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ISSN 0543-5846
METABK 62(3-4) 423-426 (2023)
UDC – UDK 669.14.018:621-42:620.16:539:374:518.1=111

DEFORMATION ANALYSIS OF RUNNING ELECTRIC HOIST

Received – Primljeno: 2023-03-04
Accepted – Prihvaćeno: 2023-04-20
Original Scientific Paper – Izvorni znanstveni rad

According to the practical engineering application, three-dimensional modeling of electric hoist and I-beam track is carried out, and the model is simplified to determine the electric hoist load, roller acceleration and speed, and the Abaqus software is used to simulate, analyze the simulation results, observe the actual maximum load under the track stress and strain to meet the requirements, calculate the allowable stress, Observe whether it exceeds the allowable stress and whether plastic deformation occurs. If the numerical simulation results of stress and strain are within the safety requirements, the project can be implemented.

Keywords: Q235 stress; I-beam; allowable stress; plastic deformation; numerical simulation

INTRODUCTION

Running electric hoist is a kind of light and small lifting equipment, which is widely used in various industries where light and small materials need to be lifted, transported and transported [1]. It is mainly composed of guide rail, traveling motor, lifting motor and other parts. It is generally installed on the suspended I-beam or combined aluminum alloy guide rail. It is usually controlled manually by wire control or remote control, that is, by manual operation button to control the lifting or lowering of the lifting motor, so as to lift or unload materials; The bidirectional operation of the horizontal walking motor is controlled by manual operation of the button, so as to realize the purpose of changing the position of materials, namely, handling materials [2]. As the name indicates, I-beam is a kind of "work" type section steel. The inner surface of the upper and lower flange has inclination, which makes the outer flange thin and the inner flange thick. Therefore, the section characteristics of the I-beam in the two main planes differ greatly, and it is difficult to play the strength characteristics just in the application. Although the I-beam market also appeared on the thickened I-beam, I-beam section by direct pressure is good, tensile, but the section size because the wing is too narrow, can't resist torsion. Whether the I-beam is ordinary or light, because the section size is relatively high and narrow, the moment of inertia of the two main sleeves of the section is relatively large. Therefore, generally, it can only be directly used in the web plane bending members or it is composed of lattice stressed members. On the axial compression member or perpendicular to the web plane and bending members are not suitable, which makes it in the application range has a great limitation. In engineering application, its working state will vary according to the actual load. Excessive load will cause large elastic deformation of the track. Excessive acceleration or speed of the same load may also affect the deformation of the track. In serious cases, it may cause plastic deformation of the track beyond its yield stress, which may cause safety hazards. In the actual situation, there are six weights with different masses. In the Abaqus numerical simulation, when the maximum weight is operated, observe and analyze his stress-strain simulation diagram, if the maximum stress does not exceed the allowable stress and there is no plastic deformation in the track under the three states of uniform acceleration, uniform deceleration and uniform speed, the other conditions can be safely carried out, so the track can be safely used.

In this paper, the 32a I-beam is used as the track in the project, and the model is built to simulate the finite element, and the force and deformation of the track under a certain load are analyzed.

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FINITE ELEMENT MODEL ESTABLISHMENT

Q235 is low carbon steel, with good plasticity and welding performance, and good forming ability. All many profiles (such as angle steel, round steel, I-beam, channel steel and other materials are Q235), and have certain strength. It is suitable for engineering structures such as bridges and buildings, with good practical performance, relatively low price, and cost-effective [3]. Q235 steel is divided into four grades, namely A, B, C and D, according to the different carbon content. The track used in this project is Q235A grade steel, its main chemical composition is C 0,14-0,22 %, Mn 0,30-0,65 %, Si ≤ 0,30 %, S ≤ 0,050 %, P ≤ 0,045 % [4], and the rest is Fe. The dimension parameters of I-beam are shown in Table 1. The biggest difference with H-beam

Table 1 **I-beam dimensions**

	Value/mm
Height of section	320
Width of section	130
The web is thick	9,5
Flange thickness	15
Inner arc radius	11.5
End arc radius	5,8

