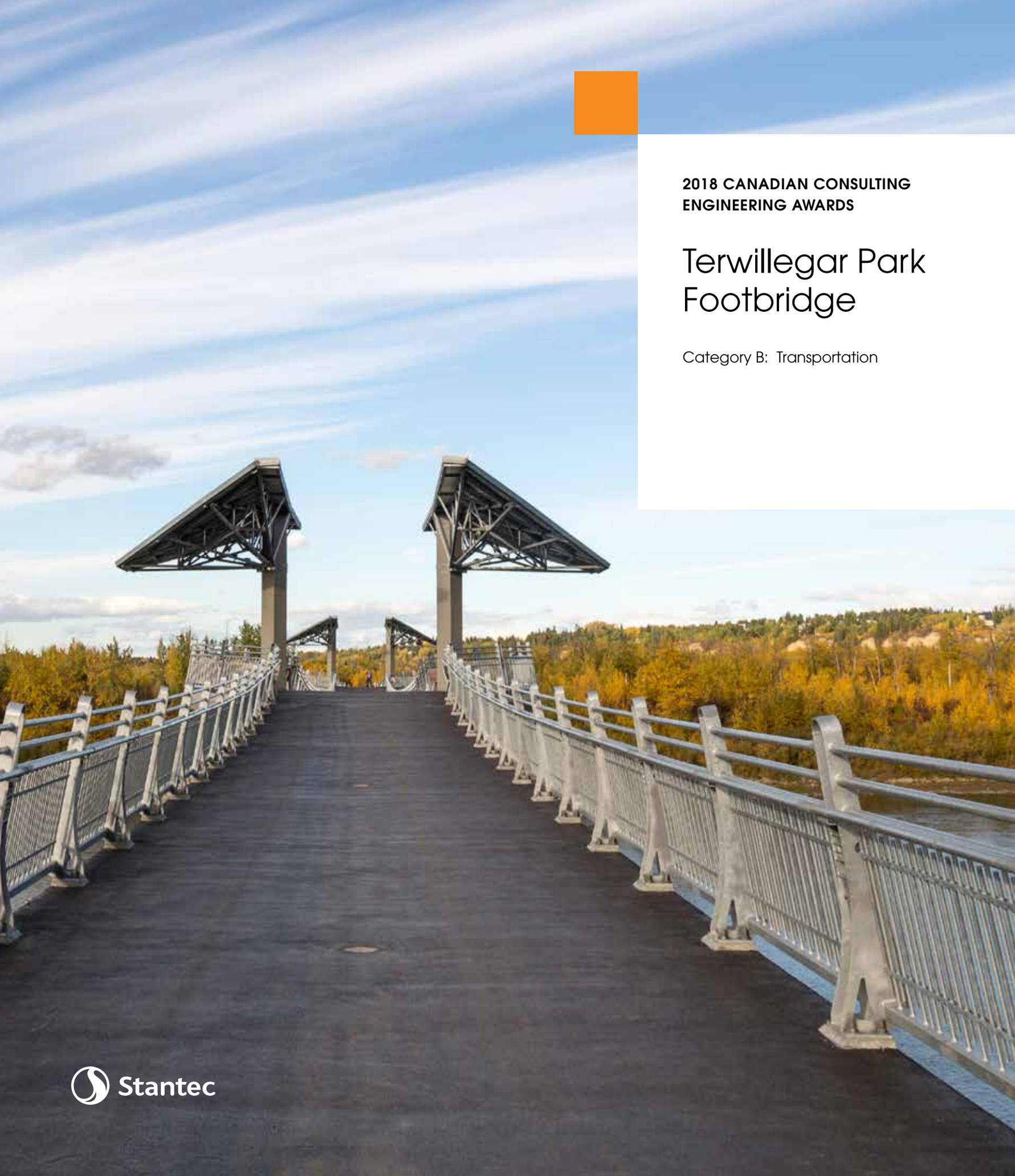


2018 CANADIAN CONSULTING ENGINEERING AWARDS

Terwillegar Park Footbridge

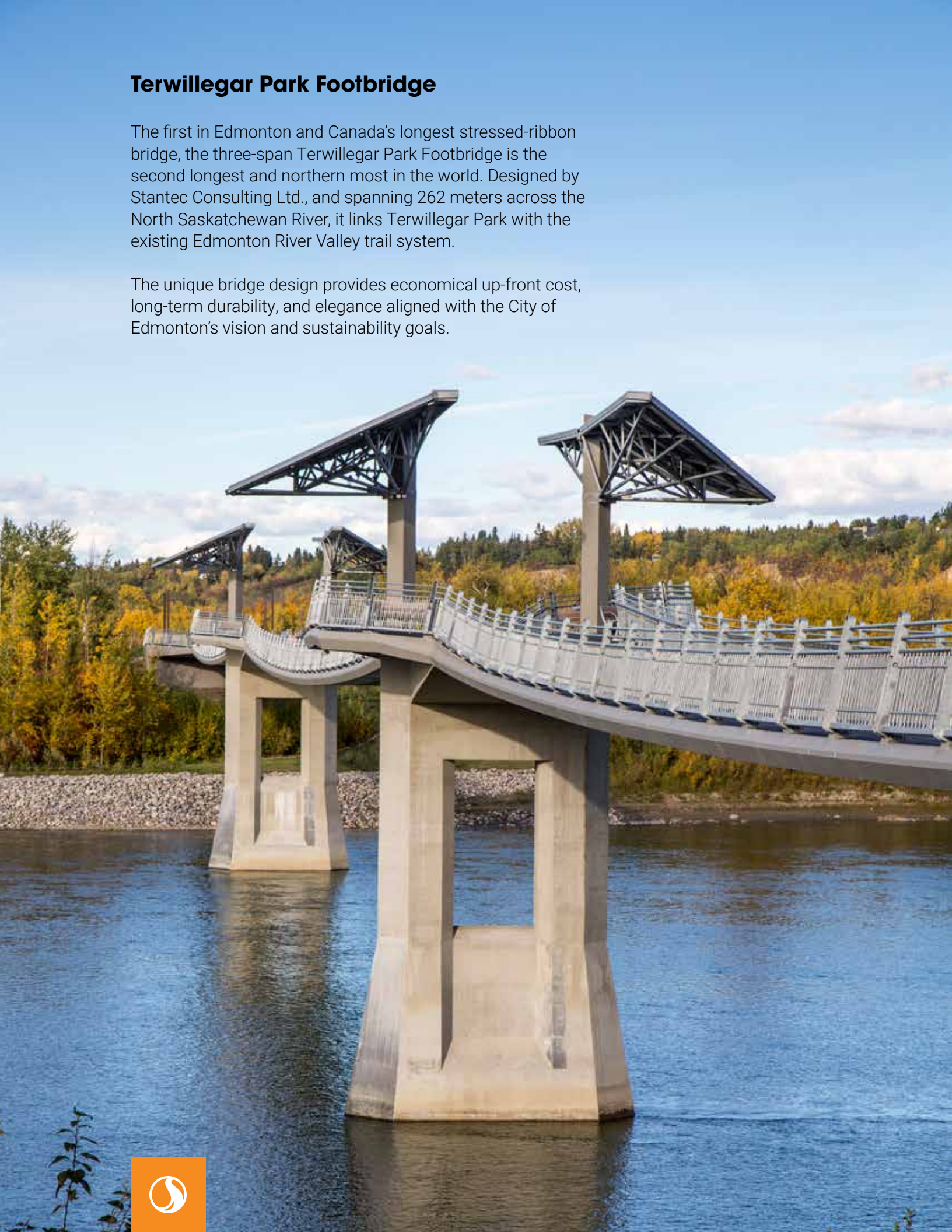
Category B: Transportation

Stantec

Terwillegar Park Footbridge

The first in Edmonton and Canada's longest stressed-ribbon bridge, the three-span Terwillegar Park Footbridge is the second longest and northern most in the world. Designed by Stantec Consulting Ltd., and spanning 262 meters across the North Saskatchewan River, it links Terwillegar Park with the existing Edmonton River Valley trail system.

The unique bridge design provides economical up-front cost, long-term durability, and elegance aligned with the City of Edmonton's vision and sustainability goals.



Q.1 INNOVATION

As part of the current multi-use trail system expansion, the City of Edmonton called for proposals in January 2013 for a new footbridge crossing the North Saskatchewan River. The project would include construction of approximately 3.5 kilometres of trails to connect to the park system on both sides of the river.

The City challenged consultants to develop concepts that were innovative, fit the context of the deep natural river valley, and meet strict budget and schedule requirements. The bridge and trails project needed to satisfy environmental, historical, and archeological requirements, and follow a comprehensive public consultation process. Following an extensive conceptual and preliminary design, it was determined that a three-span, continuous concrete stressed-ribbon bridge was the most suitable option to meet the City's needs.

Completed in October 2016, the Terwillegar Park Footbridge is now **Canada's longest stressed-ribbon bridge and is the second longest in the world**, spanning 262 m across the North Saskatchewan River.

Stressed-ribbon bridges may be thought of as a combination of segmental post-tensioned concrete design and suspension bridge design, with the complexities of both unified elegantly. Owing to the various ground conditions to anchor the suspension and post-tensioning cables, different bridge geometry, and environmental conditions (such as temperature effects), every stressed-ribbon bridge is a unique structure making the design truly original. This bridge structure is considerably rare with only about 60 stressed-ribbon bridges worldwide and now only two in Canada. The Terwillegar Park Footbridge is the first stressed-ribbon bridge built in Edmonton, the first multispan stressed-ribbon bridge in Canada, and the northern most in the world.

The use of embedded supporting cables in the 86 shallow-depth precast panels for the deck surface allowed for the desired minimalistic and elegant rope or "ribbon"-like profile of the bridge. This provides the the end user with an appearance of a self-suspended concrete structure, having a remarkable maximum span-to-depth ratio of 215:1 (about 10 times more slender than typical bridges).

