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Case History-3

Control Measures for Installation and Removal of Temporary Earth Retaining Walls

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The process of wall installation and removal may cause excessive ground movements if not properly controlled. Proper control measures should be implemented to minimise the effect of wall installation and removal, hence avoiding unnecessary damage to the adjacent structures. This paper highlights some control measures for wall installation and removal to minimise the impact of wall installation and removal. Case histories of wall installation and removal are also presented to demonstrate the important of implementing control measures during wall installation or removal.

Close proximity to existing buildings



Picture 1

As the city developed, buildings get closer. Due to high land prices in the city, developer may need to optimise the land use. This often resulted in basement constructed next to adjacent buildings. Such situation poses great challenges to the construction team. Installation of retaining wall in close proximity to existing buildings requires proper selection of machinery and tools and proper control and supervision of the piling works. In addition, designer should also need to allow adequate set-back distance for the safe installation of the retaining walls. Damage to the neighbouring building may cause unnecessary repair cost and also delay in construction program. Figure 1 shows an example of installation of retaining wall in close proximity to existing building. Figure 2 shows a typical basement construction in close proximity to existing building where various control measures can be adopted to minimise potential damage to adjacent buildings.

Case study of installation of soldier pile wall by vibro-hammer

Figure 3 shows a plan layout for a housing development with a basement. In the original design, 3 site investigation boreholes were drilled. Results of these 3

site investigation boreholes showed that the ground consisted of residual soils and weathered rocks of the Bukit Timah Granite. In view of the favorable ground conditions shown in all 3 boreholes and no concern of lowering of ground water level, the designer has adopted a soldier pile wall with structural lagging in between the soldier pile as the retaining wall system. During installation of soldier piles using vibro-hammer, a few neighbouring houses was reported damage. Work was stopped for 3 months for further investigation. As part of the investigation, 2 additional site investigation boreholes along an existing drain was conducted. Results of these two new site investigation boreholes showed the presence of very soft clay and very loose sand with SPT N value of 0. The designer has concluded that the damage to adjacent houses was caused by the installation effect of soldier piles using vibro-hammer in very soft soils.

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In view of presence of very soft soils, the designer has enhanced the retaining wall system with additional sheet pile wall to provide an effective water cut-off wall during basement excavation. Standard Pressed-in method was adopted to install the additional sheet pile wall. No damage was reported during the sheet pile wall installation. Such example suggested that standard pressed-in method may be adopted as a control measure to minimise the impact of installation of sheet piles wall for site located in difficult ground conditions and in close proximity to existing buildings.





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Case study of wall removal by vibro-hammer

Figure 4 shows a plan layout for a high-rise private residential development with 2-level of basement. Figure 5 shows the section of the retaining wall system. The ground conditions consisted of Fill layer overlying a thick layer of soft marine clay. Sheet pile wall and compressive ring slabs (where part of the permanent basement slab was used as compressive ring to support the basement excavation) was adopted as retaining system. Such retaining wall system is getting popular among designer in Singapore as it is a robust retaining system that able to provide effective support to restrict ground movement, and hence minimizing potential damage to the adjacent buildings. Ground movements at the end of basement construction was within its design limit as shown in Figure 6. The builder decided to remove two sections of the temporary sheet pile wall next to open car park. Vibro-hammer was used for the sheet pile extraction. Excessive ground movement was observed after the sheet pile extraction and the open car park and the adjacent road was damaged. This case study show that it is necessary to implement control measure such as proper equipment and method statement during sheet pile removal to avoid potential damage to adjacent properties.



| | Building settl | ement/monitori | na | |
|--|--|--|---|--|
| After completion of | Instrument Ref. | Current reading | Alert level | Work Suspension |
| basement works | WP1 | -2.8m | -1.4m | -2.0m |
| Ground settlement at | WP5 | -1.6m | -1.4m | -2.0m |
| alert level | GS9 | -26mm | 25mm | 35mm |
| | | Contraction of the second second second | | |
| During removal of | Building settl | ement/monitori | na | Jun 2013 |
| During removal of sheet pile wall | Building settl Instrument Ref. | ement/monitori Current reading | ng Alert level | Jun 2013 Work Suspension level |
| During removal of sheet pile wall • Excessive ground | Building settl Instrument Ref. GS1A | ement/monitori Current reading | ng Alert level 25mm | Jun 2013 Work Suspension level 35mm |
| During removal of sheet pile wall • Excessive ground settlement way beyond work | Building settl Instrument Ref. GS1A GS2B | ement/monitori Current reading -172mm -131mm | ng Alert level 25mm 25mm | Jun 2013 Work Suspension level 35mm 35mm |
| During removal of sheet pile wall Excessive ground settlement way beyond work suspension level. | Building settl Instrument Ref. GS1A GS2B GS3A | ement/monitori Current -172mm -131mm -155mm | ng Alert level 25mm 25mm 25mm | Jun 2013 Work Suspension level 35mm 35mm 35mm |

Figure 6

Control measures for wall removal

Figure 7 shows a summary of control measures may be adopted by the project parties to minimise the impact of removal of the temporary earth retaining wall. Proper implementation of such measures may help to minimise the risk of damage to the adjacent structures.

| Control measures for wall removal |
|---|
| Designer assessment Designer to assess the potential impact of wall removal on adjacent structures. Designer to specify on plan whether the retaining wall to be removed or to be left-in. |
| Detailed method statement of wall removal If wall removal is allowed (for example for site located in green field area), designer to specify on plan type of equipment to be used and detailed method statement that should include necessary precautionary / mitigation measure to prevent ground loss during wall removal. |
| Proper supervision of wall removal Supervising qualified person or its qualified site supervisors to supervise wall removal in accordance with the approved plan and method statement. |
| Figure 7 |

*This case history is based on the presentation at "IPA Seminar on Pressed-in Technology in Singapore", which was held on 2 March 2017.



A Brief CV of Dr. Ng Tiong Guan

Dr Ng Tiong Guan is the immediate past president of the Geotechnical Society of Singapore. He graduated from the University of Technology Malaysia with Bachelor in Civil Engineering 1st Class Hons. Degree in 1992 and obtained his PhD degree from the National University of Singapore in 1999. He co-founded a specialist geotechnical consulting firm GeoEng Consultants in Feb 2002, which became part of Golder Associates in Nov 2011. Dr Ng is currently the Principal of Golder Associates and Executive Director of Golder in Singapore. Dr Ng specialises in analysis, design and supervision of earth retaining system, deep foundation and ground improvement works.

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A Brief CV of Dr. Poh Teoh Yaw

Dr. Poh is a Deputy Director with Building and Construction Authority which oversees and administers the regulatory framework on building structure safety in Singapore. He is a geotechnical specialist with over 18 years of practical experience. He has authored over 18 publications in geotechnical design and construction including those published in international peer-review journals and conferences.