

13 HOURS TO REPLACE A SUPERSTRUCTURE

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Project Overview – The Construction and the Players

The MTO Construction Contract 2012-4001 consisted of the Kirkwood Avenue and Carling Avenue Westbound Overpass Bridge Replacements using Rapid Replacement Technology on the Queensway (Highway 417) in Ottawa, Ontario, Canada. The tendered work also included Excavation, Grading, Hot Mix Paving, Structural Bridge Rehabilitation, ATMS and Electrical works.

On Saturday July 6 and Sunday July 7 of 2013, WSP's (formerly GENIVAR) CA team oversaw the replacement of the Kirkwood Avenue Overpass where a new bridge superstructure was replaced for each direction of the Queensway. The superstructures were replaced using Rapid Replacement (Heavy Lift Bridge Replacement) Technology which consisted of three pairs of Self-Propelled Modular Transporters (SPMTs). On Saturday July 13 and Sunday July 14, the Carling Avenue Westbound Overpass was replaced using the same technology.

Initial construction to widen the existing overpass substructures began late in the summer of 2012 with minimal disruption to the travelling public on the Queensway. The new superstructures were constructed in staging areas on temporary support structures adjacent to the existing overpasses. The new superstructures were constructed to a stage where few construction activities were required on the Queensway once the rapid replacement had been completed.

The Kirkwood Avenue superstructure replacement took only 13 hours to complete, making it the fastest rapid replacement in Ottawa. On Saturday July 6, the Queensway lane closures began at 3:00 pm and were fully closed at 6:00 pm. By 7:00 am Sunday morning traffic was using one lane of the Queensway and was fully open by 9:30 am. The Carling Avenue WB superstructure replacement was completed in a similar time and fashion to Kirkwood Avenue. In traditional construction, the replacement of the superstructures would have taken 2-3 years to complete with major traffic impacts involving lane closures and staged construction.

The Client for this project was the Ministry of Transportation Ontario (MTO). The MTO is the provincial ministry of the government of Ontario which is responsible for transport infrastructure in Ontario. The ministry is in charge of various aspects of transportation in Ontario, including the establishment and maintenance of the provincial highway system.

The Contractor for this project was Aecon Construction and Materials based out of Toronto, Ontario. As the Contractor, Aecon was responsible for the construction and completion of the contract as outlined by the Construction Contract Tender. With many high complexity construction contracts performed successfully by Aecon in the past, the replacements of the overpass superstructures on the Queensway were performed to a high standard of quality.

WSP provided the Construction Contract Administration Services for this project. The purpose of the Contract Administration Services for a Superstructure Rapid Replacement Project is to provide Project Management, Contract Administration, and Contract Inspection as outlined by the Clients' Construction Contract Administration Agreement. Our CA team consisted of **Paul Sararas** as Contract Administrator, **Paul Frey** and **Brandon Kadoski** as Senior Inspectors, **Stéphan Lalonde** as Junior Inspector, and **Don Green** as Project Manager. For the duration of the project we had been inspecting and administrating the work done by the contractor to construct and replace the Kirkwood Avenue and Carling Avenue Westbound Overpasses.

Contract Administration Services – Project Specific Service Requirements

As mentioned previously, the purpose of the Contract Administration Services for a Superstructure Rapid Replacement Project is to provide Project Management, Contract Administration, and Contract Inspection as outlined by the Clients' Construction Contract Administration Agreement.

The Project Manager is responsible for Project Management of the Construction Contract Administration Services under the Agreement, including project coordination, quality, and cost and schedule control. The Project Manager takes full responsibility for the deliverables of the assignment, manages resolution of issues, is the main contact for administration issues during shut down periods (winter), and provides timely analyses and recommendations to the Client for all issues regarding Extension of Time Requests, Change Orders, Claims, Negotiations, Change Proposals, design and construction problems encountered on the contract, and to resolve any resulting – Contractor, outside agency – and/or public concerns.

The Contract Administrator is responsible for providing the Contract Administration Services and Deliverables in accordance with the Construction Contract Administration Agreement. The CA addresses issues and concerns from both the Client and the Service Provider with respect to expectations and results with emphasis on the Services and Deliverables. Other activities performed by the CA include discussing documentation to be copied to the Client, change of work, requirements for providing input in to Post Construction Engineering Appraisal through the Design Package Evaluation, and reviewing Regional Policy regarding Media, MPP, and General Public Inquiries.

