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FRAMED STAY-IN-PLACE FORMWORK: EFFICIENCY AND IMPLEMENTATION

Abstract. *The article investigates the efficiency of constructing enclosure structures made of lightweight concrete using framed stay-in-place formwork with a light gauge steel framing system (LGSF), and examines the experience of applying the obtained results at active construction enterprises, including within the context of Ukraine's recovery and rebuilding.*

The relevance of the chosen topic is determined by the urgent need for rapid and resource-efficient construction, recovery, and rebuilding of residential and public buildings. The application of combined technologies is proposed as an effective solution for reducing construction timeframes, labor intensity, and overall costs without compromising quality.

The research combines logical-analytical and systems-based methods. As a result, the most effective organizational and technological model for constructing residential complexes using framed stay-in-place formwork based on LGSF was identified. A comprehensive evaluation of the technical and economic indicators was performed. In particular, it was established that, compared to the baseline (design) solution, the application of the developed technologies and the optimization of organizational and technological processes can: reduce construction duration by up to 70 %; increase profitability up to 41.8 % and lower total construction costs, including financing through loans, by 21.5 %.

An analysis was conducted on the implementation of two developed solutions – "Building Wall" (UA149402) and "Framed Stay-in-Place Formwork System" (UA154847) – at multiple real construction sites in Odesa and the Odesa region. The article presents photographic documentation of the assembly process and a visual analysis of how the developed technologies align with practical implementation.

The prospects for further scientific research are outlined, including the search for effective solutions for the construction, repair, rehabilitation, and rebuilding of buildings using stay-in-place formwork and light gauge steel framing.

Key words: light gauge steel framing (LGSF), framed stay-in-place formwork, enclosure structures, organizational and technological modeling, optimization, repair, rehabilitation, rebuilding, fast-assembly elements.

Introduction. In Ukraine, there are over one hundred thousand damaged or destroyed buildings that require urgent and high-quality repair or rebuilding. The demand for the construction (rebuilding) of new fast-assembly housing is constantly increasing, particularly for internally displaced persons and those who have lost their homes entirely. Equally important is the repair or rebuilding of damaged or destroyed public buildings (such as office centers, higher education institutions), warehouses, industrial facilities, and other structures. These types of facilities require construction technologies that minimize downtime and allow for the rapid restoration of operational functionality.

In this context, the search for and implementation of effective construction technologies capable of reducing project duration and costs without compromising quality is critically important. One of the most efficient methods for rapid repair and construction – already proven on the construction market – is the use of light gauge steel framing (LGSF) for fast-assembly structural systems. In addition, in the field of cast-in-place construction, the technology of stay-in-place formwork is gaining increasing popularity.

The combination of these two technologies – framed construction using LGSF and stay-in-place formwork – and their industrial-level application significantly increases the effectiveness of repair and construction activities by reducing costs, labor intensity, and execution time compared to traditional structural and technological approaches.

In this context, the issue of optimization becomes highly relevant. When using such technologies, optimization enables the identification of the most effective organizational and technological models (i.e., work execution schedules) considering real-world constraints. Determining optimal models and testing work organization scenarios using modern software tools improves the manageability of construction processes and ensures maximum efficiency under limited-resource conditions – an especially important factor during large-scale recovery efforts.

Therefore, the study and implementation of framed construction technologies using LGSF and stay-in-place formwork for casting lightweight concrete mixtures is of high **relevance** for active construction companies. **The practical results** of implementing such technologies and their corresponding effective organizational and technological models are particularly valuable. This is evidenced by the obtained patents and the successful application of the researched solutions across construction projects of various functional purposes under real-world conditions.

Materials and methods. The study employed a combination of logical-analytical and systems-based methods aimed at evaluating the efficiency of the construction technology for enclosure structures using framed stay-in-place formwork with light gauge steel framing (LGSF).

At the initial stage, logical-analytical and systems approaches were applied to select the most effective organizational and technological model by generalizing and analyzing the results of previous research.

In addition to theoretical analysis, an empirical assessment of the implementation experience of the stay-in-place formwork technology utilizing LGSF framing was conducted across several construction sites. This involved collecting and systematizing photographic documentation from completed projects, demonstrating key stages of the system's assembly process, including the installation of thermal profiles, mounting of stay-in-place formwork panels, fastening of U-shaped elements, and more.

