Interview Report

A novel pile extraction method: The best practical use of the GEOTETS Method (Simultaneous backfilling during pile extraction)

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Fig. 1 Overview of GEOTETS Method

Foreword

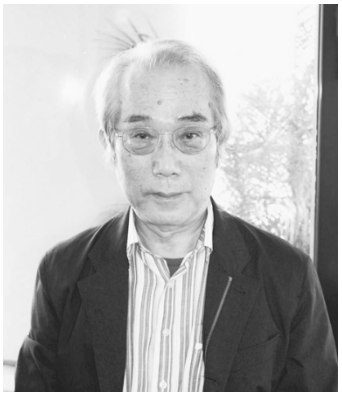
When temporary retaining walls are required, prefabricated piles such as steel sheet piles are often utilized since they can be extracted and reused optimizing economy. However, the process of pile extraction may cause ground displacement due to voids which occur during pile extraction. The extent of the problem of ground displacement is not normally easy to predict, and robust solutions to this had not been in place until recently.

The GEOTETS Method (simultaneous backfilling during pile extraction), which can analyze and minimize the ground displacement risks, has been attracting attention in recent years. In this report, the IPA interviewed the GEOTETS Method Research Society to get to the core of the method and its future potentiality.

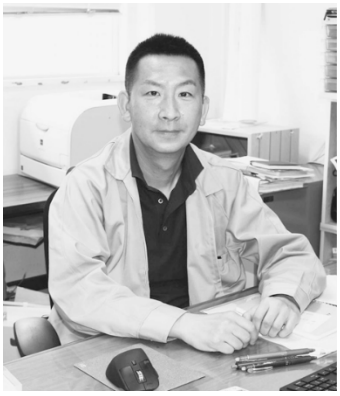
Name of the method: GEOTETS Method (simultaneous backfilling during pile extraction)
Interviewee: Mr. Hiroaki WATANABE, chairman of GEOTETS Method Research Society (Hyogo, Japan)
URL: https://www.hikinuki.jp/

Mr. Hiroaki WATANABE
Chairman of the GEOTETS Method Research Society

Mr. Yasuhiko NISHI
CEO of Civil Assist Co., Ltd., Kyoto, Kyoto, Japan



Hiroshi YOKOTA, Professor Emeritus
at University of Miyazaki
(Co-researcher)



Yoshinori FUKUBAYASHI, Associate Professor
at University of Miyazaki
(Co-researcher)

Q1: What is the GEOTETS Method (simultaneous backfilling during pile extraction)

Steel sheet piles are currently the most popular retaining wall pile materials to be extracted and reused in the construction of temporary retaining walls. With the GEOTETS Method, injection pipes (small diameter steel pipes) used for backfilling are installed adjacent to the sheet pile retaining walls before sheet pile extraction. Spacing between adjacent injection pipes differs, depending on site conditions. The typical spacing is every 6 sheet piles. The dual component reactive backfilling materials are mixed on-site and discharged from the tip of the injection pipe, simultaneously with pile extraction. Generally, the backfilling material is around 4 times the volume of the sheet pile (minimum two times). However, this may need to be adjusted in accordance with the actual void volume and other site conditions.

The backfilling material does not harden while fluid, but only when standing. Thus, voids can be fully backfilled with the materials. Moreover, only absolute minimal alkali contents of the material seep into surrounding water, therefore, the method is also environmentally friendly. The sequence of the GEOTETS Method is described in Fig. 2, Fig. 3 and Fig. 4 below.