The On Site Inspection for this style of project includes the inspection of Substructure Widening, Staging Areas, Temporary Structure, Superstructure, Rapid Replacement, and Reinstatement. The On Site Inspector is to ensure the inspection task requirements are carried out as outlined, and ensure that all applicable milestone inspections are carried out and documented in the appropriate daily construction diaries. It is the responsibility of the On Site Inspector to provide construction inspection for workmanship using sound knowledge of design standards, specifications, and materials associated with construction, Laws and Regulations including Environmental, Occupational Health & Safety requirements and their application in construction contracts.

The Off Site inspection requirements for Rapid Replacement include the inspection for the fabrication and coating of structural steel components. A Structural Steel Coating/Welding Inspector provides Quality Assurance inspection for the Contractor/Fabricator Structural Steel Coating operations and implements the submitted Structural Steel Monitoring Plan. This inspector is required to perform welding visual inspection and structural steel fabrication and erection inspection, as per the requirements specified in the Contract documents. All welding and fabrication visual inspections in the shop require prior approval by the Client, with random QA welding inspections during fabrication.

Contract Administration Services - Scope of Rapid Superstructure Replacement Project

The goal of this project was to replace two overpass structures with new widened superstructures on rehabilitated substructures using rapid replacement technology over the course of one weekend per structure to reduce the impacts to public traffic.

For daily construction activities the Contractor was restricted to areas defined as construction staging areas and the existing bridge area within the MTO right-of-way and established Temporary Limited Interests immediately adjacent to the bridge area. These areas incorporated all of the construction of the rehabilitation and widening of the substructures, construction of the new superstructures, daily delivery of materials and operations, storage of equipment and materials and miscellaneous construction.

Operations immediately prior to the Rapid Superstructure Replacement were defined as Pre-Rapid Superstructure Replacement operations and required the removal of the approach slab and asphalt, earth excavation, sawcutting and stabilizing the ballast walls, backfilling the existing structure ballast walls including subdrain installation, and placement of temporary hot mix asphalt to be completed during three (3) weekends with lane closures.

The Rapid Superstructure Replacement operations required earth excavation, removal of the existing EBL and WBL superstructures (including the attached ballast walls) from their existing location and transportation to the construction staging area for dismantling, transportation and erection of the new EBL and WBL superstructures from the construction staging area to their permanent location, granular backfilling to the structure, placement of hot mix asphalt, and installation of temporary concrete barriers to be completed during a weekend with a full bridge closure.

The waterproofing operations for the new bridge decks were to be completed in the construction staging area while they were supported on temporary structures. Requirements were established to protect the waterproofing membrane and protection boards in case of rain from the time of completion of waterproofing operations to the deck paving operations.

Operations immediately following the Rapid Superstructure Replacement were defined as Post-Rapid Superstructure Replacement operations and required earth excavation (including sawcutting and removal of hot mix asphalt), grading and placement of granular base for approach slabs, construction of approach slabs using rapid set concrete, placement of hot mix asphalt, and placement of median barrier walls on approach slabs using rapid set concrete (including electrical embedded works and installation of electrical conductors between the affected light standards) to be completed during three (3) weekends with lane closures.

The rehabilitation work at the existing substructure, widening of the existing substructure as well as the reconstruction of city streets required many operations including, but not limited to, earth excavation and granular backfilling, sidewalk construction, grading and paving, abutment widening including piling at abutment extensions, concrete removal and refacing at existing abutment walls, full depth concrete removal of existing abutment walls, electrical, and concrete sealing.

All of the work detailed in the scope of this project required rigorous inspection conforming to the requirements outlined by the Client's Contract Administration and Inspection Task Manual, or CAITM for short. Many inspection tasks required hours of vigilant observation paired with detailed record keeping and documentation of these observations.

