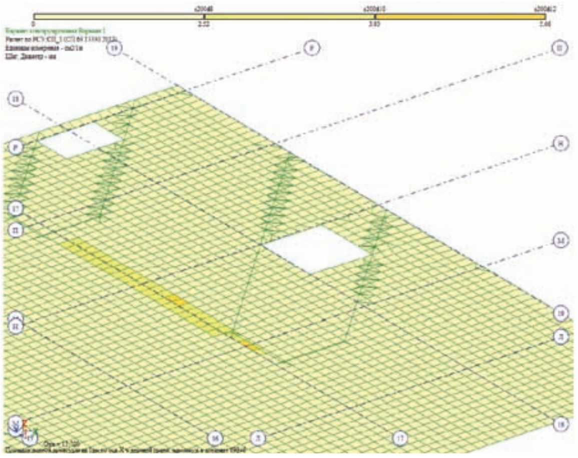

Figure 16. Required reinforcement in the roof slab. Upper along the X axis (fragment)

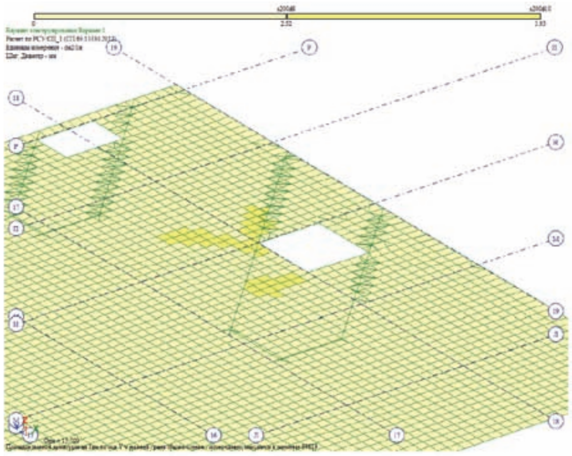

Figure 17. Required reinforcement in the roof slab. Bottom along the Y axis (fragment)

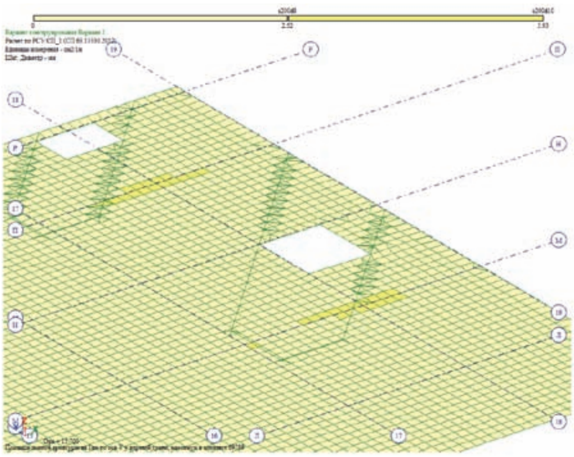

Figure 18. Required reinforcement in the roof slab. Upper along the Y axis (fragment)

CONCLUSION

The maximum displacement along the Z axis of a 7 m long roof beam is 22.6 mm. The required column reinforcement (25.6 cm^2) does not exceed that obtained as a primary model calculation result (28.2 cm^2).

The required beams and roof slabs reinforcement obtained as a result of calculating the secondary model does not exceed that obtained as a result of calculating the primary model.

was established that when such a situation occurs – when one of the columns is switched off from operation – the remaining load-bearing elements take on additional forces without losing strength and stability, i.e., resistance to progressive collapse is ensured based on the calculation results of the ozone-sorption block building secondary model in axes 4–19 m/o K–R (fast filter section) for an emergency situation.

