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Strengthening Technology for Damaged Floor Slabs through Compression Zone Enlargement and External Reinforcement

Abstract. The article presents a technology for strengthening reinforced concrete floor slabs by enlarging the compressed zone and using external reinforcement. A 50 mm-thick monolithic overlay is installed on top of the slab, while steel channels are anchored below using chemical fasteners. The slab is pre-leveled with jacks; after hardening, the beams are removed. Full-scale hydrostatic tests confirmed the restored load-bearing capacity and minimal deflections (~2 mm). The method eliminates the need for dismantling, accelerates reconstruction, reduces costs by up to 58%, and preserves interior geometry - making it highly suitable for restoring war-damaged residential buildings.

Keywords: floor slab strengthening; reinforced concrete overlay; external reinforcement; chemical anchors; load-bearing capacity; building rehabilitation

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Introduction.

As a result of the military actions in eastern Ukraine, a significant number of buildings have been damaged, particularly in the city of Kharkiv. According to official data, as of September 2024, a total of 7,047 multi-storey residential buildings in the Kharkiv region had been partially or completely destroyed, along with hundreds of educational, medical, and other facilities [1]. In 2025 alone, the restoration of 160 multi-storey residential buildings is planned [2].

One of the most challenging tasks in the reconstruction process is the repair of reinforced concrete floor slabs in damaged panel buildings [13]. Typical residential buildings from the 1980s, constructed with large-format precast floor slabs, possess a highly standardized structural system, which enables the application of unified strengthening solutions. However, substantial slab deterioration - such as cracking in the tension zone and excessive deflections - necessitates effective strengthening or replacement methods to restore the load-bearing capacity.

Review of Methods for Strengthening Reinforced Concrete Floor Slabs

Increasing the thickness of the compressed zone involves casting a 40–60 mm concrete layer on the top surface of the slab, anchored to the existing structure [1]. This method has proven effective in Ukraine during the restoration of slabs damaged by military actions, achieving up to 58% *cost savings* compared with full slab replacement [1], [5].

External reinforcement with FRP (carbon or glass fiber strips) is widely used internationally. It improves the strength and fatigue resistance of slabs without adding significant weight [6], [7]. However, this method has limited fire resistance and relatively high cost. An alternative is external steel reinforcement, which is simpler and more economical to install, though it requires corrosion protection [8].

Post-tensioning is applied to slabs exhibiting excessive deflection. It enables the introduction of counteracting forces without increasing self-weight, but requires complex installation procedures and specialized tensioning equipment [9].

The additional beams method consists of installing new steel or concrete members beneath the slab. This increases stiffness but may reduce the clear height of the room. Studies in Ukraine have confirmed a significant reduction in slab deflection after installing such beams [2], [10].

In summary, all reviewed methods improve the load-bearing capacity of reinforced concrete floor slabs. The most common strengthening approaches include:

- *Installation of additional beams* – the placement of supplementary steel or reinforced concrete beams beneath the slab, allowing them to carry part of the load. This can be implemented either as bottom-side strengthening (e.g., using props or steel channels) or by embedding beams into the slab body. However, for panel-type multi-storey buildings, this method is limited: the slab thickness (~160 mm) and the low story height do not allow embedding beams within the structure, while external beams reduce the usable room height. Additionally, cutting through the slab voids to install beams weakens the building's stiffness and requires extra measures to ensure spatial stability of the structural frame.

- *Concrete overlay (cast-in-place strengthening layer)* – installing an additional monolithic reinforced concrete layer on top of the slab, which acts as an enlarged compression zone. Reinforced concrete overlay increases the slab's effective depth, thereby improving stiffness and crack resistance. Effective performance can only be achieved with reliable bonding between the new and existing concrete, which is ensured through surface cleaning, roughening, and the installation of anchors (drilled-in steel dowels). This method does not significantly reduce room height (a 50–60 mm layer), but it slightly raises the floor level, which can be compensated by screed adjustments or thresholds. Practice shows that for typical panel buildings, the reinforced concrete overlay is the most appropriate solution, as it does not require slab removal and preserves room geometry.

