CFA – Continuous Flight Auger

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This report aims to explain the development of the Continuous Flight Auger (CFA). For this, we will first go back in time to return to the genesis of the CFA. Next, we will talk about its development until today. Finally, the last part of this report will be devoted to the future of the CFA.

The origin

The French process of the CFA has now existed for more than half a century. Before its appearance, the piles were mainly made by driving prefabricated elements. Indeed, the main processes used for the building were the FRANKI pile (pounded pile) and the PAUMELLE pile (molded pile).

Productivity: 4 to 6 piles per day

For the piles of civil engineering structures which represent large diameter piles, their execution was done by means of a “trépancurette” (picture below) or the BENOTO EDF 55 (drilled cased).

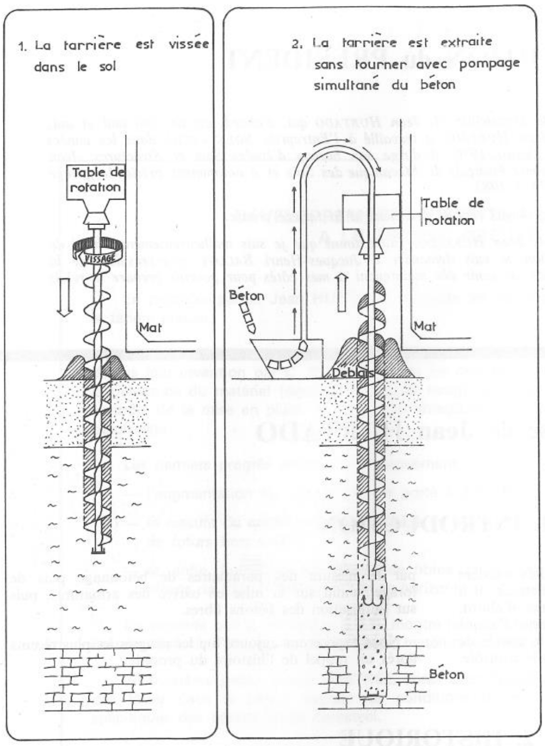
Productivity: 1 to 2 piles per day

The other technique used at that time was bored piles with support (bentonite) fluid utilizing large WILLIAMS and CALWELD augers.

Productivity: 6 to 10 piles per day

To increase the productivity of the process, in 1963, PIEUX GRIMAUD company entrusted Mr. Bourg with the study of a machine allowing screw-shaped precast concrete piles to be screwed into the ground. However, as the piles were not equipped with reinforcements to take up the torsion generated by screwing, they broke very quickly. The process was quickly abandoned.

It was following this failure and at the same time as the impetus for ready-mixed concrete and concrete pumps, that Mr. BOURG planned to use the same machine to attach it to a tube fitted with steel helical blades.



To make the stake, this tube was driven into the ground to the desired depth. Once the depth was reached, the tube was raised while simultaneously injecting the concrete. This technique maked it possible to replace the soil that is stored in the interstice of the blades with fresh concrete. Subsequently, waiting bars were set up in the concrete.

Very quickly, three difficulties appeared:

- The low rotation torque of the machines made it difficult to drive the auger in compact soils at great depths
- Stopping the concreting when removing the screw creates necking and a cut in the pile
- The installation of a reinforcement cage in the pile, when the pile must be reinforced at any height, was complex

Over the years, development around the CFA process has provided an answer to these limitations.

Development

The development of the CFA did not focus only on the method of realization, but through the creation of regulatory texts, the improvement of machines, drilling tools, the quality of the concretes used and the instrumentalization.

The first construction site

The first project was carried out in Mérignac (France) in 1964, with the installation of 40 piles 12 m deep and 350 mm in diameter, in the ground.

Productivity : 10 to 15 piles per day

Yields were increased gradually with the sequence of several projects.

Control offices were increasingly confronted with this process and played a role in its validation.

A first control system was set up by Mr. PAREZ. This system controlled the correct execution of the pile through the concreting pressure.

Regulations

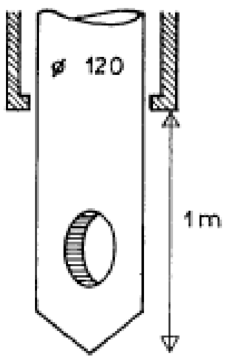
The number of construction sites where the CFA is being used is increasing, which underlines a need for standardization to frame this new drilling technique.

It was not until 1974 that the first regulations were introduced. The basic texts were drawn up by MM. CHADEISSON and BRULOIS. This work was continued and published in June 1978.

This galloping evolution of the CFA slowed down since the piles could only be reinforced by means of waiting bars. To solve this problem the association for the quality of foundations (ASQUAF) established specifications in September 1980. After this, the foundations executed using a CFA complied with Art. 1.11 of D.T.U 13.2 "Installation of reinforcement cages in the concrete of vertical piles".

It was during this period that instrumentation improved with the appearance of new drilling parameters such as forward speed and drilling torque.

Type 3



The CFA experienced a turn in the 1980s with the installation of the first telescopic tubes. This tube intervenes during the ascent of the auger when the concrete is pumped. This tool allows the tube to be constantly immersed in the freshly poured concrete. This guarantees the quality of the concrete over the entire height of the shaft. The piles made by means of this new tool, take the name of "CFA type 3" (fascicule 62 titre V of 1993).

