SPECIALTY CONCRETE APPLICATIONS

WESTON TUNNEL
PHASE 3 GRADE SEPARATION & JOHN STREET PEDESTRIAN BRIDGE

PROJECT CREDITS

OWNER
Metrolinx

ARCHITECT OF RECORD
Parsons Inc.

ENGINEER OF RECORD
AECOM

GENERAL CONTRACTOR
Kenaidan Contracting Ltd.

FORMWORK SUPPLIER
Aluma Systems Canada Inc.

MATERIAL SUPPLIER
Ontario Redimix, A division of CRH Canada Goup Inc.

ADDITIONAL PARTICIPANTS

- Avertex Utility Solutions Inc.
- Brascon Stainless Steel Fabricators Inc.
- DTAH
- E.S. Fox Limited
- Euclid Canada
- Global Precast Inc.
- H & S Equipment
- Harris Rebar
- HC Matcon Inc.
- Ironworkers Local 721
- Lexsan Electrical Inc.
- National Concrete Accessories
- Obayashi Canada Ltd.
- PNR RailWorks Inc.
- Rocky River Construction Limited
- Technicore Underground Inc.
- Walter's Inc.

PROJECT FACTS

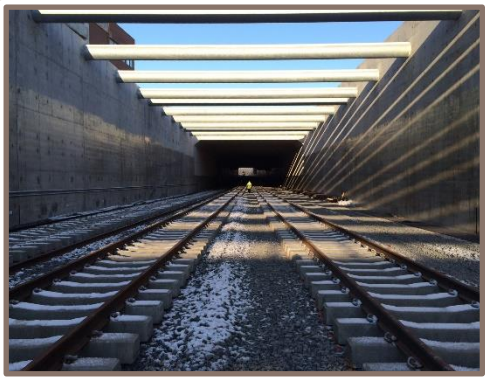
LOCATION Toronto, Ontario

CONTRACT VALUE $297,494,769

TUNNEL & GRADE SEPARATION
SUBSTANTIAL COMPLETION November 30, 2014
CONCRETE 71,000 m^3 **FORMWORK** 55,000 m^2
SIZE 1.2 km long corridor | 450 m long retaining wall
TUNNEL 185 m long, 3 m diameter
EXCAVATION >230,000 m^3

JOHN ST. PEDESTRIAN BRIDGE
SUBSTANTIAL COMPLETION September 7, 2016
CONCRETE 630 m^3 **FORMWORK** 1,860 m^2
SIZE 27.7 m long bridge
5.5 m wide, 4.8 high at arch peak
16.1 m high sign

2017 Ontario Concrete Awards



The Weston Tunnel – Phase 3 Grade Separation contract was awarded to KO Constructors, a joint venture of Kenaidan [Applicant Lead and Managing Partner (60% partner), General Contractor and Mechanical Subcontractor] and Obayashi Canada Ltd. [Team Member (40% partner) and General Contractor]. In 2014, a change order was issued and the contract amended to include the John Street Pedestrian Bridge as part of the scope of work on this project.

WESTON TUNNEL – PHASE 3 GRADE SEPARATION

The Georgetown South Weston Tunnel Phase 3 Grade Separation contract is one of several contracts that added tracks to the Kitchener rail corridor and expand GO Transit service. The track capacity increase is to allow for the future expansion of three additional tracks. It also accommodates the new Air Rail Link between Toronto's Union Station and Toronto Pearson International Airport.

Located between Weston Road and Lawrence Avenue, the contract consisted of lowering the rail corridor, relocating two mainline live tracks, constructing a 1.2 km long concrete structure, with ballast and base slabs, retaining walls, and walls supported by struts, including a concrete covered portion between King Street and Church Street. Two roads crossing the rail corridor were constructed on the top of the roof slab of the rail corridor. The work also included installation of 4,100 m of trackwork.

Work was largely restricted due to the limited area available around the CN and CP Corridor, and close proximity to significant buildings, including residences, as well as existing water mains, sewers, fibre optic works and live railways. The project scope included relocation of existing utilities, installation of a new storm sewer, and the replacement of the existing sanitary sewer along Rosemount Avenue. Precise scheduling was a key factor to allow for undisrupted GO/CP Rail trains.