The collected visual materials served as the basis for a visual-analytical assessment of the compliance of actual solutions with the developed technologies and research outcomes, as well as confirmation of the practical feasibility of the proposed solutions. Photographic documentation was performed directly on construction sites during the implementation of the proposed technologies.

Analysis of recent research and publications. As noted in the introduction, the application of framed technologies (using LGSF) combined with stay-in-place formwork represents a widely accepted solution for repair and rebuilding (construction). Consequently, many researchers and construction professionals have studied these technologies both separately and in combination.

Regarding the implementation of advanced practices, doctor of technical sciences, professor V. Saviovskyi in [1] considers the use of stay-in-place formwork as a variant of precast-monolithic structures.

In [2], doctor of technical sciences, professor I. Shumakov and PhD candidate V. Buhaievski investigate the optimization of parameters in repair and construction works, as well as effective structural and technological solutions for the repair and reinforcement of bridge pier structures using stay-in-place formwork. The study also addresses the reduction of repair duration and the improvement of load-bearing capacity and service life of bridges by applying stay-in-place formwork alongside optimization measures.

Researchers P. Koval and S. Stoyanovich from the Kyiv national university of construction and architecture explored the use of composite panels as stay-in-place formwork in [3].

Scientists from the Ukrainian state university of science and technology examined the possibilities of utilizing local materials for the fabrication of stay-in-place formwork and its application in low-rise construction [4]. This is especially relevant under the resource constraints faced during Ukraine's rebuilding efforts.

Studies [5, 6] focus on the specific features of using profiled steel sheets as stay-in-place formwork in floor slab construction.

D. Khokhriakova in [7] analyzed the technological applicability of light gauge steel framing (LGSF) for prefab construction, focusing on fast-assembly buildings and structures.

The purpose of the study is to select the most effective organizational and technological model for the construction of residential complexes using stay-in-place formwork and light gauge steel framing (LGSF).

The following research **tasks** have been identified:

1. Based on the conducted optimization considering existing constraints, determine the most effective organizational and technological model for erecting a residential complex using stay-in-place formwork with an LGSF frame.
2. Perform a technical and economic assessment of the effectiveness of the conducted research.
3. Analyze the implementation of the research results in Odesa city and the Odesa region.
4. Identify promising directions for further scientific work considering the research outcomes.

Scientific novelty. For the first time, the most effective organizational and technological model for the construction of residential complexes using stay-in-place formwork and light gauge steel framing (LGSF), filled with lightweight expanded polystyrene concrete mixture, has been determined, taking into account existing financing methods.

Presentation of the main material. Previous studies [8–11] conducted numerical modeling based on the construction of the "Avignon" residential complex in Odesa. The construction study was performed using two patented solutions – "Building Wall" (UA 149402) and «Framed Stay-in-Place Formwork System» (UA 154847) [12, 13].

At the first stage of the research [9], an analysis of the effectiveness of known and developed solutions was carried out using a multicriteria analysis methodology [14, 15].

After selecting the most effective solution for erecting enclosure structures, the second stage involved numerical modeling of key performance indicators using the example of the "Avignon" residential complex construction in Odesa [10–11]. The methodology of experimental-statistical modeling was applied [16, 17]. The studied indicators included "construction duration", "average funding intensity", "maximum funding intensity", "construction cost", "construction cost considering loan financing" and "profitability". Variations of the factor space such as "work overlap" and "number of working hours per week" were also examined.

Study [11] investigated the obtained dependencies under the introduction of an existing constraint – the necessity to pay interest on loans. It was assumed that the "construction cost" component consisted of 10 % company's own funds and 90 % loan funds. The loan interest rate was set at 10 % per annum with a 1 % bank commission for monthly loan payments. Additionally, laboratory testing of the developed technologies was conducted [8].

Based on previous studies, this work selected the most effective organizational and technological model for constructing residential complexes using the developed solutions and performed a calculation of technical and economic efficiency.

