IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

Performance analysis of the node shell on a container door based on ANSYS

To cite this article: Qingzhou Li *et al* 2018 *IOP Conf. Ser.: Earth Environ. Sci.* **108** 022076

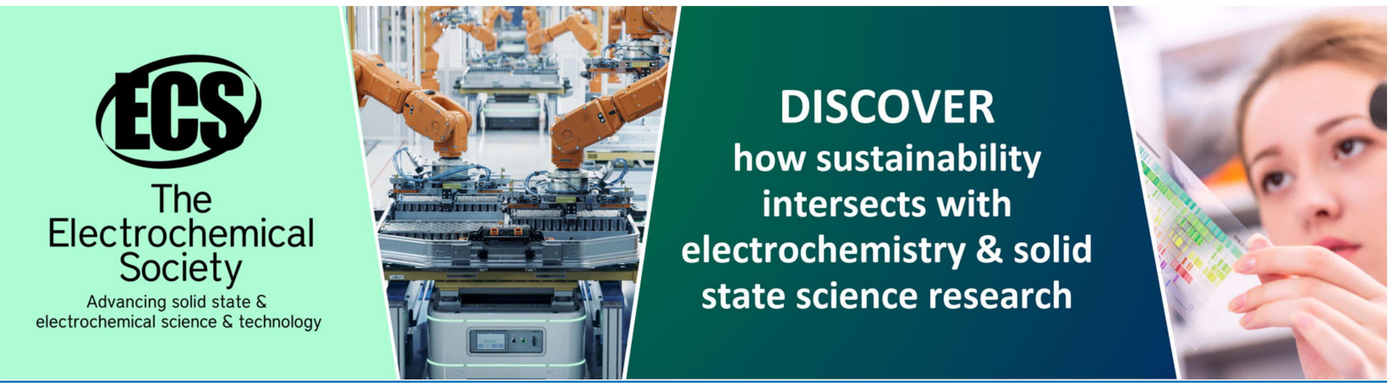
View the article online for updates and enhancements.

You may also like

- Coexistence of nanowire-like hex and (1 × 1) phases in the topmost layer of Au(100) surface
Artur Trembulowicz, Barbara Pieczyrak, Leszek Jurczyszyn et al.

- Density functional theory study of the mechanical behavior of silicene and development of a Tersoff interatomic potential model tailored for elastic behavior
SangHyuk Yoo, Byeongchan Lee and Keonwook Kang

- Evaluation of terpene-based hydrophobic deep eutectic solvents as skin permeation enhancers
Yuta Araki, Yuma Hamada, Norika Imamura et al.



This content was downloaded from IP address 18.118.45.162 on 07/05/2024 at 07:50

IOP Conf. Series: Earth and Environmental Science **108** (2018) 022076 doi:10.1088/1755-1315/108/2/022076

Performance analysis of the node shell on a container door based on ANSYS

Qingzhou Li, Yi Zhou, Changqing Hu, Jiamin Cheng, Xiaochen Zeng

Beijing Institute of Aerospace Control Devices, Beijing 100039, China.

*Corresponding author e-mail: lqz_work@126.com

Abstract. The structure of thenode shell on a container door was designed and analyzed in this study. The model of the shell was developed with ANSYS. The grids of the model were divided based on the Hex dominant method, and the stress distribution and the temperature distribution of the shell were calculated based on FEA (Finite Element Analysis) method.The analysis results indicated thatthe location of the concave upward side has the highest stress which also lower than the strength limit of the material. The temperature of the magnet installation location was highest, therefore the glue for fixing the magnet must has high temperature resistance. The results provide the basis for the further optimization of the shell.

1. Introduction

The container is an important component of vessels, trains and vehicles. The characteristics of the container have important effects on the vessels or trains.

Cope taro et al. [1] analysed the thermal performance of PCM in refrigerated container based on simulation and experiment. Zha et al. [2] analysed the mechanical performance of container structure. Jiang et al. [3] analysed the effects of crosswind intensity on the cross stability of container trains running on plain. Sun et al. [4] analysed the liquid sloshing process of a tank truck based on numerical simulation. Furthermore, Wang et al. [5] analysed the heat transfer performance of a dangerous goods container based the simulation method.

In this paper, the structure of thenode shell on a container doorwas designed and analysed. The calculation model was developed with ANSYS. The stress distribution and the temperature distribution of the shell were calculated based on simulations and analysed.

