



Midskog hydropower station: repair of a dam from the 1940's



Surface at the water intake hydrodemolished down to the rebars by a Jetframe from Conjet.

The Midskog hydropower station is part of the river Indal's water regulation system in Northern Sweden. The dam was built during the 1940's and is a combined earth fill and concrete dam.

The total length of the crest is 1.404 m (4.600') of which the concrete dam part is 390 m (1.300'). At its maximum height the dam is 27 m (89') above ground level. The station is owned and operated by

Vattenfall (The Swedish State Power Board), the main electrical power-producer in Sweden with some 50 percent of all electricity produced. Average water flow at the Midskog Power Station is 370 m³ per second (785.000cfm) and the turbines have been dimensioned to take 640 m³ per second (1.350.000 cfm). The normal water head is 29 m (95'). Midskog has 3 turbines with an installed power of totally 145 MW.



CONJET AB
P.O. Box 507
SE-136 25 HANINGE
SWEDEN

PHONE:
+46 (0)8 55 65 22 40
FAX:
+46 (0)8 55 65 22 60
E-MAIL:
conjet@conjet.com
WEBSITE:
www.conjet.com

Hydrodemolition to avoid micro cracks

A recent inspection showed damage to the concrete that should be repaired without further delay. The damage consisted of frost erosion and mechanical break down of the surface layer around the water line on the upstream side of the dam and along the side beams of the crest of the dam.

Furthermore, there have been damage along the joints on the downstream side of the dam in the form of chalk leaching. The work comprises the removal of damaged and deteriorated concrete from the affected surfaces as well as the application of new concrete by means of shot-crete. The job specification calls for hydrodemolition as the only allowable method to work on the dam surfaces. Mechanical demolition methods were not allowed as these are considered to cause too many micro cracks in the remaining concrete.

When the job was bid the tender documents specified some 800 sq.m. (8.600 sq.ft) of concrete surface to be removed to a depth of 3-10 cm (1-4"). As work progressed, the concrete was found to be more damaged than what was expected, therefore another 1400 sq.m. (15.000 sq.ft) have been added to the contract.

Equipment from Conjet AB

NCC (The Nordic Construction Company) was awarded the job. For the hydrodemolition they were utilizing two machines delivered from Conjet AB, the world's leading manufacturer of this type of equipment. Horizontal surfaces on the dam crest as well as easy to get vertical surfaces close to the crest, such as the side beams, are treated by a standard Conjet robot. This robot has been slightly modified to make it possible to reach surfaces which are as much as 4 m (13') below the surface on which the robot travels.

The power pack connected to this robot, the Conjet Power Pack 120/1.200, delivers 120 l/min (32 gpm) at max 1.200 bar (17400 psi). The pump is powered by a 400 Hp diesel engine and the package is mounted inside a 20 foot container together with water filters, a water tank and other useful accessories.



Jetframe positioned and ready for operation

Jetframe system eliminates scaffolding

A new frame-mounted manipulator, Jetframe 122, has been designed for work on the vertical and inclined parts of the dam which are difficult to reach with the standard robot. This frame is light and flexible and intended for use together with a skylift, a winch or a work platform. The Jetframe is positioned on the surface to be treated and started. The automatic function will then lead the nozzle in a pre-programmed manner over the surface while the operator

comfortably stands on the dam crest and monitors the process. When the operation is finished, the frame is repositioned and the process starts all over again. The Jetframe 122 is also powered by a Power Pack 120/1.200. Occasionally when the robot has not been operating, the contractor has connected two Power Packs to the Jetframe. Then altogether some 700-800 Hp high pressure water power has been delivered to the Jetframe 122.

NCC has chosen to mount the Jetframe 122 on a skylift with 25 m (82') reach. With few exceptions, this reach will allow all surfaces to be reached



The Jetframe mounted on a carrier

from a parking position at the dam crest. With the skylift the contractor has managed to reduce each setup time to a minimum. Furthermore they have made sub-stancial savings by eliminating the need for work platforms and scaf-folding. Furthermore the operator can do all maneuvering from a convenient standing position at the dam crest. The automatic function on the Jetframe 122, as well as the power for the hydraulic motors, is achieved by connecting it to a standard Conjet robot or to a specially developed Control unit. The Jetframe will reach almost any surface, however, small spots are normally treated with a hand lance. When the hand lance is used, though, the power output from the pump must be considerably reduced and the capacity reduced accordingly.

Hydrodemolition finished in two months

The contractor started to work at the site in mid April, 1991. Hydrodemolition commenced at beginning of May when temperature allowed the use of waterjet and by the end of June the hydrodemolition part of the job was finished. Altogether 2.200 sq.m. (24.000 sq.ft) concrete surface has been treated during this period. The hydrodemolition part of the project was operated on a one shift basis, however certain overtime was necessary.

Hydrodemolition, the only possible method

Vattenfall is extremely satisfied with the results of the hydrodemolition and states that this is the only good method

to repair a structure as sensitive as a concrete dam. No microcracks develop in the remaining concrete, which is the case when the concrete is removed by means of hammering. Furthermore the surface which has been treated by hydro-demolition gives a better bonding than conventionally treated surfaces. Another important feature with the Conjet method is selectivity i.e. poor concrete is removed selectively only down to a preset quality level. This contributes to a better quality work as it removes bad concrete and leaves the good quality concrete where it is. The two Conjet units which were in use at this site have a capacity corresponding to about 50 men with jackhammers. This high capacity is essential especially when working on the up-stream side of the dam. Here the job has been done "dry" i.e. the waterlevel of the dam has been lowered to allow the-job to be done above the water surface. The sooner the job is finished, the sooner can the water level be raised again and the full turbine power output can be restored.



Conjet robot with vertical attachment operating from dam crest. Note debris catcher.



Downstream side of the dam treated by a Conjet Jetframe



CONJET AB
P.O. Box 507
SE-136 25 HANINGE
SWEDEN

PHONE:
+46 (0)8 55 65 22 40

FAX:
+46 (0)8 55 65 22 60

E-MAIL:
conjet@conjet.com

WEBSITE:
www.conjet.com

CE, EMC certified

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