Mechanical analysis of full fastener scaffold

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Abstract. As a convenient working platform for construction, scaffold, especially fastener scaffold, is more and more widely used in projects. However, with the increasing utilization rate, the frequent accidents of scaffold also make scaffold safety issues receive extensive attention. This paper uses ANSYS to establish the finite element model of fastener scaffold and studies the effect of joint rigidity on the scaffold’s bearing capacity.

1. Introduction
Scaffolding is a steel frame working platform for construction convenience, and it is an important construction tool. Fastener scaffold has been widely used due to its advantages of simple processing, relatively economic, convenient handling, simple disassembly, as well as assembly, flexible erection, and strong versatility[1]. In construction, the double-row fastener steel tube scaffold has certain research and specification, while the full fastener steel tube scaffold continues to use the double-row fastener theoretical method and calculation model, which is obviously not completely safe and reliable[2]. Therefore, this paper mainly takes full fastener steel tube scaffold as the research object and analyses the effect of joint rigidity on the scaffold’s bearing capacity.

2. Finite Element Modeling of Full Fastener Steel Tube Scaffold
This paper chooses full fastener steel pipe scaffold as research object. The specific arrangement of the scaffold is shown in Figure 1. The scaffold is made of Q235 steel and 48.3 x 3.6 steel pipe.

The joints of scaffolding are connected by right angle fasteners, which are semi-rigid. This paper studies scaffold model with semi-rigid joints. Torsional rigidity of joints ranges from 19 to 25 kN.m/rad[3]. By establishing a simplified model and setting different torsional rigidity of spring, it is found that the greater the rigidity, the closer the joint is to the rigid joint, the smaller the rigidity is, and the closer the joint is to the hinge joint. This paper takes the joint rigidity as 20 kN.m/rad[4], and the calculation model obtained is shown in Figure 2.

In addition to self-weight, load 5630N in Y direction at Longitudinal 1/4 and transverse 1/2 positions (X = 1.5m, Y = 2m, Z = 1m) on the top of the scaffold.
3. Calculation results of semi-rigid scaffold model

From Figure 3, it can be seen that the maximum deformation and displacement are both at the position where applied load, and the maximum displacement is 0.002121m.

From Figure 4, it can be seen that the maximum bending moment is 737.283N·m at the position where the load is applied.
Figure 3. Deformation Diagram after Loading.

Figure 4. Bending Moment Diagram of the Scaffold Model.

Figure 5. Stress Diagram of the Scaffold Model.
From Figure 5, the results of ANSYS calculation show that the maximum stress is 140 MPa at the loading position.

4. Comparison of the rigidity and semi-rigidity of scaffold model joints

The ideal overlap for steel frames is rigid connection. This paper also studies and compares the rigid joints and semi-rigid joints. Establish scaffold structure with rigid joints and apply the same load to the scaffold model at the same position. The calculation results of rigid joints are obtained by ANSYS and compared with semi-rigid joints. The comparison results are shown in Table 1.

| Working Condition | Maximum Displacement (mm) | Maximum Turning Angle (rad) | Maximum Bending Moment (N·m) | Maximum Stress (MPa) |
|-------------------|---------------------------|-----------------------------|-------------------------------|---------------------|
| Rigidity          | 1.982                     | 0.004975                    | 714.84                        | 136.42              |
| Semi-rigidity     | 2.121                     | 0.00523                     | 737.283                       | 140.58              |
| Increasing percentage | 7.01%                    | 5.12%                      | 3.14%                         | 3.04%               |

5. Conclusion

In practical engineering, it is difficult to connect horizontal bar and vertical bar with fasteners rigidly, and they are semi-rigid because of artificial deviation and quality problems. The research object of this paper is full fastener steel tube scaffold, which uses spring to simulate semi-rigidity of joints. Through comparative analysis, this paper concluded that the deformation and internal force of semi-rigid scaffold are larger than rigid scaffold. Rigid joints are ideal, and semi-rigid joints are closer to the actual situation.

It shows that in practical engineering, fasteners should be tightened so that fasteners do not rotate. The closer the joints of scaffolds tend to be rigid connections, the higher the bearing capacity and safety of scaffolds can be.

References

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