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LIFTING METHOD TO ANALYZE PIPELINE DEFORMATION

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Lifting is to use lifting equipment to lift components and install them to the designated position. On the main structure, lifting equipment is used to transport the flue and transport the sectional flue to the designated position. Certain deformation will occur during the lifting operation of the flue due to its force condition, but it is not known whether it is elastic deformation or plastic deformation. Therefore, this paper analyzes the stress and strain of the flue during operation by finite element method, and observes and analyzes the influence of plastic deformation on the whole flue.

Keywords: Q235 stress; hoisting; plastic deformation; stress-strain; finite element analysis

INTRODUCTION

Lifting is the construction work that uses lifting equipment to lift components and install them in the design position. Divided into parts lifting and whole lifting. The former is to lift each component of the building and structure in turn; The latter is to assemble each component into an overall structure on the ground and then carry out hoisting. The former is used this time, and the different types of flue are hoisted to the designated position in order of precedence. As shown in Figure 1, the flue on the main structure is divided into three different specifications. This paper analyzes the stress of the flue with the largest diameter during operation. Selvam Janani et al. used ABAQUS software to accurately design the cold-formed thin-wall steel structure to the appropriate size. Through numerical simulation and research, it was found that under the application of light load, some thin-wall components in the cold-formed section would undergo distortion buckling, and even after buckling, these components still maintained high strength. The influence of the thickness of the specimen and the choice of stiffener type on the ultimate strength and deflection is proved by the finite element analysis and the experiment.[1] İlgün Abdulkerim et al. studied the flexural performance of concrete filled steel tube beams with rectangular, circular and square sections, carried out four-point bending tests on 12 concrete filled steel tube beams, and gave and discussed the load/torque-displacement curves extracted from the experimental results. Finally, the nonlinear finite element model (FEM) was established by ABAQUS to simulate the experiment, and it was found that the simulation data had good compatibility with the experimental data. [2]

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In this paper, through the application of hoisting in engineering, the actual hoisting is modeled in 3D, and the finite element numerical simulation is carried out to analyze the stress and strain of the flue under the hoisting mode.

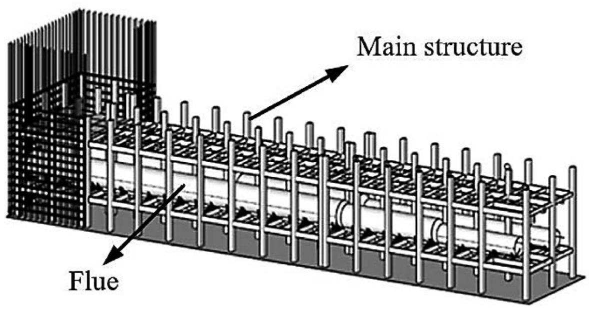

Figure 1 Flue distribution diagram

Finite element model establishment

Q235 has good plasticity and welding performance, molding ability is very good, all many profiles (such as Angle steel, round steel, I-steel, channel steel and other materials for many Q235), and has a certain strength, suitable for Bridges, buildings and other engineering structures, good practical performance, the price is relatively cheap, cost-effective [3], Q235 steel is divided into A, B, C, D four grades, according to the different carbon content to be divided. The material of the flue is Q235B, the main chemical composition is shown in Table 1 [4], and the other components are Fe. Firstly, a three-dimensional modeling was carried out for the hoisting of the flue. The material of the wire rope was 80# steel of high carbon steel with a diameter of 30 mm, and the thickness of different types of flue was different. The outer diameter analyzed in this paper was 6 028 mm, the inner diameter was 6 000 mm, the length was 3 976,7 mm, and the thickness of the flue was 24 mm.

The upper end of the wire rope is suspended by the electric hoist through the hook, so only the wire rope can be retained. The 3D model after modeling is shown in Figure 2.