The highest value of profitability (Y_4) in the construction of the «Avignon» residential complex using stay-in-place formwork is $Y_4 = 41.82$ %. Accordingly, the factor values work overlap (X_1) and number of working hours per week (X_2) are $X_1 = 85.21$ % and $X_2 = 80$ hours, respectively. Let us verify the feasibility of the selected most effective organizational and technological model by other key performance indicators. At these factor values, they are:

– construction duration (Y_1): $Y_1 = 272$ days (minimum value, thus most effective);

– average funding intensity ($Y_{2.1}$) and maximum funding intensity ($Y_{2.2}$): $Y_{2.1} = 56.744$ million UAH/month and $Y_{2.2} = 61.173$ million UAH/month, respectively (the least effective values in the absence of immediate larger funding portions; however, considering the presence of "conditionally fixed costs" and the existing constraint, these values are more reasonable as they allow faster building erection and earlier profit from housing sales);

– construction cost considering loan financing (Y_{3k}): Y_{3k} = 632.485 million UAH (minimum value, thus most effective).

Considering that all studied key performance indicators of the residential complex construction under the combined factor space of work overlap (X_1) and number of working hours per week (X_2) at values X_1 = 85.21 % and X_2 = 80 hours are most effective, the organizational and technological model shown in figure 1 is finally adopted.

To determine the technical and economic efficiency of the research results, baseline (design) values of the performance indicators (at factor values work overlap (X_1) = 74.61 % and number of working hours per week (X_2) = 40 hours) were compared with the indicator values of the selected most effective organizational and technological model (fig. 1):

– construction duration of the residential complex was reduced by 71.6 %;

– average and maximum funding intensity increased by 71.2 % and 71.7 %, respectively. However, this does not overall affect construction efficiency because it depends only on the availability of a larger volume of funding over a shorter period;

– total construction cost considering loan financing was reduced by 21.5 %;

– profitability of construction increased from 11.39 % to 41.82 %.

The following section reviews the implementation experience of the developed technologies "Building Wall" (UA 149402) and "Framed Stay-in-Place Formwork System" (UA 154847) [12, 13], as well as outlines prospects for further research.

The first solution – UA 149402 «Building Wall» [12]. According to this solution, enclosure structures are constructed using stay-in-place formwork made of cement-bonded particle boards on a steel frame composed of bent galvanized profiles – LGSF (light gauge steel framing) – and filled with expanded polystyrene concrete.

The second improved solution – UA 154847 «Framed Stay-in-Place Formwork System» [13]. It differs from the first in that, instead of cement-bonded particle boards, thermal insulation panels made of expanded polystyrene are used on the exterior side as stay-in-place formwork, while moisture-resistant gypsum board is applied on the interior side.

Let us consider **examples** of the application of these developed solutions in the Odesa region and the city of Odesa. The first example is the construction of townhouses in the Club Marine residential complex (fig. 2). Additionally, these technologies were used in the construction of townhouses in the «Avignon» residential complex in Odesa on the Black Sea coast (fig. 3). Figures 2 and 3 demonstrate that these technologies have been implemented and are effectively used for erecting low-rise buildings along the Black Sea coast. Such solutions can also be applied in the rebuilding of destroyed buildings, as confirmed

