



Structural performance of repaired reinforced concrete beams with damaged compression zones: an experimental study using digital image correlation

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Article history

Received 27.02.2026

Accepted 08.04.2026

Available online 11.05.2026

Keywords

reinforced concrete beams;
digital image correlation;
structural repair; load-bearing
capacity; flexural behavior.

Abstract

This study investigates the repair effectiveness of reinforced concrete (RC) beams with crushed compression zones and reduced tensile reinforcement. The aim was to evaluate the restoration of load-bearing capacity and flexural performance after repair using polymer-modified mortar. The experimental program included four-point bending tests, high-precision displacement monitoring, and digital image correlation (DIC). Experimental results were compared with predictions obtained from a non-linear sectional deformation model and with reference beams having reduced reinforcement but no damaged compression zone. The repaired beams reached a reinforcement yield moment of 8.62-8.97 kNm and an ultimate bending moment of 9.5 kNm. The strain in the repaired compression zone remained below the ultimate strain capacity of the repair mortar, indicating stable composite action between the original concrete and the repair material. The repair method increased the reinforcement yield moment by approximately 35%, confirming effective restoration of the compression zone and improved structural performance. The results demonstrate the usefulness of DIC for assessing repaired RC beams and support the application of polymer-modified repair systems for beams with damaged compression zones.

DOI: 10.30657/pea.2026.32.22

1. Introduction

Restoring the load-bearing capacity of damaged reinforced concrete (RC) structures is a crucial issue in modern construction and engineering. Damage to RC beams due to various environmental factors can lead to a reduction in their strength and stability, which, in turn, decreases the safety of building and structure operation. Therefore, the development and implementation of methods that ensure effective restoration of the load-bearing capacity of damaged structures is a relevant

task. One promising approach is the use of specialized repair technologies and innovatively developed new materials capable of restoring the initial physical and mechanical properties of concrete in compressed zones.

In this context, experimental research into the restoration process of damaged RC beams is important to demonstrate the effectiveness of these methods in practice. Specifically, improving basic methods of surface preparation, application of repair materials, and their bonding with the damaged structure is essential. Additionally, an important aspect is the analysis



and comparison of the load-bearing capacity of restored beams with undamaged ones, which allows for an assessment of the effectiveness of the repair work. This approach helps identify key factors that affect the strength of restored structures and develop recommendations for optimizing technological processes.

Thus, restoring RC beams is a complex engineering task that requires thorough study and a systematic approach to the selection of materials and methods. Effective restoration of damaged areas ensures the safe and long-term operation of structures.

2. Aims

This study aims to evaluate the effectiveness of restoring the load-bearing capacity of damaged reinforced concrete beams through the application of Sika MonoTop-4012 repair mortar. The article focuses on the experimental analysis of the strength of restored beams and their comparison with undamaged samples. Additionally, the study explores the process and optimal choice of restoration methods for the compressed concrete zone, which is critical for ensuring the structural integrity and durability of RC elements.

3. Literature review

The assessment, restoration, and strengthening of damaged reinforced concrete (RC) beams have been extensively studied due to the growing need to extend the service life of aging infrastructure and ensure structural safety under increasing operational demands. Degradation mechanisms such as reinforcement corrosion, fatigue, environmental exposure, seismic actions, and construction defects significantly reduce load-bearing capacity and serviceability. In this context, both experimental and theoretical investigations have contributed to understanding structural behavior, improving repair methodologies, and enhancing monitoring techniques.

The mechanical performance of RC beams is strongly influenced by the condition of reinforcement. Experimental studies have demonstrated that even partial reduction of reinforcement cross-section leads to a substantial decrease in flexural capacity and ductility (Blikharskyy and Selejdak, 2021). Corrosion-fatigue interaction further accelerates degradation under sustained or cyclic loading (Blikharskyy et al., 2021a; Devendiran and Banerjee, 2023), while the corrosion susceptibility of reinforcing steel depends on the properties and composition of the surrounding concrete (Blikharskyy et al., 2021b). The physico-mechanical characteristics of thermally hardened reinforcement also affect structural reliability, especially under long-term loading (Kopiika et al., 2022). From a materials science perspective, fatigue crack growth resistance and heat treatment modes play a decisive role in determining the residual performance of steel elements (Lenkovskiy et al., 2017; Ostash et al., 2011; Ostash et al., 2019). The degradation of steel in aggressive environments has been further analyzed in studies of inclusion spacing and corrosion processes (Lipiński, 2023; Lipiński and Ulewicz, 2023; Lipiński and Wach, 2020), which are relevant to understanding reinforcement durability.

