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TREVI

REFERENZA TECNICA - *TECHNICAL REFERENCE*

Riksdagens Hus
(Parliament House)

Stockholm, Sweden

Jet Grouting
Cut-Off Wall

Cliente : *Owner:*	RIKSDAGS ADMINISTRATION Real Estate Unit
Contrattista principale : *Main Contractor :*	**NCC Construction Sverige AB**
Durata dei lavori : *Duration of work :*	**2004 - 2005**

Introduzione

Most of the Stockholm old town is founded on wooden piles that are several centuries old. While Stockholm is raising about 400 mm per century due to the elevation of the land after the ice age, the piles become exposed to the air and start to decompose, leading to loss of bearing capacity and structural stability.

Big parts of the old town have already been saved through underpinning, but nothing was done to the island of the Parliament Building. In the late 1960s it was decided that the old wood foundation was to be preserved and an investigation came to the conclusion that measures to stabilize the level of the ground water had not to be taken until after the turn of the century.
Following a thorough geotechnical investigation around the Parliament Building, a full scale test was made in 2000 by installing jet grouting columns to form a cut-off wall. The success of the test convinced the designers that the jet grouting method would be the solution to keep the water level above elevation +0.70 m, safe limit for the wooden piles under the Building.

Project description

The cut-off has been designed about 150 m long, formed by two rows, 375 mm apart, of single fluid secant jet grouting columns, for a total of 515 units with a 1000 mm diameter at 750 mm centre to centre, connecting an existing weir on one side of the island and a new sheet pile weir on the other side. It had to penetrate the granite bedrock for 1.5 m, thus having a depth varying from 15 to 35 m and a total surface of about 2600 square metres.

The wall was divided into eight sectors and each sector was subject to a separate trial test. In December 2003 the cut-off contract was awarded to Hercules-TREVI Foundations AB, for a total amount of about 5.5 million euros.

Fig.A

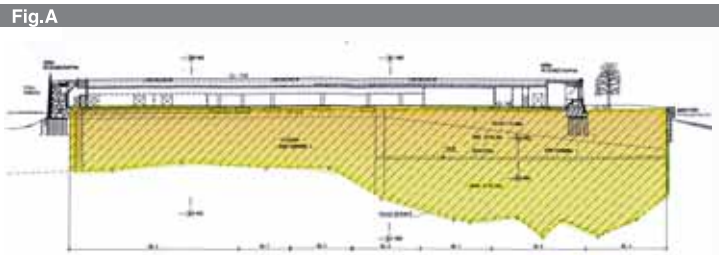
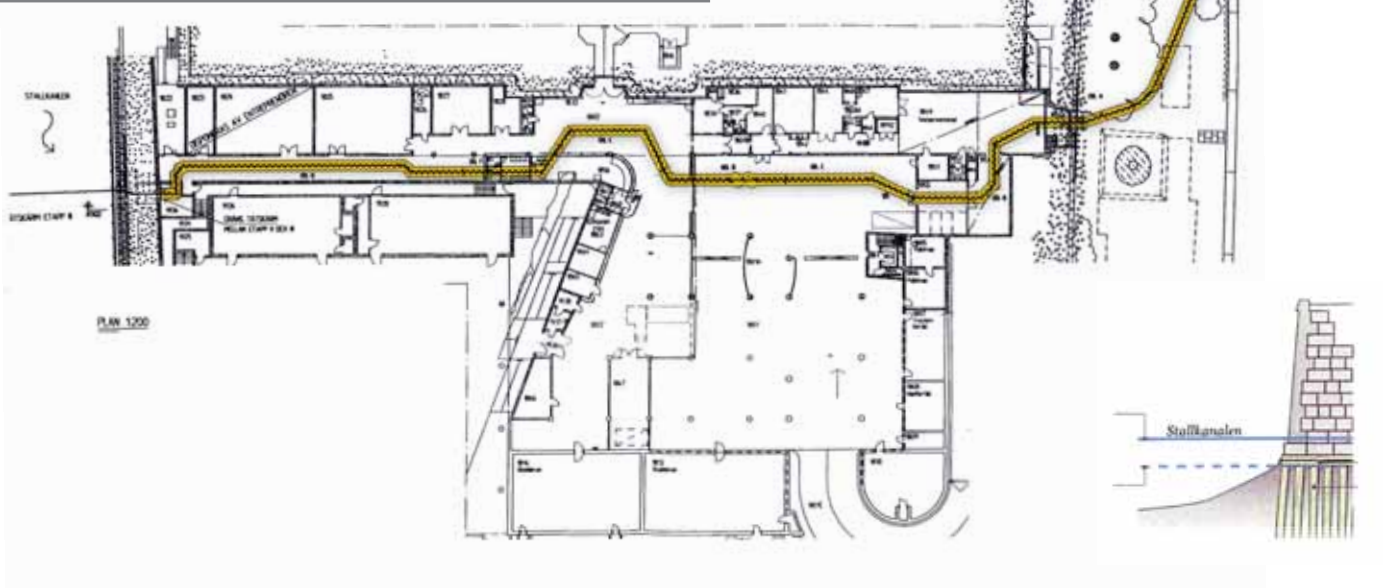