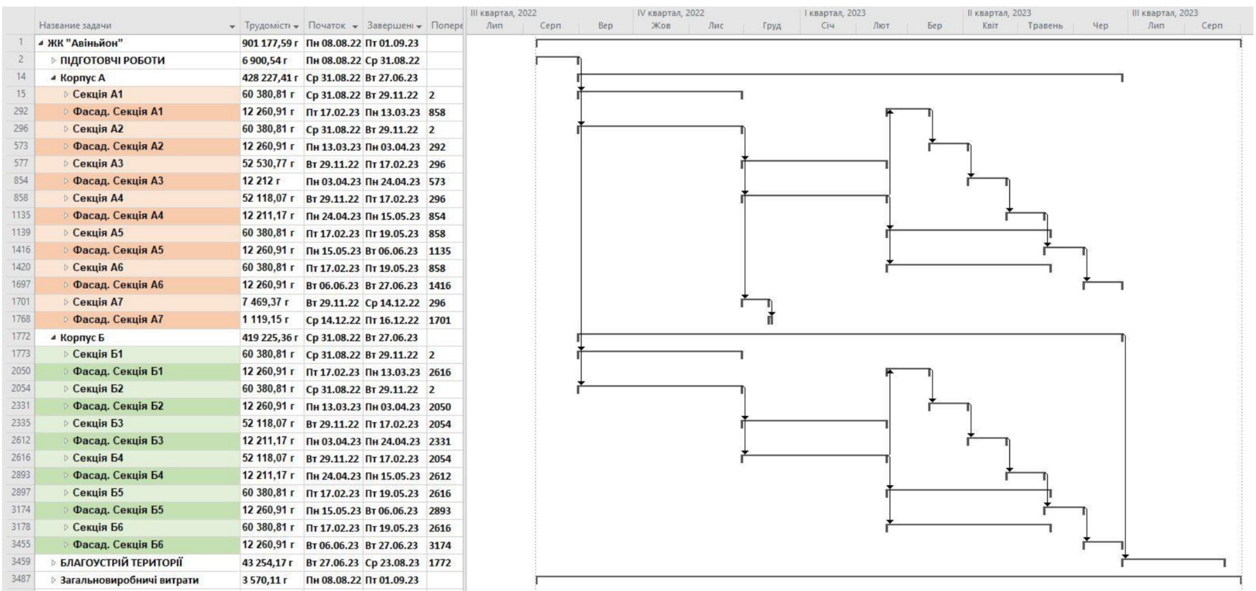

Fig. 1. The most effective organizational and technological model for constructing a residential complex using stay-in-place formwork, obtained considering existing constraints at factor values of "work overlap (X_1)" X_1 = 85.21 % and "number of working hours per week (X_2)" X_2 = 80 hours (5 days, two-shift work, 8 hours each)

Fig. 2. Photographic documentation of the implementation results of the developed structural and technological solutions (construction of townhouses in the «Club Marine» residential complex) in Odesa city

Fig. 3. Photographic documentation of the implementation results of the developed structural and technological solutions (construction of townhouses near the «Avignon» residential complex in Odesa city)

Fig. 4. Photographic documentation of the implementation results of the developed structural and technological solutions (construction of a restaurant in Vilkovo, Odesa region)

by real-world implementation experience. For instance, in the city of Vilkovo, a restaurant was constructed within 3 months using the developed technologies (fig. 4).

Figure 3 illustrates the application of the second (modernized) solution, the "Framed Stay-in-Place Formwork System" (UA 154847). For the interior walls, moisture-resistant gypsum boards are used as stay-in-place formwork on both sides. For the exterior walls, expanded polystyrene panels are applied on the facade side, while moisture-resistant gypsum boards are installed on the interior side.

The implementation of the developed technologies, shown in figure 4, confirms that they can be used not only for low-rise residential buildings but also for public institutions.

The developed technologies have their own material base for the production of LGSF frame elements and are already proving themselves in the field of mass construction. Using these technologies, an entire settlement was erected in the village of Sukhy Lyman (fig. 5).

The next important direction for implementation and application is the construction of "lightweight upper floors" (fig. 6). This is especially relevant in the context of restoring damaged buildings.

Figure 6 demonstrates that the developed technologies can be used for superstructure additions or as non-load-bearing enclosure structures in multi-storey public and residential buildings. In particular, they are applicable during the restoration of damaged buildings because these technologies are efficient and help reduce the load from the self-weight on the underlying structures.

The developed technologies and even further modernized versions of these technologies have already been implemented in a number of real construction projects. However, this article focuses on the key ones.

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Implementation Confirmation. The research was carried out within the framework of three research and development and experimental design works (R&D and Experimental Design Works) at the Odesa State Academy of Civil Engineering and Architecture (OSACEA):

1. R&D and Experimental Design Work No. 0124U004607: Structural and technological solutions for the installation of energy-efficient enclosure structures of buildings and facilities;

2. R&D and Experimental Design Work No. 0124U004596: Organizational and structural-technological solutions for the repair,


a) b)

c)


d) e)

Fig. 5. Photographic documentation of the implementation results of the developed structural and technological solutions (construction of private buildings in the "Sukhy Lyman" settlement, Odesa region): a) – shallow strip foundation construction; b) – installation of the LGSF frame; c) – sheathing the LGSF frame with stay-in-place formwork made of cement-bonded particle boards on both sides; d) – concreting with expanded polystyrene concrete mixture according to the developed proprietary technology; e) – final finishing of private buildings

rehabilitation, and rebuilding of destroyed and damaged buildings and facilities;

3. R&D and Experimental Design Work No. 0121U111213: Development and optimization of organizational-technological and managerial solutions for construction and reconstruction.