Damage to RC beams frequently manifests in the compressed concrete zone, especially under combined mechanical and environmental actions. The influence of concrete structure on failure mechanisms has been examined by Vitaliy et al. (2021), while characteristic damage forms under moisture exposure were analyzed by Semko et al. (2023). Experimental investigations of stress-strain states in damaged RC elements under operational loads highlight the redistribution of internal forces after cracking (Kopiika et al., 2021). Research on monolithic slabs damaged in the compressed zone confirms that restoration strategies must consider both structural mechanics and technological conditions of repair (Kramarchuk et al., 2023). Earlier works on strengthening damaged RC tanks and foundations further demonstrate the complexity of rehabilitation in real construction practice (Kramarchuk et al., 2021; Kramarchuk et al., 2018). Practical reconstruction strategies for industrial facilities and building structures have also been discussed by Katunský et al. (2015) and Koteš et al. (2023), emphasizing diagnostic evaluation before intervention.

The flexural response of RC beams has been investigated through both classical and modern analytical approaches. Branson (1965) established foundational concepts for instantaneous and time-dependent deflection calculations, later extended to incorporate shrinkage and loading history effects (Scanlon and Bischoff, 2008). Contemporary models account for nonlinear stress-strain behavior of concrete and reinforcement, improving predictions of strength and ductility (Chen and Ho, 2015). Experimental studies have evaluated deflection ductility under mid-span loading (Bouazid et al., 2021), shear-flexure interaction effects (Campione et al., 2020), and the influence of stirrup orientation and shear span-to-depth ratio (Hunegnaw and Wondimu, 2021). Numerical simulations using advanced computational tools, including CASTEM software, have been applied to estimate ultimate deflections (Haytham et al., 2022), while compatibility-aided truss models provide reliable predictions for shear-critical beams (Kim, 2021). Axially restrained beams exhibit distinct flexural behavior that requires combined numerical and theoretical analysis (Hu et al., 2022). Investigations into mixed-mode crack deflection and fracture mechanics further deepen understanding of failure processes (Malíková et al., 2020).

Strengthening techniques using fiber-reinforced polymers (FRP), especially carbon fiber-reinforced polymer (CFRP), have proven effective in restoring flexural and shear capacity of damaged beams. Experimental research on prestressed CFRP plates demonstrated improved load-bearing capacity and crack control (Li et al., 2022a), while continuous CFRP RC beams exhibit enhanced flexural behavior (Pang et al., 2021). The performance of FRP-strengthened beams depends on multiple parameters, including bonding quality and reinforcement configuration (Sengun and Arslan, 2022). Shear strengthening using GFRP stirrups has also been experimentally and theoretically analyzed (Li et al., 2022b). The failure mechanisms of corroded RC beams strengthened in shear and bending zones confirm the importance of comprehensive reinforcement strategies (Yuan et al., 2021). Optimization of prestress levels in beams reinforced with shape memory alloy

bars provides additional opportunities for performance enhancement (Yang et al., 2021).

However, while FRP systems effectively enhance tensile zones, restoration of the compressed concrete zone remains comparatively underexplored. The use of high-performance repair mortars and fiber-reinforced concrete has shown promising results in improving structural integrity (Czajkowska et al., 2020; Czajkowska et al., 2023). Studies on fibre concrete deformation monitoring and numerical analysis confirm the need for combined experimental–analytical approaches (Adamczak-Bugno et al., 2022). Research on load-bearing capacity near support zones and in continuous beams also contributes to understanding stress redistribution after repair (Kos et al., 2022; Dorofeyev and Pushkar, 2023). Evaluation of steel-concrete composite slabs under short-term loading further expands knowledge of composite behavior (Vatulia et al., 2020).

