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PRELIMINARY DISCUSSION ON BUILDING FOUNDATION TREATMENT AND FOUNDATION SELECTION IN KARST AREAS IN WUHAN CITY

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Abstract: Several geomorphological units and their stratigraphic distribution in Wuhan City were sorted out. According to the stratigraphic characteristics of the karst sections of different geomorphological units, the stability of karst foundations, building foundation treatment methods and foundation selection principles were analyzed and evaluated for engineering geological survey and design.
Keywords: Wuhan City, Karst, Foundation treatment, Foundation selection, Borehole backfilling

1 KARST TYPES AND SPATIAL DISTRIBUTION IN WUHAN URBAN AREA

Karst is an undesirable geological phenomenon, which is a different geological form produced by the dissolution of soluble rock in groundwater. Three basic conditions must be met for the development of karst: 1) The site is distributed with soluble rock formations, such as limestone, dolomite and other carbonate rocks; 2) Groundwater with dissolving ability; 3) The groundwater has good circulation conditions.

1.1 Characteristics of Karst Types in Wuhan City

There are mainly two types of karst in Wuhan: covering type and buried type. Exposed karst is rarely distributed in the urban area. Covering karst, because the carbonate rocks are directly covered with Quaternary loose accumulations, it has a greater impact on the stability of the building site and foundation. In buried karst, there are thicker Cretaceous to Lower Tertiary rock formations above the carbonate rocks. Due to the large burial depth, they are covered by a large thickness of insoluble rock formations, so they have little impact on the stability of the site.

1.2 Spatial Distribution of Covered Karst in Wuhan City

Wuhan City is located in the middle reaches of the Yangtze River. The Yangtze River passes through the urban area of Wuhan roughly from south to north. The landforms of Wuhan City extend to both sides based on the Yangtze River and can be divided into the Yangtze River Class I Terraces, the Yangtze River Class II Terraces, and the Yangtze River Class III Terraces (Longgang). Three large units. Controlled by the regional geological structure, the distribution of overlying karst in Wuhan is roughly divided into three strips: north, middle and south. The trends are nearly east-west and basically span three large landform units.

1.3 Main Forms of Covering Karst

The carbonate rocks distributed in the overlying karst areas in Wuhan are mainly limestone and dolomite. Karst generally develops on the surface of the rock layer or within a certain depth in the upper part of the rock layer. The karst forms on the surface of the rock layer generally include stone buds, karst ditches, and karst troughs. Karst forms are generally caves and fissures, and most of the caves are filled with soft to plastic clay soil.

2 STRATIGRAPHIC DISTRIBUTION CHARACTERISTICS OF KARST AREAS IN DIFFERENT GEOMORPHOLOGICAL UNITS IN WUHAN CITY

The karst sections in Wuhan City are located in different geomorphological units, and the distribution and properties of the Quaternary overlying strata are also different. There are mainly three situations:
1) The first-class terrace of the Yangtze River: The Quaternary overlying layer of the first-class terrace of the Yangtze River has a typical binary structure. The upper part is soft plastic clay soil, and the lower part is slightly denser sandy soil. The upper part of the first-class terrace of the Yangtze River has The karst is often in direct contact with the sand layer. The sand layer is a confined water aquifer. The confined water of the sand layer has hydraulic connections with the Yangtze River. However, the sand has no cohesion and is easily affected by the flow of groundwater and collapses into karst holes, causing ground Collapse. Most ground collapses in Wuhan City occur in such karst areas.
2) The rear edge of the Yangtze River Class I terraces and the Yangtze River Class II terraces: The upper part of the covering layer of this landform unit is soft to soft plastic clay soil, below it is slightly dense to dense sandy soil, and below the sand soil is soft to hard plastic clay soil , so the karst on this type of landform unit is not in direct contact with sandy soil. The karst is covered with clay soil. The clay soil has a certain cohesion, has a spanning capping effect, and is

a water-isolating layer that connects the confined water of the sand layer with The karst water is separated so that there is no hydraulic connection between the two. Ground collapse generally does not occur in such karst areas.
3) The third-level terrace of the Yangtze River (ridge and hillock section): The covering layer of the third-level terrace of the Yangtze River (ridge and hillock section) is mainly Quaternary old clay soil. The upper part of the karst cover on this landform unit has a small plastic shape. Generally speaking, the lower part of clay soil is hard plastic to hard old clay soil, and there is generally hard plastic red clay on the limestone layer. This kind of karst area is not a ground subsidence area in Wuhan City.

3 FOUNDATION TREATMENT METHODS IN KARST AREAS OF DIFFERENT GEOMORPHOLOGICAL UNITS

When carrying out engineering construction in karst areas, the development of karst on the site must first be identified through engineering geological survey, supplemented by geophysical survey when necessary. According to national regulations, engineering geological survey of karst areas, in addition to the detailed survey corresponding to the construction drawing design stage, also requires construction survey. According to the specific foundation type, before foundation construction, the development of karst under the foundation must be accurately identified. When the foundation adopts natural shallow foundation (such as independent foundation, raft foundation), the construction survey arranges exploration holes column by column. When the foundation adopts pile foundation, the construction survey arranges exploration holes column by pile. The karst conditions discovered during construction surveys are usually dealt with as follows:
1) For karsts that are in direct contact with the sand layer on the first-level terraces of the Yangtze River, it is necessary to set up a bottom-type water-proof curtain around the site, carry out deep stirring and sealing of the sand layer within a certain depth in the site area, and carry out filling and filling of the karst cave. , to ensure the stability of the site and prevent ground collapse. Engineering construction in such karst areas is costly.
2) For the karst on the rear edge of the Yangtze River Class I terraces, the Yangtze River Class II terraces and the Yangtze River Class III terraces (ridge and hillock sections) that are not in direct contact with the sand layer, only the caves discovered during construction surveys can be filled and filled.