REFERENCES

1. **Onoprienko A.R., Solovyov A.K., Rimshin V.I.,** The use of solar energy for heating premises in the southern regions of the Russian federation in the spring-autumn period. Light & Engineering, **32(1)**, pp. 18-22 (2024) DOI: 10.33383/2023-067
2. **Mihail V. Lukin, Svetlana I. Roshchina, Anastasia V. Lukina, Rimshin V.I.,** Computer modeling of energy-efficient joints of wood composite panels. International Journal for Computational Civil and Structural Engineering, **20(1)**, pp. 68-80 (2024) DOI: 10.22337/2587-9618-2024-20-1-68-80
3. **Valeriy Telichenko, Vladimir Rimshin and Ekaterina Ketsko,** Promising directions for the artificial intelligence development in the housing and utilities sector. E3S Web of Conferences, **533**, 05001 (2024) DOI: https://doi.org/10.1051/e3sconf/202453505001
4. **Telichenko V., Rimshin V., Ketsko E.,** Digital robotic systems for non-destructive reinforced concrete structures testing. E3S

Web of Conferences, **533**, 02045 (2024) DOI: 10.1051/e3sconf/202453302045
5. **Rimshin V.I., Roshchina S.I., Lesovik R.V., Lukin M.V., Lukina A.V.**, Prolongation of the life cycle of wooden structures due to the use of joints on aluminum connectors. Eurasian Chemical Communications, **6**, p. 122 (2024) DOI:10.48309/jmpcr.2024.183586
6. **Monastyrev P.V., Elchishcheva T.F., Makarchuk M.V.1, Erofeev V.T., Rimshin V.I., Erofeeva I.V.,** The effect of montmorillonite on the rheological and physico-mechanical properties of a thermosetting polymer composite. International Journal for Computational Civil and Structural Engineering, **20(2)**, pp. 109-117 (2024) DOI: 10.22337/2587-9618-2024-20-2-109-117
7. **Rimshin V., Ketsko E.,** Justification of strengthening of reinforced concrete structures of an industrial building with composite materials. Lecture Notes in Civil Engineering, **372**, pp. 129 (2024) https://doi.org/10.1007/978-3-031-36723-6_14
8. **Rimshin V., Khamrakulov R., Alikabulov Sh., Radjabov Y., Abdurakhmonov A., Mirazimova G., Jamolova M.,** Study on the possibilities of increasing the effectiveness of thermal insulation of enclosing structures in window openings using low-emission coatings and films. E3S Web of Conferences, **563**, 02024 (2024) DOI:10.1051/e3sconf/202456302024
9. **Semenov V.A., Morozov S.V., Arishin S.V., Kuzina O.N., Rimshin V.I., Makisha E.V.,** Formal specification and verification of requirements in architecture and construction using the express modeling language Programming and Computer Software, **50 (5)**, pp. 376-391 (2024) https://doi.org/10.1134/S036176882470018X
10. **Svetlana Roshchina, Mikhail Lukin, Ekaterina Ketsko,** Scientific Basis of Studying the Pile Foundations Bearing Capacity During Building Reconstruction. Lecture Notes in Civil Engineering, **576**, pp. 283-294 (2024) https://doi.org/10.1007/978-3-031-81635-2_28
11. **Svetlana Roshchina, Anatoly Krishan, Ekaterina Ketsko,** Tube-Concrete Structures Stress-Strain State Theory. Lecture Notes in Civil Engineering, **576**, pp. 295-301 (2024) https://doi.org/10.1007/978-3-031-81635-2_29
12. **Shafranovsky T., Rimshin V., Varlamov A., Merkulov S.,** Comparison of the durability of buildings in a group. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062004 (2021) DOI:10.1088/1757-899X/1079/6/062004
13. **Rimshin V.I., Kurbatov V.L., Erofeev V.T., Ketsko E.S.,** Comprehensive survey of the silt reservoir structures technical condition. IOP Conference Series: Materials Science and Engineering, **1079 (4)**, 042077 (2021) DOI:10.1088/1757-899X/1079/4/042077
14. **Kostyuchenko Ya.B., Varlamov A.A., Rimshin V.I., Bykov G.S., Roschina S.,** Bearing capacity of steel-polystyrene concrete slab. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062003(2021) DOI:10.1088/1757-899X/1079/6/062003
15. **Varlamov A.A., Rimshin V.I., Davydov A., Minnatov A.R., Kurbatov A.M.,** Research of the degradation process of reinforced concrete structures. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062005 (2021) DOI:10.1088/1757-899X/1079/6/062005
16. **Telichenko Valery, Rimshin Vladimir, Ketsko Ekaterina,** Design and Calculation Solutions for Designing Biological Treatment Facilities on The Pumping Station Example. AIP Conference Proceedings, **2497**, 020009 (2023) https://doi.org/10.1063/5.0103519
17. **P. A. Amelin , V. I. Rimshin , A. A. Kryuchkov , D. V. Obernikhin,** Finite Element Modeling of the Work of Bent Reinforced Concrete Elements of Rectangular Section in the Abaqus Software Environment. Lecture Notes in Civil

