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Column Foundation Challenges: A J-Bolt Case Study at Historic Seremban Station

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Abstract

Seremban Railway Station is a significant historical landmark in Malaysia that is currently undergoing modernization. During the upgrading process, j-bolts exhibited insufficient exposed length for proper nut engagement and anchorage of the new steel column base plates. Hence, this study aims to evaluate the stress distribution and displacement characteristics of the j-bolt after implementation of additional threading work and to determine the effectiveness of the proposed additional threading modification based on stress distribution and overall structural integrity at Seremban Railway Station. A structural performance method performed by implementing Finite Element Analysis (FEA) on four different additional threaded length of j-bolt was carried out using SolidWorks simulation to evaluate the stress distribution and displacement behaviour of the modified configuration. The j-bolt model was developed and assigned with appropriate material properties, followed by the application of boundary condition representing the actual structural constrains and loading condition. A mesh sensitivity setup implemented to ensure result accuracy. Static structural analysis was then performed to obtain the Von Mises Stress distribution and displacement respond of the system. Based on the surveying data on site and material properties sample from the supplier, the input can be used to structure analyse the affected j-bolt. FEA of the modified j-bolt models showed that the maximum stress ranged from 3.857×10^9 $(N/m^2)$to 4.571×10^9 (N/m^2), while the maximum displacement ranged from 0.9144 mm to 0.9788 mm under the applied loading conditions. Model 5 achieved the longest additional threaded length of 126.2 mm with stress value of 4.571 GPa whereas Model 4 recorded the shortest threaded length of 122.22 mm. The maximum stress recorded in these optimized models remained above the material's yield strength of 2.039×10^8 Nm^2. This finding suggest that the threaded modification did not maintain sufficient stiffness and load carrying capacity while preserving the overall strength j-bolt. In overall, additional threaded work on embedded j-bolt is proven to be structurally instable and not suitable for engineering applications.

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1. Introduction

This research is focus on the additional threaded work implemented on the affected j-bolt structural performance and to see if the proposed rectification can be use as corrective solution at Seremban Station Upgrading Project. This research provides crucial insight in the structured understanding on how j-bolt threaded modification can affect the stability and safety of the steel lattice column connection at Seremban Station. By evaluating the performance of the additional threading installation, the research offered practical engineering guidance for selecting method that are not compromise structural integrity. Hence, the outcome contributed to safer construction practices for addressing similar site issues in future infrastructure project. During construction progress at Seremban Station, a structural issue was discovered with embedded j-bolt casted in concrete stump as shown in at gridline C, D, and E. These affected j-bolts, which are used in primary anchor of the steel structure column base plates, were discovered to be insufficient exposed length for proper nut engagement and anchorage. Furthermore, the j-bolt has been implanted in the concrete stumps making it harder to rectify the length of the j-bolt.

Fig 1 shows that the threaded portion of the existing J-bolt at the site is too short, preventing the nut from being further tightened to achieve the required thread engagement for the lattice column. This limitation will increase the like hood of poor stability under applied load and structural failure (Pedersen, 2013, 2024). Furthermore, this issue can affect the connection between all trusses of the structure during the installation of the steel members

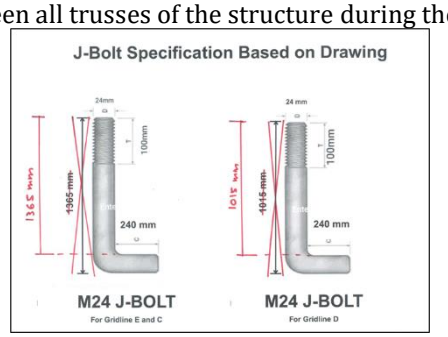


Fig. 1 *J-bolt specification based on drawing for Seremban station*

Based on the identified problem of insufficient exposed j-bolt length at Seremban Railway Station and proposed additional threading modification, this study seeks to answer the stress distribution and displacement characteristics of the j-bolt after the implementation of additional threading work and the effectiveness of the modification in maintaining integrity and load carrying capacity under applied loading conditions. This study aims to evaluate the stress distribution and displacement characteristics of the J-bolt after the implementation of additional threading work at Seremban Railway Station. To determine the effectiveness of the proposed additional threading modification based on stress distribution and overall structural integrity.

