

Conservatoriumhotel Amsterdam, geotechnical design and monitoring

Conservatoriumhotel Amsterdam, conception géotechnique et instrumentation

Stoel van der A.E.C.

CRUX Engineering BV Amsterdam & Universiteit Twente

Vink D., Bouma J.

CRUX Engineering BV Delft

ABSTRACT: This article deals with the geotechnical design of the building pit and the foundation restoration of the Conservatoriumhotel Amsterdam. It involves a selection of results of analytical and Plaxis calculations and damage predictions regarding vibrations and settlements. The second part of the paper deals with the execution of the works and the important role of a pro-active monitoring-system and careful communication with all stakeholders. It briefly outlines the monitoring plan, type and results of the monitoring and the risk management during implementation. Some measurement results are compared with predictions and two calamities that occurred during the construction will be specifically addressed. This will clearly show the added value of monitoring and active risk management, that eventually has led to the successful completion of this project in 2011.

RÉSUMÉ : Cet article traite de la conception géotechnique de la tranchée couverte du bâtiment et reprise en sous œuvre des fondations du Conservatoriumhotel Amsterdam. Il s'agit d'une sélection de résultats de calculs analytiques et Plaxis et des prévisions concernant les dommages dus aux vibrations et les tassements induits. La deuxième partie de l'article traite de l'exécution des travaux et le rôle important que la surveillance pro-active et de la communication prudent avec toutes les investisseurs. Le plan d'instrumentation est brièvement décrit ainsi que le type et le suivi, des résultats et de la gestion des risques lors de la mise en œuvre. De plus les résultats des mesures sont comparés aux prévisions. Deux sinistres qui se sont produits lors de la construction seront abordés. La valeur ajoutée de l'instrumentation est montrée ainsi que la gestion active des risques qui a finalement conduit à la réussite de ce projet en 2011.

KEYWORDS: geotechnical design, building pit, Plaxis, monitoring, restoration

1 INTRODUCTION

In Amsterdam, at Van Baerlestraat 27, the stately listed building of the "Rijkspostspaarbank" (Imperial Bank, see Figure 1) is situated. It was originally built between 1899 and 1901 by Imperial architect, D.E.C Knuttel. The building was previously reassigned to function as Sweelinck Conservatory and was since 2008 radically converted into a luxurious hotel, including over 9000 m² of five star hotel and 85 parking facilities. This conversion has been one of the most expensive (more than 30 million euro) hotel refurbishments ever.

This renovation required a number of radical structural changes that led to a complex task with regard to the geotechnical design. The most important of these tasks was realising a two level parking / basement including a (-3) swimming pool in the courtyard of the existing building. Special attention had to be paid to the many historical details in the buildings that were incorporated in the new design and had to be preserved. In addition, the building location is flanked by two tram lines and the Van Gogh Museum and Rijksmuseum and the Royal Concert Hall, resulting in numerous logistic restrictions.

2 SOIL CONDITIONS

At the location, the typical Amsterdam soil profile (Figure 2) is found. The top layer of the first meters below surface level consists of Anthropogenic sand. Below this top layer the Holocene deposits are found until a depth of about 10-15 m below surface level. The Holocene formation can be divided (from top to bottom) into peat, clay, silty sand, clay and peat. The Holocene lies on top of the Pleistocene sands which are divided by an intermediate silty, clayey sand layer. The phreatic water level is found about 0.4 m below surface level.



Figure 1. Aerial photo of the building Stradivarius

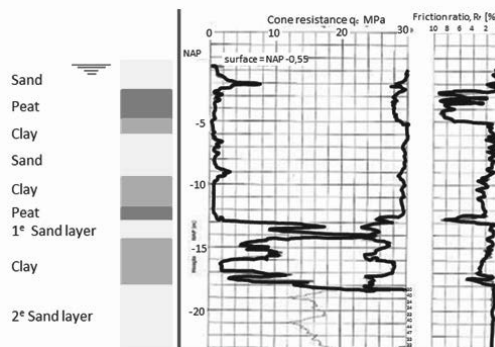


Figure 2. Amsterdam soil conditions

3 CONSTRUCTION AND BUILDING LAYOUT

In Figure 3, 4 and 7 the lay out of the building and building pit are shown. Because of the very deep excavation next to the pile foundation of the existing building, much precaution had to be paid to settlements and angular distortion (damage) of this listed building. Also, the bending moments in the existing wooden piles were a major concern. This resulted in a staged excavation as shown in Figure 4. Note the different excavation levels of the two excavations A and B, which cause an asymmetrical load situation and displacements. An extra complication was that the building site could only be accessed through a narrow entrance in the eastern part.

