THE ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI
FASCICLE XIV MECHANICHAL ENGINEERING, ISSN 1224-5615
2024

CONSOLIDATION OF A FOUNDATION LOCATED ON TERRAIN WITH A HIGH DEGREE OF SLIPPING

Conf. dr. ing. Gina Diana MUSCĂ
Student Eng. Silviu Marian TOADER
"Dunărea de Jos" University of Galați,
Engineering and Agronomy Faculty in Brăila,
Research Centre for Machines and
Technological Equipment's Mechanics, Romania

ABSTRACT

The work entitled "Consolidation of a foundation located on terrain with a high degree of slipping", represents the set of technical works aimed at stabilizing the foundation land and increasing its bearing capacity depending on the type of land on which a building and/or construction is built, and is carried out based on a detailed geotechnical study and a technical consolidation project.

KEYWORDS: *consolidation, foundation design, engineer, geotechnical study, land, degree of slip.*

1. INTRODUCTION

The work entitled " Consolidation of a foundation located on terrain with a high degree of slipping " represents the set of technical works aimed at stabilizing the foundation ground and increasing its bearing capacity depending on the type of soil on which a building and/or construction is built, and is carried out based on a detailed geotechnical study and a technical consolidation project. It also aims to protect the construction against displacements or failures caused by landslides [1, 2].

The types of soil in our city area are loess, which can be clayey or dusty, characterized by high porosity. Under the action of external loads, the action of water additionally settles.

The construction of piles as structural elements is carried out in accordance with the regulations in force regarding the materials from which the piles are made, as well as the complementary provisions of the standards SR EN 14199:2015 Execution of special geotechnical works [7].

To create a pile foundation, it is necessary to specify information regarding the specific conditions of the site:

- the stratified structure of the foundation soil, accompanied by the relevant geotechnical parameters;
- the seismicity level determined for the area;
- the position of the surface waters, including the upper and lower floors, if applicable;
- the characteristic level of the groundwater table, as well as any foreseeable variations over time;
- the aggressive nature of the groundwater and surface waters, especially for foundations required with a raised base;
- the presence of biological agents that can degrade wood, in the case of using wooden foundations;
- the estimated depth of any erosion processes, where applicable.

2. CHOOSING MICROPILES

Micropiles are structural elements of small diameter (generally between 100–300 mm), executed by drilling and filled with mortar or concrete, often reinforced with a steel bar (figure 1).

The structural elements of micropiles can directly or indirectly transmit loads from the superstructure to the foundation soil and/or can reduce the deformations of the structure [5, 6].

Therefore, they are exposed to all forms of loads specific to piles, namely compression or lateral tension.

The materials used are: cement paste or mortar, metal reinforcement, and drilling fluids (water or bentonite).

Figure 1 Exemples of micropiles

2.1. Classification of micropiles

According to the execution method, piles can be:
- prefabricated piles are installed in the field by:
- driving, vibration, pressing (vibropressing), screwing.

Executed on site - piles executed on site are made by: Drilling, vibration it vibropressing.

According to the size of the diameter, piles executed on site can have: a small diameter (with a diameter of less than 600 mm) or a large diameter (with a diameter of 600 mm or larger).

According to the method of supporting the walls of the holes, piles executed on site by drilling can be: drilled in dry and uncased, drilled under mud, drilled with recoverable casing, drilled with non-recoverable casing, or drilled with continuous drill.

Depending on the direction of the stress relative to the longitudinal axis, piles can be: - subjected to axial compression or tensile stresses; - subjected to transverse stresses; - subjected simultaneously to axial and transverse stresses.

2.2. Advantages and disadvantages of reinforcing a foundation

If, following a previously conducted geotechnical study, the suitable ground for the foundation is located at great depths, the groundwater level is high or the foundation area is unstable, surface foundation technologies become ineffective and often inappropriate [4].
Areas where bored piles or micropiles technology is used include:
- consolidation of existing foundations;
- temporary or permanent supports for excavation of basements;
- deep foundations in areas where conventional piles cannot be installed;
- wave stabilization;
- foundations for micro wind power plants;
- consolidation of weak soils to form a load-bearing and/or supporting structure, respectively, indirect foundations for bridges and retaining walls.