Engineering, **307**, pp. 268-275 (2022) https://doi.org/10.1007/978-3-031-20459-3_34

18. **Rimshin V.I., Truntov P.S.,** Technical inspection stages of the textile industry building. Izvestiya Visshih Uchebnih Zavedenii, Seriya Tehnologiya Tekstilnoi Promishlennosti, **1 (403)**, pp. 153-158 (2023) DOI 10.47367/0021-3497_2023_1_153
19. **Krishan A.L., Astafeva M.A., Chernyshova E.P.,** Numerical and Experimental Investigation of Axially Loaded Columns with Spiral Reinforcement. Materials Science Forum, **1087**, pp. 163-168 (2023) DOI: 10.4028/p-7841oa
20. **Alexey Bulgakov, Jens Otto Wen-der Yu, Vladimir Rimshin and Alexey Shleenko,** Structural organization of robotic building and mounting complexes. Journal of Robotics and Mechatronics, Proceedings of the 40th ISARC, Chennai, India, ISBN 978-0-6458322-0-4, ISSN 2413-58442023, pp. 208-213 (2023) DOI:10.22260/ISARC2023/0030
21. **V. Telichenko, V. Rimshin, E. Ketsko,** Engineering structures stability against progressive collapse. E3S Web of Conferences, 02037 (EDP Sciences, 2023) https://doi.org/10.1051/e3sconf/202341002037 FORM-2023
22. **Vladimir Rimshin, Anatoly Krishan, Elena Korol, Svetlana Roshchina, and Igor Shubin,** Square-Section Tube-Concrete Structures Studying Under Axial Compression Both with Spiral Reinforcement of the Concrete Core and Without Reinforcement. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 165-181 (2023) https://doi.org/10.1007/978-3-031-30570-2_15
23. **Artem Strekalkin, Mikhail Sergeev, Dmitry Reva , and Vladimir Rimshin,** Strength and Deformability of Butt Joints Made of Wood with Local Modification. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 191-199 (2023) https://doi.org/10.1007/978-3-031-30570-2_17
24. **Mikhail Lukin, Roschina Svetlana, and Vladimir Rimshin,** Mechanical Properties of Polymer Composition Based on Dimethacrylic Polyester with Nanostructured Filler for Wood Modification. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 277-287 (2023) https://doi.org/10.1007/978-3-031-30570-2_25 18
25. **Martinov V., Lukin M., Rimshin V., Rusak K., Ivaniuk A.,** Influence of Different Types of Aggregates on the Structural Properties of Fiber-Reinforced Concrete. Lecture Notes in Networks and Systems, **403 LNNS**, pp. 1467–1476 (2022) DOI: 10.1007/978-3-030-96383-5_164
26. **Neverov A.N., Truntov, P.S., Ketsko E.S., Rimshin, V.I.,** Calculating the Strengthening of Construction Structures Before the Reconstruction of the Building. Lecture Notes in Civil Engineering, **182**, pp. 173–179 (2022) DOI: https://doi.org/10.1007/978-3-030-85236-8_14
27. **Lukin M., Martynov V., Rimshin V., Aleksiievets I.,** Reinforced Concrete Vertical Structures Under a Gently Sloping Shell of Double Curvature Under the Influence of Progressive Collapse. Lecture Notes in Civil Engineering, **182**, pp. 577–587 (2022) DOI: 10.1007/978-3-030-85236-8_50
28. **A.L. Krishan, V.I. Rimshin, I.L. Shubin, M.A. Astafeva, A.A. Stupak,** Compressed Reinforced Concrete Elements Bearing Capacity of Various Flexibility. Lecture Notes in Civil Engineering, **182**, pp. 283–291 (2022) DOI: 10.1007/978-3-030-85236-8_26
29. **Rimshin V.I., Roshchina S.I., Ketsko E.S.,Truntov P.S., Kuzina I.S.,** Engineering Calculations of Acidifier Retaining Walls During Water Treatment Facilities Designing. Lecture Notes in Civil Engineering, **182**, pp. 55–73 (2022) DOI: 10.1007/978-3-030-85236-8_5