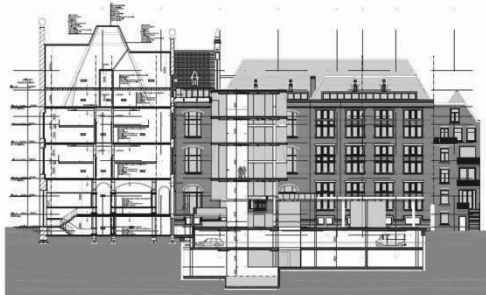


Figure 3. Section C-C: new situation (note swimming pool at -3)

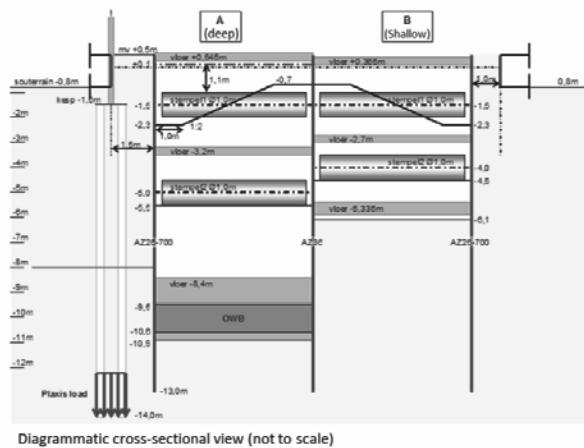


Figure 4. Schematic cross-section C-C, NAP = reference level

4 GEOTECHNICAL DESIGN

Because of the asymmetrical excavation and the need to assess soil and building deformations, 2D FEM Plaxis calculations were performed. In Figure 5 an example of the used model for section C-C is shown (see Figure 7). Based on the deformations and stresses resulting from this model, the vertical deformations and inclination of the existing building were determined, see Figure 6. The sheet piles and struts were designed in such an iterative way that the damage prediction resulted in an acceptable damage class (see Table 1).

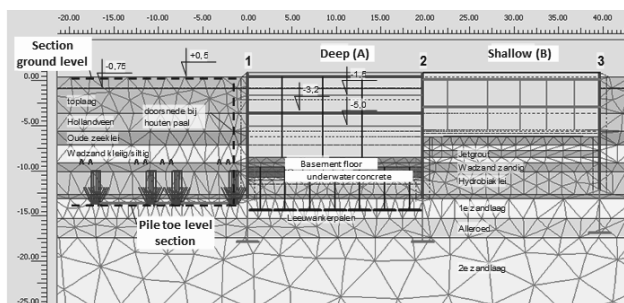


Figure 5. Plaxis geometry section C-C, shallow excavation NAP -6,1m.

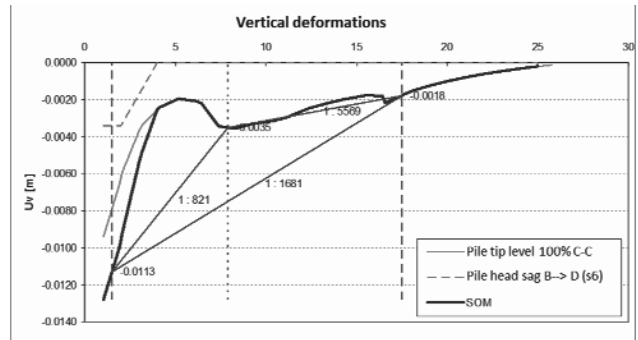


Figure 6. Vertical deformations in building, section C-C.

Because of the proximity of the existing building, full of marble stairs and exquisite tiles that had to be preserved, all the applied foundation system were vibration free: the sheet piles AZ26 were pushed and the Hek-piles were screwed.

Table 1. Results damage prediction sect. C-C (based on BRE regulation / Netzel 2010)

u_v	L/H	β	E_h	Δ/L	ϵ_{tot}	Damage class
m	-	-	%	-	-	-
-0.0113	1:1605	0.066	0.0002	0.00088	-	Slight (minor aesthetic damage)

L/H = Ratio depth/height of the building Δ = Vertical deflection
 B = Relative angular distortion ϵ_h = Horizontal strain
 ϵ_{tot} = Total building strain u_v = vertical displacement

5 MONITORING

5.1 General

Because of the sensitive nature of the existing building and the high complexity of the execution of the works, an extensive monitoring program was implemented. Figure 7 shows a general overview including the position of the levelling point (bolts) and inclinometers. By measuring the inclination of the sheet piles, an excellent comparison could be made between predictions and execution for all stages of the works. The leveling points were mainly used to verify whether the inclination indeed resulted in the predicted building deformation. This is particularly useful because some deviation from the predictions is not uncommon.