2. Methodology

The method used to overcome the problem was quantitative analysis, using the SolidWorks as the structural analysis platform to evaluate the effects of additional threading work on j-bolt. The data is collected through surveying on site to identify the structure level of the subject.

2.1 Data Collection and Characterization

Surveying data were obtained from the as-built levels of the bottom nuts at Gridlines D and E, as measured by the surveyor on 22 November 2025. The data obtained contains 4 columns from gridlines D and E based on as-built level measurements from the on-site surveyor. The location of each column from 4 points, showing the reference level bottom nut, reference level top of the stump, highest reference level bottom nut, grouting thickness, and lastly, reference top of the j-bolt. This parameter is taken in order to find the balance height of the j-bolt top of the thread that is required to be added. In **Fig 2**, the design drawing of the J-bolt layout clearly illustrates the location and arrangement of the J-bolt and nut within the concrete stump.The drawing shows the dimension of non-shrink grout, as the design height is 25 mm. Inside the grout will be the levelling nut, which is important as it can be adjusted to achieve a certain level. On top of the grout would be the top plate of the lattice column, whereas the design reference level is 52.297 meters.

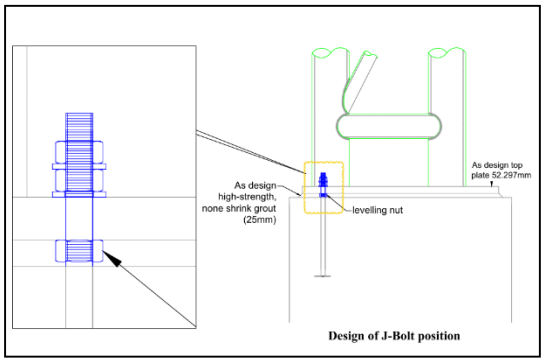


Fig. 2 *Design of j-bolt position as design*.

2.2 SolidWorks

SolidWorks uses parametric modelling, in which the geometry is defined by parameters and constraints, allowing changes to propagate automatically throughout the model. This significantly improves design efficiency and facilitates design modifications (Khameel B. Mustapha, 2022). This parametric approach allows to rapidly explore design alternatives and make iterative improvements withut redrawing models from scratch, which is particularly advantageous in complex engineering project requiring many design iterations (Suresh, 2021). Furthermore, SolidWorks support integrated structural and performance analysis tools that can simulate stress, displacement and load bearing behaviour to validate structural integrity and performance (Hussain et al., 2024).

In this research, the bolt material will be the same, only the thread additional length is different for each stump. Each stump will give different thread length value. From the SolidWorks we shall achieve the output of which j-bolt has best structural performance. SolidWorks will simulate differences from output of each stump. Since tensile and shear or yield stress are same, only thread length is different. The thread length for each stump data is important for the output. Hence, the output of this analysis able to show the average performance of all bolt of stump. This allows to conclude whether additional threading is adequate for all stumps or only some. SolidWorks will then generate output producing clear indicator if increasing threading gives higher capacity or whether capacity meets required load. This analysis can determine the minimum required thread length needed to achieve the target structural performance, which is essential for evaluating the effectiveness of the additional threading work.

2.3 Analysis Setup

The structural analysis was carried out using SolidWorks Simulation to evaluate the mechanical performance of the designated component similar to the existing j-bolt at site. Based on **Fig. 3,** the process began with the creation of a three-dimensional (3D) model using SolidWorks Part Design. After the model was completed, the material properties were assigned to represent the actual material behavior. A new static study was then created in SolidWorks Simulation to perform the structural analysis. Boundary conditions such as fixed supports were defined to simulate the real operating constraints of the component. External loads were subsequently applied to represent the forces acting on the structure. The model was then integrated into finite elements through the mesh generation process to enable numerical analysis. After the mesh was generated, the simulation was executed to solve the finite element model. Finally, post-processing was performed to obtain the results, including stress, strain, and displacement distributions, which were then evaluated and extracted for further analysis and discussion in this study.

