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ACHIEVING CONCRETE DREAMS

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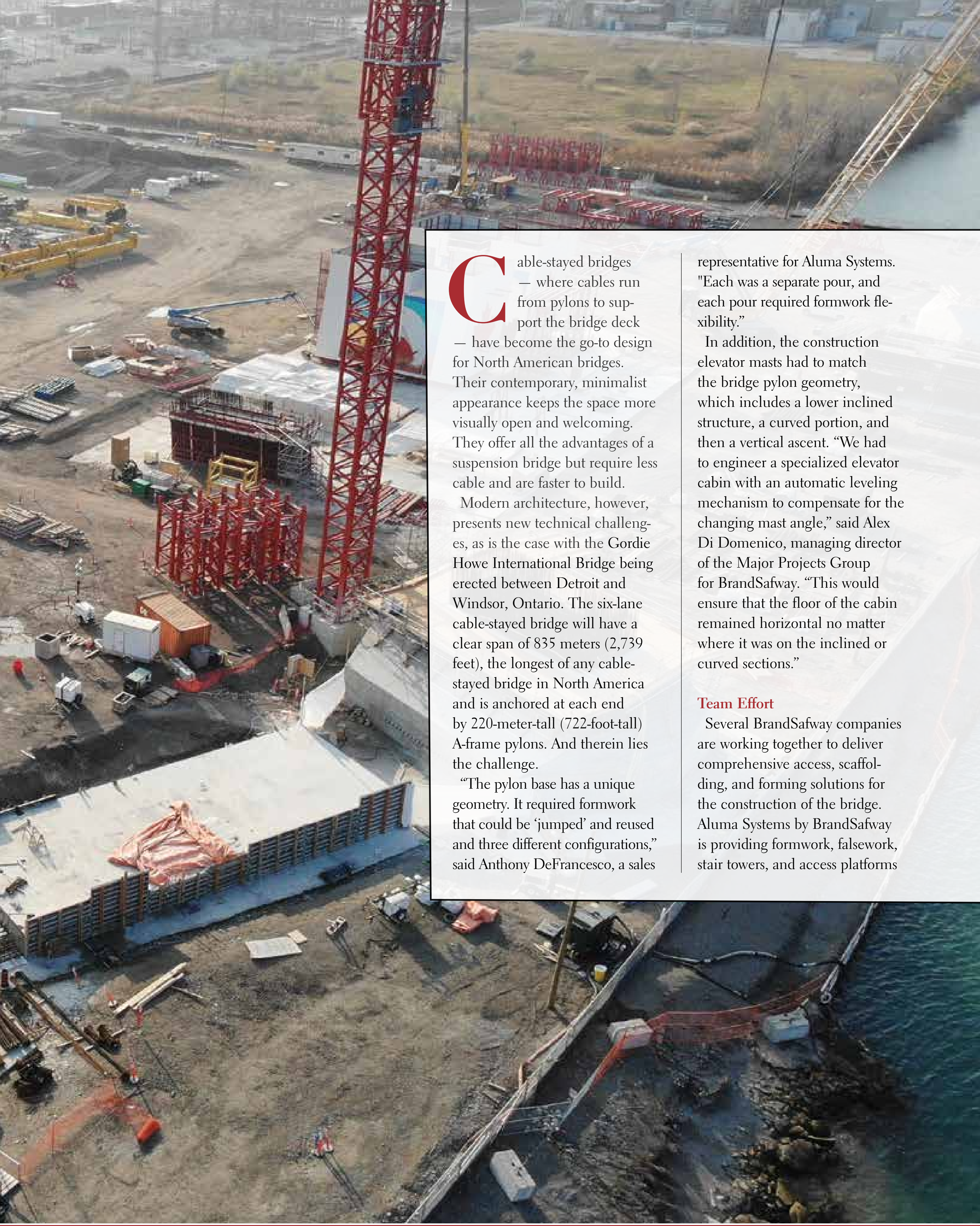
THE GORDIE HOWE INTERNATIONAL BRIDGE PROJECT COMBINES CREATIVITY, ENGINEERING, AND SAFETY.

BY JERRY DOLLY



Cable-stayed bridges — where cables run from pylons to support the bridge deck — have become the go-to design for North American bridges. Their contemporary, minimalist appearance keeps the space more visually open and welcoming. They offer all the advantages of a suspension bridge but require less cable and are faster to build.

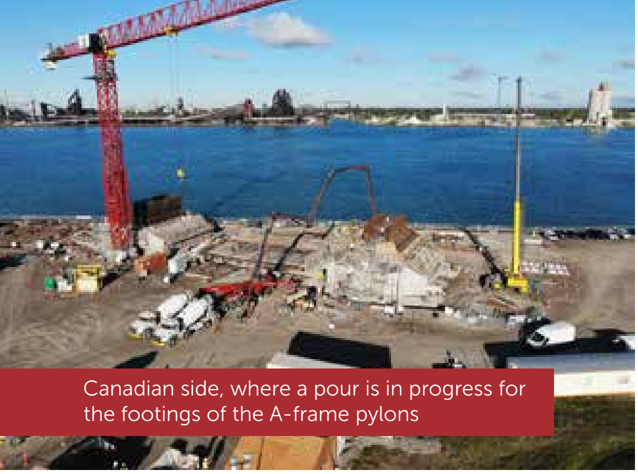
Modern architecture, however, presents new technical challenges, as is the case with the Gordie Howe International Bridge being erected between Detroit and Windsor, Ontario. The six-lane cable-stayed bridge will have a clear span of 835 meters (2,739 feet), the longest of any cable-stayed bridge in North America and is anchored at each end by 220-meter-tall (722-foot-tall) A-frame pylons. And therein lies the challenge.

