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Project Entry for

ARBOUR STONE RISE PEDESTRIAN BRIDGE
Calgary, Alberta

THE CITY OF CALGARY

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

Delcan

TRANSPORTATION • INFORMATION TECHNOLOGY • WATER

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PROJECT HIGHLIGHTS

The Arbour Stone Rise Pedestrian Bridge forms part of the City of Calgary Pathway System and spans a major expressway. The 134 m bridge connects the communities of Arbour Lake and Royal Oak and provides access to the new LRT station at Crowfoot Centre. The bridge was constructed using appropriately 'green' materials and with dimensions suitable for wheelchair access, bicycling, roller-blading and walking. Durable materials such as high performance concrete and coated rebar were used to increase the life cycle value and result in a sustainable structure with reduced life cycle cost.

Design was undertaken by a team consisting of Delcan, Lombard North Landscape Architects and the City of Calgary. A rigorous analysis of site conditions, establishment of design criteria and research into sustainable construction materials was undertaken at the commencement of the project to develop bridge configurations that reflect the project intent and character of the site. Important considerations in this regard included: work within the Transportation/Utility Corridor; grades appropriate for wheelchair access; integration with two residential neighbourhoods via a 600 m long new paved pathway and landscaping; dynamic loads on the bridge from wind; construction over a major expressway; life cycle optimization analysis and; use of environmentally sustainable materials.

This two span arch bridge boasts two regal steel arches intended to mimic the clouds during a Chinook. The area topography, high embankments, depressed roadway, and large span requirements to bridge the expressway make this an ideal location for the slender and dramatic arches. The focus on aesthetics continues with an oscillating wave pattern in the railing reflecting the curves of the arches.

The first of a suite of pedestrian bridges planned for connecting communities across the new Stoney Trail Ring Road, the Arbour Stone Rise Bridge in its slender elegance captures the spirit of the City and sets the stage for meeting development needs in a cost-effective, durable, people-friendly, environment-enhancing manner.

PROJECT DESCRIPTION

Introduction

The Arbour Stone Rise Pedestrian Bridge forms part of the City of Calgary Pathway System and spans a major expressway. The 134 m bridge connects the communities of Arbour Lake and Royal Oak and provides access to the new LRT station at Crowfoot Centre. The bridge was constructed using appropriately 'green' materials and with dimensions suitable for wheelchair access, bicycling, roller-blading and walking. Durable materials such as high performance concrete and coated rebar were used to result in a maintenance free structure.

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Bridge Location

The location of the bridge is in a visually prominent location on the new Calgary Ring Road between the Crowchild Trail and Country Hills Boulevard interchanges. The bridge connects the communities of Arbour Lake and Royal Oak and provides a connection from the west to the nearest LRT station. From the location of the bridge, there is a clear view west to the mountains and east to the downtown City skyline.

Stoney Trail, over which the bridge crosses, had recently been widened and was expected to be further widened prior to the completion of the new bridge. The need for a pedestrian overpass in this location was established based on the City of Calgary's Pedestrian Overpass Priority Study (POPS).

Design Objectives

The prime objective of this project was to construct a new pedestrian bridge and approach paths to cross over Stoney Trail, meeting all code requirements and

providing a capacity to carry all required design loads. Other design goals included as follows:

- Provide a pedestrian and bike friendly safe and accessible crossing over Stoney Trail;
- Provide an aesthetically pleasing bridge;
- Provide a low maintenance and durable structure and approaches;
- Ensure the structure is easily inspectable;
- Ensure constructability that has minimum impact on Stoney Trail; and
- Ensure design meets construction budget limit.

Key Stakeholders and Authorities Having Jurisdiction

As users of the new crossing, the key stakeholders were first and foremost the residents of the connecting neighbourhoods of Arbour Lake and Royal Oak. It was desirable that any new structure take full advantage of its potential for views of the mountains to the west and to the downtown skyline to the east.

