Case Stories

Conjet assists in World's most extensive concrete bridge repairs

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The use of brackish water in the concrete mix led to extensive and complex concrete repairs to Sweden's combined Svinö and Öland Bridge that reached nearly twice the cost of the original structure when restoration is finally completed. Crumbling piers have been covered with reinforced concrete shells and the affected foundations strengthened. Repairs were focused on the deck, including replacing some of the parapets, joints and bearings by contractor Nordic Construction Company for client Swedish National Road Administration, Vägverket.

A Conjet Robot 363 MPA high pressure water jetting hydrodemolition machines played a key role assisting in repairs to the bridge deck. Contractor Waterjet Entreprenad AB, worked as the specialist hydrodemolition contractor for NCC, were using its Conjet Robot 363MPA, to selectively remove concrete from the edge of the deck and clean and expose reinforcing for NCC to cast on new sections of parapet.

"Biggest brigde repair project ever"

"This is probably the world's most extensive concrete bridge repair project and hydrodemolition, with certified equipment, has been the only approved and specified method of removing concrete from bridge decks and other sensitive structures in Sweden for the past 20 years," says Vägverket bridge repair project manager Jan-Olof Bolin. "This technique of using very high pressure jets of water to remove the concrete does not cause any damaged to the healthy concrete left behind. It also removes concrete from above or below any reinforcement, which is also cleaned of any rust. Hydrodemolition also produces a very rough and uneven surface, which provides a strong bond at the interface for the new concrete to key onto. In my opinion it is the only concrete removal method that meets the required adhesive bond strength of at least 2 MPa set out in the draft European structural concrete repair standard EN 1504-3, which in effect we've been using for the past 20 years anyway."

6,320 m long multi-span bridge

The 6,320 m long multi-span bridge links the Swedish mainland at Kalmar with the Baltic islands of Svinö and Öland across the deep channel of Kalmar Sound. The initial 248m long reinforced concrete Svinö bridge continues directly into the similar and main 155 span Öland bridge. This consists of a 23 span low level viaduct on the mainland side, a high level eight span 910 m long structure over the 80 m wide navigable channel, followed by a further 124 low level spans to Öland island. The bridge's 13m wide single cell reinforced concrete box deck is supported at the end of each span by a single rectangular reinforced concrete pier. All piers are founded on mass unreinforced concrete slab footings, with about one third of them supported on either concrete or tubular steel piles.

"The bridge fated from the start"

Contractor Skanska Cementgjuteriet designed and built the Svinö and Öland bridges, together

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

Distributor/Agent

with the approximate 2km of approach roads for SKr62.7M, approximately SKr400M at 2004 prices. Skanska requested and Vägverket approved the use of brackish water in the concrete mix instead of more expensive fresh water. Construction of the then Europe's longest road bridge started at the beginning of 1968 and has been plagued with concrete chloride attack ever since it was completed in 1972.

"The bridge was charged with salt and fated right from the start," says Jan-Olof Bolin. "The concrete had an initial and allowable 0.2% chloride content, but the effects of the slightly higher 0.5% chloride level of the sea combined to set up an electric cell, which generated chloride levels of 6% to 7% in the concrete." The problem was further compounded by the use of porous limestone, which, together with only 30 mm of cover to the reinforcement, allowed the salt water to penetrate the structure.

Severe chloride attack of bridge piers above and below sea level was first noticed in the early 1980s. Spalling of the concrete and corrosion of reinforcement affected the vast majority of the pillars. Some piers had deteriorated so badly that only half the cross sectional area of reinforcing bars remained. Extensive repair was the only option for the vital crossing, which now carries an average 5M vehicles/year, compared with originally forecasted 350,000/year. Repairs started in 1990 and NCC completed restoration in 2000 of 141 of the 155 piers in two separate phases at a combined total cost of SKr460M. At the end of 2002 NCC started on the SKr100M third phase contract to restore an initial 2,300 m of parapet and replace 19 joints and some of the bridge's bearings.


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Exposed bridge deck reinforcement

The repair

NCC first removed the concrete parapet kerb or edge beam with a saw making a horizontal cut flush with the deck surface. Waterjet Entreprenad AB, Sweden's largest and one of Europe's biggest specialist hydrodemolition contractors, followed on with its Conjet Robot 363 MPA connected to a 550 kW Conjet Powerpack delivering clean fresh water at a pressure of 1150 bar and flow of 234 litres/min. With these settings the Robot 363MPA removed 0.2 m³/m of the 45 MPa strength concrete from the edge of the deck at an average rate of 30-35m/day. "We are very satisfied with the Conjet Robot 363 MPA as it is so much more versatile and easier to use and maintain than our older Robots," says Waterjet Entreprenad AB project engineer Rickard Zander. "Because of these major advantages we are able to achieve a 60% to 70% machine utilisation, which is the amount of time out of our complete working day that we use the Robot to remove concrete. On the Oland project the Robot 363 MPA removed

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The Conjet Robot 363 removed per day in average some 30 to 35 m of deteriorated concrete from the edge of the deck.

an average 1 m³/high pressure hour, which is between 6 m³ and 7 m³/day."

After Waterjet removed a length of the deck edge and exposed and cleaned the original steel reinforcement, NCC followed on casting on a new section of reinforced deck and integral parapet edge beam. NCC and Waterjet stagger these repairs from each side of the bridge to prevent the risk of any chloride cross contamination from the old concrete being removed and new concrete. In addition Waterjet is also using a pair of its earlier Conjet 230 Robots to cut out an average of 8 m³ of concrete and remove all the old reinforcing from each of the 19 joints for NCC to replace with new.

"The current third phase of repairs to the parapet, joints and bearings was finished in May 2005," said Jan-Olof Bolin. "This brought the total overall cost of inspections, testing and renovation to about SKr750M, nearly twice the cost of the original bridge at today's prices."


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A 6 320 m long multi-span bridge.

Equipment used
1 Conjet Robot 363MPA
1 Conjet Power pack 540-550kW
234 lpm at 1150 bar

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Applied Waterjet Technology

Conjet

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