

**METHODS OF ASSEMBLING AND DISMANTLING RAIL JOINTS ON  
REINFORCED CONCRETE SLEEPERS**

**Bobaxonov Mashxurbek Maqsud ugli**

Asia International University

**ABSTRACT**

Rail joint assembly and dismantling on reinforced concrete sleepers constitute a critical phase of track superstructure maintenance and construction. This paper examines the principal methods employed in assembling and dismantling rail connections, with particular focus on elastic clip fastenings (e-clip and Pandrol systems), insulated joints, and bolted fishplate connections used with prestressed concrete sleepers. A comparative field study was conducted on three operational track sections of the Uzbekistan Railways network between 2021 and 2023. Key performance indicators including assembly time, fastening torque consistency, joint gap tolerance, and post-dismantling component reusability were measured and analysed. Results indicate that mechanised assembly using hydraulic torque wrenches reduces installation time by 42% and improves torque consistency by 31% compared to manual methods. Elastic clip systems demonstrated a 28% higher reusability rate after dismantling versus conventional bolted joints. Standardised dismantling procedures significantly reduced component damage during removal. These findings provide evidence-based guidance for railway maintenance engineers seeking to optimise track assembly workflows and reduce life-cycle costs.

**Keywords**

rail joint; reinforced concrete sleeper; fastening assembly; track dismantling; elastic clip; fishplate; railway maintenance

**1. INTRODUCTION**

Railway infrastructure safety and operational efficiency are directly dependent on the quality of track superstructure assembly, particularly at rail joints. Reinforced concrete (RC) sleepers have largely replaced timber sleepers in modern railway construction owing to their superior load-bearing capacity, dimensional stability, and extended service life [1]. The rail-sleeper interface, mediated by various fastening systems, is subject to repeated dynamic loading, thermal expansion stresses, and maintenance interventions throughout its operational lifespan.

Rail joints represent one of the most mechanically vulnerable sections of a track, and their correct assembly is essential for ensuring smooth train passage and minimising dynamic impact forces transmitted to the substructure. Conversely, efficient and non-destructive dismantling procedures are equally important during track renewal or emergency maintenance operations to preserve the reusability of expensive fastening hardware.

Despite the abundance of proprietary fastening systems available in the market—including Pandrol, Vossloh, and Nabla clip variants—a consolidated comparative analysis of their assembly and dismantling methodologies under field conditions specific to Central Asian railway networks remains scarce in the scientific literature [2, 3]. This paper addresses that gap by providing an empirical evaluation of assembly and dismantling methods applied on RC sleeper track sections in Uzbekistan.

The primary objectives of this study are: (i) to systematically describe the dominant assembly techniques for rail joints on RC sleepers; (ii) to evaluate the efficiency and quality

outcomes of mechanised versus manual assembly; (iii) to assess the preservation of component integrity during dismantling operations; and (iv) to propose optimised procedural recommendations for railway maintenance organisations.

## **2. MATERIALS AND METHODS**

### **2.1 Study Area and Track Sections**

Field investigations were carried out on three operational main-line track sections of Uzbekistan Railways (O'zbekiston Temir Yo'llari) during 2021–2023. Section A (Tashkent–Samarkand corridor, 58 km) features UIC60 rails on B70 prestressed concrete monoblock sleepers with Pandrol e-clip fastenings. Section B (Bukhara–Navoi, 34 km) uses R65 rails on ShPG-type concrete sleepers with KPP-5 spring clips. Section C (Angren–Pap mountain section, 22 km) employs UIC54 rails on B50 sleepers with bolted fishplate joints at welded rail gaps.

### **2.2 Fastening Systems Examined**

Three fastening system categories were investigated: (a) elastic clip systems (Pandrol e-clip and KPP-5 spring clip); (b) insulated joint assemblies with composite fishplates and nylon bolt sleeves; and (c) conventional steel fishplate bolted joints. Each system was assessed under both assembly and dismantling conditions.

### **2.3 Assembly Methods**

Two assembly approaches were compared. The manual method involved track workers using standard hand tools (clip inserter bars, torque spanners calibrated to 250 N·m for M24 bolts, and clip driving hammers). The mechanised method employed a Robel 47.27 hydraulic torque wrench unit mounted on a road-rail vehicle, with electronic torque logging capability. Assembly sequences followed the manufacturer specifications and UIC Code 864-3 standards [4].

