

Influence of Air Gaps in Fastening System at KTMB Electrified Double Track in Kluang

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Abstract

The fastening system in trackwork construction plays a critical role in ensuring the stability, safety, and longevity of railway tracks. It secures the rails to the sleepers or ties using clips, bolts, or specialized fasteners, maintaining proper gauge and alignment essential for smooth train operations and preventing derailments. By absorbing and distributing dynamic loads from passing trains, the fastening system helps stabilize the track structure and reduces vibrations and noise. However, the fastening system at the KTMB Kluang site has revealed air gaps, posing concerns for long-term track quality. This study aims to assess the impact of these gaps on quality, analyze potential causative factors' frequency, and evaluate the effectiveness of quality risk assessment based on air gap occurrences. Methodologically, it involves meticulous 100-meter track inspections to conduct air gap monitoring towards the fastening, acquiring fastening component details from YTL's server pending permission, and incorporating testing reports. Studies found that the presence of air gaps in a tension clamp fastening system can be influenced by workmanship, the quality of materials, also thermal expansion and contraction. The obtained result leads to the conclusion that air gaps stem from poor workmanship and subpar material quality, with misalignment during installation and weak materials contributing. This study will be expected to contribute to the railway industry, particularly in trackwork construction and fastening installation, potentially enhancing the comfort and safety of train operations.

1. Introduction

YTL Construction in consortium with SIPP Rail Sdn. Bhd. are undertaking the construction of the 192 km electrified double track project from Gemas to Johor Bahru. The electrified double-track project (EDTP) Gemas-Johor Bahru route ran through Segamat, Kluang, Kulai, and Kempas Baru, which are the four primary districts in the area. [1] A system of highways and railroads connects Kluang to neighboring cities. Kluang had a momentous year in 1915. The central area of Johor built its administrative center there. Additionally, Kluang railway connections with other important cities were established in the same year [2]. The integrity of railway fastening systems is paramount for ensuring safety and stability, yet the discovery of air gaps at the KTMB Kluang site has raised concerns regarding potential risks. These gaps pose a multifaceted threat, including compromising track alignment, thereby heightening the risk of derailment, exacerbating noise pollution through increased rail

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movement, and necessitating heightened maintenance efforts. To mitigate these risks, a comprehensive study is proposed to delve into the factors underlying the occurrence of air gaps within the Electrified Double Track Project (EDTP) spanning from Gemas to Johor Bahru. Objectives encompass identifying the ramifications of air gap presence, quantifying the frequency of contributing factors, and evaluating the adequacy of current risk assessment methodologies. The research focal point is Section 3 at Kluang, where a meticulous analysis of a 100-meter stretch of railway track, including sleepers, will be conducted, with material specifics sourced from the YTL server. However, it is pertinent to acknowledge certain limitations of the study, such as its narrow scope confined to railway fastening systems, examination solely within Section 3 from Paloh to Renggam, and reliance on two key documents, namely the Statement of Needs (SON) and the Permanent Way Manual (PWM) 2015 (Rev. 1/2019), for compliance.

In the context of the track system, the functions of track fastening mechanisms are multifaceted, including firmly anchoring rails to sleepers or bearers, maintaining rail gauge, distributing wheel loads to rails, sleepers, and the track substructure, resisting lateral and vertical forces induced by rail movement, and mitigating vibrations. However, the installation of Vossloh fasteners, utilized in the EDTP project, has revealed the presence of air gaps, which pose several notable disadvantages. Air gaps jeopardize the overall stability of the track system, potentially amplifying lateral movement and compromising structural integrity. Moreover, their presence accelerates wear and tear on track components, exacerbated by continuous movement and vibrations, leading to expedited deterioration of fastening elements such as bolts and clips. Illustrated in Figure 1 is a depiction of air gap occurrences within the fastening system at Section 3, Paloh – Renggam, providing visual context to the identified challenges and emphasizing the imperative for remedial action.