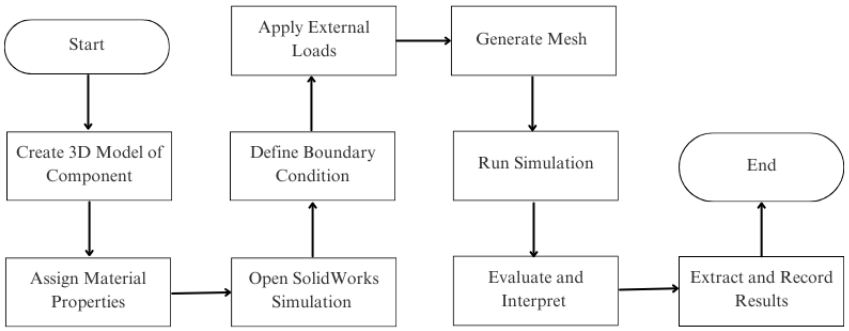


Fig. 3 *Structural Analysis Process Flow in SolidWorks*

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As shown in the **Table 1**, the geometry and dimensional details of the j-bolt for each sample were labelled as Model 2, Model 3, Model 4, and Model 5 used in the analysis. The dimensions shown in this table were derived from the survey data, where the surveyor measured the as-built level of the stump at each gridline location. These measurements were used to determine the remaining exposed length of the j-bolt thread on site. Based on the difference between the designed level and the measured stump level, the required balance of thread was calculated to identify the structural strength of j-bolt when additional threading work are done. As shown in **Table 1**, four sample models located at gridlines D and E were considered. The thread length for the models ranges from 122.20 mm, while the total bolt length varies between 866.80 mm and 1218.80 mm. All models have a constant bolt diameter of 240 mm. These dimensional values were subsequently used as input parameters for the structural modelling and analysis of the j-bolt to evaluate its performance under the specified conditions.

Table 1 *Geometry of j-bolt*

Name	Gridline	Dimension		
		Thread Length	Bolt Length	Diameter
Model 2	D	123.20	867.80	24
Model 3	D	124.20	866.80	24
Model 4	E	122.20	1218.80	24
Model 5	E	126.20	1214.80	24

2.3.1 Material Properties

Table 2 presents the material properties used for the j-bolt model in the structural analysis conducted in SolidWorks. The material selected for the analysis is galvanised steel, which is similar with the material used for the existing j-bolts installed at the Seremban station site. The selection of galvanised steel is appropriate as it provides good mechanical strength and corrosion resistance, which are important for the structural components exposed to outdoor environmental conditions. Based on the material data applied in the simulation, the galvanised steel has a yield strength of 2.03943 x 108 N/m^2 and a tensile strength of 3.56901 x 108 N/m^2, indicating its capability to withstand significant loading before yielding or failure occurs. In addition, the material has an elastic modulus of 2 x 1011 N/m^2, which represents the stiffness of the material and its ability to resist displacement under applied loads. The Poisson's ration of 0.29 describes the relationship between lateral and axial strain when the material is subjected to stress. Furthermore, the mass density of galvanised steel is 7,870 kg/m^3, which reflects the weight characteristic of the material used in the model. These material properties were assigned to all j-bolt models to ensure that the simulation results accurately represent the behaviour of the actual j-bolts installed at site.

Table 2 *Material properties of j-bolt model in SolidWorks*

Properties		Components
Name:	Galvanised Steel	
Yield Strength:	2.03943e+08 N/m^2	Model 2
Tensile Strength:	3.56901e+08 N/m^2	Model 3
Elastic Modulus:	2e+11 N/m^2	Model 4
Poisson's Ratio:	0.29	Model 5
Mass Density:	7,870 kg/m^3	

2.3.2 Boundary and Loading Condition

The structural analysis setup of the j-bolt model, including the applied boundary conditions and loading configuration as illustrates in **Fig. 4**. In this analysis, a fixed support was assigned from the end of the threaded portion to the bottom end of the bolt. This boundary condition was applied to represent the actual site condition, where the lower portion of the j-bolt is embedded and restrained within the concrete foundation. By fixing the region, the model stimulates the constraint provided by the surrounding concrete, preventing any displacement or rotation at the embedded section. Meanwhile, the external load was applied at the top of the threaded end of the j-bolt and directed upwards. This loading condition was used to simulate the tensile force acting on the bolt, which may occur during service conditions when the bolt is subjected to pulling forces from connected structural components. The applied boundary conditions and loading configuration enable the analysis to evaluate the stress and strain behaviour of the j-bolt under tensile loading.

