ДГКС ASES E-33
Kongres 2026
Congress 2026

doi: 10.67563/ASESCONF2026083V

Milica Vidović[1], Jelena Carević[2], Ivan Milićević[2]

REUSE OF PRECAST CONCRETE ELEMENTS: REVIEW AND EXPERIMENTAL CASE STUDY

Summary: The reuse of precast reinforced concrete (RC) elements is an effective way to reduce the environmental impact of the construction industry. However, practical implementation remains limited by regulatory, technical, and market barriers. To facilitate reuse, the principles of design for deconstruction should be incorporated into precast structures. This paper reviews current requirements and guidelines for reusing precast RC elements and summarizes experimental studies on dry and semi-dry demountable connections, focusing on their performance across the first and second life cycles. Furthermore, an experimental case study of a demountable connection between a precast RC column and a foundation is presented. The reviewed studies indicate that precast RC elements can be reused, but their behaviour in the second life cycle should be systematically analysed, as they exhibit similar or lower structural performance.

Keywords: reuse, precast concrete structures, demountable connections, first and second life cycle

PONOVNA UPOTREBA PREFABRIKOVANIH ARMIRANOBETONSKIH ELEMENATA: PREGLED I EKSPERIMENTALNA STUDIJA SLUČAJA

Rezime: Ponovna upotreba prefabrikovanih armiranobetonskih (AB) elemenata može značajno smanjiti negativan uticaj građevinske industrije na životnu sredinu. Međutim, njena praktična primena je i dalje ograničena regulatornim, tehničkim i tržišnim preprekama. Ukoliko se prefabrikovane konstrukcije projektuju kao demontažne, povećava se mogućnost za njihovu ponovnu upotrebu. U radu je dat pregled postojećih zahteva i smernica vezanih za ponovnu upotrebu prefabrikovanih AB elemenata, kao i eksperimentalnih istraživanja suvih i polusuvih demontažnih veza u prvom i drugom životnom ciklusu. Prikazana je i eksperimentalna studija slučaja demontažne veze prefabrikovanog AB stuba i temelja. Pregledom istraživanja zaključeno je da je ponovna upotreba prefabrikovanih AB elemenata moguća, ali da treba pažljivo analizirati njihovo ponašanje u konstrukciji, jer tokom drugog životnog ciklusa mogu pokazati iste ili lošije karakteristike.

Ključne reči: ponovna upotreba, prefabrikovane betonske konstrukcije, demontažne veze, prvi i drugi životni ciklus

[1] Faculty of Civil Engineering, University of Belgrade, Belgrade, Republic of Serbia, milica@imk.grf.bg.ac.rs
[2] Faculty of Civil Engineering, University of Belgrade, Belgrade, Republic of Serbia

1. INTRODUCTION

The construction industry is one of the largest consumers of natural resources and the major contributors to waste generation and greenhouse gas emissions [1]. In response to these environmental challenges, the principles of the circular economy have gained increasing attention in recent years [1]. Among the available circular strategies, the reuse of structural components is considered more beneficial than recycling because it preserves the embodied energy, material value, and functionality of existing elements while reducing the demand for new raw materials and minimizing construction and demolition waste [2], [3]. Consequently, the reuse of reinforced concrete (RC) elements has emerged as a promising approach for reducing the environmental impact of the construction industry [2], [3].

Precast RC structures are particularly suitable for implementing circular economy principles. In addition to advantages such as improved quality control and reduced construction time, prefabrication enables disassembly, replacement, and reuse of structural elements or connection components [4], [5]. However, successful reuse requires that these objectives were already considered during the design phase. The concepts of Design for Deconstruction (DfD) promote the development of structures that can be dismantled, inspected, and reassembled with minimal damage to their components [1]. In such systems, dry and semi-dry demountable connections play an important role, as they ensure quick assembly, straightforward disassembly, and the possibility for repeated reuse while maintaining high-quality elements and reliable construction processes [3]–[5].

Despite the advantages that precast RC structures offer, the use of reused elements or the design of new constructions using DfD principles is not widely implemented. There is still no comprehensive methodology within current design standards and guidelines for the assessment, certification, and design of reused precast RC elements [3]–[5]. Also, there are no guidelines for implementing DfD principles in new construction. Existing standards primarily address new construction and provide limited guidance on evaluating residual structural capacity, defining acceptance criteria for reclaimed elements, and designing reusable connection systems [3]–[5]. As a result, the practical implementation of reusable precast concrete structures remains largely dependent on research findings and project-specific solutions [3], [5].