Progress through machines

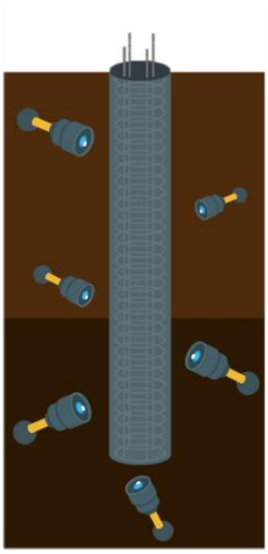
To drive augers with ever larger diameters, at ever greater depths, the machines must gain in power. This development has enabled them to reach drilling torques of up to 400 kN.m, far from the 9.5 kN.m of the first machines of the 1960s.
This translates into ever greater depth and diameter records.

The latest record was achieved by the company Soletanche Bachy Fondations Spéciales on September 23, 2020, with the construction of a 50 m pile reinforced at full height.

Who could have imagined that in 1963?

The future of CFA

The development of the CFA has focused a lot on improving machinery and servoing. The theme which has not been much exploited, or which has remained at the research stage is the instrumentalization of the post construction stake. The main difficulty with deep foundations is that you can't see them! Indeed, the piles are structural elements made in the ground. It is thus difficult to observe them to control their quality. How to check the verticality of the pile? How to be sure of the diameter of the barrel over its entire length? How to control the quality of concreting?
To overcome these potential non-conformities, the calculation standards impose several safety coefficients to reduce the bearing capacity of the ground or the resistance of the materials (concrete or steel).
If we could guarantee the perfect execution of the pile, these safety factors could be reduced. Therefore, the performance of the process could be increased by maintaining the current production technique. This opens a field of possibilities.



We can imagine creating robotic probes to auscultate the pile and even to have a 3D image.
Today, certain experiments make it possible to equip the pile with probes which, under a given load, allow us to determine the lateral friction and the mobilized tip.
In the future, thanks to this equipment, we will be able to examine the piles and determine their resistance to postpone the life of the structure they support.
This auscultation could determine the performance of the existing piles in order to reuse them for a new structure.

Interview: major CFA site

The following interview sheds light on a site where the CFA process was used. On this site, the potential of the CFA was pushed to its maximum. Marie LERAY who worked on this project, works as an engineer for NGE FONDATIONS, shares her experience with us.

Mustafa*: *Can you tell us about this project?

Marie: This project was carried out in the spring of 2019 to build the support structures on the highway A40 for the construction of a new two-way motorway area next to Bonneville (Haute-Savoie).

With a span of 44 m and a width of 15 m, the crossing bridge was designed as a mixed metal-concrete structure. In order to limit the inconvenience of motorway users, the bridge was designed without a central pier. As support structure, 2 abutments were seated on 24 foundation piles, 12 piles per abutment. Piles were drilled with a CFA with a diameter of 1,220 mm and fully reinforced to a depth of 30 m.

Mustafa: Why did you use the CFA process to build the foundations?

Marie: The geological terrain, in line with the abutments to be built, was very mediocre. Without the CFA process, we would have had to pipe over a significant height (drilled casing) or use a stabilizing fluid during drilling (drilled mud), which would have forced us to set up a mud treatment plant. In addition, on this site we did not have a very large footprint for the construction of the piles. This constraint would not have allowed us to set up these workshops for mud drilling or casing drilling, which require more substantial installations.

Mustafa*: *What were the advantages of the CFA?

Marie: The first was mentioned just before, it was the fact of having a drilling workshop as compact as possible because of the little space available to the right of the abutments. The other advantage stems from the geology of the site. The structure is built in the valley of the Arve. The main characteristic of this valley is the presence of alluvium over 50 m deep with poor mechanical properties. In fact, the foundations could only be deep (30 m deep in this case). These terrains are perfectly suited to the CFA technique (ease of drilling, maintenance of the walls by the soil then by the concrete) and the calculation parameters are more favorable in a CFA than in a simple borehole (skin friction and tip resistance).

In addition, the CFA allows us to make one pile per day including drilling, concreting, and equipping the reinforcement cage. This performance would not have been possible with any other drilling technique.

Mustafa*: *What was the specificity of this project?

Marie: We can say that it was arming the piles all the way up.

The regulations require the piles to be reinforced over their entire profile when it comes to piles for the foundations of engineering structures. This is understandable when you know that these structures are calculated to have a lifespan of 100 years. In addition, this bridge is located in seismicity zone 4, the highest existing level in mainland France, and is classified in category III of importance. These seismic hypotheses impose larger sections of reinforcement and in particular constructive provisions to be respected (installation of hoops rather than the spiral).

Moreover, 2 test piles were executed near the abutments. This allowed us to guarantee the perfect execution of the final piles. We were able to execute an efficient lifting of the 30 m cages during the production and confirm that the concrete used was satisfactory for the insertion of the reinforcements.

References

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Credits photo of a 50 m pile taken by the company SOLETANCHE BACHY FONDATIONS SPECIALES: Cédric Helsly

Credits photos of the interview: ©vuedici.org / NGE FONDATIONS

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