Static Loading Simulation on Temporary Platform and Ladder Absorbent Chamber Design

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Abstract: This study utilizes SolidWorks software to thoroughly examine the structural layout and static load simulation of a temporary platform and ladder in an adsorbent chamber. SolidWorks, a computer-aided design (CAD) and computer-aided engineering (CAE) software, offers robust tools for 3D modeling, simulation, and analysis, making it ideal for this type of structural assessment. Finite element analysis (FEA), a simulation model within SolidWorks, is employed to determine stress distribution and safety factors. The results demonstrate the platform's maximum stress at 198.65 MPa, below the yield strength of ASTM A36 Steel, leading to a safety factor of 1.3. These findings validate the design's safety and reliability for industrial use.

Keywords: Static Load Simulation, Temporary Platform, Ladder Adsorbent Chamber, Structural Safety

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Introduction

Temporary platforms and ladders are indispensable in industrial settings, such as adsorbent chambers, where they provide essential support and access for workers performing installation and maintenance tasks. The design of these structures must adhere to stringent safety and structural integrity guidelines to prevent accidents and ensure operational efficiency. In industrial environments, the safety and effectiveness of these components are paramount, necessitating robust design validation processes. According to Saeed et al. and Sun et al., proper structural design and validation are critical to maintaining operational safety and efficiency in industrial applications (Saeed et al., 2024; Sun et al., 2023).

The conventional design methods may not fully capture the intricate interactions between various structural components and the forces they endure. This study addresses this gap by employing advanced simulation techniques using SolidWorks software. SolidWorks, a powerful CAD and CAE tool, offers comprehensive capabilities for 3D modeling, simulation, and analysis, making it well-suited for this type of structural assessment (Simeonov et al., 2017; Yang et al., 2022). Utilizing SolidWorks allows for a detailed geometric depiction of the platform and ladder, which is essential for accurate stress analysis and design validation.

Finite element analysis (FEA) within SolidWorks is a crucial aspect of this study, providing a robust framework for modeling and analyzing the structural response of the temporary platform and ladder to static loads. FEA breaks down the structure into smaller elements, enabling precise evaluation of stress and strain patterns within the components. This method is particularly useful for identifying high-stress areas that may require additional reinforcement or design modifications (Li et al., 2023; Madukauwa-David & Drissi-Habti, 2016) By simulating real-life load conditions, FEA helps ensure that the design meets all necessary safety standards and can function reliably under specified operational conditions.

The primary objectives of this research are to determine the maximum stress levels and safety factors for the temporary platform and ladder under static load conditions. The platform is designed to bear a weight of 600 kg, while the ladder is intended to support a maximum load of 100 kg. The material selected for construction is ASTM A36 Steel, known for its excellent mechanical properties and widespread use in structural applications (Kim et al., 2024). By conducting detailed simulations and analyzing stress distributions, this study aims to validate the design and confirm its compliance with safety standards (Cicconi et al., 2020; Fan et al., 2022; Xie et al., 2023).

Ultimately, this research contributes to the broader field of industrial design by demonstrating the benefits of using advanced simulation tools for structural analysis. The findings underscore the importance of thorough design validation processes, emphasizing that engineers can enhance the safety and reliability of industrial structures by incorporating FEA and SolidWorks into their design workflow (Błazik-Borowa & Gontarz, 2016; Woolley & Whitehouse, 2022). This approach not only reduces the risk of accidents but also improves operational efficiency, providing valuable insights for future design projects involving temporary platforms and ladders in similar industrial settings.

Research Method

The research begins with the design of the temporary platform and ladder using SolidWorks software, a robust tool for creating detailed geometric models essential for accurate stress analysis. The platform is designed to bear a weight of 600 kg, while the ladder is intended to support a maximum load of 100 kg. SolidWorks facilitates the creation of intricate geometric representations, specifying the dimensions, shapes, and connections of both the platform and ladder. The dimensions are as follows: the platform measures 2m x 1m x 0.05m, and the ladder is 2m in height with rungs spaced 0.3m apart. This precise modeling establishes a solid foundation for subsequent analysis.