30. **Tho V.D., Korol E.A., Rimshin V.I., Anh P.T.,** Model of stress-strain state of three-layered reinforced concrete structure by the finite element methods. International Journal for Computational Civil and Structural Engineering, **18(2)**, pp. 62–73(2022) DOI: 10.22337/2587-9618-2022-18-2-62-73

СПИСОК ЛИТЕРАТУРЫ

1. **Onoprienko A.R., Solovyov A.K., Rimshin V.I.,** The use of solar energy for heating premises in the southern regions of the Russian federation in the spring-autumn period. Light & Engineering, **32(1)**, pp. 18-22 (2024) DOI: 10.33383/2023-067
2. **Mihail V. Lukin, Svetlana I. Roshchina, Anastasia V. Lukina, Rimshin V.I.,** Computer modeling of energy-efficient joints of wood composite panels. International Journal for Computational Civil and Structural Engineering, **20(1)**, pp. 68-80 (2024) DOI: 10.22337/2587-9618-2024-20-1-68-80
3. **Valeriy Telichenko, Vladimir Rimshin and Ekaterina Ketsko,** Promising directions for the artificial intelligence development in the housing and utilities sector. E3S Web of Conferences, **533**, 05001 (2024) DOI: https://doi.org/10.1051/e3sconf/202453505001
4. **Telichenko V., Rimshin V., Ketsko E.,** Digital robotic systems for non-destructive reinforced concrete structures testing. E3S Web of Conferences, **533**, 02045 (2024) DOI: 10.1051/e3sconf/202453302045
5. **Rimshin V.I., Roshchina S.I., Lesovik R.V., Lukin M.V., Lukina A.V.**, Prolongation of the life cycle of wooden structures due to the use of joints on aluminum connectors. Eurasian Chemical Communications, **6**, p. 122 (2024) DOI:10.48309/jmpcr.2024.183586
6. **Monastyrev P.V., Elchishcheva T.F., Makarchuk M.V.1, Erofeev V.T., Rimshin V.I., Erofeeva I.V.,** The effect of montmorillonite on the rheological and physico-mechanical properties of a thermosetting polymer composite. International Journal for Computational Civil and Structural Engineering, **20(2)**, pp. 109-117 (2024) DOI: 10.22337/2587-9618-2024-20-2-109-117
7. **Rimshin V., Ketsko E.,** Justification of strengthening of reinforced concrete structures of an industrial building with composite materials. Lecture Notes in Civil Engineering, **372**, pp. 129 (2024) https://doi.org/10.1007/978-3-031-36723-6_14
8. **Rimshin V., Khamrakulov R., Alikabulov Sh., Radjabov Y., Abdurakhmonov A., Mirazimova G., Jamolova M.,** Study on the possibilities of increasing the effectiveness of thermal insulation of enclosing structures in window openings using low-emission coatings and films. E3S Web of Conferences, **563**, 02024 (2024) DOI:10.1051/e3sconf/202456302024
9. **Semenov V.A., Morozov S.V., Arishin S.V., Kuzina O.N., Rimshin V.I., Makisha E.V.,** Formal specification and verification of requirements in architecture and construction using the express modeling language Programming and Computer Software, **50 (5)**, pp. 376-391 (2024) https://doi.org/10.1134/S036176882470018X
10. **Svetlana Roshchina, Mikhail Lukin, Ekaterina Ketsko,** Scientific Basis of Studying the Pile Foundations Bearing Capacity During Building Reconstruction. Lecture Notes in Civil Engineering, **576**, pp. 283-294 (2024) https://doi.org/10.1007/978-3-031-81635-2_28
11. **Svetlana Roshchina, Anatoly Krishan, Ekaterina Ketsko,** Tube-Concrete Structures Stress-Strain State Theory. Lecture Notes in Civil Engineering, **576**, pp. 295-301 (2024) https://doi.org/10.1007/978-3-031-81635-2_29
12. **Shafranovsky T., Rimshin V., Varlamov A., Merkulov S.,** Comparison of the durability of buildings in a group. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062004 (2021) DOI:10.1088/1757-899X/1079/6/062004