Challenges During Construction - Contractor's Plan and Scheduling

The timeframe given to complete the construction contract was approximately 17 months (June 2012 to November 1, 2013). The Contractor was required to submit a critical path schedule that reflected operational constraints, interim completion dates, and other scheduling requirements specified in the Contract. The schedule was reviewed by the Contract Administration Services who determined whether it was acceptable according to the prescribed general conditions for construction contracts. Updated schedules were prepared and submitted to the Contract Administrator prior to all regularly scheduled site meetings. Updated schedules submitted reflected actual progress of the Work and any additions, deletions, or revisions to the Work that arose since the previous update. At regularly scheduled site meetings, the Contractor explained the revisions and any increase or decrease in resources required to complete the Work on time.

As part of the construction contract, the Contractor was required to complete the superstructure replacements for both bridges between July 5, 2013 and August 26, 2013. The replacements could only occur on a weekend and start on a Saturday and finish within the allowable timeframe. The only caveat was that both overpass structures could not be scheduled for rapid replacement on the same weekend.

Incentives and disincentives applied equally to each of overpass structures, which dictated the contractors plan and scheduling for the Rapid Superstructure Replacement operations.

In the event that all work required in opening of either the eastbound and westbound median lanes or outside through lanes to public traffic was completed to a usable facility by 11:00 a.m. Sunday, the Owner would pay to the Contractor an incentive of \$20,000.00 and an additional incentive of \$5,000.00 per each 15-minute period earlier opening to a maximum of four periods, for a total maximum of \$20,000.00.

Inversely, in the event that all work required in opening of either the eastbound and westbound median lanes to public traffic to a usable facility was NOT completed prior to 11:01 a.m. Sunday, the Owner would deduct from its payments to the Contractor \$20,000.00 and an additional \$5,000.00 per each 15-minute period to a maximum of four periods, for a total maximum of \$20,000.00.

If all work required in opening lane 2 and the ramps to public traffic to a usable facility was completed prior to 12 noon, Sunday, the Owner would pay to the Contractor an incentive of \$20,000.00 and an additional incentive of \$5,000.00 per each 15-minute period to a maximum of four periods, for a maximum of \$20,000.00.

But, if all work required in opening lane 2 and the ramps to public traffic is NOT completed to a usable facility prior to 12:01 p.m. Sunday, the Ministry will deduct from its payments to the Contractor \$25,000.00 and an additional \$10,000.00 per each 15-minute period thereafter until 5:00 p.m., Sunday to a maximum of \$200,000.

Therefore the total potential maximum incentive was \$80,000 and the total potential maximum disincentive was \$265,000.

In order to accelerate the schedule of the construction contract the Contractor proposed to eliminate one weekend from the Pre-Rapid Superstructure Replacement operations and Post-Rapid Superstructure Replacement operation, reducing the required weekends for this work from 3 weekends to 2 weekends each. The proposal altered the construction staging for approach slab removal and reinstatement by increasing the work area at the median to be completed over two separate weekends into one, thus eliminating the requirement for a third weekend of work. The proposal was reviewed by the Contract Administrator for completeness and cost savings while still adhering to the contract specifications and spirit of the project. Upon review it was decided that the proposal would be accepted and the schedule was able to be accelerated.

The Contractor was also able to accelerate the schedule by performing work during the winter months instead of shutting down. Working during the winter improved the Contractor's estimated completion date greatly, but required the Contractor to implement cold weather protection measures which reduced the efficiency of the work being completed. Along with reduced efficiency, additional inspection and monitoring was required for concrete placement to ensure that material specifications were met and the quality of the final product was achieved. As part of the monitoring during cold weather concrete placement, the contractor is required to submit temperature records that log the change in temperature of the concrete during a seven day curing

period. The CA reviews the records and ensures that the temperature threshold is not exceeded and variation in temperature is within the specified values during the curing period.

Challenges During Construction - Impacts to Traffic

Lane closures were coordinated through the Contract Administrator. A minimum of 48 hours' notice of intended lane closures was given to the Contract Administrator to allow time for coordination.

The contractor submitted to the Contract Administrator a detailed plan for carrying out work in proximity to traffic lanes and indicated the timing and method of controlling and protecting public traffic. The Contract Administrator reviewed the plan to ensure it met the requirements of the operational constraints then notified the Contractor whether or not it is acceptable.