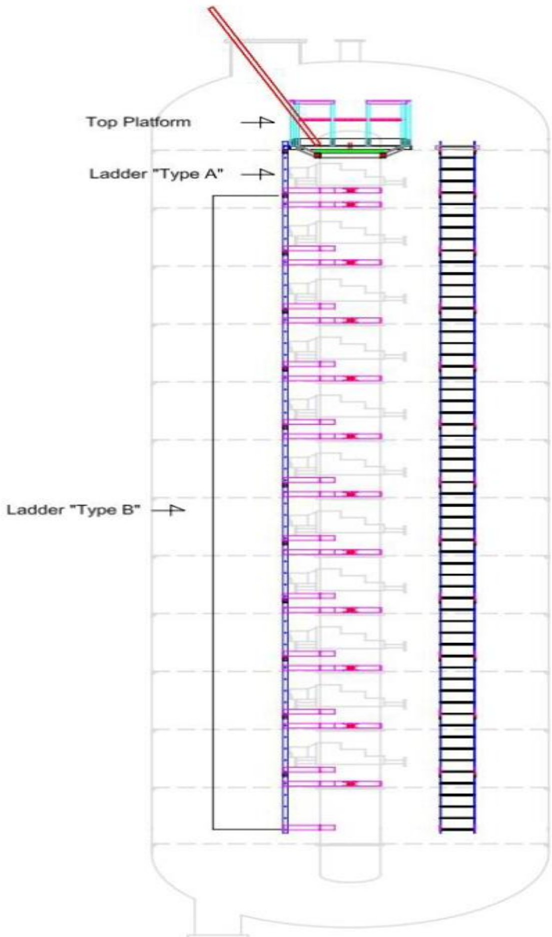

Figure 1 Platform and Ladder Design

Following the completion of the geometric model, finite element analysis (FEA) is conducted within the SolidWorks environment to simulate the structural response to static loads. FEA involves dividing the model into smaller elements through a process called meshing. A higher resolution mesh is applied to regions anticipated to experience significant stress variations, thereby enhancing the accuracy of the results. The material properties of ASTM A36 Steel, including a yield strength of 250 MPa, are assigned to the model. Boundary conditions are set to replicate the real-life operational environment, providing necessary support and constraints (Błazik-Borowa et al., 2022).

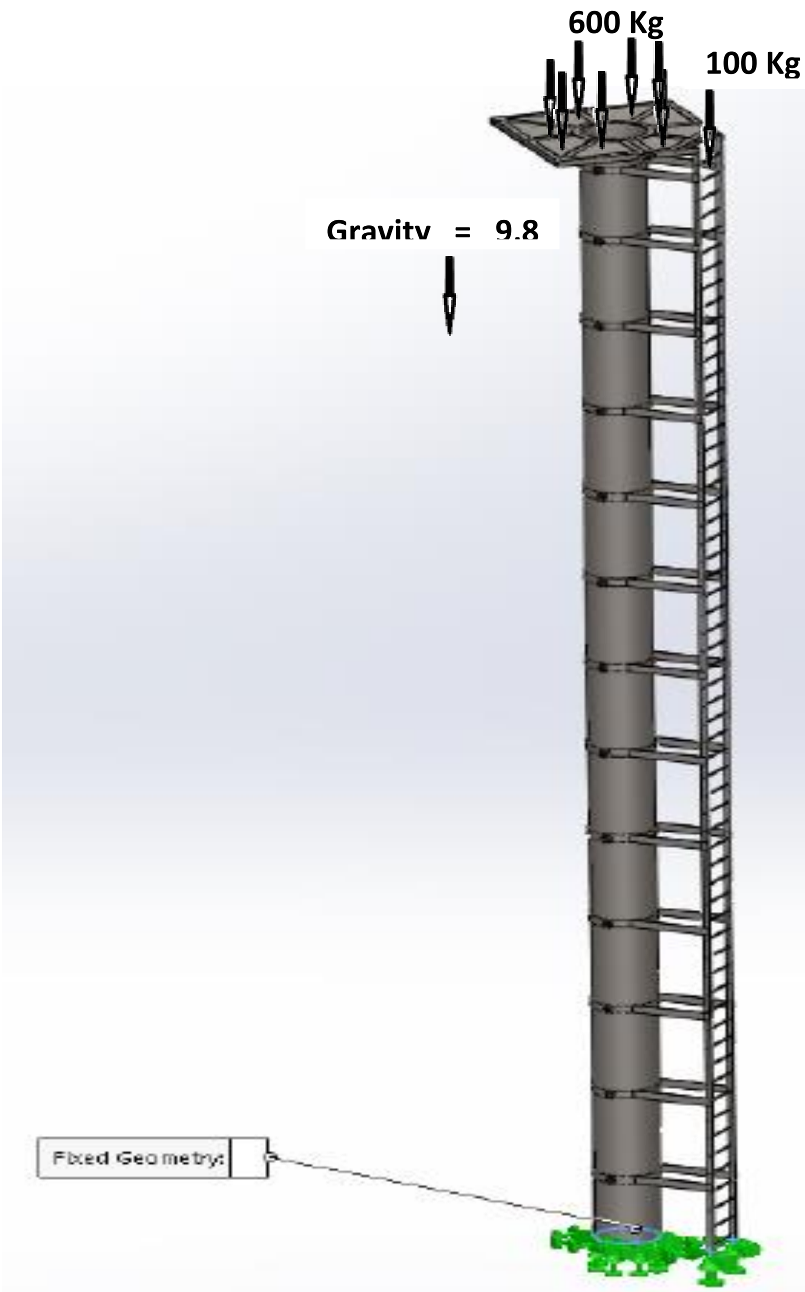

Figure 2 Finite Element Analysis

The simulation configuration involves applying gravity and static loads to both the platform and ladder. The platform is subjected to a uniform load of 600 kg, while the ladder carries a load of 100 kg. Each simulation run examines the stress and strain distributions within the structure, focusing on maximum stress levels, deformation patterns, and the factor of safety (FoS) for each component. To ensure consistency and reliability, the simulation is performed five times. The results provide critical data on the structural strength and safety of the design, confirming its compliance with necessary standards and its ability to operate safely under specified conditions (Cicconi et al., 2020; Xu et al., 2024).