- *Crack injection* – used when cracks are present in the slab. Cracks are filled under pressure with polymer or cementitious compositions, restoring the monolithic continuity of the slab. The method is effective only for minor damage and does not significantly increase load-bearing capacity; it merely restores integrity and protects reinforcement from corrosion.

- *Prestressing (post-tensioning)* – a method in which additional tensioned elements (bars or tendons) are installed in the slab to induce counteracting internal forces. Post-tensioning may be performed by threading steel cables or rods through drilled holes in or along the slab and tensioning them. This increases stiffness and crack resistance. The method is effective but requires complex equipment and high precision, thus it is rarely used in emergency-damaged buildings.

- *External reinforcement with composite materials (FRP)* – bonding or mechanically fastening polymer strips or laminates made of high-strength fibers (carbon, glass, etc.) to the slab. FRP materials significantly increase strength without adding weight.

Their advantages include minimal added mass and no need for “wet” processes. However, disadvantages include high material costs, the need for skilled installation, and reduced effectiveness at elevated temperatures (fire). FRP is suitable for restoring the strength of beams or slabs with minor damage, allowing continued use of structures with minimal architectural changes and reduced repair time.

The listed methods can be combined. In particular, combined strengthening systems often include a concrete overlay on the top surface and external steel elements on the underside. Several such solutions have been proposed in Ukraine for cases of severe wartime damage. For example, one study describes the strengthening of damaged hollow-core slabs in an industrial building by installing steel beams within the slab voids, combined with a fiber-reinforced concrete topping and additional transverse beams underneath. In another case, during the reconstruction of a five-storey building in Lviv that suffered direct shell impacts and fire, the slab voids were filled with reinforcement cages while simultaneously installing a reinforced concrete overlay on top.

However, in typical residential panel buildings, such methods are structurally constrained. Reducing the clear height of rooms or significantly raising the floor level is unacceptable due to the already limited storey height. Likewise, chasing or cutting into thin precast panels weakens both the slabs and the overall structural system. Therefore, the most optimal solution is strengthening by applying a reinforced concrete overlay, provided that reliable composite action with the existing damaged panel is ensured through anchoring.

Given these considerations, the remainder of the article focuses specifically on the technique of enlarging the slab's compression zone - i.e., installing an additional reinforced concrete layer on the top surface - in combination with external steel reinforcement in the tension zone and chemical anchors.

Installation Procedure for the Proposed Slab Strengthening System

Structural solution. The strengthened reinforced concrete slab acts compositely with a new monolithic concrete layer on top and steel elements installed at the bottom. The compression zone is formed by the concrete overlay - a supplemental slab approximately 50 mm thick, made of heavy concrete (aggregate fraction 10–20 mm), placed on the top surface of the existing slab. In the tension zone along the underside of the slab, steel channels (No. 10U according to DSTU 3436-96) are installed as external reinforcement. The steel beams are positioned parallel to the slab span with a spacing of about 0.9 m (i.e., 3–4 channels per 3 m-wide slab), coordinated with the arrangement of the slab's internal reinforcement.

Chemical anchors connect all elements of the system, ensuring composite action between the old and new concrete and the steel beams. Specifically, the anchors transfer shear stresses along the contact

surfaces and prevent slipping of the overlay relative to the slab, while also fastening the steel channels to the underside of the slab. Steel anchor rods (bolts) of a diameter determined by calculation (e.g., M20, strength class 8.8) are used as anchoring elements. The connection is chemical: a drilled hole is filled with a two-component epoxy resin, after which the anchor

bolt is inserted; once cured, the resin provides reliable adhesion to the concrete.

Anchors are placed at approximately 500 mm intervals along the beams. The anchorage depth is calculated to ensure that the anchors penetrate into the existing slab and partially extend into the overlay zone, acting as shear studs. The structural scheme of the strengthening system is shown in Fig. 1.