Accurate experimental monitoring is essential for evaluating both damaged and restored structures. Digital Image Correlation (DIC) has become a powerful non-contact method for full-field strain and displacement measurement (Schreier et al., 2009; Niezrecki et al., 2018). The development and application of DIC in RC structures have been comprehensively reviewed by Blikharsky et al. (2022), demonstrating its reliability in assessing stress–strain states. Experimental applications of VIC-2D systems and image-based diagnostics confirm high precision in crack measurement and deformation monitoring (Cintron and Saouma, 2008; Cruz et al., 2019; Li et al., 2020; Dizaji et al., 2021). Combined use of acoustic emission and DIC techniques further enhances non-destructive evaluation of reinforced beams (Sharma et al., 2021). Fundamentals of speckle pattern preparation and measurement accuracy have been documented in technical guidelines (Speckle Pattern Fundamentals, 2021). The integration of non-destructive methods with numerical analysis improves structural health monitoring and reliability-based evaluation (Adamczak-Bugno et al., 2022; Koteš et al., 2022).

Modern assessment approaches increasingly incorporate machine learning for predicting fatigue performance of RC beams (Song et al., 2022). Moreover, vibration effects on load-bearing structures (Ilnytskyy et al., 2019) and implementation of quality management methodologies in construction processes (Jagusiak-Kocik and Ulewicz, 2023) reflect the interdisciplinary expansion of structural reliability research. National standards such as DSTU B V.2.6-156:2010, DSTU B V.1.2-3:2006, DBN V.2.6-98:2009, and international provisions including Eurocode 2 (2004) provide regulatory frameworks for nonlinear deformation analysis and serviceability assessment.

Overall, the reviewed literature demonstrates substantial progress in understanding degradation mechanisms, strengthening technologies, and monitoring techniques for RC beams. Nevertheless, limited research addresses the combined restoration of reinforcement damage and compressed concrete zone deterioration under realistic loading conditions while integrating high-precision experimental monitoring with nonlinear theoretical analysis. This gap highlights the relevance of further experimental studies aimed at validating restoration

methodologies and assessing their effectiveness in improving structural performance and durability.

Therefore, despite extensive research on reinforcement corrosion, FRP strengthening, and nonlinear analysis of RC beams, the restoration of beams already damaged in the compressed concrete zone remains insufficiently studied. In particular, the structural behavior of elements with crushed compression concrete combined with reduced reinforcement area has not been comprehensively investigated under realistic loading conditions. For this reason, the topic of restoring reinforced concrete beams with destruction in the compressed zone is highly relevant and requires further detailed experimental research, which is presented in this study.

4. Materials and Methods

A reinforced concrete (RC) beam sourced from the university testing laboratory was selected for both experimental investigation and numerical modelling. The specimen exhibited overall dimensions of $2100 \times 200 \times 100$ mm. Longitudinal reinforcement in the tensile region consisted of $\varnothing 20$ A500S rolled steel bars, whereas the compression zone was reinforced with two $\varnothing 6$ A240S bars. Transverse reinforcement was provided by U-shaped $\varnothing 6$ A240S stirrups with a uniform spacing of 75 mm (see Fig. 1).

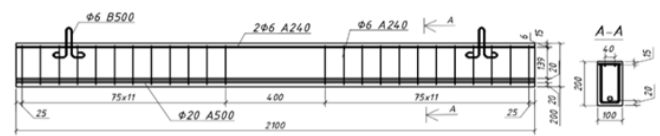


Fig. 1. General view illustrating the reinforcement layout of the tested specimens

Under conditions simulating simultaneous reinforcement corrosion and deterioration of the compressed concrete zone, the effective cross-sectional area of the tensile reinforcement was reduced to a diameter of 12 mm within the pure bending region over a 120 mm length at the midspan of the beam.

