Mechanical Analysis of ROPS Lateral Loading Test-bed for Mining Dump Truck

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Abstract. This paper analyzes the static load of the ROPS side loading test-bed of the mine dump truck by using the finite element method, obtains the distribution law of the stress and deformation, discusses the feasibility of the simulation analysis, and makes a beneficial exploration for the design and improvement of the similar ROPS in the future.

1. Introduction
The road surface of mine dump truck is very complex when it is running under the bad off highway condition. It is necessary to analyze and optimize the ROPS of the cab to further improve the safety.

In this paper, the lateral loading test-bed of a certain ROPS (rollover protection device) is taken as the research object. The finite element method is used to simulate and analyze the stress and deformation distribution. The results show that the original design meets the use requirements, and the research in this paper provides a good reference value for ROPS design and maintenance.

2. Problem Background and Existing Problems
The mining dump truck is mainly used for short-distance transportation from the mining site to the loading and unloading site in large-scale open pit or large-scale earthwork engineering. The site working conditions are extremely poor. In order to ensure the life safety of the driver, the cab must have a rollover protection device, which is ROPS. When the vehicle operates normally or rolls over, ROPS shall have enough strength and rigidity to resist the injury to the driver.

The rollover process belongs to the plastic large deformation, and the rollover process belongs to the complex nonlinear category, so it is difficult to accurately describe the rollover process. It needs a lot of simplification to use the finite element nonlinear analysis, but the actual results are quite different from the simulation results.

3. Original Parameters of the Problem
The required loading test force and energy for calculation are shown in Table 1: the hydraulic cylinder is 32Mpa.

| Model  | Machine quality M(kg) | Side loading F (N) | Lateral load energy U (J) |
|--------|-----------------------|-------------------|---------------------------|
| NTE330 | 178400                | 1070400           | 212296                    |

Table 1. Force and energy calculation results
4. Establishment and Solution of Finite Element Model

Shell 8nodes93 shell element is selected as the element, Q345B is selected as the material, the elastic modulus is 206gpa, Poisson's ratio is 0.3, full restraint is set between the base and the ground, and the force is applied at the oil cylinder, Acting on the small spanner of 800×805, the size is 4.005mpa, and the direction is in the negative direction of X axis.

Figure 1. Physical model

Figure 2. Finite element model diagram

Figure 3. Global stress nephogram
5. Results analysis: most of the stress strength of the column is below 194mpa, which is smaller than the yield strength of Q345B material 295mpa, so the structure is safe; The maximum displacement is 11mm at the top. It conforms to the national standard GB/T 17922-2014 laboratory test and performance requirements for roll over protective structure of earth moving machinery, structural safety; There is a stress concentration at the connection between the diagonal bar and the column under lateral loading, and the stress is 436Mpa.

5. Structural Improvement Scheme of Lateral Loading Test Stand

5.1. Structural Improvement Plan I
For the connection between column and inclined bar, the material with higher strength is used, such as Renault 953. Make the structure safer.
5.2. Structural Improvement Plan II
It is more reasonable to use the transverse short plate as the middle baffle at the loading position. The original 800 × 805 long longitudinal baffle is changed into 800 × 300 short transverse baffle, and the maximum stress is reduced from 436mpa to 222mpa. It shows that the transverse short plate can effectively reduce the force on the structure of the test-bed, reduce the maximum stress, and achieve the purpose of improvement.

5.3. Structural Improvement Plan III
It is more reasonable to use pin shaft connection. The maximum stress decreased from 436mpa to 232mpa. The results show that the pin shaft connection can effectively reduce the force on the test-bed structure, reduce the maximum stress, and achieve the purpose of improvement.

![Figure 6. Stress nephogram of scheme II](image1.png) ![Figure 7. Stress nephogram of scheme III](image2.png)

The research data and conclusions of this paper have certain reference value to the actual ROPS design.

6. References
[1] Haipeng C 2013 D, Numerical simulation test of rollover protection structure -- nonlinear finite element analysis, Jiangsu university.
[2] Jing Z 2006 J, Research on lateral force of bulldozer's overturning and falling object protection structure, Hoisting and transportation machinery (04):65—68.
[3] Xiandong D 2014 D, Cab analysis and optimization of mining dump truck based on high dimensional model, Hunan University.
[4] Chang L, Yeze L and Zhinyong Y 2014 J, Strength simulation analysis of ROPS and FOPS in cab of engineering vehicle, Agricultural equipment and vehicle engineering(11):41—43.
[5] Xiaohuan X 2014 D, Ergonomic design of loader cab and lightweight research of the whole machine, Southeast University.
[6] Bao Z 2012 J, Finite element analysis of heavy load mining dump truck based on ANSYS command flow, Mining Engineering Research(4): 75-78.
[7] Junxun Z 2014 D, Study on safety performance and structure optimization of FOPS / ROPS device in cab of engineering vehicle, Yangzhou university.