

Serial Report

Development History of SILENT PILER (Part 1)

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The Birth of SILENT PILER

The history of the "SILENT PILER", a hydraulic pile press-in/extraction machine begins in 1973, when Mr. Akio Kitamura, a founder of GIKEN LTD., brought the idea to Mr. Yasuo Kakiuchi, a former president of Kakiuchi Shop (currently known as KAKIUCHI Co., Ltd.), who ran a machine manufacturer locally in Kochi City, Kochi Prefecture, Japan.

At that time, excessive vibration and noise generated in foundation works, especially when steel sheet piles were driven in for earth retaining walls, were social problems as a form of industrial pollution. To their best knowledge then, there was no pile driving machinery anywhere in the world, not to generate noise and vibration.

Mr. Kitamura, who held up the sign of a "company with antipollution measures", felt that his own company should not be a source of construction pollution and explored ways to install steel sheet piles using a completely different system from conventional impact or vibratory hammers. One day, he recalled a scene from the construction site for a new hotel where a hole passed through the H beam for the earth retaining wall was cracked by the lifting wire when it was pulled out by a service crane. It was often experienced at construction sites that temporarily installed steel sheet piles would not be easily pulled out due to soil sticking around them. This vivid memory brought a great idea to him. Paying attention to the fact that "piles once driven would not come out easily", he came up with a system to install a pile, gripping some piles previously driven in, and using their resistant forces against being pulled out as a reaction force.

Based on this idea, Mr. Kakiuchi and Mr. Kitamura worked together by trial and error, from design to production. In the development, nothing could be referred to as a model, so the required movement and force of each machine part were decided by Kitamura's intuition and experience. Then, in 1975, the first memorable unit was finally completed. Mr. Kitamura named it "SILENT PILER", which literally means "a quiet piling machine". Taking the initials of Kitamura, GIKEN, and Kakiuchi, and the press-in force capacity of the unit (100 tons) into consideration, the machine model was named "Model KGK-100A" (Photo 1).



Photo 1. Model KGK-100A

Practical Use and Commercialization

The initial unit was a prototype to demonstrate Kitamura's idea. He immediately asked Mr. Kakiuchi to design and manufacture a practical version. He made it an absolute requirement for the practical type itself to be as lightweight and compact as possible. The machine was thus made significantly lighter and smaller by separating the hydraulic pump of the power source from the machine main body, and a remote-controlled operation was selected to improve its operability. Consequently, the model KGK-100B (Photo 2) was completed as the second unit.

From the model KGK-100C which is the third unit, preparations were made to commence examining the quality of some main components (i.e. the use of cast steel for structural parts) and producing commercial units. However, due to insufficient strength of the components, failures such as broken centre shafts and cracked clamps occurred, and further improvement was essential to achieve the required performance close to that of the original concept.

There were some problems still remaining in the model KGK-100D (Photo 3), which is the first commercial unit. It was assumed that the machinery might break down on site, which customers understood before the purchase. Predictably, mechanical failures frequently occurred. The quality of the main components (i.e. Chuck, Clamps) as well as a hydraulic system composed of pumps, valves, joints, motors and other apparatus was still low and their strength was not sufficient for the piling operation. In any case, the machinery did not reach a high degree of perfection. However, with the sale of

four units in the following three months, Mr. Kitamura decided to establish a manufacturing and sales company, Giken Seisakusho Co., Ltd (currently known as GIKEN LTD.). To become a full-fledged construction machinery manufacturer, it was necessary to supply high-performance machinery in a stable manner and to provide mechanical support that would be trusted by customers, thus, a new maintenance plant was built. By improving the maintainability and durability of the machine, the model KGK-100H (Photo 4) was produced through the use of high-quality parts and the technical knowledge already accumulated.

Approximately 100 units of the first mass production machine, the model KGK-100H, were sold from 1978. The SILENT PILER began to be sold widely as an industrial product manufactured on the production line. In addition, any newly developed machine was subjected to proof testing in the construction department of GIKEN before marketing. This way, the production perfection was being improved.