The RC beam was designed to ensure that failure would initiate in the pure bending zone along the normal sections (see Fig. 2). Longitudinal and transverse bars were assembled into a reinforcement cage using industrial resistance welding. The concrete, of strength class C35/45, exhibited a compressive strength of 48.2 MPa according to the results of cubic testing.

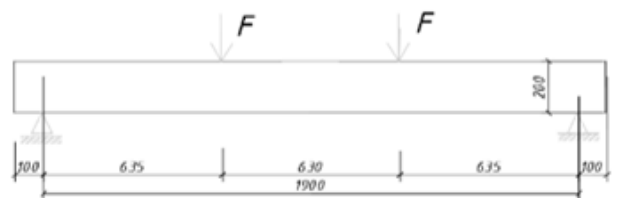


Fig. 2. Overall view illustrating the investigated specimen

A general view of the specimen, with overall dimensions of $2100 \times 200 \times 100$ mm, is presented in Fig. 2. The load was applied as two concentrated forces positioned at one-third of the effective span (1900 mm), separated by a distance of 633 mm. The applied forces were incrementally increased by 10%

of the calculated bearing capacity at 10-minute intervals to allow stabilization of the measurement results. Loading was performed using a hydraulic jack in combination with a distribution beam.

Experimental investigations were conducted employing both strain gauges and digital image correlation (DIC) to minimize measurement errors and validate the research methodology. Submicron, non-contact strain gauges were affixed to one surface of the beam, whereas the opposite surface was dedicated to DIC implementation (see Fig. 3). This configuration ensured reliable and complementary application of both measurement techniques.



Fig. 3. Overall view of the experimental testing stand

After the completion of each experiment, the recorded images were transferred to the VIC-3D software package for further processing using the digital image correlation (DIC) method. At the initial stage, the correctness of the camera calibration was verified, and the synchronization of the captured image pairs was checked. In addition, the boundaries of the investigated concrete region were defined to establish the region of interest (ROI) for subsequent analysis. At the next stage, according to the recommendations of the software package and to ensure an appropriate signal-to-noise ratio in the correlation process, the optimal correlation parameters were selected. In particular, the subset size was set to 25 pixels, while the step size was defined as 5 pixels. The processing of the obtained data from the high-resolution cameras was carried out using an algorithmic image

correlation analysis that tracks the displacement of individual local subsets of the speckle pattern relative to the initial reference configuration of the specimen. This procedure enabled the determination of the displacement and strain fields over the investigated surface of the concrete element

Experimental methodology for RC beam measurements. High-precision, submicron non-contact sensors were employed to ensure accurate assessment of strain and stress. In the present study, Micro-tech sensors with a resolution of 1×10^{-4} mm and a measurement error below $13 \mu\text{m}$ were utilized (see Fig. 4). The acquired data were transmitted to a computer via Bluetooth, enabling continuous monitoring of the specimen up to ultimate failure. Measurements were recorded at 1-second intervals. Two submicron sensors were dedicated to capturing the deformation of the most compressed concrete fibers, while steel reinforcement strains were monitored using conventional strain gauges mounted on mechanical holders. Along the beam height, five sensors were strategically positioned, with the first sensor located 20 mm from the top edge and the remaining four installed at 30 mm intervals. Beam deflections were monitored using five additional submicron sensors: one at midspan, two at the locations of applied loads, and two directly above the supports.



Fig. 4. Microtech measuring gauges were applied in the course of the experimental research

To implement the digital image correlation (DIC) technique in the investigation of the RC beam, specimen preparation was required. The beam surface was carefully cleaned and leveled using a grinding stone and an electric grinder. DIC analysis was conducted over a 400×200 mm concrete section located in the pure bending region using a dedicated high-resolution camera. An additional camera was employed to monitor deformations along the reinforcement. The camera was positioned 550 mm from the surface of interest, with the lens aperture set to f/5.6 (see Fig. 3), and configured using Fly Capture software. For DIC application, a suitable speckle pattern was generated: black dots with diameters ranging from 0.3 to 0.7 mm were applied on a white background covering approximately 50% of the surface area. All procedures were performed in accordance with established guidelines and recommendations (Efimenko et al., 2014). Subsequent analysis and post-processing of the acquired images were carried out using VIC-2D-7 software.