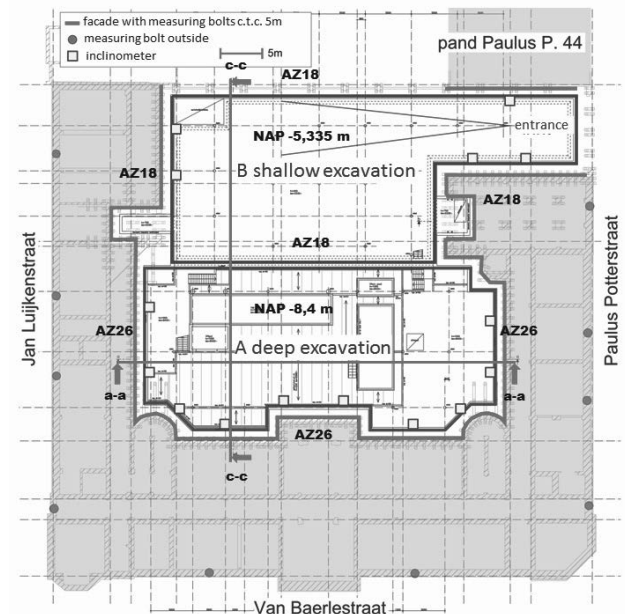


Figure 7. Overview leveling points (bolts) and inclinometers.

The monitoring proved to be particularly valuable because of the occurrence of two incidents during construction.

5.2 Incident 1

Incident 1 occurred during the excavation of building pit A. The situation at that time is illustrated by Figure 8 (by a recommendable, remotely operable, permanent webcam!) and Figure 9.



Figure 8 Overview building pit (at the time of incident)



Figure 9. Top view building pit (at the time of incident; © Google)

To limit the displacements the execution sequence has been that, after placement of the sheet piles and the excavation for the NAP -1,5m and -5,0m struts, the water table was first set up again before wet excavation to NAP -10,5m commenced. After hardening of the underwater concrete floor, the water table was lowered again. It was then timely discovered that the -5,0m struts and girder were not in position, see Figure 10. Pumping was stopped immediately to access the situation.

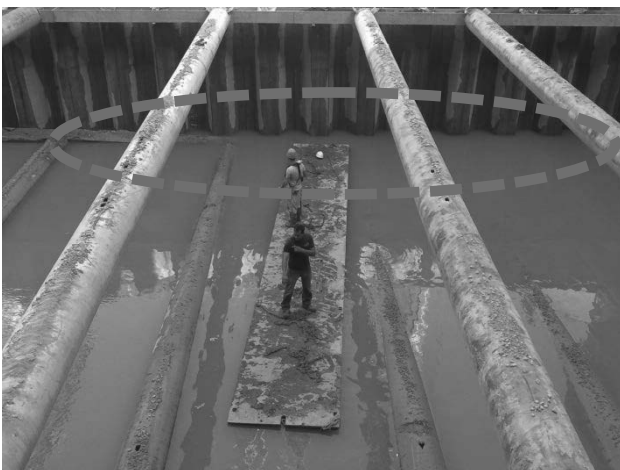


Figure 10. Situation at 2nd level girder (collapsed during excavation)

In order to be able to inspect the girder and struts, the water table had to be lowered further than calculated (-6,5m without strut). It was found that, probably because of excavating under the girder, it's consoles were removed, thus causing it to 'hang by a tread'. Because of the extensive monitoring and modelling, an alternative model could be made very quickly based on actual deformations, from which it could be concluded that the deformations resulting from the mitigating measures stayed within acceptable boundaries, see Figure 11. Thus, within three weeks and without significant delay in construction, the strut and girder could be repaired allowing for further excavation of the pit.