Photo 2. Model KGK-100B



Photo 3. Model KGK-100D



Photo 4. Model KGK-100H

Self-Walking Function

In 1981, GIKEN launched the model KGK-80C, the first model with a self-walking function in the first in-house design. For the SILENT PILER the self-walking function was truly revolutionary. Heavy cranes to move machine locations were no longer needed. The function also enabled various piling systems in places with overhead restrictions such as power lines and bridges, and in places close to existing structures. Firstly, the press-in force was reduced from 100 to 80 tons by narrowing down the practical range of the press-in force and four clamps were reduced to three, which meant that the weight of the main body was reduced to 5.8 tons. In addition, the installation method of the main cylinder was changed. Before the model KGK-80C, the tube side of the main cylinder had been fixed to the leader mast, and the machine height was the same at the top and bottom of the press-in stroke (Fig. 1).

In contrast, the KGK-80C aimed to slim down by reducing the machine height at the lowest position of the press-in stroke, fixing the rod side of the main cylinder to the leader mast. It was also successful in simplifying the mechanism by eliminating the auxiliary cylinder required when pulling out piles. Furthermore, the chuck-up speed in no-load state was greatly improved, incorporating a hydraulic differential circuit. The most important improvement beside the weight reduction was to install two sheet piles: one adjacent to the reaction piles and the other to the following pile, using the same reaction piles by moving the saddle and slide frame, enabling press-in piling machines to self-walk on previously installed piles rather than relocating by a service crane.

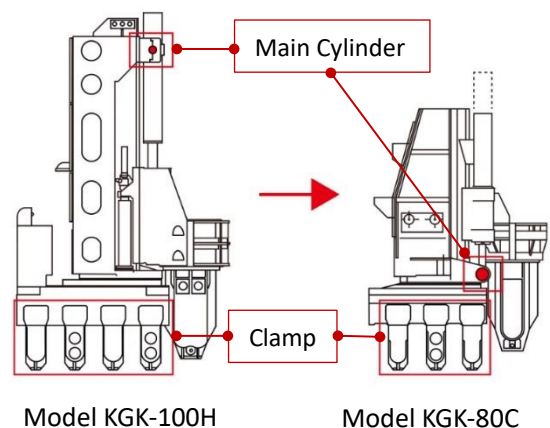


Fig. 1. The difference of 100H and 80C

By the end of 1985, two models, the model KGK-80C4 (Photo 5) and model KGK-130C4 (Photo 6), could self-walk at right angles. These models were equipped with a function so that two piles right and left could be installed from the same location before the machine self-walks to the corner, achieved by modifying the way to grip and rotate a pile in the chuck. Hence, improved drivability by easing restrictions and keeping reaction force on the corner piling was achieved (Fig. 2).

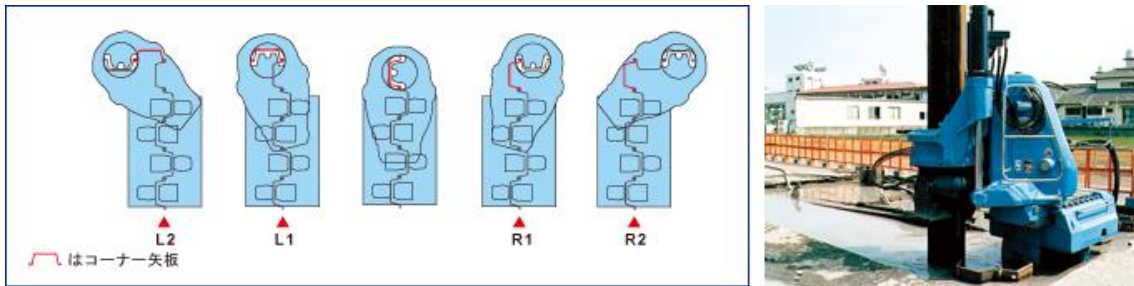


Fig. 2. Corner installation

After that, the following model FT70 (Full-turn 70) (Photo 7) was launched in 1987. The most important function was to set the top of the previously installed pile, which is behind the machine, on the ground level, by rotating the leader mast 360 degrees on the centre pin and re-pressing it in.