During the experimental investigation, two full-height cracks developed along the beam, enabling the extraction of a concrete fragment measuring $300 \times 100 \times 100$ mm that was

no longer structurally connected to the main body of the specimen (see Fig. 5).



Fig. 5. Overview of the damaged region of the RC beam

This methodology proposes the use of epoxy adhesive to re-attach the removed concrete section measuring 300x100x100 mm back to its original position on the beam. This method was implemented on two twin test specimens.

The first step in the preparation for bonding involved creating a gap of 5-10 mm between the concrete insert and the body of the beam, followed by cleaning the surfaces of dust and weak concrete residues (see Fig. 6).



Fig. 6. Surface preparation and gap for restoration work

For the bonding procedure, Sikadur-30 epoxy adhesive was employed. Sikadur-30 (Sikadur®-30) is a thixotropic, two-component epoxy-based adhesive specifically formulated for the bonding of construction materials. It possesses high mechanical strength and is used for repairing chips and damage to concrete structures (see Fig. 7).



Fig. 7. View of the damaged area of the RC beam

The main physical and mechanical properties of Sikadur-30 epoxy adhesive are provided in the documentation. After preparing the surfaces, the Sikadur-30 epoxy adhesive was prepared by mixing components A and B for 3 minutes to achieve a homogeneous mass. The finished adhesive was applied to the concrete surface in a thin layer (see Fig. 8), and then quartz sand was sprinkled on top (see Fig. 9) to ensure mechanical bonding, thus creating a priming layer between the surfaces. This work was performed on all surfaces that needed to come into contact.



Fig. 8. Priming the surface with epoxy adhesive

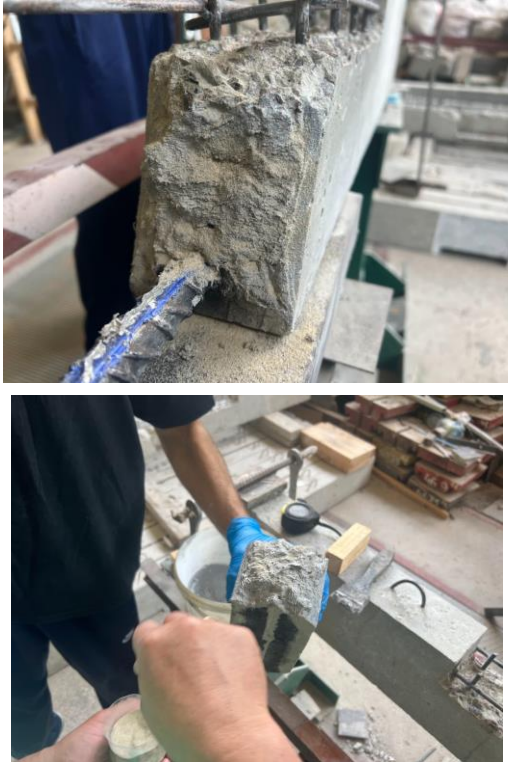


Fig. 9. Sanding the surface

The next step involved applying a thicker layer of Sikadur-30 over the primed surface and positioning the concrete piece that needed to be bonded in its designed position (see Fig. 10).



Fig. 10. Positioning the insert in the designed position and securing it

After aligning and securing the concrete insert, Sikadur-30 epoxy adhesive was used to fill all gaps, forcing it into the bonding areas (see Fig. 11).



Fig. 11. Pressing in the epoxy adhesive and allowing it to cure

This method was applied in conjunction with the technique for restoring the compressed concrete zone after damage, using the repair compound Sika MonoTop-4012 (Sika MonoTop®-4012). After a 24-hour curing period of the epoxy adhesive, a metal formwork was installed, and the Sika MonoTop-4012 repair mortar was cast into the compressed concrete region. The final configuration of the restored compression zone of the reinforced concrete beam, incorporating the bonded concrete insert, is illustrated in Fig. 12.