Result and Discussion

The SolidWorks simulation results provide detailed insights into the stress distribution and structural response of the temporary platform and ladder. The platform's maximum stress was 198.65 MPa, below the yield strength of ASTM A36 Steel, ensuring no permanent deformation. The safety factor of 1.3 confirms the design's compliance with safety standards. Stress contour maps highlight high-stress regions, particularly at joints and connections, which are critical for maintaining structural stability.

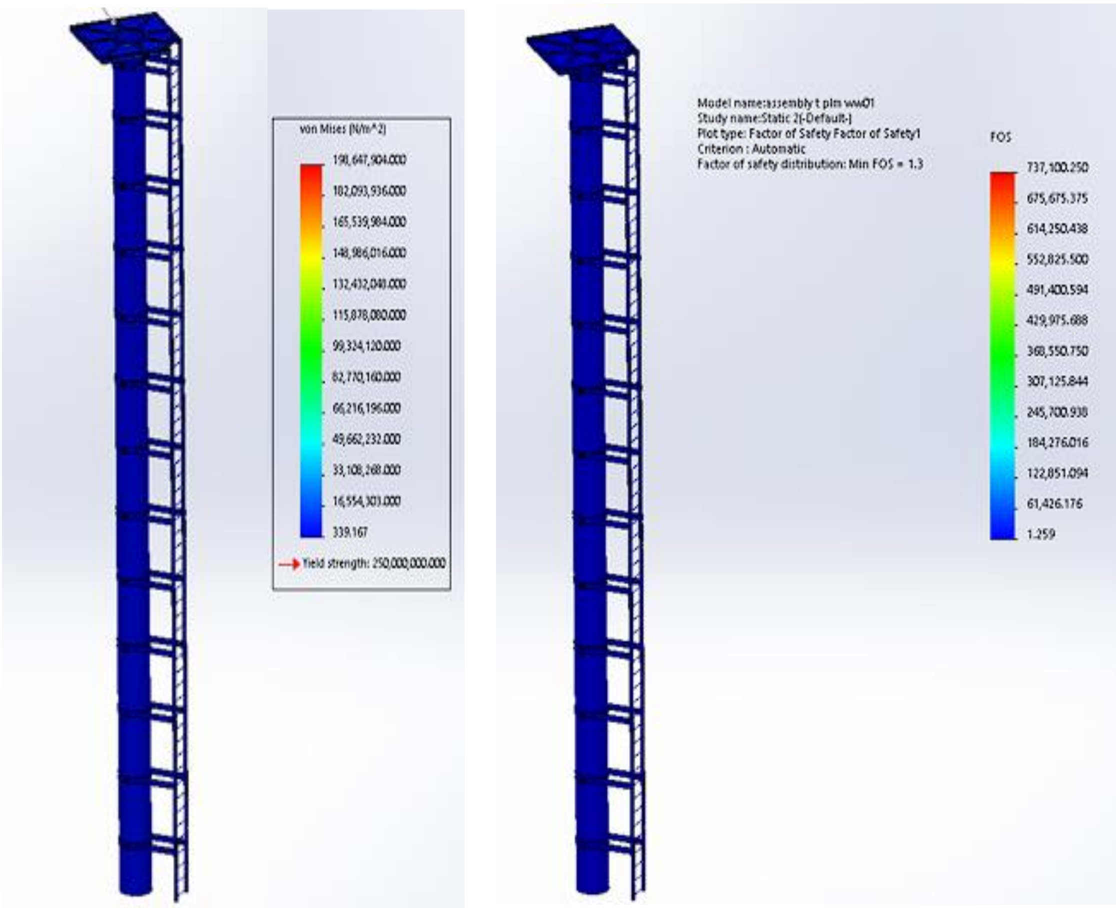

Figure 3 SolidWork Analysis Result

The ladder's stress analysis showed it could safely hold 100 kg, with stress levels well below the material's yield strength. The results emphasize the importance of using robust simulation tools like SolidWorks for design validation, enabling engineers to proactively address potential issues and improve design safety and efficiency.

Conclusions and Future Work

The study effectively demonstrates the stability and safety of the temporary platform and ladder designed for an adsorbent chamber. The simulation results validate the components' ability to sustain specified loads, with safety factors meeting required standards. Regular inspection of high-stress areas identified in the simulation is recommended to maintain structural integrity. Future designs could benefit from further optimizing mesh density in FEA for more accurate results. Incorporating advanced simulation tools in the design process enhances structural safety and operational efficiency in industrial settings. The study is limited to static load analysis and does not consider dynamic loads or fatigue analysis, which are crucial for comprehensive structural performance evaluation. Expanding the research to include multiple case studies or various design configurations would improve the generalizability of the results. Exploring design improvements or optimization techniques, such as topological optimization, could enhance the structural efficiency and safety of the platform and ladder.

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