This paper presents an overview of current requirements and guidelines related to the reuse of precast RC elements, with particular emphasis on demountable connection systems and their design parameters. Experimental studies on dry and semi-dry reusable connections are reviewed, with the focus on their performance during the first and second life cycles. In addition, an experimental case study of a demountable precast column-to-foundation connection is presented and evaluated for structural performance, ease of disassembly, and reusability.

2. REUSE OF PRECAST REINFORCED CONCRETE ELEMENTS

Previous research has concluded that adequate connection detailing is essential for enabling the reuse potential of precast RC structures [6]. This chapter presents a literature review aimed at identify existing standards and guidelines relevant to the reuse of precast reinforced concrete (RC) elements. In addition, it reviews experimental studies on demountable connections in precast RC structures, with particular emphasis on studies in which specimens were tested in two life cycles. The purpose of this review is to identify connection solutions that enable disassembly and reuse, as well as the key design parameters influencing their structural performance.

2.1. REQUIREMENTS FROM EXISTING STANDARDS AND GUIDELINES FOR REUSE

Current design standards provide general, limited and indirect guidance for the reuse of precast reinforced concrete elements. There is no comprehensive methodology for selecting, assessing, certifying and designing reused precast RC elements. The ISO 20887 [7] represents one of the most relevant international standards, as it provides general principles for Design for Disassembly and Adaptability (DfD and DfA). The main principles of DfD include accessible, independent, reversible, simple, standardized and safe connections, with avoidance of unnecessary finishes and treatments that may limit reuse. Components should be durable, replaceable, easy to handle, transport, and reassemble, while connection details should allow disassembly with standard tools, with minimal damage to adjacent elements. Proper documentation, disassembly planning, lifting provisions and, where necessary, spare parts are essential to support future reuse and circular economy business models. However, ISO 20887 [7] does not provide specific design models for reused precast RC elements. Beyond standards, manufacturers of connection systems for precast concrete structures have also recognized the need for reuse-oriented solutions. Accordingly, some industrial case studies have demonstrated the disassembly and reassembly of existing connection systems as a practical step toward the future reuse of precast concrete elements. One such example is the *Peikko white paper* [8], in which the company performed a practical demonstration of the disassembly and reassembly of grouted column-to-foundation joints, as well as a prefabricated precast concrete frame. The researchers who conducted this study [8] followed the methodology for disassembly and reassembly that was suggested by ISO 20887 [7], but the samples were not subjected to any type of loading during the process.

The *ReCreate – Reusing precast concrete for a circular economy* is a research project focused on developing and testing methods deconstructing, assessing, and reusing precast concrete elements in new buildings [9]. They suggested the following reuse procedure: pre-deconstruction audit, structural investigation, deconstruction design and execution, full-scale testing, when necessary, redesign and reassembly, and product approval [10]. The key properties required for structural verification include concrete compressive strength, reinforcement strength and layout, cover depth, durability-related parameters, damage level and possible hazardous substances [11]. But, again, the methodology for designing reuse precast concrete elements or calculating their bearing capacity was not determined.

2.2. DEMOUNTABLE CONNECTIONS FOR REUSABLE RC STRUCTURES-EXPERIMENTAL VALIDATION

The literature review of existing experimental studies was conducted to identify criteria used to assess the reusability of precast RC elements. Slab-to-slab and slab-to-beam, beam-to-column, and column-to-foundation connections in precast RC structures were analysed.

2.2.1. Slab-to-slab and slab-to-beam connections

Available studies on demountable slab-to-slab connections remain largely limited to conceptual solutions or preliminary tests, and no complete slab-to-slab connection system has been experimentally validated in the second life cycle [5]. Therefore, the most relevant experimental validation related to reusable slab connections is currently the slab-to-beam connections proposed by Li et al. [12]–[15]. The connection consists of embedded steel boxes in the precast beam and steel channels in the precast slab, connected by accessible high-strength bolts and end plates. This layout enables bolt replacement and disassembly of the beam and slab without significant damage to the main concrete elements. The layout of the proposed connection is shown in Figure 1.

