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Effect of Ground Stack for Additional Internal Force and Deformation of Underground Pipeline

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Abstract

Based on three dimensional finite element model of underground pipeline, the ground wall additional loads influence on underground pipeline stress characteristics, and the further analyzing the influence regular of different effect of soil, load location, and different buried depth to pipe stress characteristics were studied. The research results show that when the distance between load center and axis increased, the pipeline axis position of pipe maximum displacement and maximum bending moment and shear force decline significantly, but when the distance is increased to a certain value, the pipeline of the maximum vertical displacement and internal force is almost zero. of the maximum vertical displacement and internal force is almost zero. Different pipeline have minimum value of maximum axial displacement and vertical displacement in the soft soil ， and maximum axial displacement in clay, vertical displacement in the sandy soil is the largest. Maximum axial displacement of UPVC pipe in clay is 2 times for maximum axial displacement in soft soil. The vertical displacement of different material pipes are increased with the increase of buried depth, but the concrete pipe and steel pipe of maximum axial tension increase significantly increased with the increase of buried depth, but the change of UPVC pipe is quite gentle.

Keywords

Finite element; Wall; Pipeline; Displacement; Axial force; Bending moment.

1. INTRODUCTION

The large-scale finite element general software ABAQUS is used to carry out numerical simulation of the pipeline, to study the influence of the ground wall on the mechanical characteristics of the lower pipeline, and to determine whether the pressure generated by the additional load generated by the upper wall on the pipeline exceeds its design pressure value. In the simulation process, the model is simplified to a certain extent, and its basic assumptions are:

(1) The engineering geological conditions are simplified, and the soil layers are assumed to be uniformly distributed in the simulation process.

(2) The material of the soil layer is assumed to be an isotropic material.

(3) Boundary conditions and loading conditions of the model: the upper surface of the model is a free surface, the lower surface is all constrained surfaces, and displacement constraints in the X and y directions are applied, and the surrounding sides are horizontal constraint surfaces, and the horizontal displacement constraints in the X direction are applied; Gravity load all elements of the model.

(4) The model does not consider the regional tectonic stress, only the stress caused by gravity.

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2. FINITE ELEMENT MODEL OF PIPELINE

In order to simplify the calculation, the constitutive model of the geotechnical material used in this paper is the Mohr-Coulomb constitutive model, and the pipeline adopts the elastic material model. Table 1 shows the material parameter characteristics of each material partition. At the same time, in order to consider the interaction between the soil and the pipeline, the Mohr-Coulomb contact model is used between the pipeline and the soil, and the embedded contact is used for the contact between the pipeline and the soil.

Table 1. Material parameters

Material	Density g/cm^3	E(Pa)	μ	Cohesion(kPa)	Internal friction angle (°)	Expansion angle(°)
Pipeline	7.8	2.05e11	0.3	/	/	/
Clay soil	1.85	4.5e7	0.35	25	24	15

3. CALCULATION RESULTS

3.1 Pipe Overlaid Flag Stand

The flag stand is 4.8m long, 1m high, 3.3m wide, and the pipeline is buried 1.3m deep. The pipe diameter is 273.1mmx6.4mm. The pipeline passes through the lower part of the longitudinal center of the flag platform, and the standard value of constant load is $25kN/m^2$, as shown in Figure 1.

Figure 1. Pipe overlaid flag stand

The top flag platform is simplified as a uniform load acting on the foundation soil, as shown in Figure 2.