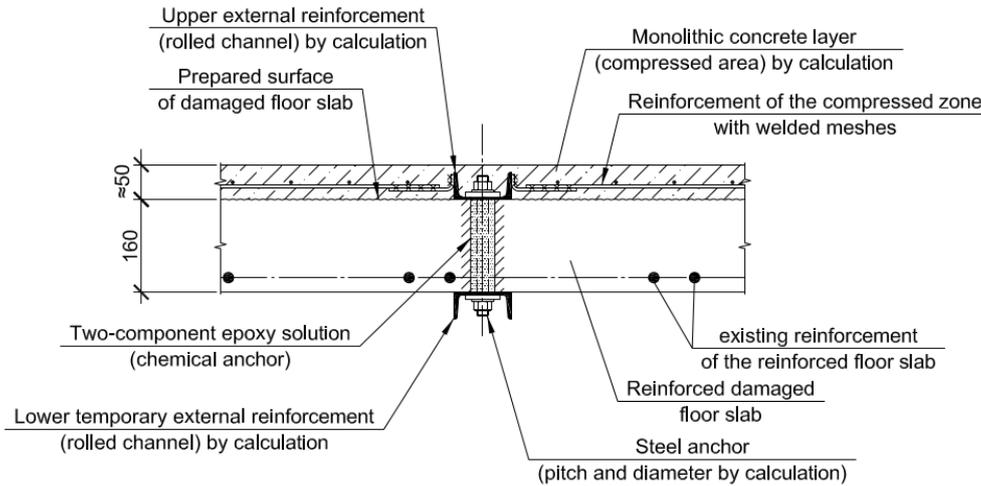


Figure 1 – Scheme of floor slab strengthening by enlarging the compression zone (steel beams underneath, anchors, and concrete overlay on top)

Preparation for the works. Before the main strengthening works begin, the damaged slab must be properly prepared. All damaged areas should be fully exposed: the delaminated concrete cover should be removed, loose fragments cleared away, and cracks cleaned. The slab surface is cleaned of dirt, finishing materials and dust. If necessary, sandblasting or hydroblasting is applied to expose sound, strong base concrete.

The top surface of the slab should be roughened (e.g., by scoring or milling) to improve the bond between the existing slab and the new concrete overlay. Large cracks are recommended to be injected with an

epoxy composition to restore monolithic behavior prior to the installation of the strengthening system.

Slab unloading and leveling. An important stage is the temporary unloading of the slab and correction of its deflection. Field observations show that damaged slabs often exhibit deflections exceeding the allowable limit ($L/200$). In our case, for a 6-meter span, the permissible deflection is approximately 30 mm, and this value had been exceeded (the slab sagged beyond the norm). Therefore, before strengthening, the slab is lifted using jacks and adjustable props (Fig. 2). Typically, telescopic construction props and horizontal girders are used.