The Terwillegar Park stressed-ribbon footbridge is an outstanding example of sustainability, innovation, and originality of design using concrete and steel cables to produce an exciting and fun structure that will enhance the lives of Edmontonians and be a source of pride for decades to come.

Q.2 COMPLEXITY

The stressed-ribbon design concept is sleek and simplistic in form; however, the engineering analysis and design of stressed-ribbon bridges is quite complex. The stressed-ribbon of concrete stretches over two piers and must be anchored by large concrete abutments which are stressed to the bedrock using 77 corrosion protected ground anchors per abutment. The maximum horizontal force required to support the tension in the stressed-ribbon structure is as much as 55,000 kN (equivalent to the weight of 16 Boeing 747 aircrafts).

As a cable supported ribbon of concrete, the structural behavior is geometrically non-linear. As a precast concrete segmental bridge, the bridge is erected segmentally panel by panel, concreting in the troughs and closure pours and then post-tensioned. More complex non-linear structural analysis with time-dependent (staged) construction must be performed. Sags and slopes of the deck under various loads and temperatures were calculated. The long-term effects of creep and shrinkage must be considered in the design since these also affect sag and slopes. Under the effects of temperature change in a northern climate such as in Edmonton, the bridge sag will vary as much as 1.0 m at midspan. Despite these complexities, the design team was able to predict the sags and shape of the structure with remarkable accuracy during the various erection stages, often within tens of millimeters of accuracy, for a variety of load and temperature conditions reflecting on the quality of analysis and design required for this type of structure.

Q.3 SOCIAL AND/OR ECONOMIC BENEFITS

The Terwillegar Park Footbridge is a key connector and icon in the world-renowned Capital Region River Valley Park that follows 88 kilometers of the winding North Saskatchewan River and spans through 18,000 acres of park. It connects the existing river valley trail system through the West End Trails initiative.

The bridge focuses on usability and benefits to its users by improving livability with integrated, accessible pedestrian and bicycle networks, encouraging people to explore and enjoy connections with natural environment, and promoting the importance of recreation and active living, all while sustaining and protecting our environment and adhering to the highest environmental standards.

The innovative, elegant ribbon of concrete that spans 262 m from the south bank to the north bank of the river valley, demonstrates that it is possible to construct a major 'signature' bridge with minimal impact to the environment, minimal visual impact, and thereby advance the state of practice in yet another new form of construction. While the Terwillegar Park stressed-ribbon footbridge project has advanced the use of concrete for a relatively new type of structure in this beautiful river valley setting, it is certain that the cost effectiveness, low footprint, and minimal environmental impact design will be utilized on other projects in the near future. Others will follow, and the knowledge and experience gained in the Terwillegar Park Footbridge project will be exceedingly beneficial in achieving new goals through the use of concrete.

Q.4 ENVIRONMENTAL BENEFITS

The use of pre-cast concrete construction provided an efficient way to cast the deck in advance, minimizing the construction schedule and environmental impact. The thin, rolling structure is aesthetically pleasing and reduces the visual impact in the river valley. The post-tensioned deck is extremely durable with the structure having a long lifespan and low maintenance costs.

By supporting the superstructure on cables internal to the deck, a slender structure could be constructed from above without the use of falsework and the associated impact in the river valley. As well, the use of precast panels as the formwork for the high performance concrete trough pours eliminated the need for traditional deck formwork, which largely is disposed of after its use.

The project included an environmental assessment where a number of measures were taken to protect the environment and wildlife. The footprint of the project was kept to a minimum to limit disturbance to the river valley environment. In-river activity was minimized and kept to a restricted window and promoted innovative construction methodologies.

The selection of materials, such as concrete, that are sustainable with low environmental impact was preferred. Where lighting is provided, low energy LED lighting was used where possible.

While the Terwillegar Park Footbridge project has advanced the use of sustainable materials in a new type of structure in this beautiful river valley setting, it is certain that the cost effectiveness, low footprint, minimal environmental impact design will be used on other projects in near future.

Q.5 MEETING CLIENT'S NEEDS

This innovative bridge project, delivered within strict limitations on funding and schedule, aligns with the City's vision to preserve, protect, and enhance our valuable and cherished park system and will be enjoyed by Edmontonians now and in the future.

No additional funding could be applied to the project which meant that construction cost estimates and schedules had to be precise and accurately developed at the conceptual and preliminary design stage and the selected option must be successfully tendered within budget. Considerable effort was devoted to this task to develop accurate estimates of cost and schedule for each option. This was a major contributor to meeting the City of Edmonton's cost and schedule requirements.

The beautiful bridge canopies are not just designed to provide shade but also allow users to sit and enjoy the bridge and the picturesque views of the Edmonton river valley, even when weather conditions are less than perfect. Sitting under the canopies, users are protected from the rain and can enjoy the cascading rainwater waterfall, enhancing the experience, and allowing the user to feel closer to the water.

The remarkable shape and form of the bridge design doesn't just get the user from one side to the other—it provides fun and excitement for cyclists, boarders, runners, and all who travel over the undulating path. It's a fun bridge—something that was achieved by proposing and designing an innovative stressed-ribbon as opposed to other more commonly used designs.


STERLING