STUDENTS´ VISIONS ON MICROPILE WALL APPLICATIONS: HOW TO CONSTRUCT A LARGE DIAMETER PILE OR AN UNDERPASS

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ABSTRACT

At Turku University of Applied Sciences, innovation pedagogy is a learning approach that defines in a new way how knowledge is assimilated, produced and used in a manner that can create innovations. The inventions can be used as an environment for studies and e.g. micropile technology has been a topic for tens of students. This paper introduces students´ visions on potential applications of micropile walls used in gravity foundations or large diameter piles and - when installed horizontally - in underpass construction.

BACKGROUND

Creating innovations presupposes knowledge and the ability to apply it (Jaatinen et al 2013). At Turku University of Applied Sciences (TUAS), innovation pedagogy (Putkonen et al 2010, Kairisto-Mertanen et al 2012) has a notable role in the institution’s strategic policy. Innovation pedagogy aims at providing the students with professional skills that enable them to participate in innovation processes of their future organizations. It has been discovered that the development of inventions and patents offers an interesting learning environment in itself (Lehtonen et al 2012).

In innovation pedagogy the social aspects of learning and working are emphasized and project-based learning methods where learning happens in multidisciplinary teams form an essential share of the studies. The traditional approach is that students receive new information and skills as a student and only begin to apply it in the innovation processes after finding employment. The innovation pedagogy wants to challenge by highlighting that knowledge should be utilized in innovation processes already while studying. In other words, from the learning viewpoint, knowledge should be accumulated and applied simultaneously. In this environment, it is possible for students to participate in innovation processes and learn the required innovation skills. (Lehtonen & Räsänen 2012)

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Developing the method sets challenges for the development of both pile material and pile installation equipment. As a learning environment, the development of the C pile has produced half a dozen graduate theses and several project works. When foreign exchange students have participated in research hatcheries at TUAS, they have been given a learning task related to the invention. A typical example of these learning tasks might be to find possibilities for the use of the invention in their home country.

When developing innovations, the students recognize the information that is supposed to be found through studying. Innovations also include the risk of failure which is an integral part of development in the context of working life. Facing risks and failures is valuable capital which a student can acquire when working with innovations. (Lehtonen & Räsänen 2012)

The C pile (Fig. 1) is a patented new way of making a micropile. Unlike former micropiles, the top-hammered C pile is utilized in an open profile and installed into the ground with a new kind of eccentric drilling process. (Hyyppä et al 2012)

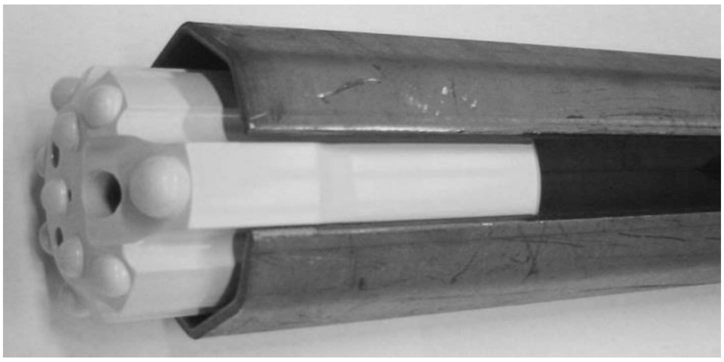

Figure 1. The C pile is an open steel section, installed using a new kind of an eccentric drill (Hyyppä et al 2012).

INSTALLATION OF MICROPILE WALLS

Drilled piles have been used for retaining walls constructed in Finland, Sweden and Norway since 2008. Drilled pile walls can be used in demanding soil conditions where installation of conventional sheet piles can face penetration problems or vibration risks. In Northern Scandinavia and Finland, hard and large boulders are common obstacles in the overburden limiting use of conventional sheet pile and retaining wall methods. (Uotinen and Jokiniemi 2012)

Two variations of drilled pile walls have been introduced recently in the Nordic countries based on either drilled steel pipe piles (RD piles) or an application of open section drilling utilizing C and CT profiles (Fig. 2). Using open section drilling, a drilled pile wall can be implemented starting with embedding of an open C section (Fig. 2A) and the wall can be extended using CT profiles (Fig. 2B). The first C profile contributes an open access to the next element. The T part of the CT profile penetrates to the previous C section creating a locking structure and the C part of the CT profile is an access to the next element, and so on.