The rehabilitation work at the existing substructure, widening of the existing substructure as well as the reconstruction of affected city streets required traffic management measures to be implemented on city streets prior to, during and following the Rapid Superstructure Replacement operation. The implementation of these traffic management measures were completed as outlined in the construction contract in phased construction. This allowed adequate space for the contractor to safely and effectively complete the required work while ensuring public vehicle and pedestrian traffic had safe access through the construction zone.

Full closure of the Highway was required to perform the rapid replacement of the overpass structures. Closing down lanes, in excess of the allowable closures, were not to commence until 5:00 p.m. on Saturday, with full closure at 6:00 p.m. All eastbound and westbound vehicles were required to exit and re-enter the highway at interchanges on either end of the work zone, away from any construction operations during the rapid replacement.

The median lane or the exterior lane in each direction was to be re-opened by 11:00 a.m. on the Sunday and the lane adjacent to the median or exterior lane was to be re-opened by noon on Sunday. The remaining lane, median or exterior, and any city street and ramp closures were to be open by 6:00 a.m. on Monday.

Early full closure was not to be allowed, but the Contractor was too focused on the bonuses attributed to completing the rapid replacement works as fast as possible that lane closures began well before the prescribed times outlined in the contract. This early closure provided the Contractor with enough time to perform the rapid replacement operation well before the required re-opening times, resulting in the Highway being fully open to public traffic after only 13 hours from initial closure. Early closing penalties were waived through consultation with the Client due to the greatly reduced impact to public traffic during full closure of the Highway. As the CA you are to enforce the requirements of the contract. But as with many construction contracts, one must weigh the benefits over the drawbacks of adjusting requirements in order to please the client and the public when dealing with high profile works.

Challenges During Construction - Third Party Influence

The Contractor was responsible for coordinating traffic signal and street lighting work on city streets with City Representatives. The City of Ottawa Street Lighting Maintenance Contractor was responsible for the removal and reinstallation of the street lighting poles within the contract limits. This was required to allow the transport of the new bridge superstructure and the removal of the old one within a confined area. All of the above ground traffic signal work as identified in the Contract drawings were to be performed by the City of Ottawa Traffic Signal Representatives. The City representative was also responsible for all traffic signal & joint use lighting cable installation and terminations. The Contractor was responsible for all underground installation including maintenance holes, conduits and pole foundations for the traffic signal system. As part of the Contract Administration Service to the Client, the inspector should liaison minimally between the contractor and a third party only to ensure the coordinated works are being completed to the specifications and standards outlined in the contract tender.

Due to storm system and other road works completed on city streets by city workers prior to the rapid replacement contract going to construction, many aspects of the traffic signal and street lighting work on city streets encompassed in the contract were altered or deleted during construction. Therefore the coordination with City Representatives resulted in increased administration to consider delays, extra work, and reduction in the contracted work for traffic signals and street lighting on city streets. This coordination with City Representatives was the responsibility of the contractor, but due to increased involvement by the City Representatives on a mostly Provincial contract the Contract Administrator had to liaison with this Third Party as well as with the Contractor and Client.

Communication is a vital key when coordinating work between multiple parties with their properties at stake. The Contract Administrator must now address the issues and concerns of the third party while concurrently providing their services to the Client in a tactful and professional manner. Without open communication of issues and concerns, a project can suffer financially and impact scheduling immensely.

Challenges During Construction - Surprises and Unique Construction

The Contractor was given access to the as built drawings for the existing overpass structures to be replaced indicating the dimensions and materials of the existing structure. Regardless of the access to these plans it was determined that the existing overpass structures contained asbestos transite conduit and asbestos cork board that needed to be removed according to current environmental and safety standards. The removal and disposal of this hazardous material contributed to significant delays and additional costs associated with this project. The main reason why additional costs were required to dispose of the hazardous material was that asbestos was not identified as a hazardous material within the construction contract tender. A change order of significant cost was issued to compensate for the delay in production as the material was removed and disposed of

accordingly. As part of the Contract Administration Design Package Evaluation we have encouraged the Ministry to take notice of any and all hazardous materials that may exist in existing structures.