In the first life cycle, the specimens were tested under monotonic push-out loading, and failure was generally governed by bolt shear fracture, while the concrete beam and slab, as well as the embedded steel box and channel, remained largely undamaged. The reusability of this connection was further assessed by testing reassembled specimens in a second life cycle. After the first loading phase, the specimens were disassembled, damaged bolts were replaced, and the specimens were reassembled and tested again. The failure mode remained governed by bolt shear, while the ultimate shear capacity, initial stiffness and peak slip generally decreased by approximately 5–20%, depending on bolt diameter, connector spacing and steel box thickness. Although this reduction indicates that the behaviour in the first life cycle cannot be directly assumed for the second, the connection still exhibited adequate deformation capacity and stable mechanical behaviour after reassembly. Therefore, these studies confirm the reuse potential of the proposed slab-to-beam connection. A key design criterion of the proposed demountable connection was to concentrate failure in the replaceable bolts, while preventing significant damage to the concrete beam and slab, thereby preserving the main RC elements for future reuse.

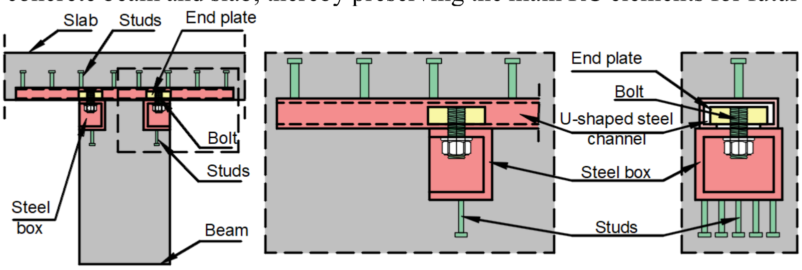


Figure 1: Demountable slab-to-beam connection - adapted from [12]–[14]

2.2.2. Beam-to-column connections

Aninthaneni et al. [16]–[17] experimentally investigated an emulative dry beam-to-column connection with a steel end plate embedded at the beam end and through anchor bolts passing through the column. The beam longitudinal reinforcement was welded and anchored to the embedded steel plate, while additional bent-up bars and stiffeners were used to improve shear transfer and increase the connection's stiffness and moment resistance. The connection was completed by clamping the through bolts to a steel backing plate at the rear side of the column. The bolts were pretensioned, and the connection was designed as an overdesigned joint, intended to remain rigid and elastic while plastic hinging developed in the beam outside the connection region, as shown in Figure 2 a. The authors also tested a related configuration using stiffened steel angles and horizontal and vertical through bolts inserted through steel ducts embedded in the beam and column, as shown in Figure 2 b. Two layouts were tested: one with steel angles only and another with additional embedded steel web plates for shear transfer. Rubber sheets or dental plaster were used to improve contact between the steel connection and concrete surfaces. This configuration followed the same demountable connection concept, but with a different steel connection layout.

For both connection solutions, experimental cyclic tests were conducted on two specimens with identical connection layouts. In the first test, failure occurred in the precast beam outside the connection region. The connection was then disassembled, the damaged beam was removed, and a new beam was connected to the same column for the second test. The results showed no significant difference between the two specimens, with plastic hinging again developing in the beam outside the connection. The tested dry end-plate connection exhibited behaviour comparable to wet-jointed or monolithic beam-to-column joints, with favourable energy dissipation. The study confirmed that the connection is demountable and that, if damage is limited to the beam, the beam can be replaced while the RC column and connection region can be reused.

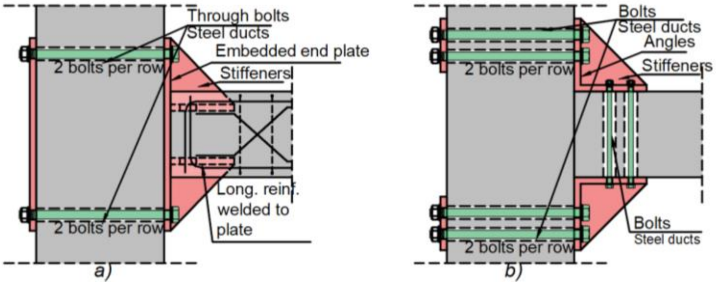


Figure 2: Beam-to-column connections with bolts adapted from [16]–[17]*: a) connection with embedded steel end plate and stiffeners b) connection with steel angles and stiffeners*