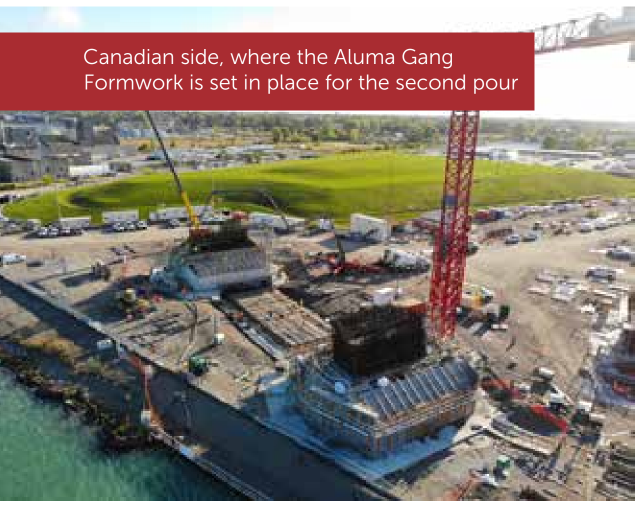
"The pylon base has a unique geometry. It required formwork that could be 'jumped' and reused and three different configurations," said Anthony DeFrancesco, a sales representative for Aluma Systems. "Each was a separate pour, and each pour required formwork flexibility."

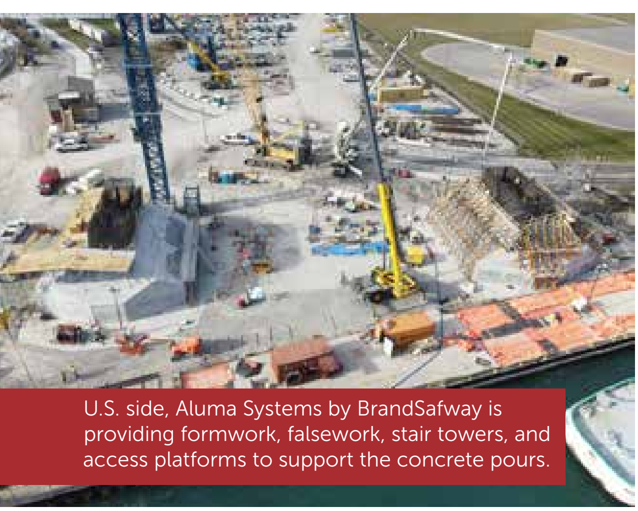
In addition, the construction elevator masts had to match the bridge pylon geometry, which includes a lower inclined structure, a curved portion, and then a vertical ascent. "We had to engineer a specialized elevator cabin with an automatic leveling mechanism to compensate for the changing mast angle," said Alex Di Domenico, managing director of the Major Projects Group for BrandSafway. "This would ensure that the floor of the cabin remained horizontal no matter where it was on the inclined or curved sections."

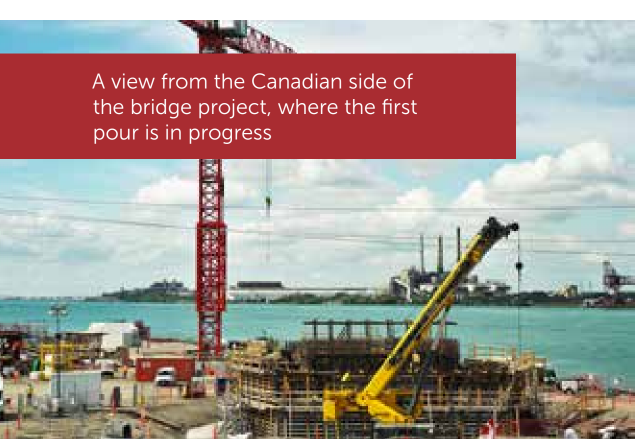
Team Effort

Several BrandSafway companies are working together to deliver comprehensive access, scaffolding, and forming solutions for the construction of the bridge. Aluma Systems by BrandSafway is providing formwork, falsework, stair towers, and access platforms


Canadian side, where a pour is in progress for the footings of the A-frame pylons


Canadian side, where the Aluma Gang Formwork is set in place for the second pour


U.S. side, Aluma Systems by BrandSafway is providing formwork, falsework, stair towers, and access platforms to support the concrete pours.


A view from the Canadian side of the bridge project, where the first pour is in progress

to support the concrete pours for the main pylon footings. This includes custom, preassembled formwork panels for the footings, caisson collars, crane foundations, pylon starters, and a base platform for access, storage, and temporary elevators surrounding each pylon.

