

Foundations

Working on piles with brains

In Switzerland, the Brextor system has established itself as a rational and precise method for pile head milling. However, it was a long way to series production, as entrepreneur and inventor Alois Portmann tells us while walking around the construction site. The next big step for his company is to expand abroad.

from Stefan Schmid

The milling disc guides the machine operator Sandro Hodel with round movements over the pile head. In a

few minutes it mills its way through the concrete up to the reinforcement bars. As soon as the chisels of the milling disc reach the iron, a slight jolt goes through the Excavator. Then at the end of the the first phase of pile head preparation the ends of the reinforcing bars with spots of colour marked.

The row of piles serves to stabilise the slope, as anchors cannot be placed due to the proximity of the site boundary. On the construction site for the new headquarters of Energie Opfikon, workers from the Aregger company

are using the system for the first time.

After a theoretical course and a visit to the workshop of BRC Engineering AG in Rain, Lucerne, the workers are now being introduced to the finer points of pile head machining with the Brextor system. Also on site is Alois Portmann, BRC owner and inventor of the process. He gives personal tips, shows prudent tricks for using the equipment - and the gentle processing of the pile heads.

Inner- and Outer Cutter as a clou

The brextor head is used in a second step. The drill can be coupled to the drive for processing the piles in just a few steps.

A hole drilled beforehand in the centre of the pile serves to guide the Inner Cutter and to direct the physical forces towards the centre. There the drill head breaks the core tension of the concrete with the Inner Cutter. A second milling cutter removes the concrete on the outside, whereby the surface tension must be reduced in order to avoid spalling on the pile cylinder. To carry out milling operations inside and outside simultaneously is part of the well thought-out principle of the process. Due to the conical tip of the Inner Cutter, a natural cone is created, which absorbs the slipping against all sides.



Milling inside and outside at the same time is part of the well thought-out principle of the Brextor.



In a first phase, the milling disc is used to remove the pile head down to the reinforcement bars (left picture). In a second process step, the inner cutter breaks the core tension, the outer cutter simultaneously breaks the surface tension of the concrete (right picture).

To compensate for the circular movements of the excavator, the Brextor Head must always be pressed down gently in the perpendicular, otherwise the cutter could damage the reinforcement of the piles with a diameter of one metre. The line manager, an electronic instrument, helps the machine operator to check the circular movement of the excavator. A laser connected to the machine receiver on the drive shows how much material must be removed. The milling process is completed in five to ten minutes. The result is an even hollow cylinder, which still contains the reinforcing bars for the further processing. A nearly perfect drilling process has been achieved. "The Brextor system is nothing more than the application of physical laws," explains Portmann.

Know the market

It was a long way until the system was fully developed for rational pile head processing, as Portmann tells us. After gaining experience in the commercial business, the road builder with a polishing diploma set up his own business at the turn of the millennium, renting, selling and servicing construction machinery. With the rental business he catches the trend early on. At the same time he is on the road as a subcontractor on countless construction sites. With an affinity for technology, Portmann therefore knows the needs of the industry and special civil engineering. And because he constantly evaluates equipment for his rental programme, he has a good overview of the manufacturers' offers. The idea for a more rational processing of pile heads is born at the family table during a technical discussion among construction professionals.

During a training course, he became aware of the principle of rock cutters with longitudinal cutting heads for hollowing out piles and tried out such a device. Despite certain advantages in the processing, he is not satisfied with the result.

Gain experience

Other procedures also prove to be disadvantageous. Certain devices push pile heads hydraulically, whereby both the handling and the alignment of the force effect are difficult.

These can only be used in areas without reinforcement, in the worst case iron is bent or torn off, which makes the work for the connection reinforcement difficult.

In order to achieve a good quality result, the piles used to have to be worked by hand. And to prevent damage, the smallest possible equipment was usually used. But the method is time-consuming, so larger hydraulic hammers are often used. But because the effect of impact energy is difficult to control, damage to the piles is almost inevitable.



The result after the second phase of pile head processing is a hollow cylinder, which still contains the reinforcing bars. These are then exposed.