Xiao et. al [18], [19] and Ding et.al [20] proposed a DfD beam-to-column connection developed as a beam-to-beam connection placed outside the joint core, in order to avoid damage concentration in the column region and enable future disassembly. In the first solution, the middle precast beam was seated on short protruding beams extending from the column, while continuity of the longitudinal reinforcement was achieved by welding and a small amount of post-cast concrete was added in the connection zone, as shown in Figure 3 a. In the later solution, the same concept was improved by incorporating embedded I- and T-section steel elements in the reusable beam to increase shear resistance and prevent buckling of the longitudinal reinforcement. The improved DfD joint was tested on full-scale interior frame specimens under quasi-static cyclic loading. The original specimens were first loaded up to 2% interstorey drift, selected as a post-earthquake limit state that allowed deconstruction and reuse of the beam. After deconstruction, the same middle beams were reinstalled, and the reused specimens were tested to failure. The results showed satisfactory load-bearing capacity and stable hysteretic behaviour after reassembly, although the reused specimens exhibited reduced displacement ductility due to damage accumulated during the first loading stage. No sudden failure occurred, confirming that the middle beam could be reused in a second life cycle if prior damage is properly controlled and accounted for.

Wang et al. [21] tested post-tensioned precast beam-to-column joints with steel jackets and replaceable mild steel bars. The beams were prestressed against the column using unbonded post-tensioned strands, while steel jackets protected the beam ends and column from concrete crushing, as presented in Figure 3 b. Replaceable mild steel bars, connected to the beam-end steel jackets either directly or through replaceable steel angles, were used as energy-dissipating components. Under cyclic loading, yielding was primarily confined to the mild steel bars, while the post-tensioned strands and beam reinforcement remained elastic. The precast joint exhibited strength comparable to that of the monolithic specimen, negligible residual deformation, and limited concrete cracking under service-level seismic drift. After the first test, the damaged mild steel bars, replaceable angles and post-tensioned strands were replaced, while the precast beam and column were reused and retested. The reused specimen exhibited seismic behaviour very similar to that of the original precast specimen, with comparable strength, stiffness, and energy dissipation. Therefore, the main criterion for reuse was the concentration of inelastic deformation in replaceable steel dissipators, while the concrete members and the prestressing system remained largely undamaged or were replaceable. This confirmed the possibility of disassembly, replacement of damaged components and reuse of both the precast beam and column.

Cai et al. [22] investigated self-centring post-tensioned precast beam-to-column connections with replaceable steel top and seat angles. The precast beam and column were connected using unbonded post-tensioning strands, while the top and seat steel angles were bolted to the beam and column and acted as replaceable energy-dissipating fuses, as shown in Figure 3 c. The seat angles also provided support for the beam during assembly. The authors conducted displacement-controlled cyclic loading tests on precast beam-to-column subassemblies. The results showed that the main nonlinear deformation was concentrated in the steel angles, while the precast beam, column and post-tensioning strands remained almost elastic up to high drift levels. The reuse potential was assessed by retesting one previously loaded specimen after replacing the steel angles. The reused specimen exhibited hysteretic behaviour almost identical to the original, with only slight reductions in strength and initial stiffness due to pre-existing cracks in the beam. Therefore, the main reuse criterion was the concentration of damage in replaceable steel angles, while the primary concrete members and post-tensioning system remained largely undamaged and capable of being reused.

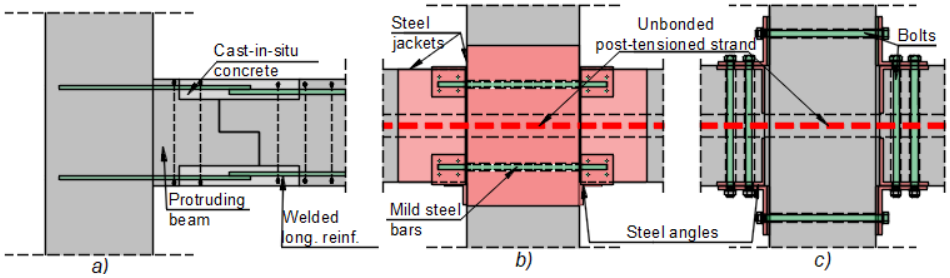


Figure 3: Beam-to-column connections: a) with partial cast-in-situ concreting – adapted from Xiao et. al [18], [19] *and Ding et.al* [20]*, b) post-tensioned connections – adapted from Wang et al.* [21]*, c) Cai et al.* [22]