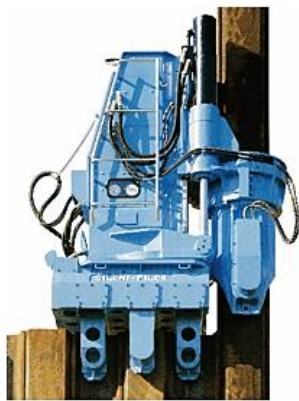


Photo 5. Model KGK-80C



Photo 6. Model KGK-130C 4



Photo 7. Model FT 70

Automatic Operation and Optimal Design

In 1991, the model AT Series was unveiled. In fact, they were the first machine equipped with a computer control technology (Photo 8). The advantage they offered was to enable automatic pressing-in and extracting operations, which let operators to start improving their productivity. In terms of mechanical appearance, the rounded shape was adopted to disperse stress, like a light but strong "eggshell." The components were made of a special cast steel with excellent toughness and hardness, manufactured by Sumitomo Heavy Industries Cast and Training Co., Ltd. (currently known as SUMITOMO HEAVY INDUSTRIES HIMATEX CO.,LTD.) at the request of GIKEN. The cast steel was twice as strong as conventional ones at that time. It greatly contributed to the realization of optimal design, such as reducing the thickness of the components for considerable weight reduction.

In 1995, the SA Series was developed. While the automatic operation system of AT Series controlled the press-in/pull-out stroke on an hourly basis, a more accurate automatic operation became available with the SA Series, by adopting a magnetic type stroke sensor that could detect the upward and downward motion distance of the chuck, and controlling the settings of the press-in and extraction forces together (Photo 9). In addition, the development of the super jet reel for the water jetting* that could be easily attached to/detached from the main body of the press-in piling machine, was a great innovation that improved the drivability and workability of piling operations (Photo 10).

*Water jetting is a type of driving assistance where piles are installed while injecting pressurized water into the ground from a nozzle, fitted onto the pile toe, to reduce penetration resistance (toe resistance, shaft resistance). It may also reduce interlock resistance.



Photo 8. Model AT90



Photo 9. Model SA75



Photo 10. SA75 with super jet reel

Model Applicable to Hard Ground

The Crush Piler SC100 (Photo 11) was the first model applicable to hard ground, of which the development began after the SA Series in 1997. Former units of SILENT PILER had a weakness in that it was difficult to install piles into hard ground. Even press-in piling assisted with water jetting was not able to install piles into stiff and hard ground such as cobbles, boulders and rocks.

Mr. Kitamura was aware of the need for machines applicable to hard ground since the beginning of the first unit development. He had repeatedly produced prototypes since the 1980s. At last, in 1997, the piling technique "simultaneous inner augering" was established in which a casing auger was mounted on the chuck. The gravel was bored with it, then the pile was pressed in while extracting the casing auger. The product was introduced to the market as a Crush Piler SC100.

In the following year, the successor model SCU-400M (Photo 12) applicable to harder ground conditions was developed. This model accomplished difficult construction to install steel sheet piles into weathered rock, including approximately 5m diameter boulders in Hong Kong. With the model SCU-400M, the driving assistance applicable to hard ground was improved, and applicable ground conditions were dramatically expanding.

Starting with the model SCU-400M, various augering parts (i.e. casings, augers and other apparatus) were developed and improved, particularly auger heads which affects the performance of Crush Piler. Hence, the shape of auger heads, and the material, shape, arrangement and angle of bits were further developed, in order to enhance the boring performance while minimizing the impact on surrounding ground (Photo 13).



Photo 11. Model SC100



Photo 12. Model SCU-400



Photo 13. Various auger heads

(To be continued on Part 2 and Part 3)