Use of grout flushing improves structural capacity and water tightness of the wall. Grout can be used as insulation material, too. (Lehtonen 2013)

Drilled pile walls can be used as temporary or permanent structures. Typically, the wall has capacity to take both high vertical and lateral loads when needed. (Uotinen & Jokiniemi 2012)

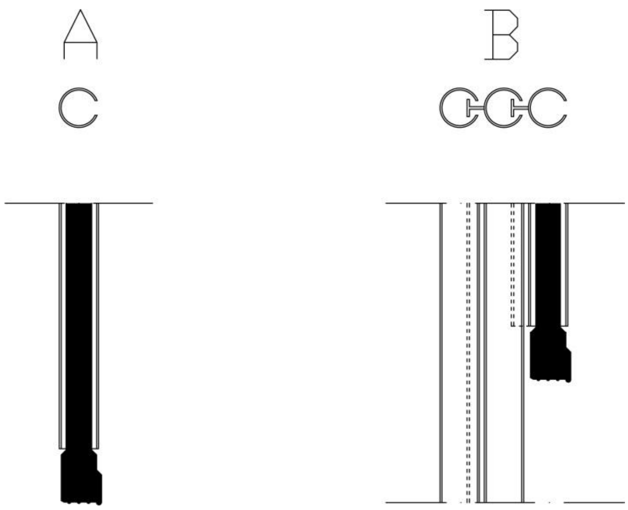

Figure 2. Installation of a CT micropile wall: the first pile is type of C and the following piles are drilled using CT profiles (Lehtonen 2013).

CT MICROPILE WALL IN LARGE DIAMETER PILES

The CT micropile wall can be used to construct specific shapes suitable for use as the shaft of a large diameter pile (Fig. 3). The shaft can be implemented in form of an entire circle or using a butt joint at starting point of drilling (Fig. 3d). The center of the drilled shaft can be treated e.g. using deep mixing or jet grouting. The large diameter piles, made from CT micropiles, have applicability energy towers (monopole foundations) and bridges (multiple structures founded on large diameter piles), see Fig. 4.

Potential advantages favoring the use of CT micropile walls include:

- The diameter of a drilled shaft or a gravity foundation can be chosen between 0,5 m and several meters – there is no upper limit using CT micropiles.
- The CT micropiles can be lengthened and mechanical couplers have been developed for embedding of e.g. 1 to 6 m long elements.
- The center of the large diameter pile can utilized as part of the gravity foundation when the center is treated e.g. using deep mixing, jet grouting or pressure grouted micropiles.
- Drilled shafts or gravity foundations can be easily installed e.g. in demanding environments (mountain areas, isolated islands, pathless wildernesses) or even under basements using light machinery for CT micropile embedding.

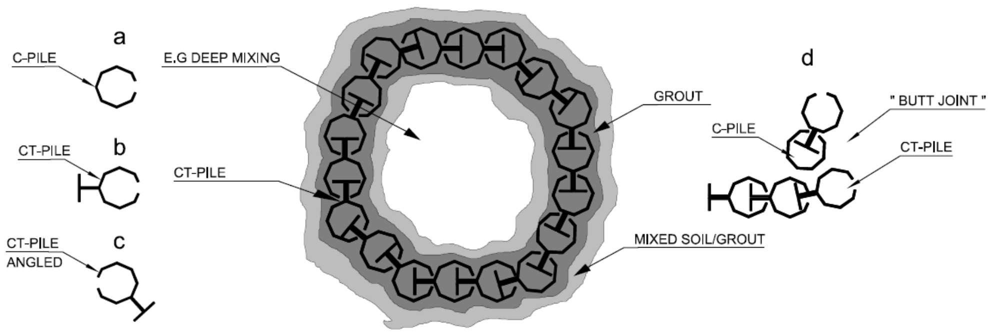

Figure 3. A proposal to construct a large diameter pile using a C pile (a) and CT elements (b), with angled versions (c) when needed. The large diameter pile can be an entire circle e.g. in sandy soils or equipped with a butt joint (d) when drilling meets boulders or respective obstacles. (Laakso 2014)