AlumaSafway, another BrandSafway company, is providing access stairs as well as an elevator on the Canada bridge site in Windsor. BrandSafway is supplying the elevator on the United States bridge site in Detroit. The two elevators will provide access for on-site personnel along the height of the main pylons and to the jump form systems during construction.

Solid Footing

The pylon footings have an elongated octagonal shape with a total length of 20.8 meters (68.2 feet) and width of 18 meters (59 feet). The footing also rises in three sections with distinct geometries, a 3-meter (9.8 feet) straight wall, a 2-meter (6.6 feet) angled wall and then a final leg that angles as it transitions into the pylon leg.

Each section required its own separate pour. The first pour used 960 cubic meters (1,256 cubic yards) of concrete, or about 120 truckloads. Placing the concrete in stages provided thermal control as the concrete cured and allowed for the forms to be repositioned.

"Our global engineering team in Toronto combined a number of standard systems to create a hybrid solution to match the dynamic shape of the footing," said DeFrancesco.

The base of the system was Aluma Gang formwork, or an assembly of panels prefabricated from lightweight aluminum beams, steel walers, adjustable clamps, and high density overlay (HDO) plywood. The system assembled quickly, was easy to handle, and could be assembled in any length, height, or configuration required.

DeFrancesco noted that "The waler used has a number of holes along the length of the beam, allowing Aluma to effectively achieve the shape and construction method the client had requested."

This flexibility was important, as the first was broken into two sections to be reused into the third pour, while the second pours each used three sections of panels to allow the client the ability to monitor and coordinate each pour sequence. With the unique shape of the footing, erecting the formwork in sections enabled better access for vibration.

"As the vibrating was taking place in one section, another panel was moved into place. The pour proceeded like clockwork for over16 hours," said DeFrancesco. "It required a lot of coordination between all the teams involved on site, as the process ensured that there was no honeycombing or breaks in the concrete. It cured out properly and gave a clean, seamless finish that looks like a single pour."

The flexibility of the hybrid formwork was critical for managing the loads during the third pour. At this stage, the formwork for the first pour was completely removed. However, using a combination of vertical walers and diagonal braces, the forms for the third pour transferred the loads back to the formwork for the second pour.

While some of the connection nodes and smaller components were custom fabricated parts, most of the formwork used standard rental components.

Safety as the Base

Aluma Systems was also contracted to provide a scaffold-based access platform around the circumference of the footings, as well as four stair towers for each footing. To increase the load rating from the standard 25 pounds per square foot to 100 pounds per square foot, this scaffold featured aluminum strongbacks beneath double-deck planking and heavy-duty posts.

"The client's primary objective was to ensure the safety of everyone on site. Stair towers were used instead of ladders whenever possible to ensure safer access. In addition, all designs were checked against installation by employees and engineers of both firms to ensure exact compliance of parts and dimensions," said Robert Fallowfield, director of business development for Aluma Systems. "It was a pleasure to work with companies who share our commitment to safety as the first priority."

The Windsor-Detroit Bridge Authority (WDBA, a Canadian Crown corporation) is responsible for the delivery of the Gordie Howe International Bridge, through a public-private partnership. Its private-sector partner, Bridging North America, began working on the project in 2018.

The pours for all four footing platforms of the bridge began in August 2020 and were completed in November. Deliveries for the hoists began in May, and the hoists will remain in use until August 2023.

Rise Above

The A-frame pylons presented challenges for the engineers designing the elevator solution, because the pylons tilt at a 10-degree angle as they rise to an approximate height of 140 meters (459 feet). The midsection curves for about 25 meters (82 feet) before the final 50-meter (164-feet) rise straight up. A conventional hoist mast that maintains a constant angle would require extremely long ties and varying distances between the elevator cab and the formwork. The cab would remain fixed but tilted to maintain a reasonably level surface.

"With the solution developed by the engineers, the cab follows the pylon and remains at a fixed distance of about 3.5 meters (11.5 feet) from the formwork system. As a result, we eliminated the need for adjustments every time we jump the form," said Di Domenico. "The cab's automatic leveling mechanism utilizes hydraulics and an inclinometer to pivot the angle of the cab so the floor remains level as the elevator progresses along the pylon."

The elevator can support a load of 2,721 kilograms (nearly 3 tons). The cab interior measures about 1.5 by 2 by 3 meters (4.9 by 6.6 by 9.8 feet) and travels at a speed of 60 meters per minute (197 feet per minute) using a rack and pinion system. The roof of the cab features an integrated sliding cantilevered work platform on each side. They travel in and out to span the gap between the cab and the pylon, providing workers with access to install the mast ties and manage the forms.

The mast tower sections will be hoisted using a tower crane, but the mast ties and formwork will be done from the elevator. Further, the mast hoist/elevator system will be used for dismantling, because the tower crane may not be available during this time and it's the safer, faster, and lower-cost option.

"The Gordie Howe International Bridge gave us the opportunity to work with some great partners to deliver safe and innovative solutions," said Di Domenico.

About the Author

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U.S. side, the third pour of the pylon main footings