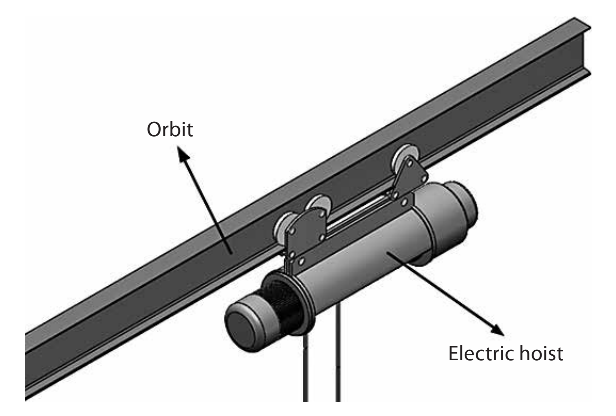

Figure 1 Three-dimensional view of assembly

is that the thickness of I-beam at the track has a certain slope. The rail and electric hoist assembly is shown in Figure 1.

The electric hoist has three rollers on each side of the track, and the diameter of each wheel is 200 mm. Since there are only roller parameters and calculations in the electric hoist during the finite element analysis, its model is simplified and only the rollers are retained. Because the orbit is too long and the simulation time is too long, the simulation results are not easy to watch, so the length of the simulation is reduced to facilitate the observation of the simulation results, and the correctness of the results will not be affected. The simplified model is shown in Figure 2.

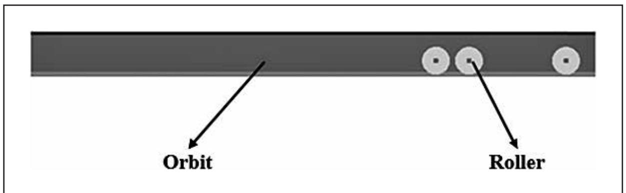

Figure 2 Simplified diagram of assembly

NUMERICAL SIMULATION

First of all, SolidWorks software is used to establish the 3D structure of electric hoist and I-beam track and assemble it. The format is converted and imported into Abaqus software. Finite element modeling is carried out on the imported assembly, the force and strain of the track are observed, material attributes of Q235A are created, and the track is given material attributes. The numerical simulation data to be output should be selected. The stress and strain conditions should be selected this time. Then, the interaction should be created to set the friction coefficient and create constraints. The load of the electric hoist is evenly distributed to each roller, and finally each roller is given the same initial speed or acceleration. At this time, attention should be paid to whether the direction of speed meets the requirements.

Meshing is an important link in the establishment of finite element model, which requires more problems to be considered and requires a large amount of work. The meshing form will directly affect the calculation accuracy and calculation scale. During grid division, in order to ensure the accuracy of numerical simulation, the mesh size should be selected according to the three-dimensional model and material properties and as small as possible. The number of grids will affect the accuracy of the calculation results and the size of the calculation scale. Generally speaking, with the increase of the number of grids, the calculation accuracy will be improved, but at the same time, the calculation scale will also increase, so two factors should be weighed when determining the number of grids [5]. The stress on the top of the track is not obvious and there is basically no deformation. Therefore, the mesh size can be relatively large, and the middle part of the track has uniform thick-