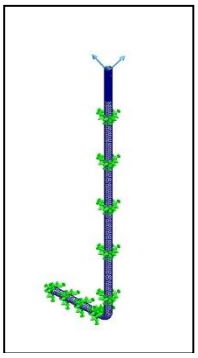


Fig. 4 *Fixation of support and loading condition of model j-bolt.*

2.3.3 Mesh Generation

Mesh generation is an important step in structural analysis because it divides the 3D model into a large number of smaller elements connected by nodes. This process allows the Finite Element Analysis (FEA) to approximate the behaviour of the structure under applied loads and boundary conditions. In this study, mesh generation was carried out using the solid mesh feature available in SolidWorks simulation. The purpose of the mesh generation is to convert the continuous geometry of the model into discrete elements so that numerical calculations can be performed to determine stress, strain, and displacement distributions within the structure. The mesh was generated using a blended curvature based meshing technique with high mesh quality settings. The element size used in the analysis was 8.18344 mm for both the maximum and minimum element sizes. The mesh size controls the level of detail in the simulation, where smaller elements generally provide more accurate results, especially in regions with complex geometry such as the threaded section of the j-bolt. However, smaller mesh sizes also increase the computational time required for the analysis.

Based on **Fig.5**, the generated mesh consists of 31,575 nodes and 18,019 elements. Nodes represent the connection points between elements represent the small subdivisions of the geometry used approximate the structural behaviour. A higher number of elements and nodes generally improves the accuracy of the simulation results because the model can capture more detailed stress distribution throughout the structure.

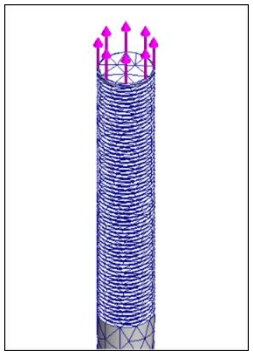


Fig. 5 *Mesh generation of the j-bolt model in SolidWorks.*

3. Result and Discussion

The result from SolidWork simulation using Finite Element Analysis (FEA) as shown in **Table 3** below to evaluate the maximum stress, displacement and strain for each different modified threaded length of j-bolt. Each model demonstrates a different result value due to the variation in height, which influences the structural behaviour and stress concentration of the component. Model 2 recorded the highest maximum stress value with threaded length is 123.20 mm, while model 3 with length of thread 124.20 mm, showed the lowest stress value among all model analysed. Model 5 produced the highest maximum strain value of $13.30 \times 10^{-3}\ \varepsilon$ indicate that the j-bolt expereienced the greatest displacement among all configurations under the applied loading condition. However, model 2 recorded the lowest maximum strain value of $10.38 \times 10^{-3}\ \varepsilon$, indicate the j-bolt pprovided better resistance to displacement compare to others. Apart from that model 3 and model 4 showed moderate strain values of $11.57 \times 10^{-3}\ \varepsilon$ and $10.46 \times 10^{-3}\ \varepsilon$.

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Table 3 *Maximum stress, displacement and strain result for different height configurations*

No	Name	Additional Threaded Length (mm)	Maximum Stress (N/m^2)	Maximum Displacement (mm)	Maximum Strain (ε)
1	Model 2	123.20	4.571×10^9	0.9203	10.38×10^{-3}
2	Model 3	124.20	3.857×10^9	0.9360	11.57×10^{-3}
3	Model 4	122.20	4.068×10^9	0.9788	10.46×10^{-3}
4	Model 5	126.20	4.473×10^9	0.9144	13.30×10^{-3}

Fig. 6 shows the Von Mises stress distribution for 4 models obtained from the structural analysis conducted using SolidWorks simulation. Based on the contour plot, the maximum stress occurs at the curved threaded region at the top of the j-bolt, which is the location where the external load is applied. The region experiences higher stress concentration due to the combination of bending and tensile forces acting on the curved geometry of the bolt. In contrast, the straight shaft portion of the bolt experiences significantly lower stress, as indicated by the blue contour distribution along the vertical section. However, the stress magnitude in Model 3 is significantly lower than in Model 2, 4.571×10^9 N/m² suggesting that the structural configuration of Model 3, 3.857×10^9N/m² distributes the applied load more effectively along the bolt.

