A NEED FOR SPEED

Thirty-eight huge footings for the New Champlain Bridge in Canada are being installed using a specially-built floating foundations installer

Speed of construction is a particularly crucial aspect of Montreal's New Champlain Bridge project, which is currently under way across the St Lawrence River. The new structure will take over from the existing Champlain Bridge, which is one of the busiest crossings in the country, but which urgently needs replacing due to structural problems (*Bd&e issue 84*). The owner of the existing bridge, the Jacques Cartier & Champlain Bridges Corporation, has been carrying out strengthening works to the structure to ensure it remains safe for use until the new bridge is finished, hence speed is of the essence.

The existing bridge carries about 40 to 60 million cars, trucks and buses a year, and is a critical passageway for local and national economies. In terms of Canada-US trade, more than US$20 billion worth of cross-border goods is estimated to pass through this trade corridor each year.

Specialist contractor Sarens is working for the Signature on the Saint Lawrence Group, a consortium of contractors SNC Lavalin, Dragados, Flatiron and EBC which is responsible for building the new bridge. The reference design is by Dissing & Weitling and Arup with the contractor's detailed design team consisting of SNC Lavalin, TY Lin International and International Bridge Technologies. It is being built under a public-private partnership for Transport Canada (*Bd&e issue 80*).

Work on site started in the summer of 2015 and the bridge is intended to be completed by the end of next year. The project includes construction of the new 3.4km-long Champlain Bridge, a new 470m bridge for L'Île-des-Sœurs, and highway improvement works at the approaches.

The 42-month construction timeline presents a great engineering challenge, particularly since it coincides with other major highway work, including the repairs to the existing bridge, the Turcot Interchange and the Bonaventure Expressway.

To meet the challenging timeline, the decision was made to maximise the off-site fabrication of concrete and steel parts. For this purpose, a total of five jetties have been created to allow for dry construction of various parts of the bridge and to serve as docks for mooring the many vessels that are being used.

The original request for proposals put out by the client suggested that the foundations would be installed in situ. This would have required cofferdams and major excavations at each of the 74 pier locations, and would have been expensive and slow to carry out. The SNC Lavalin/Dragados/Flatiron consortium approached Sarens to suggest an alternative.

Installing each footing takes on average just 10 hours

"The main reason for seeking an alternative was the difficulty of building the caisson etc for each location," says director Steven Sarens. "Not only would this have been time-consuming and expensive, it would have required a lot of other types of vessels and what's more, the temporary works would have had to be removed after construction was finished."

Each footing is 11m square by 2m deep and is installed with its 'pier starter' column, which makes the overall assembly a total of 14m high. The weight of the footing ranges between 600t and 1,000t.

The system developed by Sarens enables these footings to be floated out and lowered into place within a tolerance of 50mm – quite an achievement in an extremely wide river where currents can be up to 4.6m/s.

The FFI consists of a catamaran – built using Sarens' standard modular barge system – with a large gantry which has the ability to lift, transport and install precast elements weighing up to 1,000t. The lifting equipment has a turntable that allow it to rotate 360°, and two skidding systems that allow it to move in both directions. Sarens explains that the FFI uses the company's existing modular barges but the special thruster system is what makes the difference.

Draught is not an issue on the Saint Lawrence River, where water depth is only 9m at the deepest, but the strong currents and the number of foundations required were the critical considerations for the design of the system. "The river is very wide, and the currents are up to 4.6m/s, which is extremely high," says Sarens; "That's why we proposed making it a self-propelled system."

