

Summary of Steel Slag Pile Composite Foundation

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Abstract

Steel slag pile composite foundation as a way of foundation reinforcement can be widely used in many building engineering fields. This paper considers that steel slag pile composite foundation can greatly improve the bearing capacity of foundation, reduce the settlement of foundation, and reasonably reduce the construction cost.

Keywords

Steel slag pile; composite foundation; bearing capacity; construction

1. Introduction

In recent years, China has made tremendous achievements in urbanization construction. However, the problem of large population base and less land per capita is becoming more and more serious, which seriously affects the pace of urbanization development in China in the future. Ocean area accounts for 29.2% of the earth's surface area. The development of human urbanization is bound to face the ocean and demand land from the ocean.

Steel slag is an industrial waste produced in metallurgical industry, and its production is estimated to be about 8%-15% of crude steel output by current production technology. For a long time, the reuse rate of steel slag in our country is far lower than that in developed countries, and most of them are used for foundation pit backfilling. A large number of agricultural land is occupied by its waste dump, and because of its alkaline chemical composition, the surrounding environment is alkaline, so that the environment is polluted. As the largest steel production country in the world, China produces hundreds of thousands of tons of scrap every day, so the recycling and reuse of steel slag must be paid attention to.

Steel slag pile composite foundation will play an exemplary role in land reclamation and steel slag waste utilization. The advantages of steel slag piles are small pollution, fast construction speed, simple construction equipment and relatively low cost. Therefore, it can be widely used in soft soil foundation treatment of industrial and civil buildings. However, as the principle of deformation and failure of composite foundation has not been fully explored, there are still many uncertain factors to be solved urgently, such as the uncertainty of calculation model and performance parameters, which requires us to conduct a large number of field pile test, supplement and improve the design formula of steel slag pile composite foundation, which is in engineering. It has great application value.

2. Types of Composite Foundation

The bearing capacity of composite foundation is shared by two materials with different stiffness, pile and soil between piles. In these two materials, pile is the main bearing member because of its high strength. Therefore, according to the strength and material composition of pile, composite foundation can be divided into three categories:

2.1 Flexible Pile Composite Foundation (Bulk Soil Pile)

There are mainly gravel pile composite foundation, gravel pile composite foundation, pebble pile composite foundation and steel slag pile composite foundation.

2.2 Rigid Pile Composite Foundation (Concrete Piles)

There are mainly cement fly ash pile composite foundation and plain concrete pile composite foundation.

2.3 Semi-rigid Pile Composite Foundation (Solid Pile)

There are mainly lime-soil pile composite foundation, soil pile composite foundation, lime pile composite foundation, lime-fly ash pile composite foundation, jet grouting pile composite foundation, deep mixing pile (powder spraying and grouting) composite foundation, compacted cement-soil pile composite foundation. For semi-rigid pile composite foundation, its bearing characteristics are closely related to its pile structure strength.

3. Working Behavior of Steel Slag Pile Composite Foundation

After the steel slag pile is poured into piles, a series of chemical reactions take place in cement, which produces a variety of stable crystalline compounds insoluble in water. The continuous growth of crystalline compounds fills in the gap between aggregates, thus forming rigid piles with high strength steel slag piles. The surrounding foundation soil is compacted by steel slag pile, and its bearing capacity is increased after being confined by compaction. So the upper load is shared by pile and soil, and the bearing capacity of natural foundation is greatly improved. As an important part of steel slag pile composite foundation, reasonable setting of ground cushion can greatly increase the bearing capacity of pile body and soil between piles and improve its mechanical properties. Steel slag piles not only fully play the role of rigid piles, but also fully excavate the bearing capacity of soil between piles. The deformation of foundation has been significantly reduced, and the bearing capacity of composite foundation has been improved.