13. **Rimshin V.I., Kurbatov V.L., Erofeev V.T., Ketsko E.S.,** Comprehensive survey of the silt reservoir structures technical condition. IOP Conference Series: Materials Science and Engineering, **1079 (4)**, 042077 (2021) DOI:10.1088/1757-899X/1079/4/042077
14. **Kostyuchenko Ya.B., Varlamov A.A., Rimshin V.I., Bykov G.S., Roschina S.,** Bearing capacity of steel-polystyrene concrete slab. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062003(2021) DOI:10.1088/1757-899X/1079/6/062003
15. **Varlamov A.A., Rimshin V.I., Davydov A., Minnatov A.R., Kurbatov A.M.,** Research of the degradation process of reinforced concrete structures. IOP Conference Series: Materials Science and Engineering, **1079 (6)**, 062005 (2021) DOI:10.1088/1757-899X/1079/6/062005
16. **Telichenko Valery, Rimshin Vladimir, Ketsko Ekaterina,** Design and Calculation Solutions for Designing Biological Treatment Facilities on The Pumping Station Example. AIP Conference Proceedings, **2497**, 020009 (2023) https://doi.org/10.1063/5.0103519
17. **P.A. Amelin, V.I. Rimshin, A.A. Kryuchkov, D.V. Obernikhin,** Finite Element Modeling of the Work of Bent Reinforced Concrete Elements of Rectangular Section in the Abaqus Software Environment. Lecture Notes in Civil Engineering, **307**, pp. 268-275 (2022) https://doi.org/10.1007/978-3-031-20459-3_34
18. **Rimshin V.I., Truntov P.S.,** Technical inspection stages of the textile industry building. Izvestiya Visshih Uchebnih Zavedenii, Seriya Tehnologiya Tekstilnoi Promishlennosti, **1 (403)**, pp. 153-158 (2023) DOI 10.47367/0021-3497_2023_1_153
19. **Кrishan A.L., Astafeva M.A., Chernyshova E.P.,** Numerical and Experimental Investigation of Axially Loaded Columns with Spiral Reinforcement. Materials Science Forum, **1087**, pp. 163-168 (2023) DOI: 10.4028/p-7841oa
20. **Alexey Bulgakov, Jens Otto Wen-der Yu, Vladimir Rimshin and Alexey Shleenko,** Structural organization of robotic building and mounting complexes. Journal of Robotics and Mechatronics, Proceedings of the 40th ISARC, Chennai, India, ISBN 978-0-6458322-0-4, ISSN 2413-58442023, pp. 208-213 (2023) DOI:10.22260/ISARC2023/0030
21. **V. Telichenko, V. Rimshin, E. Ketsko,** Engineering structures stability against progressive collapse. E3S Web of Conferences, 02037 (EDP Sciences, 2023) https://doi.org/10.1051/e3sconf/202341002037 FORM-2023
22. **Vladimir Rimshin, Anatoly Krishan, Elena Korol, Svetlana Roshchina, and Igor Shubin,** Square-Section Tube-Concrete Structures Studying Under Axial Compression Both with Spiral Reinforcement of the Concrete Core and Without Reinforcement. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 165-181 (2023) https://doi.org/10.1007/978-3-031-30570-2_15
23. **Artem Strekalkin, Mikhail Sergeev, Dmitry Reva , and Vladimir Rimshin,** Strength and Deformability of Butt Joints Made of Wood with Local Modification. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 191-199 (2023) https://doi.org/10.1007/978-3-031-30570-2_17
24. **Mikhail Lukin, Roschina Svetlana, and Vladimir Rimshin,** Mechanical Properties of Polymer Composition Based on Dimethacrylic Polyester with Nanostructured Filler for Wood Modification. Proceedings of MPCPE 2022, Lecture Notes in Civil Engineering, **335**, pp. 277-287 (2023) https://doi.org/10.1007/978-3-031-30570-2_25 18
25. **Martinov V., Lukin M., Rimshin V., Rusak K., Ivaniuk A.,** Influence of Different Types of Aggregates on the Structural Properties of Fiber-Reinforced Concrete. Lecture Notes in Networks and