Figure 2 shows a micropiles drilling rig.

Figure 2 Micropiles drilling rig

2.3. Design of pile foundations

Bored piles are the subject of the foundation branch and are actually a type of special foundations, requiring modern technologies and extensive geotechnical studies.

Their significant dimensions (length) are of great help, because in this way the piles can reach the solid layers of the soil, thus anchoring the construction to be built [8, 9].

To design a pile foundation, it is necessary to carry out the following steps:
- carrying out a geotechnical study to establish data regarding the site conditions;
- choosing the type of pile both in terms of quality and in terms of the methods of their installation;
- test loading.

The technological stages followed to carry out the consolidation works with micropiles (figure 3) are:
• preparation of the work platform and drawing out the work;
• execution of the drillings;
• manufacture and insertion of the reinforcement in the drilled holes;
• casting or injection of the body of each pile separately;
• fixing the micropiles (connection with the ground);
• connection with the superstructure.

STAGE 1: preparation of the work platform and marking out the work;
STAGE 2: execution of the drillings;
STAGE 3: fabrication and insertion of the reinforcement into the drilled holes;
STAGE 4: casting or injection of the body of each pile separately;
STAGE 5: fixing the micropiles (connection with the ground);
STAGE 6: connection with the superstructure.

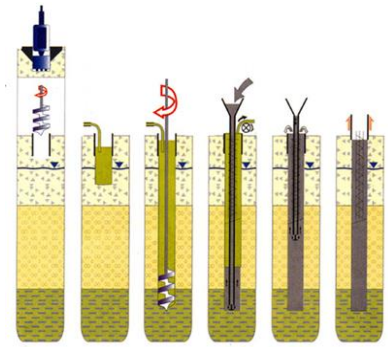

Figure 3 Stages of drilling technology

Stage 1

Preparation of the work platform and marking out the work. The steps to be followed to carry out this stage are:

Verification (before starting the work) whether underground or overhead networks, pipes (water or gas), or cables (electrical, fiber optic) are in operation at the work site.

To the extent that these exist and are affected by the execution of the work, they will be diverted before starting the drilling.

Removing vegetation from the work surface by extracting all tree roots and disposing of them.

Compaction of the work platform. Access ramps are built at these platforms. At this step, the height of the platform after compaction will correspond to the height in the project.

The drilling axes will be marked out against a fixed reference point, by respecting the distances in plan between the rows according to the project and materializing the axes through stakes.

Stage 2

Execution of drillings

Drilling is done with equipment that ensures the diameter, length, and, possibly, the inclination according to the provisions of the project. Micropiles are executed in any category of terrain, cohesive-non-cohesive, above or below the hydrostatic level, at any inclination, including subhorizontal.

Drilling is carried out using the following methods: with the help of an auger cutter, with dry knife drilling or with drilling fluid (biodegradable foam, bentonite-cement mixture), with rotary percussive drilling (crossing obstacles or anchoring in rocks) it with a tubular cutter with diamond teeth (crossing existing foundations). Injections with suspensions based on cement or other materials, executed at different pressures, allow for the creation of multiple anchor bulbs, which increase their bearing capacity.

Stage 3

Injection at low pressures

The suspension is injected from the bottom of the borehole upwards, generally through a plastic tube, specially fixed to the reinforcement according to the project details (in the case of welded casings) or inserted directly into the borehole. The injection is performed as follows:

Phase I: the borehole filling injection, without pressure, is performed if no suspension losses are observed in the borehole. This will be performed simultaneously with the extraction of the protective casing;

Phase II: 4-5 hours after the primary filling injection, an injection under pressure of up to 5 bar is performed, if suspension losses are observed in the borehole, as early as stage I. The suspension in the borehole is then completed up to the project level through a filling injection.

3. DRILLING EQUIPMENT

Klemm is a German manufacturer of equipment specialized in drilling for micropiles, anchors, and other geotechnical works (figure 4). Their drills are recognized for their reliability and versatility.

➤ Common features of Klemm drills:

- track-mounted – easy to maneuver on rough terrain - hydraulic articulated arms,
- allow drilling at various angles (vertical, oblique, horizontal),
- interchangeable drilling heads – for different methods (rotation, rotary percussion, etc.),
- equipped with automatic systems – for pressure, speed, and depth control.