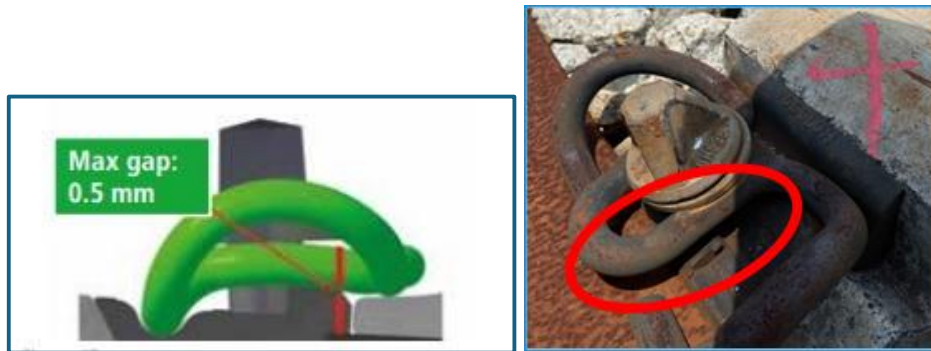


Figure 1 Air gaps in fastening system at Section 3, Paloh – Renggam

2. Selection of Vossloh Fastening System

Vossloh rail fastening systems are designed to stand up to the most demanding track conditions in the world, from extreme climates and geographic landscapes to highly trafficked lines that constantly withstand heavy carloads (over 75 MGTs annually). Vossloh rail fastening solutions are widely recognized and appreciated for its comparatively long service life and minimal lifecycle costs. There are a few efficiencies and cost saving attributes which minimize the total cost of ownership. The development and integration of advanced materials, such as composite plastics components replacing steel components (utilized in competitive systems); have significantly reduced the overall weight, thereby reducing shipping cost to the customer's job site.

During installation, Vossloh rail fastening systems can be preassembled in the factory with all the prefabricated elements pieced together and the tension clamps in the pre-installation position (resting on grooves on the guide plate). At the construction site, the tension clamps are simply pushed into the correct position and tightened. No fastening elements need be removed for rail welding [3][4].



Figure 2.1: Vossloh Fastening System W 14 HH with tension clamp Skl 14 R [1]

System W 14 consists of the following components (per sleeper):

Pos.	Quantity	Components
1	4x	Plastic dowel Sdü 25
2	2x	Elastic rail pad Zw 687a
3	4x	Plastic angled guide plate Wp 14K ^{1,2}
4	4x	Tension clamp Skl 14 R
5	4x	Sleeper screw Ss 35 with washer Uls7

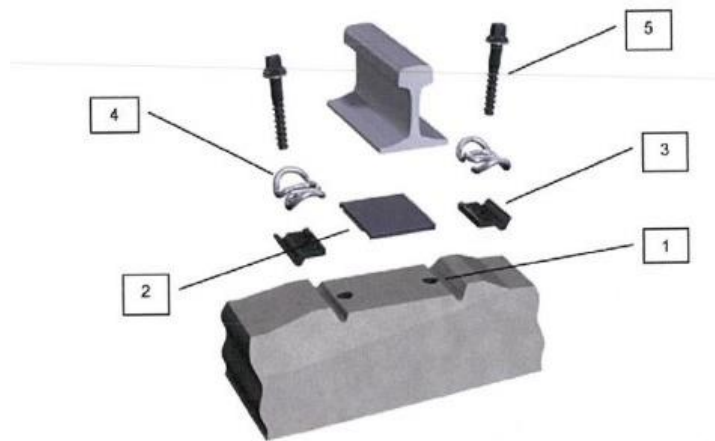


Figure 2.2: The details of concrete sleeper with the Vossloh fastening assembly. [1]

2.1 Air Gaps presence in EDTP Gemas to Johor Bahru

The term "air gap" in the context of a fastening system for railway tracks refers to the space or distance between tension clamp and angled guide plate that are out of allowed tolerance. The fastening system in a railway track is crucial for holding the rails in place and ensuring stability and safety during train operations. Air gaps are designed to provide certain allowances for movement, expansion, contraction, and other dynamic forces that the railway track may experience. Rail fastening systems are pivotal components in the rail infrastructure as they clamp the rail to the sleepers, preventing the transverse and longitudinal deviations of rails from the sleeper. They also aid in maintaining the gauge and preserving the designed track geometry. Failures of fasteners can cause an increase in wheel flange wear, reduce the safety of train operations, and may lead to catastrophic accidents [5].

During torque wrench inspections along the EDTP from Gemas to Johor Bahru, the maintenance team discovered that many screw fasteners had air gaps exceeding the tolerable limit of 0.5mm set by Vossloh, the supplier of the fastening system. To measure these gaps, the team uses a taper gauge, a tool for measuring gap width, hole diameter, and other dimensions. To ensure each sleeper's air gap falls between 0.5mm and 1.5mm, the team meticulously checks and cleans each component - dowel, rubber pad, and tension clamp. Any fasteners exceeding the tolerable gap value are retightened using a torque wrench, set to a maximum of 300Nm. Regular

inspections prevent air gap issues, ensuring track stability and safety compliance with stringent railway standards, thus demonstrating a commitment to safety and regulatory requirements.