The City of Calgary is the owner of the bridge, and is the Project Manager responsible for procuring the construction of the bridge. The City will also be responsible for maintaining the bridge. The bridge, as well as its immediate approaches, is constructed on Transportation/Utility Corridor (TUC) land and TUC has jurisdiction over the road passing under the bridge as well as the nearby storm water ponds. The TUC, managed by Alberta Infrastructure, is an established Restricted Development Area that surrounds the City of Calgary. The lands are protected for specific development uses, being the high standard Ring Road systems, major power lines, pipelines and linear municipal utilities, requiring careful planning, permissions and consultation with Alberta Infrastructure throughout the design development for the crossing.

Landscape, Site Selection and Path Connections

Initial steps included the design, development, planning and implementation of landscape related components of the project, as they related to the site selection of the pathway and ultimately the bridge structure. Elements of this early stage included: discussion and review of possible or alternative bridge locations; the establishment of conceptual designs; layout and configurations of landscape elements associated with the project; the development of a final layout for the bridge; pathway connections; and, other landscape related elements. The team reviewed and assessed utility and transportation easement restrictions on site, undertook a detailed review of the site area including topography and grading issues, potential community pathway connections, wet pond areas, proposed future

community linkage requirements, sightlines, construction and reclamation issues, and so on.

The path configuration over the course of the conceptual design migrated northeast as the consideration of ground slope conditions and Calgary Parks' routing requirements took shape. The original site considered was just east of the existing storm ponds northeast of the Crowchild Trail Interchange and southwest of the current crossing location. This location was less preferable to a location further east since the berms on either side of Stoney Trail increased in height as you moved the bridge east, allowing for less structure or less fill and retaining wall.

The resulting pathway is approximately 600 meters in length and was constructed as a standard 2.5 meter wide regional trail. Extending from Royal Birch in Royal Oak in the west, the path follows the 85th Street road right-of-way and gas line easement to the Stoney Trail TUC. From that point, the pathway begins to climb the natural grade of the TUC until it reaches the bridge elevation south of the 85th Street right-of-way.

On the east side of the new bridge the regional trail connection extends northward until it intersects and returns to the road right-of-way at which point it turns east,

follows the existing natural grade of the right-of-way, and ultimately connects into the existing sidewalk trail system at Arbour Crest Drive.

During the course of construction, measures were taken to minimize disturbance of the naturalized vegetation of the TUC and, in selected areas, limited numbers of native trees/shrub materials were introduced to define the location and layout of the pathway. On the east side of the bridge, due to the extremely exposed conditions of the top of road cut, and the presence of underground utilities, screen plantings were introduced.

Public Art Opportunities

Throughout the design development, it was important that public art opportunities be identified, and included as such that they could benefit the project in a meaningful way. As in any project, the inclusion of art to a large extent depends on the structure chosen. If the bridge itself does not make a strong visual statement (for example - a precast deck option), then the elements chosen as art could visually dominate. These elements would provide the visual interest to the users and the traveling public. On the other hand, if an arch or some other visually strong structure type is chosen, the public art should complement the arch's expression and not compete or complicate the visual expression.

A list of ideas for consideration in the inclusion of public art within the project was developed, and focused on elements such as:

- Handrail design;
- Deck/path inlays;
- Pier shaping;
- Arch connection elements;
- Enclosure structures; and
- Seating areas or "art plaza" spaces near the western bridge abutments in order to take full advantage of the western mountain views.

Design Development and Considered Alternatives

A range of alternatives were presented to the City responding to the site conditions and possible span configurations.

A truss option was considered early on, however this would be a steel structure with many exposed and interconnected surfaces which could lead to corrosion and higher maintenance costs so this option was not pursued further.

Several cable stay concepts were also developed for this site since the span is generous and thus could be suited for a bridge of this type. These options were deemed too costly for the City's budget and so were not considered further.

From the remaining functional and economical options, which included girders and arches with various support configurations, three specific arrangements were chosen to be considered in more detail.

The three primary options chosen for further consideration covered the range of feasible, functional and economic choices. The first option was a continuous concrete box girder configuration with foundations consisting of three piers and two abutments. The second option was a two span steel arch configuration with short end spans, and the third option was a single span steel arch with short end spans.