2.2.3. Column-to-foundation connections

Guo et al. [23] proposed a prefabricated RC column with a replaceable column-base connection intended to concentrate seismic damage in replaceable steel components rather than in the main concrete members, as shown in Figure 4. The upper part of the specimen was a conventional RC column, while the lower part was formed as a reduced concrete-filled steel tubular column connected to the foundation through external replaceable steel fuses. The steel fuses were bolted to both the column base and the foundation and acted as the main energy-dissipating components. Padding blocks were placed between the steel fuses and the column to provide lateral support, while additional buckling restraint plates were used to limit fuse buckling. The reduced column-base section was designed to promote rocking at the interface, reduce the deformation demand in the fuses, and protect the RC column, concrete-filled tube (CFT) column segment and foundation from significant damage.

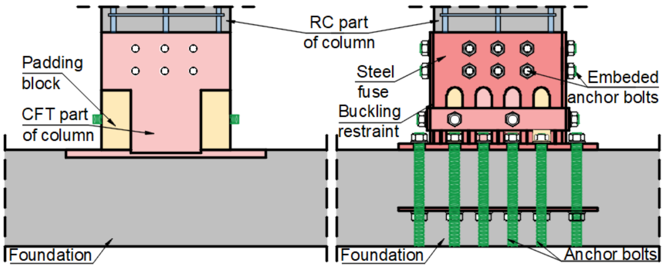


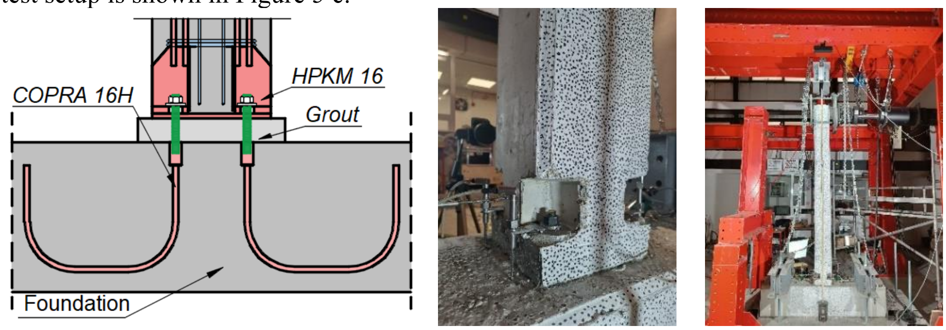
Figure 4: The configuration of the column-to-foundation connection adapted from Guo et al. [23]

To evaluate the reuse potential of the proposed column-to-foundation connection, Guo et al. [23] tested four full-scale prefabricated RC column specimens under cyclic lateral loading. Each specimen was tested twice: in the first stage, the specimens were loaded up to a drift ratio of 2%, after which the damaged steel fuses and padding blocks were replaced. In the second stage, the reused specimens were tested again under the same configuration up to a drift ratio of 4%. The 2% drift limit was selected to satisfy repairability requirements, since larger drift levels would make post-earthquake repair more difficult. The results showed that damage was mainly concentrated in the replaceable steel fuses and padding blocks, while the column and foundation remained essentially undamaged. After replacement of the damaged components, the specimens exhibited cyclic behaviour similar to that observed before replacement, particularly up to 2% drift, confirming that the main column and foundation components could be reused after replacing the damaged connection parts.

The reviewed studies show that existing reusable connections mostly rely on concentrating the damage in predefined regions or connection parts. However, the reuse potential of standard, widely used industrial connection systems remains unvalidated. To address this gap, the following case study investigates the reuse potential of a demountable column-to-foundation connection based on column shoes and anchoring couplers in two life cycles.