Fig.B

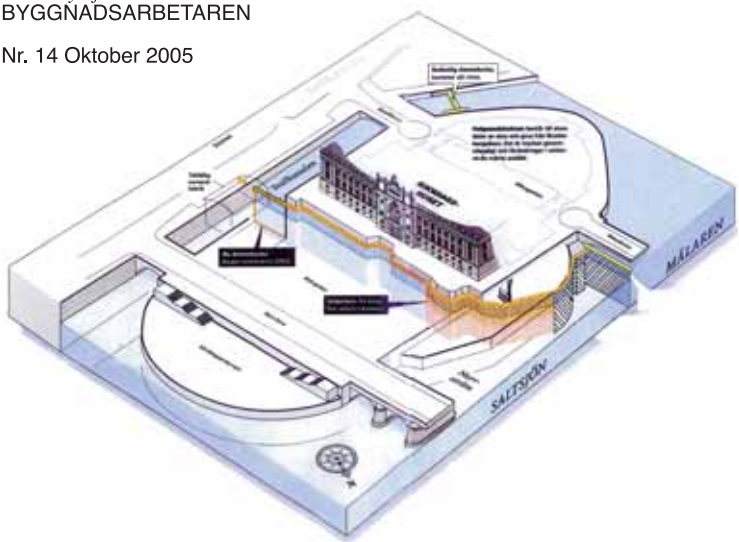


Geology

The Parliament Building is located on the Helgeandsholmen island, which is part of the Stockholm ridge, a moraine zone, which runs through Stockholm. The ridge consists of materials deposited during the ice age and rests on solid rock at a depth of about 30 m. The top layer contains medieval deposit of backfill materials such as large amounts of rocks, gravel and wood, with obvious voids and decompressed zones.

Courtesy of:
BYGGNADSARBETAREN

Nr. 14 Oktober 2005



Technologies

The complexity of the job increased with the requirements that the Parliament activity had not to be disturbed by the works, the local safety and environmental laws had to be strictly enforced and the site impact on the landscape had to be minimized. Neither drilling water nor grout spoil could fall into the surrounding waters. In order to satisfy these requirements, Hercules-Trevi erected a special two-storey trestle building in the canal close to the island, where the mixing plant was set up. Everything was containerized to prevent pollution, and all pipelines and hoses were buried to minimize the site impact. The grout spoil was pumped back to the plant where the sand was separated and the grout was partially recycled or pumped to backfill large voids in the island. The sandy part of the spoil was dumped into containers for drying and disposal. The standard Soilmec GM-25 mixing equipment was modified in order to be able to operate using both fresh water and recycled grout spoil. A modification in the computerized system and in the software enabled the mixing unit to evaluate the density of the fluid and to add the necessary cement to obtain the specified grout. Most of the wall was installed from the basement and the underground rooms of the building, as low as 2.1 m high, using Soilmec SM-103 electric powered mini-drilling rigs.

Quality control

Colouring additives were added to the grout to better evaluate the results in the cored samples. Since the maximum allowed tolerance on verticality was 2% with all data recorded, an overburden drilling method was used with a 4" down-the-hole hammer. Every single column was monitored by an inclinometer and the results were plotted to prepare an as built drawing, while the jetting parameters were recorded versus depth using an automatic recording device.

Since the wall minimum required unconfined compressive strength was 5 MPa, the whole cut-off wall was checked by vertical and inclined coring, with laboratory compressive tests on selected samples. Permeability tests were also performed in the cored holes and several piezometers were installed upstream and downstream the cut-off wall for future monitoring.
The results of final tests were fully accepted by the Client, with only few additional columns installed as reparatory works.

Main quantities

Jet Grouting	columns n° 515	Ø 1000 mm	depth 30 m	Total drill 12.000 m *(Jet Grouted lenght 9500 m)*
Core drilling and check holes			depth 10-35 m	Total 4.000 m
Steel sheet piling				Total 1.000 m^2
Micropiles			depth 30 m	Total 450 m

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