The type and degree of damage is difficult to assess and in the worst case is only visible long after the impact on the pile head. Due to possible health hazards, the legal requirements for manual processing are being tightened in Germany. In France, workers are allowed to carry out pointed work with an impact drill for a maximum of three hours.

A risky practical test

"I feel most comfortable not with standard solutions but with special applications. If others don't do it, I occupy that niche," says Portmann. So another solution had to be found. Mechanics in charge of maintenance are implementing initial design ideas. Prototypes are created, but still without the desired effect. Well-known manufacturers waved goodbye after the idea was presented. Stubbornly he lets the construction change.

"Not every improvement has always worked out right away. But I wanted to know why something didn't work and how it could be made to work," says Portmann, describing the tough way to find the solution by trials.

A retired agricultural machinery designer with proven expertise in mechanics and hydraulics, who happens to be a neighbour, suggests combining inner milling and outer milling cutters in the drill head. That was the breakthrough. "We achieved a good result right away," explains Portmann. However, he still lends an open ear to the practical people on construction sites and receives valuable suggestions on how the design can be changed so that the equipment can be quickly converted and adapted to the respective dimensions of the piles. The system is further optimised for contract work. "All this was only possible because we have good in-house mechanics," emphasises Portmann.

Convinced of the invention's practicality, he took the big step in its application in 2007 with an order as subcontractor of the Strabag company. Thousands of 50-mm piles were to be worked at that time in the new building for the Aldi distribution centre in Domdidier FR. "In the worst case, I would have had to sharpen up," he judges his courage laconically in retrospect, but the system had passed the practical test.

Tightening construction processes

By using the Brextor system and applying for a patent, Portmann is gaining a technical competitive advantage in the Swiss market for pile head processing. However, over time the threat of market dominance has aroused some suspicion in the industry, which he considers unfounded from today's perspective. This would have required too much manpower and machinery, which would not have made sense for special applications. Therefore he changes the strategy and also offers the system for sale. The first customer is the Eberhard company. Afterwards, more and more engineers recognise the advantages of the process. Experience has shown that planners at that time were not satisfied with the conventional methods of pile-head treatment, either from the point of view of construction technology or calculation. Damage to pile heads due to improper processing had led to conflicts between planners and specialist foundation engineers, says Portmann. It had been difficult to achieve the required quality at a given cost, which had led to additional claims. Since the Brextor system allows the machining time to be easily estimated, working and machine hours can be calculated more accurately. This is also in the interest of the client.

By using the Brextor system and integrating it into the organisational processes, construction programmes can be streamlined, which requires meticulous planning. "We had to find out again and again that too few piles were ready for processing and expensive waiting times were incurred," says Portmann. The procedure has definitely found acceptance on the market when the Brextor method was explicitly mentioned in a tender. With the changed market presence, a memorable name for the proven devices had to be found, which the staff came up with. In the meantime, the brand has become established in the Swiss construction industry.

Boring out piles for rehabilitation work

However, the Brextor is not only suitable for pile-head treatment, it is also used for renovation work. When the concrete of a pile is contaminated by inclusions, the core is milled out to a depth of up to six metres, fitted with a new pile cage and filled with structural concrete.



Foreign material and dirt in the concrete impair the static function of piles. With the inner milling cutter, piles can be bored out to a depth of six metres for renovation work, so that a second pile cage can be concreted in.

In order to create a stable foundation for H-beams or pipes, it is also possible to mill out the pile head core. The device can be used for all piles with reinforcement cage and structural concrete, which is the case in the vast majority of applications. However, the system is also suitable as an earth drilling device. It is not possible to use the Brextor if there are reinforcing irons in the centre of the piles.

Standards taken as a yardstick

For the connection reinforcement of the superstructures, the exposed reinforcement can be of different lengths. For floor slabs, the reinforcement must be less high than for pillars, which must meet earthquake safety standards. In this case the pile head reinforcement must have a certain length. Only then the iron layer can connect the under-reinforcement and further reinforcement. The drill head with the cutters and the biter are designed in such a way that standard reinforcements up to a height of 1.8 metres can be exposed. The dimensions are not chosen at random. In order for the tensile forces of the reinforcement to have a continuous effect, a rule of thumb of structural statics states that the height of the overlap must correspond to forty times the diameter of the iron, as the building practitioner Portmann explains. With 40 mm iron, the dimension would therefore be 1.6 metres. "With a length of 1.8 metres we are on the safe side. We thereby cover 90 percent of the required mass for the exposed reinforcement," says Portmann. Special designs with longer components are possible, however.

