BROKK®

Breaking the walls of Singapore's tourist complex

Singapore has started building a large hotel and casino complex and the project is expected to be completed in record time. The entire complex is built on reclaimed land and the soft ground conditions create major challenges for the foundation. Thick diaphragm walls had to be built and part of the walls had to be demolished after the foundation was laid. This tough job – in confined space and under a tight time schedule – was an excellent job to test the first Brokk 400 in Asia.

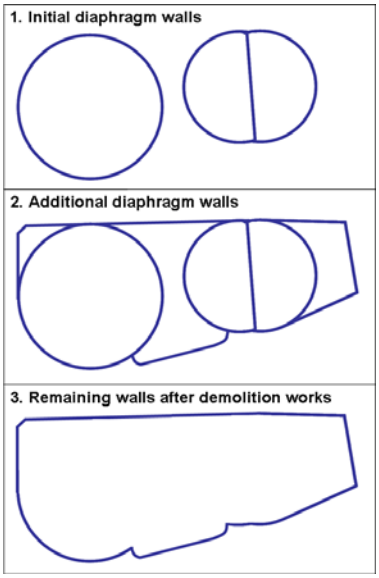
The construction of the three 57-story hotel towers

Conceptual image of the completed complex

The Southeast Asian city-state of Singapore, an internationally renowned financial centre and one of the busiest and most modern freight handling centres in the world, is now also striving to become a top tourist destination. With its ambitious Marina Bay Sands project, Singapore will in a near future have a gigantic complex complete with convention facilities, casino, theatres, museum and an impressive hotel complex. The hotel will consist of three 57-story towers with a total of 2,600 hotel rooms. The rooftops of the three towers will be connected using a sky terrace at a height of nearly 200 metres. The terrace will offer a view of Singapore's shore and skyline and have gardens, scenic walks, restaurants, a swimming pool and an observatory.

Diaphragm walls due to soft soil

The entire development was built on reclaimed land with soft ground conditions. With almost 40 percent of the total development underground, the foundation proved to be a very challenging project. In order to avoid subsiding ground, deep diaphragm walls had to be installed into the ground before the area could be excavated. If the entire basement was to be excavated before the starting the construction of the towers, there would have been a long delay. Also, the bigger the excavated area, the more complex it will be to secure the diaphragm walls with struts and supporting slabs. To expediate construction, it was decided to build smaller cofferdams with diaphragm walls for each of the hotel towers. These samller cofferdams could be excavated without struts and, as soon as the foundation was laid, the constructon of the towers could commence. The construction of the permanent diaphragm walls and the



Construction sequence of foundation

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excavation of the rest of the underground complex could be done simultaneously as the towers were built. The contract to construct the towers, once the cofferdams were excavated, was awarded to Ssangyong Engineering & Construction.

Two diaphragm walls with steel struts in between for stabilization

A challenging demolition task

Once the entire underground complex was excavated, and the foundation secured, the temporary diaphragm walls separating the hotel basements had to be demolished. Technocrete Pte. Ltd., one of the leading specialist demolition contractors in Singapore and in the region, was awarded the contract for all demolition work in the hotel construction project. Technocrete was faced with a tough challenge and a very tight schedule. The demolition of the diaphragm walls could only be done after all basement floor slabs were in place. The headroom between floors was only three meters high and the diaphragm wall was 1.5 meter thick, constructed by heavily reinforced Grade 50 concrete.

Technocrete proposed a combination of wire cutting and breaking methods to demolish the diaphragm wall. Wire cutting was used whenever both sides of the diaphragm wall could be accessed and there was room to lift out the cut blocks by crane. All other remaining parts were demolished using hydraulic breakers.

Technocrete had two units of Brokk 330 and both were mobilized onsite. But the two machines were not enough to meet the schedule. Technocrete mobilized several 5-ton Airman AX45 mini-excavators to expediate the demolition. However, after facing a number of problems with the mini-excavators, Technocrete decided to purchase two units of B400, Brokk's biggest demolition machine till date, to meet the demanding schedule.

The mini-excavator's low-energy breaker with an arm-system optimized for digging resulted in a very low performance

Problems with mini-excavator

The main problem with mini-excavators was the lack of power and therefore productivity. First of all, mini-excavators are designed for digging and therefore not able to carry very big breaker. Also, the two-part arm system result in a significant loss of power when breaking forward and the 'knuckle' on the arm system kept hitting the ceiling. This resulted in a very slow demolition rate. In addition, the operator needs to sit unprotected on top of the excavator since the driver's cabin due to the limited headroom. The diesel fumes generated in confined space makes the situation even more unpleasant for the operator.

Brokk 400 is just like all other Brokk machines; electrically powered, radio-controlled, and equipped with a three-part arm system. But this 5-ton machine is equipped with a 520 kg breaker with an impact energy of 1048 joule. The difference in result, compared to the mini-excavator, was obvious from the very beginning. The Brokk machine was breaking loose big lumps of concrete at a time compared to

the concrete chippings that were broken off by the mini-excavator.

Performance test

During initial deployment, Brokk carried out a performance test on the B400. An isolated section of the wall was demolished while measuring the time. The wall section was 6 meter wide, 4 meter tall and 1.5 meter thick, resulting in a total of 36 cubic meters.

In this test, the total time taken solely for breaking was about 9 hours which works out to a productivity of 4 cubic meters per hour. On average, it took Technocrete roughly three days for complete demolition of this type of wall, including cutting the reinforcement bars and remove all the debris. This is estimated to be around five times the performance of the mini-excavator of similar weight.

With the incredible power of Brokk 400, Technocrete is now in the advantage position to secure more demolition jobs of similar nature.

Brokk 400, a 5-ton radio-controlled, electric machine with 1000 joule impact energy in every hit.

Brokk 400 breaking roughly 4 cubic meters per hour allowing for total removal of 36 cubic meters in 3 days

Conclusion

Brokk 400, Brokk's biggest demolition robot, proved to be highly effective for breaking heavily reinforced Grade 50 concrete. The performance of the machine was not affected by the three meter head room or the fact that the job took place in the basement.

The productivity of Brokk 400 proved to have roughly five times the performance of a conventional mini-excavator of similar size. Given the tight time frames for the construction of Singapore's latest tourist complex, the performance of B400 proved to be an essential component to meet the overall deadline for the hotel towers. ♦

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