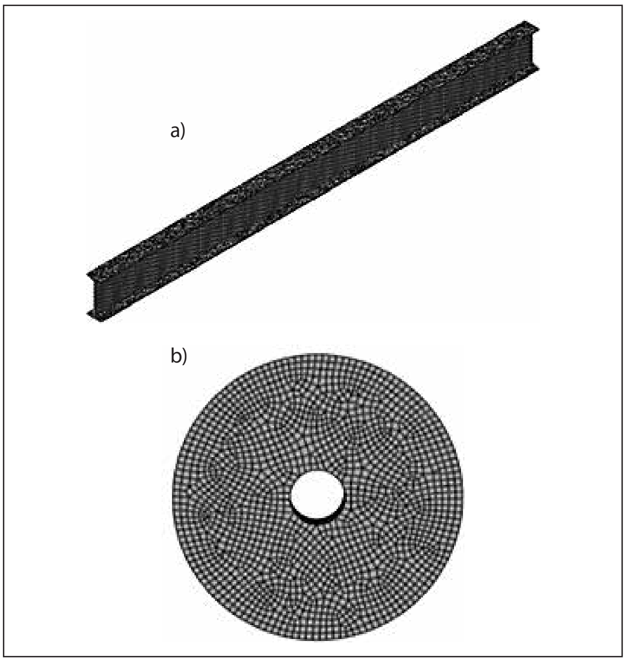

Figure 3 3D grid diagram: (a) Orbit; (b) Roller

Table 2 **Number of grids**

Object	Volume/ mm/s	Number of grids
Orbit	0	279 867
Roller	628	4 133

Table 3 **Experimental parameters**

Experimental parameters	Value
Orbit material	Q235A
Roller speed/mm/s	1 256
Roller acceleration/mm/s^2	±314
Roller load/kg	690

ness. The mesh size is minimum at the lowest part of the track, which can shorten the calculation time without greatly affecting the results. The final grid is shown in Figure 3. The specific grid number is shown in Table 2. Table 3 shows the process parameters for numerical simulation.

SIMULATION RESULTS AND ANALYSIS

According to the above modeling method and finite element analysis based on the selected process parameters, the stress and strain simulation results of I-beam under uniform acceleration, uniform speed and uniform deceleration conditions are obtained respectively. In this paper, the maximum load under the actual working condition is taken as the force exerted by the roller. Through the numerical simulation results of its uniform acceleration, uniform speed and uniform deceleration, it can be seen that it meets the requirements of the actual project, the maximum stress on the track is 134 MPa, the allowable stress calculation formula is:

$$\sigma = \frac{\sigma_S}{n} \quad [1]$$

In the formula, -yield limit of material, is 235 MPa [6] - safety factor, is 1,34 [7].

Therefore, the allowable stress is 175 MPa. It can be seen from Figure 4 that the maximum stress on the track under uniformly accelerated operation is 134 MPa, which does not exceed the allowable stress of I-beam. As can be seen from Figure 5, the maximum stress on the track at constant velocity is 129,6 MPa, which does not exceed the allowable stress of I-beam. As can be seen from Figure 6, under the condition of uniform deceleration, the maximum stress on the track is 127,5 MPa. Therefore, the maximum stress on the track during the whole operation process is generated during uniform acceleration and does not exceed the allowable stress and yield strength.

As can be seen from the strain diagram, it can be seen from Figure 7, the maximum strain of the track during uniformly accelerated motion is 6,699×10^{-5} mm, but the maximum strain is basically not observed in the figure, and the strain is basically around 2×10^{-5} mm. As can be seen from Figure 8, the maximum strain of the track under uniform velocity is 6,389×10^{-5} mm, which is the same as that under uniform acceleration, the maximum strain is basically not observed, and the strain is also around 2×10^{-5} mm. As can be seen from Figure 9, under the condition of uniform deceleration, the maximum strain of the track is 6,628×10^{-5} mm, which cannot be observed under the same three conditions, indicating