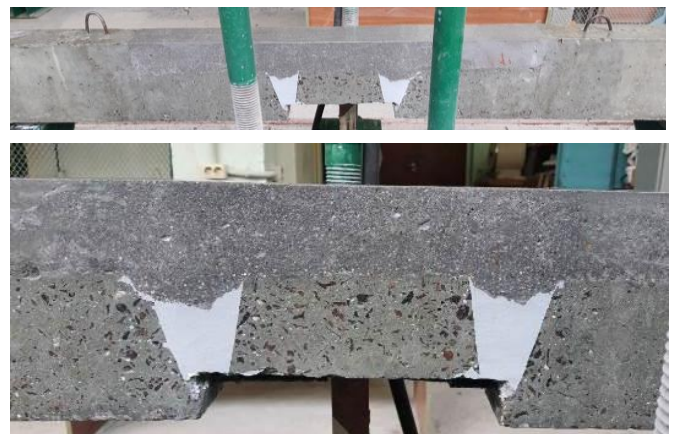


Fig. 12. Overall appearance of the RC beam post-restoration via bonding, with emphasis on the repaired compressed concrete region

5. Results and discussion

A significant feature of modern calculation methods is the use of a nonlinear deformation method, which accounts for realistic nonlinear stress-strain diagrams for concrete and bilinear diagrams for reinforcement.

In the graphs of this section, the following notation for RC beams is adopted: Rebar_Theor – theoretical deformation of thermally-strengthened working reinforcement; Conc_Theor – theoretical strain of the most compressed concrete fiber; Conc_Exp_Indic – experimentally measured strain of the most compressed concrete fiber obtained via submicron computerized sensors; Rebar_Exp_Indic – experimentally measured strain of the tensile reinforcement obtained via submicron computerized sensors; Conc_Exp_DIC – experimentally measured strain of the most compressed concrete fiber using the digital image correlation (DIC) technique; Rebar_Exp_DIC – experimental deformation of the tensile reinforcement using DIC; Defl_Theor – theoretical deflection; Defl_Exp_DIC – experimental deflection according to sub-micron computerized indicators; Defl_Exp_Indic – experimental deflection using DIC.

Samples of RC beams RC-1.1 and RC-1.2, with reinforcement of 20 mm diameter A500C class rebar, were pre-treated by reducing the diameter to 12 mm over a 120 mm segment within the pure bending zone before casting. The RC beams were damaged with crushed concrete in the compression zone, unloaded, and then restored by bonding with Sikadur-30 and repairing the compression zone using Sika MonoTop-4012 as described above.

Experimental data on tensile testing of the reinforcement indicated that yielding of the tapered rebar begins at $\sigma_{yk} = 445.5$ MPa, with strain at yield $\varepsilon_{yk} = 216 \cdot 10^{-5}$. During testing, the moment at which yielding began in the working reinforcement was $M_{y,ind} = 8.97$ kNm as per sub-micron indicators and $M_{y,DIC} = 8.62$ kNm as per DIC, indicating the attainment of the ultimate load-bearing capacity of the RC beams through the tensile reinforcement (see Fig. 13).

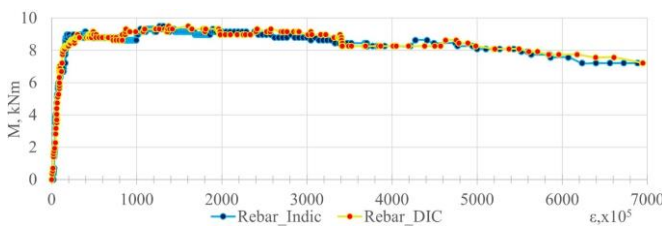


Fig. 13. Averaged experimental moment-strain curves of the tensile reinforcement for RC beams RC-1.1 and RC-1.2: Rebar_Indic – measured using submicron sensors; Rebar_DIC – obtained via the digital image correlation (DIC) technique

The maximum moment sustained by beams RC-1.1 and RC-1.2, leading to rupture of the rebar at ultimate strain $\varepsilon_{ud} = 6950 \cdot 10^{-5}$, was $M_y = 9.5$ kNm (see Fig. 13).