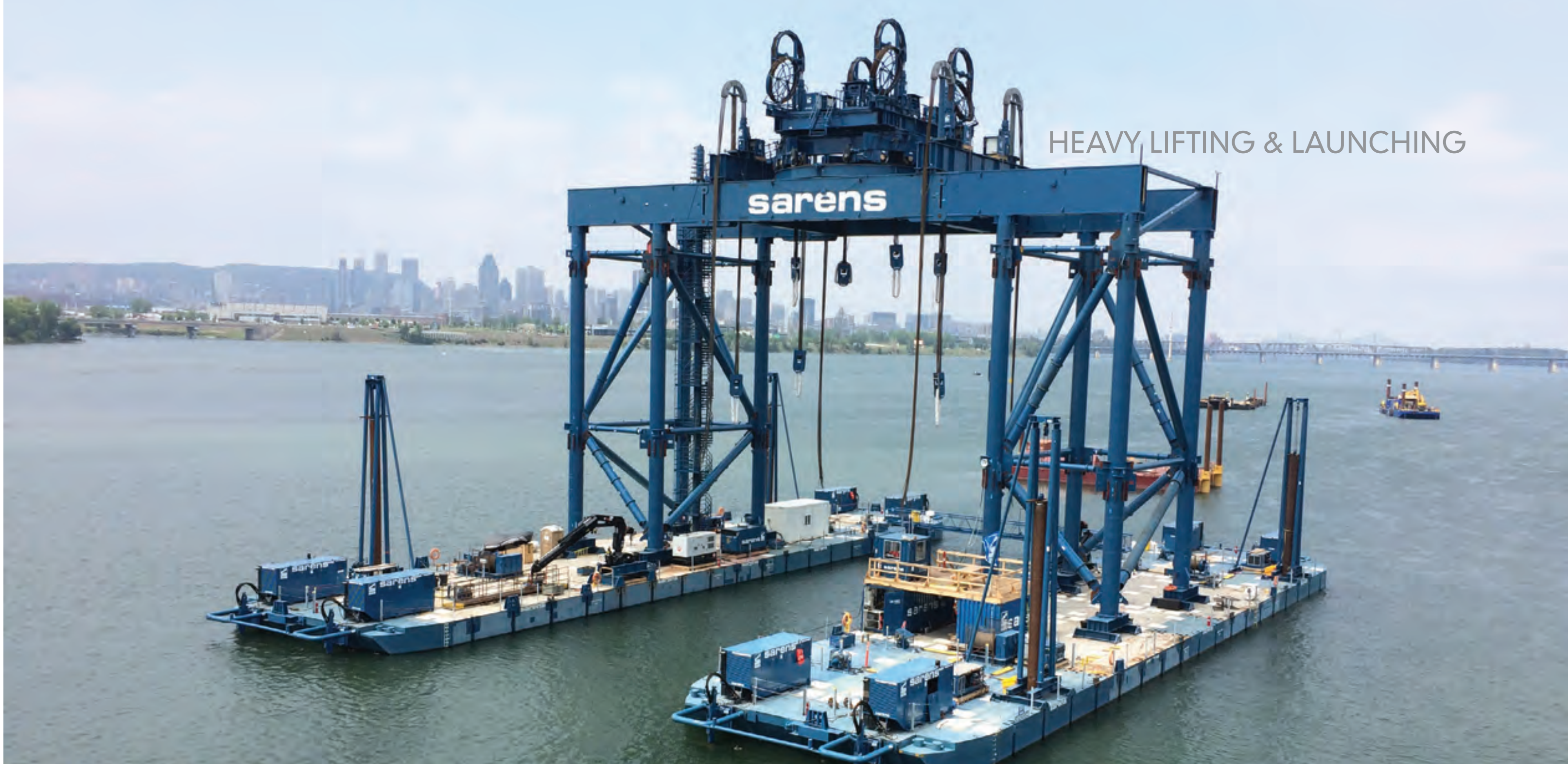
Once the FFI has picked up a unit from the casting yard, it uses its global-positioning system to bring the unit within half a metre of the final position, then employs its spud legs and anchors to fix itself in place while carrying out the fine positioning.

This is done using the turntable and skidding systems which allow it to rotate the unit through 360°, and to move it backwards and forwards and from side to side using the skidding system in two horizontal directions.

Between them, the barges are equipped with eight thrusters, sixteen winches, four spuds, two multi-lifting towers with gantry beams and rotation bogies and eight 450t strand jacks – the system design is a combination of structural and maritime engineering along with hydraulic and electronic steering systems. They are all operated from a single control panel and the operation of the system exceeded expectations, says Sarens.

As well as the currents in the river, and the positioning accuracy that was demanded, another major challenge was to fulfil all the relevant administration that was needed to get the barge system approved. As Sarens explains, the custom-designed FFI was considered a marine vessel by Transport Canada, and as such had to be designed to meet the relevant standards for such a vessel.

Installation of the first footings took place in July 2016 and as *Bd&e* went to press there were just a few foundations left to be put in place, with this part of the work expected to be completed the same month. The operation to install a single footing takes on average about ten hours, which is much quicker than had originally been anticipated, says Sarens. Units are picked up at the casting yard at around 7.30am and the furthest footing location is about 1km distant. The catamaran can be back at the quayside around 5pm the same day.



The barges carry eight thrusters, 16 winches, four spuds, two multi-lifting towers and eight 450t strand jacks

Some of the piers for the new crossing are on land, and some are being installed using the temporary jetty that the contractor has built on one side of the river. All the piers in the open water are being built using the FFI, and this amounts to just over half the total number. Other options that were considered were to use a barge-mounted crane, but while this would have been feasible, it was dismissed as wind would have been an issue for the crane jib and for its stability.