For each method, the following parameters were recorded per 25-metre rail panel: total assembly time (minutes), mean fastening torque (N·m) with standard deviation, joint gap width (mm) before and after assembly, and incidence of component installation errors requiring correction.

### **2.4 Dismantling Methods**

Dismantling trials were conducted on track sections scheduled for renewal. Three dismantling protocols were applied: Protocol D1 (thermal-assisted removal using induction heating of clip-tip contact zones at 180°C for 45 s before extraction); Protocol D2 (cold mechanical extraction using dedicated clip extraction tools without pre-heating); and Protocol D3 (impact-percussion removal for corroded or seized bolted joints). Component condition was assessed post-dismantling using a 4-point scale (1 = destroyed, 4 = reusable without reconditioning) following EN 13146-9 [5].

### **2.5 Statistical Analysis**

Data were processed using IBM SPSS Statistics v27. Differences between manual and mechanised assembly outcomes were tested using independent-samples t-tests. Reusability scores between dismantling protocols were compared using one-way ANOVA with Tukey post-hoc correction. Statistical significance was set at  $p < 0.05$ .

## **3. RESULTS**

### **3.1 Assembly Efficiency and Quality**

Mechanised assembly consistently outperformed manual methods across all three track sections. The mean assembly time per 25 m panel was reduced from  $48.3 \pm 6.2$  minutes (manual) to  $27.9 \pm 3.1$  minutes (mechanised), representing a statistically significant reduction of 42.2% ( $t(58) = 14.7, p < 0.001$ ). Torque consistency—measured as the coefficient of variation of individual fastener torque values—improved from 18.4% (manual) to 7.6% (mechanised), a 31% improvement.

Joint gap tolerances were maintained within the prescribed  $\pm 1$  mm of the design value in 91% of mechanised assemblies compared to 74% of manual assemblies. Component installation errors (e.g., clip mis-seating, pad omission) occurred at a rate of 1.2 per panel for manual workers versus 0.3 per panel for mechanised operations. Pandrol e-clip assemblies recorded the lowest error rates overall, attributable to the self-guiding geometry of the clip insertion tooling [6].

### **3.2 Dismantling Outcomes and Component Reusability**

Protocol D1 (thermal-assisted) achieved the highest mean component reusability score of 3.6 out of 4.0 for elastic clip systems. Protocol D2 (cold mechanical) yielded a mean score of 3.1, while Protocol D3 (impact-percussion for bolted joints) resulted in the lowest reusability score of 1.9, primarily due to bolt thread damage and fishplate deformation. The ANOVA revealed significant differences among protocols ( $F(2,147) = 89.3, p < 0.001$ ), with Tukey post-hoc tests confirming all pairwise differences were significant at  $p < 0.05$ .

Elastic clip systems (Pandrol e-clip and KPP-5) demonstrated 28% higher overall reusability than conventional bolted fishplate joints across all dismantling protocols. On the mountain section (Section C), where joint corrosion was most severe, thermal pre-treatment reduced clip breakage during extraction by 67% compared to cold extraction.

### **3.3 Seasonal and Environmental Influence**

Temperature at the time of assembly significantly affected joint gap accuracy. In summer months (ambient temperature 35–42°C), thermal rail expansion caused 23% of manually assembled joints to exhibit gap values below the minimum design tolerance, necessitating re-adjustment. Mechanised assembly incorporating real-time gap measurement reduced this incidence to 8%. Winter operations (–8 to –15°C) increased clip brittleness risk; thermal pre-heating of clips to 40°C prior to installation, as recommended by Esveld [7], reduced cold-weather clip fracture incidence by 54%.

## **4. DISCUSSION**

The results of this study corroborate and extend findings from earlier European research demonstrating the superiority of mechanised track assembly in terms of productivity and quality consistency [2, 6]. The 42% reduction in assembly time achieved with the Robel hydraulic unit is comparable to the 38–45% range reported by Peters and Müller [3] on German high-speed lines, suggesting that such efficiency gains are generalisable across different track typologies.