Compression modulus of steel slag pile is much larger than that of surrounding soil, so its compressibility is smaller. The bearing capacity of steel slag pile comes from the lateral pressure and frictional resistance of the soil around the pile, which keeps the shape of the pile and bears the load. In order to maintain the deformation coordination between the pile and the soil between the piles, stress concentration will occur on the pile body, and the additional stress in the soil will gradually concentrate on the pile body with the deformation of the foundation, and the additional stress of the soil burden will be reduced accordingly, so the steel slag will play the role of the pile. Generally, under the same conditions, the bearing capacity of steel slag pile composite foundation is more than 20% higher than that of gravel pile composite foundation. At the same time, due to the high equivalent compressive modulus of composite foundation, it is beneficial to reduce the settlement of buildings.

4. Research History and Present Situation at Home and Abroad

4.1 History and Current Situation of Foreign Studies

As early as in the period of vigorous development of iron and steel industry, developed countries of foreign metallurgical industry began to develop and use steel slag. In 1970, at the Second Mineral Waste Utilization Conference held in the United States, the American Slag Association proposed using various steel slags as aggregates in the construction industry.

After 1980, Sumitomo Metal Company of Japan used steel slag as roadbed material. After indoor test and in-plant road test, and two years of follow-up investigation, it was proved that steel slag is an excellent roadbed material.

In recent years, the quantity and technical level of steel slag used in construction projects will be improved in Western countries, especially many new technical standards and construction regulations are formulated by the United States and Japan.

4.2 History and Current Situation of Domestic Research

For decades, China has been insisting on the reuse of steel slag, and has been applied in many fields such as metallurgy, agriculture, building materials and so on.

In 1998, Wuhan Iron and Steel Group Corporation organized the test of using steel slag as backfilling material for foundation, and formulated interim technical regulations for construction of backfilling foundation for internal use.

Tao Huang et al. (1998) studied the design ideas and testing methods of steel slag pile composite foundation, and made a comprehensive analysis from the technical, economic and social perspectives. Xiaozhang Wang et al. (2000) studied the mechanism of improving bearing capacity of various steel slag pile composite foundations, the physical and chemical characteristics of piles and the characteristics of bearing capacity of various piles. On this basis, the design parameters of composite foundations were adjusted through experiments.

Chonglun Zhang (2001) analyzed the stress sharing ratio between pile and soil and the distribution law of lateral excess pore water pressure in the process of pile formation.

Generally speaking, due to the special physical and mechanical properties of steel slag, the research results are not systematic enough, so the popularization and application of steel slag pile is slow.

The research, development and application of steel slag in China is still in its infancy, and the benefit of steel slag reuse is low. In some areas of our country, steel slag piles have been applied, but compared with other applied piles, their theory is far from perfect, and there is no standard to determine their bearing capacity, so they can only be estimated approximately, resulting in very conservative results, and their reinforcement effect can only be obtained by means of field experiments.

5. Prospects

Tangshan is the cradle of China's modern industry and the first of many Chinese industries. In particular, the annual output of iron and steel exceeds 200 million tons, which provides strong support for the modernization of the motherland. With the development strategy of "one port and two cities", a new way of integration and development of port-industry-city with Tangshan characteristics will be found. This requires vigorous development and construction of port facilities. However, the construction of port can not avoid the influence of weak foundation. The abundant iron and steel output and port development and construction will inevitably urge the government, schools and scientific research institutes to jointly develop and utilize steel slag piles, so as to make them continuously improve and develop.

6. Conclusion

- (1) Reducing the amount of coarse steel slag and increasing the amount of fine steel slag can reduce the material porosity, make the steel slag pile reach the predetermined strength and improve the bearing capacity of composite foundation.
- (2) Steel slag pile can be used in many complex geological conditions, such as muddy soil, saturated and unsaturated clay, collapsible loess and other soft foundations.
- (3) According to the geological conditions and design requirements, steel slag piles can change the bearing capacity of piles and their compaction effect on Soil by changing the conditions of determining pile diameter, pile spacing and pile length, so as to improve the bearing capacity of soil.
- (4) The low price of steel slag raw materials reduces the overall cost of construction, and provides a new shortcut for the recycling of steel slag, which will inevitably become a new technology of ground treatment vigorously promoted.

References

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