Systems, **403 LNNS**, pp. 1467–1476 (2022) DOI: 10.1007/978-3-030-96383-5_164

26. **Neverov A.N., Truntov, P.S., Ketsko E.S., Rimshin, V.I.,** Calculating the Strengthening of Construction Structures Before the Reconstruction of the Building. Lecture Notes in Civil Engineering, **182**, pp. 173–179 (2022) DOI: https://doi.org/10.1007/978-3-030-85236-8_14
27. **Lukin M., Martynov V., Rimshin V., Aleksiievets I.,** Reinforced Concrete Vertical Structures Under a Gently Sloping Shell of Double Curvature Under the Influence of Progressive Collapse. Lecture Notes in Civil Engineering, **182**, pp. 577–587 (2022) DOI: 10.1007/978-3-030-85236-8_50
28. **A.L. Krishan, V.I. Rimshin, I.L. Shubin, M.A. Astafeva, A.A. Stupak,** Compressed Reinforced Concrete Elements Bearing Capacity of Various Flexibility. Lecture Notes in Civil Engineering, **182**, pp. 283–291 (2022) DOI: 10.1007/978-3-030-85236-8_26
29. **Rimshin V.I., Roshchina S.I., Ketsko E.S., Truntov P.S., Kuzina I.S.,** Engineering Calculations of Acidifier Retaining Walls During Water Treatment Facilities Designing. Lecture Notes in Civil Engineering, **182**, pp. 55–73 (2022) DOI: 10.1007/978-3-030-85236-8_5
30. **Tho V.D., Korol E.A., Rimshin V.I., Anh P.T.,** Model of stress-strain state of three-layered reinforced concrete structure by the finite element methods. International Journal for Computational Civil and Structural Engineering, **18(2)**, pp. 62–73(2022) DOI: 10.22337/2587-9618-2022-18-2-62-73

Telichenko Valeriy Ivanovich, the President of MGSU, Doctor of Technical Sciences, Professor, Honored Scientist of the Russian Federation, the Academician of the Russian Academy of Architecture and Construction Sciences (RAACS), Professor of the Department of Construction of Thermal and Atomic Power Stations, Moscow State University of Civil Engineering, 129337, Moscow, Yaroslavskoe shosse, 26, Russia, president@mgsu.ru

Теличенко Валерий Иванович, Президент ФГБОУ ВО «Национальный исследовательский Московский государственный строительный университет», Доктор технических наук, профессор, Заслуженный деятель науки Российской Федерации, академик Российской академии архитектуры и строительных наук (РААСН), профессор кафедры Строительства объектов тепловой и атомной энергетики МГСУ, Федеральное государственное бюджетное образовательное учреждение высшего образования «Национальный исследовательский Московский государственный строительный университет» (НИУ МГСУ), 129337, Центральный федеральный округ, г. Москва, Ярославское шоссе, д. 26, president@mgsu.ru

Rimshin Vladimir Ivanovich, Doctor of Technical Sciences, Professor, Corresponding Member of the Russian Academy of Architecture and Construction Sciences (RAACS), Honored Builder of the Russian Federation, Professor of the Department of Housing and Utilities Sector Moscow State University of Civil Engineering, 129337, Moscow, Yaroslavskoe shosse, 26, Russia, v.rimshin@niisf.ru

Римшин Владимир Иванович, Доктор технических наук, профессор, член-корреспондент РААСН, Заслуженный строитель РФ, профессор кафедры Жилищно-коммунального комплекса, Федеральное государственное бюджетное образовательное учреждение высшего образования «Национальный исследовательский Московский государственный строительный университет» (НИУ МГСУ), 129337, Центральный федеральный округ, г. Москва, Ярославское шоссе, д. 26, v.rimshin@niisf.ru

Ketsko Ekaterina Sergeevna, postgraduate student, Research Institute for Building Physics of Russian Academy of the Architecture and Construction Sciences, 129238, Moscow, Lokomotivny p., 21, Russia, kkuzzina@mail.ru

Кецко Екатерина Сергеевна, аспирант, Научно–исследовательский институт строительной физики Российской академии архитектуры и строительных наук (ФГБУ «НИИСФ РААСН»), 127238, г. Москва, Локомотивный проезд, д. 21, kkuzzina@mail.ru