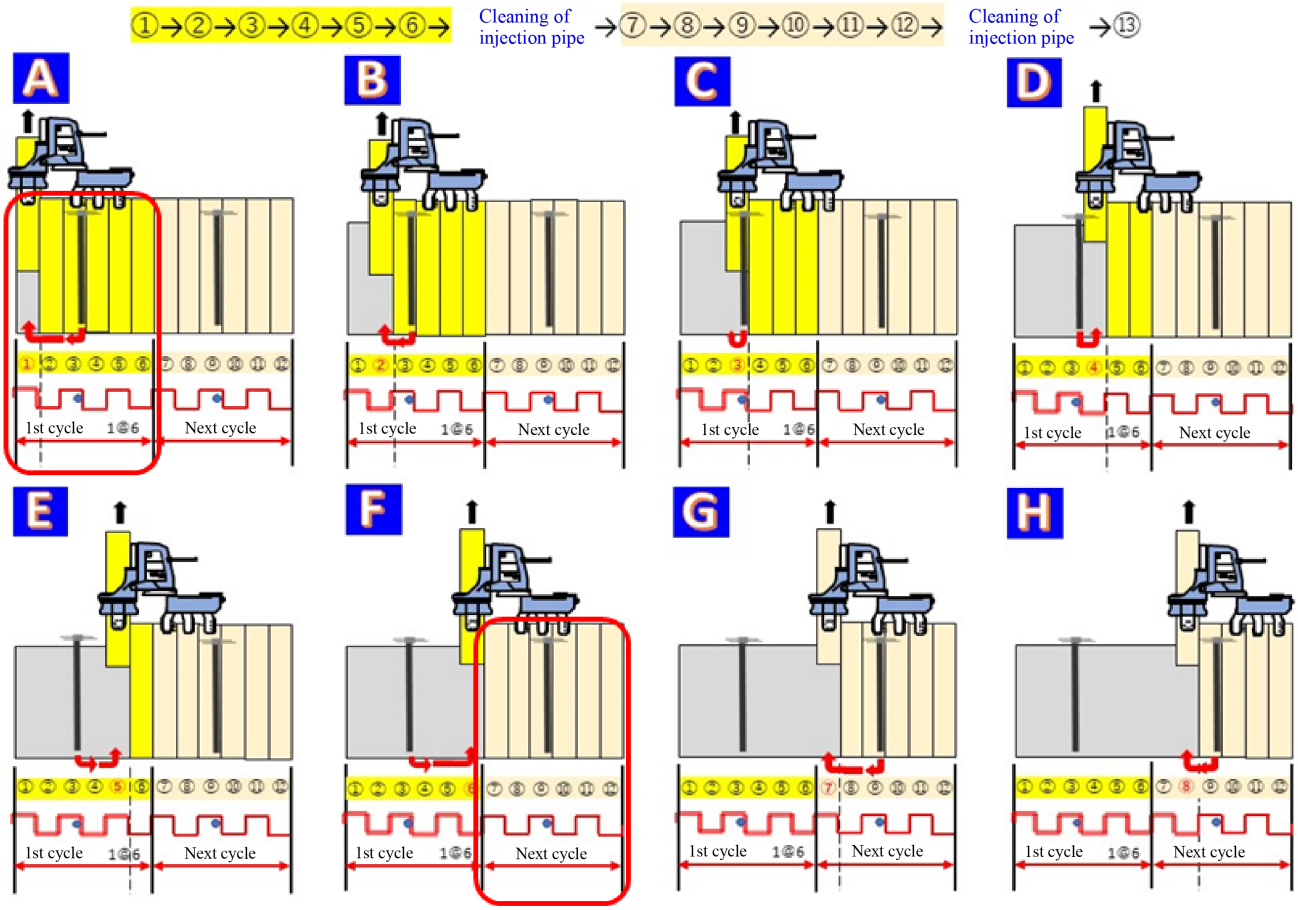


Fig. 2. Sequence of GEOTETS Method

Fig. 3. Insertion of injection pipe

Fig. 4. Backfilling (above water)

View the webpage of GEOTETS Method Research Society for more details.

Q2: What inspired you to develop the method? Please tell us about the background of the development.

Removal of retaining walls may cause ground displacement due to voids which occur during pile extraction. However, the risk of ground displacement is sometimes disregarded or ignored despite its importance. Even if it had been considered, there had not been a robust solution to ground displacement, and the problem has remained in the construction industry for a long time.

