

Analysis of New Type Elevating Mechanism for Hybrid Forklift Based on ANSYS

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Key words: hybrid technology; forklift; elevating mechanism; simulation analysis

Abstract: A new kind of elevating mechanism for hybrid forklift has been designed. The 3D modeling for the upright mounting is using CATIA 3D software. And then, the elevating mechanism for hybrid forklift was simulated by the finite element analysis software ANSYS. Under different working conditions, such as upright mounting load、upright mounting rise or upright mounting decline, maximum deformation extent and deformation stress points were analyzed. By analyzing, maximum deformation extent and deformation stress points are within a reasonable range, a new type elevating mechanism for hybrid forklift suffices requirement of the design.

Introduction

With the development of technology and development of the market economy, harbor transportation and logistics warehousing are blooming. Although as compared with developed countries, logistics warehousing is still in the initial stage in our country. The State Department's "The National Development Planning of Logistics Park (2013-2020)" was unveiled in 2013, the development of logistics warehousing has risen to the national strategic level. The policies shall be further carried out so as to decrease the logistics park operating cost and bring benefits to logistics companies. Infrastructure development and perspective of equipment makers, such as forklift、crane are directly related to logistics will rise. Logistics equipment plays a more and more important role in economic development [1, 2].

As harbor transportation and logistics warehousing developed, the demand of forklift has been rising rapidly in recent years [3, 4]. Forklift, a high-efficiency equipment of mechanized handling and short distance transportation, which was used for stations, ports, airports, factories, warehouses, received high-speed development with the release of China's consumption potential and further integration of the logistics industry norms surely usher in rapid development period[5].

Constructing finite-elemental modal

3D modeling of elevating mechanism for hybrid forklift for the upright mounting is using CATIA 3D software. Then, the 3D models of the upright mounting by using CATIA software are saved as STP files. The upright mounting of 3D models are imported into ANSYS, and then to accomplish import of the upright mounting of 3D models. After importing the model, because it's structural characteristics is complex, using the method of smart division and local refinement to plot numbered cell mesh.

After mast mesh model, a total of 125,331 nodes, 84,838 units, as shown in Fig. 1.

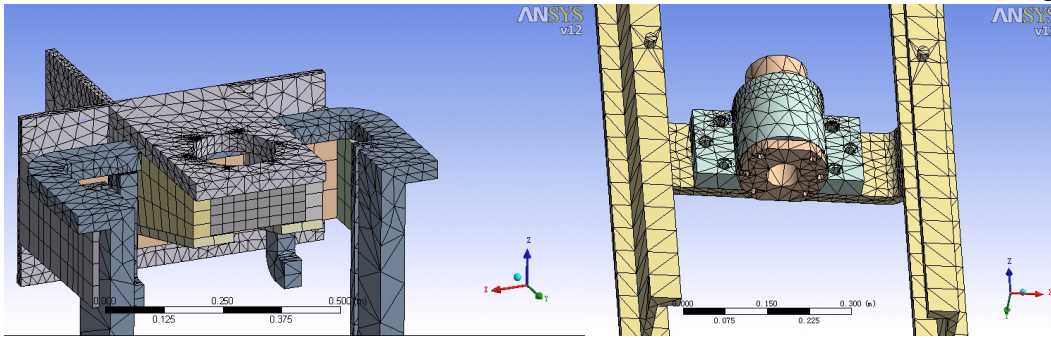


Fig.1 mast mesh model

Finite element analysis of elevating mechanism for hybrid forklift

The upright mounting of hybrid forklift applied load is measured by two different work conditions. According to the different work conditions, outer upright mounting, inner upright mounting and ball screw assembly are respectively analyzed.