In addition, a floating crane would not have been able to access the site due to restricted headroom under the existing bridges.

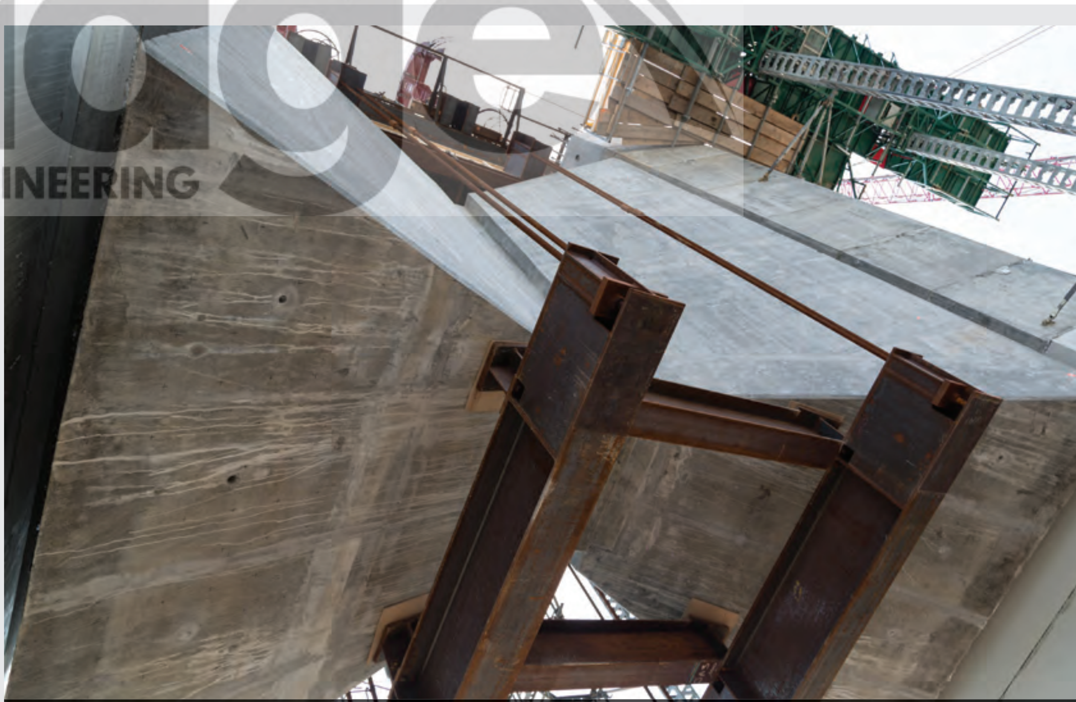
The FFI has the advantage that it is built entirely of existing equipment, so it can all be reused and recycled once this job is complete. Happily it was also the most economical solution, says Sarens, especially for a system that was capable of installing each unit within a single 12-hour shift

SUPERSTRUCTURE MILESTONES

As work comes to a finish on the pier foundations, construction of the main tower and piers is continuing in parallel. In early July contractors reached another milestone with installation of the first pier cap on the cable-stayed bridge, and later the same month, the final lift of the tower cross-beam took place. The pier cap was put in place in two pieces over a period of several days in July.

Lifting each half-cap is a complex operation, as operation leader for structural steelwork on the cable-stayed bridge, Pierre Velghe, explains: "This is not a standard tandem lift, as we have seen on other parts of the project. This operation calls for two 650t cranes. We have to pick up a 261t piece, with all the equipment, horizontally and then rotate it to the vertical so it can be installed. This is actually the first time the piece is placed upright, since pier caps are built, stored and shipped entirely horizontally."

Field engineer for the cable-stayed bridge Scott McDonach adds, "Our team faces two principal challenges with the pier caps. It is essential that we put up the transition pieces, juxtaposing the piers within the approved tolerances and giving us a solid base to install the pier caps. We then need to make the connection in the centre of the pier cap with pinpoint accuracy, if the piece is to be solid and properly fulfill its function."



The lower cross-beam was raised to its final elevation last month *(July)*

The pier cap is a crucial structural element that ensures distributes the loads between the two piers. In all, 37 caps will be put in place over the coming months.

The final lift of the tower cross-beam followed on from the first lift in March, in which it was raised approximately 20m above the deck of the bridge. Over the coming weeks, the installation of post-tensioning bars will make it possible to attach the cross-beam to the tower which will then be built to its full 170m height.