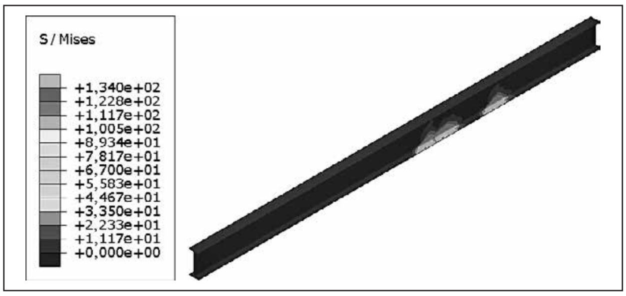

Figure 4 Stress at uniform acceleration

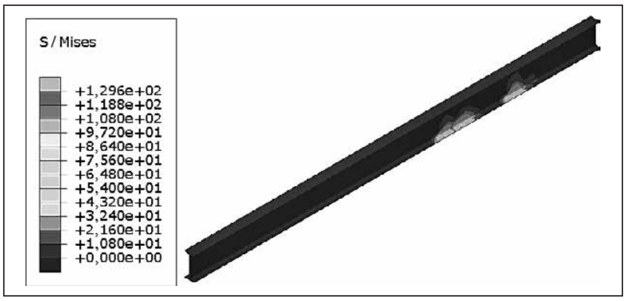

Figure 5 Stress at constant velocity

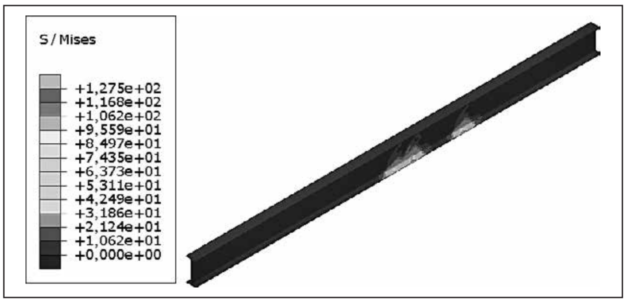

Figure 6 Stress at uniform deceleration

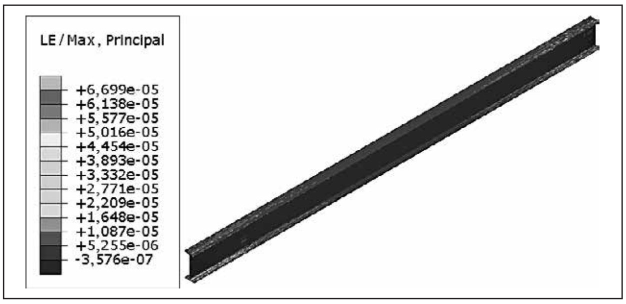

Figure 7 Strain at uniform acceleration

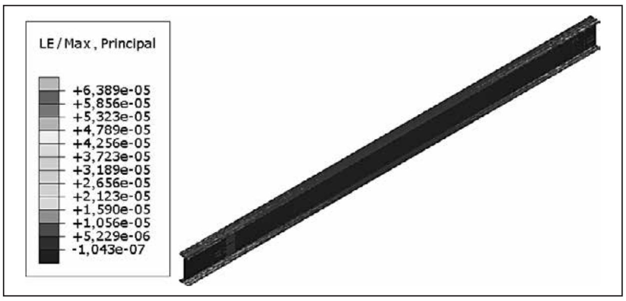

Figure 8 Strain at constant velocity

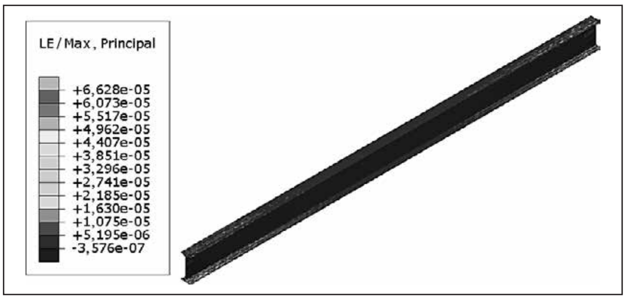

Figure 9 Strain at uniform deceleration

that the maximum strain is very little and the strain is very small. At this time, the load reaches 8 200,5 kg and the force acting on each wheel is 6 900 N. Under the condition of 314 mm/s^2 uniform acceleration and at the highest speed of 1 256 mm/s, only extremely small plastic deformation occurs. The largest shape variable is also generated during uniform acceleration, which is 6,699×10^{-5} mm, which is very small for the whole, and it can be considered that no deformation occurs. The operation and safety of the electric hoist will not be affected.

CONCLUSION

Under the actual maximum load, its acceleration and speed can meet the engineering needs. Under the numerical simulation and experimental verification, when the electric hoist is in operation, its rollers acceleration is 314 mm/s^2, that is 0,5 rad/s^2, its speed is 1 256 mm/s, that is 2 rad/s, there will be no plastic deformation affecting the operation and safety, and the maximum stress does not exceed the allowable stress, so it can be applied in practical engineering.

Acknowledgments

This work is supported by the Tangshan Talent Foundation Innovation Team (20130204D) and funded by Key research and development plan of Tangshan science and technology (22281802Z).

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Note: The responsible translator for English language is W LIU-North China University of Science and Technology, China