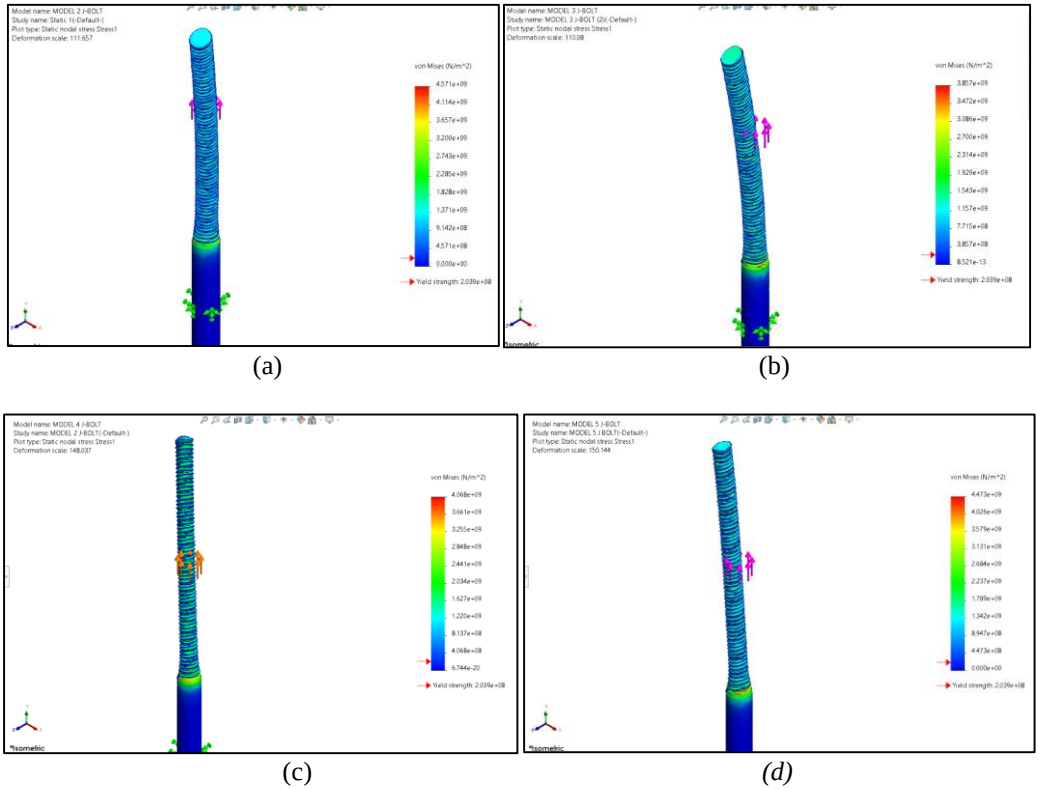


Fig. 6 *Von Mises stress distribution (a) Stress distribution on model 2 j-bolt. (b) Stress distribution on model 3 j-bolt.* (c) *Stress distribution on model 4 j-bolt. (d) Stress distribution on model 5 j-bolt.*

Structural displacement refers to the displacement or change in shape experienced by a structural component when subjected to an external load (F. Yang et al., 2021). In this analysis, displacement is used as indicator of the structural integrity and stiffness of the j-bolt system, where lower displacement values generally indicate better structural performance and higher resistance against displacement under loading conditions. **Fig. 7** shows Von Misses Stress distribution on four j-bolt models. The displacement results for all j-bolt models show a consistent cantilever-like behaviour, where displacement is minimum at the fixed embedded base (0 mm) and increases towards the free upper end. The maximum displacement occurs at the curved top region due to bending effects under tensile loading. Model 4 records the highest displacement at 0.9788 mm, indicating the lowest stiffness. Model 3 shows improved performance with 0.9360 mm, while Model 5 demonstrates the best structural

performance with the lowest displacement of 0.9144 mm. Model 2 records a slightly higher value of 0.9203 mm compared to Model 5.