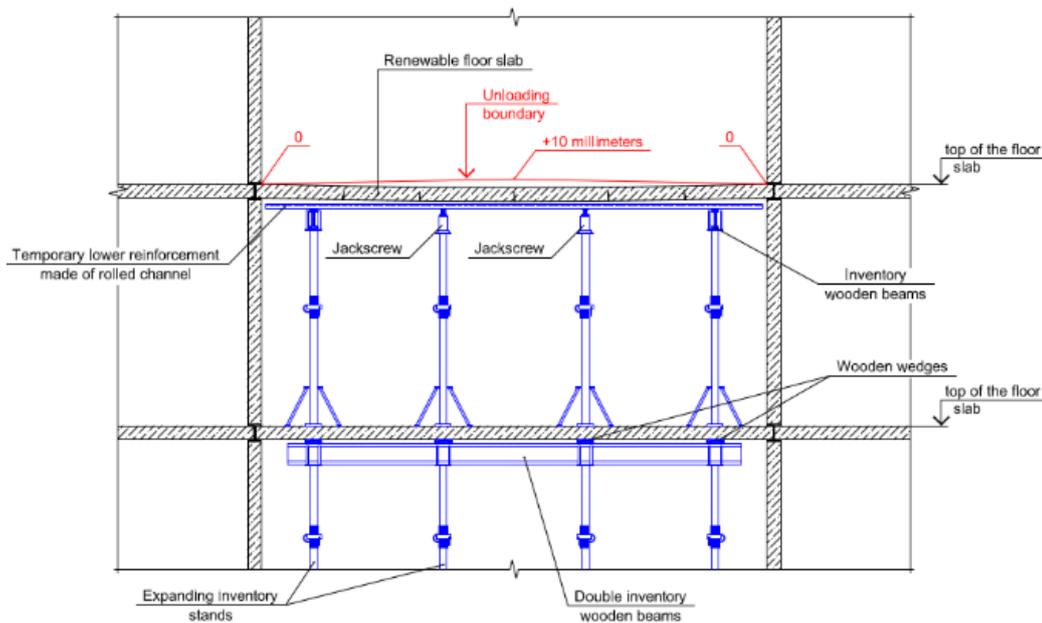


Figure 2 – Scheme of slab unloading and leveling (lifting the slab by 10 mm using jacks).

The props are placed beneath the slab, and the central zone is carefully lifted by about 10 mm. This slightly “over-bends” the slab upwards so that after the supports are removed and the new concrete gains strength, the slab becomes as level as possible. After lifting, control level measurements are taken. If necessary, the slab’s position is fixed—some jacks are left under tension, or temporary supports (wooden posts, steel tubes) are installed to maintain the corrected geometry.

Installation of external reinforcement and anchors. The next step is the installation of steel channels along the underside of the slab (Fig. 3). If the slab is supported by props, the channels can be pressed directly against its bottom surface (between the props). The selected profiles - No. 10U, with a length matching the full span of the slab (6 m) - are fixed to the slab using chemical anchors. To do this, holes with a diameter corresponding to the anchors (e.g., 22 mm for an M20 bolt) are drilled through the slab so that each hole also passes through the web of the channel. Bolts are inserted from below through holes in the channel flange and into the drilled cavities; the cavities are then filled with epoxy compound, and once the resin hardens, nuts are tightened to press the steel beams firmly against the slab.

As a result, composite temporary girders are formed - i.e., beams consisting of steel channels and part of the existing slab connected by anchors. These composite members carry

part of the load and hold the slab in the lifted position. Subsequently, they ensure composite action during concreting of the upper surface and partially replace the temporary props.

After the steel beams have been installed, part of the temporary supports (jacks) can be removed. The slab is already fixed in its design position due to the attached channels, so auxiliary props that obstruct work on the top surface may be removed or relocated. This approach allows all upper-side operations (reinforcement placement, concreting) to be performed without cluttering the space below the slab with scaffolding.

Installation of upper reinforcement. Before concreting, reinforcement for the overlay is placed on the top surface of the slab. Typically, this consists of a steel mesh or a cage made of bars (e.g., Ø6–8 mm with ~150 mm spacing), which acts as tensile reinforcement in the upper layer (in case upward bending cracks occur). The reinforcement is placed on spacers to ensure a concrete cover of 20–30 mm above the existing slab surface.

Additionally, vertical anchors are installed in the upper holes (if they are not through-holes) to improve bonding. These are often the same chemical anchors driven 100–120 mm into the existing slab so that they protrude 50–60 mm above its surface. Once the concrete is cast, these anchors become monolithically embedded in the new layer, ensuring composite action by acting as shear connectors.