In the past, cement & bentonite grout injection was generally utilized to fill voids caused by pile extraction. However, it was not practical to carry out injection works concurrently with pile extraction. As a result, the surrounding ground was left unstable for a certain period of time after pile extraction, which sometimes caused ground displacement. This fundamental problem has been known for more than 20 years in the industry and the GEOTETS Method inventor was often asked if this problem could be overcome. In order to meet industry expectations and satisfy his desire to develop an original method, he decided to put his idea to practical use. He implemented his concept of "simultaneous backfilling" to minimize risks of ground displacement. Furthermore, he deemed that his technology would be backed by academic theories, therefore, he cooperated with the University of Miyazaki at the early stage of his development.

Q3: Currently, how is the risk of ground displacement assessed, in the case of pile extraction?

We still see projects in which ground displacement risk is disregarded or ignored. According to *"Specification for Temporary Structures of Road Earth Works (1999 Edition, Japan Road Association)"*, the theoretical extent of ground displacement typically reaches 45°+ϕ/2 as shown in Fig. 5. Where the extent of ground displacement is concerned, the magnitude of the displacement is normally estimated taking the pile installation method, excavation sequence, lateral deformation of retaining walls and pile extraction method into consideration. However, depending on ground conditions, it is known that the actual extent of ground displacement sometimes reaches further than the formula (45°+ϕ/2) suggests. It may be up to 2-3 times the pile length. Thus, we think that the risks of ground displacement are greater than the theoretical formula stated in the specification.

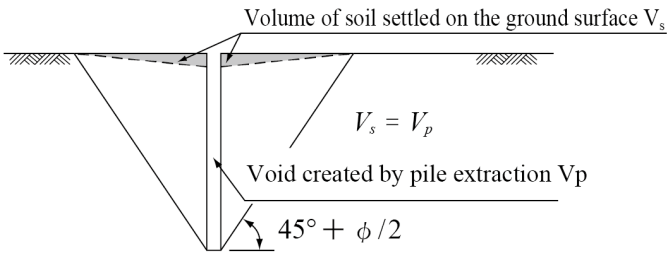


Fig. 5. Theoretical extent of ground displacement due to pile extraction

Q4: Please tell us about process of bringing the method to the market?

We first brought the method to the market in 2007. After that, at the introduction stage of marketing, our brand recognition was not widespread and the majority of inquiries we received were kind of SOS inquiries, which required urgent remedial works after ground displacement had occurred. It took us quite a long time to disseminate information to people about the risk of ground displacement. However, after the method gained recognition to a certain degree with the increase in method usage, the majority of inquiries we receive nowadays are ground displacement prevention rather than SOS inquiries. Regarding the GEOTETS project achievements, there were 130 project applications in 2021 and 530 in total as of June 2022.

Q5: How does the GEOTETS Method Research Society assess incoming inquiries?

It is not easy to measure the magnitude of the ground displacement in advance. However, the GEOTETS Method Research Society is able to estimate both the extent of ground displacement and settlement to a certain degree by utilizing the Peck's formula, based on the given geotechnical investigation report and examining previous project data. We compile an estimation and similar project data as a report and submit it to the project owner.
Nevertheless, how much risk they take is eventually up to the discretion of the project owner, taking into account the cost benefit performance on each project in determining the volume of the backfilling.

Q6: It is sometimes the case that sheet piles are left in place even if they are for temporary use, due to uncertainties of the potential risk of ground displacement. If this is excessive risk aversion, is it avoidable by utilizing the GEOTETS Method?

Certainly, the GEOTETS Method enables project representatives to minimize the risk since that was the reason for its development. In fact, project representatives who do not want to leave temporary sheet piles in place because they may become obstacles in future development if they are left in place, often rely on the method. Specifically, it is against the law to leave temporary material in public land in Japan so the GEOTETS Method is quite often specified on projects. "Extractability" and "Reusability" are the biggest advantages of steel sheet piles. These advantages are not a factor with regard to cast in-situ bored pile walls, or slurry walls. Therefore, we would appreciate it if people could maximize the effectiveness of steel sheet pile solution by utilizing the GEOTETS Method.