The obtained research results make it possible to identify **promising directions** and form the basis for further scientific work in the field of erection, rebuilding, and repair of buildings using stay-in-place formwork and framed systems made of light gauge steel framing (LGSF).

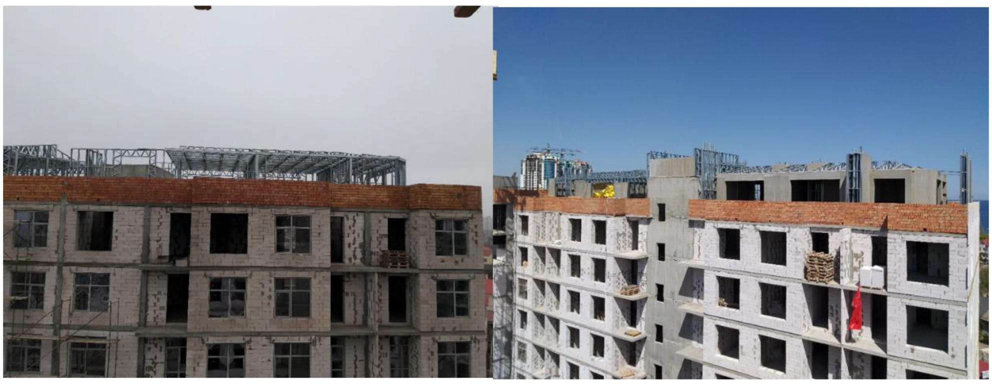
The following directions for further research are highlighted:

1. Development of new and improvement of existing solutions for erecting framed enclosure structures made of LGSF and stay-in-place formwork, taking into account the obtained research results; determination of their efficiency and investigation of physical-mechanical characteristics.

2. Search for the most effective models for erection, repair, rehabilitation, and rebuilding of buildings using stay-in-place formwork.

a) b)

b)



c)

Fig. 6. Photographic documentation of the implementation results of the developed structural and technological solutions: a) construction of the 3rd floor addition in a kindergarten on Shevchenko Avenue in Odesa; b) erection of enclosure structures of the multi-storey "Avignon" residential complex in Odesa; c) addition of the top floor in the multi-storey building of the "Club Marine" residential complex in Odesa

3. Continuation of research on the implementation of obtained results into educational processes, scientific work, and further introduction into construction production

Conclusions

1. Based on the analysis of identified patterns and optimization performed (through the introduction of existing constraints), the most effective organizational and technological model (work execution schedule) for the erection of a residential complex using stay-in-place formwork was determined.

2. According to the calculation of the technical and economic efficiency from numerical modeling and optimization, it was established that compared to the baseline (design) solution: the construction duration of the residential complex was reduced by 71.6 %; the total construction cost including credit financing was reduced by 21.5 %; and construction profitability increased from 11.39 % to 41.82 %.

3. The effectiveness of the research results has been confirmed by positive practical implementation experience in the educational process and the operations of several construction companies across multiple sites in the city of Odesa and Odesa region.

4. The obtained research results allowed the identification of promising directions for further scientific work in the search for effective solutions for the erection and rebuilding of buildings using stay-in-place formwork and a frame made of light gauge steel framing filled with lightweight polystyrene concrete mixture.

