

Study on the joint connection optimization of tall formwork steel pipe support frame

Jingxiang Wang, Lin Zhu, Yuxin Yao, Wenjie Wang, Zirui Zhu and Ning Wang*

School of North China University of Science and Technology, Tangshan 063210, China;

Abstract

In view of the fracture problem of tall formwork pin, the finite element software ABAQUS is used to optimize the mechanical analysis and simulation of the tall formwork steel pipe. The results show that the analysis of the optimized node model can clearly explain that the carrying capacity of the optimized node model is significantly improved.

Keywords

Tall mold; disc node; optimization analysis; ABAQUS.

1. Introduction

With the rapid development of domestic construction projects, especially the construction facilities with large space, large span and large load are widely used in people's production and life, so the more than a certain scale of dangerous formwork support system projects^[1]It is the key and difficult point of construction technology research. The collapse accidents of formwork support frame mostly occur during preloading or unloading, load transfer, concrete pouring and vibration, and support removal, that is, when the load or bearing capacity of the accident changes^[2]. The existence of these problems will have an impact on the construction safety of the project and the stability of the support structure. In recent years, there have been many serious and malignant accidents of horizontal formwork support system collapse (as shown in Table 1), causing a serious social impact. Therefore, it is of great significance to study high branching techniques. Domestic and foreign experts have also carried out a series of studies^{[3]-[6]}.

Table 1 Table of template accidents in recent years

Order number	Time	Project location	Cause of the accident and the casualties
1	In November, 2023	Shanxi Yongxin Tonghai Railway Logistics Co., Ltd. Yongxin railway special line collection station construction project coal blending system raw material coal shed no. 2 locomotive room	The vertical and horizontal spacing of the vertical poles of the mold frame support system is too large, the horizontal pole of the system is too large, the frame body is not set with horizontal scissors support, the aspect ratio of the frame body does not meet the standard requirements and the full height is not set with the wall parts, and the frame body and frame do not form an effective connection with the frame structure, which reduces the overall stability of the scaffold. There in seven deaths.
2	In January, 2022	The roof of a five-story building building in Beijing collapsed	When pouring the roof of the fifth floor, the floor spacing was higher, and the steel pipe was too thin to bear the weight, and the collapse occurred. One person was killed and eight people were injured.

3	In January, 2020	A tourism development project in Jiangxia District, Wuhan city	The support frame collapsed, killing six casualties and five people
4	In January, 2019	A project in Putian City, Fujian province	The support frame slipped, killing seven people and killing five people
5	In August, 2018	Underground garage in a community in Dezhou city, Shandong province	Six people were killed and two were injured when a formwork support frame collapsed

The research object of this project is the commonly used tall formwork steel pipe support system (as shown in Figure 1), aiming to provide scientific and reasonable technical support and safety monitoring method for building construction. In view of the current commonly used bearing type plate buckle (as shown in figure 2) high die connection node in the shear fracture problem, ABAQUS finite element analysis and optimization, on the premise of economic and convenient installation, reference hinge connection way increase the shear force surface to prevent a single face force is too big and local shear, new connection node structure is put forward.

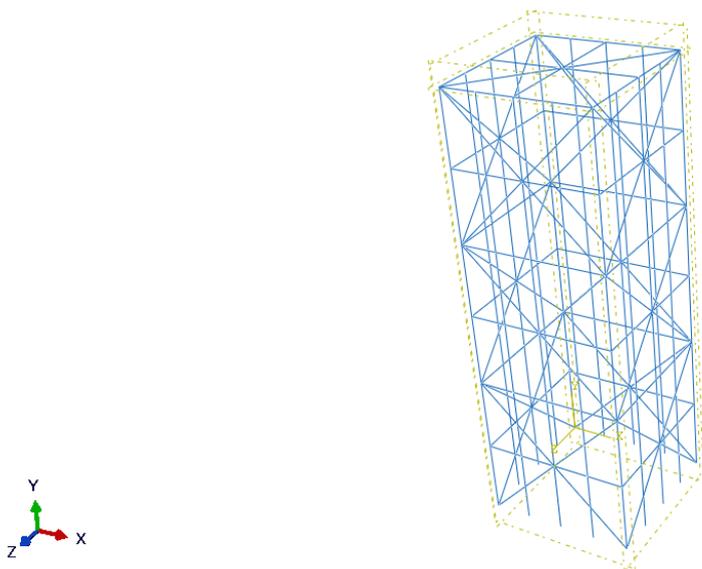


Figure 1. Tall formwork support system



Figure 2 Break of tall support pin

2. Research methods

In this paper, the whole rod model of the whole tall mold is established, and the corresponding stress cloud map is obtained to analyze the most dangerous part of the whole.