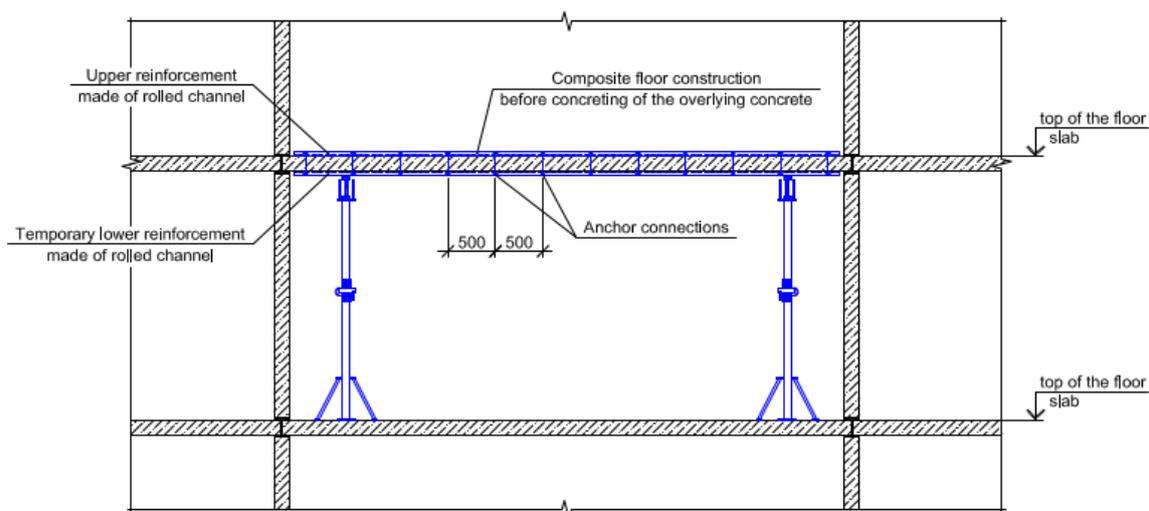


Figure 3 – Scheme of composite elements formed by the floor slab and external reinforcement using rolled steel channels

Concrete casting of the overlay. After preparing the reinforcement, the new concrete layer is placed (Fig. 4). Formwork (wooden or plastic boards) approximately 50 mm high is installed around the perimeter of the slab to prevent the concrete from spreading. A high-quality concrete mix is recommended, not lower than class C20/25, with fine aggregate to ensure good adhesion and proper filling of the thin layer. Before casting, the entire surface of the existing concrete is moistened with water, or preferably coated with a bonding layer (a cement-sand slurry or a special adhesive “contact layer”). Concreting is performed uniformly across the slab to the design thickness (e.g., 50 mm). The mix is compacted with a needle vibrator (if the layer thickness is sufficient) or by rodding, ensuring that no voids remain - especially around anchors and dowels. The surface of the overlay is levelled with a straightedge.

Curing of concrete. Freshly placed concrete requires suitable curing conditions. It is protected from drying out by being covered with plastic sheeting or burlap and regularly

moistened during the first 7 days. At +20°C, the concrete reaches approximately 70% of its strength after one week, and full design strength after 28 days. The supports must not be removed, nor may the slab be subjected to loading, until the required strength has been achieved.

Removal of steel beams. After the concrete overlay has reached its design strength (at least 28 days, or based on the results of control cube tests), the lower steel channels are no longer required as permanent strengthening elements (Fig. 5). Calculations have shown that due to the increased effective depth of the slab and its composite action with the new layer, the existing reinforcement is capable of resisting all design bending moments without the assistance of the channels. Therefore, the channels can be dismantled and reused at other locations.

To remove them, the nuts on the anchor bolts are unscrewed and the beams are detached from the slab (a light tap may be required if the beams have adhered to the concrete). The anchor rods remain embedded within the slab

and continue to connect the overlay to the original concrete. If any rods protrude below the slab, the excess length can be cut flush with the surface.

After removal of the steel strengthening, the slab acts as a fully composite structure: the original precast panel together with the new concrete overlay, connected by anchors.



Figure 4 – Concrete casting process

Control measurements and testing. The final stage involves verifying the reliability of the strengthened slab. First, a visual inspection is carried out—absence of new cracks or the progression of existing ones after the removal of the steel beams indicates proper structural performance. Geodetic measurements of slab deflection are also conducted: elevation marks at the center and edges are compared after removing the supports. In our case, thanks to the prior upward adjustment of the slab by 10 mm, the final deflection after removing the steel channels was minimal. According to calculations, a total deflection of approximately 26 mm under full design load was expected, which is below the allowable limit of 29.5 mm ($L/200$). The actual deflection, however,

was even smaller due to the initial lifting and amounted to roughly half of the permissible value—around 15 mm.

The most demonstrative test is the full-scale hydrostatic loading test [14]. This method creates a uniformly distributed load on the slab by applying a water layer of known thickness. In the restored residential building in Kharkiv (64 Nataliia Uzhvii Street), three strengthened slabs on the 8th floor were tested using this hydrostatic method. Waterproof borders were constructed on the floor surface, and the slabs were filled with water to the required level, simulating the design load. Deformations were measured using dial gauges before and after the removal of the steel strengthening beams.