A major component to this project was the rehabilitation work at the existing substructure requiring Type C Partial Depth Concrete Removals. Type C Concrete Removals are defined as partial depth concrete removals that typically apply to abutments, wingwalls, pier columns and caps, bearing seats, retaining walls and vertical walls of culverts and tunnels. Traditionally, partial depth concrete removals on abutment faces require many labourers with hand chipping hammers to remove the desired depth of concrete from the face of the substructure and any additional delaminated concrete. In order to improve production rates, the Contractor had proposed the use of a remote control excavator with scabblers attachment to complete the desired partial depth concrete removal to a uniform 25mm depth at the front and side faces of the existing abutment stem walls. Before acceptance of a new method for Type C Partial Depth Concrete Removal the Contractor had to demonstrate that the equipment would not damage the underlying concrete and reinforcing steel bar while achieving the desired depth of the concrete removal. A trial run was performed on a small portion of the abutment face to demonstrate that this new method of concrete removal was acceptable, and was found to be so. Additionally, as the use of this unique equipment is not covered by the standard special provision that outlines the requirements for Type C Partial Depth Concrete Removal, the Contract Administrator was required to obtain the manufacturer specifications of this equipment and determine whether power output and operating frequencies fell within prescribed limits of similar operations requiring partial depth concrete removal. After review of the manufacturer specifications for the equipment to be used for removal and the trial run demonstrating the advantage to this removal method as opposed to traditional means, the Contractor's proposal was accepted and the new method of Type C Partial Depth Concrete Removal was accepted. This new method meant that only one operator was required to perform this operation and could perform work 24 hours a day, barring any equipment breakdowns and maintenance. Production rates were greatly improved and the highly time intensive work of uniform partial depth concrete removal was completed much quicker than if completed by traditional means.

The construction contract tender indicated that when finishing the concrete surface on the new superstructure concrete deck on temporary structure the finishing equipment shall be capable of finishing the entire deck by mechanically screeding and finishing the concrete surface. Due to the location of where the Contractor chose to place the screed rail for the bridge deck finishing machine, the entirety of the deck was not able to be mechanically screeded and finished. The location of the concrete deck, where barrier wall is to be placed, was hand finished instead of mechanically finished. This hand finishing resulted in the surface tolerance of the deck to be out of specification, requiring additional work to correct. Upon review, the Contract Administration Services should not have allowed the Contractor to place the screed rail where they did and instead enforced that the screed rail should be placed in such a way that the finishing equipment would be capable of mechanically screeding and finishing the entirety of the concrete deck.

The Construction Contract Administration Agreement for this project required the Contract Administration Services to supply an Office Person/Junior Inspector and two Senior Inspectors for the purpose of daily on-site inspection of workmanship and material quality. The intent of the inspection duties was to have one Senior Inspector as the primary inspector on site for all construction works with the Office Person/Junior Inspector available to assist in addition inspection as required. The second Senior Inspector was anticipated to be summoned to the site only during the existing bridge ballast wall pre-cut and approach slab removal and replacement work, asphalt paving (Pre-Rapid Superstructure Replacement and Post-Rapid Superstructure Replacement operations), and during the Rapid Superstructure Replacement operations, which require overnight and weekend inspection. Due to the high complexity of the work being performed and the accelerated schedule implemented by the Contractor with no winter shut down period, there were many separate crews performing many different construction tasks on site concurrently requiring the aid of the Office Person/Junior Inspector more than anticipated. Many construction tasks requiring night work well before the Pre, Post, and Rapid Superstructure Replacement operations required the Senior Inspector to be present, therefore requiring the Office Person/Junior Inspector to perform all inspection duties during the day. The high complexity of this project demanded that the Office Person/Junior Inspector be on top of all documentation and correspondence received and sent during construction or suffer major delays, but since the Office Person/Junior Inspector had to aid the Senior Inspector on site so frequently the office administration suffered greatly. Once the Pre-Rapid Superstructure Replacement operations began the second Senior Inspector was summoned to site. Through much discussion with the Client, the Contract Administration Services retained the second Senior Inspector for the remainder of the construction contract to ensure all inspection tasks were being covered while allowing the Office Person/Junior Inspector to focus on maintain professional documentation and correspondence.