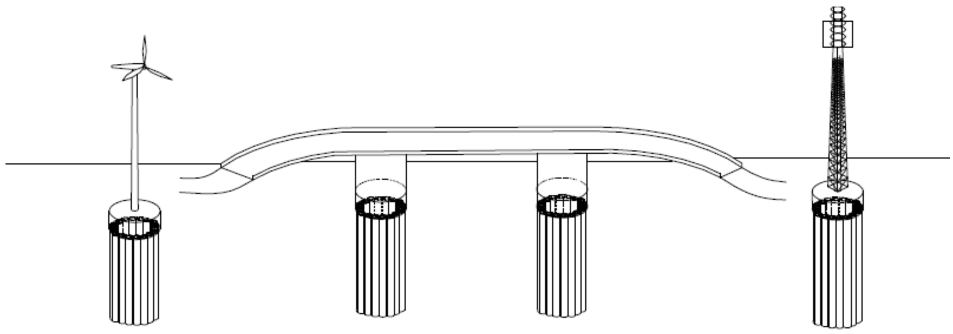

Figure 4. C/CT based drilled shafts can be used as gravity foundations or conventional large diameter piles. (Laakso 2014)

TUNNEL EXCAVATION

Until now, construction of underpasses beneath existing railway embankments has been challenged by limitations in breaks of train service. Traditionally, the underpass has be excavated extremely quickly and the bridge deck can be built simultaneously nearby the underpass (Lehtonen et al 2001). It is proposed that if the CT micropile wall would be installed horizontally, the underpass could be constructed without any stop in train traffic (Fig. 5).

The CT micropile wall would be in the form of an arch and the compressed structure could be e.g. shotcreted. The tunnel for the underpass is possible to excavate in stages while maintaining uninterrupted rail service above: (i) drilling using e.g. cement grouting a horizontal CT micropile wall in an arch shape, (ii) excavation of the first 2 m in the tunnel, (iii) shotcreting of the first excavation, (iv) the second 2 m excavation, (v) the next concreting and so on.

Other types of tunnels could be constructed using CT micropile wall technology, too. The method could be applicable especially when the tunnel is constructed in demanding soil conditions, including e.g. boulders and respective obstacles. Potential advantages in tunneling with CT micropile wall technique include:

- Drilling is applicable in any soil conditions.
- Shotcreting allows high bearing capacity to the tunnel roof.
- Traffic on the embankment is not needed to stop during the underpass construction.

CONCLUSIONS

R&D of micropiles has offered an environment on innovation studies for tens of students at TUAS. Especially new open section drilling method has challenged students to envision use of the CT micropile walls in unexpected applications.

In the production of innovations, learning and developing are often connected appearing as two aspects of the same concept. The student can learn several issues in the innovation process, covering, for example, tacit knowledge, networking and challenges to meet uncertainty. At its best, innovation is an inspiring and challenging learning environment for the learner. When developing innovations, the students recognize the information that is supposed to be found through studying.