Table 1 **Q235 chemical composition/wt.%**

C	Mn	Si	S
0,12~0,20	0,30~0,70	≤0,30	0,045
P	Cr	Ni	Cu
≤0,045	≤0,30	≤0,30	≤0,30

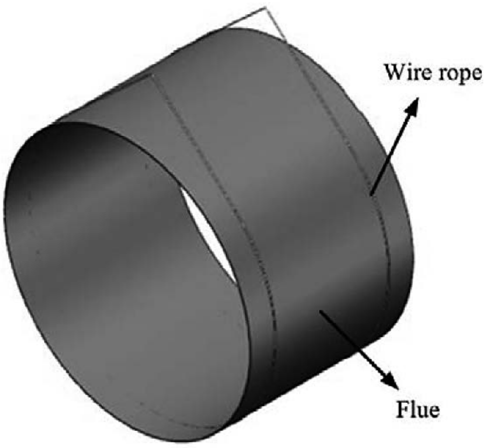

Figure 2 Three-dimensional diagram of the flue

Numerical simulation

First, modeling was carried out in SolidWorks software, the three-dimensional structure of steel wire rope, flue and weld was established and assembled, and then the format was converted and imported into Abaqus software. Finite element modeling was carried out on the imported assembly, the stress and strain conditions of welds in the flue were observed, and material properties of Q235B, 80# steel and weld were created. They are assigned to the flue and the wire rope respectively, and then create an analysis step of a certain length and frequency. At the same time, the numerical simulation data to be output is selected. What is needed this time is the stress-strain situation, after the interaction is created, the friction coefficient is set and the constraint is created. The center point of the flue and weld is selected as the reference point, and the center point is coupled with other positions. The reference point is selected at the contact point between the upper end of the wire rope and the electric hoist hook, and the boundary conditions are defined, so that it can move in the forward direction and limit its movement and rotation in other directions. Choose natural gravity, after that, according to the running state of the reference point of the previously selected steel wire rope, give a certain initial velocity or acceleration, and give the same speed to the flue when the constant speed, the given speed should meet the actual requirements of the project, too large is easy to produce safety hazards, too small will lead to too long engineering time affecting the efficiency, so the speed should be properly selected.

Next is an important link in the establishment of finite element model, grid division, grid division needs to consider more problems, the workload is relatively large, the grid form has a direct impact on the calculation accuracy and calculation scale. In addition, in order to ensure the accuracy of numerical simulation, the size of the grid should be determined according to the needs of numerical simulation and material properties, and 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 be doubled, so two factors should be weighed when determining the number of grids. Because the flue as a whole is a very symmetrical and uniform structure, its force condition is relatively uniform, so the size of the flue can be relatively large when dividing the grid for the flue, which can shorten the calculation time, and will not have a great impact on the result. The final grid is shown in Figure 3. The specific grid number is shown in Table 2.

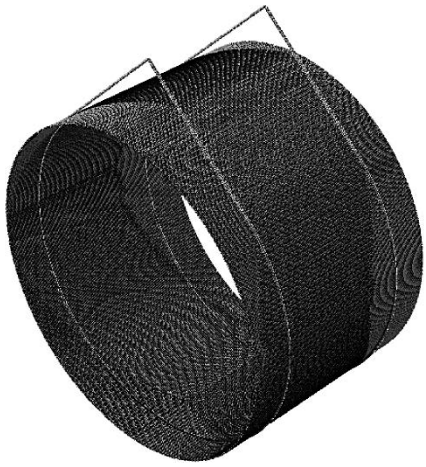

Figure 3 3D grid diagram

Table 2 **Grid number**

Object	Number of grids
Flue	383 968
Wire rope	7 980

Simulation results and analysis

According to the above modeling method, the same speed and acceleration are applied to the top of the wire rope according to the operating speed and acceleration of the electric hoist, with the maximum speed of 314 mm/s and the acceleration of ±78,5 mm/s^2. The numerical simulation results of the stress and strain of the track and weld under the condition of uniform acceleration, uniform speed and uniform deceleration are obtained respectively.

From Figure 4 and Figure 5, it can be observed that during the lifting process under uniform acceleration, when the acceleration is 78,5 mm/s^2, the maximum stress

Figure 4 Uniform acceleration stress diagram

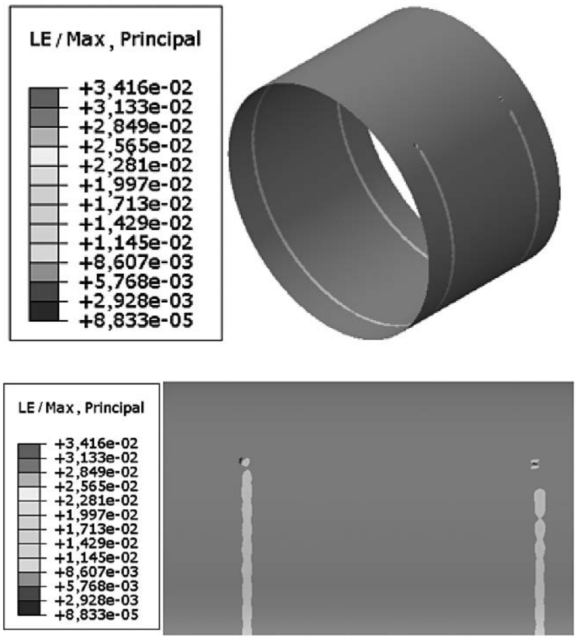

Figure 5 Uniformly accelerated strain diagram

in the other parts of the flue except for the contact with the wire rope remains around 215 MPa. The total strain of the flue is maximum at 0,3 416 mm, with the majority of the strain at 0,08 607 mm. The thickness of the flue is 24 mm, and the maximum deformation is only about one percent of the flue thickness. Therefore, under uniform acceleration, the lifting method will not have a significant impact on the weld seam of the pipeline.