Flexible thanks to a modular system

The Brextor system includes several attachments that can be individually adapted to different pile sizes. Due to standardisation, there is little tolerance for concrete removal on the outside, which is why the external cutter must always be adapted to the specific conditions. The outer cutter can be changed in 20 minutes, the inner cutter takes about 45 minutes. A hexagonal key is all that is needed to change the various components, which are secured with bolts. For rows of the same pile head size, the changeover time is correspondingly shorter. Thanks to the modular system, all parts of the drill head and outer cutters can be combined. In addition, drill heads and milling discs use the same drive unit.

It is therefore possible to machine 100 and 80 mm piles with a 50 mm internal cutter and only change the external cutter at a time.



The Brextor system's drill head and biters are 1.8 metres long. This means that reinforcements can be exposed up to an appropriate height so that the length of the connecting reinforcements meets the standards of earthquake safety.



The biter exposes the reinforcing bars (phase 3). Any residue on the concrete surface and between the rebars is removed with an electric hammer.

Goals for international expansion

The Brextor system is well placed to become a standard in pile head processing in Switzerland. Winning the special prize "Internationalisation" at the Swiss Innovation Challenge 2017 was the impetus to also offer the system on the world markets. BRC Engineering AG was founded in April 2019 in order to further develop the international market. For international expansion, the business plan sets out clear targets for 2021 and 2022, with the system enjoying 20 years of patent protection in key markets since its entry in 2007. "I am convinced that our system will establish itself on the market," says Portmann.

A distribution agreement for market development in Europe already exists with Kinshofer, a company specialising in attachments, and since mid-August there has been a cooperation agreement with the Singapore based trading company ICE Far East Pte. The initial focus is on Malaysia, Hong Kong, Singapore and Thailand. During technical discussions in Bangkok, Portmann was able to convince himself personally of the customers' interest in the process and his construction expertise. Also, in Asia the pile head processing is not solved. There are large areas of many countries at low sea level. Due to the unstable subsoil, pile foundations are therefore of great importance. BRC Engineering AG also maintains intensive contacts with the Arab market and South Africa.

The worldwide market potential for special applications of pile head machining is estimated at \$750 million according to the company's calculations based on market studies. Especially for the Asian market, where piles with a diameter of two and a half to up to three metres are not uncommon, the system is to be further developed, whereby the height of 1.8 metres is to be left at the drill head and biter. The constructors can also imagine a kind of mini-Brextor for processing small piles and equipping the system with an electric drive.

In order to be able to produce higher quantities, the system was further developed to series production stage. Components such as the carbide chisels are sourced from German suppliers, mounting plates, inner cutter Carriers and parts of the biter from Italy. As the company expands abroad, discussions also arise about relocating production to the sales markets. But Portmann wants to stick to the local production site as far as possible. «My greatest wish is that we can keep the production and thus the jobs in Switzerland.»

Use of the biter

In the meantime, the workers of Aregger AG are now setting about exposing the reinforcement in the hollow cylinder, which was created after the drill head was used, in a third step. For this they attached the biter to the drive module. Machine operator Hodel positions it near the hollow cylinder and then lets the concrete crumble with a force of 150 tons. It requires skills to avoid damaging the reinforcement. Then a slight twist, squeeze again and the reinforcement becomes visible. Finally, an electric hammer is used to remove concrete residues between the irons. It takes a 15 minutes until the irons come out of the pile in a suitable condition for further processing. If things go well, the 143 piles on this construction site will be finished in a week. ■



The Aregger company is using the Brextor for the first time in Opfikon. Photo: Entrepreneur Hans Aregger, Brextor inventor Alois Portmann and Urs Odermatt, Head of Civil Engineering Aregger (from left).

Bilder: Stefan Schmid

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