Bibliography

1. Савйовський В. В. Аналіз та впровадження передового досвіду – запорука ефективності будівництва. *Будівельне виробництво*. № 67. 2019. С. 66–72. URL: https://doi.org/10.36750/25242555.67.6672 (дата звернення: 21.01.2025).
2. Шумаков В. І., Бугаєвський В. О. Оптимізація параметрів ремонтно-будівельних робіт при відновленні залізобетонного шляхопроводу. *Будівельне виробництво*. № 77. 2024. С. 3–10. URL: https://doi.org/10.36750/2524-2555.77.3-10 (дата звернення: 21.01.2025).
3. Коваль П. М., Стоянович С. В. Використання композитних плит як незнімної опалубки при бетонуванні плити проїзної частини мостів. *Будівельні конструкції. Теорія і практика*. 2017. Вип. 1. С. 55–62. URL: https://repositary.knuba.edu.ua/handle/987654321/472 (дата звернення: 02.01.2025).
4. Дікарев К. Б., Мовчан О. Ю., Папірник Р. Б. Використання локальних матеріалів для виробництва незнімної опалубки для зведення малоповерхових будівель. *Український журнал будівництва та архітектури*. 2024. № 6 (024). С. 144–151 URL: https://doi.org/10.30838/UJCEA.2312.271224.144.1122 (дата звернення: 02.01.2025).
5. Семко О. В., Гасенко А. В., Фенко О. Г., Дарієнко В. В. Раціональне використання несучої здатності сталевих профільованих листів незнімної опалубки сталезалізобетонних перекриттів. *Центральноукраїнський науковий вісник*. 2022, Вип. 5 (36), ч. 2. С. 153–161. URL: https://doi.org/10.32515/2664-262X.2022.5(36).2.153-161 (дата звернення: 21.01.2025).
6. Лапенко О. І. Сталезалізобетонні плити в незнімній опалубці. Архітектура, будівництво, дизайн в освітньому просторі : колективна монографія / За заг. ред. д-ра іст. н. В. В. Карпова Рига, Латвія : «Baltija Publishing», 2021. С. 236–263. URL: https://er.nau.edu.ua/handle/NAU/52349 (дата звернення: 21.01.2025).
7. Хохрякова Д. О. Фактори технологічності prefab-конструкцій із сталевих тонкостінних холодноформованих елементів. *Сучасні проблеми архітектури та містобудування*. 2022. № 63. С. 358–371. URL: https://doi.org/10.32347/2077-3455.2022.63.358-371 (дата звернення: 21.01.2025).
8. Meneylyuk O., Bochevar K., Nikiforov O. Long-term thermal productivity of polystyrene concrete in a new composite wall in a fixed formwork. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*. 2023. № 3 (195). P. 66–74. URL: https://doi.org/10.33271/nvngu/2023-3/066 (дата звернення: 21.01.2025).
9. Meneylyuk O. I., Kyryliuk S. V., Bochevar K. I. Evaluation of the new constructive-technological solution of the fence structure in the non-removable formwork. *Modern construction and architecture*. 2022. № 2. P. 113–122. URL: https://doi.org/10.31650/2786-6696-2022-2-113-122 (дата звернення: 21.01.2025).
10. Менейлюк О. І., Бочевар К. І., Маньківська Д. А. Зміни рентабельності будівництва житлового комплексу «Авіньйон» під впливом організаційних факторів. *Будівельне виробництво*. 2022. № 74. С. 30–34. URL: https://doi.org/10.36750/2524-2555.74.30-34 (дата звернення: 21.01.2025).
11. Руссий В. В., Бочевар К. І. Моделювання показників ефективності зведення житлового комплексу «Авіньйон». *Сучасне будівництво та архітектура*. 2023. № 6. С. 123–132. URL: https://doi.org/10.31650/2786-6696-2023-6-123-132 (дата звернення: 21.01.2025).
12. Стіна будівлі: пат. 149402 Україна : E04C 2/00; E04C 2/292. № u 2021 00397 ; заявл. 02.02.2021 ; опубл. 17.11.2021, Бюл. № 46. 6 с. URL: https://sis.nipo.gov.ua/uk/search/detail/1638660/ (дата звернення: 22.01.2025).
13. Система каркасної незнімної опалубки: пат. 154847 Україна : E04C 2/00; E04C 2/292. № u202203576 ; заявл. 26.09.2022 ; опубл. 27.12.2023, Бюл. № 52. 5 с. URL: https://sis.nipo.gov.ua/uk/search/detail/1777345/ (дата звернення: 22.01.2025).
14. Менейлюк І. О., Руссий В. В. Багатокритерійний аналіз для вибору рішення укріплення схилу. *Технічні науки та технології*. 2020. Вип. 1, № 19. С. 337-344. URL: https://doi.org/10.25140/2411-5363-2020-1(19)-337-344 (дата звернення: 22.01.2025).
15. Менейлюк О. І., Никифоров О. Л. Методичні вказівки з дисципліни «Інновації в будівництві». Одеса : ОДАБА, 2018. 54 с. URL: http://ktsp.od.ua/files/KontrolnaInovatsii.pdf (дата звернення: 22.01.2025).
16. Оптимізація організаційно-технологічних рішень реконструкції висотних інженерних споруд / О. І. Менейлюк та ін. К. : ТОВ НВП «Інтерсервіс», 2016. 332 с. URL: https://surl.li/fqqnuy (дата звернення: 23.01.2025).
17. Вознесенський В. А., Ляшенко Т. В. ЕС-моделі «КОНСТАНТ» квазіфундаментальних моделей у комп'ютерному будівельному матеріалознавстві. *Науковий вісник будівництва*. 2007. Вип. 42. С. 39–45.