When the fork pickup remains stationary, to inner, outer upright mounting and the ball screw pair static force analysis. Applying 90000N on nut of the ball screw pair under static load, the outer door frame stress deformation and stress analysis as shown in Fig.2 and Fig.3. The maximum deformation in supporting part of the ball screw, amount of deformation is 0.00040581m. The maximum stress in bolt holes of flange, stress value is 111.71MPa. The inner upright mounting stress deformation and stress points analysis as shown in Fig.4 and Fig.5. The maximum deformation in the ball screw nut seat, amount of deformation is 0.00041317m. The maximum stress in bolt hole of the ball screw nut seat, stress value is 140.88MPa. Ball screw pair stress deformation and stress points analysis as shown in Fig.6 and Fig.7. The maximum deformation in supporting part of the ball screw, amount of deformation is 0.00096714m, the maximum stress point is located on the part of ball makes contact with screw, stress value is 164.95MPa.

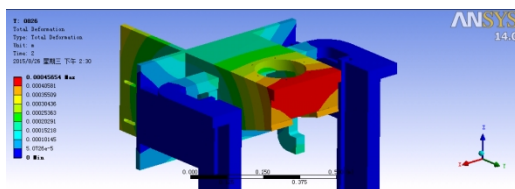


Fig.2 total deformation

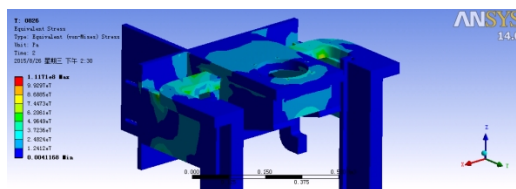


Fig.3 equivalent stress

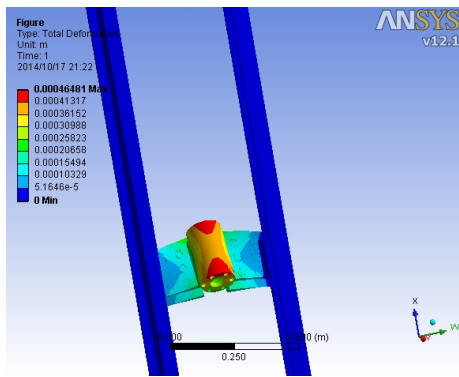


Fig.4 total deformation

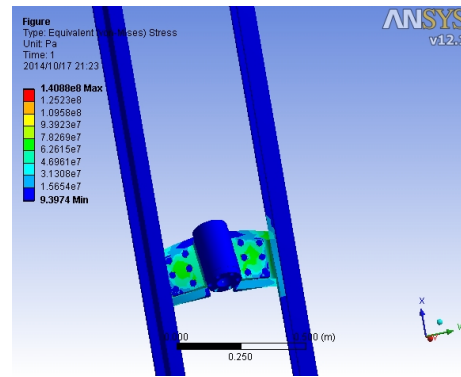


Fig.5 equivalent stress

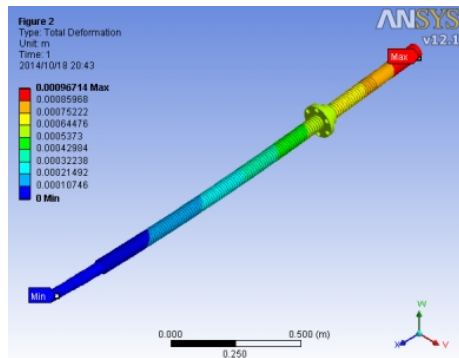


Fig.6 total deformation

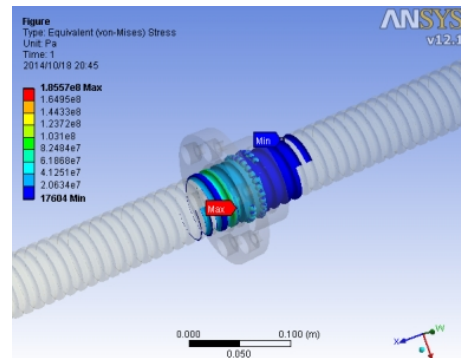


Fig.7 equivalent stress

When the process of cargo lifting emergency stop, the inner、outer upright mounting and the ball screw pair will be large impact pressure. It is particularly important, therefore, for the inner upright mounting stress to be analyzed. Applying 100000N dynamic load in the nut of the