Design Features

- New Metrolinx/GO Transit and CP tracks
- New 450 m long retaining wall on CP corridor
- City storm and sanitary sewer replacement on Rosemount Avenue
- City water main replacement at Church Street, King Street, and John Street

Key Challenges

- Co-existence between GO/CP Railways, Weston Community and Construction operations: Weekly meetings were held with Metrolinx to discuss and address community concerns
- Management of construction works and the integration with ongoing railway traffic:
  - 16 GO trains, 19 CP trains per day
  - Work was stopped when a train approached the construction site
  - Scheduled major construction operations at non-peak train times
  - Provided barriers to isolate work area from live tracks
- Restrictions due to the limited area available along the rail corridor
- Logistics - over 600 trucks a day
- Work by others: Toronto Hydro, Enbridge Gas, Rogers, Bell Utility, and CP Rail
- Access and egress within a limited site: scheduled deliveries, gatekeepers, and flag personnel at each active gate and daily review of traffic management with site personnel; a minimum of two streets crossing the railway lines had to be open for the city traffic
- Ground and surface water management (10 mm rain = 270,000 litres); daily review of dewatering plan with site personnel, ensured daily that all pumping

equipment was operating properly
- Traffic control and management
- Reconstruction of three major crossings

Scheduling Challenges

The project required only one of the three roads crossing the tunnel to be closed at any one time. This meant each of the road removals and reconstruction of the tunnel crossings were all critical path items, as one could not begin until the other was complete.

Completion of the King Street crossing and associated works was a major achievement. This involved construction of a massive box culvert connecting two kilometres of tunnel drainage to a new three metre diameter super pipe, using a tunnel boring machine. The King Street crossing was then formed above. Once King Street reopened, excavation of Church Street began.

With the new King and Church crossings in operation, removal of John Street could begin. The John Street section was unique in how the roadway was replaced by the iconic John Street Pedestrian Bridge, permanently closing off access to vehicular traffic.

The Tunnel

The scope of the tunnel work consisted of a 185 m tunnel that is 3 m in diameter, and is 20 m below King Street from Weston Road to the railway corridor, as well as a cast-in-place manhole shaft. The tunnelling operation for the 3 m super pipe was achieved using a tunnel boring machine.

Concrete

Crews placed 71,000 m³ of concrete in the 36-month schedule. The majority of the concrete placed was for the rail corridor, which consisted of 1.2 m thick base slabs, 0.5 m thick walls and a 300 m covered section of corridors of suspended slabs at 1.8 m thick. Two roadways were constructed over the suspended slabs as a vehicular bridge overpass. Placed concrete also consisted of retaining walls with a form-liner for an architectural and aesthetically pleasing effect. Over 200 m of noise barrier precast walls were installed on top of the retaining walls.

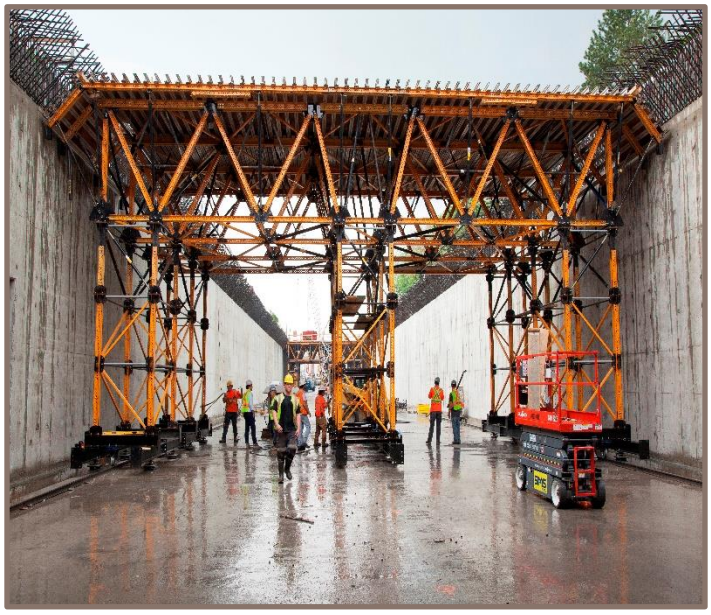
Excavation

Total excavation on the project was over 230,000 m^3, which had to be well planned and executed considering access restraints. This included shoring with secant pile and tie back, 9,200 m^2 of 1 metre diameter pile; and 14,000 m^2 of soldier pile and lagging plus tie back.