3. CASE STUDY ON COLUMN-TO-FOUNDATION CONNECTION

The aim of this case study was to experimentally validate whether both the precast RC column and RC foundation could be reused after disassembly and reassembly of the joint. The connection consisted of Peikko [24] HPKM 16 column shoes embedded in the column, COPRA 16H anchoring couplers embedded in the foundation, grout between the column and foundation, and demountable threaded rods used for connecting the column shoes with the anchoring couplers. The original specimen (OS) was subjected to cyclic lateral loading up to 1% drift. The 1% drift limit was adopted to represent a damage-limitation seismic demand, in accordance with the Eurocode 8 standard [25] drift criterion for frequent earthquakes. The connection was then disassembled, the grout was removed, and the same column and foundation were reassembled using new external threaded rods and new grout. The reused specimen (RS) was subsequently tested again under cyclic lateral loading up to a 5.5% drift. The structural response in the first and second life cycles was compared in terms of load-bearing capacity, hysteretic behaviour and damage development. The connection configuration is shown in Figures 5 a and 5 b, while the test setup is shown in Figure 5 c.



a) b) c)

Figure 5: Connection detailing and experimental setup: (a) schematic design of the demountable column-to-foundation connection; (b) assembled connection; (c) test setup.

3.1. EXPERIMENTAL TESTING

The full-scale sample of the demountable column-to-foundation joint was tested under cyclic horizontal load and constant axial force. The precast column was mounted on the RC foundation and vertically loaded by a hydraulic jack, while cyclic horizontal displacement was applied near the column top using a horizontal actuator. The same test setup was used in both life cycles. The normalised axial force was 0.05. The loading protocol was drift-controlled. In the first phase, the drift was gradually increased in small increments up to 2% (for OS up to 1%), with three cycles at each drift level. For the RS in the second phase, the drift was increased in larger increments until the test was completed. During testing, the top displacement of the column was measured using a draw-wire sensor, while LVDTs were used to measure vertical displacements of the column shoes and horizontal slip at the column–foundation interface. In addition, the frontal side of the specimen was monitored using a Digital Image Correlation system, and strain gauges were installed on the column reinforcement and anchorage reinforcement in the foundation.

3.2. DISASSEMBLY, REASSEMBLY AND REUSE

After the first cyclic test, the specimen was successfully disassembled without significant difficulty. The nuts on the external threaded rods were first unscrewed, after which the precast column was lifted from the foundation. The threaded rods were then removed, and the grout layer between the column and foundation was relatively easily mechanically removed. After the first life cycle, all reinforcement and anchorage components remained in the elastic range. Only a few cracks were observed in the column, while the foundation and embedded steel components, including the HPKM column shoes and COPRA anchoring couplers, remained undamaged. The same precast column and RC foundation were then reused in the second cyclic test. The column was placed back in the same position, while only the external threaded rods and grout were replaced with new components of the same characteristics as those used in the first joint assembly. This procedure confirmed that the main precast concrete elements and embedded steel connection components could be preserved during disassembly and reused after reassembly. The demounting procedure is shown in Figure 6.

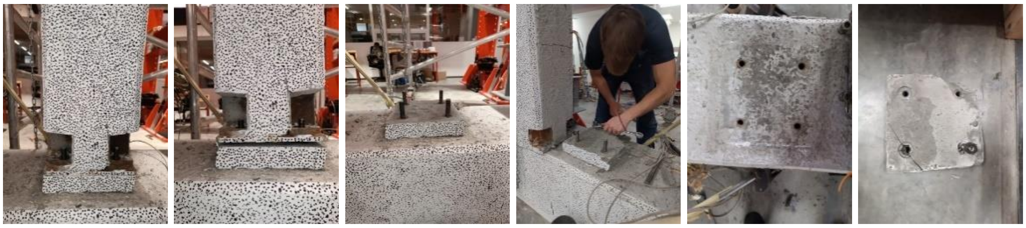


Figure 6: Demounting procedure of the precast column–foundation connection

The comparison of the joint behaviour in the first and second cyclic test showed that the hysteretic response up to 1% drift was practically the same, as shown in Figure 7. During the second life cycle, no new damage was observed in the column up to the 1% drift. The existing cracks reopened and slightly widened, but without significant additional damage. New cracks started to develop only after the loading exceeded 1% drift. The reused specimen showed stable cyclic behavior up to 5.5% drift, which corresponded to the stroke capacity of the testing equipment. These observations indicate that the demountable column-to-foundation connection allowed reuse of both the column and foundation, provided that only the grout layer and external threaded rods were replaced after disassembly.