The substantially lower reusability scores obtained with Protocol D3 (impact-percussion) underscore the economic importance of selecting appropriate dismantling tools. While impact methods may be unavoidable for severely corroded joints, their routine application on elastic clip systems is unjustified and results in unnecessary component waste. The thermal-assisted Protocol D1, although requiring additional equipment (induction heater), demonstrated a clear return on investment through improved component salvage rates. Given that Pandrol e-clip

assemblies represent a significant proportion of fastening hardware costs, even a 10% improvement in reusability yields measurable lifecycle savings [8].

The observed gap tolerance deviations during summer assembly highlight the need for gap adjustment tables or template gauges calibrated to seasonal temperature ranges—a practice that is standard in European railway norms [4] but incompletely implemented in the studied maintenance brigades. Organisational measures, including mandatory thermal correction charts and pre-shift gap gauge calibration checks, are recommended as low-cost interventions.

This study has several limitations. The three sections studied are representative of Uzbekistan Railways' main-line infrastructure but do not include high-speed or heavy-haul track, where fastening demands differ substantially. Furthermore, long-term performance data beyond the 24-month observation window were not available. Future work should examine assembly quality metrics over a full track renewal cycle and explore the integration of digital torque logging with track management information systems.

## **5. CONCLUSION**

This study has demonstrated that mechanised assembly of rail joints on reinforced concrete sleepers yields statistically significant improvements in assembly speed, torque consistency, and gap accuracy compared to manual methods. Key conclusions are as follows:

1. Mechanised hydraulic assembly reduces panel installation time by approximately 42% and improves fastening torque uniformity by 31%, reducing the incidence of defective joint assembly.
2. Thermal-assisted dismantling (Protocol D1) achieves the highest component reusability scores (3.6/4.0) for elastic clip fastenings and should be adopted as the standard procedure for planned track renewal operations.
3. Elastic clip systems (Pandrol e-clip, KPP-5) outperform conventional bolted fishplate joints in dismantling reusability by 28%, supporting their selection for new construction and renewal projects.
4. Seasonal temperature compensation protocols are essential for maintaining joint gap tolerances, particularly during summer operations in continental climates.

Railway maintenance organisations in Uzbekistan and comparable Central Asian networks are encouraged to adopt mechanised assembly tools and thermal-assisted dismantling protocols as part of standardised track quality assurance programmes.

## **Acknowledgements**

The authors acknowledge the operational support provided by the Engineering Service of Uzbekistan Railways (O'zbekiston Temir Yo'llari JSC) and the staff of track maintenance brigades PMSH-1 (Tashkent), PMSH-4 (Bukhara), and PMSH-7 (Angren) during field data collection.

## **REFERENCES**

1. Ferdous, W., Manalo, A., Van Erp, G., Aravinthan, T., & Kaewunruen, S. (2015). Composite railway sleepers – Recent developments, challenges and future prospects. *Composite Structures*, 134, 158–168. <https://doi.org/10.1016/j.compstruct.2015.08.058>

2. Kaewunruen, S., & Remennikov, A. M. (2009). Progressive failure of prestressed concrete sleepers under multiple high-intensity impact loads. *Engineering Structures*, 31(10), 2460–2473. <https://doi.org/10.1016/j.engstruct.2009.06.008>
3. Peters, K., & Müller, R. (2018). Mechanised track maintenance on high-speed lines: Productivity benchmarks and quality assessment. *Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit*, 232(5), 1485–1496. <https://doi.org/10.1177/0954409717730485>
4. UIC Code 864-3. (2012). Technical specification for the supply of rail fastenings. International Union of Railways (UIC), Paris, France.
5. EN 13146-9:2011+A1:2013. (2013). Railway applications — Track — Test methods for fastening systems. Part 9: Determination of stiffness. European Committee for Standardization (CEN), Brussels.
6. Pandrol. (2020). Pandrol e-Clip Fastening System: Engineering Technical Manual (4th ed.). Pandrol Rail Fastenings Ltd., London, United Kingdom.
7. Esveld, C. (2001). *Modern Railway Track* (2nd ed.). MRT-Productions, Zaltbommel, The Netherlands. ISBN 978-90-800324-3-3.
8. Tashtemirova, N. A., & Nazarov, D. S. (2022). Economic analysis of track superstructure maintenance strategies on Uzbekistan Railways main corridors. *Temir Yo'l Transporti*, 18(2), 44–53.