Utility Relocation

Additional contract responsibilities included relocation of existing utilities, installation of a new King Street storm sewer, and the replacement of the existing sanitary sewer along Rosemount Avenue.

The scope also included three water mains under the main tunnel using directional drilling, a new storm sewer, and the replacement of the existing sanitary sewer along Rosemount Avenue.



JOHN STREET PEDESTRIAN BRIDGE

KO Constructors was awarded an additional work package for the John Street Pedestrian Bridge in November 2014. The new bridge crosses the GO rail corridor, reconnecting John Street from Rosemount Avenue to Weston Road, keeping John Street accessible to pedestrians and cyclists.

The Village of Weston was founded in 1796 on the banks of the Humber River, along which some of the most picturesque bike trails in Toronto can be found. It was this bicycle-centric culture that inspired the bridge's twin arch design. Echoing spokes of a bike wheel, a sculptural wave of steel ribs flank both sides of the bridge. The main arch is 4.8 m tall and is complimented by a high standard of

architectural finishes, including handrails and screening.

The 27.7 m long architectural steel footbridge is 5.5 m wide and was installed in a single lift operation using a 400 tonne crane. 11 pre-cast deck panels were installed and then topped with a cast-in-place concrete slab to form the walkway. Due to the new airport UP Express train schedule, the bridge erection and pre-cast installation took place during a four-hour window when the trains were not running.

Kenaidan self-performed the associated concrete works, including bridge supports, retaining walls, staircases, and sidewalks. A large portion of the concrete walls are exposed with a form-lined finish, and the staircase and feature walls showcase complicated geometry. The structure is highlighted by a 16.1 m high signage tower that acts as an urban marker for bridge crossing, incorporating local identity signage, and prominent lighting.

Design Features

- Two above-deck arches, tilted outwards and offset from each other to support the bridge crossing
- Diagonal and vertical struts connect the arches to the deck in a spoke-like pattern inspired by Weston's bicycle heritage
- Ramped approaches on both sides provide universal accessibility

Key Challenges

- Limited space on site
- Working directly adjacent to a live rail corridor
- The work site was split in two by the live rail corridor, with a 360 m distance between sites
- Staircases, ramps, and suspended slabs could not be poured until after the bridge was in place

INNOVATIONS

Travelling Falsework System

This newly designed travelling system was utilized for the first time in Toronto on this project. The MK Structures Motorized Traveler System for Slab Shoring is designed as a high load carrying capacity system, mainly in the civil engineering field. The structure is formed by a set of

beams that are connected to form different structures according to the loads to support in each specific application.

Two units, each 29.5 m long x 17.5 m wide (97' x 58'). Units were made up of three independent travelers each 9.9 m long x 17.5 m wide (32.5' x 58'). Each traveler unit was made up of 4 trusses laced together to form one complete deck, supported on 3 MK towers. The trusses were 2.6 m deep. The support towers were 1.5 x 7.5 x 5.4 m high MK towers. (5' x 25' x 17.7' h).

The two units were setup, one at one end of the tunnel and the other midway through the tunnel. The first unit was utilized for eight pours and the second for seven pours, in total 15 pours. The units were designed to travel on a pre-assembled track using powered electric wheels. Ten electric and eight regular wheels per unit, divided on three control panels. The length of the traveler was limited to 9.9 m to accommodate the curvature in the structure.

There are 15 roof slabs of approximately 20 m x 20 m x 1.2 m between Church and King Streets, which comprises the covered portion of the tunnel. The travelling system was equipped with several motors, which allowed it to be dropped onto the rails following each pour and moved to the adjacent slab where it was set back in place. This system allowed for a two-week cycle from set-up to pour for a roof slab. Two of these tables were in operation, working on staggered cycles, which allowed the pour of one roof slab per week.

To resist the "Time dependent rock deformation (rock

swelling) at the Georgian Bay formation"

The design required to place the concrete walls against 150 mm thick dynamic foam, which requires a prepared smooth surface of maximum 10 mm tolerance on the drilled caisson wall and the excavated rough shale surface (2,000 m long x 7 m deep).

Solution - two-sided forms were used in lieu of a 1-sided wall to create a gap between the temporary excavation support and the structural wall. The gap was backfilled after more than 100 days and reduced the rock swelling lateral movement to a few millimeters. The two-sided formwork provided higher quality and greater potential to accelerate the schedule.