2. Simulation model of the node structure a container door

Fig.1 shows the model of the node structure of a container door. The length, the width and the height were 94mm, 50mm and 157mm, respectively. It contains four batteries, a magnet, a circuit board and an antenna. Another square shell which has a length of 56 mm, a width of 27 mm and a height of 25 mm. A hall sensor was installed in the square shell. Furthermore, all of the shells were made of ABS (Acrylonitrile Butadiene Styrene) plastic.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

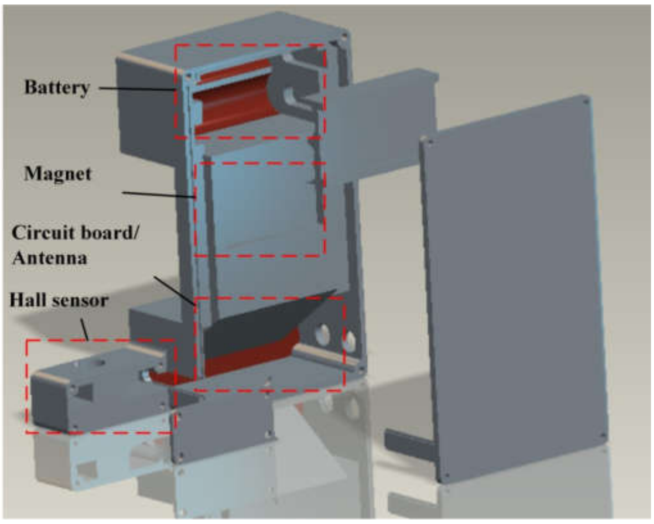
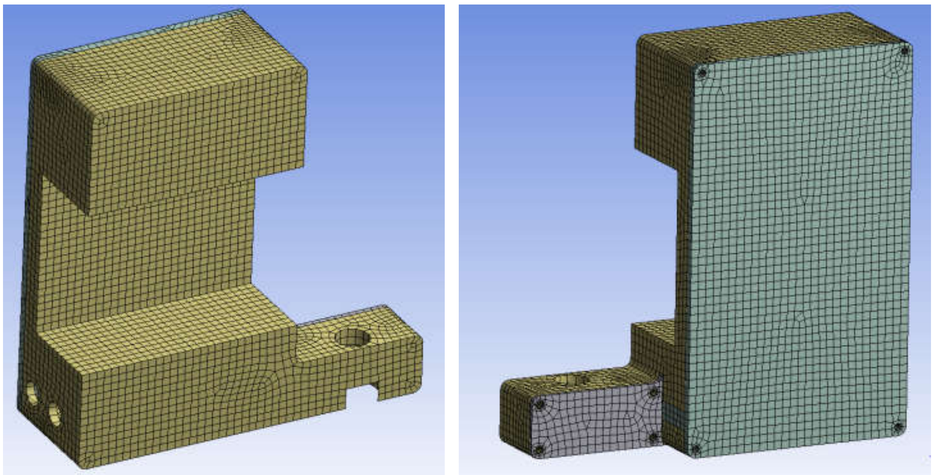


Figure 1. The model of the node structure of a container door

2.1. FEA calculation model

The calculation model of the container door node structure was meshed based on the Hex dominant method. The cells were divided with hexahedral and tetrahedral grids. The shell has about one hundred thousand of grids. Fig.2 shows the front and back view of the FEA calculation model of the container door node.

The shell has acceleration due to its own weight. Furthermore, the batteries have higher gravity in all components. The effects of other components' gravity on the stress were very small and can be neglected. Therefore, a downward equivalent stress was only applied on the installation surface of the batteries. The shell back was tightly closed with the container door under the action of the suction force of the magnet, therefore, the shell back was constrained.



(A) (B)

Figure 2. FEA calculation model of the container door node. (A): The front view, and (B): The back view.

2.2. Calculation model of the temperature distribution

The back and the concave of the shell were respectively contacted with the container door and the door handle according to the installation condition of the shell. The temperature of the metal parts of the container door and handle can reach up to 50 ℃. So the temperature of the contact face was set as

IOP Conf. Series: Earth and Environmental Science **108** (2018) 022076 doi:10.1088/1755-1315/108/2/022076

50 ℃. The other surfaces were exposed in the air, and the temperature was set as 35℃. The heat transfer coefficient, the specific heat capacity, the linear expansion coefficient of the shell materials was set up in the model, and the temperature distribution was calculated and analysed.