Q7: What project information is required when inquiring about the GEOTETS Method for a particular project?

The GEOTETS Method Research Society requires information about ground conditions, type of pile installation and extraction method, excavation sequence, type of temporary frameworks or anchors, lateral deflection of the retaining wall related to excavation, allowable ground displacement (lateral movement and settlement) to assess actual extent and amount of ground displacement.

Q8: Does the GEOTETS Method have other advantages rather than minimizing ground displacement?

Although it is not the objective of the method, the backfill material lubricates sheet pile surfaces, which reduces pile extraction resistance force, resulting in shorter construction time and a reduction in were and tear on the piling machine. In general, sheet pile cut-off walls are left in place when being used in contaminated soil to prevent contamination seepage. However, they can be extracted if the GEOTETS Method is utilized since the gelatinized backfill material is considered impermeable. Thus, the cost of sheet pile material can be minimized. The typical coefficient of permeability k of the gelatinized backfill material is around 1.0×10^{-6}cm/s.

Q9: What is the applicable depth for the GEOTETS Method?

Although the deepest application up to now is 40m, our goal is to reach 50m in the near future.

Q10: Can the GEOTETS Method be carried out in a cold weather environment?

As with cold weather concreting, it can be carried out if the backfilling material is cured for the cold weather environment.

Q11: Can the GEOTETS Method be carried out in restricted headroom, such as under overhead obstructions?

Restricted headroom does not cause any concern, as injection pipes (minimum 1.5m) can be spliced and lowered to the required depth.

Q12: Are there any unfavorable working conditions for the GEOTETS Method?

Attention must be paid if the groundwater flow velocity is 1.0×10^{-2}cm/s or greater. If so, the solidification of the backfilling material might be corrupted.

Q13: Up to now, all applications of the GEOTETS Method were carried out in Japan. Are there any plans to implement the method outside of Japan?

We acquired a patent for the method at the initial stage of the development, eyeing the global market. As the first step of expanding overseas, we have established an office in Vietnam and employed Vietnamese engineers there. We also plan to penetrate into Thai and Singapore markets sometime in the future. From these bases, we will expand our business further into the South East Asian market.

In order to disseminate information about the GEOTETS Method to the global market, we also plan to establish an English webpage describing the method.

Q14: We have heard that one of the issues with the GEOTETS Method is that it is not fully documented. Do you have a plan to fully document the underground backfilling sequences of the method?

530 projects utilizing the GEOTETS Method have already been completed, and we can supply sample case histories to assess similar upcoming projects. Although we need to do this on a case-by-case basis at the moment, we could compile the know-how into a technical document or specification and open it to the public.

Another challenge is to improve the accuracy of predicting the volume of the backfilling material, depending on working conditions. As we accumulate case histories and analysis results of the method and put these into a database, we would eventually be able to picture the situation below ground.

Q15: Please tell us about your predictions for the future. Do you have a target number of actual applications and/or corporate members?

Basically, it is ideal if both pile extraction and backfilling are carried out in one operation, by the same company. Therefore, we would like IPA corporate members to be members of the GEOTETS Method. As a short-term goal, we are targeting 200 applications in the year 2022.

Q16: Please proffer your message to people in the industry.

It will be more and more emphasized to reuse temporary retaining wall materials, in terms of reducing the risks of obstacles in future developments, SDGs and decarbonization. However, currently in the construction industry the potential risk of ground displacement due to the extraction of retaining walls, tends to be underestimated. Therefore, if proper countermeasures are not in place during extraction works, it may result in undermining the advantages of reusing temporary retaining wall materials. As we stated previously, we would dissuade people from relying completely on or underestimating the risk with the theoretical formula of the extent of ground displacement ($45°+\phi/2$). To reiterate, the actual extent of ground displacement sometimes reaches further than the formula ($45°+\phi/2$) suggests.

In the future, with further dissemination of the GEOTETS Method, we want to develop a better formula than the current one, which can be adopted in standard construction guidelines or specifications.