The ultimate strain of the most compressed fiber of the repair material Sika MonoTop-4012 was not attained. At the initiation of reinforcement yielding, the average strain in the most compressed fiber of Sika MonoTop-4012 was measured

as $\varepsilon_{sika} = 102 \cdot 10^{-5}$, and at the moment of rebar rupture, it reached $\varepsilon_{sika} = 214 \cdot 10^{-5}$ (see Fig. 14).

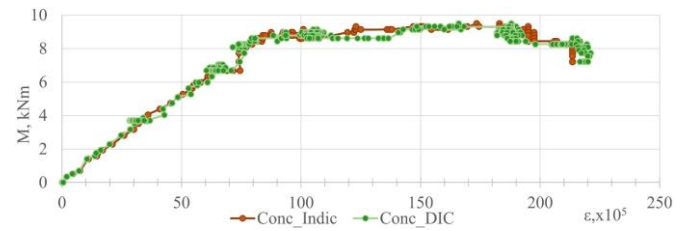


Fig. 14. Averaged experimental moment-strain curves of the most compressed fiber of the Sika MonoTop-4012 repair mortar for RC beams RC-1.1 and RC-1.2: Conc_Indic – measured using submicron sensors; Conc_DIC – obtained via the digital image correlation (DIC) technique

The ultimate deflection of RC beams RC-1.1 and RC-1.2 was determined as $M_{f,u,ind} = 8.62$ kNm using submicron sensors and $M_{f,u,DIC} = 8.26$ kNm via digital image correlation (DIC) (see Fig. 15).

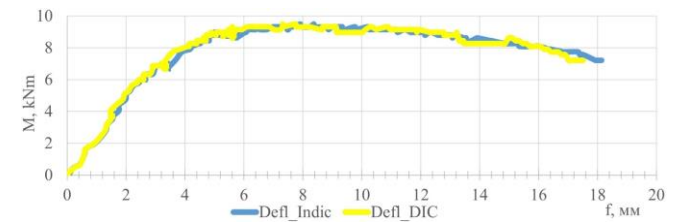


Fig. 15. Averaged experimental moment-deflection curves for RC beams RC-1.1 and RC-1.2: Defl_Indic – measured using submicron sensors; Defl_DIC – obtained via the digital image correlation (DIC) technique

Theoretical calculations yielded a reinforcement yield moment of $M_{y,th} = 5.39$ kNm and an ultimate strain of the most compressed concrete fiber at $M_{cu,th} = 6.49$ kNm, with the corresponding ultimate deflection occurring at $M_{fu,th} = 5.68$ kNm. The resulting moment-strain and moment-deflection curves for concrete and reinforcement (see Figs. 16 and 17) were generated based on both theoretical predictions and experimental measurements of the undamaged RC beams.

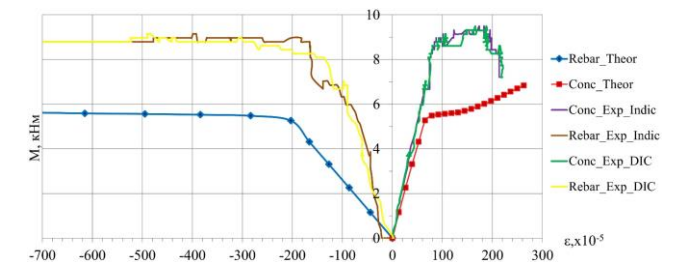


Fig. 16. Comparative analysis of theoretical and experimental data for RC beams RC-1.1 and RC-1.2: moment-strain curves of the tensile reinforcement and of the most compressed concrete fiber

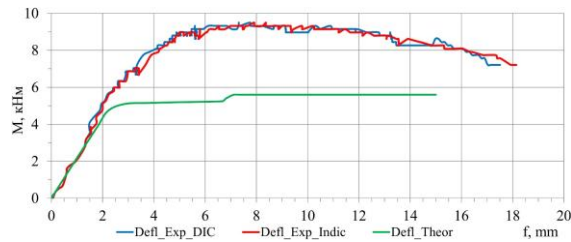


Fig. 17. Comparative analysis of theoretical and experimental data for RC beams RC-1.1 and RC-1.2: moment–deflection curves

Testing of beams RC-2.1 and RC-2.2 with tapered reinforcement to 12 mm, but without damaged concrete compression zones, was also performed for comparison with damaged beams restored with Sikadur-30 and Sika MonoTop-4012. The experimental results are summarized in Table 1.