3. Methodology

3.1 Research Methodology

The information was gathered from a review of the literature. All the workflow of the research methodology are and will be based on the flowchart from Figure 3.1

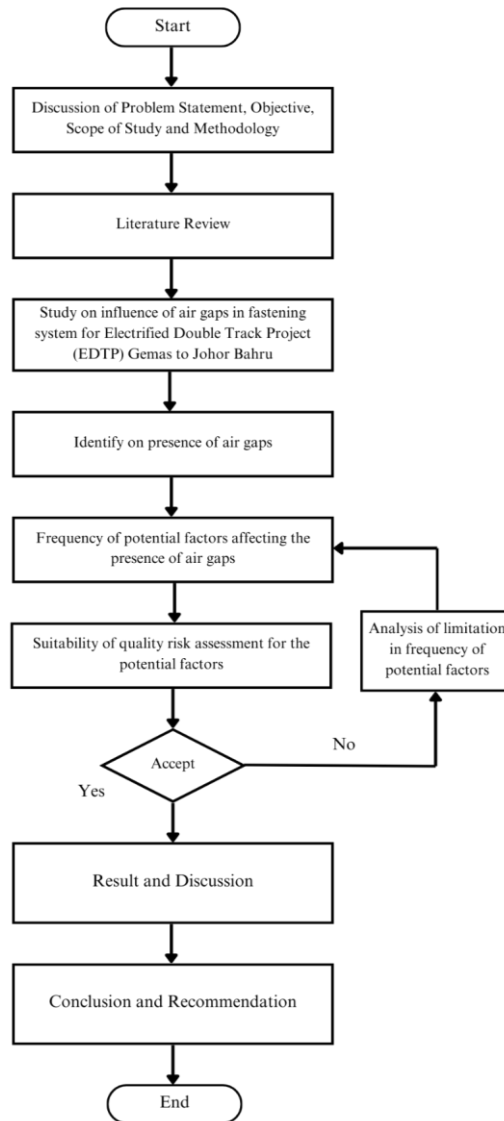


Figure 3.1: Flowchart Methodology of study

3.2 Identify the effect on Presence of Air Gaps

Regular inspection of railway tracks is crucial to identify and address safety issues promptly. The frequency and intensity of inspections may vary depending on factors such as track usage, environmental conditions, and regulatory requirements.

A physical examination of the track and fastening components to identify visible signs of wear, damage, or misalignment. The purpose of torque wrench inspection is to detect any obvious issues, such as loose or missing fasteners, damaged clips, or irregularities in the track structure. Checking and adjusting the torque of fasteners,

such as bolts and nuts, to ensure proper tightness. It also prevents the loosening of fasteners, which could lead to instability and the development of air gaps.

3.3 The Frequency of Potential Factors Affecting the Presence of Air Gaps

The lack of workmanship skill and practices can significantly impact the presence of air gaps, especially in contexts where precision and attention to detail are crucial, such as construction, manufacturing, and various engineering applications. Workmanship refers to the skill, care, and quality of work that goes into the production or construction of something. When there is a deficiency in workmanship, it can lead to various issues, and one of them is the creation or worsening of air gaps.

The quality of materials used in a fastening system for railway tracks can significantly impact the presence of air gaps. Air gaps in the fastening system can lead to various issues such as increased track instability, vibrations, noise, and ultimately compromise the safety and efficiency of the railway network. Vossloh Fastening System W14 used for highly elastic rail fastening for high speed and conventional rail, the established solution for ballasted track with concrete sleeper.

Changes in temperature can cause track components, especially metal rails, to expand or contract. If the track design does not account for thermal variations, it may lead to the creation of gaps. Expansion joints and proper rail fixation help manage thermal effects and reduce the likelihood of air gap formation. This thermal expansion and contraction can lead to changes in the dimensions of the fastening components.

3.4 Suitability of Quality Risk Assessment

The purpose of the mockup is to show poor-quality work that has been rectified by the maintenance team. Installation of air gaps must follow the method statement that has been standardized. Among the things that will be considered in the installation of fastening is proper placement and workmanship skill of fastening installation. Data collection will be taken from this method and will be analyzed to prove the factors of the presence of air gaps. By implementing mockup procedure, the fastening system can be ensured to follow the standard specification and regulations.