3. Analysis of stress distribution and temperature distribution

3.1. Analysis of stress distribution of the shell

The stress distribution of the shell was calculated in this section. Fig.3 describes the stress distribution from the front view, the back view and the upward view.

From Figure.3 (A) we can see that, the stress was very small, and lower than 3 MPa. As shown in Figure.3(B), the location of the maximum stress was the concave upward side (As shown in Figure.3 (C)), due to the gravity of the batteries on the tress of the shell. The maximum stress was 11.36 MPa. However, the maximum stress is far lower than the strength limit of the ABS resin, therefore, the design of the shell meets the strength requirement.

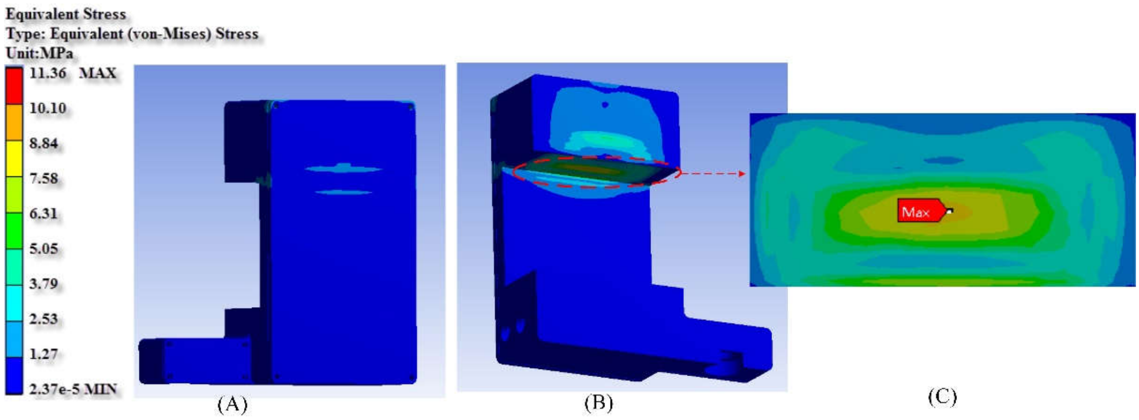


Figure 3. The stress distribution of the container door note. (A): The back view of the stress distribution, (B): The front view of the stress distribution, and (C): The upward view of the stress distribution.

From Figure.4 we can see that, there is a stress concentration area in the inner wall of the battery installation, due to the gravity of the batteries on the tress of the inner wall of the shell. This part is also the site in particular need to pay attention to during shell design and modification optimization. In the shell optimization, the stress concentration can be reduced by thickening the wall or increasing the ribs here.

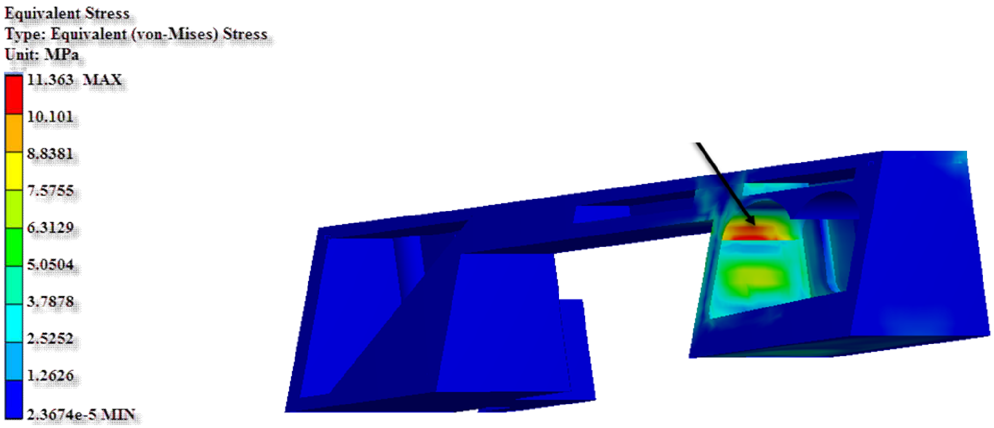
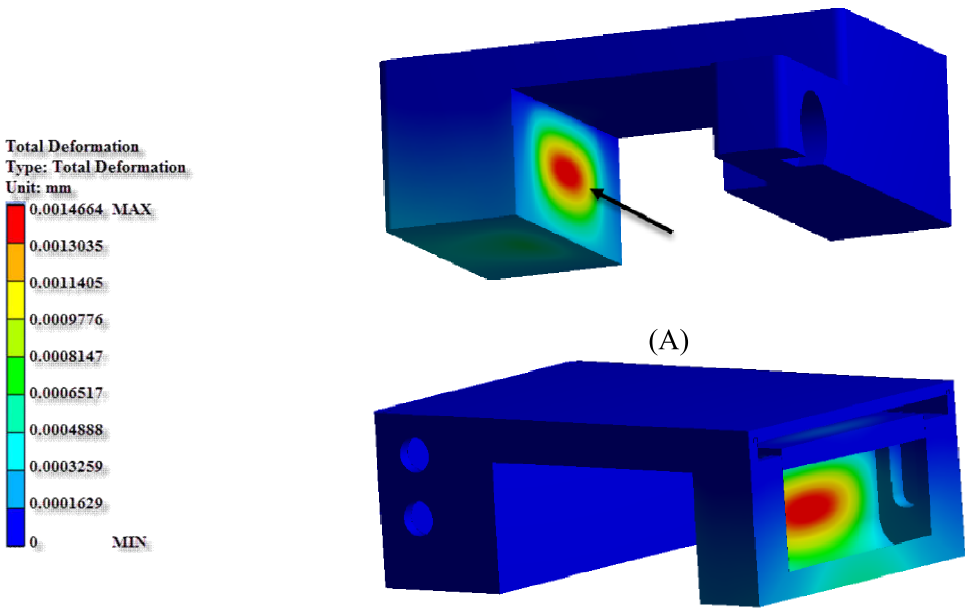


