Go Forth: Pumping solutions for Queensferry Crossing

VERDERFLEX®

An iconic landmark

For 50 years, the Forth Road Bridge has stood proudly over the Firth of Forth and is an icon of Scottish engineering and construction prowess. The bridge, now designated as a world heritage site, serves as a pivotal asset of the transport network and the region's economy.

Since it was opened in 1964, maintenance & engineering teams have attended to every element of the bridge, examining the structural integrity of the pier supports, protective coatings, the effects of corrosion and the road itself.

Due to open in 2017, the new Forth Replacement Crossing (to be known as the Queensferry Crossing) will be the centrepiece in a major upgrade of the transport network, representing a £1.35 billion investment. At 1.7 miles in length, the Queensferry Bridge will be the longest three-tower, cable-stayed bridge in the world and features many innovative features for strength and long service-life.

The International FCBC (Forth Crossing Bridge Constructors) Joint Venture is responsible for the delivery, design and build of the Bridge, including the main aspects of the road itself.

The client's challenge

Providing the strength to the road for the significant weight of traffic flow is a chain of load-bearing plates, constructed in a double-layered assembly with approximately 40mm between them. This space is filled with a special ultra-high strength grout. The grout itself gives exceptional structural support and resistance to vibration and the demanding environmental conditions. The grout is mixed onsite with water to be a flowable slurry at approximately 1000cps. The grout must be applied within 10 minutes of mixing or within 60 minutes should it be kept in a state of agitation. The grout itself was required to be pumped between the force plate assembly, however the crucial difficulty was that the workforce onsite would not be able to see the spread of the grout due to the view of coverage being obscured by the bearing plate. The flow rate of the grout was another complicating factor: too fast and the grout may develop a greater proportion of entrained air – an 'aero bar' effect, which would affect the structural qualities of the grout. Too slow a flow rate and the grout would set before the surface area was filled.

The pumping challenge was thus; supply a pump suitable for the handling of a quantity of abrasive slurry that would fill in the bearing plate structure at each of the supporting piers, which would be able to deliver a repeatable and exact flow rate with a pumping principle that would not affect the state of the grout and would not add air pockets. The pump also had to be robust to the environmental conditions and be able to self-prime, run dry and be easily flushed

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following each use of the grout as any residue would set hard and cause at best an inconvenience and at worst a write-off of the pump.

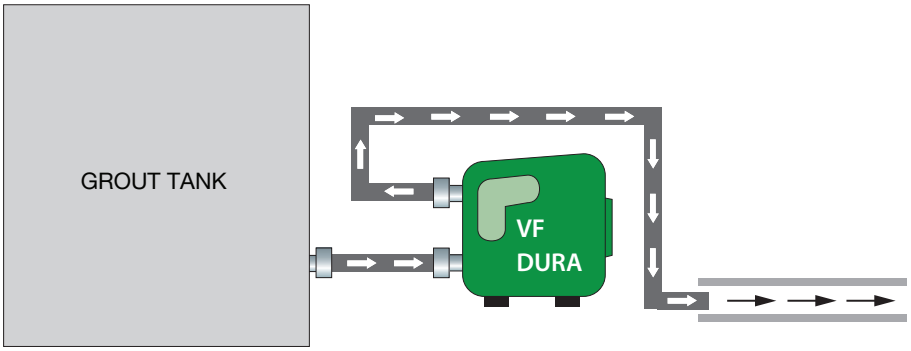
The Verder solution

Verder UK were approached for a recommendation. The Verder UK representative for Scotland and Cumbria visited the FCBC site offices to consult with the project engineer, gain a greater understanding of the process and to obtain samples of the grout. This grout was then trialled at the Verder UK service centre in West Yorkshire to establish its flow characteristics.

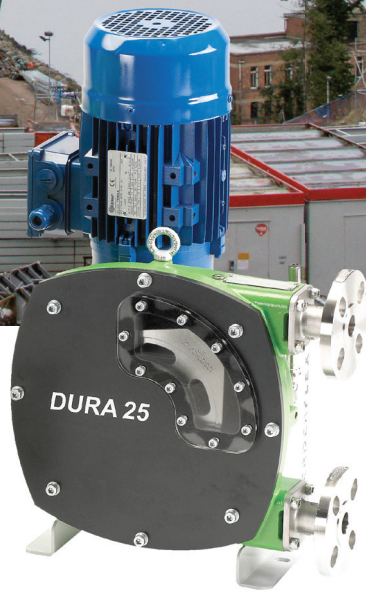
Peristaltic power

The recommendation for the grout was a Verderflex Dura 25 peristaltic hose pump with natural rubber hose. The Dura range proved an excellent choice for several key reasons:

- The pump delivers a constant flow rate which can be altered by adding an inverter to vary the speed of the pump. This can be incrementally changed to allow for the subtle changes in air temperature, humidity and other environmental conditions that needed to factored into every grout batch throughout the year.



- The peristaltic pumping principle is excellent for the handling of abrasive slurry as a rotor and shoe mechanism moves the product through a rubber hose by a simple compressions and relaxation action, similar to an oesophagus.
- There are no moving parts in the flow path as the internal surface of the hose is the only part of the pump which has contact with the fluid so it is low shear and prevents any cross-contamination.
- Higher viscosity, solid particles and S.G. products are easy to handle through a large 25mm internal diameter. The pumping action can even be reversed should the pump have a foreign object in it.
- The hose can not be damaged by running dry of product – the casing acts as a bath for the internal lubricant, which provides cooling and reduction of the frictional force of the rotor shoe on the surface of the hose.
- The powerful suction force caused by the compression of the hose causing a temporary ‘seal’ allows the pump to self-prime.
- The pump is easy to flush out following each delivery of grout by simply flushing the hose.
- The Verderflex Dura 25 pump can be easily trolley, skid or pallet-mounted to transport along the bridge during the lay of each bearing plate arrangement.



Engineering the process

The Verderflex Dura was delivered to the FCBC R&D facility where over 6 months numerous trials were conducted to find the optimal delivery method with regards to flow rate and how to effectively 'inject' the grout without setting the hose carrying the product inside the grout. The Verder UK representative visited the facility to train the R&D engineers on how to operate and maintain the pump such as removing the hose, managing the liquid lubricant inside the pump and adjusting the flow rate.

Following many trials to establish a repeatable and accurate method to deliver the grout the pump was delivered to site to be mounted on a transportable pallet.

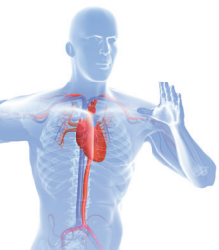
The pump delivered the grout with the hose being gradually removed as the space was filled and immediately flushed to prevent any setting of the grout inside the pump.

The pump was so successful in the effective delivery of the grout in the bearing plate assembly, it was also utilised in pumping the same fluid in the main pier support section and other sections of the project. The pump will be operating for 12-16 months during the construction of the crossing, during which time the only expected maintenance will be the regular flushing of the grout and periodic hose changes.

Andrew Shaw, the Verder UK technical sales engineer for Scotland and Cumbria was incredibly proud of the solution provided for FCBC:

"It was with great pleasure that we were asked to support the Forth Replacement Crossing. From a Verder point of view, we were working with a totally new fluid to us and I'm exceptional pleased that our engineering team and I were able to take part in the research and development phase to find a pump that could deliver a consistent and reliable performance day-in, day-out. Working on the Queensferry Crossing is a project which any engineer would be immensely proud to be involved in and it's great to know that the bridge is standing strong with a little help from our Verderflex Dura pump."

All pictures courtesy of Transport Scotland



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