Table 1. Results of experimental and theoretical moment values at the onset of reinforcement yield, achievement of limit values in the concrete fiber, and attainment of ultimate deflections

No	Ø, mm	Ø _{as} , mm	RebarExp, kNm	Rebar Theor, kNm	Rebar Exp/Theor, %	Conc Exp, kNm	Conc Theor, kNm	Conc Exp/Theor, %	Defl Exp, kNm	Defl Theor, kNm	Defl Exp/Theor, %
RC-1.1	20	12	8.8	5.39	38.7	-	6.49	-	8.44	5.68	31.36
RC-1.2											
RC-2.1			5.69	5.39	5.3	7.87	6.49	17.5	7.51	5.68	24.4
RC-2.2											

Note: Averaged data for two twin samples provided

6. Conclusions

As a result of the study, it was found that modern methods of restoring and strengthening reinforced concrete structures significantly increase their strength and durability. The use of epoxy adhesives, high-quality composite materials, and other innovative technologies allows not only to restore the original characteristics of the structures but also to improve their performance properties.

The performed literature analysis confirmed that although numerous studies address corrosion of reinforcement, FRP strengthening, and nonlinear analysis of reinforced concrete elements, the restoration of beams with crushed compression zones remains insufficiently investigated, particularly under realistic loading conditions and with simultaneous reinforcement damage.

A process-oriented experimental methodology for restoring damaged reinforced concrete beams was developed and implemented. The proposed approach combines bonding of the detached concrete fragment using Sikadur-30 epoxy adhesive with subsequent restoration of the compressed zone using polymer-modified repair mortar Sika MonoTop-4012.

The experimental program integrating high-precision submicron displacement sensors with Digital Image Correlation (DIC) demonstrated high reliability and consistency of the measurement system. The obtained strain

and deflection fields confirmed the effectiveness of combining contact and non-contact monitoring techniques for assessing the stress–strain state of repaired reinforced concrete elements.

Experimental results showed that the repaired beams reached a reinforcement yielding moment of approximately 8.6–9.0 kNm and an ultimate bending moment of about 9.5 kNm. The strain level in the repaired compression zone remained significantly below the ultimate strain capacity of the repair mortar, indicating stable composite action between the original concrete and the repair material.

The results of experimental studies showed the effectiveness of using these materials in the restoration of reinforced concrete beams. It has been established that the correct choice of reinforcement methods, taking into account the type of damage and operating conditions, can significantly increase the bearing capacity of structures with minimal resources. In addition, the use of composite materials can reduce repair time and reduce the complexity of work. Studies have also confirmed that the use of modern reinforcement methods, such as reinforcement with composite materials and application of high-strength coatings, can become the basis for further improvement of technologies in this area.

According to the experimental results for RC beams RC-1.1 and RC-1.2, in which the cross-sectional area of 20 mm diameter A500C class reinforcement was reduced to 12 mm, it was found that the yield moment of the reinforcement increased by 35%. However, the ultimate strain in the compressed fiber of the repair mortar was not reached due to rupture of the reinforcing bar. Thus, the Sika MonoTop-4012 repair mortar effectively restored the compressed zone, enhancing its strength characteristics and compensating for the reduction in reinforcement cross-section. This delay in the onset of yielding in the reinforcement demonstrates the repair mortar's efficacy in structural recovery.

Given the results obtained, we can recommend these methods for wide application in construction practice, in particular during the reconstruction and restoration of objects that have undergone significant damage.

Funding

The paper is a part of the research done within the project 2023.05/0026 (National Research Foundation of Ukraine).

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