

# Application of Steel Cylinder in Offshore Engineering

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**Abstract:** With the development of economy, the demand for marine development is increasing. Steel cylinder with large diameter has high construction efficiency and good economic benefit and is widely used in the artificial island, cofferdam and breakwater engineering. This paper, based on a project in the South China Sea, utilized the finite element method of PLAXIS 3D, analyzed the global stability of steel cylinder with large diameter and thin-walled under the action of wave load, and provided the base dates and technical supports for the project.

## 1. Project Profile

This project is an offshore project which is local in South China Sea. Steel cylinder with large diameter is used as a temporary cofferdam. In order to ensure the project safety, global stability of the steel cylinder should be calculated. The calculated parameters of steel cylinder are shown in Table 1, the parameters of soil foundation is shown in Table 2.

The water level is +0.52m, the wave load is 6500 kN. Due to the short construction time, the weakness of soil foundation under the wave cyclic load is not considered.

Table 1 Calculated parameters of steel cylinder

Elevation of cylinder top	Elevation of cylinder bottom	Depth in the soil	diameter	Wall thickness	unit weight	Poisson ratio
+0m	-50.7m	20m	22m	16mm	78 kN/m <sup>3</sup>	0.25

Table 2 Calculated parameters of soil foundation

No.	Soil name	Soil thickness/m	Density /g/cm <sup>3</sup>	Modulus compression/MPa	Soil shear strength	
					Cohesion/kPa	Internal friction angle/°
①	silt	6.8	1.6	1.7	4	4
②1	clay	4.2	1.75	4	6	5
②3	Mealy sand	2.2	1.95	7	1	30
②2	clay	4.4	1.8	4	15	6
②7	Gravelly sand	7.5	1.95	12	1	31

## 2. Analysis Results

PLAXIS 3D finite element software is used to calculate the global stability of steel cylinder, in which the Mohr-Coulomb constitutive model and strength reduction method are used. The finite element model is shown in Figure 1.

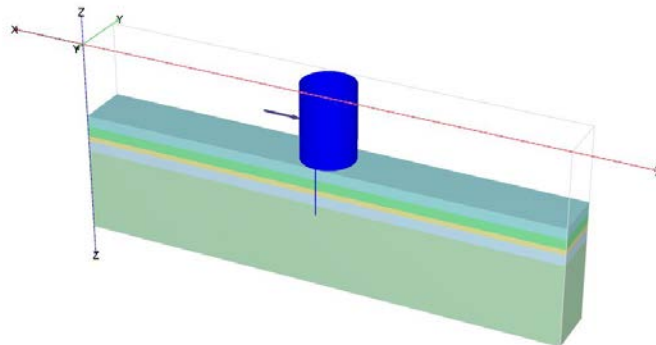


Fig.1 PLAXIS finite element model

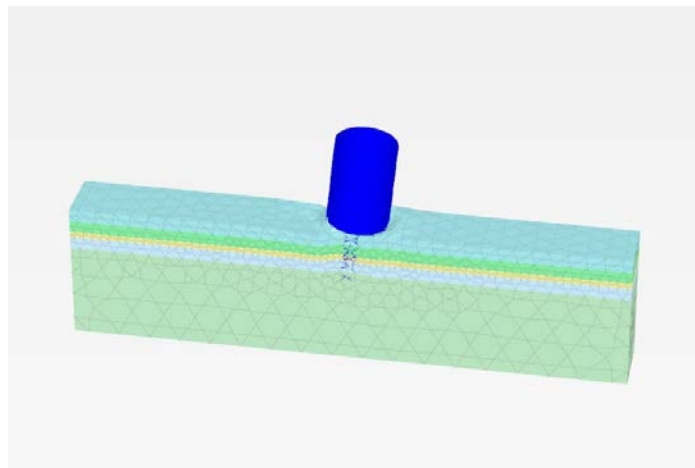


Fig.2 Deformation mesh

The model length is 200 m, width 22m, deep 80 m, elevation of steel cylinder top is +0.00m, depth in the mud is 20m, underwater depth is 30.7 m. The deformation mesh of calculate model is shown in Figure 2.

The deformation cloud chart of steel cylinder is shown in Figure 3. The calculate results of global stability is shown in Figure 4.