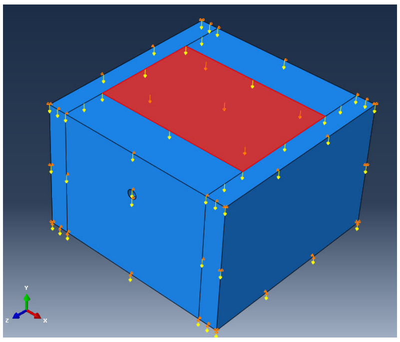

Figure 2. Diagram of load action of calculation example

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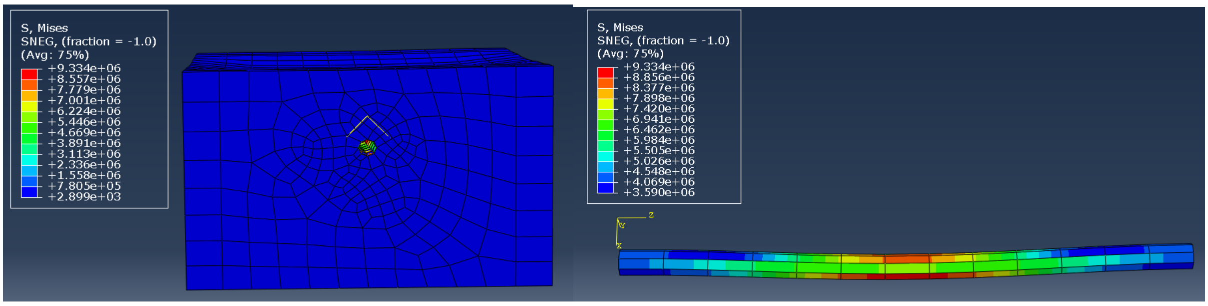
In order to determine whether the force of the lower pipe meets the design value when the wall is laid on the upper part of the pipe, the force of the pipe after the wall is laid is analyzed, as shown in Figure 3.



(a) Overall (b) Pipeline

Figure 3. Mises stress diagram of pipeline

It can be seen from the calculation that the Mises equivalent stress generated by the upper wall to the pipeline is 9.33MPa, and its maximum value appears at the bottom of the pipeline.

3.2 Pipe Overlaid Brick Wall

The pipelines are mainly buried in the cover layer with an average depth of 1.3m. The width of the overlying wall is 0.40m, the height of the wall is 4.5m, the length of the wall is 4m, the standard value of constant load is 86KN/m2, and the standard value of ground stacking or personnel load is 2.5kN/m^2, as shown in Figure 4.

Figure 4. Brick wall on the pipeline

The top wall is simplified as a uniform load acting on the foundation soil, as shown in Figure 5.

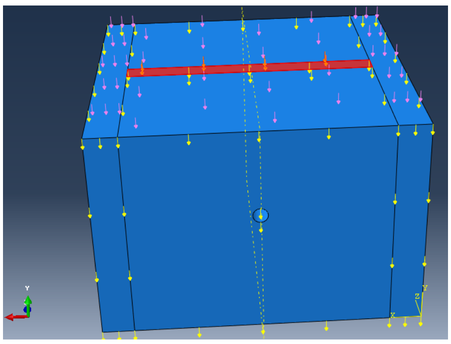


Figure 5. Diagram of load loading

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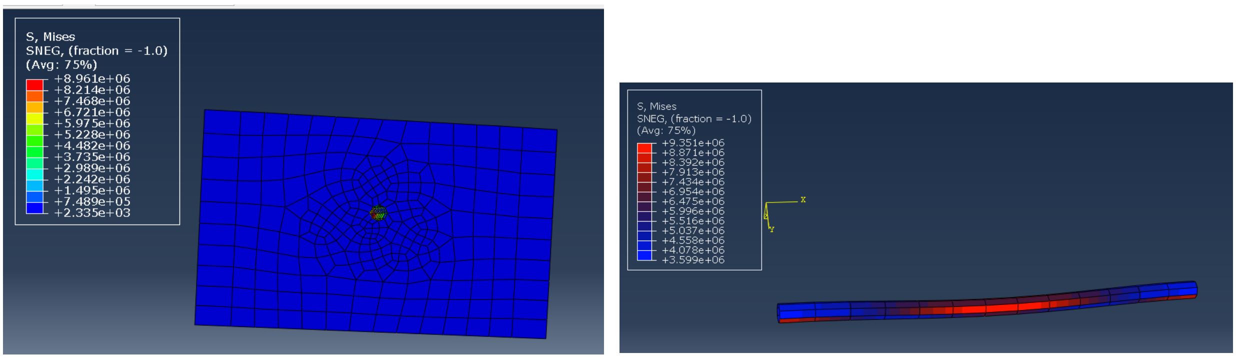
In order to determine whether the force of the lower pipe meets the design value when the wall is laid on the upper part of the pipe, the force of the pipe after the wall is laid is analyzed, as shown in Figure 6.



(a) Overall (b) Pipeline

Figure 6. Mises stress of pipeline

As shown in Figure 6, it can be seen from the calculation that the Mises equivalent stress generated by the upper brick wall to the pipeline is 8.96MPa, and its maximum value appears at the top of the pipeline.

4. CONCLUSION

The large-scale finite element analysis software ABAQUS is used to calculate the additional pressure generated when the wall is laid on the upper part of the pipeline. The results show that the stress of the pipeline under working conditions 1 exceeds the design allowable value of 10MPa, which will cause danger. Working condition 2 is close to 10MPa, which is more dangerous.

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