Each option was evaluated based on capital cost, safety, climbability, structural efficiency, suitability to ground conditions, aesthetics, disruption to traffic, visibility from adjacent neighbourhoods, serviceability, life cycle cost, and maintenance. Additionally, a full life cycle analysis was carried out on each option, resulting in the selection of a two span arch being the most suitable span arrangement and structure type.

Two Span Arch – Selected Design

The final selected design consists of a two span arch bridge, with each span crossing one direction of traffic on Stoney Trail. The bridge is a steel arch structure with a pier in the median and two abutments. The area topography, high embankments, depressed roadway, and large span requirements to bridge the expressway make this an ideal location for the pair of slender and dramatic arches. Each arch spans 60 m, and the overall bridge length is 134 m. The deck is supported on transverse floor beams supported by arch hangers. The central pier is within the clear zones in the median of Stoney Trail (in its final widened configuration) and the abutments are situated well back from the traveled road to provide adequate side clearance. The arches are thrust arches with no tension tie required at deck level. The very competent soils and deep burial (due to the slopes) of the abutment substructures allowed for the use of thrust arches founded on spread footings. A buried transverse wall provided additional thrust resistance through the development of passive pressures.

Aesthetics

The visual intent behind the architecture of this structure is to evoke the line of the clouds during the meteorological event of a Chinook. Since this bridge is experienced as arching across the west, the line of the arch is a natural reference to this phenomenon. By maintaining a shallowness to the arch, as much as is

structurally efficient, the line of the bridge can provide significance to the public in referencing this event, which is so significant in the culture of Calgary.

By its configuration, the design provides a visually interesting experience to the traveling public and provides a point of interest to the communities in the area.

Since the arches rise up beside the bridge users as they cross the structure and then disappear and reappear again, the bridge provides an interesting crossing experience. As well, the structure itself, being over 7 m in height above deck at centre spans, will provide a feeling of enclosure.

The focus on aesthetics continues with an oscillating wave pattern in the railing reflecting the curves of the arches.

Climbability

In detailing the structure, it was very important to ensure that it could not easily be climbed by pedestrians. Steel railings were installed along each side of the bridge deck, along its entire length, in a configuration as such to greatly hinder the possibility of climbing the railings or hopping over the railings. Hangers and other structural members are kept out of reach of pedestrians by positioning them 1 m beyond the outsides of the railings. The arches could pose a climbing hazard if pedestrians are allowed close enough to their ends (at the locations of the thrust blocks below the bridge). However, the arches are designed with a smooth surface and steep enough that climbing would prove quite difficult.

Serviceability

This structure exhibits excellent serviceability attributes. Vibration analysis showed that the deck required a torsionally stiff spine beam to decouple vertical and torsional vibrations. The deck system is approximately twice as stiff as the arches; therefore, unbalanced loads are primarily carried by the deck system. The arches were evaluated for buckling. Good drainage is achieved by a slope towards both abutments, removing the need for deck drains.

Maintenance

This structure's steel arches and floor beams are painted. In critical areas, the steel was galvanized or metalized as well, resulting in the steel's painting cycle being significantly lengthened. Handrails are galvanized for extended life and reduced maintenance. Details which could accumulate debris were minimized as much as possible, and no joints were used except at the centre pier which is at the high point of the deck profile.

Scope of Work

As Prime Consultant, Delcan undertook the following for this project:

- Concept Development. Several concepts were developed to a schematic design level to evaluate their appropriateness. Delcan provided all bridge architectural services for the project.
- Preliminary and Final Design of the Selected Alternative. Detailed design analysis was carried out using 3-D analysis software.
- Contract Documents. Contract drawings and specifications were produced.
- Assistance During Tendering. Delcan provided the necessary technical assistance to the Owner during the tendering period.
- Resident Engineering and Contract Administration.
- Post-Construction Project Closure.
- Engineer of Record Responsibility.

The bridge opened in 2010, at a construction cost of $4 million.