Figure 4. The stress distribution on the cross section of the container door note

From Figure.5(A) we can see that, the total deformation of the entire battery box is very small, due to the stress in the box is small. However, there is a large deformation in the external wall of the battery installation, because the gravity of the battery squeezes the walls of the shell. From the downward view on the cross section of the total deformation in Figure.6 we can see that, there is also a certain deformation in the inner wall near the battery location. In order to enhance the strength of the position of the battery, it is necessary to thicken the position, or other ways of enhancing the strength to prevent the deformation from being too large for damage.



(A)

(B)

Figure 5. The total deformation of the container door note. (A): The upward view of the total deformation, and (B): The downward view on the cross section of the total deformation

3.2. Analysis of temperature distribution of the shell

The temperature distribution of the shell was calculated in this section, as shown in Fig.4. The temperature of the shell was increased under the action of the heat transfer and convection heat transfer when the shell was exposure under the sun. From the results we can see that, the temperature of the shell back was higher, and the maximum temperature at the location for installing the magnet was higher than 50 ℃. The temperatures at the locations for installing the hall sensor, the circuit board, the antenna and the batteries were low, around 35℃. Therefore, the electron components can normally operate. The temperature analysis of the shell has positive influence on the selection of the electron components.

The results of the temperature distribution analysis indicated that: the temperature of the magnet installation location was highest, therefore the glue for fixing the magnet must have high temperature resistance. The other locations have lower temperature, so the other electron components can normally work.

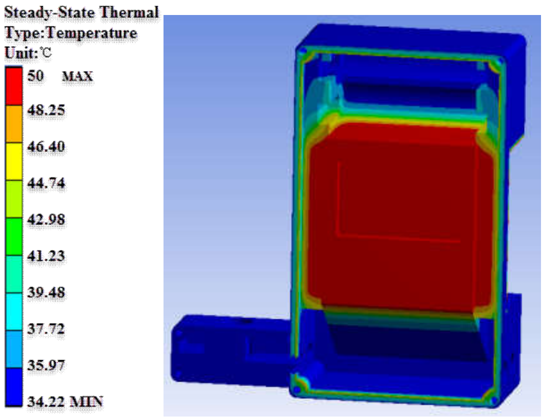


Figure 6. The back view of the temperature distribution of the shell

From the temperature distribution on the cross section of the shell in Figure.7 we can see that, there have the high temperature in the vicinity of the heating surface and near the internal material for the thermal conductivity of ABS is not strong. For the corner position of the battery, the thermal stress of the box may be affected due to the high temperature, so it is necessary to pay more attention to the thermal stress in this area. The simulation is in the extreme assumption that the temperature of the shell surface which contact with metal up to 50℃, and the temperature of the shell surface which contact with air up to 35℃. Considering the thermal conductivity of ABS plastic is not strong, the actual temperature should be lower than given temperature.