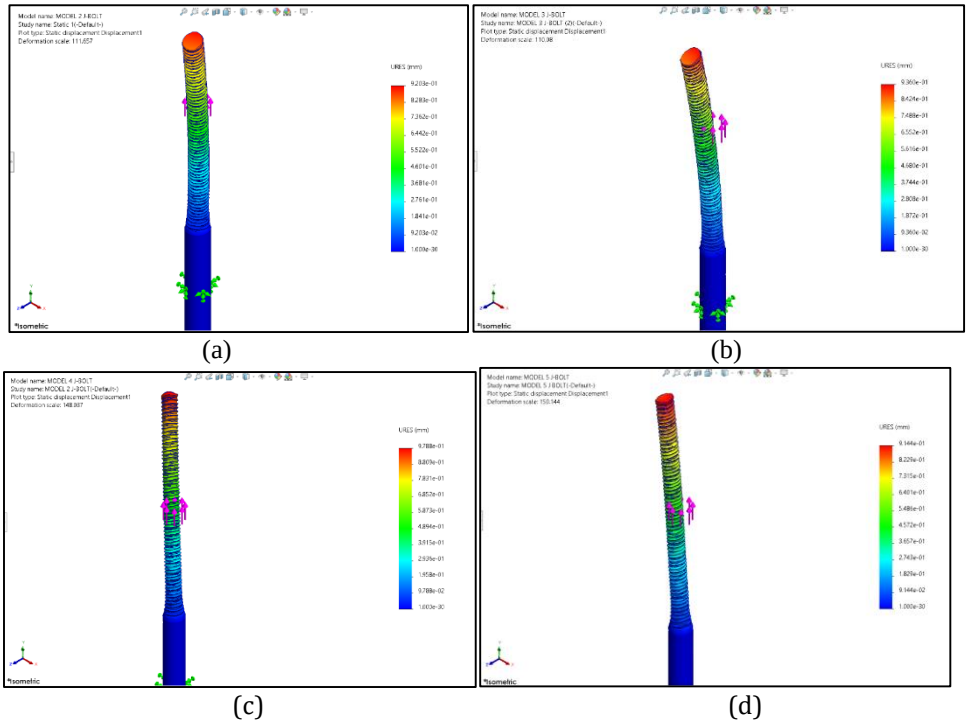
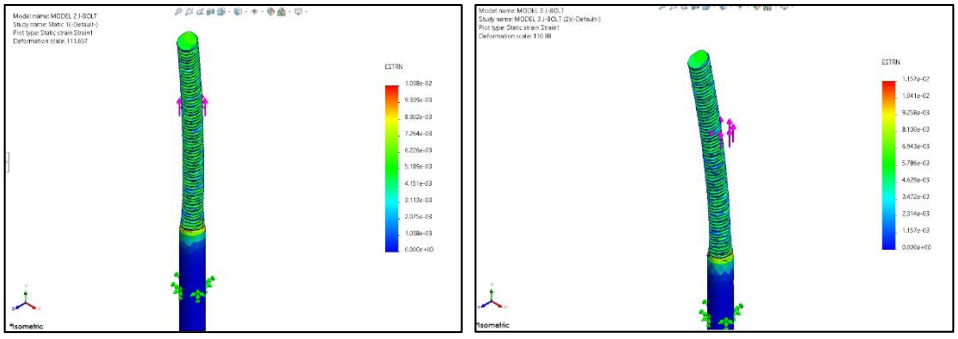
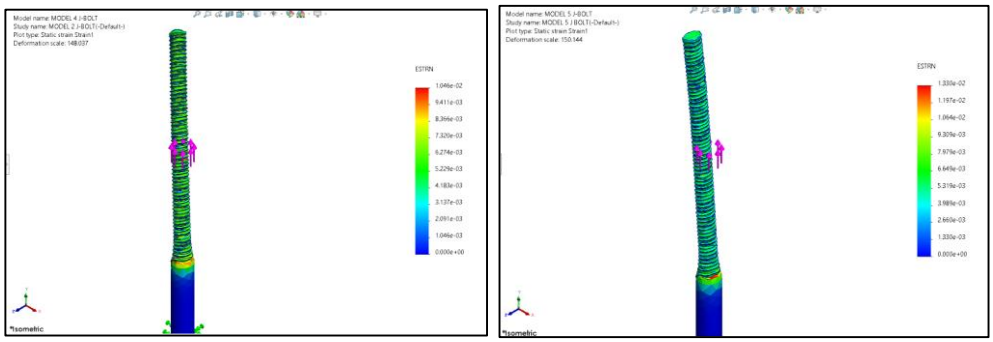


Fig. 7 *(a) Discplacement distribution on model 2 j-bolt. (b) Displacement distribution on model 3 j-bolt.* (c) *Displacement distribution on model 4 j-bolt. (d) Displacement distribution on model 5 j-bolt.*