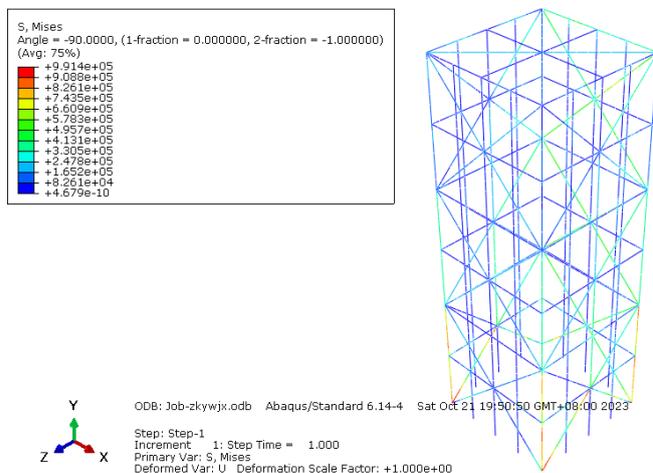


Fig. 3 Overall stress cloud diagram of tall formwork rod

In this paper, ABAQUS finite element simulation is used to test. In two different models, by applying downward 1mm deformation in the two node spans, we obtain the corresponding stress and strain relationship to analyze the advantages and disadvantages of the node model, so as to solve the corresponding problem by increasing the shear surface.

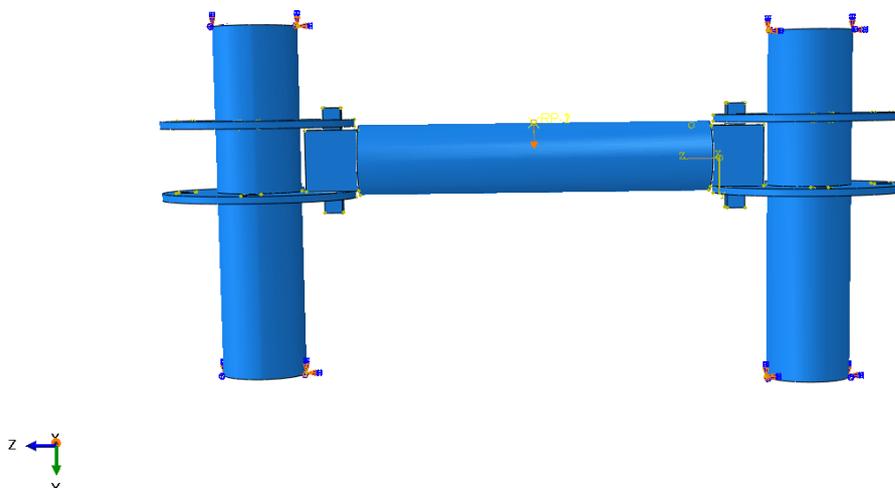


Figure 4, where the model applies the displacement

3. Modeling process

The model adopts the method of direct modeling within ABAQUS, using two circular steel pipes with diameter of 48mm and inner diameter of 3mm, with disk and square plug, and connecting the two steel pipes through 40mm diameter steel pipes. Before optimization, there is only a disc playing a supporting role. After optimization, it becomes a double disc to jointly resist deformation, which greatly improves the stiffness and carrying capacity of the structure, making it easier to construct and more economical.