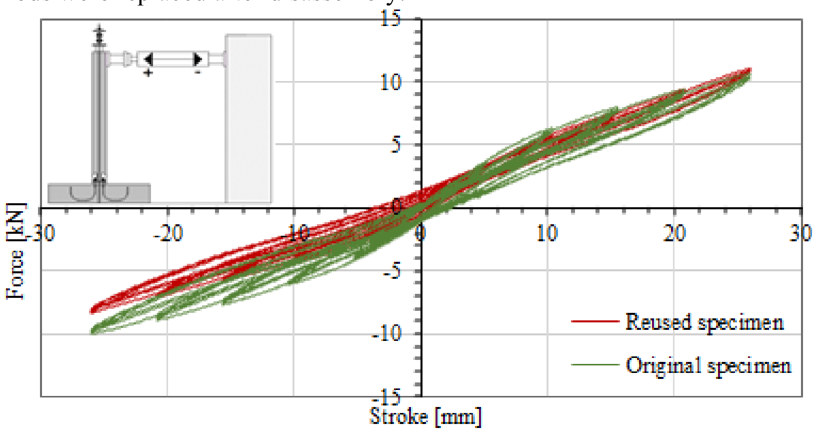


Figure 7: Hysteretic curves for 2 life cycles up to 1% drift

4. CONCLUSION

The reviewed studies indicate that demountable connections can provide adequate structural performance, yet clear and widely accepted criteria for element reuse are still lacking. A precast RC element can be considered suitable for reuse only when systematic research and assessment methods are available to explain and predict its behaviour after the first life cycle, including developed methodologies for design, monitoring, pre-demolition audits, demolition strategies and selection criteria. Formulating practical recommendations for reuse will require new verification methodologies for reuse validation, like non-destructive testing methods developed to consider all relevant loads and actions, such as earthquakes, durability and fire exposure.

- Although current standards and guidelines provide useful general principles for the design for deconstruction of precast RC elements, a complete standardized methodology for their structural reuse has not yet been established. In particular, existing design standards do not provide clear rules for the design of reusable precast RC structures, nor do they define explicit criteria for determining whether a previously used structural element is suitable for reuse.

- The literature review showed that the reuse potential of precast RC elements strongly depends on the detailing of demountable connections and on the control of damage during loading. Therefore, when designing reusable precast systems, damage should be intentionally concentrated in predefined regions, such as replaceable steel components, sacrificial connection parts, or structural elements that can be easily demounted and replaced after severe loading. The main reusable elements should remain largely undamaged, while the parts expected to experience inelastic deformation should be accessible and replaceable.

- The experimental case study confirmed that a relatively simple demountable column-to-foundation connection can enable the reuse of both the precast column and the foundation. After the first life cycle, only the grout layer and external threaded rods were replaced, while the column, foundation, HPKM column shoes and COPRA anchoring couplers were reused. The similar behaviour observed in the first and second life cycles indicates that, with appropriate connection detailing, reusable precast RC column-to-foundation systems can achieve satisfactory structural performance.

ACKNOWLEDGEMENTS

The authors would like to express their gratitude to the CircBoost – Boosting Circular Economy in Construction Industry, funded by the European Union under the Horizon Europe research and innovation programme (Grant Agreement No. 101082068), Ministry for Education, Science, and Technology, Republic of Serbia (Grant number 200092), and Peikko Slovakia, especially Zsolt Kokrehel, for their support in this research.

REFERENCES

[1] Selvaraj S., Chan T. Recommendations for implementing circular economy in construction: direct reuse of steel structures, Journal of Constructional Steel Research, 214, 2024, 108439.

[2] Jeyabalan A. K. R., Selvaraj S. K., Chan T. M., Pan W. Novel directly reusable column base connection: experimental investigations on the effects of baseplate and connector thickness, Thin-Walled Structures, 224, 2026, 114666.

[3] Schmidt B., Joachim L., Oettel V. Circular construction system with reused RC components – compressive load-bearing capacity of subtractively processed dry joints, Journal of Building Engineering, 117, 2026, 114681.

[4] Vidović M., Milićević I., Carević J. Demountable connections for structural concrete reusability – State of the art and future directions for reinforced concrete, Part II: precast frames, Building Materials and Structures, 69, 2026, 2600016V.