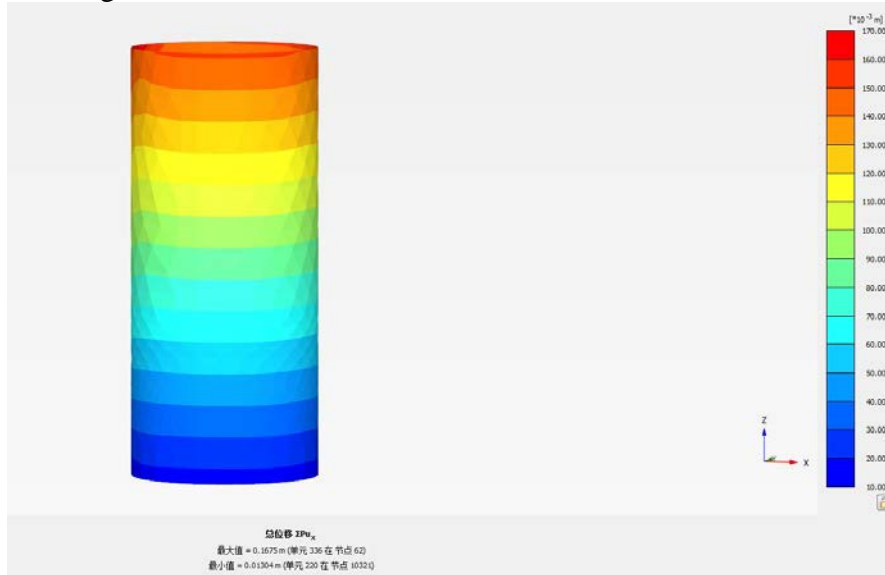


Fig.3 Deformation cloud chart of steel cylinder

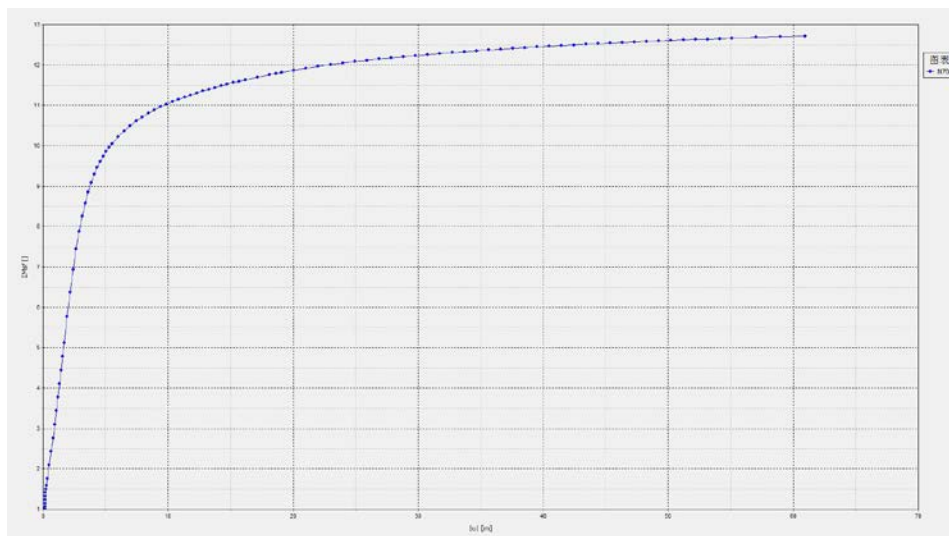


Fig. 4 Deformation-safe factor chart of steel cylinder

The calculation results are summarized in Table 3.

Table 3 Calculate results

Depth in the soil	The max lateral displacement of cylinder top	The max lateral displacement of mud surface	The max lateral displacement of cylinder bottom	Safety factor
20m	0.167m	0.067m	-0.013m	12

### 3. Conclusion

This paper utilizes the PLAXIS 3D finite element software to calculate the global stability. The main conclusions are as follows:

(1) The strength reduction method is used to calculate the global stability and the results show that the steel cylinder would not have the global instability if the embedded depth in soil foundation is 20m.

(2) Under the action of wave load, the max lateral displacement of steel cylinder top is 0.167m, The max lateral displacement of mud surface is 0.067m, The max lateral displacement of cylinder bottom is -0.013m.

(3) Due to the short construction time, the weakness of soil foundation under the wave cyclic load is not considered. In addition, as a larger- diameter and thin-walled structure, steel cylinders are prone to damage or instability. Therefore, monitor of construction period and construction safety need to be strengthened.

### References

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