Figure 5 – Removal of steel beams

The test results demonstrated the high effectiveness of the system. The maximum deflection of the slabs under hydrostatic loading before beam removal was approximately 1.95–2.1 mm, and after removal—about 2.31–2.4 mm. Thus, the difference was only ~15–20%. These deflections are extremely small compared to the allowable value of 20 mm for the given span. Therefore, even without the steel strengthening underneath, the strengthened slabs fully withstand the design load with a significant stiffness reserve. The relative stiffness after strengthening increased by roughly a factor of 10, since before the repair the deflections far exceeded the limit (over 30 mm), and the slabs were considered in an emergency condition.

Advantages and Limitations of the Proposed Strengthening System

The considered strengthening method offers several significant advantages compared to traditional approaches to repairing reinforced concrete floor slabs:

- *Preservation of existing structures without dismantling.* The slabs do not need to be removed or transported away, which is especially important in multi-storey buildings. This eliminates demolition-related operations and removes the need for large temporary supports to keep the building stable during slab replacement. The building's structural system remains geometrically unchanged throughout the repair, minimizing the risk of partial collapse. As a result, the recovery process is accelerated because there is no need to clear debris from each slab or install new full-scale formwork.
- *Effective restoration of load-bearing capacity.* The proposed system essentially restores the original or even higher strength and stiffness of the slab. Full-scale tests demonstrated that after strengthening, the slabs meet all regulatory requirements: maximum deflections of 1.5–2.5 mm compared to the allowable ~20 mm, with no

reopening of cracks. Prior to repair, the calculated loss of load-bearing capacity was approximately 50%; after strengthening, the capacity was fully restored. Thus, the slabs become suitable for safe long-term operation, and their overall reliability and seismic resistance are improved.

- *Speed and technological efficiency of execution.* All operations (cleaning, anchoring, concreting) can be performed relatively quickly using standard construction tools. With multiple teams working in parallel on different slabs, the repair rate becomes significantly higher than in the case of full slab replacement. In addition, the reduced amount of new materials shortens construction time (transport, lifting to upper floors, etc.). The absence of heavy machinery (such as cranes required for installing new slabs) further accelerates the process.

- *Material and cost savings.* The technology requires only ~50 mm of concrete overlay and a relatively small amount of steel (several channels and anchors), rather than a full new 160 mm-thick slab. This results in substantial material savings. A cost analysis performed on a real project in Kharkiv showed that strengthening a 6×3 m slab using this method is 58% cheaper than dismantling the old slab and installing a new monolithic one of the same size. Savings are achieved due to the reduced volume of concrete and reinforcement, the absence of demolition and debris removal costs, and shorter construction time. When applied at scale (hundreds of slabs), this approach can save millions of hryvnias in residential building reconstruction.

- *Minimal disturbance to architecture and utilities.* The 5 cm concrete overlay has almost no impact on the room height (it only slightly raises the floor level). The steel beams are installed underneath the slab, but they are removed once the strengthening works are completed, so the ceiling height remains unchanged. Thus, the floor geometry is preserved, and there is no need to shorten doors or modify mechanical and electrical systems routed along the ceilings. In addition, no “wet” works are required on the floor below - the entire process is confined to the apartment where the slab is being strengthened.

Despite numerous advantages, the system also has limitations that must be considered:

- *Applicability only in cases of moderate damage.* The method is effective if the slab has retained at least ~50% of its load-bearing capacity, the concrete has not lost its strength (class C16/20), and the reinforcement has not burned or been destroyed. If the slab is completely ruined or has slipped off its bearing supports, strengthening is impossible — replacement is required. Similarly, in cases of severe reinforcement degradation (loss of steel strength due to fire), the method may not provide sufficient capacity, as the existing reinforcement participates in structural action. Therefore, before deciding on strengthening, a technical inspection and laboratory testing of concrete and steel must be conducted. In the described case, the concrete strength corresponded to class C16/20 and reinforcement to class A600, which was sufficient. If the structural elements are found to be in a non-repairable emergency condition, full replacement is necessary.