[5] Carević J., Milićević I., Vidović M. Demountable connections for structural concrete reusability – State of the art and future directions for reinforced concrete, Part I: slabs, Building Materials and Structures, 69, 2026, 2600017C.

[6] Lahdensivu J., Huuhka S. Betonielementtien uudelleenkäyttömahdollisuudet, Tampere University of Technology, Tampere, 2015.

[7] International Organization for Standardization. ISO 20887: Sustainability in buildings and civil engineering works – Design for disassembly and adaptability, ISO, Geneva, 2020.

[8] Yrjölä J., Wanjala P. Dismount and reuse of precast concrete frame, Peikko Group Corporation, Lahti, 2022.

[9] ReCreate. Reusing precast concrete for a circular economy, available at: https://recreate-project.eu/, accessed 25 June 2026.

[10] Räsänen, A., Lindman, N., Matthews, B. & Lahdensivu, J. Quality management best practices in reuse of precast concrete elements, The ReCreate project, 2025.

[11] Räsänen, A., Lahdensivu, J., Gudmundsson, K., Dervishaj, A., Westerlind, H., Lambrechts, T., Vullings, M., Arnold, V. & Huuhka, S. Properties and quality of precast concrete elements deconstructed in ReCreate's pilots, The ReCreate project, 2024.

[12] Li W., Chen W., Jiang H., Su H. Flexural behavior of concrete beam and slab with novel demountable connectors, Buildings, 15 (15), 2025, 2776.

[13] Li W., Chen W., Lin X., Chen L., Lv H., Shao K. Cyclic behavior and damage mechanisms of a demountable RC joint: integrated experimental and analytical study, Structures, 79, 2025, 109609.

[14] Li W., Chen W., Lin X., Chen L., Jiang H., Su H. Experimental and numerical study on behavior of demountable shear connectors in sustainable reinforced concrete beam–slab systems, Construction and Building Materials, 445, 2024, 137918.

[15] Li W., Fan H., He S., Lin X., Chen L., Lv H. Experimental studies on fully demountable P-DBSC shear connectors in sustainable reinforced concrete beam–slab systems, Structures, 68, 2024, 107134.

[16] Aninthaneni P. K., Dhakal R. P., Marshall J. Nonlinear cyclic behaviour of precast concrete frame sub-assemblies with dry end-plate connections, Structures, 14, 2018, 124–136.

[17] Aninthaneni P. K., Dhakal R. P., Marshall J., Bothara J. Seismic performance of a sub-assembly of a demountable precast concrete frame building, Proceedings of the Tenth Pacific Conference on Earthquake Engineering: Building an Earthquake-Resilient Pacific, Sydney, Australia, 2015, 189–198.

[18] Xiao J., Ding T., Zhang Q. Structural behavior of a new moment-resisting DfD concrete connection, Engineering Structures, 132, 2017, 1–13.

[19] Xiao J., Chen Z., Ding T., Xia B. Effect of recycled aggregate concrete on the seismic behavior of DfD beam–column joints under cyclic loading, Advances in Structural Engineering, 24 (8), 2021, 1695–1709.

[20] Ding T., Xiao J., Chen E., Khan A. R. Experimental study of the seismic performance of concrete beam–column frame joints with DfD connections, Journal of Structural Engineering, 146 (4), 2020, 04020036.

[21] Wang H., Marino E. M., Pan P., Nie X. Experimental study of a novel precast prestressed reinforced concrete beam-to-column joint, Engineering Structures, 156, 2018, 68–81.

[22] Cai X., Pan Z., Zhu Y., Gong N., Wang Y. Experimental and numerical investigations of self-centering post-tensioned precast beam-to-column connections with steel top and seat angles, Engineering Structures, 226, 2021, 111397.

[23] Y. T. Lu, Z. X. Guo, Y. Liu, and S. H. Basha, "Performance of prefabricated RC column with replaceable Column-Base connection under cyclic lateral loads," Eng. Struct., vol. 240, no. April, p. 112343, 2021, doi: 10.1016/j.engstruct.2021.112343.

[24] Peikko Group, COPRA Anchoring Coupler - Technical manual, available at: www.peikko.com, accessed 25 June 2026.

[25] European Committee for Standardization. EN 1998-1: Eurocode 8 – Design of structures for earthquake resistance – Part 1: General rules, seismic actions and rules for buildings, CEN, Brussels, 2004.