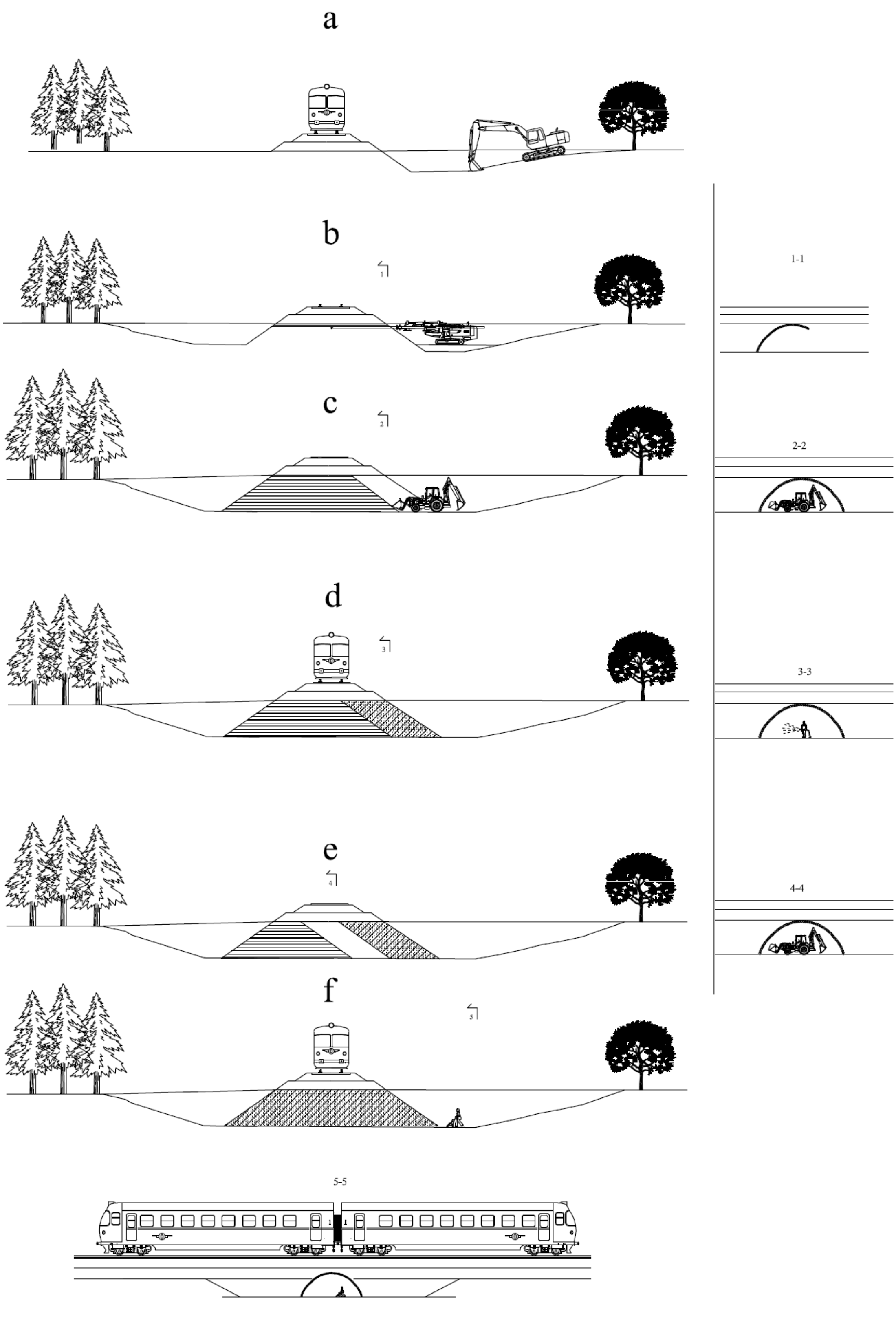

Figure 5. A tunnel is proposed to pass through an embankment with horizontal drilling. The arch is drilled using CT profiles and the roof is shotcreted after excavation. (Laakso & Hautamäki 2014)

REFERENCES

Hautamäki, J. (2014) *CT micropiles in construction of underpasses*. Project report (unpublished), Turku University of Applied Sciences.

Hyyppä, H., Hattara J., Lautkankare, R., Helmisaari, J. (2012) *Fin-C2M, New Micropile Innovations in Underpinning*, IWM2012

Jaatinen T., Roslöf, J., Putkonen, A. & Lehtonen, J. (2013). *Students' Experiences on R&D project based learning – Case ICT ShowRoom*. ICEE/ICIT-2013, Cape Town.

Laakso, J. (2014) *CT micropiles in construction of large diameter piles*. Project report (unpublished), Turku University of Applied Sciences.

Lehtonen, J., Rantala, J., Eronen, S., Koskinen, M. (2001). *Finnish Experiences from Superstructures Supported Directly on Steel Piles,* Proceedings of the XV ICSMGE, Istanbul.

Lehtonen, J., Vierimaa, R., Hänti S. and Kalen, L. (2011). *Inventions as support for learning*, in *Towards Innovation Pedagogy – A new approach to teaching and learning for universities of applied sciences*, Turku University of Applied Sciences.

Lehtonen, J. and Räsänen, M. (2012). *Inventions as an environment for learning*, Proceedings of the International Conference on Engineering Education (ICEE 2012), Turku, Finland.

Lehtonen, J. (2013). *Drilled pile technology in retaining wall construction and energy transfer*. Proceedings of the 18th ICSMGE, Paris.

Kairisto-Mertanen, L., Penttilä, T. and Lappalainen, H. (2012). *Fostering Capabilities for Continuous Innovation in University Education*, Proceedings of 13th International CINet Conference, Continuous Innovation Across Boundaries, Rome, Italy, pp. 628-639.

Putkonen, A., Kairisto-Mertanen, L. and Penttilä, T. (2010). *Enhancing engineering students' innovation skills through innovation pedagogy – experiences in Turku University of Applied Sciences*, Proceedings of the International Conference on Engineering Education (ICEE 2010), Gliwice, Poland.

Uotinen V.-M. and Jokiniemi H. (2012). *RD pile wall – a new way to build micropile retaining wall structures*, Proceedings of IWM2012, Milan.