4. Result and Findings

4.1 Data Collection for Air Gaps Monitoring

Based on Figure 4, It can be observed that the workmanship handling at site has contributed to the most potential factors affecting the presence of airgaps. When fastening systems are not installed correctly, they may not be able to secure the components tightly enough. This can lead to gaps between the components, allowing air to seep in. For example, if bolts are not tightened sufficiently, or if components are not aligned properly during installation, gaps can occur. Workmanship handling requires attention to detail to ensure all components are properly aligned and secure. If workers lack this attention to detail, they may overlook small gaps or fail to notice when components are not fitted together properly. Due to workers may not have received sufficient training on how to properly install fastening systems, they may not be aware of the correct techniques or best practices. This can lead to errors during installation that result in air gaps.

Factors Affecting Presence of Air Gaps							
Workmanship (Due to Asiakom Sub-Contractor)				Quality of Material (Due to Vossloh Fastener Supplier)			
RHS (inner & outer)		LHS (inner & outer)		RHS (inner & outer)		LHS (inner & outer)	
Qty	%	Qty	%	Qty	%	Qty	%
1812	54	1188	36	328	9.8	216	6.5

Figure 4: Data Collection for Air Gaps Monitoring

Based on the recorded data from data in Figure 5 , it is noted that the selected factors affecting presence of airgaps in fastening system used in the project are workmanship due to Asiakom Sub-Contractor with 54% for Right Hand Side (RHS) rail, 36% for Left Hand Side (LHS) rail while quality of material due to Vossloh Fastener Supplier with 9.8% for (RHS) and 6.5% for (LHS) obtained from the collection data during inspection along 500 m of track in total of 833 number of sleepers.

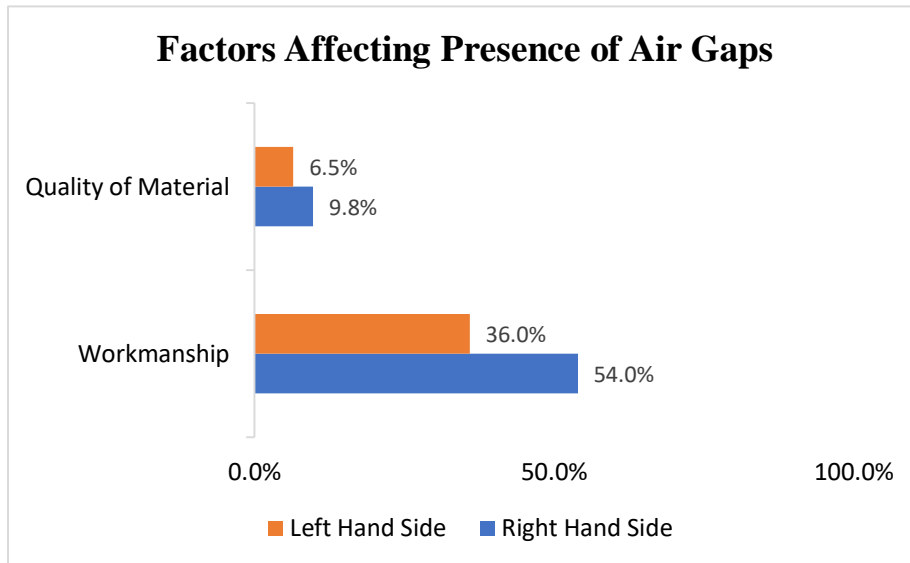


Figure 5: Factors Affecting Presence of Air Gaps

5. Conclusion

This research has successfully achieved its objectives throughout the study. The first objective, identifying the effects of presence of air gaps in fastening system, has been accomplished. Identifying these effects enables us to proactively address to overcome the issue and minimize it. The second objective, assessing the frequency of potential factors affecting the presence of air gaps, has also been achieved. The main factor affecting air gaps comes from the lack of workmanship handling during installation of fastening system. If the fastening system components are not aligned correctly during installation, it can lead to gaps between the components. These gaps can have disadvantageous effects on the performance and safety of the railway system, including increased vibration, noise, and potential damage to the track infrastructure. Therefore, ensuring proper workmanship handling skills during installation is crucial for maintaining the integrity of the fastening system and preventing the presence of air gaps.

There are a few recommendations to further enhance the significance of this research in the future. This can include conducting briefing on correct way for installation of fastening during pre-assembly and final assembly and focus on maintenance guidelines which all inspection and maintenance work must be performed in accordance with all applicable laws, guidelines and regulations informed about project progress.

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Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Author N.F.A.N, Author R.G; **data collection:** Author N.F.A.N, Author R.G ; Author S.Z.M.J; **analysis and interpretation of results:** : Author N.F.A.N, Author R.G ; Author S.Z.M.J **draft manuscript preparation:** : Author N.F.A.N, Author R.G ; Author S.Z.M.J. All authors reviewed the results and approved the final version of the manuscript.

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