- *Requirement for qualified design and execution.* This method is more complex than simply replacing a slab with a new one, as it requires engineering analysis of the composite behavior of old and new materials, selection of anchor connections, and measures for temporary slab support. The strengthening design must consider multiple factors: design loads, residual concrete

strength, reinforcement layout and diameter, anchor spacing and size, and the characteristics of the steel channels.

Errors in design or execution (poor anchoring, insufficient concrete bond, lack of slab jacking) may lead to inadequate strengthening or even sudden failure of the slab. Competent engineers and experienced builders are therefore essential.

- *Labour-intensive on site.* Although the total volume of materials is small, many operations must be performed directly on-site: drilling dozens of holes, installing anchors, concreting inside existing rooms. These are labour-intensive tasks requiring time and consumables (drill bits, resin, etc.). By comparison, installing a new slab may be faster in terms of crane operation (lifting and placing a panel), but takes longer due to preparatory work. In all cases, each situation requires a technical and economic comparison before choosing the restoration method.

- *Additional load on the structure.* The new concrete layer adds weight (~125 kg/m² for a 5 cm thickness) to the floor. This increases the permanent load on walls and foundations. Although most buildings have sufficient reserve capacity, cumulative loads must be checked, especially if all slabs on upper floors are strengthened. In the examined project, the strengthening passed all verifications—the slab withstands even the increased load (self-weight + hydrostatic test water) with ample safety margin. However, in particularly weakened buildings, strengthening of supporting elements may also be required.

- *Impact on adjacent structural elements.* During slab jacking and anchor installation, some forces may be transferred to adjacent elements (walls, joints). This requires caution: it must be ensured that lifting the slab does not disengage bearing joints or lift the wall above it. Military damage may have weakened panel connections, so before jacking, engineers must verify that the wall can safely resist these forces. Typically, lifting the slab by 1 cm causes no issues, and after the concrete overlay is cast, the slab becomes firmly connected to the walls through embedded parts, restoring joint integrity.

Overall, the advantages significantly outweigh the limitations in cases where the slabs are suitable for repair. Practical tests have confirmed the feasibility of the method: the strengthened slabs perform reliably without additional beams, providing the required load-bearing capacity and stiffness of the structure. This is particularly important for large-scale restoration of residential buildings, where the efficient use of resources and time is critically important.

Economic Efficiency of the Strengthening Method

Economic considerations play a crucial role in large-scale housing reconstruction. The strengthening technology presented in this study demonstrates high financial efficiency. As noted earlier, the pilot implementation conducted in 2023 made it possible to estimate the direct costs of repairing damaged slabs of 6×3 m. According to the results, strengthening a single slab is **58% cheaper** than dismantling and installing a new monolithic slab of the same size.

This cost reduction is achieved through several factors:

- *Reduced material consumption.* A 50 mm concrete overlay for an 18 m² slab requires only ~0.9 m³ of concrete, whereas a new 160 mm slab requires 2.9 m³ (three times more). Steel channels (No. 10U) consume approximately 60 kg of steel per slab, while new reinforcement for a monolithic slab would require 120–150 kg. Thus, the consumption of concrete and steel is

reduced by roughly half or more. Additional savings occur due to the lack of formwork materials (for monolithic casting) or the cost of prefabricated slabs (if factory-made panels were used).

- *Lower logistics costs.* The strengthening process does not require heavy-duty cranes for demolition and installation of precast panels. All materials (reinforcement, anchors, adhesives, concrete mix) can be easily lifted by standard elevators or manually. There are no expenses for removing and disposing of concrete debris from demolished slabs - this alone represents a significant cost reduction.

- *Shorter construction time.* Time is money: faster restoration means lower overhead costs for site maintenance, labour, and equipment rental. Thanks to accelerated workflow (no delays associated with demolition or large-panel installation), the overall construction time for the building is reduced. According to estimations, the application of this strengthening technology considerably shortens construction timelines compared to traditional repair methods, thereby reducing total project expenditure.

