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Statics Analysis of A Hydrogen Fuel Electric Bus Frame

Lu Zhang

Shandong Industrial Vocational College, Zibo, Shandong 255000, China

Abstract: ***in this paper a new type of hydrogen fuel electric bus frame as the research object, using three- dimensional modeling software UG and finite element analysis software ANSYS statics analysis was carried out, the under two typical conditions of statics performance evaluation and analysis, analysis of the effect is good, for the future of the hydrogen fuel electric vehicles provides some reference for further inquiry.***

Keywords: Hydrogen Fuel Electric Vehicle; the Frame; Statics Analysis.

1. ESTABLISHMENT OF FINITE ELEMENT MODEL

First in UG to establish a three-dimensional entity model of the frame, the main parts are left, right rail, for the middle connection of the beam, the front frame connection. the length of the frame is X 5.072m, the width is Y 0.952m, and the height is Z 0.73m. Due to the different shape design of the frame and the complex structure, a variety of support and fixing devices, and sometimes the load is also very complex, the frame is reasonably simplified to establish a simple, reasonable and effective model. Because, if the frame structure details are not simplified, it will bring problems in the structural finite element analysis process, such as convergence, cost of resources, and may cause inaccurate calculation results. Zhou et al. (2024) [1] proposed an automated garbage recognition model combining ResNet-50 and weakly supervised CNNs, demonstrating enhanced accuracy for waste management applications. Similarly, Lyu et al. (2024) [2] optimized 3D point cloud recognition using lightweight CNNs, achieving real-time processing efficiency for industrial automation. For infrastructure management, Liu et al. (2025) [5] developed MiM-UNet, a state-space-integrated network that significantly improves building segmentation accuracy in satellite imagery. In supply chain optimization, Wang and Liang (2025) [3] introduced a reinforcement learning framework integrating graph neural networks and self-attention mechanisms, which dynamically adapts to logistical disruptions. Expanding this, Wang et al. (2025) [8] designed a deep reinforcement learning and particle swarm optimization hybrid system for supply chain finance, showing measurable improvements in decision-making efficiency and profitability. For energy sustainability, Zhao et al. (2025) [4] employed a CNN-Bi-GRU model to forecast renewable electricity demand, addressing both short- and long-term grid management challenges. Healthcare AI applications have also progressed, as Shen et al. (2025) [6] validated an LSTM-based system for optimizing anesthetic dosing in cancer surgeries, reducing clinical risks. Concurrently, cybersecurity research by Xu et al. (2025) [7] systematically analyzed adversarial machine learning threats and defense strategies, emphasizing robustness in AI deployment. Lastly, autonomous systems saw breakthroughs with Wang et al. (2025) [9] proposing an end-to-end AI architecture for self-driving vehicles, integrating multimodal sensor fusion for real-time navigation.

Secondly, the "X_T" format file is exported through UG software, and then imported into ANSYS software, to carry out solid grid division of the frame, the selected grid is tetrahedral ten node grid and plate and shell unit. the main ways between the parts of the frame are spot welding, arc welding and bolt connection. the beams of the original frame were joined to the rail by riveting and then welding the edges, making them very strong. A Bonded constraint is used in ANSYS to define the welding constraint between beams. A total of 382 pairs of contact Bonded constraints on all welding contact surfaces were treated by the model.

Figure 1: Grid division of key parts of the frame

After the geometry is cleaned, material properties are set, and cell types are defined, the frame can be meshed using

Ansys software. Key supports, support beams, etc. Use a three-dimensional tetrahedral grid, while the longerons and beams use shell elements. The key force parts were refined by element to improve the calculation accuracy. The total number of grids of the frame was 180, 000.

2. THE APPLICATION OF BOUNDARY CONDITIONS

2.1 Body gravity

Frame mass is also one of the loads, if ignoring the weight of the frame, it will cause inaccurate calculation. Therefore, when applying load conditions, accurate application must be carried out. According to the requirements of analysis and calculation, the dead weight can be applied to the corresponding nodes as uniform load distribution, and the gravity acceleration compensation method is often used because of its convenient operation. That is, gravity acceleration of 9.8m/s2 is applied along the y direction of the graph.

2.2 Gravity of frame attachments

In practice, the frame will be fitted with appendages including carriage, toolbox, cab, etc. Where not negligible, their gravity is generally applied as a concentrated load to the corresponding node in the actual position, or as a mass element.

2.3 load force

It can be used as a concentrated load and distributed to the corresponding plane or node according to the fulcrum span.

2.4 Sometimes in order to consider the dynamic load of the body in use, the following provisions are made in the calculation of the load under bending condition In the finite element analysis of engineering structures, not all the load treatment methods mentioned above must be considered. It is necessary to choose the proper method of load treatment according to the accuracy of calculation results. For example, when the load of the frame is much greater than the frame, the weight of the attached body can be ignored, and the load can be directly applied when calculating.

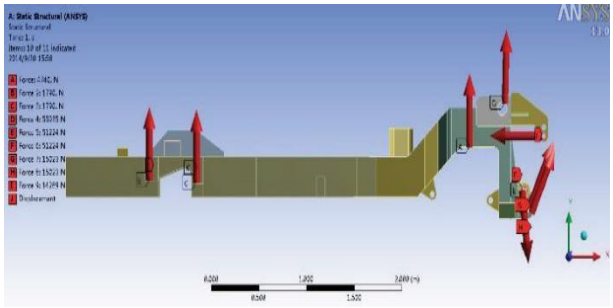

Figure 2: Setting of frame boundary conditions

3. RESULTS OF STATICS ANALYSIS

As shown in Figure 3, the maximum stress under the two conditions is 214MPa, which does not exceed the allowable stress of the material 250MPa. the maximum displacement is at the right rear end of the frame, i. e. near the right rear wheel. the maximum deformation under the two conditions is only 4.87mm, which does not exceed the maximum limit of the design specification, so the static strength meets the requirements. However, in the front section of the frame and the connection of the drive device prone to stress concentration, there may be hidden safety, in order to improve this situation, the above parts of the frame should be improved and optimized design, increase its contact area with the longeron to prevent stress concentration, and should be installed in the corresponding position of the longeron reinforcement plate.

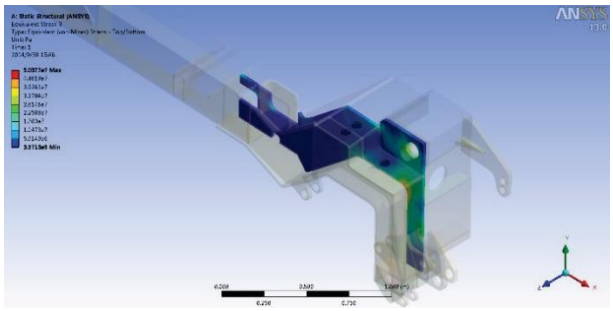

Figure 3. Statics analysis of key parts of the frame

4. CONCLUSION

In this paper, a new type of hydrogen fuel electric bus frame as the research target, using three-dimensional modeling software UG and finite element analysis software ANSYS on the statics analysis of the two kinds of typical working conditions of statics performance evaluation and analysis, analysis of the effect is good, for the future of the hydrogen fuel electric vehicles provides some reference for further inquiry.

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