The analysis of maximum strain is important in evaluating the structural performance and characteristics of each configuration. Lower strain values generally indicate better structural stability and reduced risk of excessive displacement under loading conditions (Fransplass et al., 2011). Based on the results, Model 5 produced the highest maximum strain value of $13.30 \times 10^{-3}\varepsilon$ with an additional threaded length 126.20 mm. This indicate that Model 5 experienced the greatest displacement among all configurations under the applied loading condition. However, Model 2 recorded the lowest maximum strain value of $10.38 \times 10^{-3}\varepsilon$ with an additional threaded length of 123.20 mm, indicate that this configuration provided better resistance to displacement compare to others. Apart from that, Model 3 and Model 4 showed moderate strain values of $11.57 \times 10^{-3}\varepsilon$ and $10.46 \times 10^{-3}\varepsilon$. Based on **Fig. 8**, the distribution shows that the highest strain concentration occurs at the curved upper portion of the j-bolt, where the geometry changes direction and induces stress concentration. The vertical shaft of the j-bolt generally experiences low strain, as indicated by the dominant blue color along its length. Moderate strain can also be observed near the anchorage region at the base, suggesting load transfer to the support. Overall, the strain distribution demonstrates that geometric discontinuities, particularly the curved section are critical regions contributing to displacement.



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(c) (d)

Fig. 8 *(a) Strain distribution on model 2 j-bolt. (b) Strain distribution on model 3 j-bolt. (c) Strain distribution on model 4 j-bolt. (d) Strain distribution on model 5 j-bolt.*

4. Conclusion

This study aims was to evaluate the structural performance of different j-bolt models through stress and displacement analysis using finite element simulation in SolidWorks and validate the effectiveness of additional threading as non-destructive engineering solution by comparing stress distribution and displacement across multiple models of j-bolt. The simulation results provided detailed information regarding the stress distribution, strain and displacement behavior of each mode, allowing a comprehensive assessment of their structural performance. In addition, the study successfully validated the effectiveness of additional threading as non-destructive engineering solution. Based on the obtained results, the modified j-bolt models with additional threaded length demonstrated not acceptable in stress and displacement values exceeding the material's allowable limits.

This indicates that the additional threading did affect the structural integrity or strength on the j-bolt. Therefore, the findings confirm that the proposed modification cannot be considered a practical and reliable solution for improving installation flexibility while maintaining structural safety and performance. However, laboratory testing under actual loading conditions would provide more accurate data regarding the structural behavior and performance of the j-bolt. In addition, future research can include effect of dynamic loading, fatigue, vibration, and seismic forces on the structural integrity of the j-bolt connection system, particularly for railway related structures subjected to repeated loading conditions.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The author solely contributed to the conceptualization, methodology, investigation, data collection, finite element analysis, data interpretation, visualization, writing of the original draft, review and editing, and final approval of the manuscript.

References

Pedersen, N. L. (2013). Overall bolt stress optimization. *The Journal of Strain Analysis for Engineering Design*, *48*(3), 155–165. https://doi.org/10.1177/0309324712470233

Pedersen, N. L. (2024). Optimal design of prestressed bolt thread. *The Journal of Strain Analysis for Engineering Design*, *59*(4), 281–290. https://doi.org/10.1177/03093247241232859

Suresh, K. (2021). Design Optimization using MATLAB and SOLIDWORKS. Cambridge University Press. https://doi.org/10.1017/9781108869027

Khameel B. Mustapha. (2022). *Practical Finite Element Simulations with SOLIDWORKS 2022* (Keagan Carneiro, Ed.). Packt Publihing Ltd.

Hussain, S. M., Hussain, S., Awais, M., & Hussain, S. S. (2024). *A Comprehensive Study on Cracks in Multi-span Simply Supported Beam Bridges Through SolidWorks Analysis* (pp. 244–250). https://doi.org/10.1007/978-981-97-5814-2_22

Yang, F., Veljkovic, M., & Liu, Y. (2021). Fracture simulation of partially threaded bolts under tensile loading. Engineering Structures, 226, 111373. https://doi.org/10.1016/j.engstruct.2020.111373

Fransplass, H., Langseth, M., & Hopperstad, O. S. (2011). Tensile behaviour of threaded steel fasteners at elevated rates of strain. International Journal of Mechanical Sciences, 53(11), 946–957. https://doi.org/10.1016/j.ijmecsci.2011.07.006