Fig.4 Klemm drill

Thanks to the efforts of the designers and technicians involved in this new production center, in 2023, the foreza comacchio CH 650 was launched, a machine weighing approximately 65 tons, used for large diameter drilling (figure 5) [*].

Fig.5 Comacchio CH 650

3.1 Drilling process

The drilling device consists of a metal hoe (which has a prismatic blade at its lower part), the hoe rod and

the device for attaching it to the drive cable (figure 6).

The hoe is provided at the lower part with a triangular prismatic blade, and at the upper part with a thread for screwing the rod.

The length of the hoe blade corresponds to the diameter of the drill hole. In some cases (fig. 6.a), the hoe is provided with two perpendicular blades, which allows for faster drilling of larger holes [3].

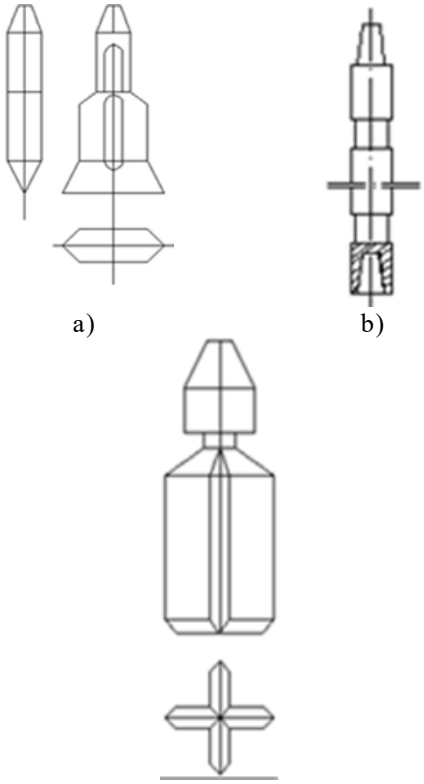

Fig. 6 Examples of hoes
a) Hoe equipped with a simple knife in the drilling process for micropiles, b) The hoe rod, c) Hoe equipped with 2 knives

4. CONCLUSIONS

- In this study, we aimed to carry out a bibliographic study as detailed as possible on the current state of micropiles and minipiles foundations, drilling technologies, and machines dedicated to drilling;
- It is a foundation solution adopted following a technical-economic calculation in order to ensure the stability and durability of a foundation construction on difficult foundation lands (with potential for slipping);
- A project is required to monitor the consolidation works during their execution, but also during the life of the construction.

REFERENCES

[1] **Budescu M. ș.a.,** *Rehabilitation of constructions* – Vesper Publishing House, Iași, 2001.
[2] **Hâncu Ghe.,** *Contributions to the use of Franki piles in irrigation works in loess areas of Romania* – Doctoral thesis, Iași Polytechnic Institute, 1970.
[3] **Muscă (Anghelache), D.G., Potîrniche, A., Căpățână, G.F.,** *Analyse of dynamic operation mode for drilling machine equipped with drill for pits digging,* ModTech International Conference 2020, Modern Technologies in Industrial Engineering, June 23rd-27th, online edition, Iași, România, ISSN 2286-4369, IOP Conference Series: Materials Science and Engineering, Volume: 916 (1), Article Number: 012070, Published: 2020 (Scopus), ISSN: 2286-4369.
[4] **Mihăilescu Ș.,** *Construction machines and aggregate processing* – Didactic and Pedagogical publishing house, Bucharest 1983.
[5] *Normative on the geotechnical design of pile foundations,* Contract no. 314/2007 MDLPL
[6] Law no. 10/1995 – On quality in construction (republished).
[7] Law no. 50/1991 – Regarding the authorization of construction works NP 074-2022.
[8] Normative from geotechnical documentation for constructions NP 125-2010.
[9] Normative regarding foundations on soils sensitive to wetting (PSU).
*https://www.revistaconstructiilor.eu/index.php/2017/03/11/ijf-drilling-solutions-comacchio-ch-450-masina-pentru-foraje-cu-diametru-mare/