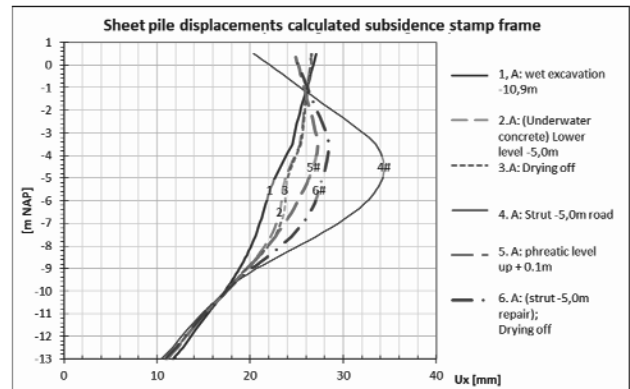


Figure 11. Inclinometer & predictions after incident at girder/strut -5.0m

5.3 Incident 2

Incident 2 occurred during the excavation of the entrance at building pit B. The situation is illustrated by Figures 12 (before) and 13 (after excavation). At the left side of the pictures, a listed building at Paulus Potterstraat 44 (PP44) is located. During the excavation of building pit B, this building started to settle, as can be seen in Figure 15. The main concern however was that the side at the entrance settled significantly more than the opposite side, thus potentially causing damage.

In November 2009 the monitoring showed that the settlement rate increased alarmingly. The frequency of monitoring was immediately increased and owner, contractor, consultants, insurer and the municipality intensively discussed a solution. This was found in a combination of allowing more deformation as long as no damage resulted from frequent building inspection and, more importantly, the remedial measure of pre-stressing the NAP -4,0m strut with 150 kN/m. The last measure resulted in a stabilisation of deformations that has held up to now. No damage to PP44 was detected.



Figure 12. Building pit at PP44 before incident



Figure 13. Building pit at PP44 during incident

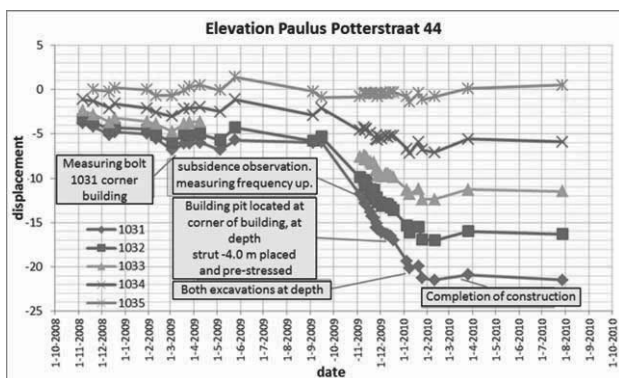


Figure 14. Displacement of building Paulus Potterstraat 44

5.4 Costs

The (interest)cost of a delayed opening of the hotel have been estimated at least at €50.000,- a week. The additional costs of the additional monitoring and damage risk assessment have however, as compared to a basic monitoring program, not exceeded €100.000. When no information would have been available after one of the calamities, construction could have been stopped for months.

6 COMPLETED WORKS

The works have been completed in 2011, not only resulting in one of the most luxurious hotels in Amsterdam, but also in a construction of both geotechnical as well as aesthetic beauty. It won the 2012 Dutch Renovation 'Golden Phoenix' award for the most effective reuse of existing property stocks. An impression of the completed work is given in Figure 14 to 16. Figure 19 shows the impressive swimming pool at -3 level, right next to the over 110 years old existing pile foundations.

7 CONCLUSIONS

The renovation of the former Rijkspostspaarbank Amsterdam to luxury five star Conservatoriumhotel has been very successful from a geotechnical perspective. Through a sophisticated geotechnical design and a detailed risk analysis of the distortions of the building before construction, combined with a meticulous and proactive monitoring and excellent communication during execution, two major incidents have not

led to significant additional costs and/or delays. The investments that have been necessary to achieve this have been minor compared to the potential cost of the delay that would have resulted from the lack of information without such a system.



Figure 15. Finished construction – atrium new-old



Figure 16. Finished inside construction



Figure 17. Finished outside construction



Figure 18. Finished swimming pool at -3 level

9 ACKNOWLEDGEMENTS

The authors wish to express their gratitude to the client Alrov Group and IQNN Vastgoed, structural engineer Van RossumRaadgevendIngenieurs, contractor Strukton NV and foundation subcontractor Van 't Hek for their contributions to this paper.

10 REFERENCES

Netzel, H.D., Building Response Due to Ground Movements, Delft University Press, March 2009, Pages 320, ISBN978-1-58603-995-0
 Van der Stoel, A.E.C. D. Vink & J. Bouma, Van RijkspostspaarbanknaarvijfsterrenConservatoriumhotel; deel 1 geotechnischontwerpConservatoriumhotel Amsterdam, Geotechniek, jaargang 16, no. 4, augustus 2012 (in Dutch)
 Van der Stoel, A.E.C. D. Vink & J. Bouma, Van RijkspostspaarbanknaarvijfsterrenConservatoriumhotel; deel 2 Monitoring en uitvoeringConservatoriumhotel Amsterdam, jaargang 16, no. 5, december 2012 (in Dutch)