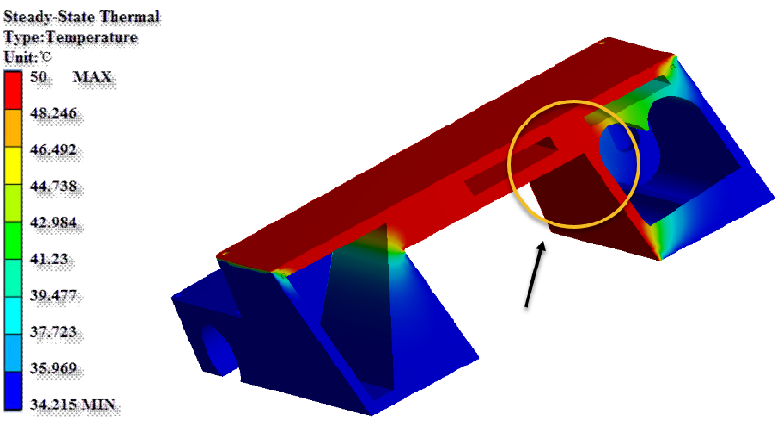


Figure 7. The temperature distribution on the cross section of the shell

Figure.8 is the total heat flux distribution on the cross section of the shell. As the heat transfer coefficient of ABS plastic is small, the whole body internal heat flow is also very small, which can be basically negligible. And just on the edge of the box body angular position has a relatively large heat flow, the maximum is 0.00458W / mm^2.

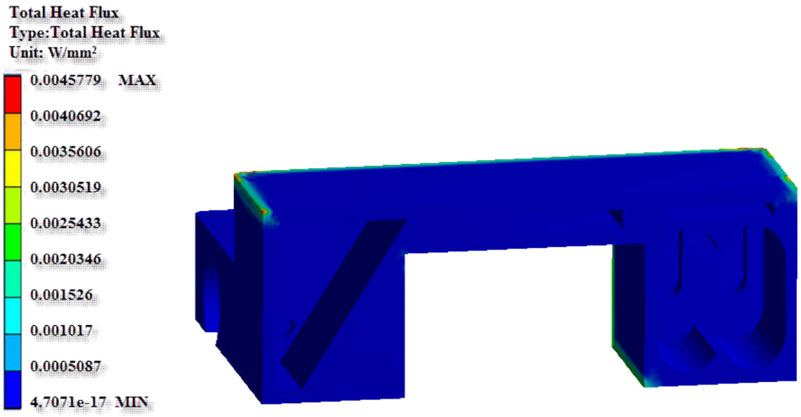


Figure 8. The total heat flux distribution on the cross section of the shell

4. Conclusion

The stress distribution, the total deformation distribution, the temperature distribution and the total heat flux distribution of the shell of a container door node were analysed in this study. The results indicated that:

The location of the concave upward side has the maximum stress, i.e. 11.36 MPa, due to the gravity of the batteries on the tress of the shell. However, the maximum stress is far lower than the strength limit of the ABS plastic. In the same place, there has the maximum total deformation.

The maximum temperature at the location for installing the magnet was higher than 50 ℃. Therefore, the glue for fixing the magnet must have high temperature resistance. The other electron components can normally work due to the low temperature at the other locations.

References

[1] Copertaro Benedetta, Principi Paolo, Fioretti Roberto. Thermal performance analysis of OCM in refrigerated container envelopes in the Italian context- Numerical modeling and validation. Applied thermal engineering, 2016 (102): 873-881.

[2] Zha Xiao-xiong, Zuo Yang, Liu Le, Wang Xin-jie. Analysis of Mechanical properties of Container structure under earthquake action. Journal of South China University of Technology, 2015 (43) 07: 92-99.

[3] Jiang Chong-wen, Zhang Jin-bai, Guan Xue-mei, et al. Influence of Crosswind Intensity on Cross Stability of Container Trains Running on Plain. Journal of the China railway society. 2011 (33) 03: 17-22.

[4] Sun Li-na, Zhou Guo-fa. Numerical simulation for liquid sloshing process of a tank truck. Journal of vibration and shock. 2012 (31) 22: 147-150.

[5] Wang Chun-sheng, Teng Shuai, Wang Xiao-hui. Numerical analysis of heat transfer of dangerous goods container. Journal of the China railway society. 2008 (30) 1: 13-18.