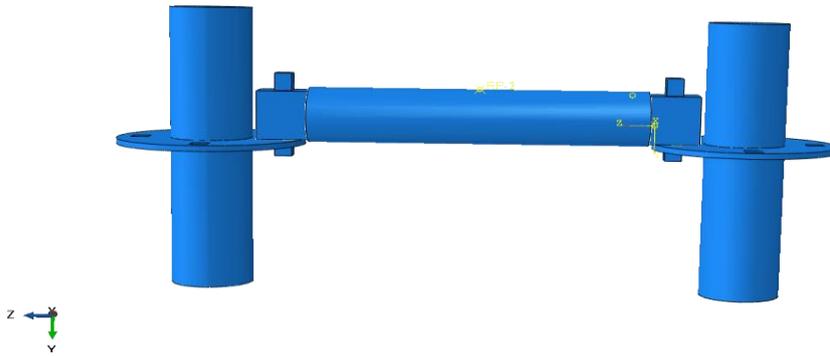


Figure 5 optimizes the pre-node model

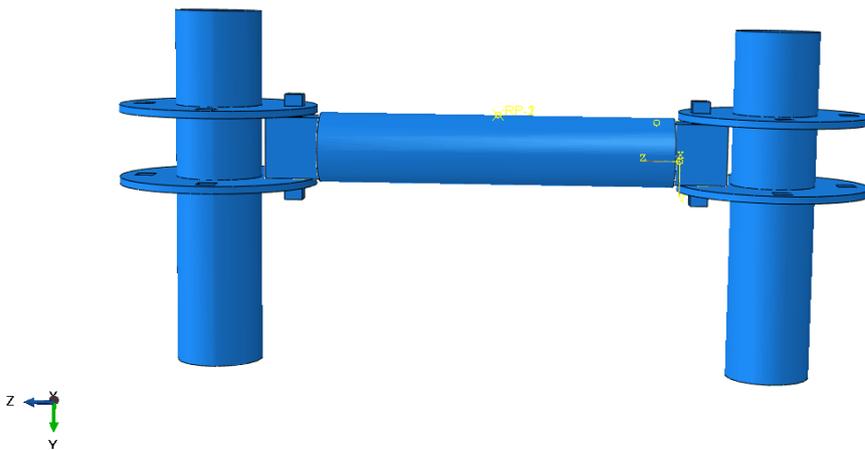


Figure 6 shows the optimized node model

The analysis of the structure shows that the contact is set as tangential penalty function and the contact is hard contact, and the general contact is set to simulate their interaction. At the same time, according to their grid division, the 6-faceted grid division is adopted, and at the same time, a small part of the disk is divided by free mesh technique, which solves the problem of grid deformity and poor analysis effect.

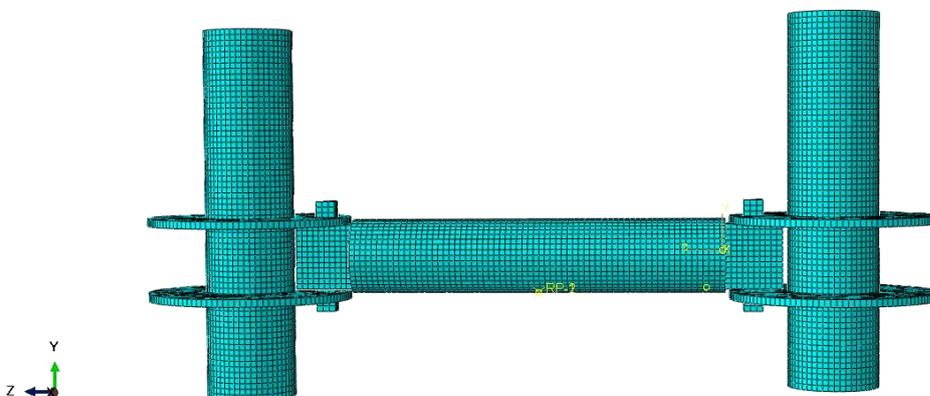


Figure 7. Model meshing diagram

4. Data analysis

After ABAQUS data simulation, take its elastic stage analysis, get the following stress strain relationship curve, including the abscissa represents strain, the longitudinal represents stress, above the curve is optimized, below the curve for the optimization, from the obvious trend, the optimized node is significantly higher than before the optimization load, better performance.

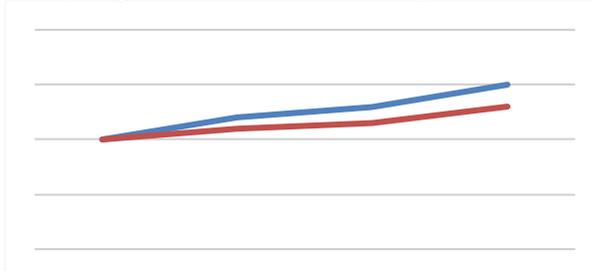
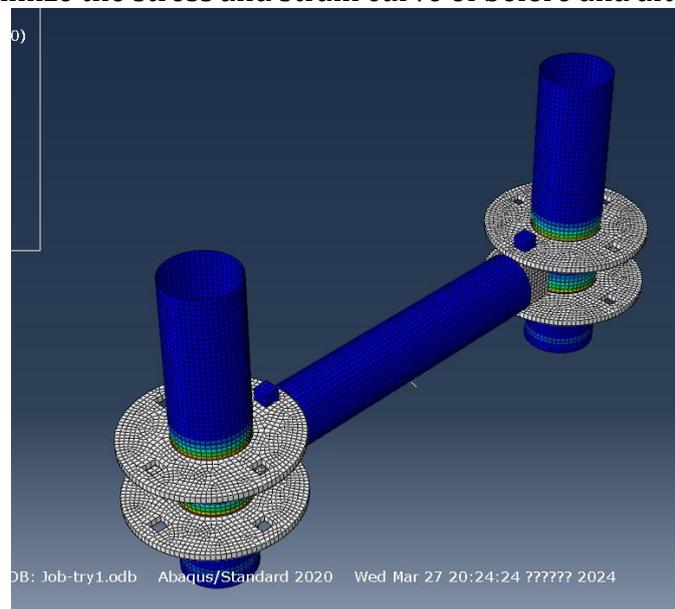


Figure 8 Optimize the stress and strain curve of before and after node model



1Figure 9 Stress nephogram of new node model

5. Conclusion

Compared with the traditional new node structure, the shear force surface of the node is larger, which is more economical and easy to install, and effectively avoids the problem of pin fracture.

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