ball screw pair, the duration was 1s, the outer upright mounting stress deformation and stress analysis as shown in Fig.8 and Fig.9. The maximum deformation in supporting part of the ball screw, amount of deformation is 0.00052027m, The maximum stress in bolt holes of flange, stress value is 196.66MPa. The inner upright mounting stress deformation and stress analysis are as shown in Fig.10 and Fig.11. The maximum deformation in the ball screw nut seat, amount of deformation is 0.0034366m, the maximum stress point is located in the inner upright mounting web, and stress value is 1040.4MPa. Ball screw pair stress deformation and stress points analysis are as shown in Fig.12 and Fig.13. The maximum deformation in supporting part of the ball screw, amount of deformation is 0.0010746m, the maximum stress point is located on the part of ball makes contact with screw, stress value is 206.19MPa.

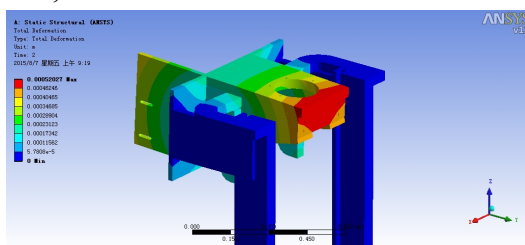


Fig.8 total deformation

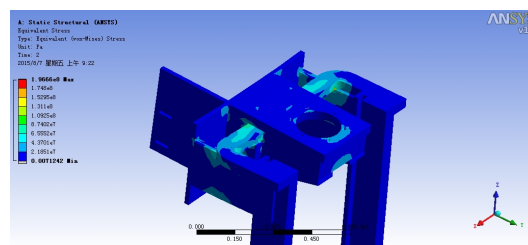


Fig.9 equivalent stress

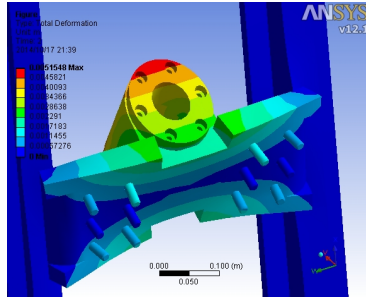


Fig.10 total deformation

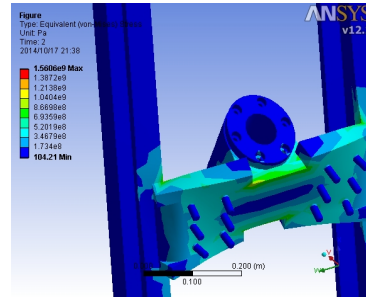


Fig.11 equivalent stress

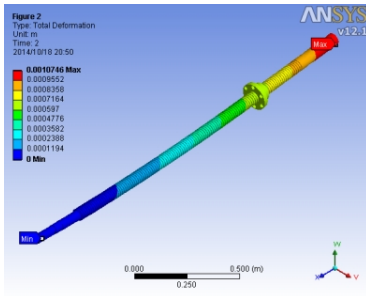


Fig.12 total deformation

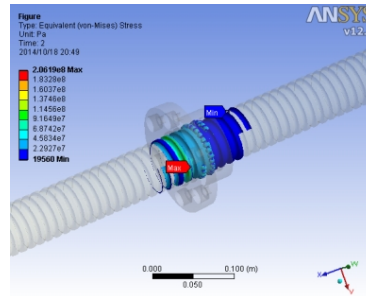


Fig.13 equivalent stress

Conclusions

A new hybrid forklift lifting mechanism was designed. It can be seen through the analysis, the amount of stress deformation and stress distribution hybrid forklift mast lifting mechanism are qualified in both work conditions. And it provides a theoretical basis for the subsequent hybrid forklift overall design and experimentation.

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