References

1. Saviovskyi, V. (2019). Analysis and implementation of pre)experience – introduction of building efficiency. *Building production*, 67, 66–72. https://doi.org/10.36750/2524-2555.67.66-72 (accessed: 21.01.2025).
2. Shumakov, I., & Buhaievski, V. (2024). Optimization of the parameters of repair and construction works during the restoration of a reinforced concrete pipeline. *Building production*, 77, 3–10. https://doi.org/10.36750/2524-2555.77.3-10 (accessed: 21.01.2025).
3. Koval, P., & Stoyanovich, S. (2017). Using composite plates as a permanent formwork for concreting plate roadway of the bridge. *Budivelni konstruktsii. Teoriya i praktyka*, 1, 55–62. Retrieved from: https://repositary.knuba.edu.ua/handle/987654321/472 (accessed: 02.01.2025).

4. Dikarev, K. B., Movchan, O. Yu., & Papirnyk, R. B. (2024). Utilization of local materials for permanent formworkproduction for low-rise building construction. *Ukrainian journal of civil engineering and architecture*, 6 (024), 144–151. https://doi.org/10.30838/UJCEA.2312.271224.144.1122 (accessed: 02.01.2025).
5. Semko, A., Hasenko, A., Fenko, O., & Dariienko, V. (2022). Profiled steel sheets of steel-reinforced concrete floors fixed formwork load-bearing capacity rational use. *Central ukrainian scientific bulletin*, 5 (36), ch. 2, 153–161. https://doi.org/10.32515/2664-262X.2022.5(36).2.153-161 (accessed: 21.01.2025).
6. Lapenko, O. (2021). Steel-reinforced concrete slabs in fixed formwork. Arkhitektura, budivnytstvo, dyzain v osvitnomu prostori : kolektyvna monohrafiya / Za zah. red. d-ra ist. n. V. V. Karpova. Ryga, Latvia : "Baltija Publishing", 236–263. Retrieved from: https://er.nau.edu.ua/handle/NAU/52349 (accessed: 21.01.2025).
7. Khokhriakova, D. (2022). Manufacturability factors of prefab – construction from steel thin-walled cold-formed elements. *Current problems of architecture and urban planning*, 63, 358–371. https://doi.org/10.32347/2077-3455.2022.63.358-371(accessed: 21.01.2025).
8. Meneylyuk, O., Bochevar, K., & Nikiforov, O. (2023). Long-term thermal productivity of polystyrene concrete in a new composite wall in a fixed formwork. *Naukovyi visnyk Natsionalnoho hirnychoho universytetu*, 3 (195), 66–74. https://doi.org/10.33271/nvngu/2023-3/066 (accessed: 21.01.2025).
9. Meneylyuk, O. I., Kyryliuk, S. V., & Bochevar, K. I. (2022). Evaluation of the new constructive-technological solution of the fence structure in the non-removable formwork. *Modern construction and architecture*, 2, 113–122. https://doi.org/10.31650/2786-6696-2022-2-113-122 (accessed: 21.01.2025).
10. Meneiliuk, O., Bochevar, K., & Mankovskaia, D. (2022). Changes in profitability of the «Avignon» residential complex construction under the influence of organizational factors. *Building production*, 74, 30–34. https://doi.org/10.36750/2524-2555.74.30-34 (accessed: 21.01.2025).
11. Russyi, V. V., & Bochevar, K. I. (2023). Modeling performance indicators of building construction using non-removable formwork. *Modern construction and architecture*, 6, 123–132. https://doi.org/10.31650/2786-6696-2023-6-123-132 (accessed: 21.01.2025).
12. Stina budivli: pat. 149402 Ukrayina : E04C 2/00; E04C 2/292. № u 2021 00397 ; zayavl. 02.02.2021 ; opubl. 17.11.2021, Byul. № 46. 6 s. Retrieved from: https://sis.nipo.gov.ua/uk/search/detail/1638660/ (accessed: 22.01.2025).
13. Systema karkasnoi neznimnoi opalubky: pat. 154847 Ukrayina : E04C 2/00; E04C 2/292. № u202203576 ; zayavl. 26.09.2022 ; opubl. 27.12.2023, Byul. № 52. 5 s. Retrieved from: https://sis.nipo.gov.ua/uk/search/detail/1777345/ (accessed: 22.01.2025).
Meneiliuk, I., & Russyi, V. (2020). Multi-criteria analysis for the selection of the decision for strengthening the slope. *Technical sciences and technologies*, 1 (19), 337–344. Retrieved from: https://doi.org/10.25140/2411-5363-2020-1(19)-337-344 (accessed: 22.01.2025).
14. Meneylyuk, O. I., & Nikiforov, O. L. (2018). Metodychni vkazivky z dystsipliny "Innovatsii v budivnytstvi". Odesa : OSACEA, 54 s. URL: http://ktsp.od.ua/files/KontrolnaInovatsii.pdf (accessed: 22.01.2025).
15. Meneylyuk, O. I. et at. (2016). Optymizatsiya orhanizatsiyno-tekhnolohichnykh rishen rekonstruktsii vysotnykh inzhenernykh sporud / K. : TOV NVP "Interservis", 332 s. URL: https://surl.li/fqqnuy (accessed: 23.01.2025).
16. Voznesenskyi, V. A., & Lyashenko, T. V. (2007). ES-modeli "KONSTANT" kvazifundamentalnykh modelei u kompiuternomu budivel'nomu materialoznavstvi. *Scientific bulletin of construction*, 42, 39–45.

