Mechanical Analysis of the ROPS Test Bench for Mining Dump Truck

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Abstract. The static and dynamic load analysis of ROPS was achieved by the finite element method, and the distribution law of stress and deformation was obtained, meanwhile, the feasibility of simulation analysis was discussed. It is beneficial to explore the design and improvement of similar ROPS in the future.

Introduction

Mining dump trucks drive under harsh off-highway conditions, and the road surface is very complicated. It is necessary to analyze and optimize the cab ROPS to further improve safety.

In this paper, a certain type of ROPS is taken as the research object and the static load analysis is achieved by finite element method, and the stress distribution law of ROPS is obtained. The results show that the original design meets the requirements of use. The research in this paper provides a good reference value for the design and maintenance of ROPS.

Research Background

Raise of Question

Mine dump trucks are mainly used for short-distance transportation from mining sites to loading and unloading yards in large open pit mines or large earth and stone works. The working conditions on the site are extremely poor. To ensure the safety of drivers, the cab must have rollover protection devices. ROPS. When the vehicle is running normally or rolling over, the ROPS should have sufficient strength and rigidity to resist injury to the driver.

Research Status

The emergence of ROPS dates back to 1967, when engineering vehicles were commonly used. Some countries such as the United States, Canada, the United Kingdom, and France have successively formulated national standards. In 1983, Shimoda Seijiro proposed the energy absorption analysis of ROPS using nonlinear finite element based on the performance test of D60 bulldozer ROPS. In 1994, Yang Lifu of Xuzhou loader plant and Zhang Jiali of Jilin University of Technology made work on ROS&FOPS of ZL40A loader. Theoretical research and experiments on falling objects and rollover protection were achieved. The test execution standards are ISO 3471:1986 and ISO 3449:1986.

The Main Method of Problem Research

The experimental loading force required according to the standard is as shown in Table 1:

Table 1. Experimental loading force table.

| Mining car model | Machine quality (kg) | Side load (N) | Lateral load energy (J) | Load (N) | Vertical load (N) |
|------------------|----------------------|--------------|------------------------|----------|------------------|
| NTE330           | 240000               | 1440000      | 285600                 | 4706400  | 1152000          |

According to the requirements, the beam in the vertical loading combination is designed to be 400t.
Establishment and Solution of Finite Element Model

Establishing a Finite Element Model

**Modeling.** In this paper, the model material select Q345B and Poisson's ratio is 0.3, and the modulus of elasticity is 205000 MPa. The SOLID187 is selected to simulate the actual model by finite element unit.

**Meshing.** Freely divide the structure.

**Applying Constraints.** This article applies directly on the geometric model and applies a full constraint on the face inside the pin.

Calculation and Data Extraction

**Loading and Calculation.** In this paper, the surface load apply at the bottom of the model according to the requirements and it is added to the center position, and the length of the surface is 1470mm, which is in line with the width of the actual cab. Because the bottom linear load \( q = 3201.63 \text{kN/m} \). The bottom mean cloth load is 6.4 MPa by calculation.

Apply the Load and Solve for the Stress Cloud and Deformation Cloud.

**Analysis of Results**

It is concluded that the most unfavorable position is in the mid-span and the bearing boundary. This paper mainly studies the maximum Mises stress in the \( \text{span} = 285.63 \text{MPa} \), which is less than the allowable stress of 196.7 MPa. It is consistent with the calculation results of material mechanics. The position where the material is most deformed is in the mid-span, which is 3.043 mm. From the center to the two from the center to both ends.

**ROPS Dynamic Performance Study**

**Purpose of Dynamic Performance Studies**

Mining dump trucks are not only affected by static loads, but also encounter a large number of dynamic loads. Therefore, it is necessary to carry out the influence of dynamic load on the dump truck of the mine car. To ensure the safety of the driver in future work.

**Choosing the Right Solution**

There are few studies on the dynamic performance of the ROPS test rig. Occasionally, and the dynamic performance study of the ROPS test rig is also a lateral loading on a 30 degree slope, so it is very little research on the vertical loading in the elastic range studied in this paper. Now, combined with the manufacturers and various factors, this paper simulate the line graph of the actual force changes with time and establish the corresponding model to research.
Create the Table Load and Solve

The first step is to clear the memory preparation analysis and the second step is to define the load-schedule parameters, and the third step is to use the table load to perform continuous transient dynamic solution. In the end, the curve of displacement response and stress response are plotted by post26 in the fourth step. Set $F_{\text{max}} = 313733\text{N}$ to get the stress diagram 4 displacement diagram 5.

Analysis of Results

In the elastic range, the larger the load, the more obvious the displacement response and stress response. After the vehicle has rolled over, according to the provisions of GB/T1792-1999, the rollover protection structure could not show obvious deformation within 5min under the specified vertical load and the maximum deformation is 6.5mm under the dynamic load. Standards compliant. The research data and conclusions of this paper have certain reference value for the actual ROPS design.

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