- *Minimized downtime of residential units.* If a building is not fully evacuated, strengthening can be carried out section by section, allowing certain apartments to return to service sooner. Even if the structure has been temporarily vacated, shorter repair time leads to earlier occupancy, reduced inconvenience for residents, and savings on temporary housing costs.

At the specific site in Kharkiv (Natalia Uzhviy St., 64), the strengthening technology was introduced experimentally, and cost calculations confirmed the figure of approximately 58% savings. This means that the economic efficiency effectively doubles: for the same amount required to replace slabs, twice as many slabs can be restored. Given the thousands of damaged buildings, this represents a particularly compelling advantage.

Naturally, not all situations allow the application of this method. However, wherever feasible, it is one of the most cost-effective solutions. As noted by the developers, the absence of slab removal and the lack of a need to temporarily support the entire building provide the main economic benefits. Additionally, the increased reliability and extended service life of the strengthened slabs offer indirect economic

advantages by postponing the need for major repairs or demolition.

Conclusions

The conducted review and research have confirmed the effectiveness of modern strengthening methods for reinforced concrete floor slabs, particularly under conditions of wartime damage. The most suitable approach for typical panel buildings was found to be the method of increasing the compression zone by applying a reinforced concrete overlay (topping) combined with an anchor-steel strengthening system. A detailed analysis of the technology showed that, with proper design and execution, this method restores the load-bearing capacity of slabs to the normative level and even provides a reserve in stiffness. Full-scale tests conducted in Kharkiv confirmed the efficiency of the system: the strengthened slabs withstood hydrostatic loading with minimal deflections (~2 mm), which justifies recommending the technology for wide implementation.

The advantages of the system include the absence of the need to dismantle slabs, significant savings in time and cost (up to 58% of the budget), increased structural reliability, and reduced material consumption of the repair. At the same time, its application requires individual structural assessments and careful design justification of the strengthening parameters. The method is appropriate for moderate levels of damage (loss of load-bearing capacity up to ~50%) and concrete strength not lower than the design grade. In cases of complete slab destruction, replacement remains the only viable option.

Overall, the strengthening technique based on increasing the compression zone and applying external reinforcement with anchors has proven to be a reliable and economically efficient solution for restoring residential buildings damaged by military actions. Its wider adoption will contribute to faster and more cost-effective reconstruction of the destroyed housing stock while ensuring the required level of safety and durability of structures. Future research may focus on optimizing the method, including selecting the optimal number and diameter of anchors, modifying concrete mix design for improved bonding, and evaluating the long-term performance of strengthened slabs in service. The initial successful results provide confidence that this method will find broad application in reconstruction practice.

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Технологія підсилення пошкоджених плит перекриття шляхом нарощування стислої зони та зовнішнього армування

Анотація. У статті розглянуто технологію підсилення залізобетонних плит перекриття шляхом нарощування стиснутої зони та зовнішнього армування, актуальну для швидкого відновлення пошкоджених бойовими діями житлових будинків панельного типу. Запропонований метод передбачає влаштування монолітного армованого шару бетону товщиною близько 50 мм (надбетонки) на верхній поверхні плити та монтаж сталевих швелерів знизу, з'єднаних з плитою хімічними анкерами для забезпечення спільної роботи. Перед підсиленням плиту тимчасово розвантажують і вирівнюють домкратами. Після набору міцності надбетонки сталеві балки демонтуються, а плита працює як композитна конструкція з відновленою несучою здатністю. Натурні випробування гідростатичним навантаженням показали, що підсилені плити відповідають нормативним вимогам міцності та жорсткості, маючи прогини лише близько 2 мм при допустимих 20 мм. Метод дозволяє повністю відновити несучу здатність плит без їх демонтажу, прискорити і здешевити відбудову – економія близько 58% коштів порівняно з заміною плит, а також мінімально впливає на геометрію приміщень. Отримані результати обґрунтовують доцільність широкого впровадження цієї технології при масовій відбудові зруйнованого житлового фонду.

Ключові слова: підсилення плит перекриття; армована надбетонка; зовнішнє армування; хімічні анкери; несуча здатність; відновлення будівель.

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