4 BASIC SELECTION PRINCIPLES FOR KARST AREAS IN DIFFERENT GEOMORPHOLOGICAL UNITS

4.1 Karst Areas Directly Covered with Sandy Soil on the First-Level Terraces of the Yangtze River

Relevant documents from Wuhan City stipulate that such areas are potential ground subsidence areas and are in principle not suitable for construction. If engineering construction is carried out, after necessary foundation treatment, regardless of the size of the building or the number of floors, the foundation must be drilled. For rock-socketed piles, one pile with one hole or one pile with multiple holes is used for construction survey (pre-drilling) before construction of the pile foundation. The penetration of the pile end into the completed bedrock (limestone or dolomite) is not less than 2.0 m, and it is ensured that the pile end is 5 .No caves exist within 0 m.

4.2 The Rear Edge of the First-Order Terrace of the Yangtze River and the Above-Ground Karst Area of the Second-Order Terrace of the Yangtze River

The surface of the soluble bedrock in such areas is covered with a certain thickness of cohesive soil. The sandy soil has no direct contact with the karst, but the upper covering layer is generally a weak soil layer with low bearing capacity and high compressibility, and cannot be used as a natural foundation. When the thickness of the cohesive soil layer on the rock layer is empirically calculated to meet the stability requirements, a composite foundation or friction pile foundation can be used for buildings with a small number of layers and a small load, and the sandy soil layer with better strength in the lower part of the covering layer is used as a composite foundation. foundation or friction type pile foundation bearing layer.

4.3 Karst Areas in the Third-Level Terraces of the Yangtze River (Longgang Section)

The overlying layer above the soluble bedrock in such areas is mostly old clay soil with good strength. The choice of foundation type can be divided into the following three situations:
1) Natural foundation and shallow foundation: When the thickness of the soil layer under the base meets the karst stability requirements and a bearing layer that meets the load requirements can be found on the upper part of the covering layer, a natural shallow foundation can be directly used, such as an independent foundation or a raft foundation.
2) Composite foundation or friction pile: When the thickness of the soil layer below the base meets the karst stability requirements, but the upper soil layer cannot be used as a natural foundation, composite foundation or friction pile foundation can be used. In order to avoid the influence of the lower karst on the pile tip, the thickness of the soil between the pile tip of the composite foundation single pile and friction pile and the rock layer should meet the karst stability requirements. Limestone, dolomite and other soluble carbonate layers generally have a certain thickness of red

clay. The red clay is hard at the top and soft at the bottom. It is a relatively weak underlying layer of the upper bearing layer. The use of composite foundation not only improves the bearing capacity of the bearing layer , while improving the strength of the weak underlying layer.
3) Rock-socketed piles: For super high-rise buildings, when natural foundations, composite foundations and friction pile foundations cannot meet the bearing capacity or deformation requirements, rock-socketed piles can only be used.

5 BACKFILLING TREATMENT OF BOREHOLES IN VARIOUS EXPLORATION STAGES IN KARST AREAS

5.1 The Hazards of not Backfilling the Exploration Boreholes in Karst Areas

As mentioned before, a basic condition for the development of karst is good water circulation conditions. Groundwater in karst sites is generally divided into karst water in the lower rock layer and stagnant water in the upper layer (supplied by surface water and atmospheric precipitation). The sand layers of the Yangtze River Class I and II terraces also contain Yangtze River confined water. Under natural conditions, the upper layer stagnant water and compressed water Water and karst fissure water are blocked by the viscous soil layer and have no hydraulic connection. However, the survey borehole drilled through the aquifer and opened the hydraulic connection channel of each aquifer, creating convenient conditions for the development of karst. Over time, the upper soil layer It will also be lost from this water flow channel, destroying the stability of the stratum in its original state, forming soil holes and sinkholes, and causing ground subsidence.

5.2 Backfilling Method for Boreholes in Karst Areas

In principle, all exploration boreholes need to be backfilled to restore the original state of the strata as much as possible, but the backfill quality of boreholes in karst areas is required to be higher.
Detailed survey drilling requires backfilling using a "soil-for-soil, sand-for-sand" method, with the focus on sealing the connection between the upper and lower aquifers.
The "one column, one hole" construction survey drilling of natural foundations and composite foundations, within the scope of the foundation, should be filled with high-grade cement slurry. On the one hand, the soil sections are grouted to restore the strength of the foundation soil. On the other hand, Grouting in rock formation sections treats potential karst, which is beneficial to the overall stability of the foundation.
The construction survey (advanced drilling) of rock-socketed piles with "one hole per pile or multiple holes per pile" requires boring pile construction and concrete pouring to form piles in situ, so there is no need to backfill the holes.

6 CONCLUSION

Karst foundation is a difficult problem that engineering geological survey and designers must take seriously. The difficulty lies in the irregularity of karst development and the unpredictability of being buried deep in the ground. This article attempts to start from various geomorphic units in Wuhan City, and by analyzing the distribution and characteristics of strata on different geomorphic units, it summarizes the foundation treatment methods and foundation selection of karst sections on different geomorphic units. It does not seek accurate calculations, but accurate judgments. For reference by those engaged in engineering geological survey and design.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

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