From Figure 6 and Figure 7, it can be observed that during the lifting process, when the speed is constant at

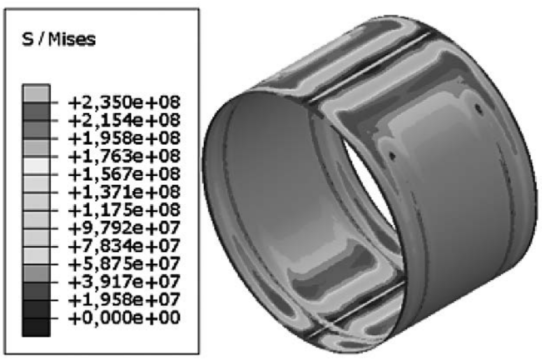

Figure 6 Uniform velocity stress diagram

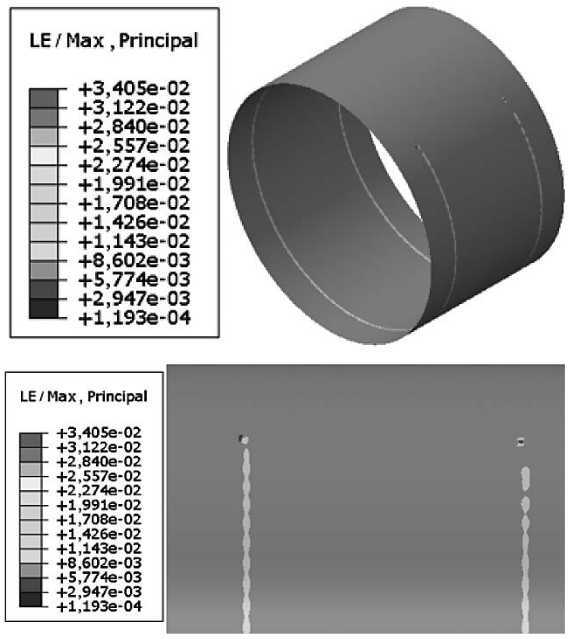

Figure 7 Uniform velocity strain diagram

314 mm/s, the maximum stress at other parts of the flue remains around 215 MPa. The total strain of the flue is maximum at 0,3 405 mm, with the majority of the strain

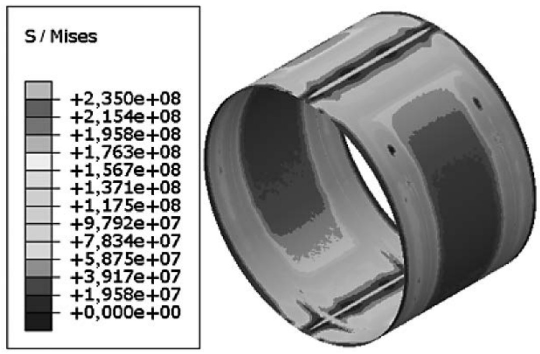

Figure 8 Uniform deceleration stress diagram

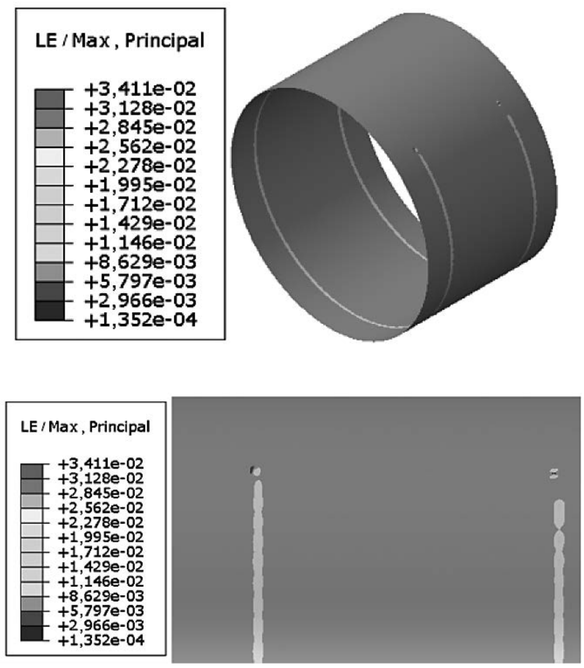

Figure 9 Uniform deceleration strain diagram

being 0,08 602 mm. The thickness of the flue is 24 mm, and the maximum deformation is around one percent of the flue thickness. Therefore, in the constant speed state, the lifting method will not have a significant impact on the weld seam of the pipeline.

From Figure 8 and Figure 9, it can be observed that during the lifting process, when in a uniform deceleration state with an acceleration of -78,5 mm/s^2, the maximum stress at other parts of the flue remains around 235 MPa. The total strain of the flue is maximum at 0,3 411 mm, with the majority of the strain being 0,08 629 mm. The thickness of the flue is 24 mm, and the maximum strain is around one percent of the flue thickness. Therefore, in the uniform deceleration state, the lifting method will not have a significant impact on the deformation of the pipeline.

CONCLUSION

In this paper, through the three-dimensional modeling and numerical simulation of the flue and weld in the project, and the analysis of the simulation results, in the process of accelerating and uniform speed under actual conditions, that is, the acceleration reaches 78,5 mm/s^2, and the maximum speed is 314 mm/s, the weld on the flue has plastic deformation in three states: uniform acceleration, uniform speed and uniform deceleration, and the maximum deformation is 0,3 416 mm, which is very small compared to the thickness of the flue, so the lifting method has little effect on the deformation of the pipeline.

Acknowledgments

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