КАРКАСНА НЕЗНІМНА ОПАЛУБКА: ЕФЕКТИВНІСТЬ ТА ВПРОВАДЖЕННЯ

Анотація. *У статті досліджено ефективність зведення огороджувальних конструкцій з легких бетонів в незнімній опалубці з каркасом із ЛСТК (легких сталевих тонкостінних конструкцій) та досвід використання отриманих результатів на діючих будівельних підприємствах. В тому числі у розрізі відбудови України.*
Актуальність обраної теми зумовлена необхідністю оперативного та ресурсоефективного будівництва, відбудови та відновлення житлових і громадських будівель. Запропоновано застосування комбінованих технологій як ефективного рішення для скорочення строків, трудомісткості та вартості робіт без втрати їх якості.
У межах дослідження реалізовано поєднання логіко-аналітичного та системного методів.
За результатами дослідження визначено найефективнішу організаційно-технологічну модель зведення житлових комплексів із використанням каркасної (із ЛСТК) незнімної опалубки. Виконано оцінку техніко економічних показників результатів досліджень. Зокрема встановлено, що в результаті застосування розроблених технологій та проведення оптимізації організаційно-технологічних рішень порівняно з базовим (проєктним) рішенням можливо: скоротити тривалість будівництва на 70 %, рентабельність збільшити до 41,8 % та загальну вартість будівництва з урахуванням залучення кредитних коштів знизити на 21,5 %.
Проведено аналіз впровадження двох розроблених рішень («Стіна будівлі» UA149402 та «Система каркасної незнімної опалубки» UA154847) на багатьох об'єктах реального будівництва в м. Одеса та Одеській області. Наведено результати фотофіксації процесу монтажу та візуального аналізу відповідності розроблених технологій практичним рішенням.

Визначено перспективи подальших наукових досліджень. В тому числі, у сфері пошуку ефективних рішень зведення, відновлення та відбудови будівель з використанням незнімної опалубки та каркасу із ЛСТК.

Ключові слова: легкі сталеві тонкостінні конструкції (ЛСТК), каркасна незнімна опалубка, огороджувальні конструкції, організаційно-технологічне моделювання, оптимізація, відновлення, відбудова, швидкомонтовані елементи.

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