The Final Product

Despite the challenges faced during construction and the omissions and errors during design, through skilled and professional Contract Administration, the Rapid Superstructure Replacement project was completed with little overall delay and within cost expectations. The contracted completion date for construction was November 1, 2013, but despite many delays the contractor was able to accelerate their schedule at key points and complete construction by December 18, 2013. The budget variation from planned to final completion only accounted for an increase of approximately \$1.6M, or 9% of the original planned cost. As with any construction contract, deficiencies associated to workmanship exist after completion of the contract and minor works are required to correct them. The overall quality of the final product met the requirements of the Client and the use of this unique construction technology has brought this project to the forefront of construction within our City.

Relationship with the Client

The Contract Administrator acts as a mediator between the Contractor and the Client reviewing requests for clarification and changes to work, providing a professional review and comment prior to forwarding to the Client. The Contract Administration Services acts in the best interest of the Client to ensure a product that meets their requirements and specifications.

On occasion, the client will ask the Contract Administration Service to conduct additional tasks, such as reviewing documentation from the designer to verify if the information matches actual field conditions. The Client may also request that the CA Services create and submit technical documents relating to ongoing construction issues and concerns for the client's internal review.

A good working relationship with the Client ensures that any issues that arise from construction can be discussed openly and professionally and a resolution can be attained that pleases all parties involved. If the Contract Administration Service feels that a situation needs to be handled a certain way and can provide proper documentation to support its claim, the client will trust and support the Contract Administration Service judgments.

Relationship with the Contractor

As with the Client, the Contract Administrator acts as a mediator between the Contractor and the Client. The CA directs the Contractor to perform work required by the Client through the use of Instruction Notices and enforces requirements outlined in the construction contract.

A good working relationship with the Contractor ensures that if any issues arise during construction the Contractor can approach the Contract Administrator in confidence to resolve the issue professionally and efficiently. The relationship with the Contractor is very important to the quality of the project. If the Contractor feels that the Contract Administration Services cannot be trusted or that they are "out to get them", there is the potential that issues that arise during construction can be buried or ignored. The Contract Administration Services must be fair and understanding but also ensure that the Client is receiving the quality product that they are paying the Contractor to produce

Lessons Learnt

For the duration of this project there were many aspects of construction that were standard procedure for a high complexity project, but unique surprises and situations still arose.

From these situations we have learnt that when performing rehabilitation works on older structures, hazardous materials are a real and serious occurrence. Hazardous materials need to be well documented and considered during all aspects of construction, from initial design to contract completion.

We have also learnt that when incentives for completing works outweigh the penalties for not adhering to standards and specifications relating to those works, corners will be cut. The overall

quality of the product and satisfaction of the owner with their product is paramount for the Contact Administration Services. When the contractor is focused on achieving these bonuses we have observed that quality, and even safety, can suffer as a consequence. Not adhering to the standards and specifications are financially miniscule when compared to the potential bonuses for early completion.

Another lesson to be learnt was the value of using new and emerging technologies to complete unique, and even standard, work. The Self Propelled Modular Transporters (SPMTs) allowed for a major component to be swapped instantaneously as opposed to taking years to rehabilitate in place, relatively speaking. This rapid replacement reduces many impacts to the general public while still providing a quality final product. The use of a remote control excavator with scabbler attachment for partial depth concrete removal allowed one operator to perform this operation, and could perform work 24 hours a day. Production rates were greatly improved and the highly time intensive work of uniform partial depth concrete removal was completed much quicker than if completed by traditional means. In this time of emergent technologies and ever changing construction practices, consideration should be given to the use of new technologies that may vary from the prescribed standards outlined for traditional construction.

Lastly, the lessons learnt from maintaining a professional relationship with the client and contractor, and any other parties involved in this project have been invaluable. With the uniqueness of this project in the nation's capital, it is fair to say that it was very high profile and always in the public eye. Our professional relationships allowed us to efficiently and effectively address any issues or concerns that arose during construction while maintaining our integrity. If a strong relationship cannot be established on a project of this scope and complexity, the results may not have been as favourable as they were. With these relationships we have built a strong bond of trust and produced a product to be proud of.